SURGERY OF THE EYE

TÖRÖK & GROUT

SURGERY OF THE EYE

A HAND-BOOK FOR STUDENTS AND PRACTITIONERS

BY

ERVIN TÖRÖK, M.D.

SURGEON TO THE NEW YORK OPHTHALMIC AND AURAL INSTITUTE; OPHTHALMIC SURGEON TO BETH ISRAEL HOSPITAL; CONSULTING OPHTHALMOLOGIST TO THE TARRYTOWN HOSPITAL

AND

GERALD H. GROUT, M.D.

ASSISTANT SURGEON TO THE NEW YORK OPHTHALMIC AND AURAL INSTITUTE; INSTRUCTOR IN THE EYE DEPARTMENT, VANDERBILT CLINIC; CONSULTING OPHTHALMOLOGIST TO THE BELLEVUE HOSPITAL, FIRST DIVISION

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PREFACE

The aim of the authors of this book has been to produce a thoroughly practical work on the surgery of the eye, one that would be equally valuable to the student and to the practitioner interested in ophthalmology.

The following plan has been pursued throughout the book: First, before describing each group of operations, we have discussed the disease for the relief of which they are intended, and have given clear indications for the selection of the proper procedure in any given case. A detailed description of the steps of each operation then follows, with a list of all the instruments required. After this the complications, that may occur at the time of operation and later, are taken up together with the post-operative care of the patient.

We have included all operations in common use today and also others that in our personal experience have given good results. This experience comprises fifteen years of practical work in Budapest at the Royal Hungarian University Eye Clinic with Prof. W. von Schulek, Prof. E. von Grosz, and Prof. L. von Blaskovics; in Berlin with Prof. J. Hirschberg, and in New York at the New York Ophthalmic and Aural Institute with Drs. Herman Knapp and Arnold Knapp.

A special feature of the book is its wealth of illustrations, drawings, and photographs, all new and original. These have been used unsparingly wherever it seemed that illustrations would elucidate the text. The drawings were made by Dr. J. J. Peters, Jr., and the photographs by Mr. F. Boyette. In preparing the book many authorities were consulted, particularly Czermak, "Die Augenärztlichen Operationen;" Terrien, "Chirurgie de l'Oeil;" Blaskovics, "Szemoperálások."

We wish to thank Dr. Arnold Knapp who was good enough to read the manuscript and make valuable suggestions, as well as other friends who have aided us. Our thanks are due to the publishers also for their courteous treatment.

Mr. E. B. Meyrowitz, of New York, very kindly furnished the cuts of the instruments.

Ervin Török,
G. H. Grout.

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CONTENTS

PART I

GENERAL SURGICAL METHODS

CHAPTER I

Surroundings and General Preparation for Eye Operations

Operating in an operating room, in the ward of a hospital, at the patient's home. Light. Position of the patient. Position of surgeon, assistants, instruments, and accessories. Preparation of a patient for an eye operation. Preparation of the surgeon and the assistants. Preparation of dressings, gauze, cotton, etc., and other accessories. Preparation of instruments. General management in the operating room before, during, and after operation. Anesthesia. Bandage. After-treatment. Postoperative complications 17

CHAPTER II

Instruments and Their Management

Knives and needles. Scissors. Forceps. Hooks. Spoons and spatulæ. Lid retractors. Lid clamps. Chisels. Curettes. Probes. Instruments for suturing. Syringes. Electrical apparatus and cautery. Armamentarium 64

PART II

SURGERY OF THE SPECIAL PARTS

CHAPTER III

Surgical Anatomy of the Eyeball

Description of the eyeball. Fibrous coat, sclera, and cornea. Vascular coat, choroid, ciliary body, iris. Iris angle. Nervous coat, retina. Aqueous. Anterior chamber. Posterior chamber. Lens. Vitreous . . 123

CHAPTER IV

Operations on the Cornea

Paracentesis of the cornea. Saemisch's keratotomy. Keratoplasty. Corneal keratoplasty; von Hippel's incomplete partial keratoplasty, von Hippel's incomplete total keratoplasty, Durr's keratoplasty. Conjunctival keratoplasty. Operations for staphyloma of the cornea; Beer's method, Knapp's method, De Wecker's method, Czermak's method. Abrasion of the cornea. Cauterization of the cornea. Tattooing of the cornea. Suturing of the cornea 132

CHAPTER V

Operations on the Sclera

Suturing of scleral wounds. Operations for detachment of the retina, paracentesis of the sclera, Deutschmann's operation, Deutschmann's injection of calf and rabbit vitreous, Müller's resection of the sclera, cauterization of the sclera 152

CHAPTER VI

Operations on the Iris

Iridectomy. General discussion on glaucoma. Small iridectomy, large iridectomy. Operations for glaucoma that are substitutes for iridectomy; anterior sclerotomy, posterior sclerotomy, sclerectomy, and sclerecto-iridectomy, cyclodialysis, trephining of the sclera. Iridotomy in eyes with lens. Operation for anterior synechia; sphincterotomy, sphincterolysis, staphylotomy, iritomy, iridolysis. Excision of prolapse of iris. Operations for iris cyst 158

CHAPTER VII

Operations on the Lens

Cataract. Subluxation and luxation of the lens. High degree of myopia. Discission of lens capsule. Extraction; linear wound, lobular wound. Combined and simple extraction. Combined linear extraction. Simple linear extraction. Combined flap extraction. Simple flap extraction. Operations for membranous and secondary cataracts. Discission of a membranous or secondary cataract. Discission with the Knapp knife-needle. Bowman's discission. Kuhnt's discission. Discission with De Wecker's pince-ciseaux. Iridotomy, capsulotomy, irido-capsulotomy, irito-ectomy, irito-dialysis. Discission with Ziegler's knife-needle. Iridocystectomy. Extraction of a membranous or secondary cataract. Artificial ripening 212

CHAPTER VIII

Operations on the Eyelids

Surgical anatomy of the eyelids. Operations for ectropion. Operations for non-cicatricial ectropion; Snellen's ligature, blepharorrhaphy, Szymanowski's operation, Kuhnt's operation, Elschnig's operation, Sattler-Blaskovics' operation. Operations for cicatricial ectropion and blepharoplasty. Operations for cicatricial ectropion; Dieffenbach's operation, Wharton-Jones' operation. Blepharoplasty; blepharoplasty with pedunculated flaps; Fricke's blepharoplasty, Dieffenbach's blepharoplasty, Burrow's blepharoplasty, Landolt's blepharoplasty, Celsus-Knapp's blepharoplasty. After-treatment of eyelid plasties. Blepharoplasty with non-pedunculated flaps (skin graft). Wolfe graft. Thiersch graft. Entropion and trichiasis. Operations for spastic entropion; Gaillard-Arlt's ligature, Celsus' operation. Operations for cicatricial entropion and trichiasis; Anagnostakis-Hotz's operation, Jaesche-Arlt's operation (Waldhauer's modification). Machek-Blaskovics' operation, Snellen's operation, Panas' operation, Kuhnt's tarsectomy. Operations for partial trichiasis; epilation, electrolysis, Spencer-Watson's operation. Operations for entropion and trichiasis on the lower lid; Flarer's operation, Kuhnt's tarsectomy on the lower lid, Ziegler's galvanocautery puncture. Canthotomy and canthoplasty. Canthotomy; Ammon's canthoplasty, Kuhnt's canthoplasty, Blaskovics' canthoplasty. Tarsorrhaphy or blepharorrhaphy. Temporary tarsorrhaphy. Permanent tarsorrhaphy. Walther-Graefe's tarsorrhaphy. Fuchs' tarsorrhaphy. Operations for epicanthus; Ammon's operation. Ptosis operations; Pagenstecher's operation, Hess' operation, Panas' operation, Motais' operation, Eversbusch's operation. Minor operations on the eyelid; injuries to the eyelid and coloboma of the lid. Ankyloblepharon. Chalazion. Hordeolum, abscess of lid, furuncle and anthrax. Tumors of the lid 302

CHAPTER IX

Operations on the Lacrimal Organs

Surgical anatomy of the lacrimal organs. Operations on the lacrimal gland; extirpation of the accessory lacrimal gland, extirpation of the orbital gland. Operations on the lacrimal passages; slitting of the canaliculus, probing of the nasal duct, Toti's operation, incision of the lacrimal sac, extirpation of the lacrimal sac, operations for fistula of lacrimal sac 372

CHAPTER X

Operations on the Conjunctiva

Operations for trachoma, expression of the follicles, Knapp's method, Kuhnt's method. Excision of the fornix. Combined excision of the fornix and tarsus. Operations for symblepharon (restoration of the cul-de-sac); Arlt's operation, Czermak's operation, Teale's operation, Knapp's operation, Wolfe's operation, Harlan's operation, Rogman's operation, May-Hotz's operation, Weeks' operation. Operations for pterygium; Desmarres' operation, Knapp's operation, MacReynolds' operation. Minor operations on the conjunctiva; subconjunctival injections, operations for pseudopterygium, operations for tumors of the conjunctiva 396

CHAPTER XI

Operations on the Globe

Enucleation of the eyeball. Artificial eye. Transplantation of fat in Tenon's capsule. Exenteration of the eyeball. Opticociliary neurectomy 420

CHAPTER XII

Operations on the Muscles

Surgical anatomy of the muscles. Advancement, resection, and tenotomy. Paralytic strabismus. Heterophoria. Convergent and divergent strabismus. Tenotomy. Advancement and resection. Landolt's advancement. Worth's advancement. Schweigger's resection. Reese's resection. De Wecker's folding operation 435

CHAPTER XIII

Operations on the Orbit

Surgical anatomy of the orbit. Incision of the orbit. Krönlein's temporary resection of the external orbital wall. Exenteration of the orbit 459

CHAPTER XIV

Removal of Foreign Bodies

Removal of foreign bodies from the eyelid, from the lacrimal apparatus, from the conjunctiva, from the cornea, from the sclera. Foreign bodies in the eyeball. Removal of foreign bodies from the anterior chamber and iris, from the lens, from the posterior chamber, from the vitreous chamber and retina, from the orbit 469

INTRODUCTION

By ARNOLD KNAPP, M.D.

Books on ophthalmic surgery have usually been either encyclopedic in their exhaustiveness or have omitted a clear description of essential fundamental knowledge, though they give the inestimably valuable result of a single operator's many years of experience. This book aims to supply the wants of the beginner in ophthalmic operations, and to avoid these two extremes. On looking over the advance sheets, it has seemed to me that the authors, to whose earnest work at the hospital I have been a constant witness for several years, have succeeded admirably in their project.

Operations on the eye demand first of all much practical exercise to acquire the proper technique in the manipulation of the instruments. This can only be accomplished by practice, observation, and suitable instruction. Other information, which can be given in a book, depends for its success upon the selection of the subject and the method of its description, in both of which the authors have shown that they know what to describe and how fully to describe it without incurring the criticism of pedantry; in other words, they have put themselves in the reader's place. The arrangement of the subject matter is simple and practical; the text is clear and brief, and brings forward the essential facts. The surgical anatomy, the clinical diagnosis of the lesions, the indications for choice of operation, the description of the operation, and the after-treatment are all fully considered and bear witness to thorough and thoughtful study on the authors' part. The text, moreover, gains by many well-chosen illustrations, which are diagrammatic enough to portray clearly the desired meaning.

The authors deserve great credit in presenting to the student a conservative and sound guide to ophthalmic surgery in the form of a compact, though detailed text-book. I consider it a privilege to assist at its launching, with these words of congratulation and wishes for its success.

SURGERY OF THE EYE

PART I

GENERAL SURGICAL METHODS

CHAPTER I

SURROUNDINGS AND GENERAL PREPARATION FOR EYE OPERATIONS

THE OPERATING ROOM AND GENERAL PREPARATIONS

Place of Operation.—Eye operations may be performed:

(*a*) In the operating room of a hospital.

(*b*) In the ward of a hospital.

(*c*) At the patient's home.

Operating Room in a Hospital.—The operating room in a hospital is the place *par excellence,* and operation there should be the rule; only in exceptional cases should it be done elsewhere. The room should be laid out on the same general lines as a surgical operating room, and should be light, airy, and easily cleansed. The walls should be smooth, and without sharp corners or mouldings where dust may accumulate. It is best that they be painted a light color, with paint that will bear washing. The windows should be high, face the north, and be equipped with dark shades, so that the room may be darkened at a moment's notice. The floor should be of asphalt or tiled and slope toward the centre, where the drain is placed. The room should be equipped with both gas and electricity, and hot and cold water.

The furniture should be simple, and of material that can be thoroughly washed and cleansed.

The operating room should be located on the same floor as the cataract ward, it being very important that the patient after a cataract operation should reach his bed with the least amount of jarring or effort on his part. It is advisable to have a separate operating room for septic cases; if this is not available, the operating room should be thoroughly cleansed and fumigated after operation upon a septic case.

The Ward of a Hospital.—In certain cases, as in extreme senility or obesity, where every movement on the part of the patient is attended with great effort, it is advisable to perform operations, which open the globe, in the ward while the patient is lying in his bed. Six to eight hours before operation all patients should be removed and the room thoroughly cleansed and put in readiness. This gives the dust ample time to settle. The bed of the patient, as well as all chairs and tables, etc., used during operation, should be covered with sterile cloths. It is self-evident that no ward should be selected where there are infectious cases present.

The Patient's House.—At the patient's home a similar procedure is followed. It is better to use a light spare room so that the patient will not be disturbed more than necessary after operation. The day before operation the room selected should be thoroughly cleansed and fumigated and unnecessary furniture removed. The room should be prepared so that the patient may remain there for at least three or four days following the operation. It is better that no one enter the room six to eight hours before the operation, to avoid the possible stirring up of dust.

All dressings, solutions, and vessels should be sterilized and placed in their proper place the day before the operation. The instruments, if possible, should be brought there sterilized. Gerson advises the following method of keeping the instruments sterile: After sterilization they are wrapped in sterile cotton and dipped into tincture of green soap. When the soap has dried they may be covered with sterile rubber tissue and packed. There are also instrument cases in which the instruments are sterilized, and the case is not opened until it is at the patient's bedside. A small portable sterilizer is also serviceable for this purpose, and the instruments can be sterilized in it at the patient's home.

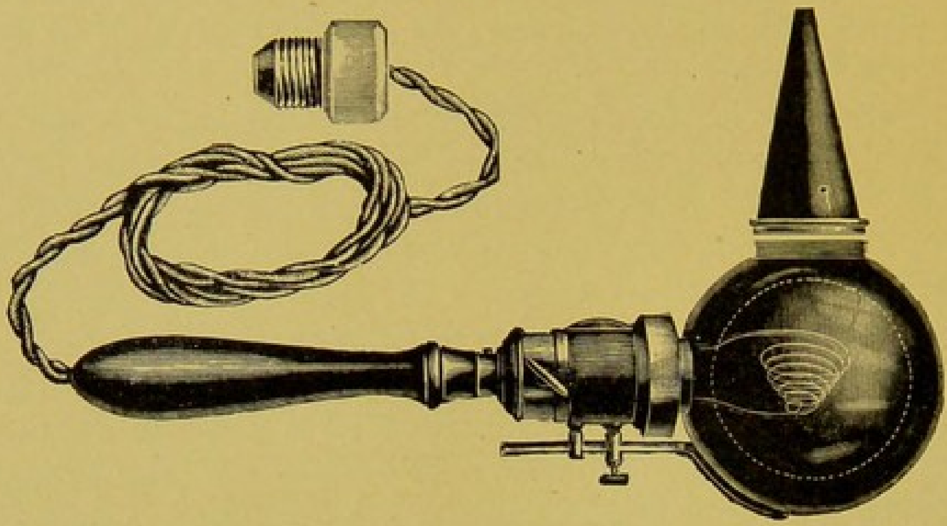
Light.—In eye operations where a small mistake may have a far-reaching and often detrimental result, it is absolutely necessary that the field of operation shall at all times be well illuminated. In a light operating room, on a clear day, daylight is sufficient for most operations. If the operating room has more than one window it is advisable to use only one and darken the others, as the reflexes on the cornea from many windows are very disturbing to the surgeon. To secure the best illumination the table should be placed near the window, its exact position varying with the position taken by the surgeon while operating.

If the "European method"[1] of operating is followed the table is placed across the window, about one meter from it. The patient's right side is toward the window, his feet being somewhat closer to it than his head. The surgeon, standing in front and at the patient's right side, will have the light coming from over his left shoulder, so that no shadow will be thrown on the field of operation by his hands. If the "American method" is followed the patient is placed with his feet toward the window, his head being slightly raised; the surgeon stands behind the patient's head, and the light falls directly on the field of operation.

In order to procure a greater illumination, a large hand lens may be used to focus the rays on the eyeball. On dull, cloudy days, or in operating in the ward or patient's home, and also in certain operations that require exceptionally good illumination (discission of a secondary cataract), artificial light is employed. For this purpose Fuchs' transilluminator (Fig. 1), Priestley Smith's (Fig. 2) or Hirschberg's photophore (Fig. 3) may be used. In places where electricity is not installed a kerosene or gas lamp will suffice if a convex lens is used to concentrate the rays of light. The lamp is placed at the distance of one meter, and slightly higher than the patient's head; to the patient's right side if the European and in front of him if the American method of operating is followed.

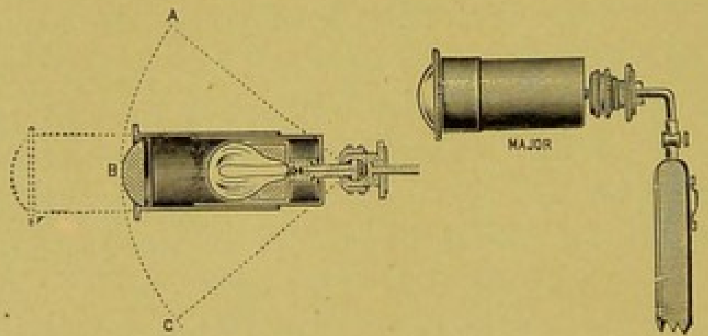
[1] The term "American" and "European" method is used throughout the book to denote the position of the surgeon during operation; in the former the operator stands behind the patient, in the latter in front of him.

Fig. 1



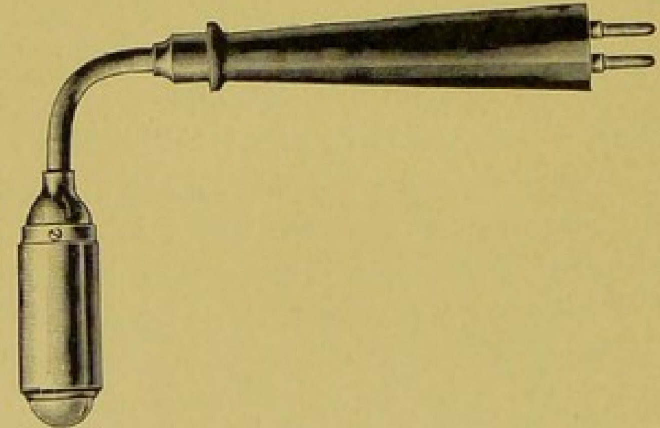
Fuchs' transilluminator.

Fig. 2



Priestley Smith's photophore.

Fig. 3



Hirschberg's photophore.

The assistant concentrates the light on the field of operation by means of the hand lens (Fig. 4), which is held with both hands,

Fig. 4

Method of illuminating field with hand lens.

the elbows being at the same time pressed against the chest. This method of holding the lens is important, because unless these directions are followed the light cannot be directed steadily on the cornea. This is very disturbing to the surgeon, as it may leave the eye in darkness at a crucial moment. In certain operations, as, for instance, extirpation of the lacrimal sac, a head mirror or electric head light may be helpful.

Position of the Patient.—In former years eye operations were performed with the patient in a sitting or reclining position; of late, however, most surgeons prefer to have the patient on the operating table. There are various types of eye-operating tables in use, the choice of which lies wholly with the surgeon. Almost any table is satisfactory if one is accustomed to it. The only indispensible requirement is that it should afford a firm and comfortable support to the patient's head, and be of such a height that the surgeon may stand erect and not be forced to stoop or raise his arms too high. Under certain conditions (senility, obesity, or operating at the patient's home) it may be necessary to operate on a patient in bed. In such cases a hair pillow is placed under the patient's head, thereby slightly elevating it. A feather pillow under such circumstances cannot be used, as being soft it allows the patient's head to sink in, and thus interferes with the movements of the surgeon's hand.

Position of Surgeon, Assistants, Instruments, and Accessories.—The position of the surgeon varies according to custom. Some stand in front of the patient at his right side, European method (Fig. 5), others behind the patient's head, American method (Fig. 6). No position has a special advantage. The method that one is in the habit of practising seems to be the easier. For those who find difficulties in operating with the left hand it is advisable to cultivate both methods, as this will allow the surgeon to use his right hand in any operation. Sitting during operation is a habit to be avoided, as a standing position allows a greater freedom of movement of both body and hands. This, of course, does not apply to operating at the patient's bedside. The most convenient arrangement under this condition is the following: The patient lies near the right side of the bed. The surgeon sits on the edge of the bed, the patient's right arm encircling his waist (Fig. 7.)

Any eye operation which does not require general anesthesia can be performed by the surgeon and one trained and skilful

Fig. 5

Position of the surgeon and assistants in the European method.

Fig. 6

Position of the surgeon and assistant in the American method.

assistant and nurse. In large institutions where several assistants are present, one may assist the surgeon, another may hold the light, the third, if necessary, to sponge, and a fourth one to give the anesthesia required. The positions taken by the

Fig. 7

Position of the surgeon and assistant when operating at patient's bedside.

assistants should in no way interfere with the movements of the surgeon. The sterilized instruments, placed in a porcelain tray, should be within easy reach, best on the left side and a little in front of the surgeon.

Preparation of a Patient for an Eye Operation.—If the patient is to be operated on in the hospital it is better that he be admitted one or two days previous to the date of operation. In the first place that we may have plenty of time to prepare him, in the second, it gives him an opportunity to become acquainted with his new surroundings; a fact that is very important with elderly patients.

General Physical Examination.—Before all eye operations a thorough examination of the system at large is necessary, special attention being paid to the circulatory, respiratory, and gastro-intestinal organs. It is apparent that no operation should be performed in case of an acute affection. In chronic diseases, however, where we cannot obtain a cure, we must endeavor to get the patient into the best possible condition before operation.

Among the disorders of the circulatory system, arteriosclerosis is dangerous, as it may cause severe complications during operation (hemorrhage). Cardiac disease is not a contraindication, but it is understood that in failure of compensation the operation is to be postponed.

Any affection of the respiratory organs that interferes with quiet respiration, especially asthma and bronchitis, should be attended to. If the cough is very severe it is better to postpone the operation, as in many cases coughing causes rupture of the wound. In less severe cases codeine and morphine are of service. It is also good practice to have the nose and accessory sinuses examined; if a sinusitis is present it should be treated before operation, as this is often the source of infection.

Special attention should be paid to the examination of the urine for sugar and albumin. Although the presence of either of them is no contraindication, both conditions may interfere with the healing of the wound and the prognosis, therefore, should be guarded. It is necessary to inform ourselves as to the condition of the urinary tract, otherwise disturbances here are often not found until after operation, when the patient attempts to urinate the first time in the lying posture.

It is necessary that the patient have free easy stools to prevent straining, which might rupture the wound after operation. Mild cathartics should be given before operation to have the bowels empty. It is well for the surgeon to inquire carefully into the habits of the patient in regard to the use of alcohol, morphine, or other drugs. If the patient is addicted to the use of one of these drugs, it is better not to cut off the supply completely but to allow him a small amount daily while he is in the hospital. No children in the teething period should be operated on, nor women during the menses or toward the end of pregnancy.

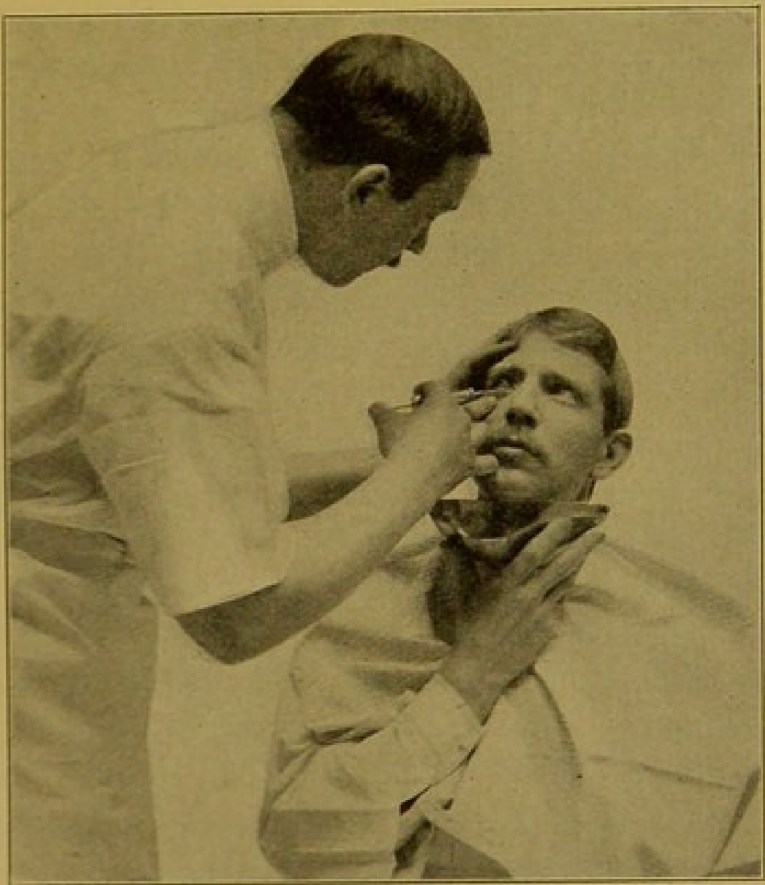
Special Examination.—As to the eye itself, special attention is to be paid to the edges of the eyelids, the lacrimal apparatus, and the conjunctiva.

The Eyelids.—The edges of the eyelids must be thoroughly examined, and if found diseased, the operation should be postponed until the condition can be cured, or at least improved as much as possible. Hordeola and blepharitis, especially ulcerative blepharitis, are to be feared. If the lid margins are found normal they should be thoroughly cleansed with chemically pure benzine, as this frees them from fat and bacteria. Benzine is an irritant to the conjunctiva, therefore great care should be taken that none enters the conjunctival sac. The epilation of the eyelashes as practised by some surgeons, although it is the most thorough method, is unnecessary. Trimming of the eyelashes, which is also practised, is only necessary in cases where they are too long, and then it can be done immediately before the operation if they interfere.

The Lacrimal Apparatus.—The lacrimal apparatus must be examined very carefully; it is not sufficient to press upon the sac to see if any secretion or tears are present in it. The conduction of tears may be hindered to a considerable extent without any visible sign. To examine the nasal duct in cases where it is apparently patent, two methods are at our command: one is the instillation of fluorescein or argyrol, the other the syringing of the nasal duct.

The first is accomplished by instilling one drop of fluorescein, 1 per cent., or argyrol, 10 per cent. solution in the cul-de-sac, and placing a cotton pledget in the nares. If the duct is patent the cotton will become stained. If it is not stained in an hour or two it is a safe surmise that the nasal duct is obstructed. A more thorough test is the syringing of the nasal duct. The canaliculus is first dilated with a conical probe and the tip of a lacrimal syringe is introduced into the lacrimal sac. The contents of the syringe, which is sterile water, is now emptied into the sac, while the patient holds his head, bent forward, over a pus basin (Fig. 8). If the lacrimal duct is patent the water will flow out of the anterior nares into the basin. If there is a stricture of the duct, part of the water will flow from the nose and the rest will regurgitate through the other canaliculus. In cases of total obstruction of the duct, all of the water flows back into the

Fig. 8



Syringing the lacrimal duct.

cul-de-sac. If a stricture has been detected, the nasal duct must be rendered patent before operation, as this is fully as dangerous as a dacryocystitis.

In cases in which the duct is obstructed, the tears collect in the lacrimal sac, and do not pass down into the nose, but later return to the cul-de-sac, carrying with them numerous pathogenic bacteria. For this reason probing should be tried; if this is unsuccessful or we are pressed for time, the canaliculi must be closed. This can be effected either by ligating the canaliculi or by cauterizing the lacrimal puncta. The ligation is performed in the following manner: A suture is passed around the canaliculus in the upper and lower lid 2 mm. internal to the punctum, and then tied. If one prefers to use the galvanocautery the punctum is slightly dilated and a pointed electrode is introduced for a distance of about 1 or 2 mm. The current is then turned on for a few seconds, and the electrode is removed while still heated.

By both methods the puncta are completely closed. When the ligation is employed the sutures are removed on the fifth day after operation. While in case the galvanocautery has been used, a conical probe is introduced on the fifth day, thereby opening up the canaliculi again. In cases where there is a purulent discharge from the lacrimal sac, the sac should be removed before the operation. Bacteriological examinations show that the bacteria on the conjunctiva often increase in number after the extirpation of the sac, therefore the operation on the eyeball should not be performed until three or four weeks after the removal of the sac.

The Conjunctiva.—In regard to the conjunctiva, all inflammations producing secretions are dangerous. In the secretion there are always bacteria in large numbers, some of which may be virulent and lead to infection of the wound and loss of the eye; in such cases, therefore, the conjunctiva must be treated. In chronic inflammations of the conjunctiva, such as chronic conjunctivitis or trachoma, where perfect cure cannot be obtained, the conjunctiva is treated with hot applications and nitrate of silver until the secretion is checked, or at least reduced to a minimum. Before operation a microscopic examination of the conjunctival secretion is made. If pathogenic or pyogenic bacteria are found, the treatment should be continued, and the operation postponed until these can be cleared from the cul-de-sac. This microscopic examination, in fact, should be made preceding all eyeball operations, even if the conjunctiva is apparently normal.

The Meibomian Glands.—The Meibomian glands should also be examined, and if purulent secretion is found in them it should be expressed and the conjunctiva treated until the glands return to normal condition.

Other Preparatory Steps.—It is good practice to explain to the patient what is expected of him during and after operation. This should be done with tact, as the patient is apt to be nervous at this time, and becomes easily frightened if too much is told to him. In this respect care should be taken to instruct him how to look downward when told; this is of the greatest importance in cataract operations. This simple but exceedingly important movement requires practice, as most of the patients are unable to look downward when the speculum is in place. It is well, therefore, to raise the upper lid with the finger and direct the patient to look downward; if he is unable to do this at the first request, he must practise it several times before operation. If an anesthetic is to be given, the patient should be prepared for it in the same manner as in general surgery. In male patients it is good practice to cut the hair short, as the bandage will not stay in place if the hair is long; in female patients the hair is to be arranged in two braids.

Preparation of the Field of Operation.—The night before operation the patient is given a bath, and the field of operation is prepared. In lid operations, if necessary, the eyebrow is shaved off, and also as much of the hair and beard as is necessary. The skin of the eyelids and adjacent parts are first thoroughly cleansed with soap and hot water, then with alcohol, and afterward with bichloride of mercury, 1 to 1000 solution. During the cleansing the patient must keep his eye tightly closed, in order to avoid the irritating solutions. A sterile dressing is applied over the field of operation, which is removed on the operating table.

In eyeball operations the eyelids and surrounding parts are cleansed in a similar manner, but no dressing is applied over night. It is unnecessary to shave the eyebrow, but it must be very thoroughly cleansed, as the hands of the operator come in contact with it during operation.

Preparation of the Surgeon and the Assistants.—The surgeon and his assistants should cleanse their hands immediately before the operation in the same manner as in general surgery. This suggestion may appear superfluous, for in operations on the eyeball the hands never come in contact with the wound, but it is important, nevertheless, because an instrument that has been handled may come in contact with a sterile one. In certain cases the blade of an instrument must be bent during operation to suit our needs, as in using the spatula to replace the iris; in such an event the part of the instrument that came in contact with the surgeon's hand will be introduced into the interior of the eyeball. Cleansing of the hands, however, should not be carried to excess, and strong antiseptics should be used for only a short time, as they diminish the tactile sense, which is of great importance in eye operations.

Cleansing the hands is best performed in the following manner: The hands are first washed with warm water and soap for a few minutes, so that the epidermis and nails will soften. After this the nails should be manicured. The hands are scrubbed with brush and soap in running water for about five minutes. A sterile gown is put on, and the hands are put in 95 per cent. alcohol for one minute, and afterward in bichloride, 1 to 1000, for two minutes, which is then rinsed off in sterile water. The operation may be performed with wet hands, or if the surgeon prefers, the hands may be dried with a sterile towel. The assistants prepare their hands at the same time in a similar manner.

Preparation of Accessories.—**Dressings.**—Gauze, cotton wipes, roller bandage, towels, sheets, gowns, etc., are sterilized in steam autoclaves. It is necessary to sterilize them for about one hour. If dry heat is used the temperature in the sterilizer should be 150° C., and the dressings should remain here for two hours. It is good practice to wrap up a sufficient quantity of dressings, gauze, etc., enough for one operation, in one package, and sterilize them *en masse*. They remain in the autoclave until operation.

Trays, Basins, Bowls, etc.—These may be sterilized by hot air or steam. They may be also sterilized by placing them in bichloride, 1 to 1000, for three or four hours, and then rinsing them in boiling sterile water. A convenient method is first to clean them with bichloride, 1 to 1000, and then to pour in a small quantity of alcohol and ignite. This renders them quickly and absolutely sterile.

Solutions.—Water, boric acid, and saline solution are sterilized by boiling them for one hour.

Eye Drops.—Cocaine, atropine, pilocarpine, etc., may be sterilized by boiling. This is best effected by placing them in a water-bath for one-half hour, the bottle being covered with cotton or gauze. It must be borne in mind that prolonged and repeated boiling spoils a solution of cocaine, its anesthetic properties become weakened, and the solution itself irritating to the eye. For this reason cocaine should not be boiled more than once or twice. Cocaine can be rendered sterile by adding bichloride to it in the proportion of 1 to 10,000; this solution is to be prepared the day before the operation.

℞—Cocaine hydrochloride	0.5	gram
Bichloride of mercury	0.005	gram
Distilled water	10.0	grams

The eye-dropper should be boiled; its rubber cap sterilized by placing it in bichloride, 1 to 1000, for three to four hours.

Preparation of Instruments.—Instruments are sterilized by dry heat, boiling, or strong chemicals. The best and simplest method is the boiling. For this purpose the non-cutting instruments are placed for ten to fifteen minutes in boiling water to which has been added enough carbonate of soda to make a 1 per cent. solution. After boiling they are placed in absolute alcohol for a few minutes, and from there they are transferred to the porcelain instrument tray and covered; the cover should not be removed until operation. If the operation is to be performed with wet instruments, the porcelain tray is filled with sterile water. In such a case it is necessary to prepare another porcelain tray filled with sterile water, into which, during operation, the used instruments are placed, to secure sterility of the first tray. The cutting instruments, wrapped in cotton or on a metal rack, may also be boiled, but only for one to two minutes, as prolonged boiling has an injurious effect on the cutting edge. For this reason many surgeons do not boil these instruments at all but sterilize them with chemicals. Tincture of green soap, carbolic acid, and lysol may be used, and the instruments are immersed for one or two hours in these solutions. This is sufficient to render them sterile, and after rinsing in alcohol and sterile water they are ready for use.

Silk, Catgut, and Needles.—Silk sutures are sterilized by boiling them in 1 per cent. bicarbonate of soda solution for one-half hour. The silk becomes swollen by the boiling, and unless self-threading needles are used, it is very difficult to thread the needle. This can be avoided by threading the suture first, and then passing the needle through a linen napkin. The napkin is folded, in order to avoid tangling the sutures, and then boiled. If separate needles are required they may be boiled in a perforated box. Catgut can be procured in a sterile state in sealed vials.

General Management in the Operating Room before, during, and after Operation.—After everything has been prepared the patient is placed on the operating table (bed). The eyelids and surrounding parts of the face are again cleansed with tepid water and soap, then with alcohol, and finally with bichloride of mercury solution, 1 to 1000; after this a cotton pledget moistened with sterile water or salt solution is placed over the eyelids. This is followed by the anesthesia.

ANESTHESIA

Anesthesia is not only important for the elimination of pain, but also to insure passiveness on the part of the patient. Anesthesia may be either general or local.

General Anesthesia.—For general anesthesia, ether or chloroform may be used. Both, of course, have an element of danger, and should be avoided whenever possible. General anesthesia should, however, be employed:

1. In adults:

(*a*) For all painful major operations, such as enucleation, exenteration of the eyeball, incision or exenteration of the orbit, iridectomy in acute glaucoma, etc.

(*b*) In eyeball operations where local anesthesia could be used, but exceptional quietness is required on the patient's part to avoid great loss of vitreous. Such operations are removal of a cysticercus or foreign body from the vitreous, etc.

(*c*) Also in smaller operations in hypersensitive or very nervous patients.

2. In children, even when a minor operation is attempted, as we cannot depend on them to remain quiet.

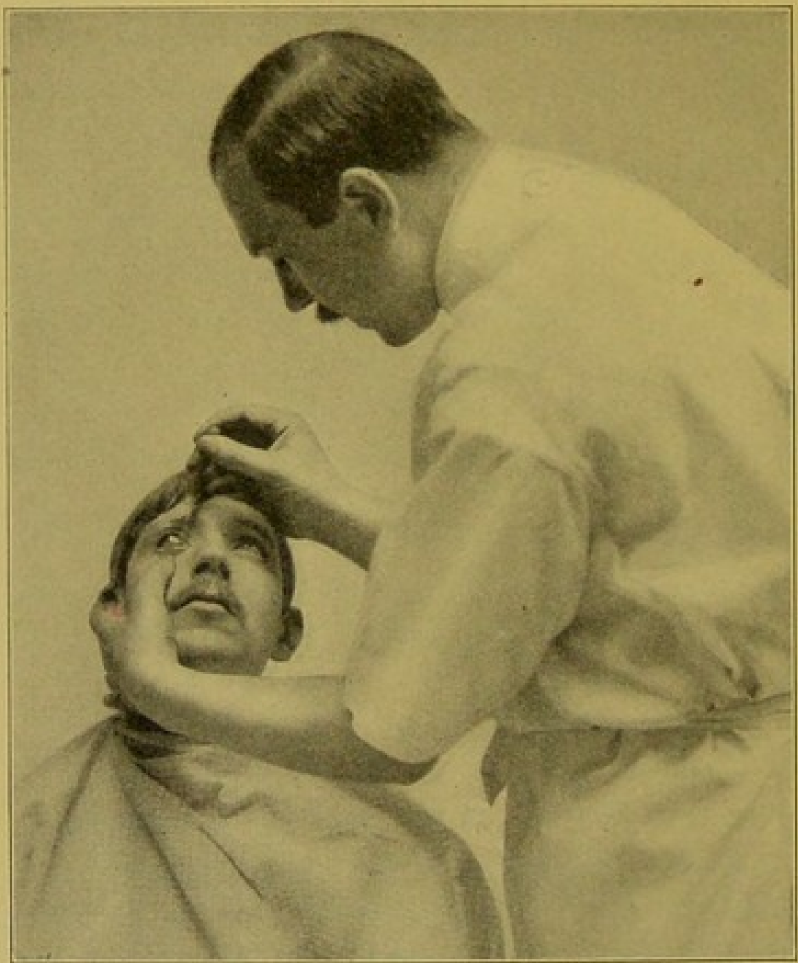
The preparation of a patient for a general anesthetic and the administration of it differs in no way from the methods used in general surgery. The inhaler is usually disturbing during operation, as it is in the way of the surgeon's hands; therefore, those methods in which the anesthetic is administered by means of nasal tubes are to be preferred. It must be borne in mind that in eyeball operations, to secure absolute quietness on the part of the patient, a deep anesthesia is necessary.

Local Anesthesia.—For local anesthesia, cocaine or one of its substitutes (holocaine, novocaine, eucaine, acoin, etc.) may be used. Although cocaine is the oldest (introduced in eye surgery by Koller, 1884), it is still the best and most commonly employed. Cocaine or its substitutes are used in eye operations by means of (*a*) instillation, (*b*) subconjunctival injection, (*c*) subcutaneous injection.

(*a*) **Instillation.**—This method is used in eyeball operations, and is done as follows (Fig. 9): The patient is directed to look upward while the surgeon pulls down the lower lid. In patients that cannot control their lids, it is well to pull down the lower lid with the thumb of the left hand, at the same time steadying the upper lid with the index finger. The dropper is brought up to within 3 mm. of the lid margin near the inner canthus, and a drop is expressed in the cul-de-sac. Care should be taken that the tip of the dropper does not come in contact with the margin of the lid. The first drop should always be instilled in the cul-de-sac and not on the cornea, as this is always a shock to the patient. The subsequent drops, after the cornea has been anesthetized, may be dropped on it. After the drop has been instilled it is well to pull the lower lid down and outward, or to exert pressure with the forefinger for about one minute on the lacrimal sac, so that the drop may not enter the nose and pharynx. This is especially important in children.

After the instillation of cocaine the patient must keep his eye closed, and a cotton pledget moistened with sterile salt solution is to be placed over the eyelid. In eye surgery cocaine hydrochloride is used in 4 or 5 per cent. solution. One drop of this solution produces a total anesthesia of the superficial layers of the cornea in two minutes. The anesthesia lasts five to eight minutes, after which it gradually wears off and wholly disappears in about fifteen minutes. The pupil begins to dilate ten to

Fig. 9



Method of instilling drops.

twenty minutes after instillation. The dilatation reaches its maximum in forty to sixty minutes, it begins to diminish one-half to one hour later, and disappears in four to five hours. There is also a slight paresis of accommodation accompanying the dilatation of the pupil.

One drop of a 5 per cent. solution of cocaine thoroughly anesthetizes the cornea; the anesthesia of the bulbar and tarsal conjunctiva is less and that of the iris almost *nil*. If we wish to have a deeper anesthesia the instillation must be repeated several times, best four or five times, at intervals of two or three minutes. Even repeated instillations of cocaine do not render the iris entirely insensitive, and manipulations of the iris are always felt by the patient. It is, therefore, advisable in all operations on the iris to make the wound gape after incision, and instil a drop or two into the anterior chamber directly on the iris.

The sensitiveness of the extrinsic muscles is greatly diminished by this method, total anesthesia, however, cannot be obtained; a few drops instilled directly on the muscle after the conjunctival incision will produce a fairly good anesthesia. It must be borne in mind that on an inflamed eye (acute glaucoma) the anesthetic effect of cocaine is almost *nil*.

Instilling cocaine is a safe method, and does not produce symptoms of poisoning. The only disadvantages are the effect that it has on the epithelium of the cornea and the dilatation of the pupil. The effect on the epithelium consists in its desquamation (also called cocaine keratitis). This is partly due to the toxic action of the cocaine and partly to the drying of the epithelium from the infrequency of winking. The solutions (4 or 5 per cent.) usually employed do not cause a toxic action on the cornea; this, as a rule, occurs when a solution of greater strength is used. The desquamation of the epithelium can always be avoided if we take care that the patient's eye remains closed after instillation, and if during operation sterile salt solution is repeatedly dropped on the cornea. The dilatation of the pupil, which from cocaine is always incomplete, is easily avoided, if not needed, by instilling alternately with the cocaine a few drops of a 2 per cent. solution of pilocarpine. If, on the contrary, a completely dilated pupil is required, this can be obtained beforehand by instilling a few drops of a 1 per cent. solution of atropine.

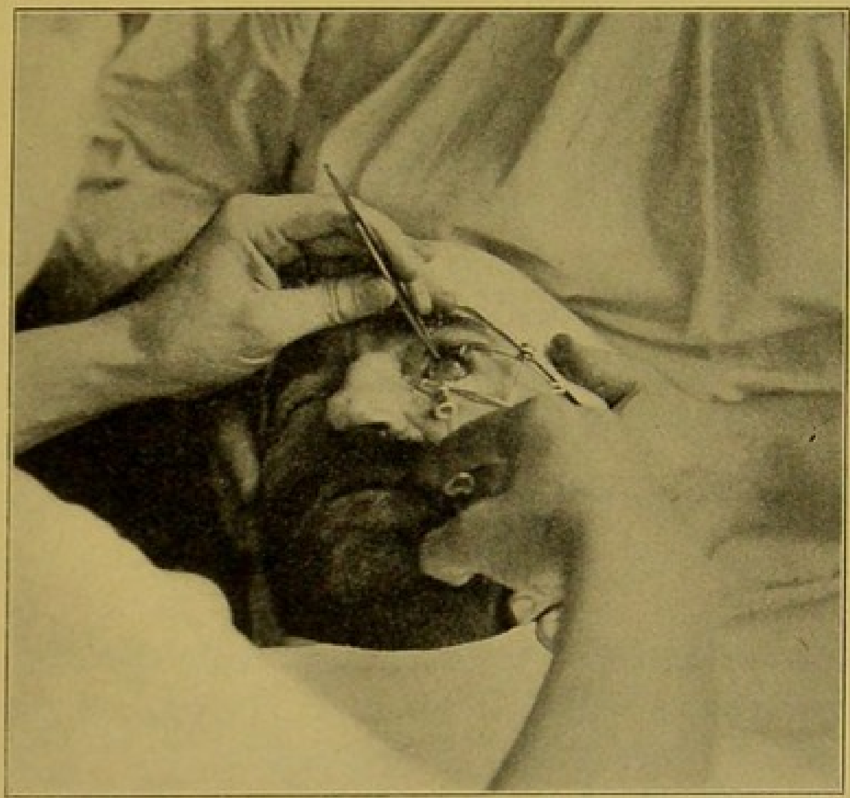
It should be remembered that although cocaine reduces the tension in a normal eye, in an eye that is predisposed to glaucoma it may induce an acute attack in consequence of its mydriatic action. On account of these disadvantages of cocaine, many surgeons use holocaine hydrochloride. It has the advantages of having no effect on the pupil, accommodation, or corneal epithelium, and of having antiseptic properties also. It is, however, more poisonous than cocaine. Usually a 1 per cent. watery solution is used, which produces a good anesthesia in about one to two minutes, the effect lasting about twenty minutes. To produce deeper anesthesia, 4 or 5 drops are necessary, instilled at intervals of about two or three minutes.

Holocaine and cocaine can be combined to advantage with adrenalin. This is a good adjuvant in eye surgery, as it not only increases the anesthetic effect of the holocaine or cocaine, but also renders the field of operation more or less bloodless. It is also of great value for the reason that by contracting the blood-vessels the absorption of holocaine or cocaine by the system is rendered slower, thus reducing still more the chances of poisoning. Adrenalin chloride is used in 1 to 1000 solution (as purchased), from which a few drops are instilled a few minutes before operation; two or three drops of this solution contract the blood-vessels and render the eye perfectly white in about twenty or thirty seconds. Its effect lasts from fifteen minutes to one hour.

(*b*) **Subconjunctival Injection** (Fig. 10).—For this purpose an ordinary hypodermic syringe is used. The eye is first anesthetized with a few drops of a 5 per cent. cocaine solution, and then the lids are held apart either by an assistant or a speculum. A small fold of conjunctiva is now grasped with a fine mouse-tooth forceps, the needle of the syringe is passed into the fold, and a few minims, according to the operation and strength of the solution, are injected. This method can be used to an advantage in operations on the tarsus and cul-de-sac. In giving the injection in the upper cul-de-sac somewhat deeper, a good anesthesia of the tarsus and also of the skin of the upper lid is produced.

It is also employed in operations on the bulbar conjunctiva and on the muscles, in which cases, although the anesthesia is entirely satisfactory, the edema caused, disturbs the relationship of the parts, greatly inconveniencing the surgeon. There is also a greater danger of a poisoning. There are cases recorded when death resulted from a subconjunctival injection of 0.02 gram ($\frac{1}{3}$ gr.) of cocaine. The symptoms of cocaine poisoning are as follows: The patient becomes pale, his forehead covered with cold perspiration, and complains of extreme weakness, which is often followed by syncope, the pulse being weak and rapid. The treatment consists in lowering the head, giving internally whisky or aromatic spirits of ammonia, and administering a few whiffs of amyl nitrite.

Fig. 10



Method of giving subconjunctival injections.

(*c*) **Subcutaneous Injection.**—This method is usually employed in operations on the lid, often in combination with instillations. The hypodermic syringe is used. A fold of skin is grasped between the index finger and thumb of the left hand, the needle is quickly thrust through the skin for a distance of about 2 mm., and a few drops of the solution are injected. After a few moments the needle is pushed in a few millimeters farther, and again a few minims injected. In this manner the entire field of operation is rendered anesthetic. This method gives a purely local anesthesia. It is well to massage the injected area so that the fluid will penetrate the deeper tissues and wait after the massage for at least five minutes before beginning the operation. The lid margin is extremely sensitive, so that to produce here a proper anesthesia the needle must be pushed down under the hair follicles.

In eyelid operations the tarsus cannot be anesthetized by a subcutaneous injection, as the fluid cannot be injected into it. A total anesthesia of the tarsus can be effected if a subconjunctival injection of twenty to twenty-five minims of a sufficiently weak solution is given deep in the upper cul-de-sac after the upper lid has been everted. If an operation is performed at the canthus it is well to inject some of the solution into the adjacent parts of both lids. In operations on the lacrimal sac the fluid should be injected into the skin around the canthal ligament, some into the sac, and some behind it.

In subcutaneous as well as subconjunctival injections, the danger of poisoning being great, cocaine is used in a very weak solution. In the New York Ophthalmic and Aural Institute the following solution is used, and has proved to be efficacious:

℞—Cocaine hydrochloride	0.05 gram
Adrenalin chloride (1 to 1000)	2.0 grams
Distilled water	10.0 grams

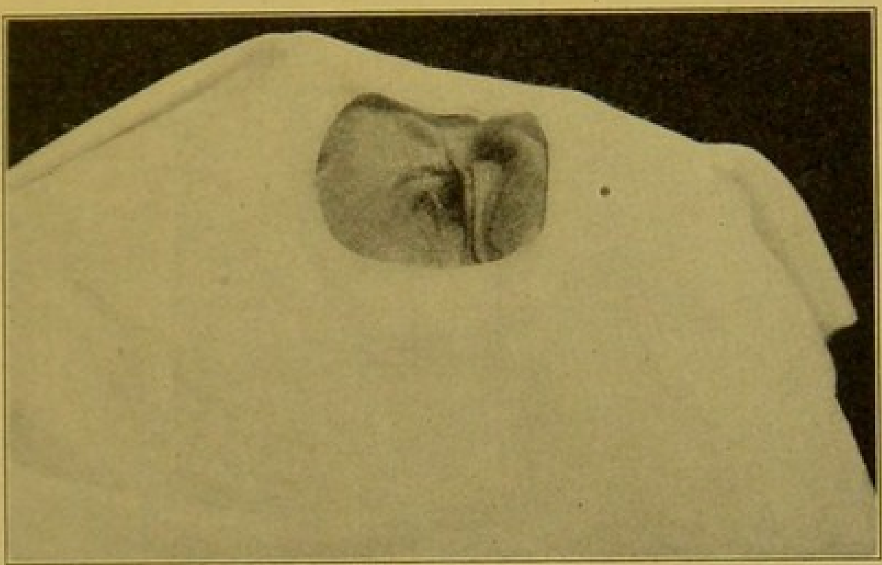
From this solution 30 to 40 minims can be injected without any danger of poisoning.

From the substitutes of cocaine, novocaine is the one that is best for subconjunctival and subcutaneous injections. This drug is about one-seventh as poisonous as cocaine, so that large quantities (10 to 15 gr.) can be injected without danger. It is a useful drug in cases where no general anesthetic can be given and large areas must be anesthetized (blepharoplasty). From a solution of 1 per cent., if the syringe holds 30 minims, 5 or 6 syringefuls can be safely injected.

PROCEDURES AFTER ANESTHESIA

After anesthesia, in operations on the eyelids and orbit, the patient's head is wrapped in a sterile towel or a special cap. His body is then covered with a sterile sheet and a towel is placed on each side of his head. A linen mask (Fig. 11) or towel with a large enough opening in it to leave the field of operation uncovered is placed over his face. If a general anesthesia is employed this mask should cover the inhaler and the anesthetist's hands also. The patient is now ready for operation.

Fig. 11



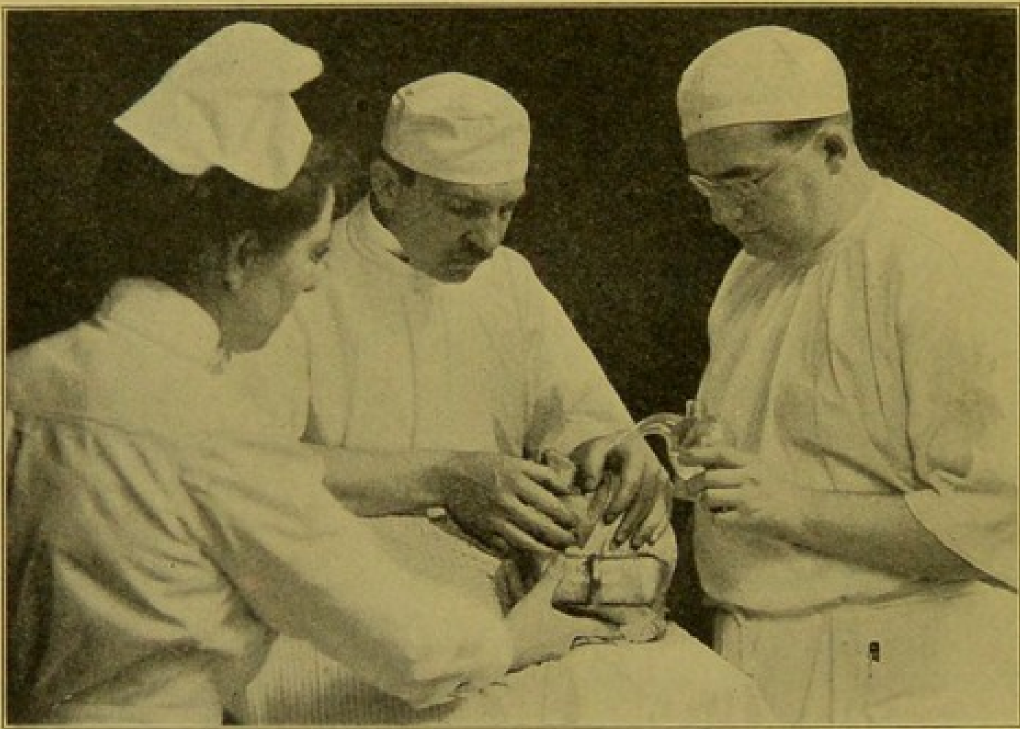
Operating mask in place.

Irrigation.—In operations on the eyeball muscles or conjunctiva the patient's head is covered with sterile towels as in lid operations. In these operations, following the instillation of the cocaine, the cleansing of the conjunctival sac should precede the operation. For this purpose a tepid salt solution or a 3 per cent. boric acid solution is used, the irrigating fluid being caught in a sterilized pus basin. The irrigation may be performed with an irrigator, syringe, or undine. The latter is the simplest, cleanest, and best, as it can be easily and perfectly sterilized.

The irrigation is performed as follows: The patient is directed to look upward, and at the same time the lower lid is drawn down, thereby exposing the lower cul-de-sac, which is now thoroughly flushed with the solution. The upper lid is then everted while the patient looks down, and gentle pressure is exerted on the eyeball with the lower lid toward the apex of the orbit. This maneuver causes the upper cul-de-sac to come into view, which in turn should be thoroughly irrigated (Fig. 12). The irrigation is usually performed by the surgeon and his assistant, the surgeon exposing the cul-de-sac and the assistant irrigating. Irrigation may be repeated after the speculum has been inserted.

The patient is now instructed as to what is expected of him during operation. The instructions should be clear and concise in order not to confuse the patient. The patient, if nervous, should be calmed and assured that the operation will be painless.

Fig. 12



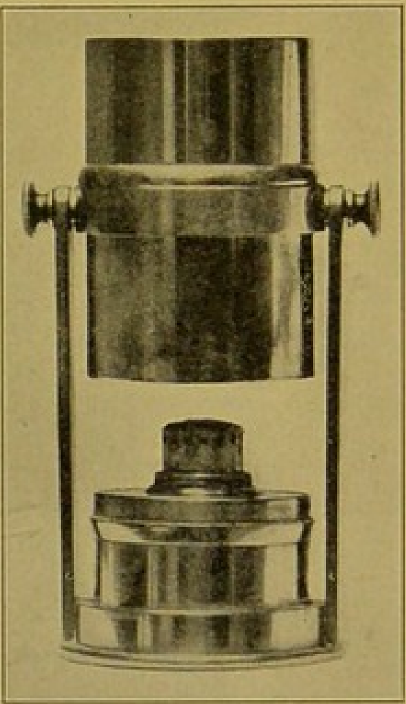
Method of irrigating the cul-de-sac with the undine.

He is told to open his mouth and breathe quietly; not to attempt to close his eye or squeeze his lids together, and also told to look where he is directed, and not move his eyes aimlessly about. After these instructions the patient is ready for operation.

Procedure during Operation.—During operation the surgeon and his assistants are clad in sterile gowns and wear sterile caps. It is not necessary to wear a mask unless the surgeon has a beard or he expects to explain the operation to some one present. In the latter case it is possible without a mask for the saliva to contaminate the wound. For this reason there should be as little speaking as possible; only the necessary orders to the patient or assistants being permissible. A rule that should be strictly enforced is that *no one should speak to the patient except the surgeon himself*, as otherwise the patient may become confused.

It must be borne in mind that the hands, skin, eyelashes, edges of eyelids, and conjunctivæ can never be considered absolutely sterile. Therefore if the blade of any instrument touches one of these surfaces (the surgeon should always be on the lookout) it should be resterilized before using. It is, therefore, good practice to have several duplicate instruments in the tray; if for any reason this is impossible, some portable alcohol sterilizer (Fig. 13) should be at hand into which we can dip the contaminated instrument for a few minutes after such an accident. Coming in contact with the bulbar conjunctiva, of course, cannot be avoided, but it should not be touched any more than is absolutely necessary.

Fig. 13



Portable alcohol sterilizer.

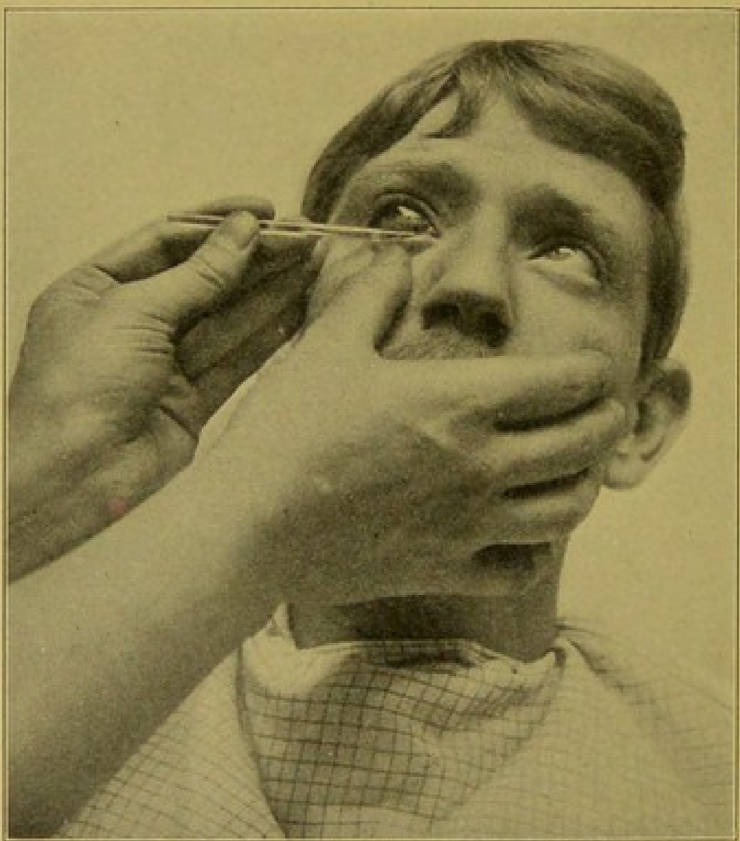
In each instance where the hands come in contact with non-sterile objects, they should be washed in bichloride solution and then in sterile water. If they come in contact with infectious materials (pus, vomit) the whole procedure of disinfecting the hands should be repeated. The operation should be performed quickly, avoiding unnecessary handling of the eye. It is a well-understood fact that bruised tissues are very apt to infection, therefore all cutting instruments should have a perfect edge. We should also remember that knife wounds are made without bruising the tissues, while scissors always bruise them to a certain extent. For this reason the knife is to be preferred to the scissors.

We should use methods of operating that insure rapid and perfect closure of the wound in preference to others, and so far as possible we should avoid such methods that necessitate coming in contact with tissues that are especially prone to infection (vitreous).

PROCEDURES AFTER OPERATION

After operation in eyelid operations the eye is closed and a bandage applied. *In eyeball operations* the speculum is removed and the patient told to close his eyes. We should impress upon the patient that he should not close his eyes tightly together, but gently as in sleep. Therefore in directing the patient to close his eyes, we should always add "gently close your eyes, as in sleep."

Fig. 14

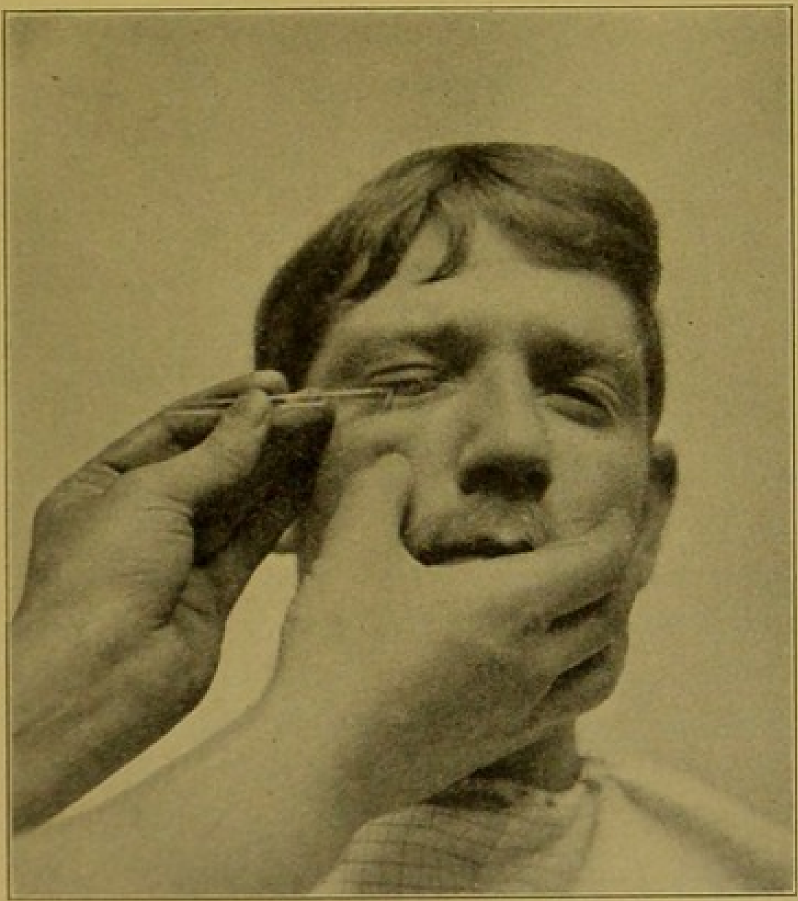


Method of applying ointment to the cul-de-sac. First step.

After a few minutes we open the eye again and remove all blood clots with an iris forceps. After this the eye is again closed, care being taken to see that it is completely so. After cocaine anesthesia the lids are apt to remain slightly open, in which case we must grasp the cilia of the lid and without pressure on the eyeball draw it down into place.

After the eye is closed the bandage is applied. Some surgeons prefer to place some form of ointment in the conjunctival sac (for instance, atropine ointment after cataract extraction) before bandaging. A small quantity of the sterile ointment is taken on a sterilized glass rod, the patient looks upward, and at the same time the lower lid is gently drawn downward. The glass rod is placed in the lower cul-de-sac and the patient is told to close his eyes. The glass rod is then drawn toward the temple, leaving the ointment behind. Great care must be taken not to exert pressure on the eyeball during this manipulation (Figs. 14 and 15).

Fig. 15



Method of applying ointment to the cul-de-sac. Second step.

Bandages and Dressings.—After all operations on the eye a bandage is used to give protection and rest to the wound (protective bandage). In certain cases where we desire firmer support (ablation of a staphyloma, enucleation, etc.) a bandage is applied more snugly so as to exert some pressure (pressure bandage). A bandage may be aseptic or antiseptic: for the former, we use sterile gauze; for the latter, iodoform or bichloride gauze is employed.

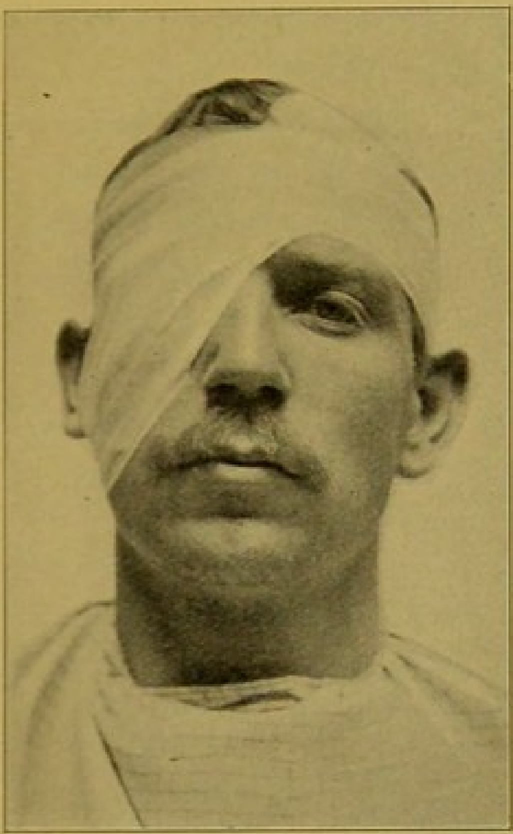
Operations on the Eyelids, Orbit, or Lacrimal Apparatus.—If the wound is clean, an aseptic dressing is applied. An antiseptic dressing should only be employed in cases where the wound is infected or where pus was found during operation. The dressing is composed of a few layers of gauze, which, if we wish better absorption, should be loosely placed over the wound. Dry gauze is always better than moist, because it absorbs the secretion better and is less irritating. The gauze is covered with sterile cotton and the whole dressing is held in place with adhesive plaster straps. The dressing is then covered with a roller bandage. For bandaging a 2-inch gauze roller bandage is the most convenient. The roller bandage should be about four yards long if one eye is to be bandaged, and about eight yards if both eyes are to be covered.

Application of Bandage.—The following method of applying a bandage will insure its security. If only one eye is bandaged (monocular) the end of the bandage is placed just below the operated eye (Fig. 16). The first turn is oblique, passing upward over the eye and forehead to the parietal eminence of the opposite side. From here it is passed backward over the occiput and then forward under the ear to the starting point. It is well, when passing under the ear, to rotate the bandage. Several such turns are taken in this manner, and then a few horizontal turns are taken around the head above the ears, to secure the position of the oblique turns. The oblique and horizontal turns are now alternated until the end of the bandage is reached.

If both eyes are covered (binocular) the bandage is started in the same position (Fig. 17). After a few oblique turns are taken over the operated eye the bandage is carried a few turns horizontally around the head. Following a few such turns the bandage is rotated at the occiput and carried over the other parietal eminence. From here it is brought down across the unoperated eye. A few turns are made in this direction, alternating with the horizontal until the end of the banadge is reached. It is well to end the bandage with a few horizontal turns.

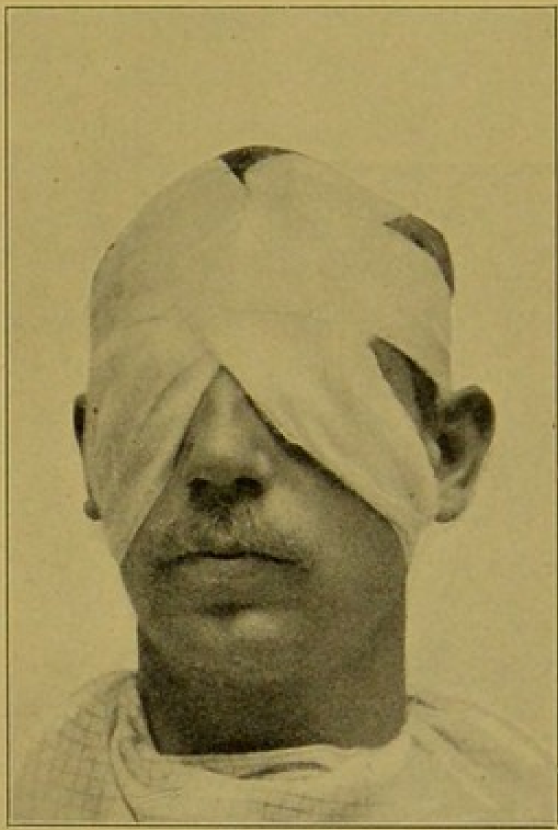
In unruly children, to prevent the bandage from slipping or the child from disturbing it, it is sometimes necessary to put on a starch bandage. This is applied over the roller bandage in a similar manner, after it has been thoroughly moistened. This bandage must be loosely applied because while drying it shrinks. To protect the ears in this case a little cotton is placed over them.

Fig. 16



Monocular bandage.

Fig. 17



Binocular bandage.

Operations on the Eyeball.—In eyeball operations antiseptic dressings are never used. They are not only superfluous, as the wound in the eyeball is covered by the lid, but they are distinctly disadvantageous. Bacteriological examinations have shown that the number of bacteria increase under an antiseptic dressing. This is explained by the fact that the disinfectant causes an irritation of the conjunctiva, which in turn increases the secretion, which is a favorable nidus for the growth of bacteria. For the same reason, dry dressings are better; wet ones cause itching and eczema, and do not absorb the secretion. The only medicated dressing that is permissible is the ointment dressing, for which 3 per cent. borated vaseline, 5 per cent. argyrol ointment, 1 per cent. atropine salve, etc., may be used. These, according to some, have antiseptic properties and do not irritate; they have, however, the disadvantage of not absorbing the secretion or blood. The best dressing is the dry aseptic dressing.

When applying a dressing, following an eyeball operation, we should always make certain that the lid is closed. After cocaine anesthesia the patient is not always able to close the eye perfectly, and it will be often noticed that the palpebral fissure remains open for a distance of 2 or 3 mm. If this is noticed the cilia of the upper lid should be grasped and the lid pulled down over the cornea; great care being taken not to exert any pressure on the eyeball. If this condition is not noticed a small piece of gauze may easily work into the conjunctival sac without the patient being aware of it, as the eye is still under the influence of cocaine. Later, when the effect of the cocaine has worn off, the gauze in the conjunctival sac acts as a foreign body, causing pain and producing an abrasion of the corneal epithelium.

Knapp's Dressing.—The eyelids are covered with a few layers of fine sterile gauze over which sterile absorbent cotton is placed. The cotton should be placed loosely and should not rise above the margin of the orbit. It is very convenient to have the dressing prepared before operation, thus saving time and unnecessary handling of it.

The following dressing (Knapp's dressing), which is employed at the New York Ophthalmic and Aural Institute, has proved very satisfactory. It is elliptical in shape, about 6 cm. in its longest diameter and 5 cm. in its shortest. It consists of two layers of sterile gauze, and cotton which is about 4 cm. in thickness. Two of these dressings, with a roller bandage and some loose cotton, are placed in a linen handkerchief and sterilized.

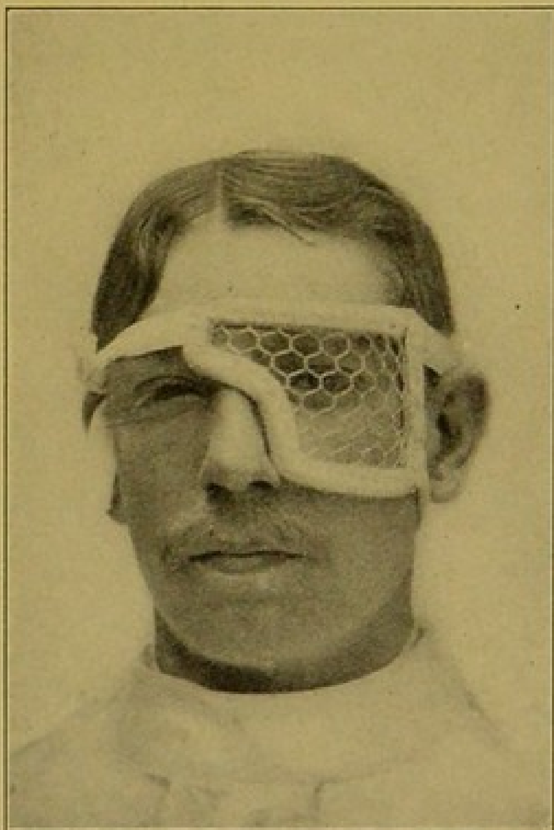
After operation the package is opened and the sterile dressing in proper shape is ready for use. If the patient's eye is deeply situated in the orbit, and the dressing is not thick enough, loose cotton is added. The dressing is then held in place with two adhesive plaster straps about 14 cm. long and 1 cm. wide (Fig. 18). One end of the strap is attached to the anterior end of the zygomatic arch, the other to the forehead. It is important that the lower end of the adhesive strap should be attached to the zygomatic arch and not to the skin of the cheek. In the latter case the dressing moves with each movement of the jaw during talking or eating. The dressing is now covered with a roller bandage, the patient's head being supported during this procedure.

The bandage should be firm and never too tight. When too tight it causes discomfort, from which the patient unconsciously tries to relieve himself, either by wrinkling his forehead or twitching his eyelids; less intelligent patients even go so far as to push their finger up under the bandage. These movements hinder the closure of the wound, and increase the possibility of infection, or if union has already taken place, they may cause rupture of the wound.

Fig. 18

Knapp's dressing in place.

Fig. 19

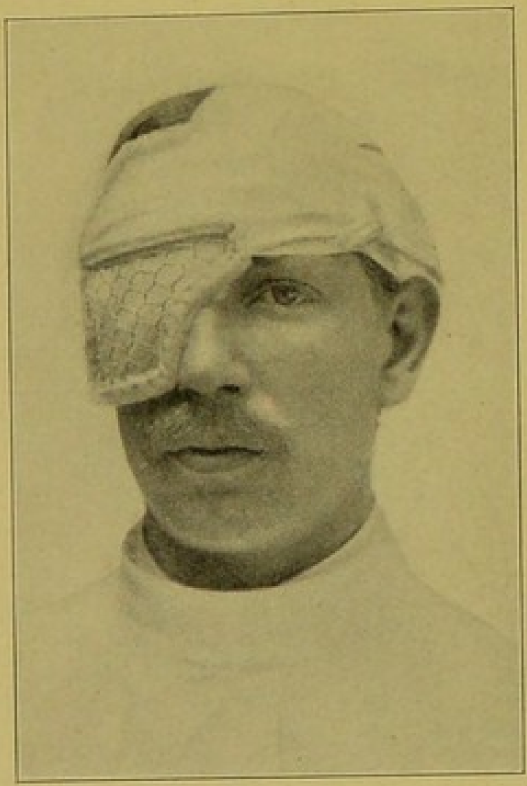


Fuchs' mask. Left.

Protective Appliances.—To prevent injury to the eye, after eyeball operations, especially cataract extraction, various protective appliances have been devised. The most practical of these are Fuchs' wire mask, Ring's mask, and the various aluminum cups.

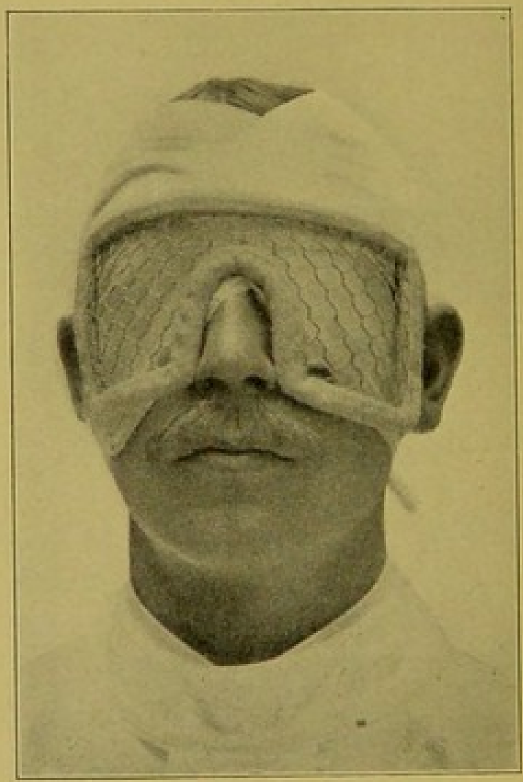
Fuchs' Mask.—The Fuchs' mask comes in three forms, a right, left, and double mask. It is made of wire netting of large mesh, the edges of which are covered with flannel. Tapes are attached to it with which it is fastened to the head. As the netting is not very stiff, it can be moulded to conform to the patient's face. The mask is apt to press on the patient's nose, so it is well to place a small pledget of cotton under it. Fuchs' mask may be placed over a roller bandage, or the latter may be entirely omitted. It is of good service, after the dressing has been left off, to prevent the patient from injuring the eye or touching it with his fingers, still allowing him the use of his eye (Figs. 19, 20, and 21).

Fig. 20



Fuchs' mask. Right.

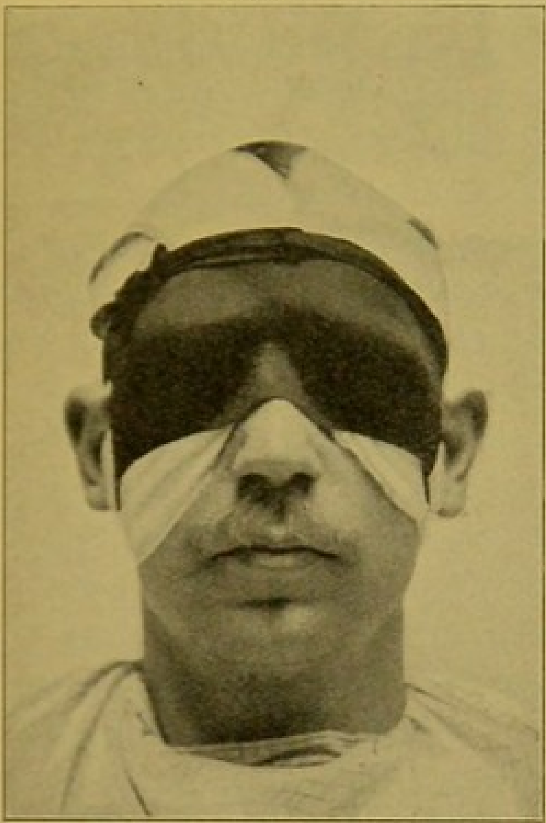
Fig. 21



Fuchs' mask. Double.

Ring's Mask.—Ring's mask is made of black sateen or papier-maché. It is firm enough to withstand considerable pressure without indenting. It is usually placed over the roller bandage, affording very good protection to the eye. The nose, here also, should be protected with cotton. The Ring mask is double, but if we wish to leave one eye open a hole can be cut in the mask over the eye that is to be left open (Figs. 22 and 23).

Fig. 22

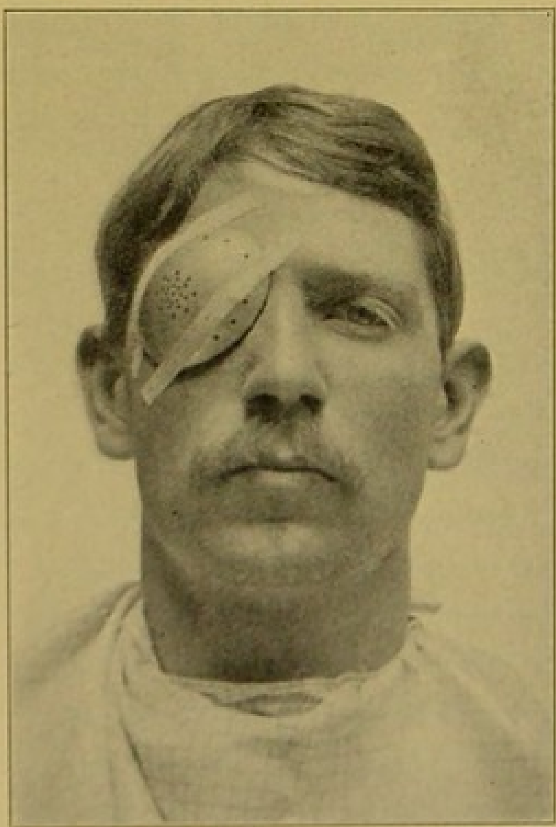


Ring's mask in place.

Fig. 23

Ring's mask giving patient one eye.

Fig. 24



Aluminum cup in place.

Aluminum Cups.—The aluminum cups (Snellen, Andrews, etc.) are also of good service. They are of special value when the dressing is left off, and afford a good protection. They are attached to the patient's face by adhesive strapping (Fig. 24).

After-treatment.—In eyelid operations, as well as in operations on the lacrimal apparatus and orbit, the same general rules are followed as in surgery elsewhere. It is advisable to change the dressing daily even of clean wounds, and cleanse the eye with warm boric acid or physiological salt solution. This not only gives relief and a pleasant feeling to the patient, but by removal of the secretion, the chances of wound infection or stitch abscess are reduced. The dressing should by no means be left in place longer than two or three days. After the removal of the sutures it is advisable to bandage the eye with 3 per cent. borated vaseline dressing for one to two days longer. In eyeball operations, especially major operations, it is best to bandage both eyes, in order to give complete rest to the operated eye. On account of the associated movements, this is impossible if the unoperated eye is left open.

No matter how small the operation, if the globe has been opened the patient should never walk to his bed, but be carried. The bed should be well made, and the sheets and night-gown smoothed out into place. He should keep quiet in bed, should not talk, and visitors should not be allowed to see him before the third day. He must remain in bed for one or two days or even longer, depending upon the operation and the condition of the wound. Lying quietly on the back causes, in most patients, intolerable backache, and many, even the young, cannot endure it; those who are older not only complain, but grow rapidly weaker and feeble, and their breathing is labored. With these patients there is danger of hypostatic congestion of the lungs or even pneumonia, so their position must be changed to a sitting one, by placing pillows or some appropriate rest under their back. If necessary, this can be done even after a cataract extraction as early as six to eight hours following the operation. On the second or third day, depending on the operation, the patient may sit up in a comfortable arm chair for a few hours. Walking should not be allowed before the fifth or sixth day.

The patient is put on a fluid diet, and all food requiring mastication should be avoided on the first three days. On the next three days semisolid food may be given, but an unrestricted diet is not allowed until the eighth day. Patients addicted to the use of drugs (alcohol, cocaine, etc.) should be given a small quantity daily. The patient's bowels should receive careful attention, as straining at stool may cause rupture of the wound. As the patient has had a thorough cleaning out the night before the operation, and since then has only had a fluid diet, the bowels may be let alone until the fourth day, when it is advisable to give him a mild cathartic. On the following days it is necessary to see that he has at least one soft easy stool daily. Some patients experience difficulty in urinating in the lying position. In such cases we may try hot applications over the lower abdominal region, or we may place him in a sitting position. If this fails we should not hesitate to catheterize.

Bandaging of both eyes for more than two or three days is not necessary after an eyeball operation. The operated eye is bandaged from four to eight days, sometimes even longer, depending upon the operation and the general progress of the healing. The dressing is changed the first time twenty-four hours after operation. Some surgeons leave the eye bandaged longer (two or three days). This is not advisable because of an increase of secretion under the bandage which allows the bacteria to increase rapidly, and also causes an unpleasant itching. In opening the eye, great care should be exercised in order to avoid pressure on the eyeball.

After the dressing has been removed the eyelids are wiped with sterile cotton pledgets soaked in lukewarm physiological salt or boric acid solution, and then the lower lid is carefully pulled down and some of the solution is dropped into the cul-de-sac. It is well to advise the patient in advance of what you intend to do, as otherwise the dropping of the solution into the cul-de-sac may cause a reflex spasm of the orbicularis. The eyelid is then dried with sterile cotton and the patient opens his eye, so as to permit examination by focal illumination. During examination the upper lid should never be raised. After the examination drops are instilled if necessary. A fresh dressing is now placed over the eye, and a bandage applied. The dressing is changed on the first three days once daily, after that, twice daily.

In most operations, even after a cataract extraction, it seldom is necessary in uncomplicated cases to bandage the operated eye longer than seven or eight days, but the eye must be protected from injury for another week. For this purpose Fuchs' mask or an aluminum cup fastened with adhesive straps to the face are of great value; under them the eye is opened and fully protected. Fuchs' mask has the advantage over the cup in that the patient can see through it, but it has the disadvantage in that it is more easily dislodged than the cup. The opened eye must be washed and cleansed twice daily, this giving great comfort to the patient. If the wound heals without complication, and the eyeball is not congested, which does not occur with small wounds before the tenth day and with larger ones before the fifteenth day, we allow the patient to leave the hospital.

After the patient returns home he should use extreme care from two to four weeks, according to the operation, and remain quietly in a slightly darkened room (no direct sunlight), with smoked glasses and an eye shade, doing no work whatsoever. He should not go out during bad, dusty, or windy weather, but when good weather prevails he may take a walk for an hour or two after sunset. During this time he should be careful with his diet and his bowels should be kept in order. He may be allowed to smoke when not in the house. After this period the patient may gradually accustom himself to his daily routine of living again, and his eyes to the daylight, but he should not resume his former duties before another week. At that time the visual acuity should be determined, and glasses prescribed if they are necessary.

The above are the general rules for postoperative treatment in uncomplicated cases. The length of the phases in the postoperative treatment varies in the different operations. These are described following each individual operation.

POSTOPERATIVE COMPLICATIONS

Wounds of the eyelid and orbit usually heal by first intention. Infection, however, may follow; in mild cases it may only be a stitch abscess, in severer cases cellulitis or erysipelas may develop. In orbital operations, subsequent to an infection, a meningitis may set in. Infection is usually due to carelessness during operation. Stitch abscess, however, may develop from infection from the conjunctival secretion. For this reason it is advisable to remove the dressing daily and to cleanse the eye with warm physiological saline solution or some mild antiseptic, taking special care to remove all secretion. If iodoform gauze is used a mild eczema sometimes follows; in such cases sterile or bichloride gauze is to be substituted for the iodoform and the affected skin is to be treated.

In eyeball operations the wound usually closes a few minutes after the operation is completed, and the anterior chamber is restored. Later the edges of the wound become slightly grayish in color, and are surrounded by a moderate ciliary injection. The cornea often shows gray lines that run at right angles to the wound (striated keratitis). According to Hess, they are due to wrinkling of Descemet's membrane. In wounds covered with a conjunctival flap the flap is often slightly edematous, owing to the filtration of the aqueous. If the filtration is more marked the aqueous may gravitate, and then the bulbar conjunctiva becomes also edematous in the lower half of the eyeball; this usually disappears in a few days. The ciliary injection slowly disappears and the eye becomes white in eight to ten days, following minor operations, and fourteen or fifteen days following major ones.

Formation of Scar Tissue.—Owing to the elasticity of the tissues, the coaptation of the wound edges is not perfect, and they are always somewhat displaced. In the first few days the wound edges are glued together by coagulated wound secretion, to which later, newly formed connective tissue is added. The closure of the wound is not firm, and in some cases the intraocular pressure may cause a slight dilatation of the scar. In such cases we notice that the wound edges, that appeared to be in apposition, are receding, and between them a dark line can be seen. Sometimes the process ends here, and a few days later a firm union follows, as the scar tissue shrinks and becomes more firm. At other times the scar remains ectatic (ectatic cicatrix), slightly bulging forward, thus causing a high degree of astigmatism and impairing the sight to a great extent. In certain cases the ectasia increases, the aqueous filters under the conjunctiva forming a cyst-like elevation around the wound (cystoid scar). Ectatic scar often arises in glaucomatous eyes.

Cystoid Scar.—Cystoid scar occurs in eyes where shreds of capsule or iris remain wedged in the wound. The interposed tissue hinders the perfect closure of the wound. The aqueous filters through and pushes before it the newly formed scar tissue with the covering conjunctiva. If the iris is wedged in the wound the ectasia may include the iris alone, and the cystoid scar is very dark in color, forming a small scleral staphyloma. Although the cystoid scar is often of no serious consequence, it may cause secondary glaucoma due to the incarceration of shreds of capsule or iris. Cystoid scar containing iris is also dangerous, as the epithelium may be abraded and infection may follow. The bacteria in these cases gain an entrance through the iris to the interior of the eyeball, and cause a panophthalmitis.

To prevent the formation of a cystoid scar, great care should be taken after operation that no shreds of tissue remain wedged in the wound. This is sometimes very difficult, and often if the root of the iris is incarcerated it is not noticed at all. The capsule is also almost invisible, and only with very good light and by a thorough search can its presence in the wound be detected. It is, therefore, good practice after all operations on the iris or lens to introduce an iris spatula between the wound edges and free them of any incarcerated tissue, even if nothing can be seen. If a cystoid scar is developing very little can be done, but a slight pressure bandage kept up for some time may be beneficial. If it has already developed, and it gives no trouble to the patient, it may be let alone. If, however, it increases in size or causes secondary glaucoma, pilocarpine should be instilled, and an iridectomy performed. The cyst itself should be opened with a Graefe knife, the incarcerated iris removed as far as possible, and then the fistulous opening that leads into the anterior chamber cauterized. This procedure repeated several times and followed by a slight pressure bandage for several weeks may bring about flattening. A conjunctival keratoplasty, after abscission, will be of great help to produce the formation of a strong scar tissue which will not yield to the intra-ocular pressure.

Non-closure of the Wound.—An unpleasant complication during healing is non-closure of the wound. In such cases the anterior chamber is not restored, and the wound being open, greater opportunity is afforded for late infection.

The causes of non-closure may be due to the incarceration of iris, lens masses, or capsule or conjunctival flap in the wound. When prolapse of vitreous occurs during operation the vitreous itself may be wedged in the wound. The interposed tissue prevents the union of the wound and allows the aqeuous to escape. Non-closure of the wound may also follow glaucoma when the intra-ocular pressure remains high after iridectomy (malignant glaucoma), and does not allow the wound edges to unite. When the non-closure is due to malignant glaucoma the eye is always lost; when due to incarceration of the iris, etc., the wound usually closes after a shorter or longer period, and no special treatment is required except that the bandaging must be kept up until the wound is healed.

This complication, however, should always be considered dangerous, as it may be the starting point of a late postoperative glaucoma.

Rupture of the Wound.—Rupture of the wound is a fairly frequent complication, and occurs usually in cases where a long incision has been made. It is more frequent following the use of the Graefe knife than the keratome. It may happen a few hours or several days after operation, and is caused by the sudden increase of intra-ocular pressure. The increase of intra-ocular pressure may be the result of sudden swelling of the lens or cortex remnants, but in most cases it follows extra-ocular causes. Such extra-ocular causes are not only direct trauma, as bumping the eye, sticking the finger in the eye, but also the pressure of the eyelids due to contraction of the orbicularis. The latter is the most common cause of rupture. It may also be the result of the pressure from a tight bandage or a bandage that has been left on the eye too long, the drying secretion causing itching which the patient tries to relieve by squeezing the lids together. Coughing, squeezing, vomiting, straining at stool or while sitting up also frequently produce rupture of the wound.

If this complication occurs the patient complains of a sudden pain in the previously painless eye, and often says that he feels that his dressing is wet. On removing the bandage we find the dressing moist and often stained with blood. The eye is irritated. In slight cases there is a subconjunctival hemorrhage around the wound; the anterior chamber is shallow or entirely absent, and there is often a slight amount of blood at the bottom of it, forming a hyphema. In severer cases the anterior chamber may be entirely filled with blood or the wound may gape widely, and iris or vitreous may be wedged in it or even be prolapsed. In very severe cases there may be hemorrhage from the ciliary body, choroid, or retina which fills the posterior chamber as well as the vitreous chamber with blood, in some cases even expelling the contents of the eyeball (expulsive hemorrhage). In light cases the blood may be absorbed within a few days without any serious damage to the eye. In severe cases the absorption takes a longer time, and more serious complications may ensue.

An infection may develop when the conjunctival secretion enters the anterior chamber or the prolapsed vitreous or iris may come in direct contact with the infective secretion of the conjunctiva and form the avenue by which the bacteria enter the interior of the eyeball. An iritis or iridocyclitis, caused by an infection or the mechanical and chemical irritation of the disintegrating blood, is a not infrequent sequel of a rupture. The vision may also be permanently impaired, due to opacities in the vitreous from unabsorbed blood, or there may develop a permanent opacity in the cornea from the staining of the blood (imbibition). Of course in cases where the vitreous and retina have been expelled, the eye is lost.

To prevent rupture, after all major operations on the globe, both eyes should be bandaged, and the patient should remain quietly in bed, not altering his position voluntarily. If he wishes to move a nurse should assist him; he should not attempt it alone. It is a good plan to put the electric-bell push in his hand, so that he can summon help when he needs it; this also gives him a feeling of confidence, and he will not worry when left alone. Following a major operation the bowels should not be moved until the third day, when a mild cathartic is given. Coughing should be controlled with opiates, and if the patient is troubled with sneezing, he should squeeze his anterior nares tightly together, which will often check the desire to sneeze.

A pressure bandage should never be applied after an eyeball operation, and the dressing should be changed daily, as this will prevent the sometimes very annoying itching. Protective appliances like Fuchs' or Ring's mask protect the eye against external violence. In changing the dressing care should be taken not to raise the upper lid, and always to tell the patient what you intend doing. If rupture has taken place the pupil should always be dilated with atropine, except in glaucoma, and the patient should be kept in bed as after operation. The operated eye should be bandaged and if necessary the unoperated one also.

If the iris is wedged in the wound nothing can be done; if it has prolapsed it should be ablated under a general anesthetic, but never replaced as this increases the chance of intra-ocular infection. If vitreous has prolapsed it should be ablated with the scissors. If there is much blood in the anterior chamber, which does not absorb in five or six days, but keeps up the irritation of the eye, it should be removed by means of a paracentesis of the cornea.

Infection.—Infection is the most dangerous of all complications, and the one that has the most serious consequences. It may take place during operation or at a later date following non-closure or rupture of the wound. It may also be of endogenous origin. The infection may start from the wound or iris.

Infection from the Wound.—If the infection starts from the wound it usually follows the operation on the second or third day, and very seldom later. The later it sets in the more reasonable is the supposition that the invasion of germs did not take place during operation but sometime afterward.

The symptoms of wound infection are the following: The eye that has been quiet and showed only the slight reaction, that usually follows operation, suddenly becomes irritated, and the patient complains of severe pain. On removing the bandage the dressing is found soaked with tears and secretion. The eyelids are edematous, and on opening the eye the conjunctival sac is found filled with tears and secretion; the bulbar conjunctiva is deeply congested and edematous, often chemotic. The wound edges are swollen, infiltrated, and yellowish in color. On the following day the yellowish infiltration of the wound and the adjacent parts of the cornea increases in size, the cornea becomes hazy and lusterless, the aqueous turbid, due to a plastic or purulent exudation from the iris and ciliary body. The pupil is contracted and the iris discolored. Hypopyon now appears, and the infiltration rapidly spreads around the cornea, forming a so-called "ring-abscess." The inflammation gradually increases in violence, so that in two or three days, rarely later, after the first symptoms, the cornea has entirely sloughed away and the clinical picture of a panophthalmitis is present. The end-result is a phthisis bulbi. At the first sign of wound infection, the infiltrated edges must be thoroughly and deeply cauterized, and atropine instilled 5 to 7 times daily. Subconjunctival injections of cyanide of mercury (Darier) or thoroughly curetting the wound, irrigating the anterior chamber with oxycyanide of mercury, 1 to 5000, and covering the wound with a conjunctival flap (Kuhnt) have also been recommended. In spite of all efforts it is seldom that the eye is saved.

Infection from the Iris.—If the infection starts from the iris, the clinical picture will vary from a slight iritis to an iridocyclitis or even panophthalmitis according to the virulence of the bacteria that have entered the eyeball. A slight iritis is not a rare complication after eyeball operations. It is not in all cases the result of an infection, but it may be due also to operative trauma, pressure from the remaining lens masses, and the traumatic and chemical effect of disintegrating blood. Whatever the cause may be it is usually benign and terminates with a few posterior synechia without any serious damage to the eye.

Its symptoms are slight ciliary injection, lacrimation, slightly turbid aqueous, and discolored iris with contracted pupil. The patient usually complains of slight pain. Atropine 3 to 5 times daily, hot compresses, aspirin, 30 to 40 gr., purgatives (calomel, 2 or 3 gr.), and rest in bed are all that are required to control it.

Iridocyclitis or Iridochoroiditis.—Iridocyclitis or iridochoroiditis follows a more virulent infection. The first symptoms set in two to three days after operation, or they may be delayed six or eight days or even longer. In most cases it is due to infection during operation, but its origin may also be endogenous. Sometimes this attack is an exacerbation of an old iridocyclitis or iridochoroiditis following the operative trauma. This applies especially to cases that have had a previous iridocyclitis following trauma or operation. For this reason it is advisable never to operate on such an eye until it has remained quiescent for at least one year.

The symptoms of an iridocyclitis are pain, lacrimation, edema of the eyelids, ciliary injection, hazy cornea, turbid aqueous, discolored iris, and contracted pupil. There is often a plastic exudate in the anterior chamber, and sometimes in the vitreous chamber also (iridochoroiditis). The course of these complications is usually chronic, the irritation keeping up for several weeks. In some cases the eyeball can be saved, the pupil and coloboma, however, become obstructed by a thick membrane of organized exudation. The sight, if perception of light and localization remain good, can be restored later (about one year) by a second operation (iridotomy). In other cases, especially when there was an exudation into the vitreous chamber (iridochoroiditis), the light perception gradually becomes extinct, the eye soft, and the end-result is an atrophy of the eyeball. These atrophic eyeballs being capable of exciting a sympathetic inflammation in the other eye, should be enucleated.

The treatment of an iridocyclitis or iridochoroiditis consists in hot applications, atropine five to seven times daily, large doses of aspirin internally, purgatives (calomel, 2 or 3 grains), 3 to 5 leeches applied to the temple, pilocarpine sweats, and inunctions of mercurial ointment. Darier also recommends subconjunctival injections of cyanide of mercury, 1 to 5000 (mercury cyanide, 0.01; sodium chloride, 1; distilled water, 50), one-half to one syringeful injected beneath the conjunctiva at the level of the upper cul-de-sac. Injections of antidiphtheritic serum, 8000 to 10,000 antitoxic units, are said to influence the condition beneficially.

Panophthalmitis.—If the virulence of the infective bacteria is great, panophthalmitis develops. This destroys the eye in a very short period. The inflammation ordinarily starts twenty-four to thirty-six hours after operation, with severe pain, swollen eyelids, ciliary injection, chemosis, hazy cornea, turbid aqueous, and hypopyon. These symptoms quickly increase in severity, and in a day or so the typical picture of a panophthalmitis is present, terminating in a phthisis bulbi. As phthisis bulbi of such origin is dangerous to the other eye, it should be enucleated. If a panophthalmitis develops the eye cannot be saved. In the early stages the attempt can be made with the therapeutic measures suggested for iridocyclitis, later the pain may be relieved, and the course of the disease shortened by an exenteration of the eyeball.

Glaucoma.—Glaucoma is one of the most serious complications following an eyeball operation. It may follow all operations in which the anterior chamber is entered, especially if the operation involves the iris, lens, or vitreous. The operations, however, that are most frequently followed by this complication are the extraction of a cataract and the discission of a secondary cataract.

Glaucoma after Cataract Extraction.—Following a cataract extraction, glaucoma may set in in a few days after the operation or later, sometimes as late as two or three years. Of course it is often a simple secondary glaucoma following an iridocyclitis, especially when a plastic exudate has formed, thus causing a total obstruction of the pupil and coloboma (seclusion and occlusion of the pupil) or the secondary glaucoma, with or without a cystoid scar, is due to the wedging of the iris or capsule in the wound. Sometimes it follows an apparently successful extraction which has been performed without any complication, and where the clinical examination reveals no apparent cause. It has been shown that eyes predisposed to glaucoma are more apt to develop this type of glaucoma, and in certain cases it may be considered a primary glaucoma, especially when the other eye that was not operated on has had glaucoma. As a rule, no predisposition can be detected, and the glaucoma must be considered as directly due to the operation. Histories of such cases show that in most eyes the restoration of the anterior chamber after operation has been delayed for a longer or shorter period. Anatomical examinations of such eyes have also revealed the fact that non-closure of the wound has been due to incarceration of the iris, capsule, vitreous, or conjunctival flap and the increased tension due to the obstruction of the iris angle. The latter is always the direct consequence of the former.

In some cases the anterior chamber being open, the iris comes in close contact with the cornea, and the eye is slightly irritated. A chronic iridocyclitis develops with exudation which glues the root of the iris to the periphery of the cornea and thus obstructs the iris angle. In other cases the corneal and conjunctival epithelium has grown through the open wound into the anterior chamber, and lines with epithelium the posterior surface of the cornea and the iris, at the same time bridging over the pupil and coloboma. The increase of tension is due either to the obstruction of the communication between the anterior and posterior chamber, or to an obliteration of the iris angle by the epithelial masses.

Symptoms.—The symptoms are those of an acute or chronic inflammatory glaucoma. To avoid this complication the cornea should not be cocainized for a too great length of time, as this hinders the wound from closing (Mellinger). The operative technique should be perfect, and the endeavor made to have clean-cut edges that coapt and close easily and quickly. After operation the iris, shreds of capsule and vitreous should always be liberated as far as possible from the wound, and care should be taken that the conjunctival flap is smoothed out. The patient should be absolutely quiet, and rupture of the wound prevented so far as possible. This form of glaucoma is usually malignant and in many cases, if it has developed, the eye is lost in spite of all efforts. Eserine, pilocarpine, dionin, hot or cold compresses prove beneficial in some cases. In other cases operative measures must be resorted to. If the iris or capsule is wedged in the wound, liberation should be attempted, and an iridectomy or iridotomy should be performed to restore the communication between the anterior and posterior chamber; sclerotomy or cyclodialysis are also to be considered.

Glaucoma after Discission.—Glaucoma after discission is in many cases caused in the same way except that the discission has been performed before the glaucoma sets in; in others it must be considered a direct consequence of this operation.

Symptoms.—Knapp says: "Low increase of tension appears not infrequently, perhaps during the first twelve hours, as a reaction from the operation, and disappears without treatment. A high degree, accompanied by increased pain during the first night, is still manifest the next day by circumcorneal injection, chemosis, and increased hardness of the globe. This degree may likewise disappear in a day or two, but it may also develop into a well-marked glaucoma with persistence of pain, swelling, and redness of lids and conjunctiva, lacrimation, and impairment of sight. These symptoms increase day by day, and very soon the iris becomes bulging in its middle portion, whereas the ciliary and pupillary edges remain in their position. The iris appears somewhat like a tube wound around the pupil, more elevated in some portions than in others. The media are dull, the fundus veiled."

The symptoms are evidently those of a seclusion of the pupil and iris bombe. The seclusion may be due to the iris becoming adherent to the lens capsule and hyaloid membrane or to incarceration of vitreous in the pupil (Czermak). The latter supposition is supported by the fact that glaucoma after discission occurs more often in cases in which the vitreous was extensively injured. Eserine or pilocarpine and hot applications sometimes combined with a paracentesis of the cornea may prove beneficial. If these are of no avail an iridectomy should be performed (Knapp).

Postoperative Mania.—This may follow eyeball operations, particularly cataract extractions. It may appear three or four days after operation, or sometimes later. It usually begins with restlessness, and the patient tries to tear off his bandage; later it develops into active mania, the patient often believes that he is being pursued by his enemies who want to kill him, and tries to escape by scaling the wall or climbing out of the window. If he is not watched carefully he may receive serious injuries. The prognosis is favorable, although in some cases permanent insanity may result. This condition may be due to fear of operation or joy at being able to see again, to the darkness in which the patient finds himself, to his strange surroundings and resulting nostalgia, and other causes. Sometimes abstinence from alcohol or some other drug may precipitate the attack. At the appearance of the first symptoms the bandage should be removed, and a nurse ordered to watch the patient carefully. Internally large doses of sodium bromide or chloral hydrate, also hyoscine and opiates, may be valuable to control the condition. It is often but not always fatal to the operated eye.

Postoperative Detachment of the Choroid.—This is a rare complication which may occur after cataract extractions and other eyeball operations. The eye suddenly becomes soft, and the anterior chamber very shallow without any sign of a rupture of the wound. With focal illumination round brownish masses can be seen projecting into the vitreous. The cause of this condition, which may set in a few days to several weeks after operation, is not understood. The prognosis is usually favorable, as the choroid later becomes attached, and the eye does not seem to suffer any ill results.

Postoperative Detachment of the Retina.—This condition follows operations where there was a loss of vitreous or where the vitreous was greatly disturbed (discission) and also where the vitreous becomes adherent to the wound. In the latter cases we often see a band of vitreous which connects the wound with the vitreous body, and by exerting traction, causes a detachment of the retina. The detachment may occur immediately after operation, but sometimes months or years intervene before this condition puts in its appearance.

CHAPTER II

INSTRUMENTS AND THEIR MANAGEMENT

The instruments used in eye surgery are partly from the general surgeon's armamentarium, but of course smaller in dimension, and partly special instruments, shaped and constructed for the needs in operating on the eye.

There are a great many of these instruments, of which only those that are the most important and commonly used are described in this chapter. Wherever it seems to be necessary the way of handling and using the instrument during operation is given. Instead of elaborate descriptions of the different positions in handling of the instruments, it appeared more practical to illustrate them. Descriptions which attempt to give the exact position of each finger, only tend to confuse the reader, without giving him the proper idea. At the end of the chapter a small armamentarium is given, which contains the instruments required for the operations described in this book.

Instruments in General.—As to instruments in general, simplicity is always a prime factor, as such instruments are not only more easily handled, but also more readily cleansed. They should be of the best material, and the cutting edges should be perfect. This is important not only from the point of view of economy, but also from that of the success of the operation, for only with perfect and faultless instruments can the clean-cut edges be made which are so important in the healing of the wound. Clean-cut wound edges unite and heal quickly, without complications. In bruised wounds there are always shreds of tissue in and around the edges that slough, delaying on one hand, the healing, and on the other hand furnishing good media for the growth of bacteria, and greatly increasing the possibility of infection.

Before operation, therefore, all cutting instruments should be tested, and only when found perfect should they be used. For testing, French trial kid, stretched over a drum, is used. The point of the instrument should pass through the kid easily, smoothly, and without any sound. In testing the edge, the instrument should cut readily, without requiring pressure. Scissors are tested by cutting the edge of the kid; and removing them with blades closed; neither the point nor the blades should catch in the kid.

During operation, the instruments should be held firmly but lightly; too tight a grip, not only causes tremor, restricted movements, and awkwardness, but it is also dangerous. By holding the instrument lightly, injury to the eye is avoided should the patient suddenly move during operation. If held lightly the instrument will move with the eye, while if it is held tightly, it will remain stationary and the eye will be injured. The operator's hand should have a gentle touch, which must be acquired by practice. The skin of the hand should not be rough but be well taken care of, as delicacy of the tactile sense is of importance in guiding the instruments. The hand should always be steadied lightly, on some convenient point of the patient's face, and free hand movements should never be attempted.

Immediately after operation the instruments should be carefully washed with warm water in order to detach all shreds of tissue or blood which may adhere. For instruments with teeth or joints, a soft brush may be used. After washing they should be carefully dried and put away, after first wiping them with special instrument oil.

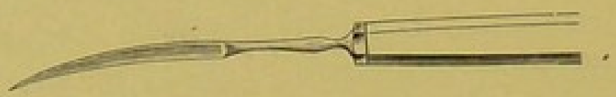
FIG. 25

Scalpel.

Knives and Needles.—**Scalpels and Bistouries.**—Both are similar but smaller than those used in general surgery (Fig. 25).

Weber's Knife (Fig. 26).—This instrument is used for slitting the lacrimal canaliculi. The blade is 2 mm. wide and slightly crescentic in shape. At the end of the blade is a small knob, which is connected to the blade by a small neck.

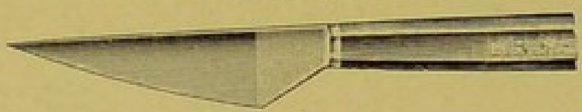
FIG. 26



Weber's knife.

Beer's Knife (Fig. 27).—Beer's knife has a triangular blade; its cutting edge is the long leg of the triangle. It was formerly used for incisions of the cornea, but it has since been supplanted by the Graefe knife.

FIG. 27



Beer's knife.

Graefe's Knife (Fig. 28).—Graefe's knife is used for incisions which penetrate the coats of the eyeball. The blade is 2 mm. wide and about 3 to $3\frac{1}{2}$ cm. in length, one edge being sharp.

FIG. 28

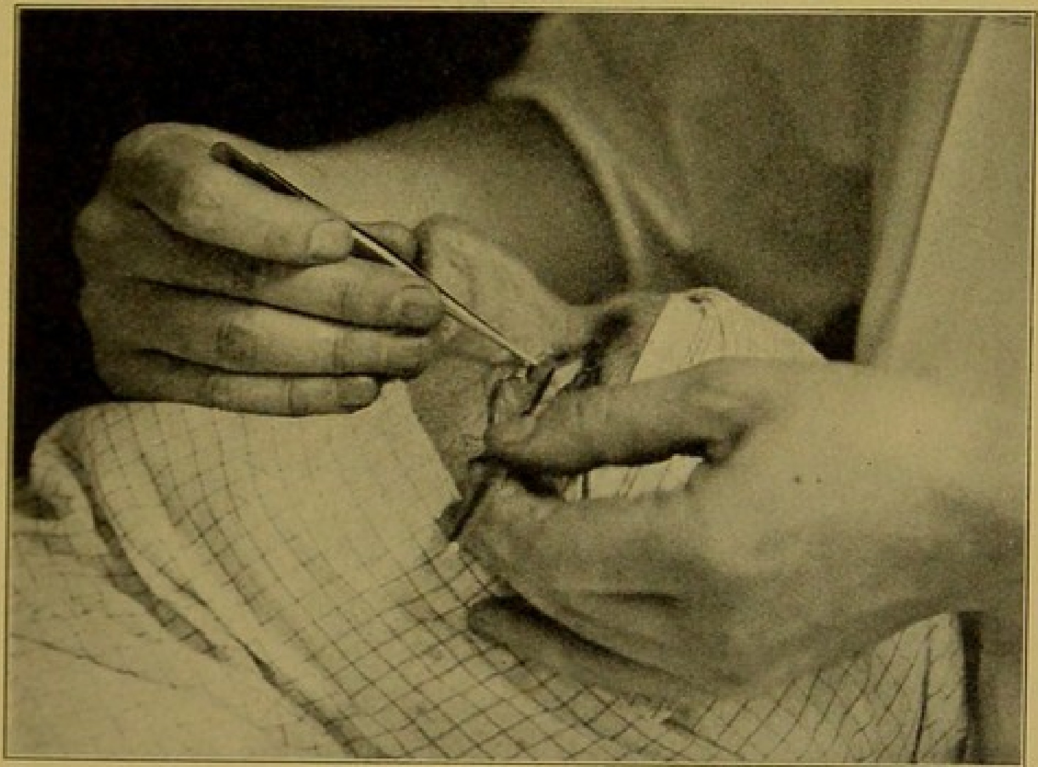
Graefe's knife.

The edges of the blade are parallel, and they join together to form the point, which is sharp on both sides. The blade is mounted on a handle of about 10 cm. in length, which is usually made of metal.

METHODS OF USING.—In making incisions, Graefe's knife is used in two ways: (1) by making a puncture and counter-puncture, and then dividing the tissues that are in front of the knife with sawing movements; (2) by plunging the knife through the coats of the eyeball, its point being directed toward the centre of the globe.

The first method is used in cataract extraction, anterior sclerotomy, etc. In this case the knife is held between the first two fingers and the thumb, in a horizontal direction, the little finger resting on the patient's temple (Figs. 29 and 30). The knife is held in the hand, which corresponds to the eye, that is to be operated on, and for that reason the right as well as the left hand is employed. The use of the left hand can be avoided by standing in front of the patient when operating on the left eye, and behind when operating on the right eye. In making the puncture, passing through the anterior chamber and making the counter-puncture, the blade of the knife should be parallel to the plane of the

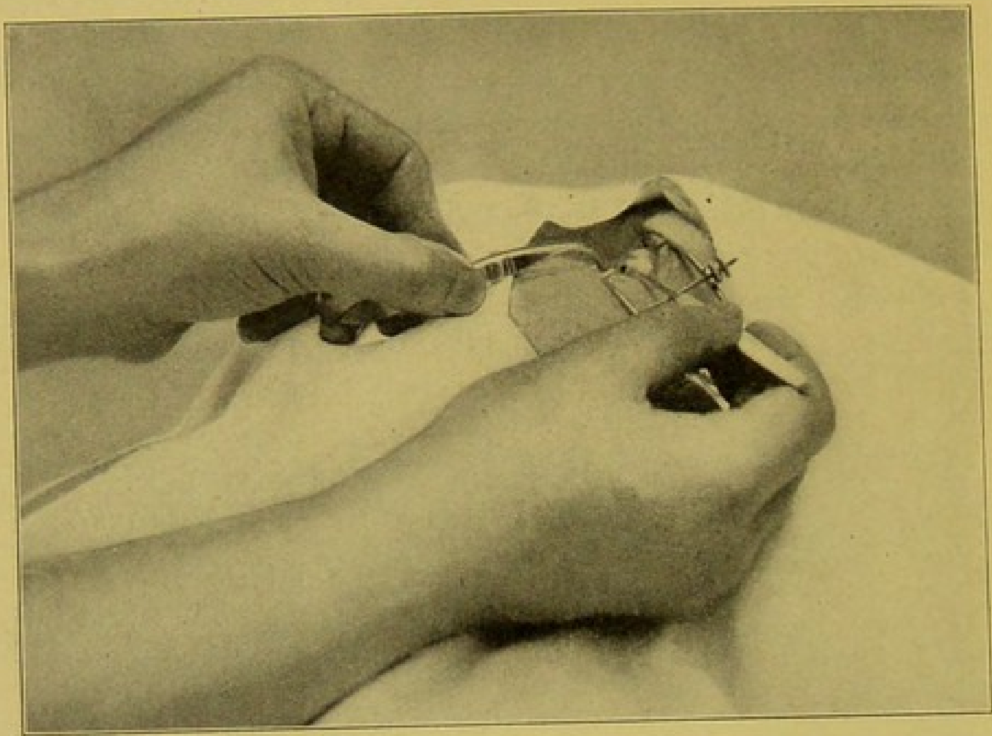
Fig. 29



American method of holding the Graefe knife for cataract extraction.

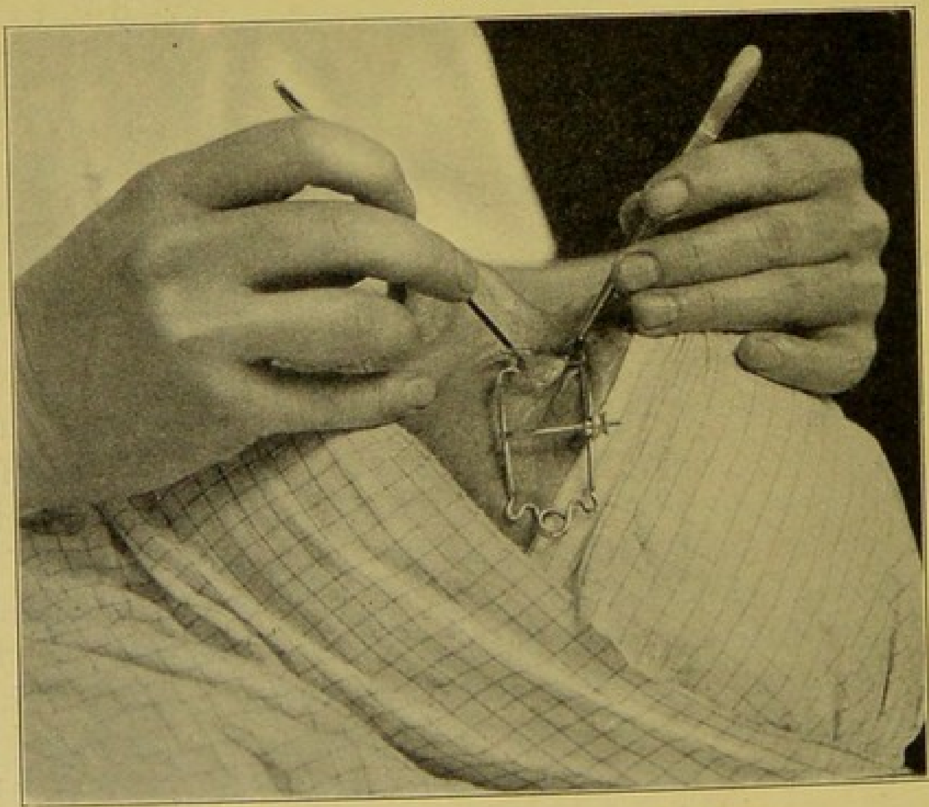
iris. If one does not adhere strictly to this rule, the point will injure the iris. If the point engages in the iris, immediately after puncture, and an effort made to free it by withdrawing the knife, there is an escape of aqueous, as the point, being smaller than the blade does not fill up the wound. By the escape of aqueous the anterior chamber becomes shallow or lost, so that the counter-puncture cannot be made. Under such circumstances, therefore, it is better to withdraw the knife and postpone the operation. If the knife engages in the iris, while carrying it across the anterior chamber or just before counter-puncture, the knife can be slightly

Fig. 30



European method of holding the Graefe knife for cataract extraction.

Fig. 31



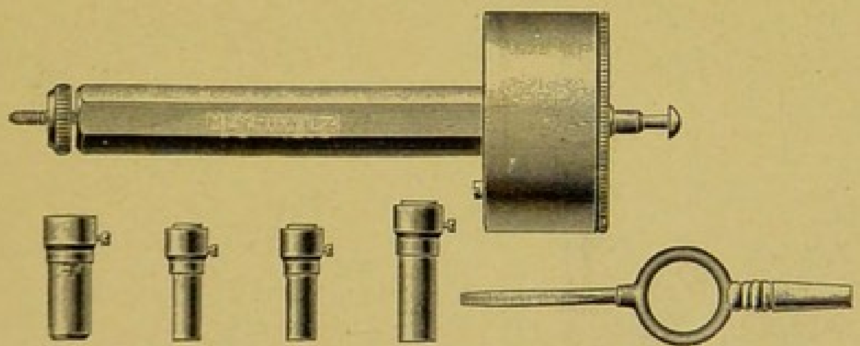
Method of holding the Graefe knife in posterior sclerotomy.

withdrawn and the iris disengaged. In this instance the blade can be withdrawn for a short distance without losing the aqueous; the blade being of equal width at all parts except the point, keeps the wound tamponed.

After counter-puncture, while making the sawing movements, the blade should not be pressed backward, nor should its cutting edge be rotated. If these precautions are not observed the wound edges will be irregular, and the iris will fall in front of the knife, which under such conditions cannot be remedied.

The second method of using the Graefe knife is employed only in operations on the sclera, such as posterior sclerotomy. The knife is held in a similar manner, as in the first method, but the handle is perpendicular to the surface of the globe; the point being directed toward the centre of the eyeball. The cutting edge is directed backward, and the blade usually runs in one of the meridians of the globe (Fig. 31).

FIG. 32

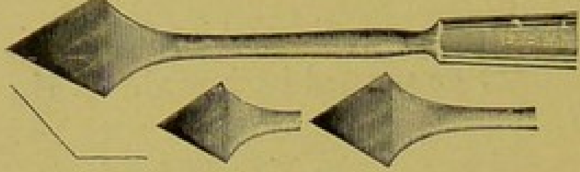


Von Hippel's trephine.

Von Hippel's Trephine (Fig. 32).—This is a small rotary knife which runs by clockwork, a small catch allowing the turning on and off of the power. It is used to make round openings in the cornea or sclera.

Keratomes.—Keratomes may be either angular or straight (Fig. 33). Straight keratomes are now very seldom used, as an angular keratome can always be substituted for them. The angular keratome has a triangular blade, sharp on both sides, whose base is attached to the shank at an angle varying from 35 to 50 degrees. The blade may be of different lengths and widths to suit the individual case. The instrument is used for making incisions of the eyeball and also in lid operations for making the intermarginal incision.

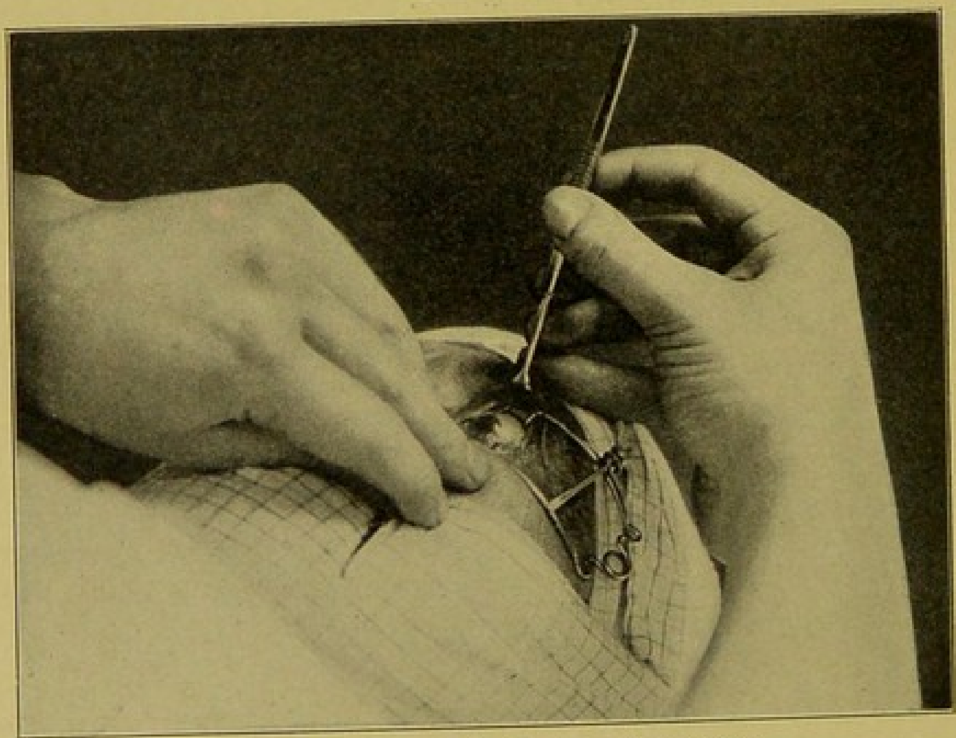
Fig. 33



Keratomes.

Method of Using.—The incisions of the eyeball with the keratome are always made parallel to the limbus, and may be situated in the cornea, limbus, or sclera. The site of the incision may be any point on the circumference of the cornea. The keratome is held between the first two fingers and the thumb,

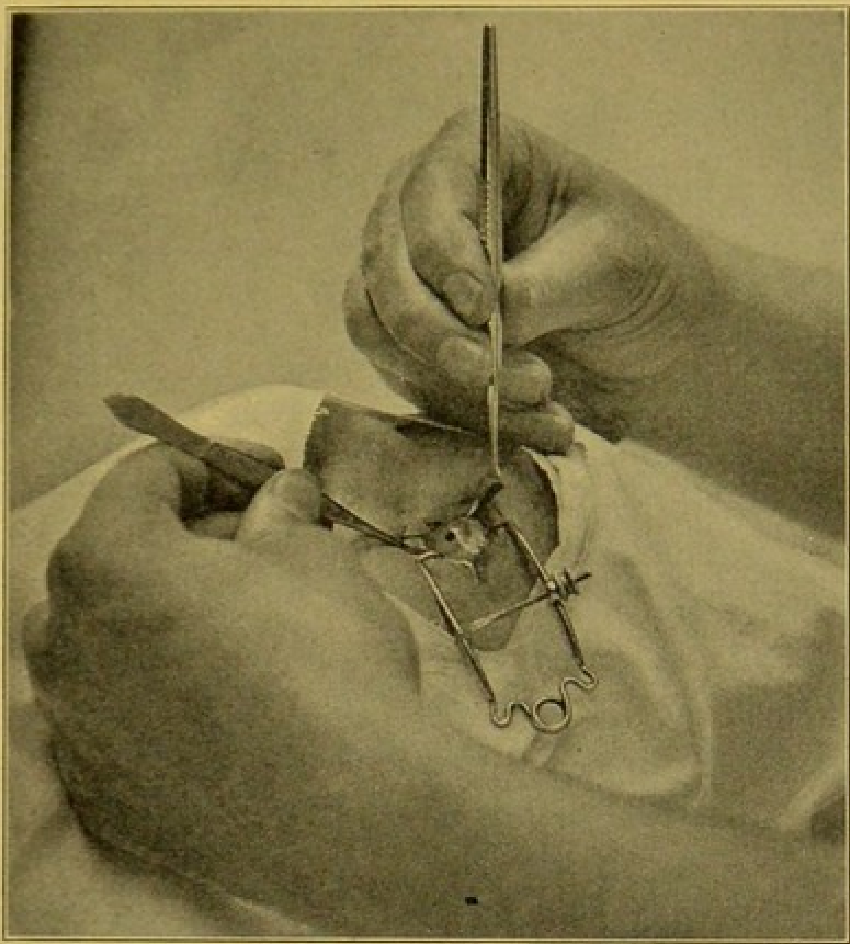
Fig. 34



European method of using keratome from above.

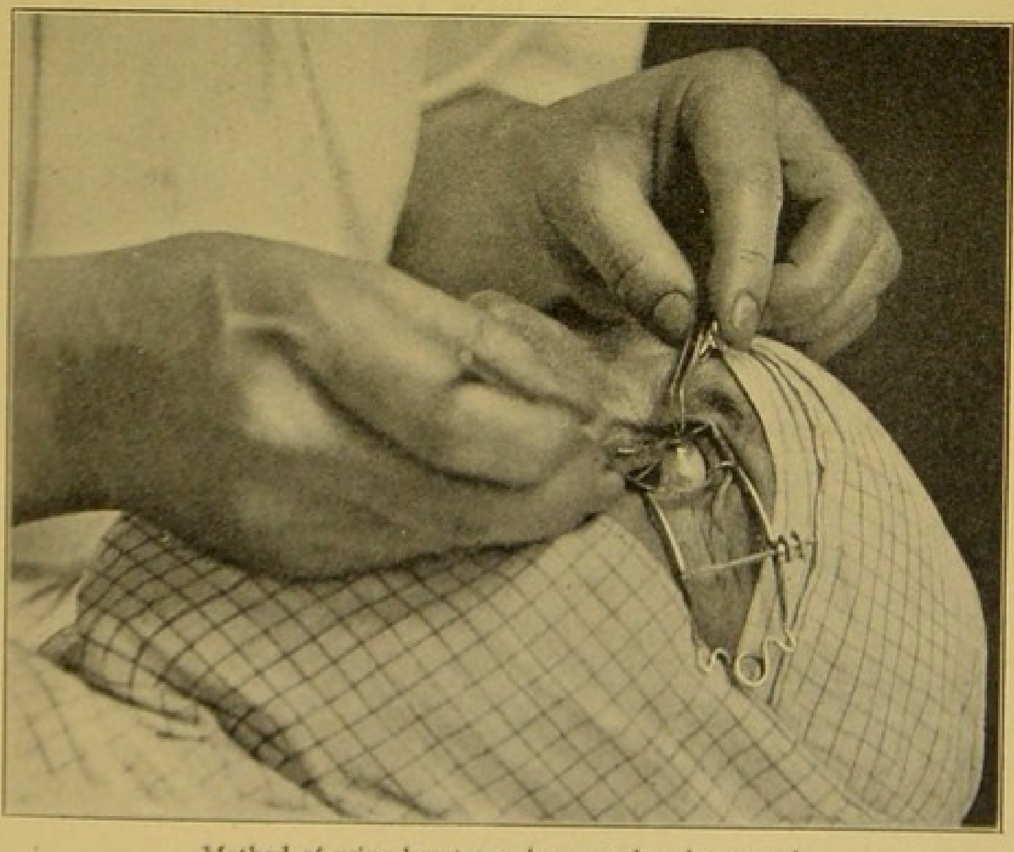
while the little finger is steadied against the face of the patient. According to the surgeon's position and the site of the incision, the keratome must be held in the left as well as the right hand. The use of the left hand can be avoided if the surgeon changes his position according to necessity (Figs. 34 to 37).

Fig. 35



American method of using keratome from above.

Fig. 36

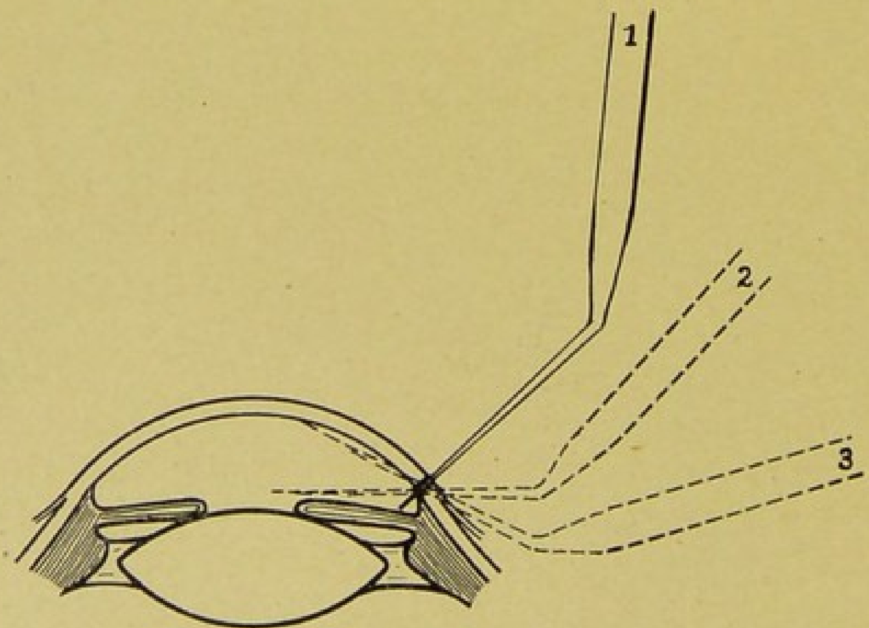


Method of using keratome downward and outward.

Fig. 37

Method of using the keratome inward.

Fig. 38



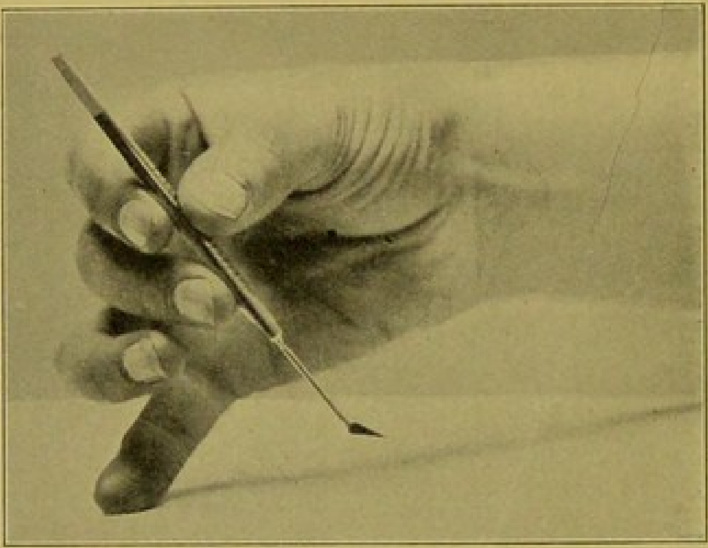
Cross-section showing position of keratome at various stages during incision

The incision with a keratome is made by pushing it through the corneal or scleral tissue into the anterior chamber. The point of the keratome is applied, rather perpendicularly, to the site chosen for the incision, and the instrument is slowly advanced, until the point appears in the anterior chamber (Fig. 38). The handle is then depressed until the blade is parallel to the plane of the iris, after which it is further advanced until the incision is of the desired length. The handle is then still further depressed, until the point comes in contact with the posterior surface of the cornea, and the instrument in this position is slowly withdrawn. To perform this maneuver with the handle of the keratome, the instrument should be held lightly and the little finger, that rests on the patient's face, should be apart from the others (Fig. 39 and 40). If the hand is held in a cramped position with the fingers close to each other (a position that almost all beginners assume) the movements of the keratome are not only greatly interfered with, but the depressing of the handle will be impossible, without changing the position of the whole hand. This is always accompanied with a jerk, and consequently loss of aqueous, making the completion of the incision impossible, and necessitating either the postponement of the operation or the enlargement of the wound with the scissors.

During incision we should not press backward, pull forward, or rotate the keratome, as any of these errors will cause an escape of aqueous; we should also watch carefully the point of the keratome, which must always follow the plane of the iris. The iris is not perfectly flat, but its pupillary margin is somewhat raised, resembling a small mound. In normal eyes this difference in level can be disregarded in making the keratome incision; in glaucoma, however, the anterior chamber being shallow, it will be in the way of the point of the keratome. In such cases, therefore, while advancing the keratome in the anterior chamber, the handle must be slightly depressed when the point is nearing the pupil and then raised so that the blade passes over the apex of the mound.

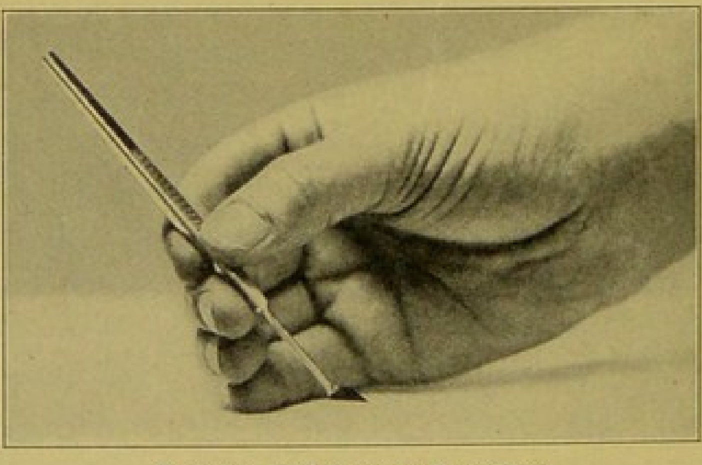
It is an important rule in using the keratome always to advance it steadily until the wound is of desired length, and never withdraw it, even in the slightest degree. If the keratome is withdrawn the wound will not be tamponed by the blade and the aqueous will escape. Under these circumstances the keratome cannot be advanced any farther without injury to the iris or lens, and must therefore be withdrawn. This makes the wound too short for the operation. It may, however, be remedied by

Fig. 39



Keratome held properly.

Fig. 40

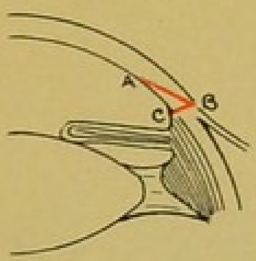


Keratome held in cramped position.

pressing the keratome against one end of the wound during withdrawal, or by enlarging the wound later with the scissors. None of these procedures give the clean-cut and regular wound that is made by pushing the keratome forward. By enlarging the wound during withdrawal of the keratome, it will always be irregular to a certain extent, while wounds enlarged with the scissors are always bruised, and are, therefore, less advantageous for a prompt healing.

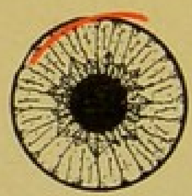
If the keratome is not held perpendicularly to the tissue, when entering the anterior chamber, an intralamellar incision may be the result; if the keratome is rotated during advancement an oblique wound will be made that lies partly in the cornea and partly in the sclera (Figs. 41 and 42). In an intralamellar incision the wound may be too short and the wound canal too long. The subsequent steps of the operation are thus made very difficult or impossible. In exaggerated cases the anterior chamber may not be entered at all, the keratome always remaining in corneal tissue. The intralamellar incision is noticed by the appearance of the blade of the keratome. In keratome incisions, that part of

Fig. 41



Intralamellar incision (*A B*) and correct incision (*B C*) with keratome.

Fig 42

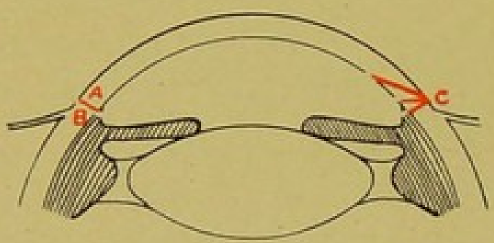


Oblique wound with keratome.

the blade which appears in the anterior chamber has the same luster as the rest of the blade that has not entered the cornea; the part of the blade engaged in the corneal wound has a peculiar dull gray lusterless appearance, and in a properly made incision this part is but little wider than the thickness of the cornea itself (1 mm.). In an intralamellar incision, on the contrary, the engaged part of the keratome is much wider. If an intralamellar incision is made and the anterior chamber has not been opened a fresh incision must be made, preferably at another site. If, however, the anterior chamber is entered by the point of the keratome, and the wound is small and very centrally located, the operation should be postponed. In other cases the incision may be enlarged with the scissors.

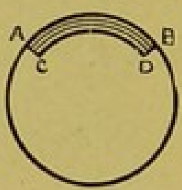
If the wound is made partly in the cornea and partly in the sclera, the error cannot be remedied. This gives rise to complications which greatly interfere with the operation, and will also diminish the good result in many cases. During withdrawal of the keratome the aqueous escapes, the pupil contracts, and the iris and lens come forward against the posterior surface of the cornea. For this reason, to avoid injury to these structures, it is necessary to depress the handle until the point comes in contact with the posterior surface of the cornea. The withdrawal must be gradual in order to avoid a sudden escape of aqueous which may cause a prolapse of the iris.

Fig. 43



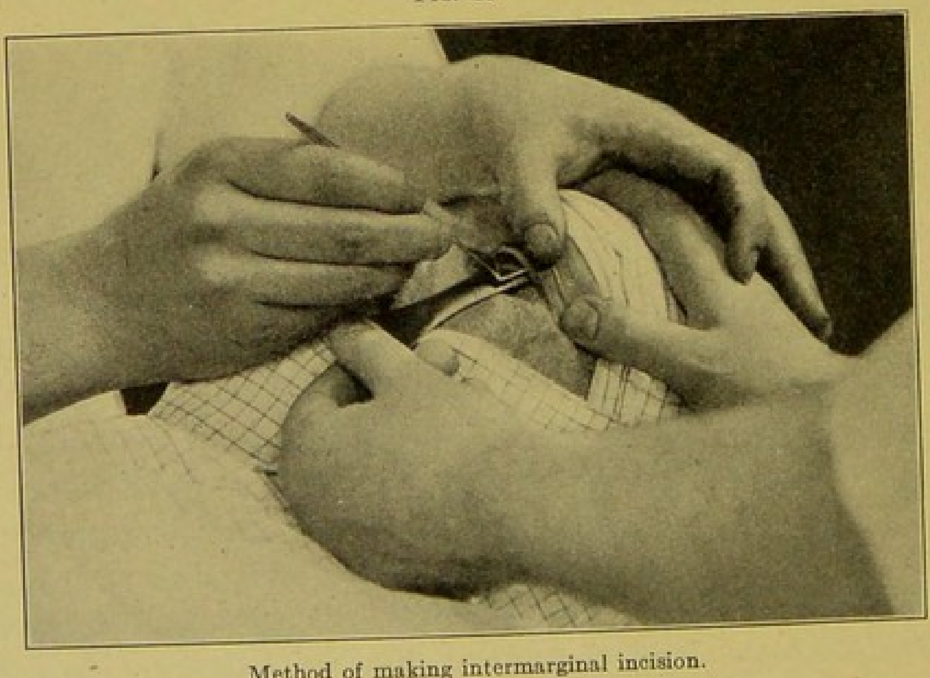
Linear wound (cross-section). *A*, anterior lip of wound; *B*, posterior lip of wound; *C*, wounds of various lengths.

Fig. 44



Linear wound showing wound canal. *A B*, outer opening; *C D*, inner opening; *A B C D*, wound canal.

Fig. 45



Method of making intermarginal incision.

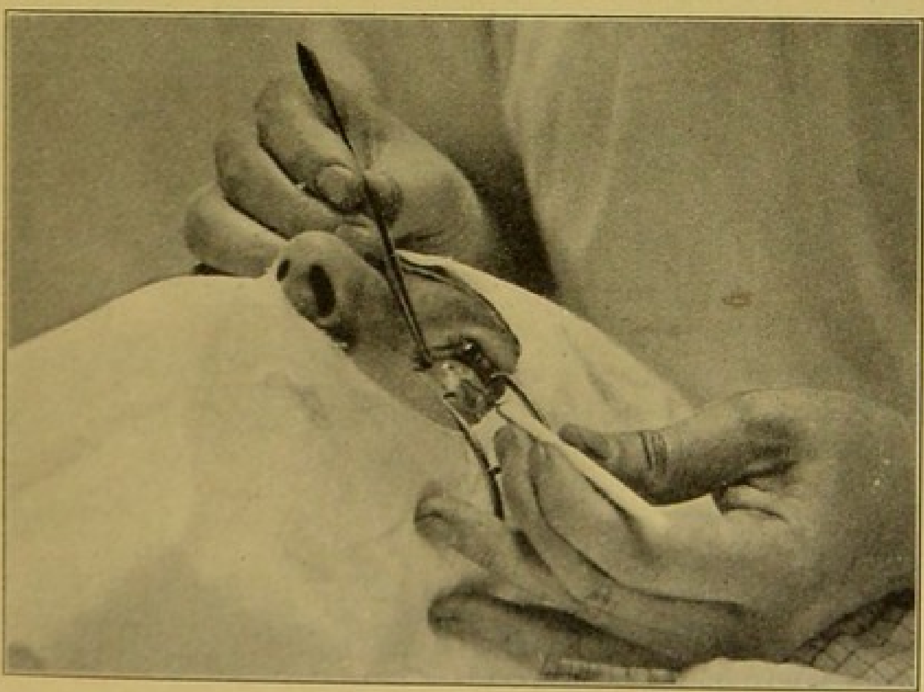
The incisions made by the keratome (called linear wounds) are short, and pass obliquely through the tissues. By means of the obliquity of the incision a wound canal is formed, the outer opening of which is longer than the inner opening. The wound has an anterior and posterior lip which overlap each other, thereby securing a quick and perfect closure (Figs. 43 and 44).

In eyelid operations the keratome is used for making the intermarginal incision. This is done as follows: A horn plate is placed under the eyelid. The assistant holds the horn plate with one hand, while with the other he draws the lid toward the outer canthus. The operator slightly everts the lid with the left thumb, exposing the intermarginal line. The keratome is held in the right hand the same as a pen or pencil, and the intermarginal line is incised with the keratome (Fig. 45).

Fig. 46

Knapp's knife-needle.

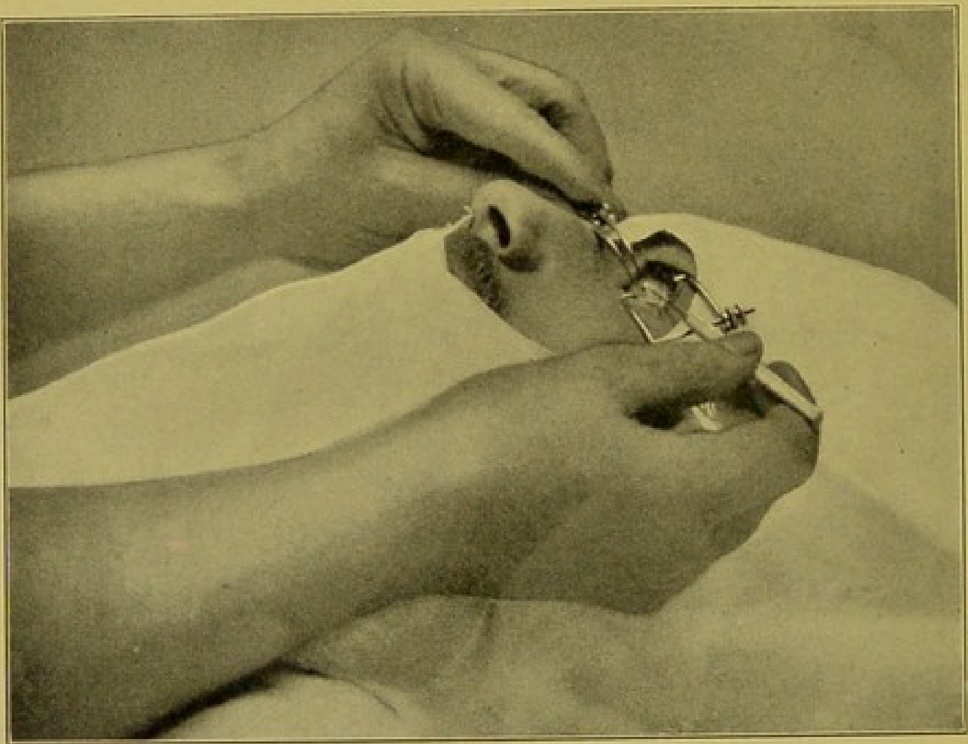
Fig. 47



American method of using Knapp's knife-needle.

Knapp's Knife-needle (Fig. 46).—This instrument is used for discission of the lens capsule, also for the incision of a secondary cataract. It consists of a handle, shaft, and blade. The blade is straight, cutting on one side only, and is from 3 to 6 mm. in length. The shaft is so proportioned that it fills exactly the opening made by the blade, so that the needle can be manipulated in the anterior chamber without loss of aqueous or injury to the cornea. The knife-needle is held with the first two fingers and thumb in exactly the same manner as the Graefe knife (Figs. 47 and 48).

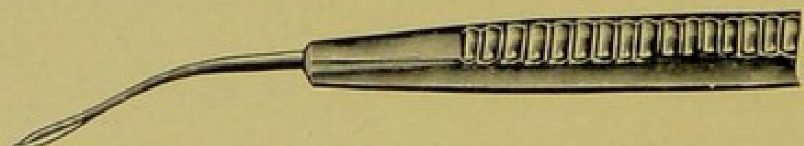
Fig. 48



European method of using Knapp's knife-needle.

Kuhnt's Knife-needle (Fig. 49).—Kuhnt's knife-needle does not differ greatly from the Knapp knife-needle, but the blade is

Fig. 49



Kuhnt's knife-needle

somewhat larger, and joins the shaft at an angle of about 120 degrees. There are separate needles for the right and left side, but there is also one sharpened on both edges which can be used from either side.

Schulek's Sphincterotome (Fig. 50).—This instrument is used to liberate anterior synechia. It is a small sickle-shaped knife-needle, the cutting edge of which is on the convexity.

FIG. 50

Schulek's sphincterotome.

Tattooing Needles (Figs. 51 and 52).—De Wecker's tattooing needle contains four or five needles in a compact bundle. The needles may also be placed in a row when a larger area is to be tattooed.

FIG. 51

Tattooing needle.

FIG. 52

Tattooing needle.

Foreign-body Needle or Spud (Fig. 53).—This is for the removal of foreign bodies from the cornea. It is a small lance-shaped instrument mounted on a suitable handle.

FIG. 53

Foreign-body needle.

Weber's Grooved Foreign-body Gouge.

Bowman's Stop-needle (Fig. 54).—This instrument is a small lance-shaped needle, mounted on a thin shaft, which is inserted into a larger one. This prevents the needle from penetrating too deeply in the anterior chamber and will also prevent the escape of aqueous.

Fig. 54

Bowman's stop-needle.

Knapp's Needle-cystotome.—It is similar to Knapp's knife-needle, but its end is bent sickle-shape. It is used for discission of the lens capsule.

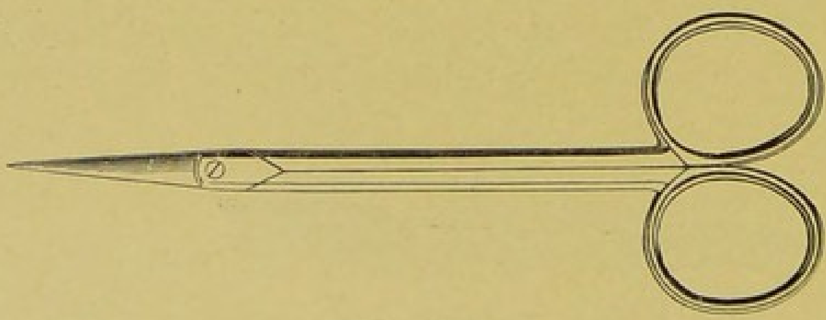
Ziegler's Knife-needle (Fig. 55).—Ziegler's knife-needle has a falciform point, with a straight-edge cutting blade 7 mm. in length. The shaft is rounded so that it completely fills the wound in the cornea.

Fig. 55

Ziegler's knife-needle.

Scissors (Figs. 56 to 61).—**Small, Straight, and Curved Scissors.**—These are used in operations on the conjunctiva and iris.

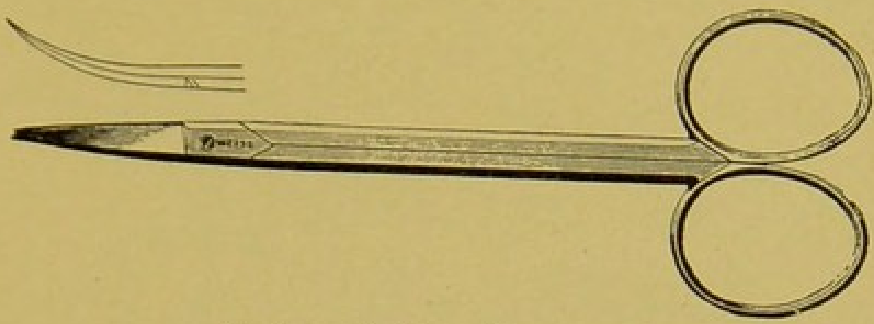
Fig. 56



Small straight scissors.

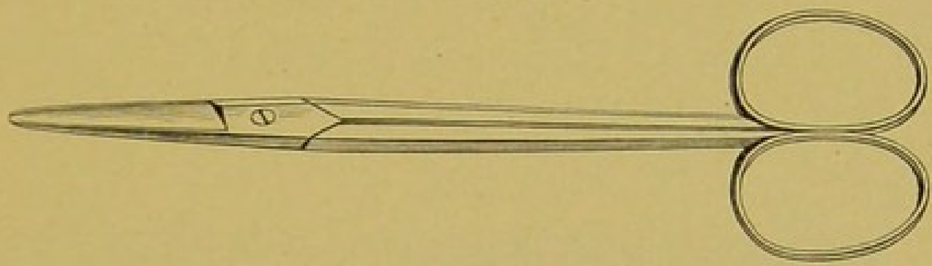
Medium Size, Curved, and Straight Scissors.—These are used in plastic and orbital operations.

Fig. 57



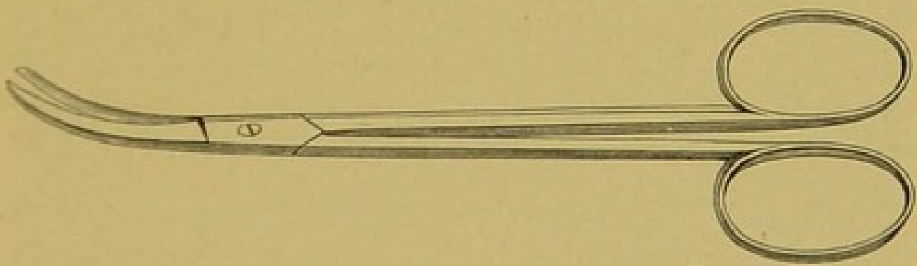
Small curved scissors (iris scissors).

Fig. 58



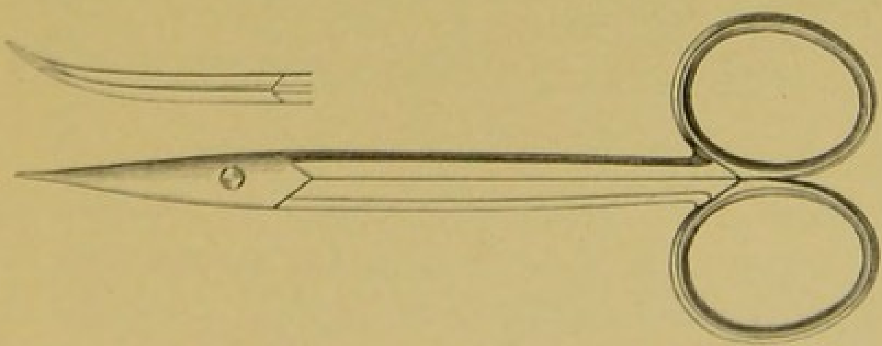
Medium size straight scissors.

Fig. 59



Medium size curved scissors.

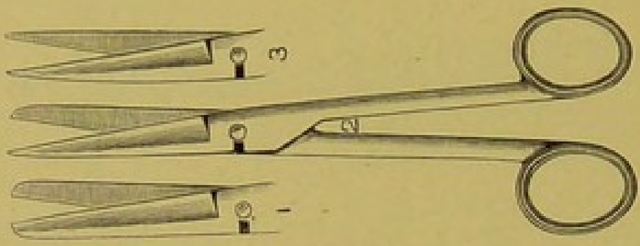
Fig. 60



Stevens' tenotomy scissors.

Stevens' Tenotomy Scissors.—These are curved, narrow-bladed scissors.

Fig. 61

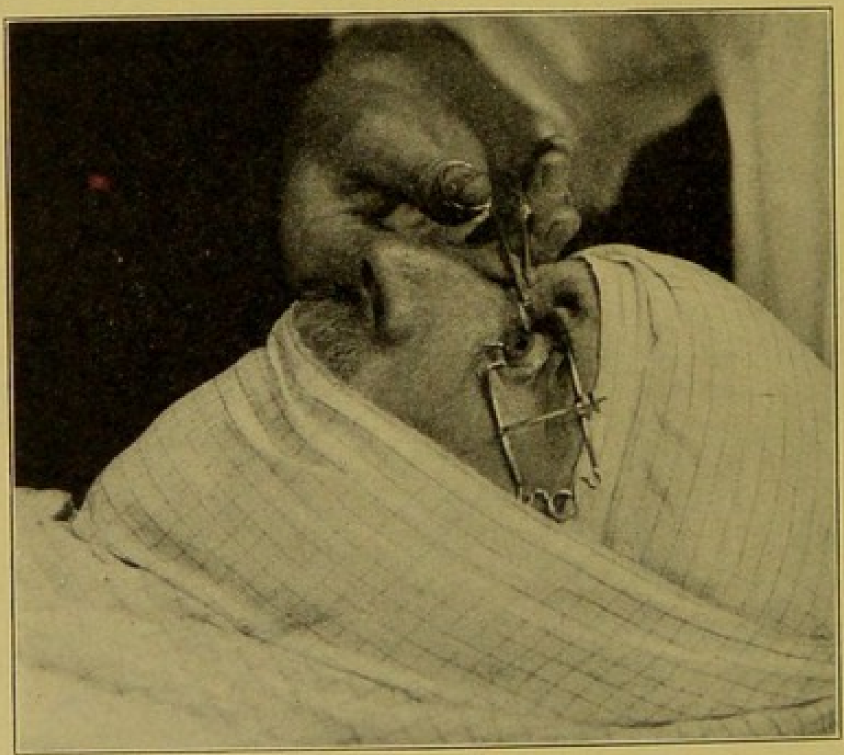


Strong straight scissors.

Strong Straight Scissors.

Method of Using (Figs. 62 to 65).—In holding the scissors the thumb is placed in one ring and the fourth finger in the other; the index finger is placed on the lock of the scissors or the patient's

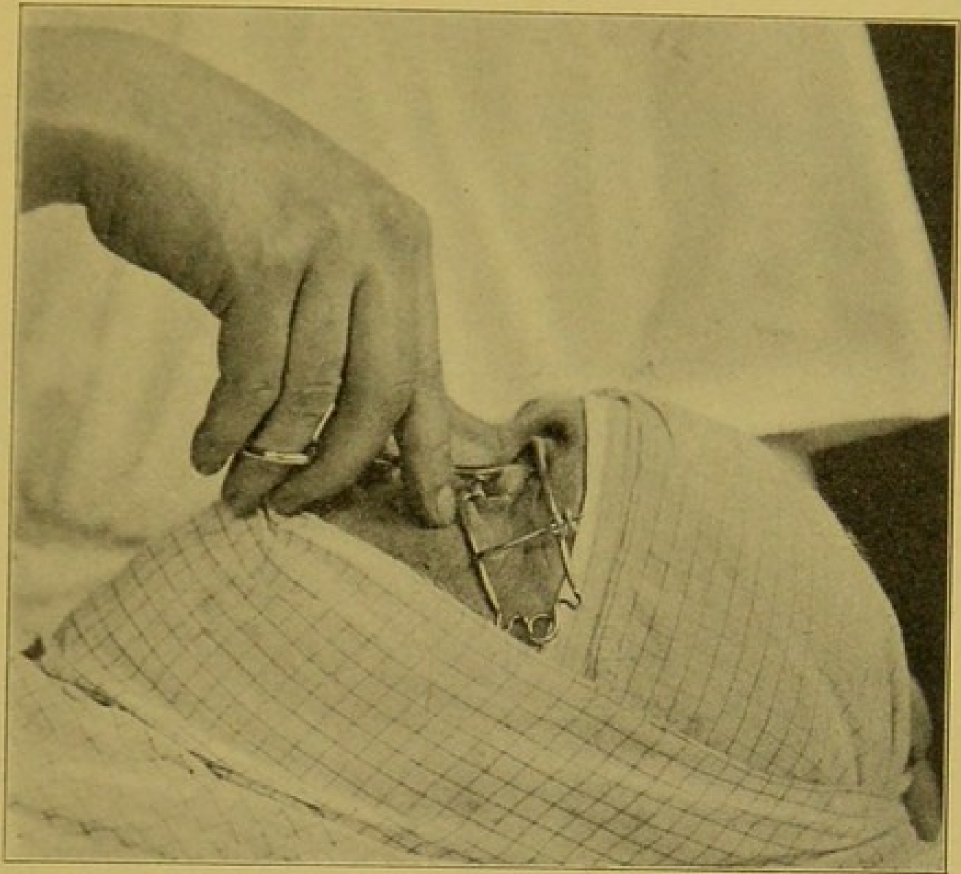
Fig. 62



Method of using scissors in various positions

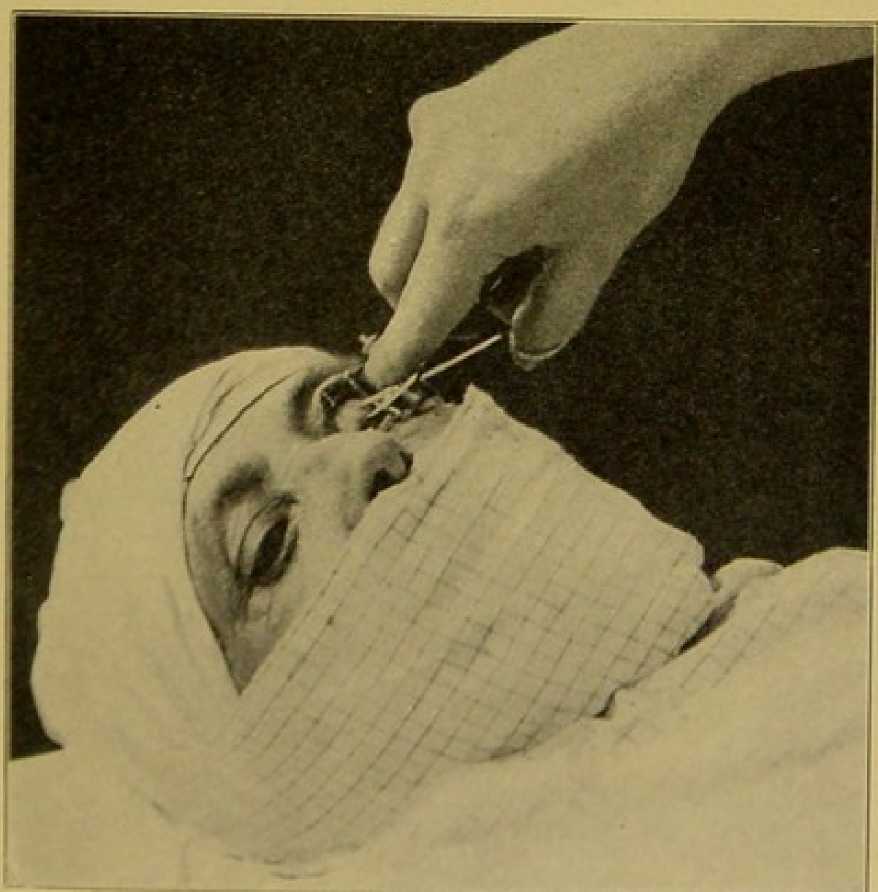
face, in which event the lock is then steadied against it. Scissors are always used in the right hand, in case the right hand cannot be used the surgeon's position is changed. For use with the left hand special scissors must be constructed.

Fig. 63



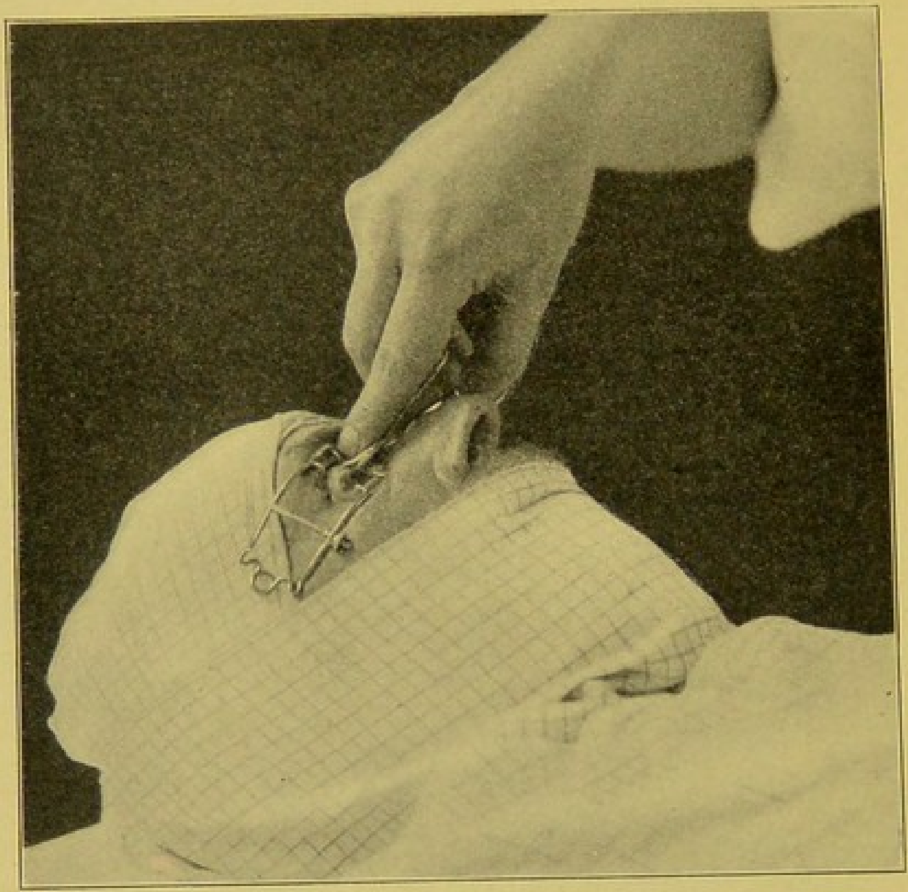
Method of using scissors in various positions.

Fig. 64



Method of using scissors in various positions.

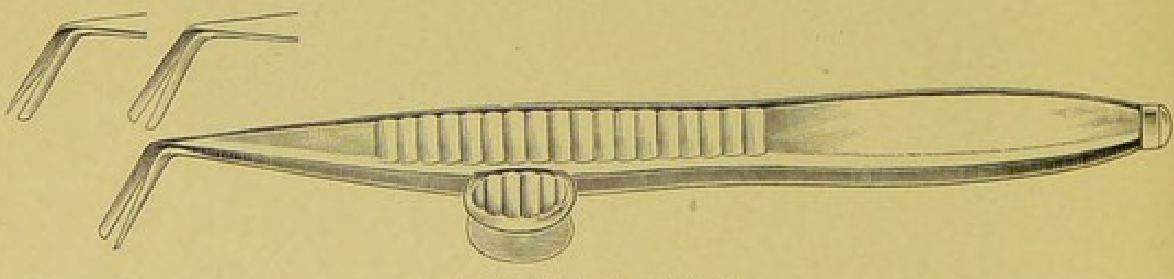
Fig. 65



Method of using scissors in various positions.

De Wecker's Pince-ciseaux (Fig. 66).—This instrument consists of two branches about 15 cm. in length, at the ends of which are attached the two blades at an angle of about 35 degrees to the

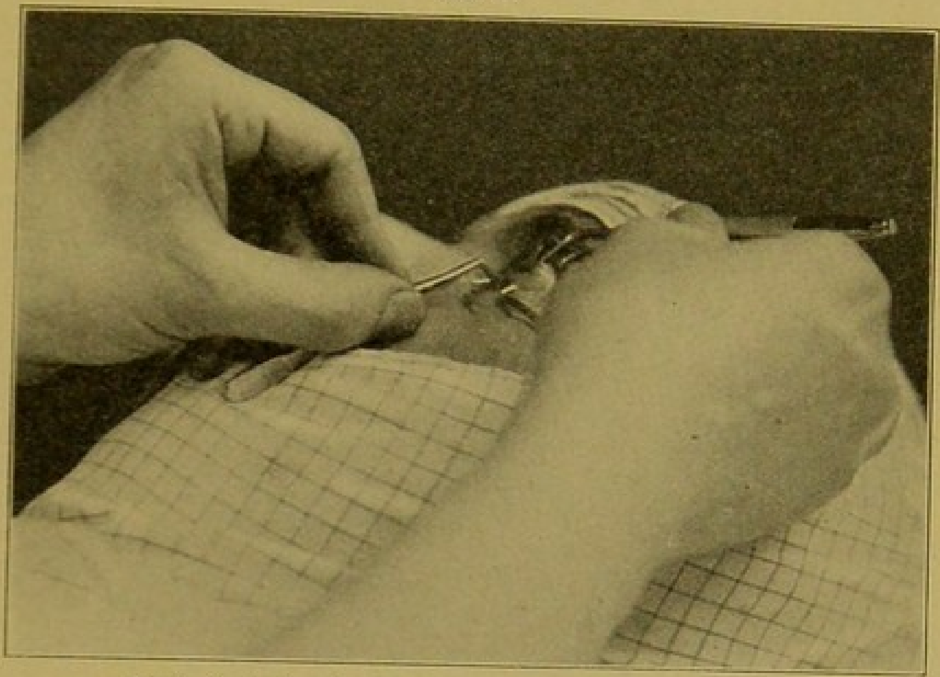
Fig. 66



De Wecker's pince-ciseaux.

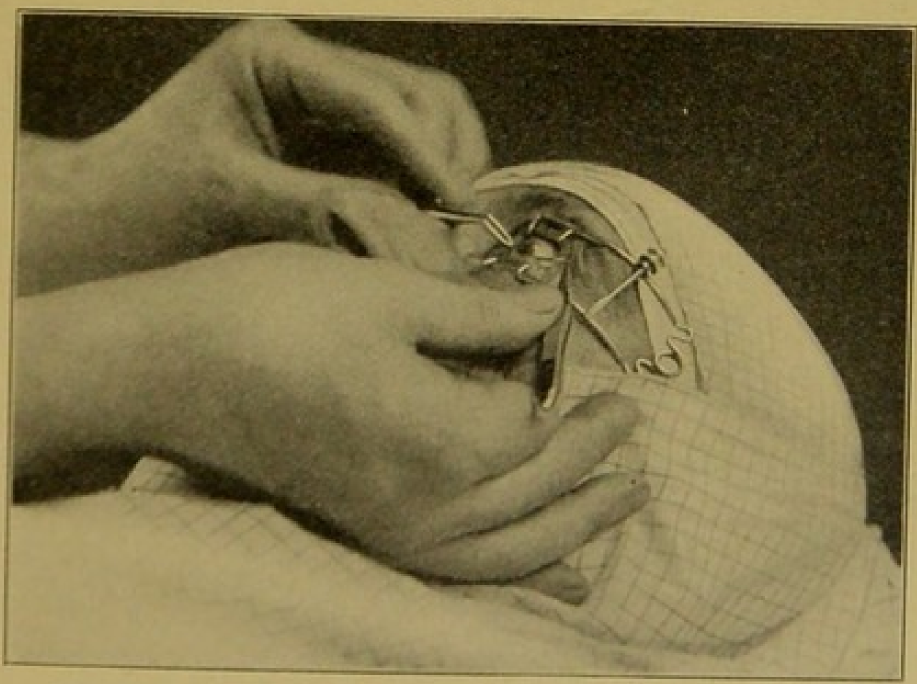
axis of the instrument; one blade is pointed and the other blunt. On each branch near its midpoint is a small wing-shaped finger rest. The branches of the instrument are so arranged that they open and close like a book. It is held between the index finger and the thumb, which are placed on the finger rests. The hand is steadied with the little finger, which is placed on some convenient point near the patient's eye (Fig. 67 and 68).

Fig. 67



Method of using De Wecker's pince-ciseaux. From above.

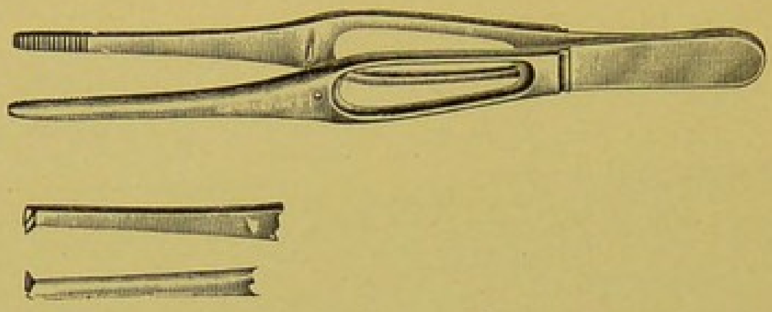
Fig. 68



Method of using De Wecker's pince-ciseaux. From the temporal side.

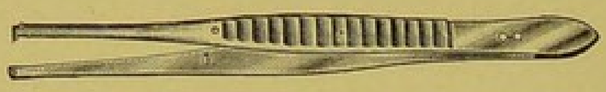
Forceps (Figs. 69 to 73).—**Rat-tooth Forceps, Mouse-tooth Forceps, and Artery Clamps.**—These instruments are the same as those used in general surgery, but smaller in size.

FIG. 69



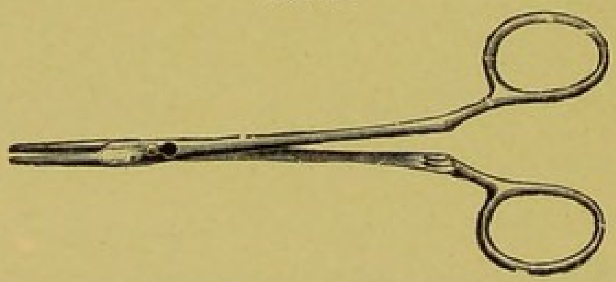
Anatomical and rat-tooth forceps.

FIG. 70



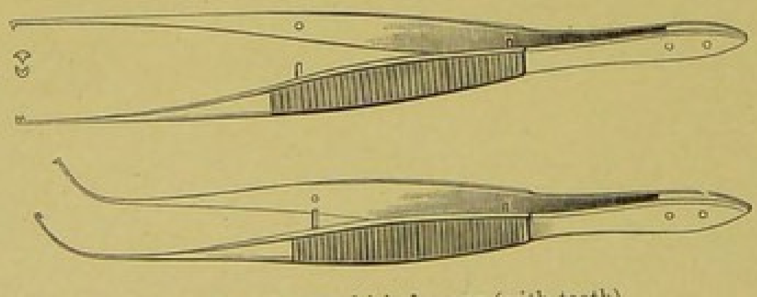
Mouse-tooth forceps.

FIG. 71



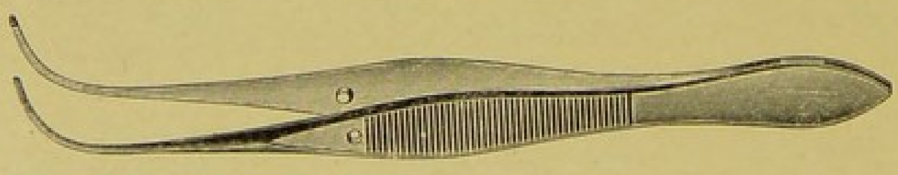
Artery clamp.

FIG. 72



Straight and curved iris forceps (with teeth).

FIG. 73

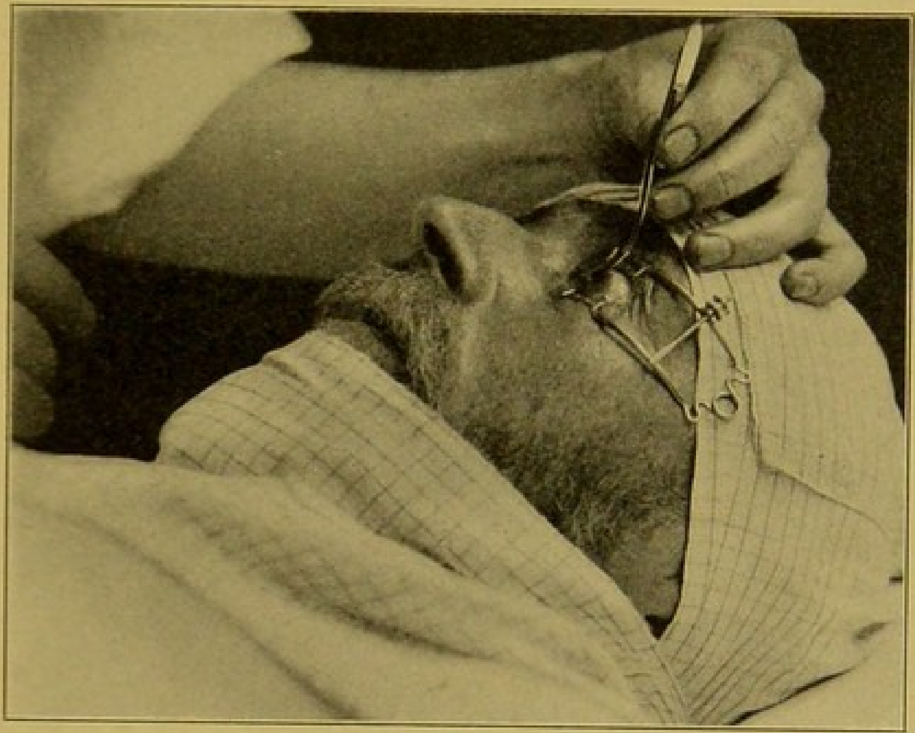


Curved iris forceps (serrated).

Medium Size and Small Anatomical Forceps.

Iris Forceps.—These are of various lengths. The ends of the blades are slightly curved, and may be serrated or may have

FIG. 74

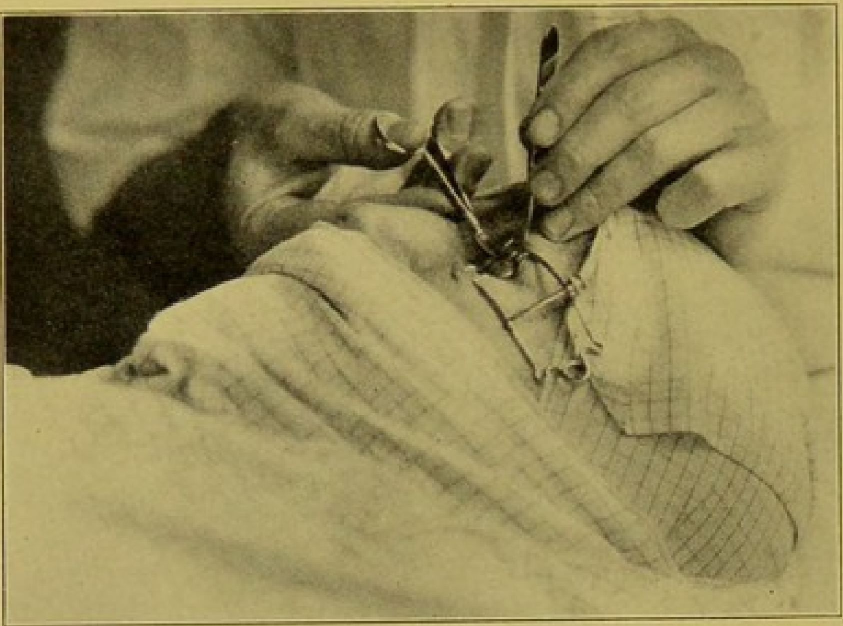


Method of using iris forceps.

FIG. 75

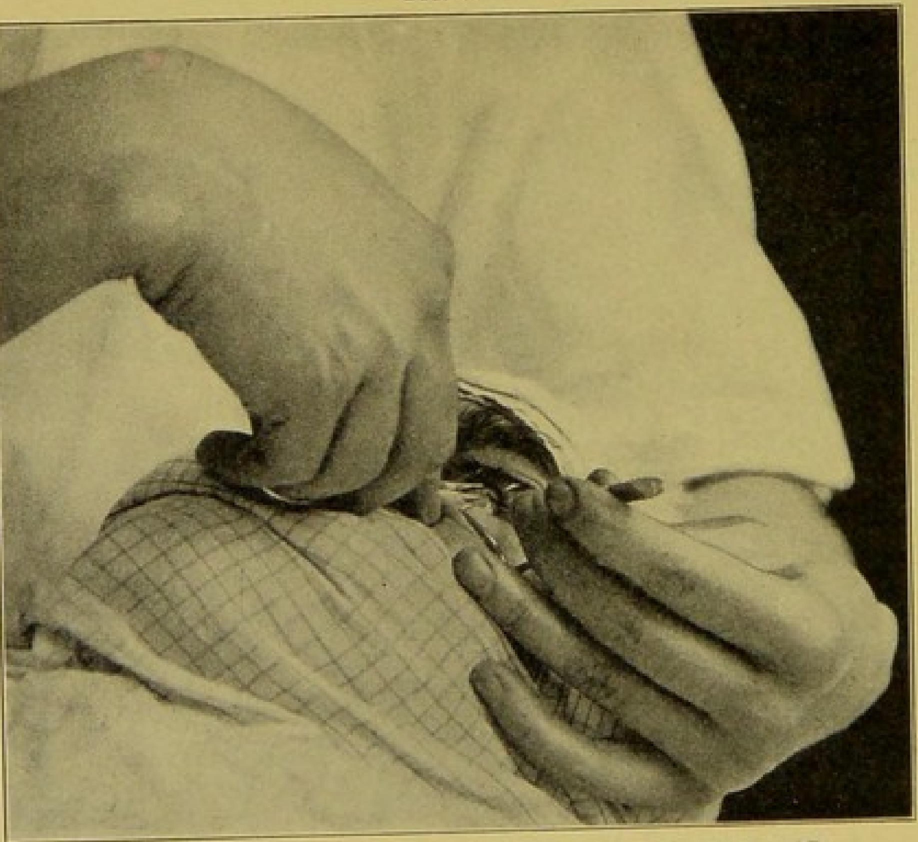
Method of using iris forceps and scissors in various positions. (*A*) teeth. They are used to withdraw the iris from the anterior chamber, and are held between the first and second fingers and

Fig. 76



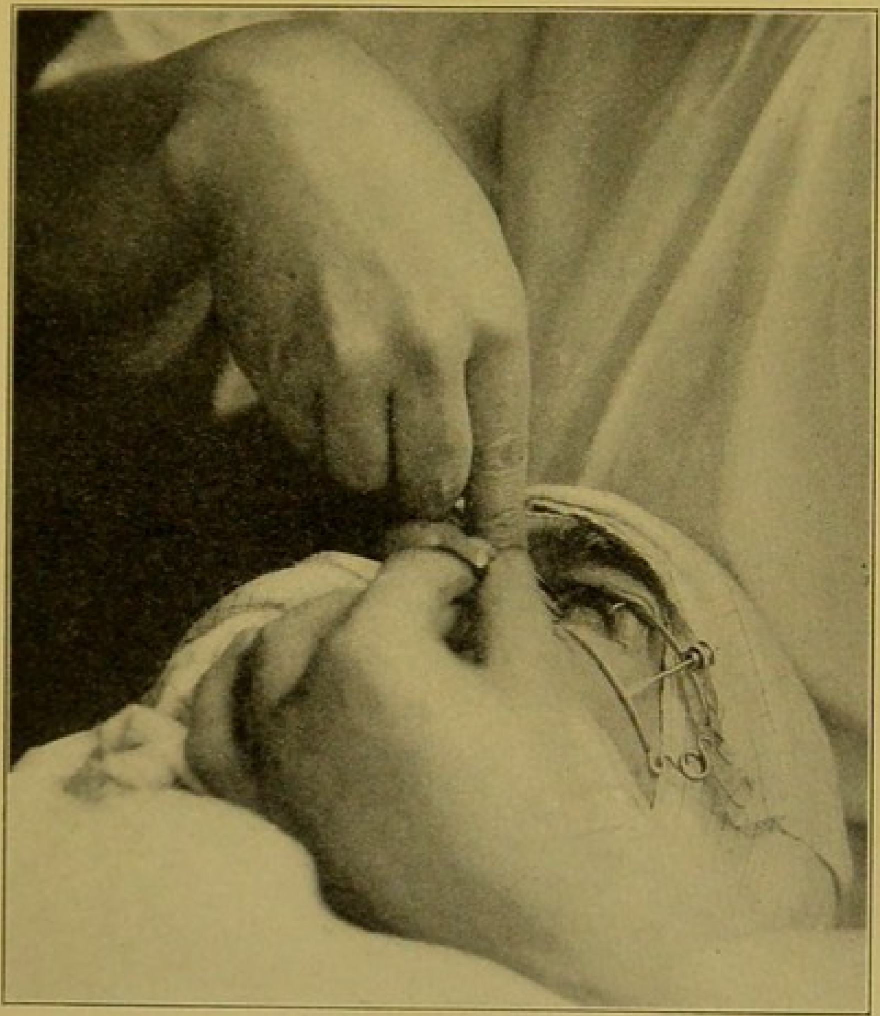
Method of using iris forceps and scissors in various positions. (B)

Fig. 77



Method of using iris forceps and scissors in various positions. (C) thumb, the little finger resting on the patient's face. As they are usually used simultaneously with scissors they are held in the left hand (Figs. 74 to 78).

FIG. 78



Method of using iris forceps and scissors in various positions. (*D*)

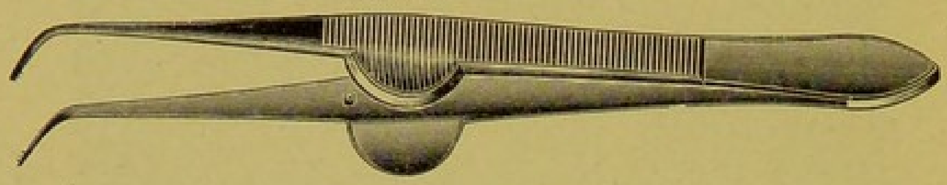
Capsule Forceps.—There are many varieties in use. The first capsule forceps was devised by Foerster. It had three teeth on

FIG. 79

Schulek's capsule forceps.

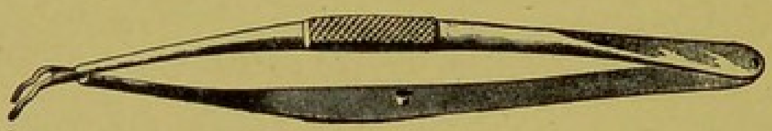
one side and two on the other. There are many modifications of this forceps in use. In the Schulek modification (Fig. 79) the advantage is that the heels of the blades do not touch when closed, thus avoiding the grasping of the iris. In Müller's modification (Fig. 80) the heels of the blades separate on pressing the branches of the forceps together. Smith's capsule forceps are also a good modification (Fig. 81).

Fig. 80



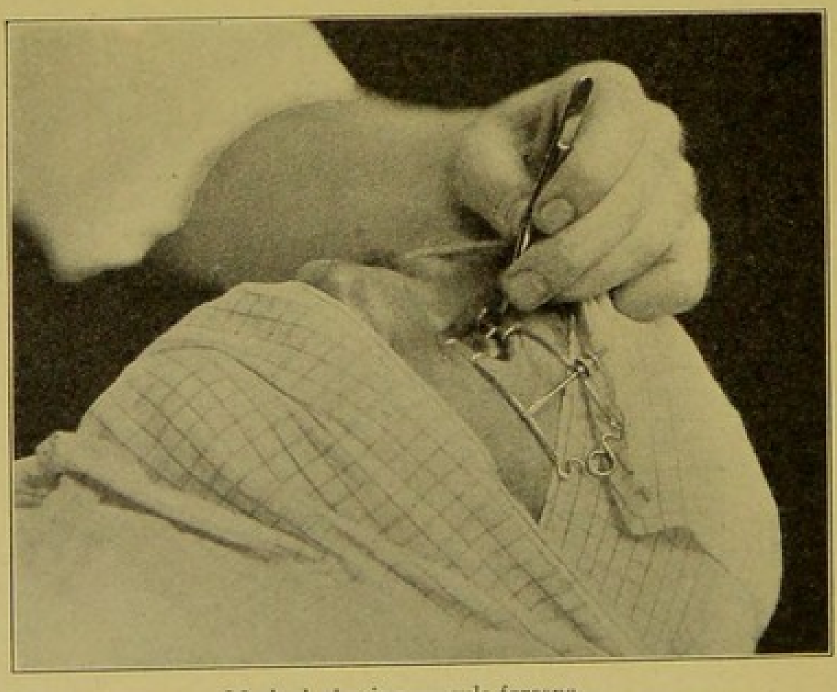
Müller's capsule forceps.

Fig. 81



Smith's capsule forceps.

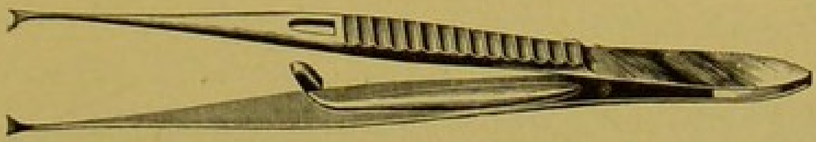
Fig. 82



Method of using capsule forceps.

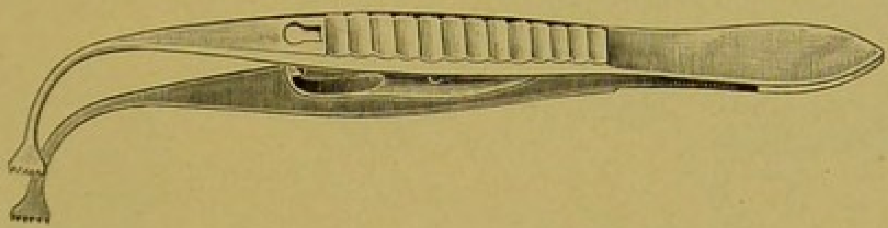
Fixation Forceps.—There are various forms and sizes of these. They may be straight or curved. Of the straight variety, Graefe's (Fig. 83) of the curved variety and Noyes' (Fig. 84) are of value. Both of the forceps are supplied with sharp teeth and a catch. The forceps are applied at the limbus with blades closed; pressing them gently against the conjunctiva, they are allowed

Fig. 83



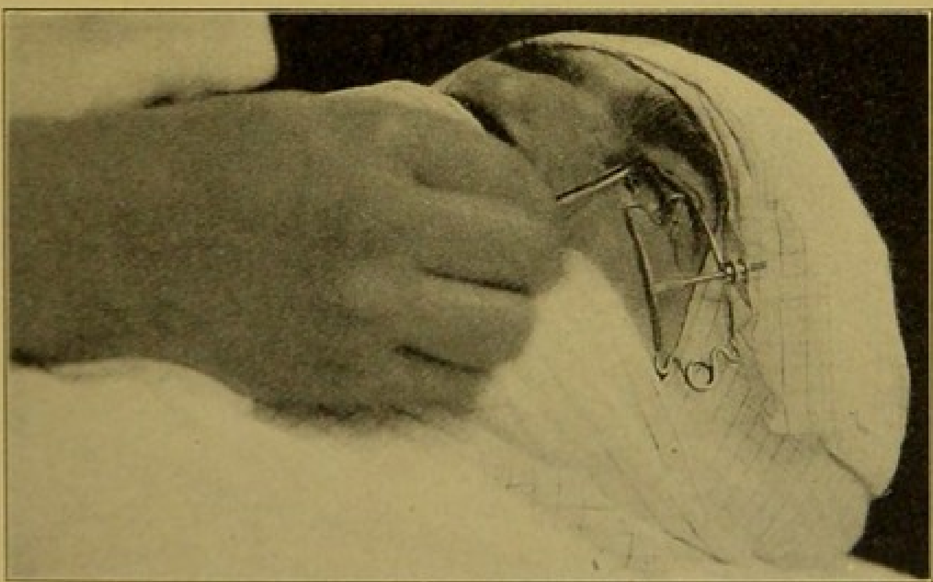
Graefe's fixation forceps.

Fig. 84



Noyes' fixation forceps.

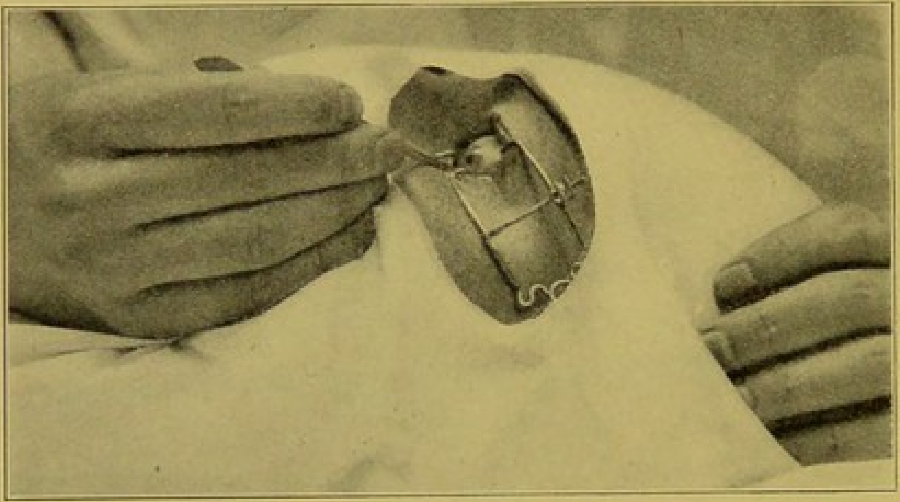
Fig. 85



Method of applying curved fixation forceps.

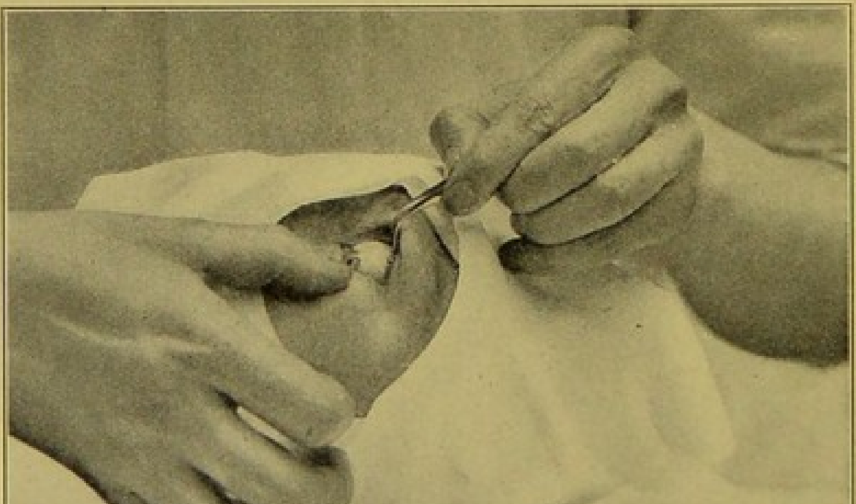
to open for a distance of about $\frac{1}{2}$ cm. and then closed. During closure they are firmly pressed against the sclera in order to secure a hold in the episcleral tissue as well as the conjunctiva. Before proceeding with the operation, we must always make certain that we have a firm hold on the eyeball. It is important to fix the eyeball at exactly the limbus for the reason that the conjunctiva is firmly adherent at this point. In operating from behind the straight forceps are of value, in front the curved forceps are better. The forceps may be held in either hand. If the surgeon is using both hands the assistant may steady the eye if there is no assistant present the forceps are to be removed (Figs. 85 and 86).

Fig. 86



Method of applying straight fixation forceps.

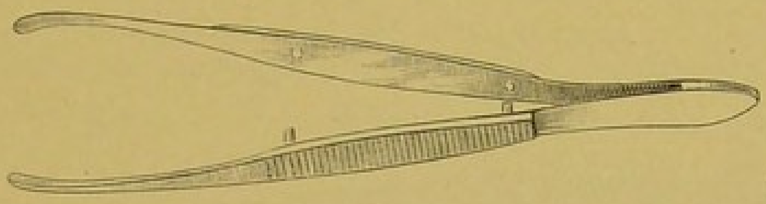
Fig. 87



Angelucci's method of fixation.

In case of an unruly patient who cannot control his orbicularis muscle, or can not govern the movements of his eyes, and where for some reason or other a general anesthesia cannot be given, Angelucci's method of fixation is of service. In this case the curved fixation forceps are used. The upper lid is raised and the fixation forceps slipped above the tendon of the superior rectus muscle which is seized. By employing this method a speculum is not necessary, as the fixation forceps retract the upper lid. The eye is thus depressed, and a spasm of the orbicularis is impossible. The only disadvantage of this procedure is that the forceps may be in the way during the section (Fig. 87).

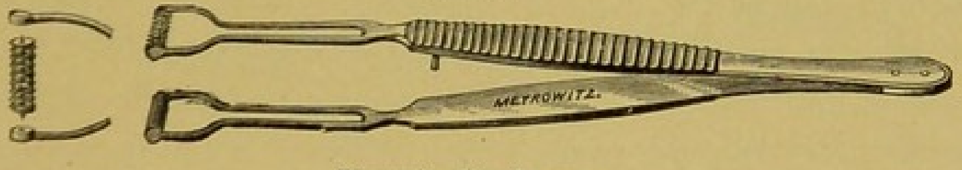
FIG. 88



Cilia forceps.

Cilia Forceps (Fig. 88).—Cilia forceps are forceps with short flat blades. They are used to remove cilia.

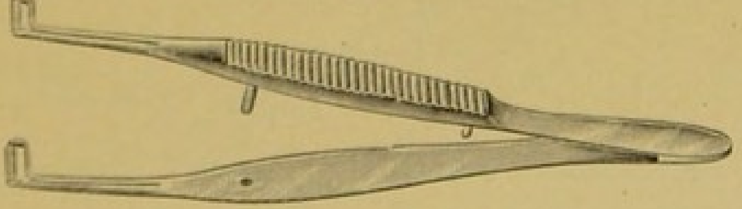
FIG. 89



Knapp's roller forceps.

Knapp's Roller Forceps (Fig. 89).—These consist of two creased cylinders about 2 mm. thick and 11 mm. long, rolling on pivots in horseshoe-shaped ends of the shaft.

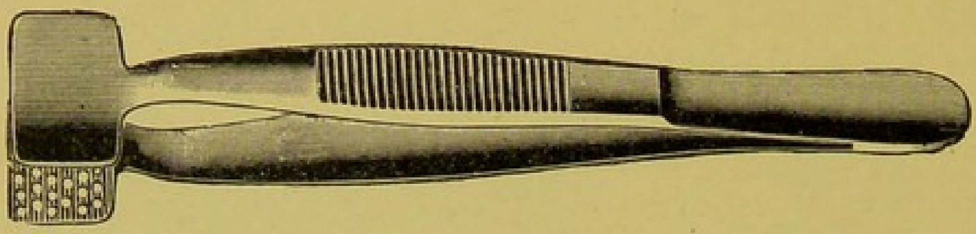
FIG. 90



Rust's trachoma forceps.

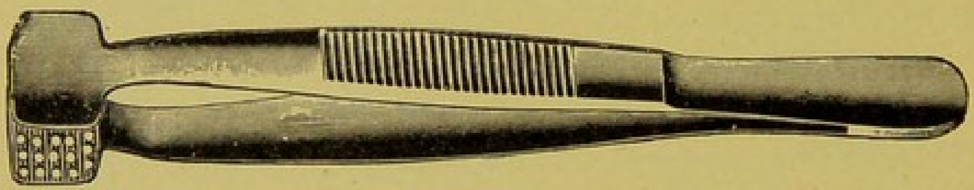
Rust's Modification.—In Rust's modification (Fig. 90) the horseshoe shape is altered so that one arm is the continuation of the shaft, while the other crosses over to support the opposite end of the cylinder. Knapp's roller forceps are used for the expression of trachoma follicles, Rust's modification being of value in removing the follicles from the canthi.

Fig. 91



Kuhnt's expressors with quadrangular plates.

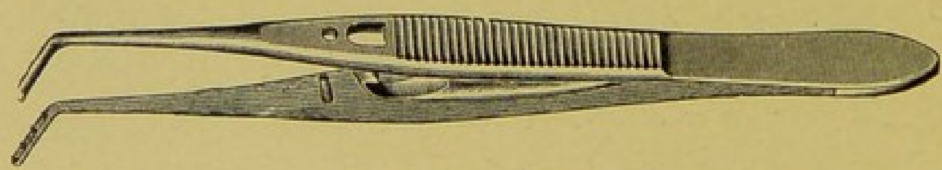
Fig. 92



Kuhnt's expressors with rounded plates

Kuhnt's Expressors (Figs. 91 and 92).—These instruments are used for the same purpose as the roller forceps. There are two forms in use: one with two quadrangular plates, the other with two rounded plates. The inner surfaces of both blades are serrated; in the quadrangular form only one blade is perforated, in the other both are.

Fig. 93

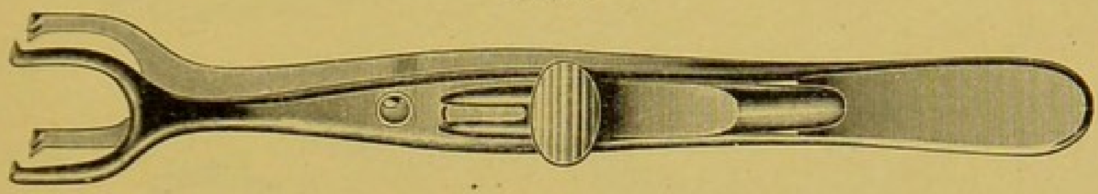


Prince's advancement forceps.

Prince's Advancement Forceps (Fig. 93).—These are used to hold the severed muscle in advancement operations. Its jaws are at right angles to the axis of the forceps. One blade is spiked and the other correspondingly perforated. It has a lock similar to the fixation forceps.

Panas' Forceps (Fig. 94).—This is a forceps for the lid, and consists of two double-forked blades that have teeth at the ends. There is a lock similar to that of the fixation forceps. It can be used to advantage in everting the lid doubly.

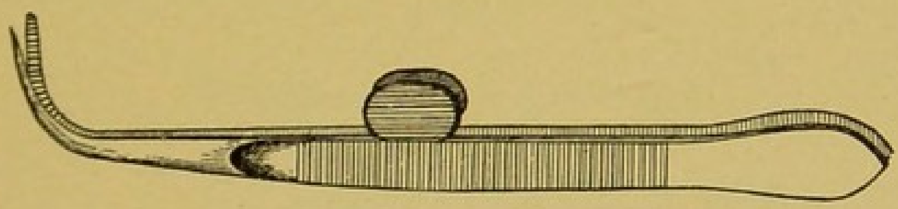
Fig. 94



Panas' forceps.

Panas' Extraction Forceps (Fig. 95).—The instrument is similar in design to the De Wecker pince-ciseaux. The ends of the blades are curved and the inner surfaces serrated. One blade is pointed, the other blunt. It is held in a similar manner to the pince-ciseaux, and is used to extract membranous cataracts.

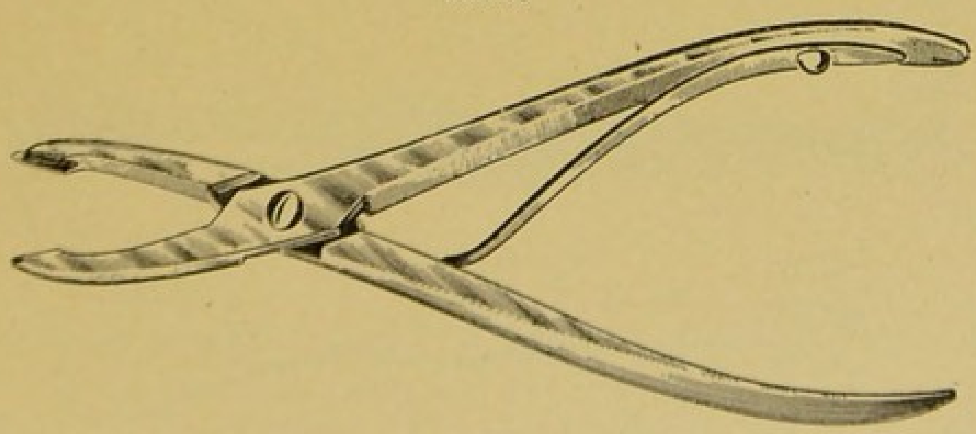
Fig. 95



Panas' extraction forceps.

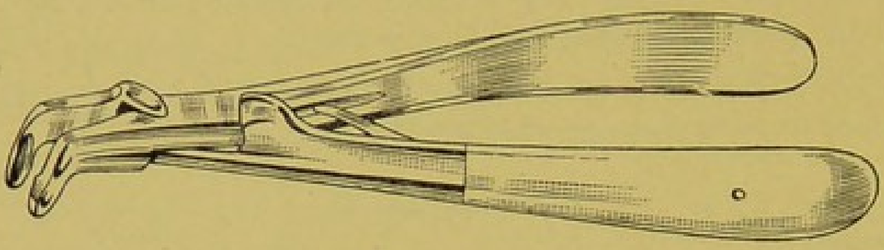
Bone Forceps of Various Sizes (Figs. 96 and 97) **and Museux Forceps** (Fig. 98).—These are used for orbital operations.

Fig. 96



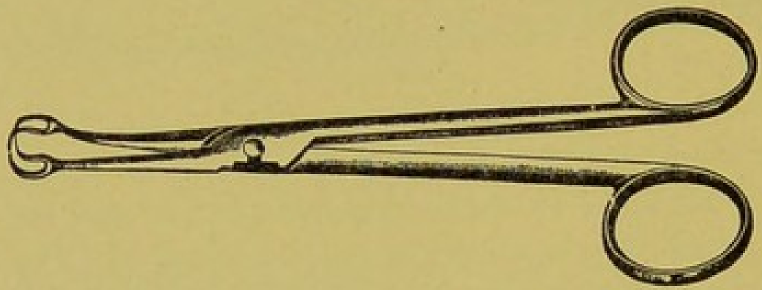
Bone forceps.

Fig. 97



Bone forceps.

Fig. 98



Museux forceps.

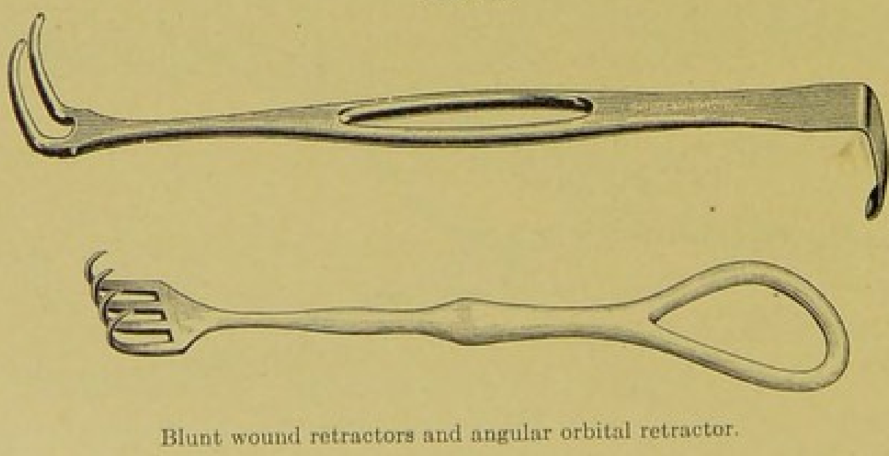
Hooks.—**Fine Sharp Wound Retractors** (Fig. 99).

Fig. 99

Fine sharp wound retractor.

Medium and Small Blunt Wound Retractors (Fig. 100.)—Orbital retractors *straight* (Axenfeld) and *angular* are used, to retract the orbital contents during operation.

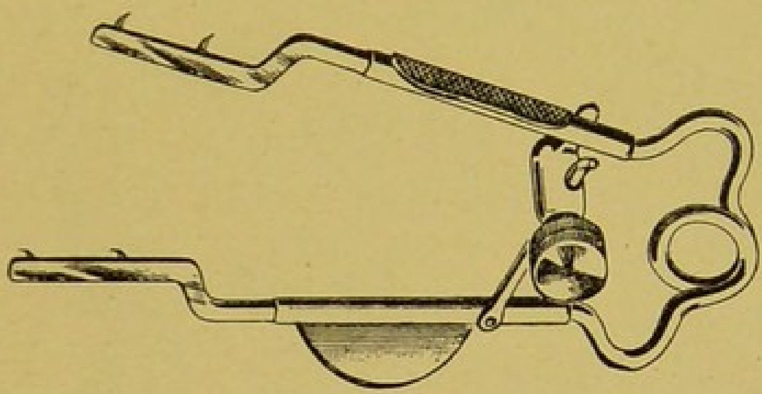
Fig. 100



Blunt wound retractors and angular orbital retractor.

Müller's Speculum (Fig. 101).—This instrument is a wound retractor used in extirpation of the lacrimal sac. It is constructed on the same principle as an eye speculum. Each branch has two hooks, which are turned outward. They are introduced into the wound, and by means of a spring retract its edges, thereby doing away with an assistant.

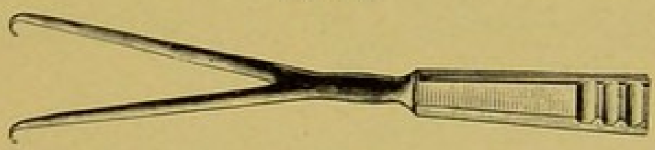
Fig. 101



Müller's speculum.

Imre's Double Hook (Fig. 102).—It is a valuable instrument in holding the upper lid doubly everted.

Fig. 102



Imre's double hook.

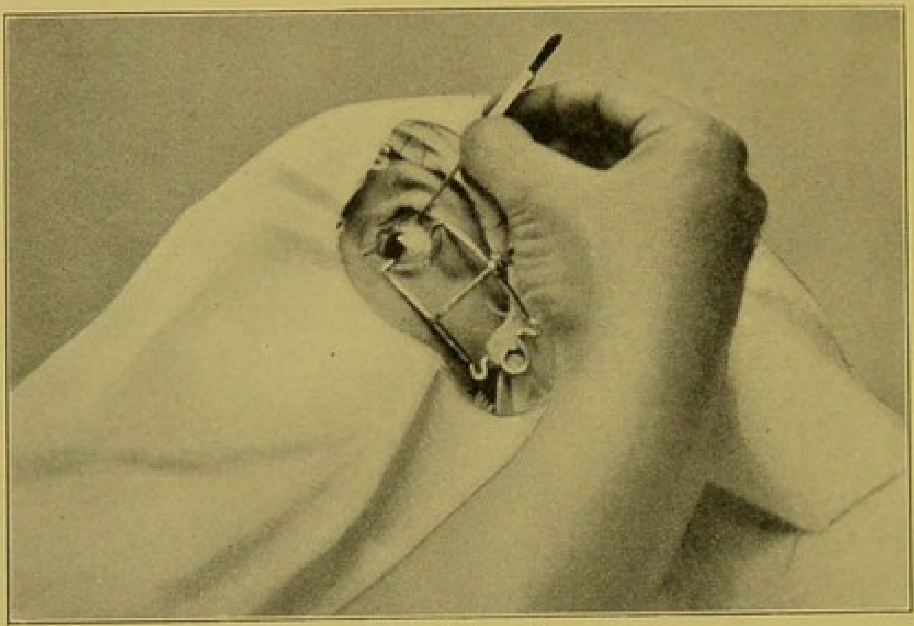
Reisinger's Tenaculum (Fig. 103).—Reisinger's tenaculum is similar to an iris forceps, but at the end of each branch there is a

Fig. 103

Reisinger's tenaculum.

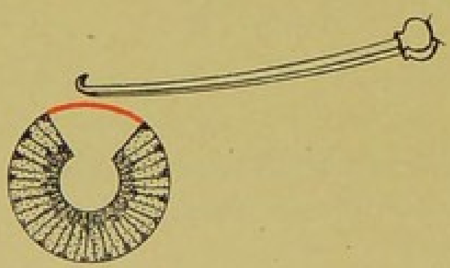
sharp hook directed forward. This is one of the best and safest instruments to use in extracting the lens after there has been a prolapse of the vitreous. The instrument is held in the same manner as the forceps, that is, between the first two fingers and the thumb (Fig. 104). It is introduced at the edge of the wound with blades closed and the convexity of the hooks downward (Fig. 105). It is then pushed obliquely into the vitreous behind the

Fig. 104



Method of using Reisinger's tenaculum.

Fig. 105



Method of using Reisinger's tenaculum. First step.

Fig. 106

Method of using Reisinger's tenaculum, showing position of instrument. Second step.

lens, where it is rotated, so that the hooks are directed toward the lens. The blades are now opened and the hooks inserted into the lens substance by depressing the handle backward (Fig. 106). The tenaculum is now withdrawn slowly with the lens attached to it. This instrument is of distinct value when there is a sclerosed lens, but of less value if the cortex is soft and friable, as the hooks do not retain their hold.

Graefe's Cystotome.—This may be either straight or bent (Figs. 107 and 108). If the bent model is used a different instrument is necessary for the right and left eye. It has a long narrow shank,

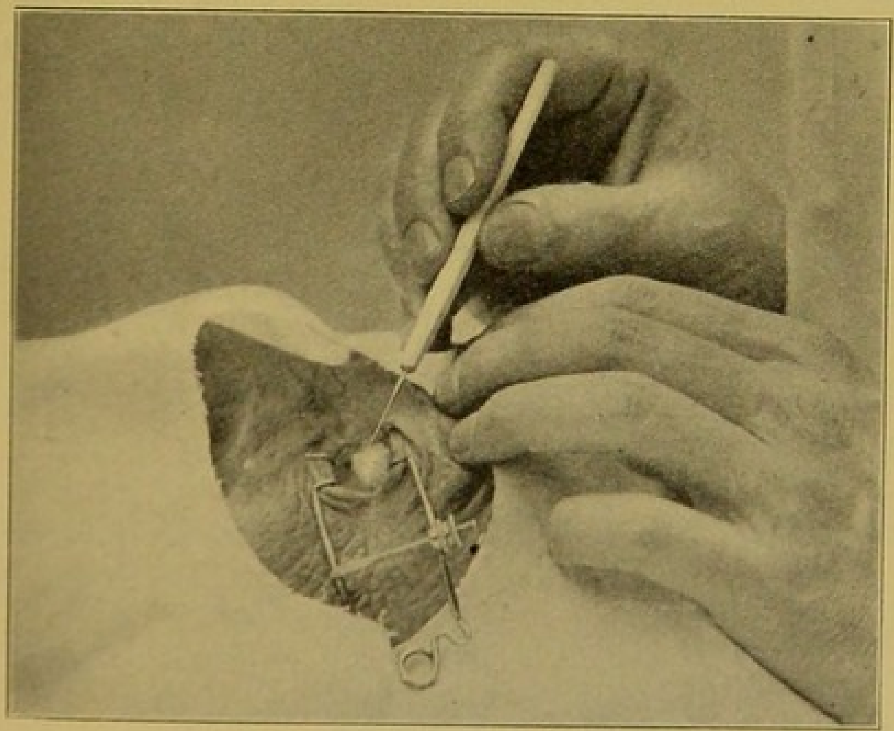
Fig. 107

Graefe's straight cystotome.

Fig. 108

Graefe's bent cystotome.

Fig. 109

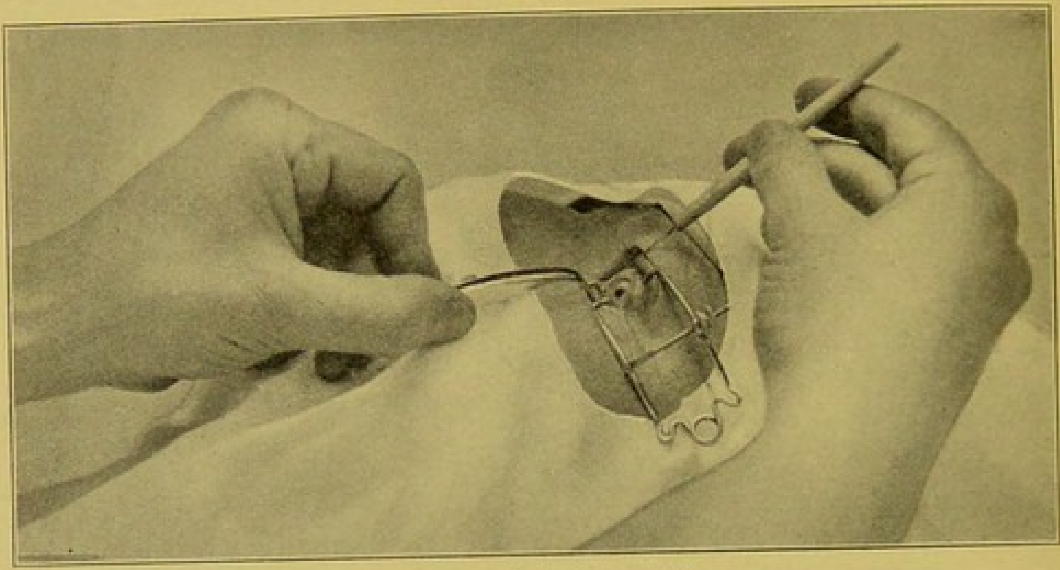


American method of using cystotome.

at the end of which a delicate sharp tooth is placed at right angles to the shaft. The instrument is held in the same manner as the Graefe knife, *i. e.*, between the first two fingers and the thumb. It is introduced into the anterior chamber at one end of the wound, with the convexity downward (Figs. 109, 110, 111).

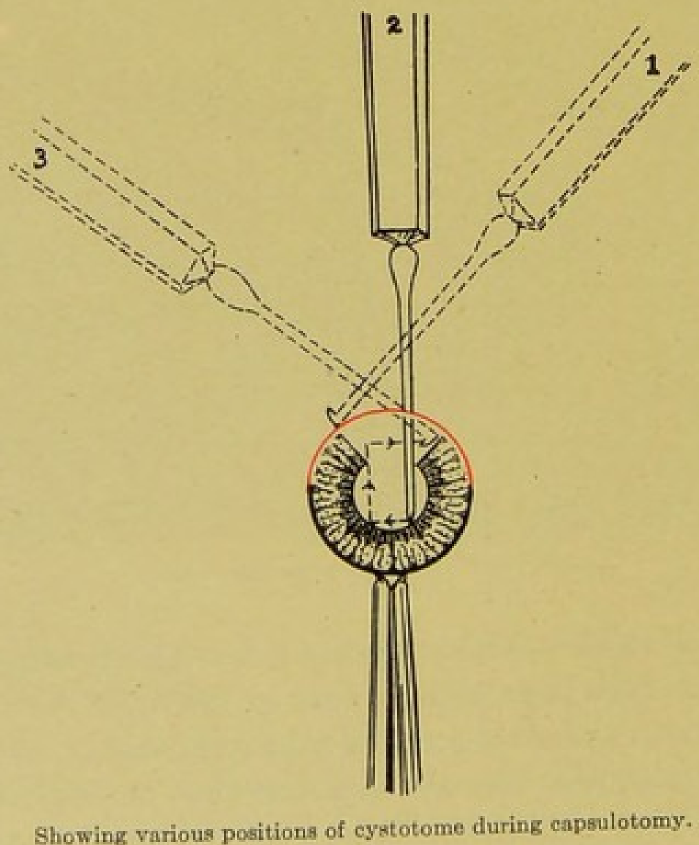
The discission of the lens capsule is then performed, and the instrument removed at the other end of the wound, with its convexity upward.

Fig. 110



European method of using cystotome.

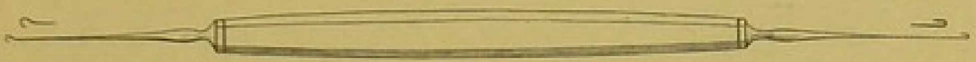
Fig. 111



Showing various positions of cystotome during capsulotomy.

Jaeger's Sharp Iris Hook (Fig. 112).—This variety consists of a fine sharp hook at the end of a flexible shaft. It is held in the same manner as a Graefe cystotome, and is used in withdrawing the iris from the anterior chamber in cases where there is no lens

Fig. 112

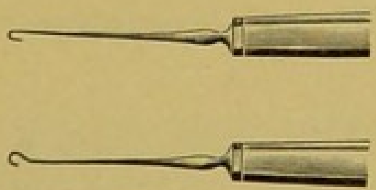


Jaeger's sharp iris hook.

present. It can also be used instead of a cystotome, and it is of service in delivering a lens where the wound is too small. In these cases the lens presents in the wound, and cannot be delivered by moderate pressure. The hook is inserted into the equator of the lens, at one end of the wound, and the lens is rotated on its anteroposterior axis.

Tyrrell's Blunt Hook (Fig. 113).—This instrument resembles the Jaeger iris hook, but is not sharp. It is used in withdrawing the iris from the anterior chamber.

Fig. 113



Tyrrell's hook

Graefe's Strabismus Hook (Fig. 114).—This hook is used in muscle operations.

Fig. 114

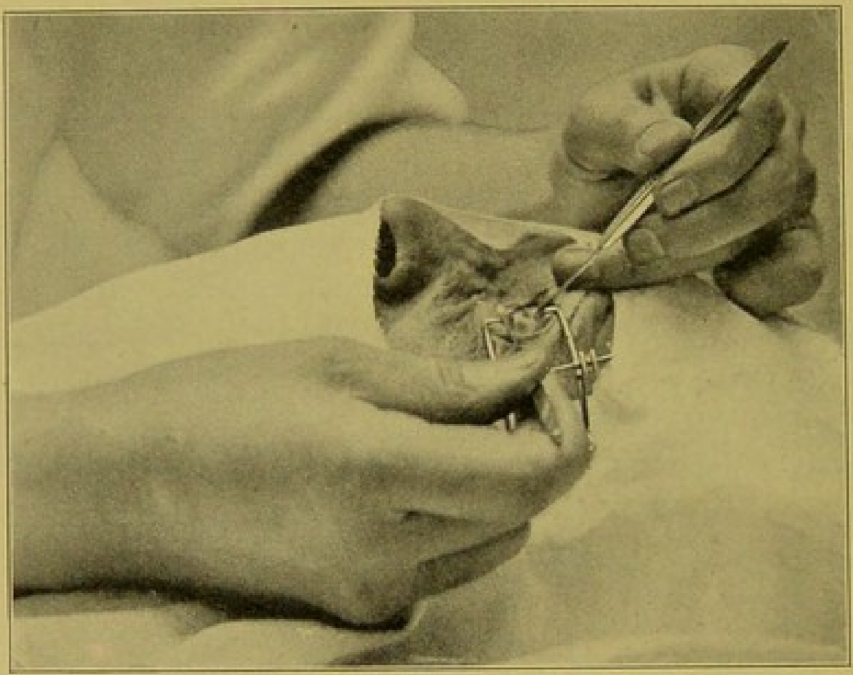
Graefe's strabismus hook.

Spoons and Spatulæ.—Daviel Spoon (Fig. 115).—The Daviel spoon is a narrow grooved spatula which is used in delivering the lens. It is held in the same way as a Graefe knife (Fig. 116, 117, and 118).

Fig. 115

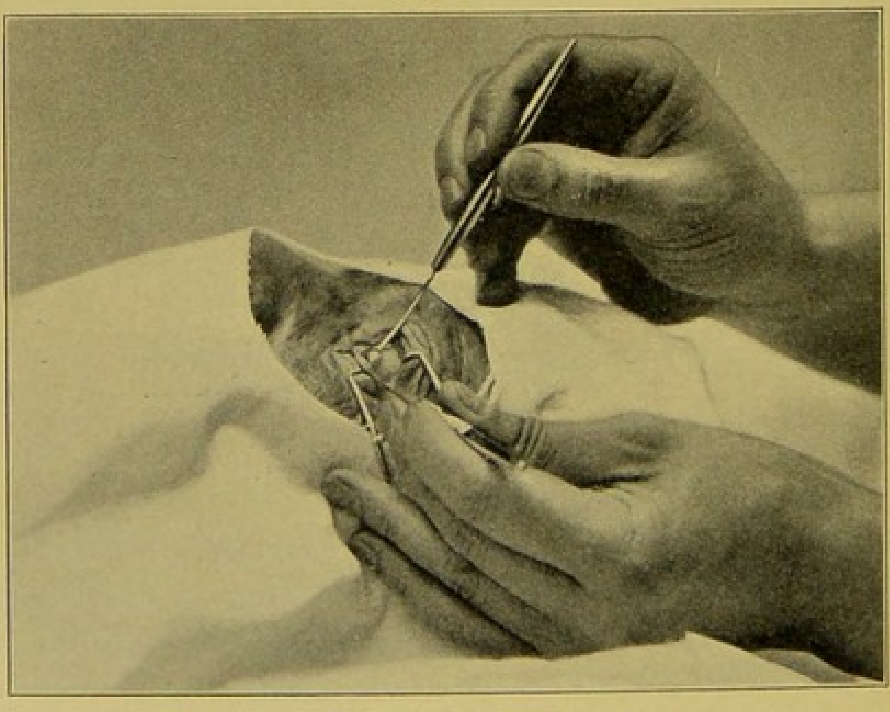
Daviel's spoon

Fig. 116



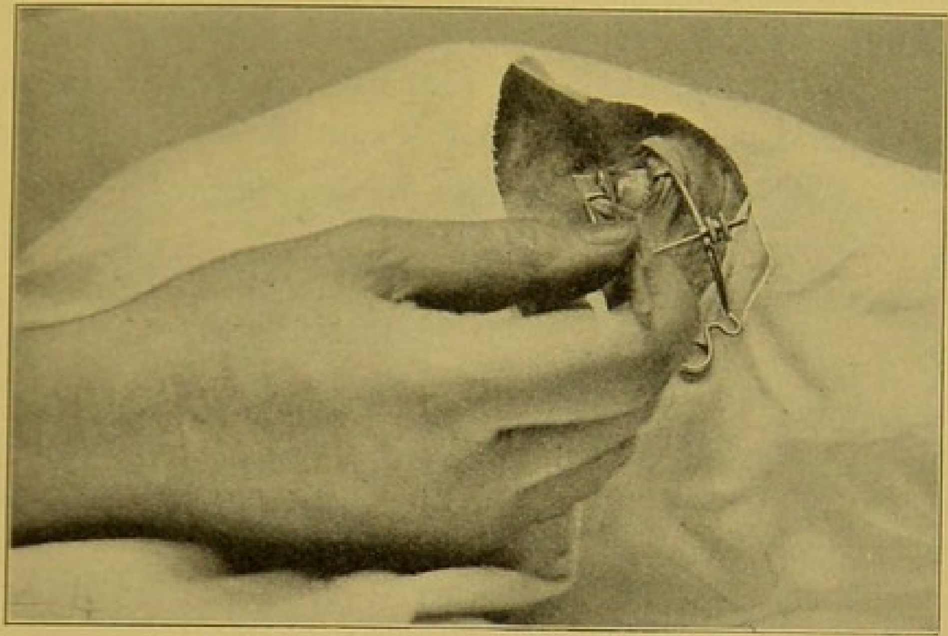
European method of using two Daviel spoons in delivering the lens.

Fig. 117



American method of using two Daviel spoons in delivering the lens.

Fig. 118



European method of using one Daviel spoon in delivering the lens.

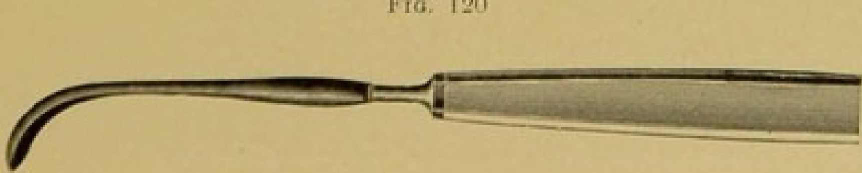
Pagenstecher's Spoon (Fig. 119).—This consists of a shallow oval-shaped bowl, about 10 mm. long and 7 mm. wide, attached to a narrow shaft. It is used in delivering the lens in its capsule.

Fig. 119

Pagenstecher's spoon.

The spoon is introduced in the wound behind the lens, and then by depressing the handle backward the lens is pressed against the posterior surface of the cornea. By withdrawing the spoon in this position the lens is delivered.

Fig. 120



Graefe's spoon.

Graefe's Spoon (Fig. 120).—Graefe's spoon is the same as Pagenstecher's, only smaller. It may therefore be used in cases where the wound is small. It is used under similar conditions and in the same manner as the Pagenstecher spoon.

Weber's Loop (Fig. 121).—In form this instrument resembles Pagenstecher's spoon, but is fenestrated; its uses are also the same.

Fig. 121

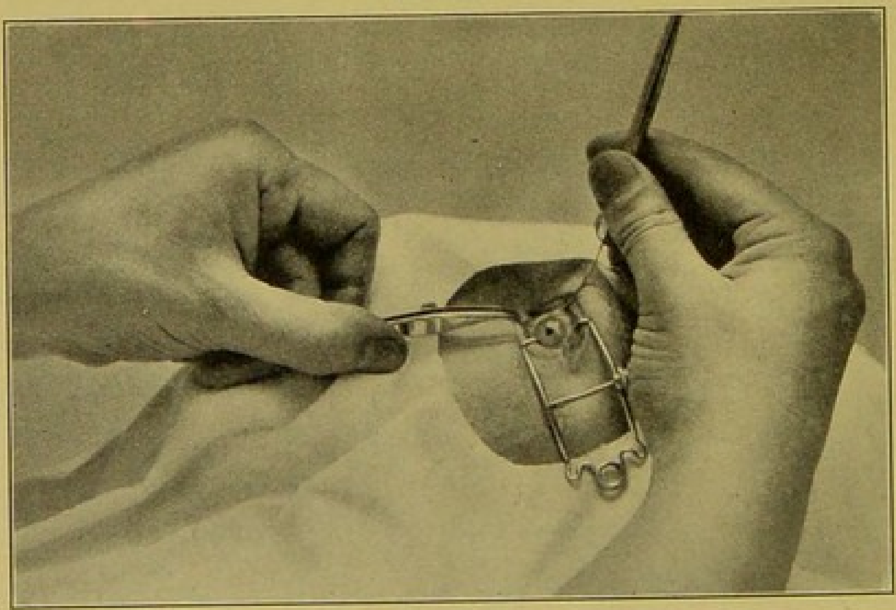
Weber's loop.

Beer's Iris Spatula (Fig. 122).—This is a narrow bladed instrument of flexible metal. It is used to replace the iris. The instrument is held between the first two fingers and the thumb in a

Fig. 122

Beer's iris spatula.

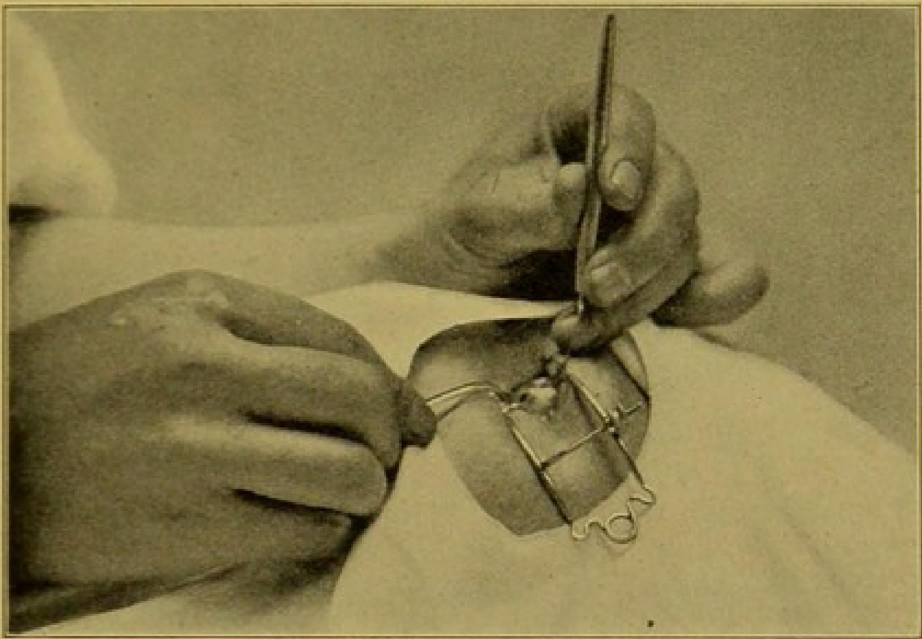
Fig. 123



European method of using iris spatula at the nasal end of wound.

similar manner to the Graefe knife. It is introduced into the anterior chamber at one end of the wound, and pushed down in front of the iris, which is stroked toward the pupil until the iris is smoothed out and the pupil assumes a round shape. If a coloboma is present it is used in a similar manner at each end of the wound (Figs. 123 and 124).

FIG. 124



European method of using iris spatula at the temporal end of wound.

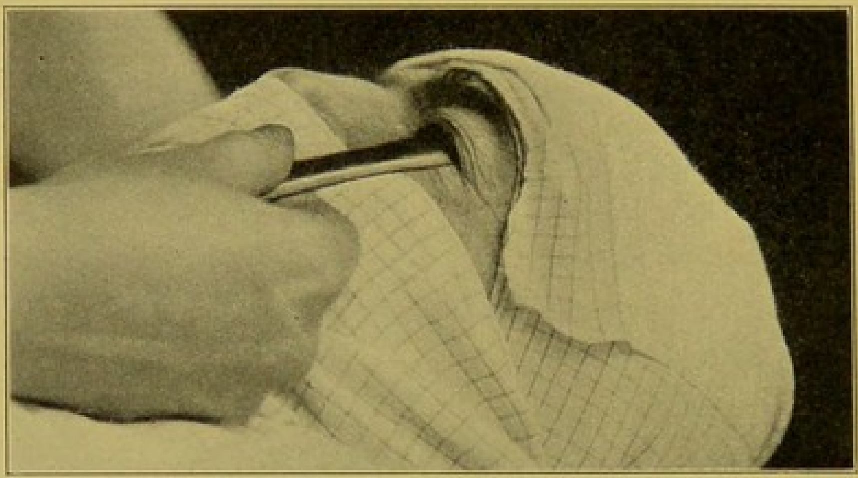
Jaeger's Horn Plate (Lid Spatula) (Fig. 125).—It is made of hard rubber or metal. It has an anterior convex and a posterior concave surface, its ends being slightly rounded. During lid operations one end is placed under the lid, the other end of the instument is held by the assistant between his first finger and thumb; the

FIG. 125

Jaeger's horn plate.

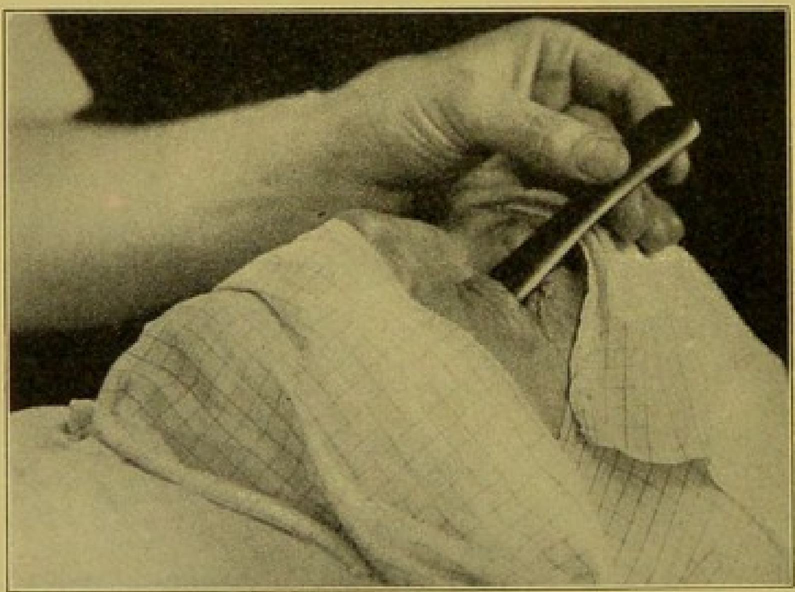
first finger is somewhat bent, and rests on the patient's cheek. By pressure of the thumb on the instrument the upper end, which is in the cul-de-sac, is pushed forward, and this puts the lid on the stretch. By keeping the instrument pressed slightly against the margin of the orbit and little outward, we will prevent the plate from slipping out of the conjunctival sac. If the lower lid is to be supported the instrument is applied in a similar manner (Figs. 126 and 127).

Fig. 126



Method of using horn plate on upper lid.

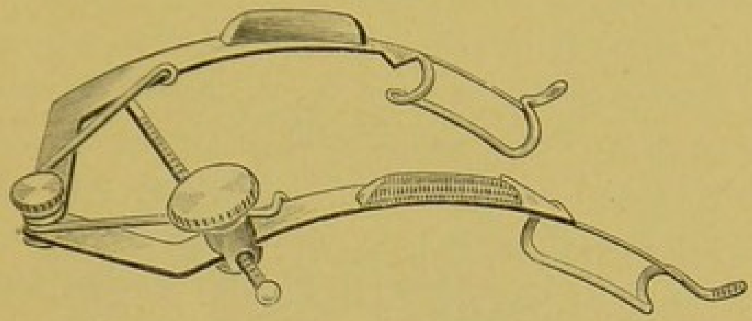
Fig. 127



Method of using horn plate on lower lid.

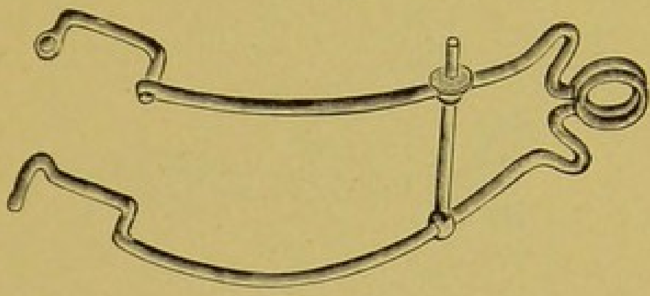
Lid Retractors (Figs. 128, 129, and 130).—The lid retractors are used to keep the palpebral fissure open during operation. There are a great variety in use. A good speculum should be light and strong, but not cumbersome. It should not press on the eyeball, and should not be in the way of the operator's hand or instruments. It should be easily managed, and constructed so that it can be quickly removed with one hand, if necessary.

Fig. 128



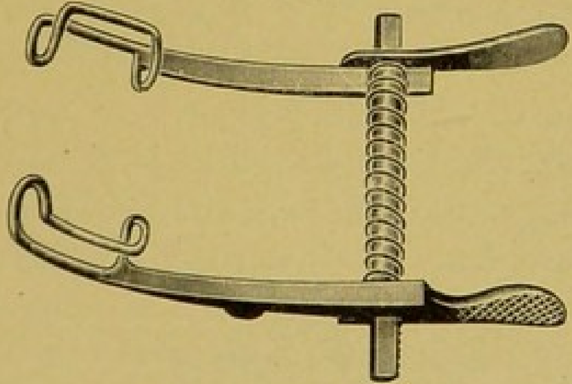
Weeks' lid retractor.

Fig. 129



Snowden's lid retractor.

Fig. 130



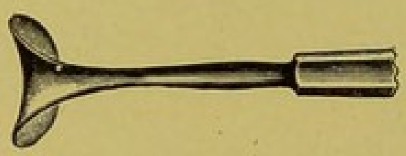
Mellinger's lid retractor.

Desmarres' Lid Retractors (Fig. 131).—These consist of two saddle-shaped metal spoons mounted on a long handle. Two are necessary to keep the lids open, and are held by the assistant.

The eyelids may be kept open by one of the above instruments or with the fingers. If the fingers are used as retractors the index finger is placed on the upper lid while the thumb is on the lower lid. By separating the fingers the eyelids are held apart. By this method it is impossible to avoid pressure on the eyeball, and it is therefore only applicable in minor operations (removal of a foreign body of the cornea) (Figs. 132 and 133).

The pressure upon the eyeball is entirely eliminated if the eyelids are retracted by the thumbs of the assistant. One thumb is placed on the upper lid near the lid margin, the other is placed on the lower lid in a similar position. The lids are now opened without exerting any pressure on the eyeball, and pressed slightly against the upper and lower margins of the orbit (Fig. 134). This is of good service, but there is always danger of the assistant, especially if not well trained, losing control of the lids. This generally happens if the lid is moist, but can be prevented to a certain extent by the assistant wrapping his thumbs in gauze.

Fig. 131

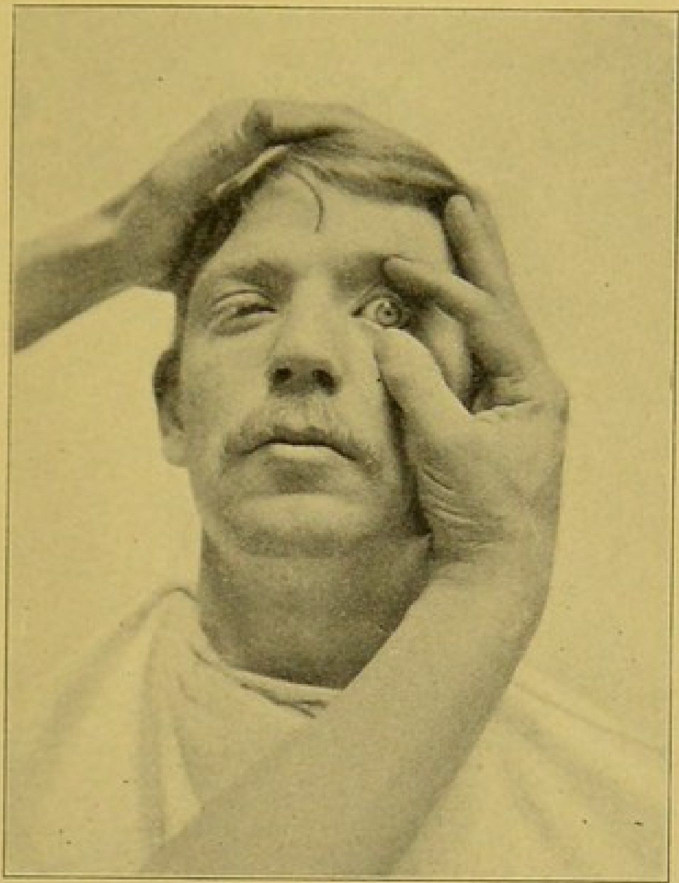


Desmarres' lid retractor.

Desmarres' lid retractors may be used in place of the assistant's thumbs (Figs. 135, 136, and 137). The method of inserting them is as follows. The upper lid is gently raised by the thumb of the operator's left hand, while the patient looks down, the spoon is then slipped under the lid and the handle given to the assistant. The patient is next directed to look upward while the lower lid is depressed, and the other spoon is placed in position. The assistant, who is holding the retractors, should not exert any pressure on the eyeball with them, nor should he retract too far. This causes traction and pressure on the eyeball by means of the conjunctiva of the cul-de-sac. This is a valuable method, but the spoons often interfere with the instruments and should not, therefore, be used in major operations on the globe.

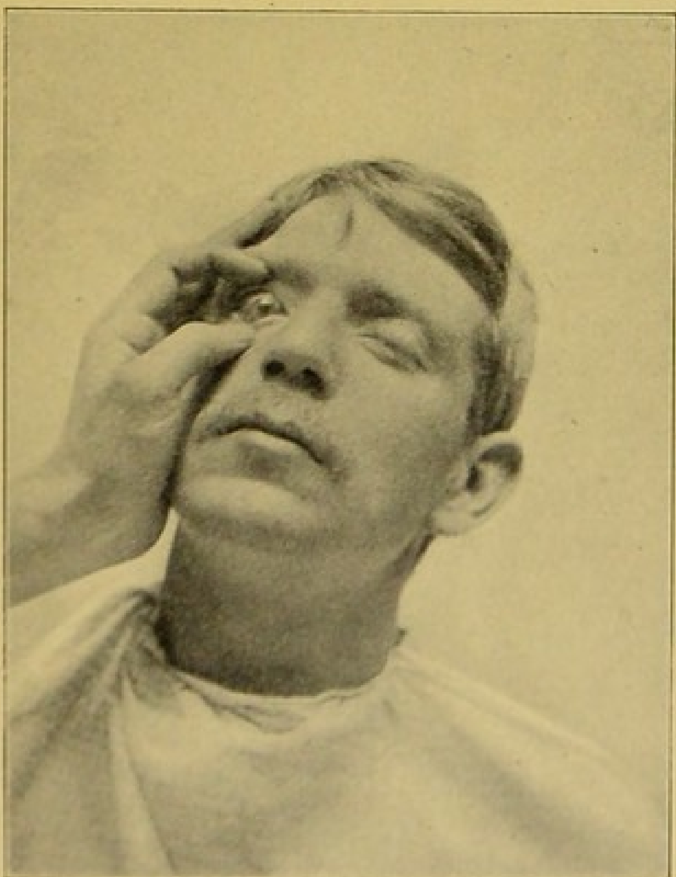
The lid speculum is inserted in the following manner: The speculum is taken in the hand that corresponds with the temporal side of the eye that is to be operated on, and the branches pressed together. The patient is told to look downward, and the upper lid is gently raised with the thumb of the other hand (Figs. 138 and 139). The upper branch of the speculum is then slipped into the cul-de-sac. After the insertion of the upper branch the patient directs his gaze upward, the lower lid

Fig. 132



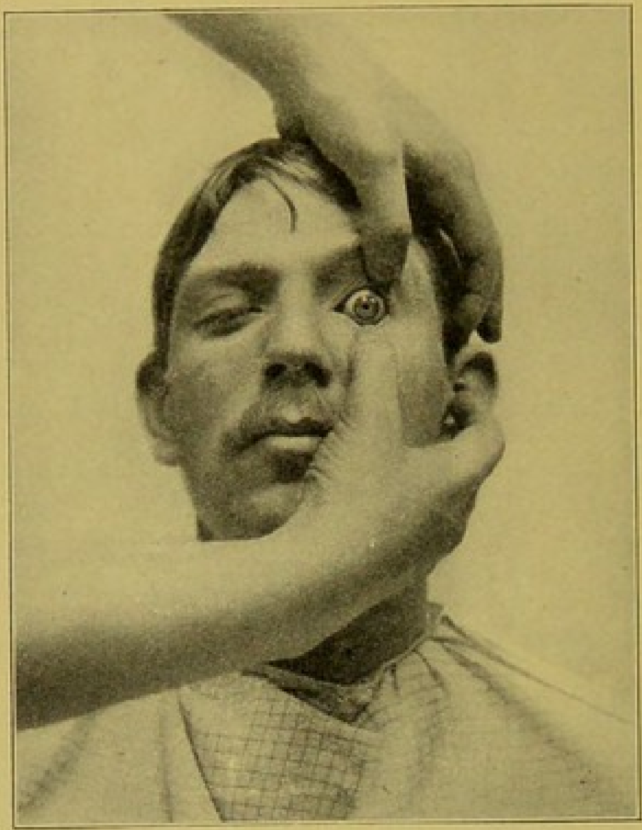
Method of retracting lids with right hand.

Fig. 133



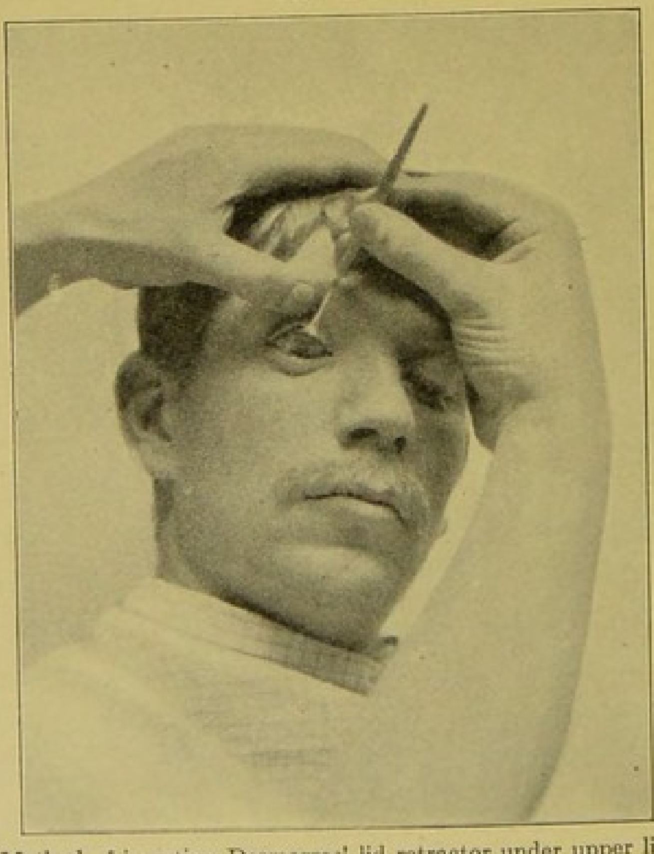
Method of retracting lids with left hand.

Fig. 134



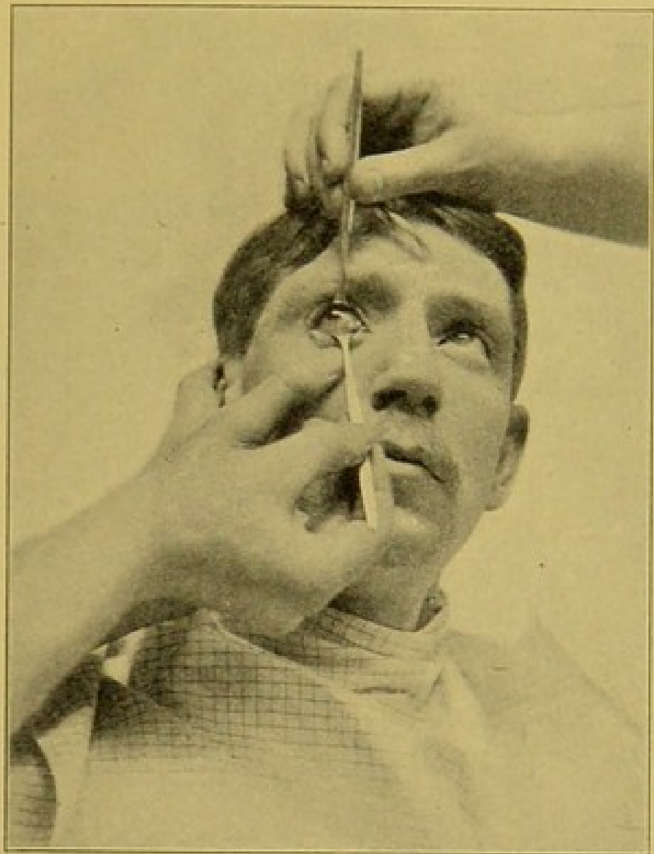
Method of retracting lids with both hands.

Fig. 135



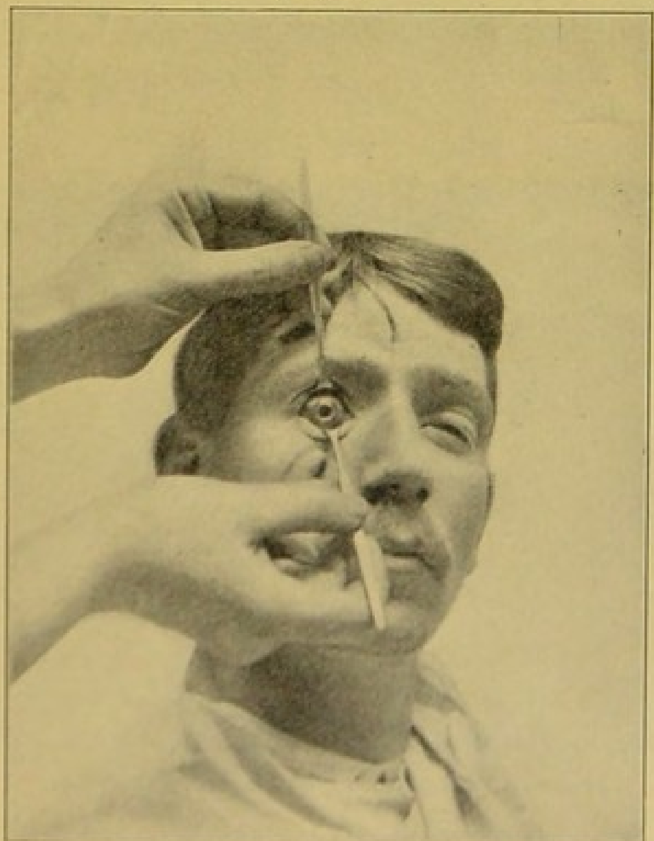
Method of inserting Desmarres' lid retractor under upper lid.

FIG. 136



Method of inserting Desmarres' lid retractor under lower lid.

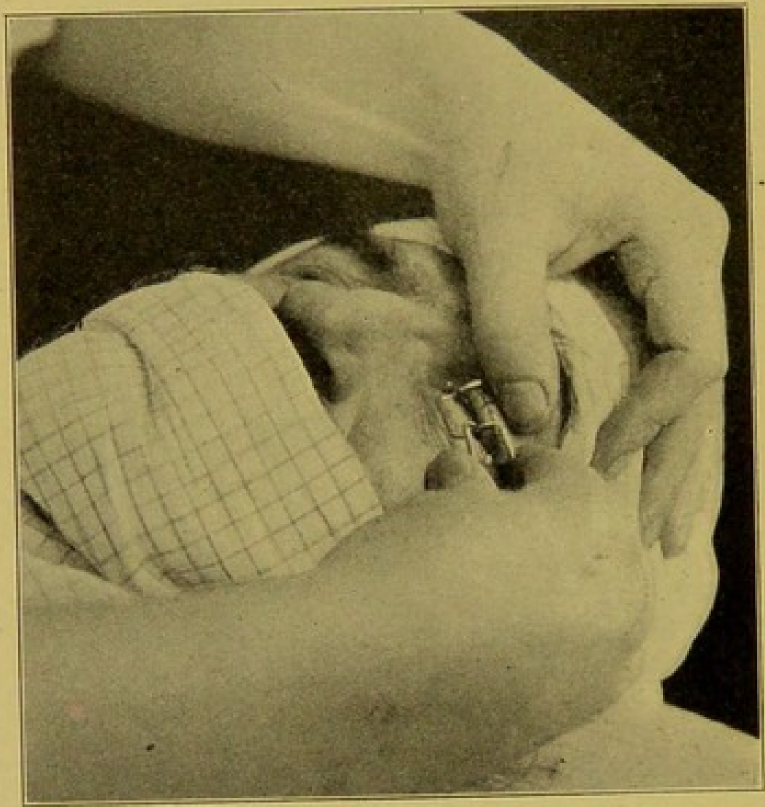
FIG. 137



Method of inserting Desmarres' lid retractors, showing both retractors in place.

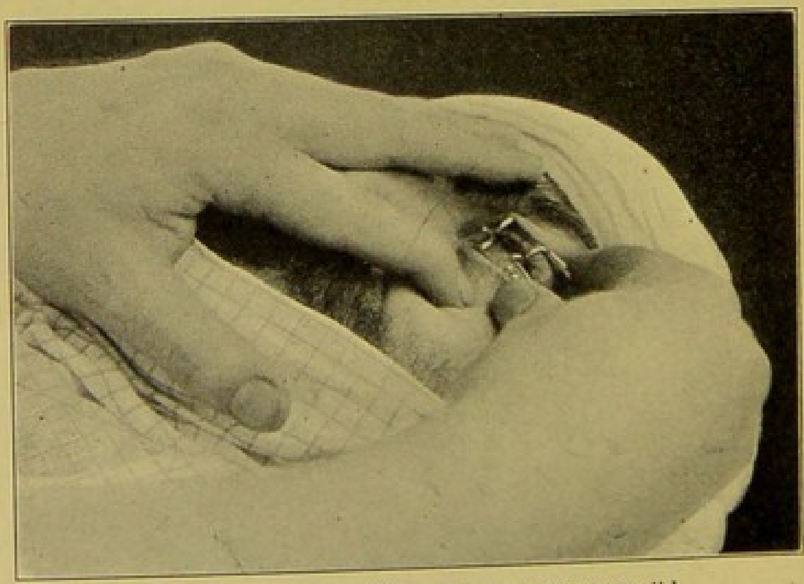
is depressed in a similar manner, and the lower branch placed in position. The branches of the speculum are now separated slowly until the palpebral fissure is of sufficient width. The

Fig. 138



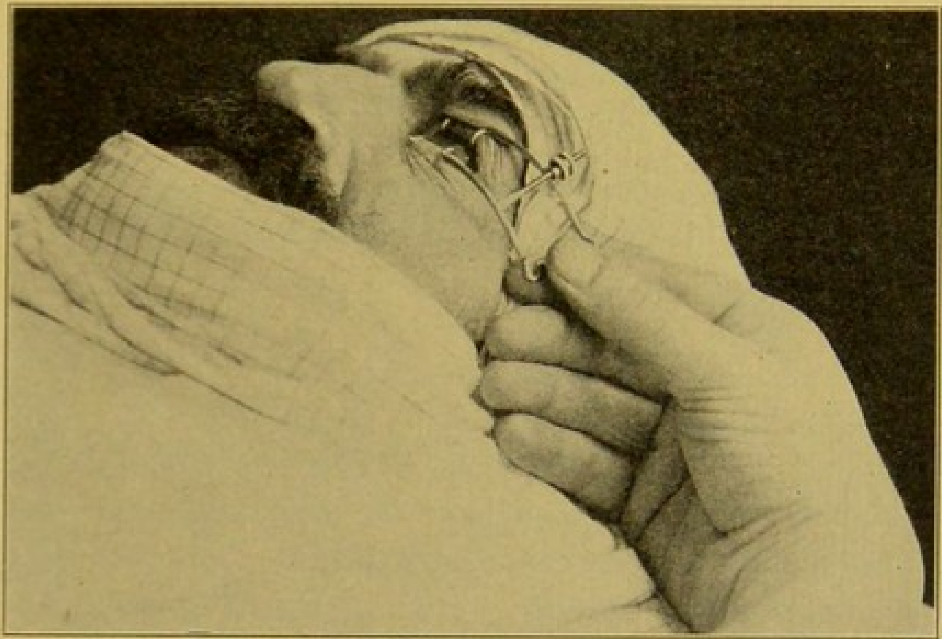
Method of inserting lid speculum under upper lid.

Fig. 139



Method of inserting lid speculum under lower lid separation of the lids should, however, never be exaggerated, as then the branches become caught under the margin of the orbit. Although the speculum retracts the lids well and does not interfere with the operator's hand or the instruments, it does not completely protect the eyeball from pressure if the patient squeezes.

Fig. 140

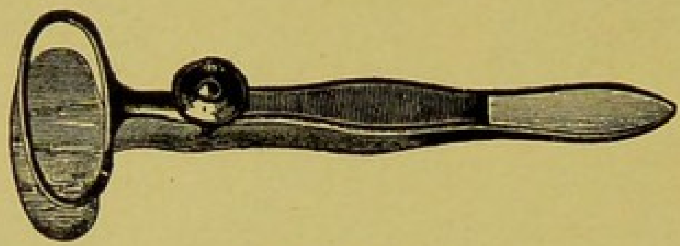


Assistant holding lid speculum.

In using Snowden's or Weeks' speculum this can be controlled to a certain extent if the speculum is held away from the eyeball by a trained assistant (Fig. 140). In this case the assistant grasps the wire spring between the index finger and thumb, and raises the speculum from the eyeball. During operation the assistant must be on the lookout for movements of the eyelids. If the patient shows any tendency to squeeze his lids together, the speculum must be raised still farther. The speculum, however, should not be raised too far, as this in itself, may cause pressure by drawing on the conjunctiva of the cul-de-sac. If the patient is unusually unruly the assistant must in addition raise the eyebrow with his free hand and press it firmly against the frontal bone. After operation the branches of the speculum are pressed together, and at the same time are slightly drawn away from the globe. The lower lid is first depressed, and the lower branch freed; then the upper branch is slowly slipped from under the upper lid, which is held away from the globe by grasping a few of the cilia.

Lid Clamps.—Lid clamps are used in eyelid operations partly to support the lid and partly to check the hemorrhage. Since the introduction of adrenalin they are but seldom used. An injection of cocaine-adrenalin will check the hemorrhage, and a horn plate will furnish the necessary support.

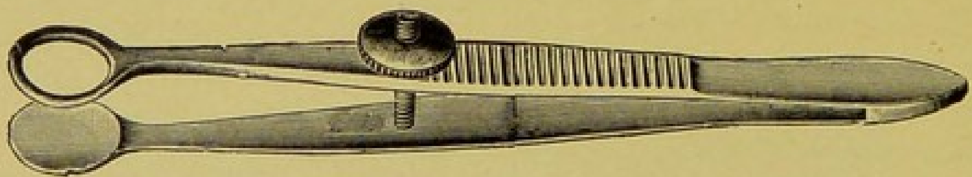
Fig. 141



Desmarres' lid clamp.

Desmarres' Lid Clamp (Fig. 141).—This instrument is shaped like a forceps with a metal plate at the end of one branch and a fenestrated blade at the end of the other. A screw serves to produce the required pressure. An instrument of small size can be used to advantage in the removal of chalazia (Fig. 142).

Fig. 142

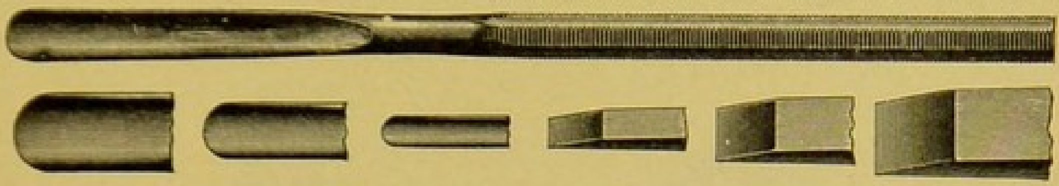


Lid clamp for removal of chalazion.

Knapp's Lid Clamp.—This is similar to the Desmarres' lid clamp, but the blades are placed at an angle to the shaft. One blade is a quadrangular plate and the other a fenestrated blade, which forms an incomplete quadrilateral. Separate instruments are required for the right and left eye.

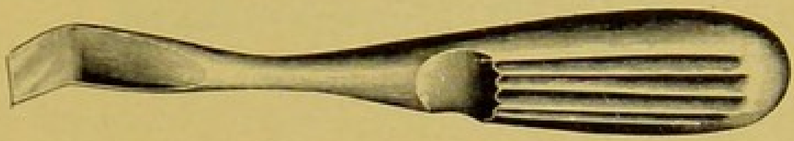
Various Other Instruments.—**Chisels** (Fig. 143).—For orbital operations, plane and grooved chisels, osteotomes, and periosteal elevators (Fig. 144) of various sizes are required. A mallet is also necessary (Fig. 145).

FIG. 143



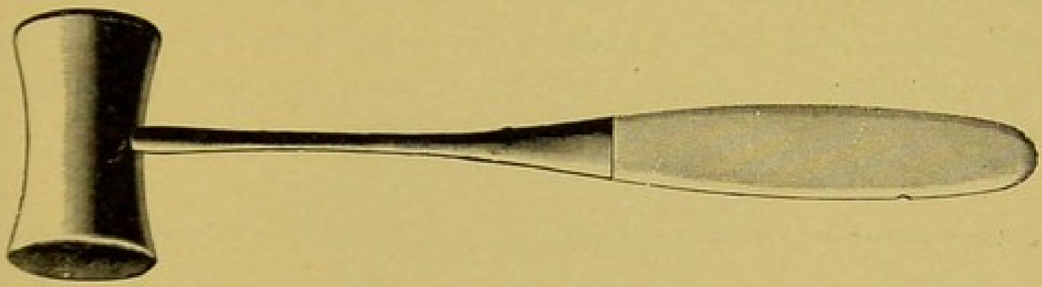
Chisels.

FIG. 144



Periosteal elevator.

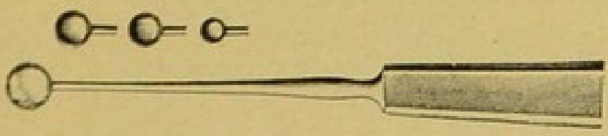
FIG. 145



Mallet.

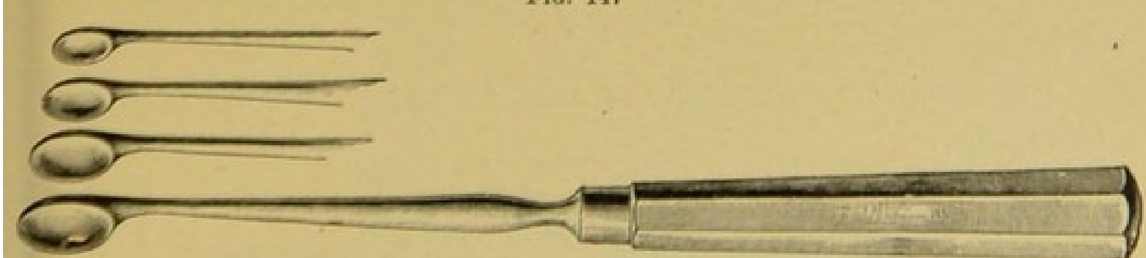
Curettes.—Meyhöfer's curettes (Fig. 146) come in various sizes, and are employed in curetting out chalazia. Larger curettes (Fig. 147) are necessary for orbital operations, and in curetting out

FIG. 146



Meyhöfer's curettes.

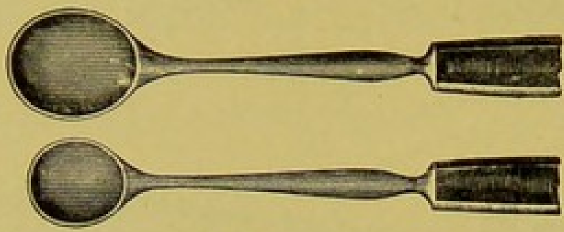
FIG. 147



Larger curettes.

the cavity after extirpation of the lacrimal sac. *Bunge's curette* (Fig. 148) is used in exenteration of the eyeball.

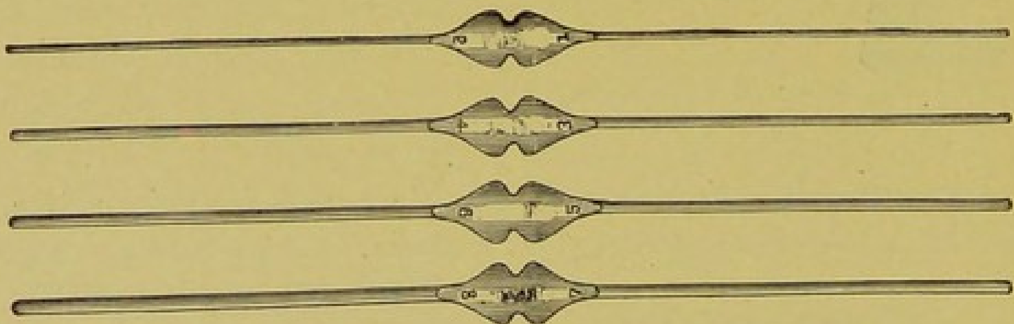
Fig. 148



Bunge's curette.

Probes.—Probes and grooved directors are similar to those used in general surgery. *Conical probes* are used in dilating the lacrimal canaliculi. *Bowman's probes* (Fig. 149) are silver probes, easily bent, and used in probing the nasal duct. They come in sets numbered 1 to 6, the smallest being $\frac{1}{2}$ mm. and the largest $1\frac{1}{2}$ mm. in diameter.

Fig. 149



Bowman's probes.

Instruments for Suturing.—Curved needles of various sizes are used. Those for larger sutures are 5 cm. in length; those for skin and conjunctiva, 2.5 cm.; and those for the cornea or sclera, 1.5 cm.

Needles with spring eyelets are of distinct advantage, as they are easy to thread.

Silk sutures and catgut are employed in various sizes and strength.

Fig. 150

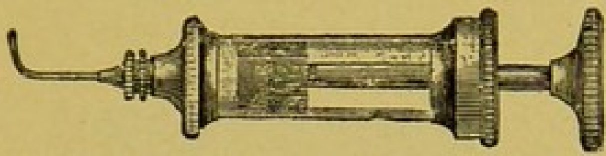
Knapp's needle-holder.

Knapp's Needle-holder (Fig. 150).

Syringes.

Hypodermic Syringe.

Fig. 151

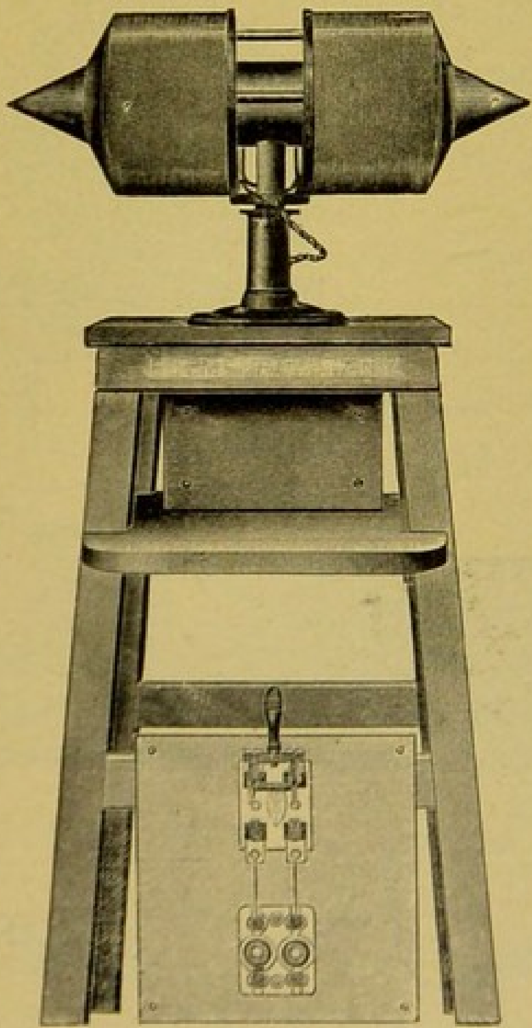


Knapp's lacrimal syringe.

Anel's syringe with various tips is used for syringing out the lacrimal sac and nasal duct.

Knapp's lacrimal syringe (Fig. 151) is smaller, and is used for the same purposes as the Anel syringe.

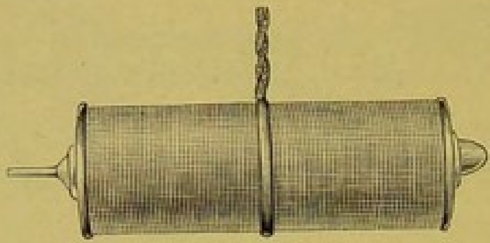
Fig. 152



Haab's giant magnet.

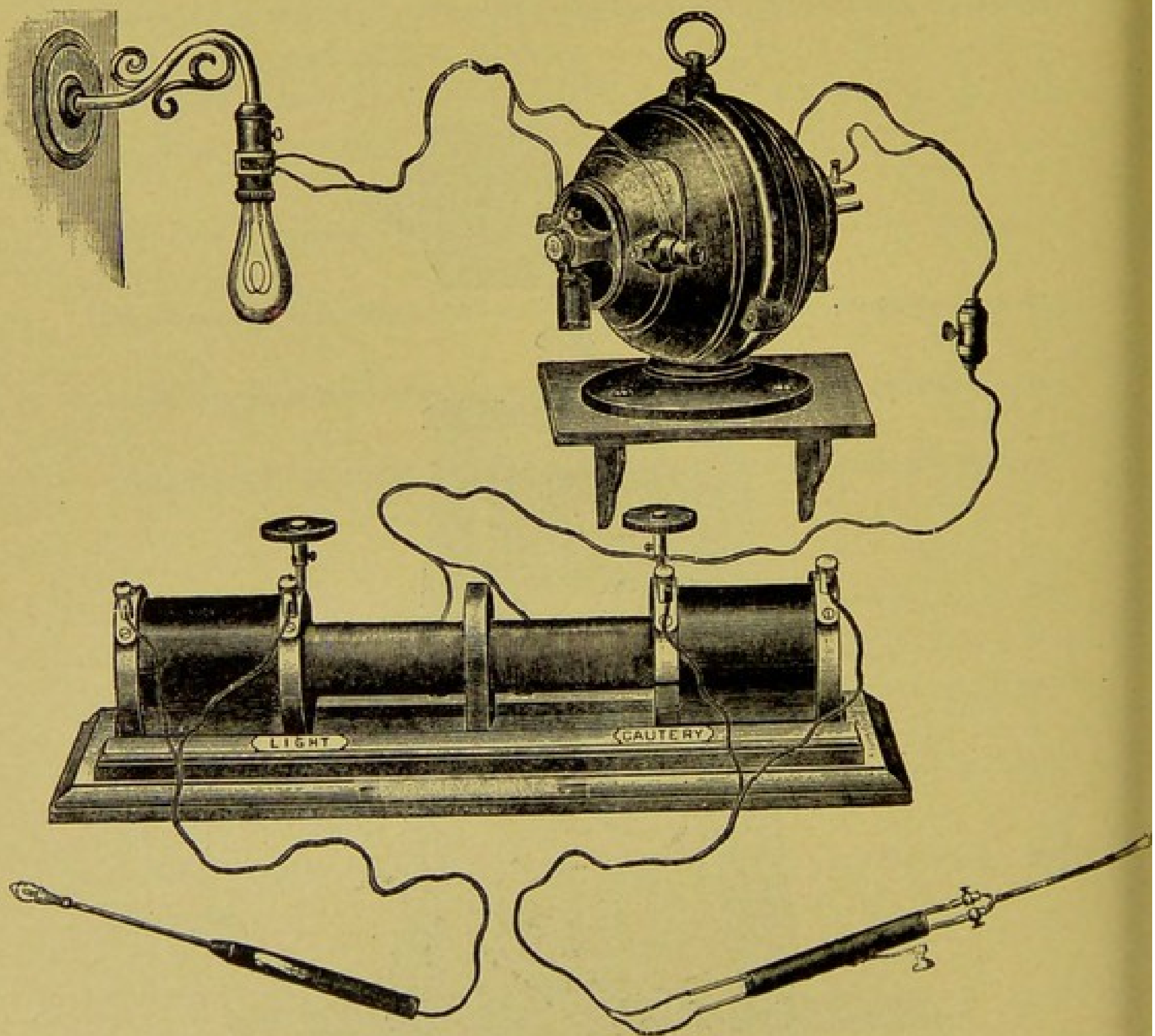
Various syringes are employed to irrigate the anterior chamber after cataract extraction (Panas, Terson, Chibret, etc.).

Fig. 153



Hirschberg's hand electromagnet.

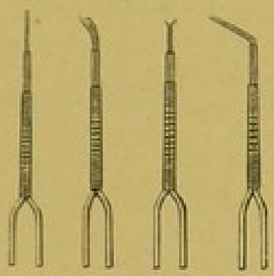
Fig. 154



Electrocautery apparatus for 110 volts, direct street current.

Electrical Apparatus and Cautery.—*Haab's giant magnet* (Fig. 152) is a powerful electromagnet, and is used for the extraction of foreign bodies from the globe.

Fig. 155



Galvanocautery tips.

Fig. 156

Electrolytic epilator.

Hirschberg's Hand Electromagnet (Fig. 153) is smaller than the former, and is used for the same purpose. It has various interchangeable tips which can be inserted into the eyeball. It can be used with a chromic acid battery.

Galvanocautery (Fig. 154) is used in cauterizing ulcers of the cornea, etc. It has tips of various sizes and shapes (Fig. 155).

Paquelin cautery is used for the same purpose where electricity cannot be obtained.

Electrolytic epilator (Fig. 156) is used in removing eyelashes. One electrode is a fine blunt platinum needle, the other the ordinary sponge electrode.

ARMAMENTARIUM

2 scalpels.
2 bistouries.
1 Weber's knife.
1 Beer's knife.
6 Graefe's knives
(Von Hippel's trephine).
6 angular keratomes, various sizes.
1 razor.

2 Knapp's knife-needles
(Kuhnt's knife-needle)
(Schulek's sphincterotome).
1 tattooing-needle.
2 foreign-body needles
(Bowman's stop-needle).
1 Knapp's needle-cystotome.
1 Ziegler's knife-needle.
1 small straight scissors.
3 small curved scissors.
1 medium straight scissors.
2 medium curved scissors.
1 Stevens' tenotomy scissors.
1 strong straight scissors.
1 De Wecker's pince-ciseaux.
2 rat-tooth forceps.
3 mouse-tooth forceps.
6 artery clamps.
1 medium-size anatomical forceps.
1 small-size anatomical forceps.
2 iris forceps with teeth.
1 iris forceps without teeth.
1 capsule forceps (Müller).
1 capsule forceps (Schulek).
1 capsule forceps (Smith).
2 fixation forceps, straight (Graefe).
2 fixation forceps, curved (Noyes).
1 cilia forceps.
2 Knapp's roller forceps.
1 Rust's roller forceps.
2 Kuhnt's expressors (each type).
1 Prince's advancement forceps.
1 Panas' forceps for lid.
1 Panas' forceps for extraction of membranous cataract.
2 bone forceps.
1 Museux forceps.
1 pair fine sharp wound retractors.
1 pair medium blunt wound retractors.
1 pair fine blunt wound retractors.

1 orbital retractor straight (Axenfeld).
1 orbital retractor, angular.
1 Müller's speculum.
1 Imre's double hook.
1 Reisinger's tenaculum.
2 Graefe's cystotomes.
1 Jaeger's sharp iris hook.
1 Tyrrell's blunt iris hook.
2 Graefe's strabismus hooks.
4 Daviel's spoons.
1 Pagenstecher's spoon.
1 Graefe's spoon.
1 Weber's loop.
2 Beer's iris spatulæ.
2 Jaeger's horn plates.
1 speculum (Weeks', Snowden's, Mellinger's).
1 pair Desmarres' lid retractors
(1 Desmarres' lid clamp).
1 lid clamp for chalazion.
3 plane chisels, various sizes.
3 grooved chisels, various sizes.
2 periosteal elevators (one small and one large).
1 mallet.
2 Meyhöfer curettes.
2 larger curettes.
1 Bunge's curette.
2 surgical probes.
1 grooved director.
1 conical probe.
1 set of Bowman's probes.
3 dozen curved needles, various sizes.
Silk and catgut.
1 Knapp's needle-holder.
1 hypodermic syringe.
1 Anel's or Knapp's lacrimal syringe
(1 Hirschberg's hand magnet).
1 galvano- or Paquelin cautery.
1 electrolytic epilator.
1 test-drum.

PART II

SURGERY OF THE SPECIAL PARTS

CHAPTER III

SURGICAL ANATOMY OF THE EYEBALL

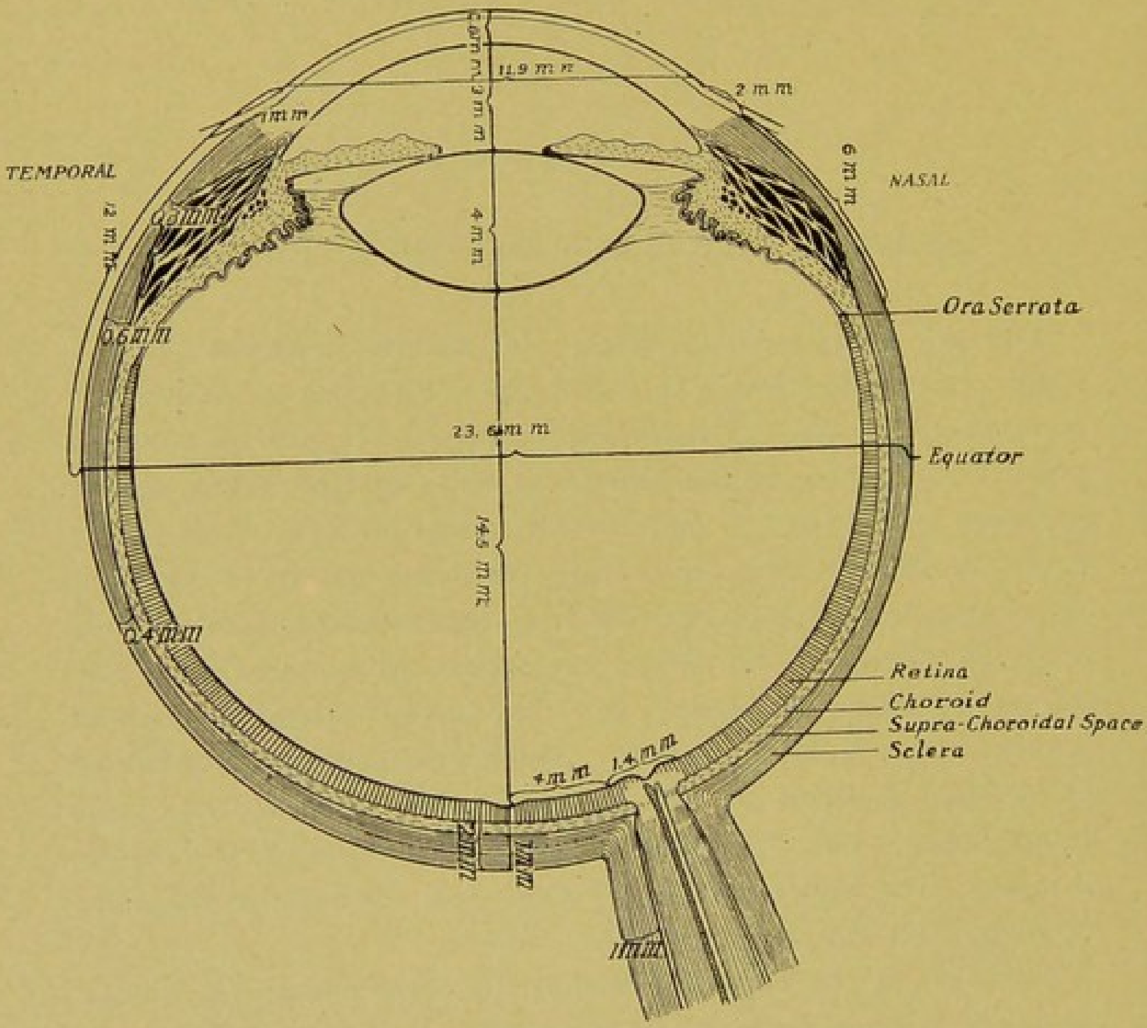
The eye is spheroid in shape. Its anterior segment shows a slight constriction which is called the scleral sulcus, and which corresponds to the sclerocorneal junction. It has an anterior pole at the centre of the anterior surface of the cornea, and a posterior pole about 4 mm. to the temporal side of the optic disk. A straight line connecting these two points is the axis or anteroposterior diameter, and lines that connect them, passing over the surface of the globe, are spoken of as meridians. By the term equator we mean a line that passes around the eyeball about 12 mm. from the limbus. The anteroposterior diameter of the eyeball is about 24 mm. (cornea, 1 mm.; anterior chamber, 3 mm.; lens, 4 mm.; vitreous, 14 mm.; retina, choroid, and sclera, 2 mm.). The horizontal is 23.6 mm., and the vertical diameter is about 23.3 mm. in length (Fig. 157).

The wall of the eyeball is formed by three coats: (*a*) fibrous coat; (*b*) vascular coat; (*c*) nervous coat.

Fibrous Coat of Eyeball.—The fibrous coat gives the eyeball its shape, and is formed by the sclera and cornea; the former forming the posterior five-sixths and the latter the anterior one-sixth of the globe.

Sclera.—The sclera extends from the optic nerve to within about 2 mm. of the limbus, where the cornea begins. It is covered with conjunctiva back to within 2 or 3 mm. of the equator. The conjunctival membrane is freely movable over it, and is connected to it by a loose connective tissue (episcleral tissue). Posteriorly the sclera is perforated by the optic nerve, which is divided into bundles of fibers which enter the eyeball through the sieve-like membrane (lamina cribrosa). Around the optic nerve the ciliary arteries and nerves pass through the sclera; near the equator,

Fig. 157



Cross-section of the globe.

in each quadrant, the venæ vorticosæ penetrate, and anteriorly, near the limbus, the anterior ciliary arteries enter the eyeball through it. The sclera is thickest near the optic nerve, being about 1 mm. at this point; passing forward from here it becomes gradually thinned until at the equator it is only 0.4 mm. Anterior to the equator it becomes again thicker, from the sheaths of the recti muscles to about 0.6 mm., while near the limbus it is the thinnest, being about 0.3 mm. in thickness at this point. This is of importance from a surgical point of view, as in advancement operations the sutures are anchored near the limbus. Knowing the fact that the sclera is extremely thin in this region, great care should be taken not to perforate it with the needle.

The sclera consists of connective tissue and a few elastic fibers; these fibers run in all directions, and interweave with one another. In the anterior part of the sclera, however, the greater portion of these fibers run meridionally. For this reason wounds in one of the meridians of the eyeball gape to a less extent than those at right angles.

Limbus.—The conjunction of the cornea and sclera is called the limbus. The cornea is placed on the sclera like a watch-crystal on a watch, *i. e.*, the sclera slightly overlaps the cornea at its margin. For this reason the limbus does not correspond to the periphery of the anterior chamber and the root of the iris, but is about 2 mm. in front of it. This is of great importance from a surgical standpoint, as incisions made in the limbus will therefore enter the anterior chamber 2 mm. in front of the root of the iris, and will not allow us to reach the latter. Consequently to open Schlemm's canal by excising the root of the iris, as in iridectomy for glaucoma, the incision must lie 2 mm. behind the limbus.

Cornea.—The cornea is a strong, elastic, and transparent membrane which is convex anteriorly and concave posteriorly. It is elliptical in shape, the horizontal diameter being 11.9 mm., the vertical 11 mm.; it is about 0.8 mm. thick in the centre, and 1.1 mm. thick at the margin. This is again a point which should be well remembered. In removing a foreign body from the cornea, it may easily be perforated, owing to its thinness, if we are not careful. The surface is covered with pavement epithelium which regenerates with great rapidity without altering the transparency of the cornea. Deeper injuries, although they heal rapidly, always leave an opaque scar. The deeper layers of the cornea are laminated, so that the operator's knife, if not guided in a proper manner, may glide between the lamellæ, causing what is known as an intralamellar incision. The cornea is not supplied with bloodvessels, and its nutrition is maintained by a system of lymph channels that form a network through its parenchyma.

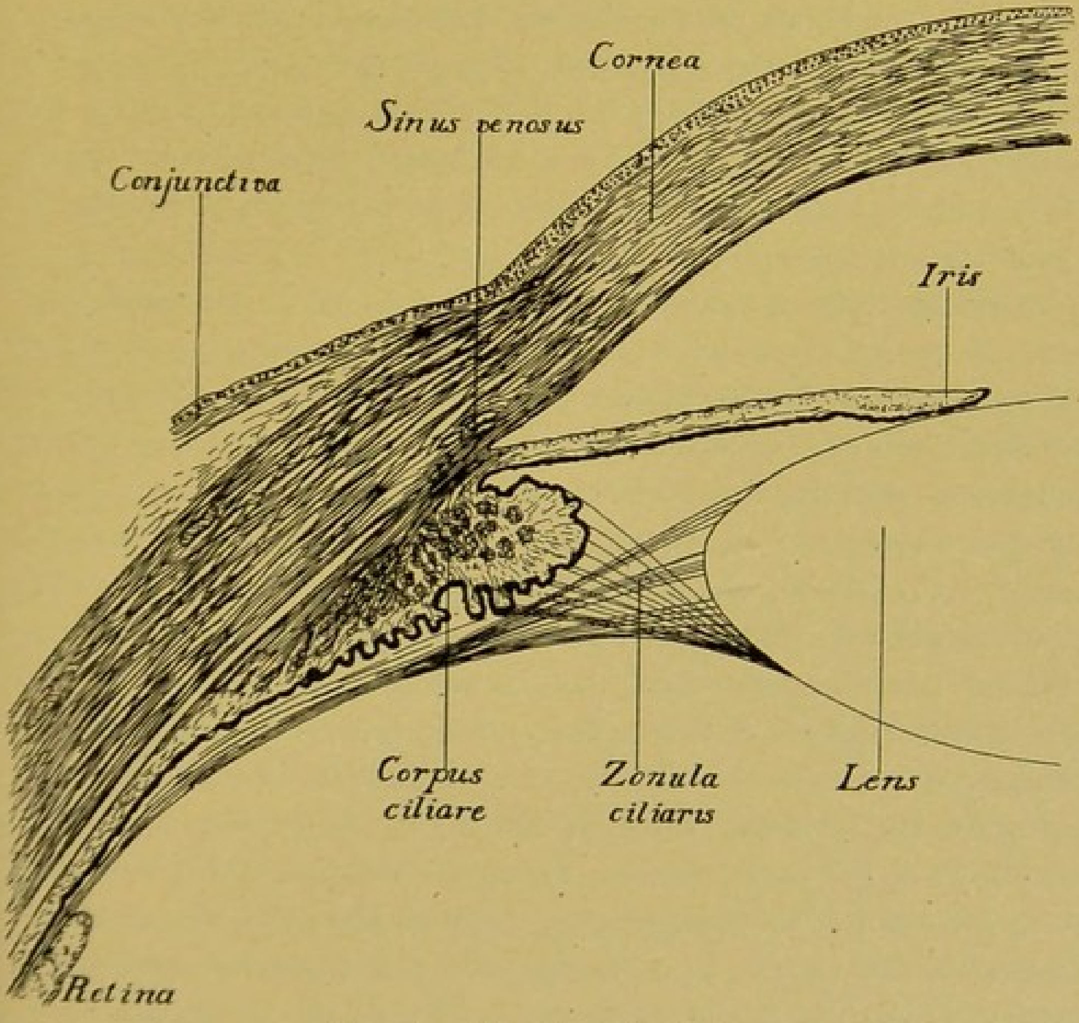
Vascular Coat of the Eyeball.—The vascular coat or uveal tract is in contact with the sclera from the optic disk to a point which lies 2 mm. behind the limbus; at this point the coat passes across the eyeball, forming a diaphragm, at the centre of which lies the pupil. Anatomically this coat is divided into three parts: choroid, ciliary body, and iris.

Choroid.—The choroid forms the posterior portion, and extends from the optic disk to a point about 8 mm. behind the limbus, where the ciliary body begins. It is firmly adherent to the sclera only at the optic disk, further anteriorly it is easily separated from it. The reason for this is that there is a lymph space between the choroid and sclera, the so-called *suprachoroidal space,* which extends in all directions from the optic disk to the ciliary body. The connection between sclera and choroid throughout this space is accomplished by a network of fine connective-tissue trabeculæ.

Ciliary Body.—The ciliary body begins 8 mm. behind the limbus, and extends anteriorly to within 2 mm. of the limbus, where the iris has its origin. It is formed by the ciliary muscle and ciliary processes, the latter lying in the posterior chamber somewhat anteriorly to the equator of the lens, but without being in contact with it. The ciliary body is extremely sensitive to all injuries; these injuries almost invariably result in a cyclitis, often destroying the eye and even endangering the other eye from sympathetic inflammation. This is the reason that injury to the ciliary body should be avoided during operation, and no penetrating wound on the eyeball should be made in the area that is bounded anteriorly by a point 2 mm. from the limbus, and posteriorly by one that is 8 mm. from the limbus; this is the region commonly referred to as the "danger zone."

Iris.—The iris has its origin 2 mm. behind the limbus, and extends across the aqueous chamber, having in its centre an opening, the pupil. The pupil does not correspond with the centre of the cornea, but is slightly displaced downward and to the nasal side. The iris has a pupillary margin and ciliary margin; the portion in contact with the ciliary body is known as the root of the iris. The pupillary margin and root do not lie in the same plane, the former is situated more anteriorly than the latter. The lens gives firm support to the iris; if the lens is wanting (aphakia), or has changed its position (luxation), the iris will tremble with the movements of the eye (iridodonesis). The iris contains two muscles, the sphincter of the pupil and the dilator;

Fig. 158



Iris angle. (After Graefe-Saemisch.)

the former surrounds the pupil, forming a ring which is about 1 mm. wide, and is often visible, owing to the difference in color between it and the surrounding tissue. The dilator is situated on the posterior surface of the iris, completely covering it.

The point where the iris, ciliary body, sclera, and cornea meet is the *iris angle* (Fig. 158). This corresponds to a point 2 mm. behind the limbus, and here we find connective-tissue trabeculæ covered with endothelium, which run in a circular direction, anastomosing with each other, thereby forming a network called the *pectinate ligament*. The spaces between the trabeculæ are known as the *spaces of Fontana*. The pectinate ligament is in close relationship with the deep layers of the cornea, with the root of the iris and with the ciliary body. It also forms the inner wall of a venous canal which encircles the cornea, and is called the *canal of Schlemm* or the sinus venosus scleræ. The exact location of Schlemm's canal is 2 mm. behind the limbus, and it is in direct communication with the anterior chamber through the spaces of Fontana. The canal is microscopic, its dimensions being 0.32 mm. by 0.048 mm. It is not always a single canal throughout its whole extent, being often divided into two or three branches, which, however, always reunite.

Nervous Coat of Eyeball.—The nervous coat is the innermost, and is of little interest from a surgical standpoint; it is called the retina, and is the expansion of the optic nerve. The retina is at all points in contact with the choroid without being firmly adherent to it, and is held in place by the pressure of the vitreous body. Posteriorly, however, it is closely attached to the optic nerve, and around the disk to the choroid by means of a few bloodvessels; it extends anteriorly as far as the ciliary body (8 mm. behind the limbus), where it apparently ends with a serrated edge called the *ora serrata*. The ending, however, is only macroscopic, as microscopically it extends much farther forward, forming the posterior layer of the ciliary body and iris. The entrance of the optic nerve is known as the *optic disk;* this does not correspond to the posterior pole of the eye, but is about 4 mm. nasally to it, in consequence, lying somewhat nearer the nasal limbus than the temporal. The diameter of the optic nerve head is about 1.4 mm. Temporally from the disk at a distance of about 4 mm. (posterior pole) is the *macula lutea* and in its centre the fovea centralis.

Contents of the Globe.—The contents of the globe are the aqueous humor, the lens, and the vitreous; the first is fluid, the second solid, and the third is of a jelly-like consistency. These media refract the rays of light, and with the exception of the lens, help to maintain the shape of the eyeball, and also exert a constant pressure on the coats of the eyeball, which is called the *intra-ocular pressure.*

Aqueous Humor.—The aqueous humor fills in the space between the cornea, lens, and vitreous. It is a transparent fluid closely resembling water, but contains slight traces of albumin. The aqueous is quickly reproduced after its escape, and after operations the anterior chamber is restored and filled with fresh aqueous a few minutes after the wound is closed. The newly formed aqueous differs somewhat in containing a larger amount of albumin. This explains the fact that after operations a few posterior synechia may be found, even if the healing was uneventful, and not complicated by an iritis. The posterior synechia develop from the coagulated albumin, which glues the iris to the lens capsule. The cavity containing the aqueous is called the aqueous chamber, and is divided by the iris into the anterior chamber and the posterior chamber.

Anterior Chamber.—The anterior chamber is bounded anteriorly by the cornea, posteriorly by the iris, and in the pupillary area by the anterior surface of the lens, and laterally (in the periphery) by the pectinate ligament which is the point where the cornea, sclera, ciliary body, and root of the iris meet (iris angle). Here again attention is called to the fact that the iris angle lies 2 mm. behind the limbus. This is the point where we must place the incision if we wish to enter the anterior chamber at its periphery; incisions placed in the limbus will enter the anterior chamber 2 mm. in front of the iris angle, and consequently 2 mm in front of the root of the iris. Although this point will be discussed under the iridectomy for glaucoma it does not seem superfluous to mention here that glaucoma is due to the obstruction of Schlemm's canal by the root of the iris. From an iridectomy therefore, no result can be expected unless the root of the iris in glaucoma is excised or, rather, torn out; the point of the operation, consequently, is that the incision should be made 2 mm. behind the limbus, this alone affording a possibility of reaching the root of the iris. The depth of the anterior chamber varies from 2.5 to 3.5 mm.

Posterior Chamber.—The posterior chamber is bounded anteriorly by the iris, medially by the lens, laterally by the ciliary processes, and posteriorly by the zonule of Zinn, and between the fibers of the zonule by the vitreous. The anterior and posterior chamber communicate with each other through the pupil. The pupillary margin of the iris is only in close contact with the anterior surface of the lens, but not adherent, and allows the aqueous to pass through. The aqueous has a constant, slowly moving current, which passes from the ciliary body (which secretes it) into the posterior chamber, then through the pupil into the anterior chamber, and from here it passes out into the venous circulation through the canal of Schlemm. The intra-ocular pressure depends upon the quantity of the aqueous, and if this stream is obstructed, increase of intra-ocular pressure (glaucoma) will be the result.

Lens.—The lens is on the same level as the ciliary body in a depression in the vitreous (fossa patellaris); its anterior surface is in contact with the pupillary margin of the iris, and it is held in place by a suspensory ligament (zonule of Zinn). It is a biconvex body with its posterior surface of a greater curvature than its anterior. It has an anterior and posterior pole and equator. Its dimensions vary with the age, and with the accommodation; in adults the lens of a cadaver is 4 mm. in thickness, about 9 mm. in width, and the length of its anterior surface (its meridian) is about 12 mm.

The lens consists of the lens capsule and lens substance. The lens capsule which surrounds the lens substance is a transparent, thin (at the anterior pole, 0.02 mm.) structureless membrane. In cataract operations we only extract the lens substance (unless the lens is extracted in the capsule) through an opening in the capsule and leave the latter behind. The lens substance is formed by the epithelial cells of the lens and the lens fibers. The former cover only the anterior surface of the lens (immediately under the capsule) and disappear at the equator; the latter form the greater bulk of the lens substance.

In children the lens substance is almost uniformly soft (soft lens), and is capable of total absorption. At about the age of twenty-five years, however, its centre becomes hard, owing to a process called sclerosis. From this age on the lens substance is divided into two parts, the hard central portion or nucleus, and the soft peripheral portion or cortex. Such a lens is not capable of total absorption (hard lens). The transition from cortex to nucleus is gradual, and as the years advance the cortex diminishes in size while the nucleus increases until about the sixtieth year of life the entire lens is sclerosed. This is of great importance from an operative point of view, as in patients under twenty-five years, in whom the lens substance is capable of absorption, discission of the lens capsule, which results in the swelling and absorption of the lens, will be indicated. In older patients where absorption is impossible the lens must be extracted.

The lens is held in place by the zonule of Zinn, which consists of many fine, transparent fibers running from the ciliary body in a fan-shaped arrangement to the equator of the lens. The fibers are in close contact with the vitreous, and there are large spaces between them through which the aqueous can reach the vitreous. The lens capsule and the fibers of the zonule are comparatively strong and elastic, so that in cataract operations they afford enough resistance to prevent the vitreous from prolapsing. If, however, the posterior surface of the lens capsule (usually referred to as posterior capsule of the lens) is ruptured (too deep discission) or the zonule is torn (dislocation of the lens) the extraction is usually attended with a prolapse of vitreous.

Vitreous Body.—The vitreous body fills the space between the retina and lens (vitreous chamber). It consists of a transparent jelly-like substance which has a transparent reticular network weaving through it; it is somewhat sticky to the touch due to the mucine that is present in it. It is surrounded by a fine and very thin (0.005 mm.) membrane, the *hyaloid membrane*. The vitreous has no bloodvessels, and is extremely liable to infection; therefore, operations which do not open the vitreous cavity should be preferred to those that do. The vitreous lost during operation is never replaced by vitreous; small quantities are replaced by aqueous, but larger ones usually mean shrinkage of the eyeball.

CHAPTER IV

OPERATIONS ON THE CORNEA

PARACENTESIS OF THE CORNEA AND SAEMISCH'S KERATOTOMY

Both operations consist in the opening of the anterior chamber for the purpose of evacuating its contents. The tapping may be performed either with an angular keratome (paracentesis) or with a Graefe knife (keratotomy).

Paracentesis of the Cornea.—Indications.—1. To reduce tension, especially in acute glaucoma, where the anterior chamber is so shallow and the pupil so widely dilated that an iridectomy cannot be performed. In such cases if miotics fail to reduce the tension, paracentesis must be resorted to in order to avoid permanent damage to the optic nerve. After the paracentesis the tension falls, the pain subsides, the miotics act better, and the anterior chamber becomes deeper so that an iridectomy is possible. It is also advised in juvenile glaucoma (buphthalmos), where it is said that by repeated paracentesis the eye becomes accustomed to the decrease of tension, and the iridectomy may be performed later with less danger. In cases of iridocyclitis, accompanied with secondary glaucoma, if the tension does not subside in a few days, a paracentesis may be done.

2. To remove swelling lens masses after traumatism or discission. The swollen lens substance causes secondary glaucoma, which if not controlled quickly destroys vision. In such cases a paracentesis will remove the lens masses and reduce the tension.

3. To remove blood (hyphema) from the anterior chamber. Paracentesis for this purpose is only necessary when the spontaneous absorption is slow, and the eye is irritated and painful. In spontaneous hemorrhage special care must be taken to evacuate the anterior chamber slowly, as otherwise the operation

may be followed by a subsequent hemorrhage greater than the original one. In hyphema following trauma, the paracentesis may be of diagnostic value also, as the blood may cover a foreign body.

4. To aid the healing of a corneal ulcer. It is a well-known fact that corneal ulcers after perforation rapidly clear up and heal. The beneficial influence is due to the decrease of tension and the consequent improvement in the lymph and blood circulation of the globe. A spontaneous perforation, especially when large and accompanied by a rapid escape of aqueous, may produce a large prolapse of the iris which is sometimes accompanied with the escape of the lens. A paracentesis in these cases forestalls this danger, as in performing this operation the aqueous is allowed to escape slowly so there is less liability of a prolapse.

5. To remove foreign bodies and cysticercus from the anterior chamber.

Paracentesis has also been advised for the treatment of inflammations of the cornea, iris, or ciliary body; also in cases of opacities of the vitreous, tuberculosis of the iris, in ectasia of the cornea, embolism of the central artery of the retina. The operation in these cases is of doubtful value, and but very rarely performed.

Preparation.—The eye is prepared as for any other eyeball operation. Cocaine is instilled, and the pupil dilated with atropine, except in glaucoma, where pilocarpine or eserine is employed. When the eye is very sensitive a general anesthetic is necessary.

Instruments.—Speculum, fixation forceps, angular keratome, Daviel's spoon, spatula, iris forceps, and iris scissors.

Operation.—The speculum is inserted and the eye fixed opposite the site of the incision.

The incision is made with the angular keratome at the lower end of the vertical meridian of the cornea, about 1 to 1.5 mm. inside of the limbus, in the cornea proper. The blade of the knife should be held perpendicularly to the cornea, and after entering the anterior chamber the handle is depressed so that the blade is parallel to the plane of the iris. If the operation is performed for the purpose of removing the swelling lens masses, it is better to make the incision above and exactly in the limbus, as in such cases an iridectomy may have to be performed. In this event the coloboma, thus produced, will be covered by the upper lid.

In cases of foreign bodies or cysticercus in the anterior chamber, the site of incision must suit the conditions of the case.

The length of the incision varies according to the indication. If the aqueous is to be withdrawn only a small opening is required, and it is sufficient if the point of the blade enters the anterior chamber. If, however, solid masses are to be removed (lens substance, foreign body, etc.) a larger wound is necessary, and the inner end of the wound canal should be about 3 or 4 mm. in length.

After the incision is of desired length, the keratome is slowly withdrawn and the fixation forceps removed. In simple evacuation of the anterior chamber it often happens that owing to the obliquity of the wound canal and the size of the inner opening the aqueous does not readily escape; under these circumstances a Daviel spoon is placed on the posterior lip of the wound, at right angles to its direction, and gently pressed backward. This causes the wound to gape and the aqueous flows out.

If a foreign body or exudate is to be removed from the anterior chamber, and it does not escape with the initial outflow of the aqueous, the operator must wait until the anterior chamber has been partially reformed, and then cause the wound to gape as described above. This maneuver may be repeated several times. If not successful, we may enter with the forceps and extract it, taking great care not to injure the iris or lens capsule. When the paracentesis is done to remove the lens masses the technique is similar to a linear extraction.

After operation the eye is examined to see if the iris is in place. If it has prolapsed it is replaced with a spatula, and then the speculum is removed and a bandage applied over the operated eye only.

Complications during Operation.—1. Intralamellar incision. This occurs when the blade passes too obliquely through the corneal tissue.

2. Injury to the iris and lens. This complication may arise if the blade of the keratome is not held parallel to the plane of

the iris during the incision; it seldom occurs, however, as the keratome does not enter the anterior chamber deeply.

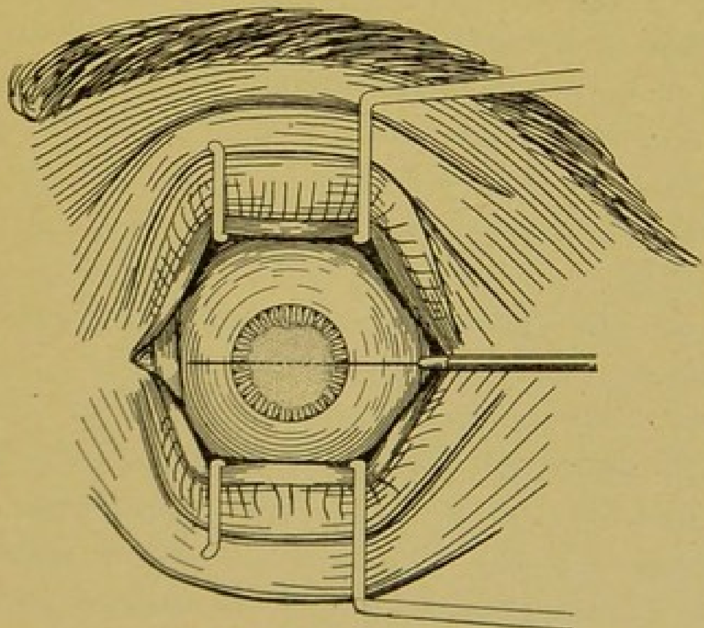
3. Prolapse of the iris. This should be replaced with the spatula. If it recurs the prolapse is to be excised.

After-treatment.—The operated eye alone is bandaged, the unoperated eye being left open. The patient is required to stay in bed at least one day. Later he may sit up, and on the third day he is allowed to walk around. The operated eye is bandaged for about four days, and during this time it is dressed daily, and atropine or pilocarpine are instilled as occasion demands.

Postoperative Complications.—Where asepsis is carefully carried out infection is an exceptional occurrence.

Saemisch's Keratotomy (Fig. 159).—Keratotomy was advocated in 1869 by Saemisch as a treatment for serpiginous ulcer of the cornea.

Fig. 159



Saemisch's keratotomy.

As a rule, the eye is cocainized, but in unruly patients general anesthesia is necessary. After the speculum has been inserted and the eye fixed at the inner extremity of the horizontal meridian of the cornea, an incision is made with a Graefe knife. The knife is held so that the cutting edge is toward the operator, and is entered in the healthy corneal tissue, near the temporal edge of the ulcer. It is pushed through the anterior chamber and emerges at a point exactly opposite the point of entrance, in healthy corneal tissue. With slow sawing movements the incision is completed dividing the ulcer into nearly equal parts.

The fixation forceps is now removed and the wound pried open with a Daviel spoon, to allow the exudate to escape. Such fibrinous exudate as is wedged in the wound as well as all necrotic tissue is removed with a forceps. The eye is now irrigated with hot sterile salt solution and bandaged. On the following days the routine ulcer treatment is continued. Saemisch also advised the reopening of the wound for several days following.

The most common complication of this operation is prolapse of the iris, which occurs during operation as well as afterward. This always results in a large anterior synechia, since to excise the iris and liberate it is dangerous on account of the exceedingly infectious condition of the ulcer. Sometimes when cocaine anesthesia is employed and the patient squeezes, there is a prolapse of lens and vitreous through the large opening. This is especially dangerous as the vitreous comes in contact with the infected area and almost always panophthalmitis ensues.

KERATOPLASTY

There are two varieties of keratoplasty: (1) Corneal keratoplasty; (2) conjunctival keratoplasty.

In corneal keratoplasty transparent corneal tissue is substituted for opaque. In conjunctival keratoplasty conjunctiva is transplanted on the cornea. The reasons for performing a keratoplasty are: (1) To improve the vision (leukoma); (2) to substitute strong corneal tissue for a thinned cornea (ectasia); (3) to cover the defect in the cornea in order to promote rapid healing (ulcer).

Corneal Keratoplasty.—The idea of substituting clear corneal tissue for opaque is very old. Although the attempt has been made many times it has never met with great success.

We distinguish between complete keratoplasty and incomplete. In complete keratoplasty the whole cornea is removed, and another one substituted for it; while in incomplete only a circumscribed area is removed and replaced. Incomplete keratoplasty is further subdivided into a total where the entire thickness of the cornea is removed, and a partial where only the superficial layers are excised.

The transplanted corneal tissue may be taken from a human eye that has just been enucleated, or from an animal (dog, sheep, rat, or chicken, etc.).

Complete keratoplasty has never given good results, and has therefore been abandoned.

Incomplete keratoplasty, even in exceptional cases, has given only mediocre results, and is therefore very rarely attempted. Although the transplanted flap may become adherent and even remain clear for a limited period, it eventually becomes entirely opaque.

Partial incomplete keratoplasty (when only the superficial layers of the cornea are removed) is the only operation that has so far given even passably good results. Cases of leukoma, where there has been no perforation (the posterior layers of the cornea remaining clear) are therefore the only cases that hold out any hope for improvement.

Von Hippel's Incomplete Partial Keratoplasty.—**Definition.**—A round area in the leukoma is circumscribed with von Hippel's trephine, and dissected off from the underlying layers of the cornea. A similar flap, but composed of the entire thickness of the cornea, is taken from a second eye and placed in the excavation.

Indications.—Simple leukoma, when it involves the whole surface of the cornea.

Contraindications.—Adherent leukoma.

Preparation.—Same as for any eyeball operation. Cocaine anesthesia.

Instruments.—Von Hippel's trephine, 2 fixation forceps, fine iris forceps, speculum, spatula, straight fine scissors, Graefe knife or straight keratome, fine curved scissors.

Operation.—The operation consists of four steps; trephining the patient's cornea; dissecting out the opaque flap; trephining the foreign eye; placing the flap in place.

I. STEP: TREPHINING THE PATIENT'S CORNEA.—After the speculum is inserted the resistance of the cornea is tested with a spatula in order to get some idea of the thickness of the leukoma. The blade of von Hippel's trephine is now exposed, according to the thickness of the flap to be removed, which is usually $\frac{1}{2}$ to $\frac{3}{4}$ mm. The trephine is then placed perpendicularly on the cornea, without pressure, and the spring released. It now penetrates until the shoulder of the blade touches the cornea, when it is stopped and removed.

II. Step: Dissecting out the Opaque Flap.—The flap is grasped with the fine iris forceps pulled somewhat above the level of the cornea, and dissected off with the Graefe knife or straight keratome with slow long strokes. No attempt should be made to remove any small opaque spots that remain behind, as there is danger of perforation. The bleeding is thoroughly checked and the speculum removed.

III. Step: Trephining the Foreign Eye.—The foreign eye is now trephined in like manner. If an animal's eye is used it is luxated forward with a strabismus hook. The blade of the trephine is exposed for a distance of 1.5 to 2 mm., so that it will pass directly into the anterior chamber, cutting out a small round flap. If the edge of the flap remains attached at some point it is freed with the fine scissors.

IV. Step: Placing the Flap in Place.—The lids are now retracted by the fingers of the assistant, and the flap is put on the spatula, care being taken that the endothelium is not injured, and placed on the cornea near the excavation. It is then slowly worked into the excavation. Iodoform powder is dusted in the eye, which is then carefully closed. Both eyes are bandaged.

Complications during Operation.—Perforation may occur, due to uneven thickness of the leucoma or to holding the trephine too obliquely. In both cases the operation is to be postponed until the wound heals in about five or six weeks. The same is to be done if after removing the flap the underlying tissue is found opaque. When the bottom of the excavation bulges forward (keratocele) a paracentesis is done before putting in the flap.

After-treatment.—Immediately after operation both eyes are bandaged and remain so until the third day. On the third day the dressing is changed and the eyes cleansed. Both eyes are again bandaged until the sixth day, when the unoperated eye may be left open. The operated eye must be bandaged for ten or twelve days.

Postoperative Complications.—The only complication that can occur is the sloughing of the flap. This happens when infection takes place or the flap has not been placed in the correct position.

Von Hippel's Incomplete Total Keratoplasty.—This operation differs from the incomplete partial keratoplasty, in that in trephining the patient's cornea the entire thickness is passed through. The operation so far, with the exception of one case,[1] has never been successful from an optical standpoint, as all flaps that have been transplanted become opaque. The operation for the improvement of vision is not a success, but in partial staphyloma it may be performed to advantage to better the curvature of the cornea, and in cases of fistula, to close the opening. It is, however, not performed very often, nowadays, as conjunctival keratoplasty has taken its place.

The patient should be put under deep anesthesia, and the cornea trephined. If the iris or lens capsule is adherent, it should be cut off, and the remaining adherent iris separated with a spatula. The lens, if opaque, is removed through the opening; the same must be done if it is transparent, but its capsule has been injured during operation. It often happens that a certain amount of vitreous is lost. When a human cornea cannot be obtained, the cornea of a dog, which is of the same thickness as a human cornea, is a good substitute.

The foreign eye is trephined in the same fashion as in the preceding operation. The transplanting of the flap is also done in the same way. The flap becomes adherent in most cases, but does not remain clear.

Durr's Keratoplasty.—This operation is used to cover defects near the limbus of the cornea following the removal of epibulbar tumors or pseudopterygia. These defects heal very slowly, and the conjunctiva is apt to become adherent to them. To prevent this complication a flap of the same shape, but somewhat larger than the defect, is taken from a rabbit's eye. The flap itself should consist of the superficial layers of the cornea and sclera,

[1] Zirm, Arch. f. Ophthal., 1907.

and should have a small tab of conjunctiva attached to it. The flap is placed in position, and two sutures are passed through the tab of conjunctiva anchoring it in the episcleral tissue.

Conjunctival Keratoplasty.—This operation was first performed by Schöler in 1876, and was later developed by Kuhnt.

The operation is especially suitable in the following cases:

(*a*) For covering defects in the cornea, after the removal of prolapse of iris, cystoid scar, or partial staphyloma.

(*b*) In cases of fistula of cornea, after its cauterization.

(*c*) In injuries of the cornea, where there is danger of infection from a chronic dacryocystitis or conjunctivitis; the wound being thoroughly cleansed and its edges trimmed before the keratoplasty.

(*d*) In cases of sluggish ulcer of the cornea, to promote rapid healing, if under the routine treatment no progress is made within a week or ten days. The base of the ulcer is to be curetted and thoroughly cleansed before covering it with conjunctiva.

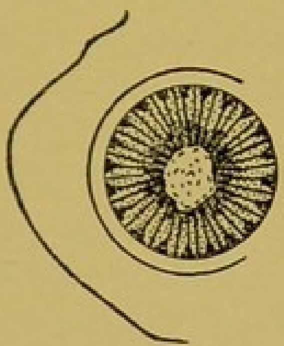
This operation, in most cases, gives good results, as the defects of the cornea when covered with the transplanted flap not only heal rapidly, but the scar formed is firm and resistant to intraocular pressure.

The operation consists in forming a pedunculated conjunctival flap, which after being dissected from the sclera is placed over the defect and sutured in position.

After the eye has been washed and cocainized the speculum is inserted. The conjunctiva is grasped with a pair of fine forceps and with the scissors it is separated from its attachment to the limbus for about one-half to three-fourths of the corneal circumference. The conjunctiva is now freed from its attachment to the sclera so that it can be easily drawn over the defect in the cornea (Figs. 160 and 161). A second incision is made in the conjunctiva concentric to the first, but at such a distance that the bridge flap that is formed shall be double the width of the defect in the cornea. In defects near the limbus the second incision may be omitted if the conjunctiva is undermined (Figs. 162 and 163). Two sutures are now put in to hold the flap in place. These are placed at each end of the flap passing through its limbal border into a fold of conjunctiva.

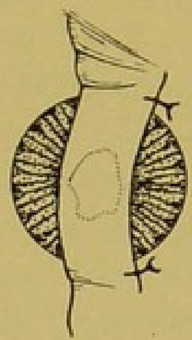
After the sutures have been inserted the flap is placed in position to see if it is large enough to cover the defect. If found to be satisfactory it is pulled to one side. At this point the ulcer is curetted; the prolapse of iris excised; the staphyloma ablated as the case may be. The flap is then pulled over the defect, smoothed out, and the sutures tied.

FIG. 160



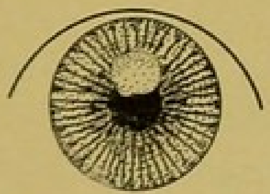
Kuhnt's conjunctival keratoplasty. (*I a*)

FIG. 161



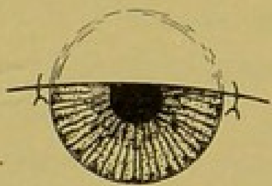
Kuhnt's conjunctival keratoplasty. (*I b*)

FIG. 162



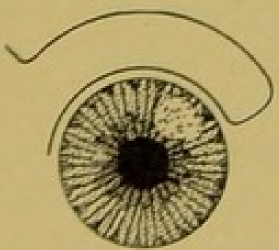
Kuhnt's conjunctival keratoplasty. (*II a*)

FIG. 163



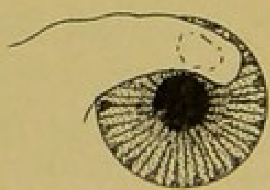
Kuhnt's conjunctival keratoplasty. (*II b*)

FIG. 164



Kuhnt's conjunctival keratoplasty. (*III a*)

FIG. 165



Kuhnt's conjunctival keratoplasty. (*III b*)

A flap can also be made with one pedicle to cover the defect, but as it is impossible to suture it, it is very apt to slip from its position (Figs. 164 and 165).

After the operation both eyes are bandaged for two to four days, after which the unoperated eye may be left open. The operated eye is to be dressed daily, but the bandage is not to be left off before the fourteenth day.

The wound in the bulbar conjunctiva heals in a short time. Only that portion of the flap that is over the defect becomes adherent. The pedicles the first few days are swollen and injected, but later they become atrophic and may be severed, and the redundant tissue, if present, trimmed off on the ninth day.

OPERATIONS FOR STAPHYLOMA OF THE CORNEA

Total as well as partial staphyloma of the cornea are conditions that not only interfere with or entirely destroy the patient's vision, but also cause other complications. Both may lead to repeated attacks of secondary glaucoma and iridocyclitis which cause pain and a further distention of the scar. When occurring in early life the sclera also may give way, thus greatly increasing the diameter of the eyeball. This complication often prevents proper closure of the lids (lagophthalmos).

Staphyloma may also be very annoying by constantly irritating the conjunctiva and causing a chronic conjunctivitis, with lacrimation and all its sequelæ. Finally, from a cosmetic standpoint, it is very disfiguring. Medical treatment is out of the question, and surgical interference alone is of value.

In partial staphyloma an iridectomy is often sufficient to relieve the secondary glaucoma as well as to improve the patient's vision. If the wall of the staphyloma is thin, and the iridectomy is followed by light bandaging for several weeks, it often becomes flat and remains so. If, however, the staphyloma is large and its wall thick, this favorable outcome will not follow the iridectomy, and ablation of the staphyloma is necessary.

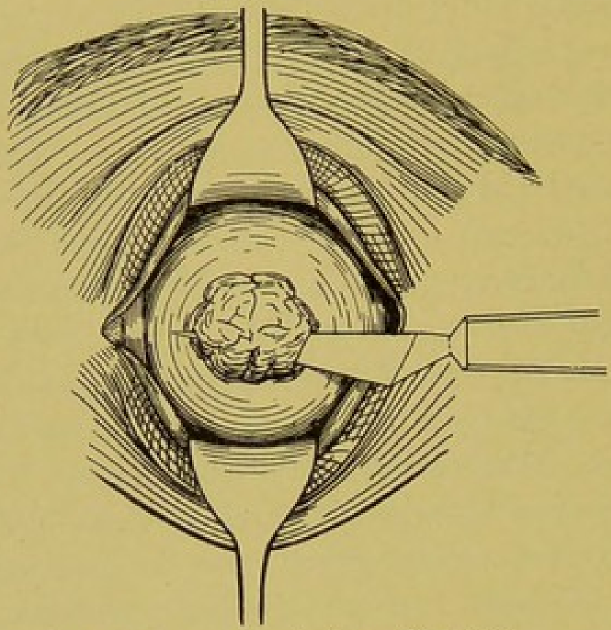
The ablation of a partial staphyloma is performed in the same manner as the ablation of a total staphyloma. It may be done a few weeks after the iridectomy or preceding it. The defect in the cornea is best covered with a bridge conjunctival flap as described on page 140.

In cases of total staphyloma no improvement in vision can be expected, and the operation is performed for cosmetic purposes only. There is a choice between two operations: (1) Ablation of the staphyloma; (2) enucleation, depending on whether or not the eye has perception of light and good localization. Ablation of the staphyloma is indicated in cases where the light perception and localization is good. Where the light perception and localization is faulty or entirely wanting, enucleation must be performed. Faulty perception of light or localization indicates that the eye has had previously repeated attacks of secondary glaucoma or iridocyclitis. In eyes that have become blind from these complications, the bloodvessels are degenerated, and an ablation of the staphyloma is very often followed by an expulsive hemorrhage. The operation may also light up the old iridocyclitis causing, if the stump is not enucleated in time, a sympathetic inflammation in the sound eye. It must be, however, taken into consideration that an iridocyclitis may follow an ablation of the staphyloma even in eyes which have good perception of light and localization. Although this danger actually exists, it is very slight, and almost eliminated since the introduction of aseptic surgery.

Beer's Method.—General anesthesia is employed. The eyelids are held apart with Desmarres' lid retractors, and the eye is fixed below. A Beer or Graefe knife is then passed through the staphyloma with its cutting edge downward, entering at the temporal end of the horizontal meridian and coming out at the nasal end. If a Beer knife is employed the fixation forceps, at this point, are removed, and the incision completed by simply pushing the knife onward, taking care that the incision follows the base of the staphyloma. If a Graefe knife is used the incision is completed with sawing movements, thus the lower half of the staphyloma is ablated. Catching the flap with the mouse-tooth forceps, the upper half of the staphyloma is separated at its base with the scissors, and removed (Figs. 166 and 167).

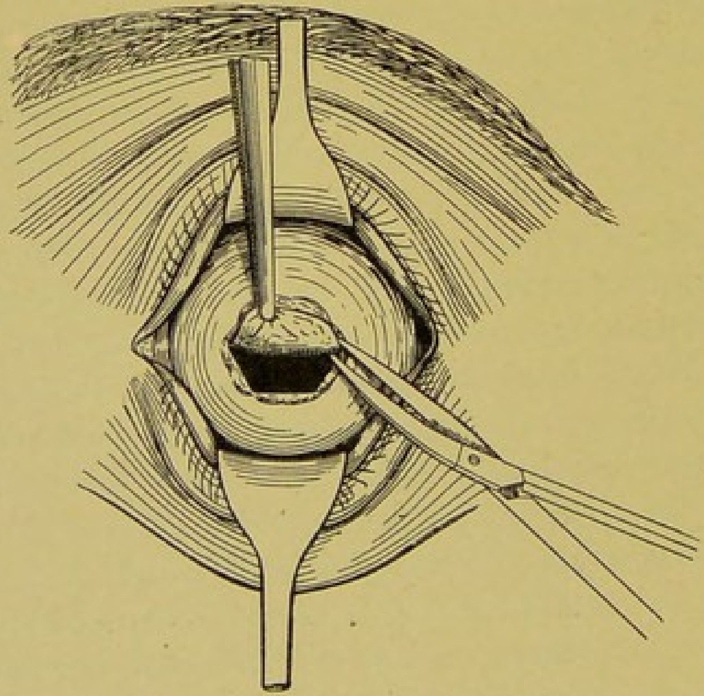
If the lens is still in the eye the capsule is opened and the lens expelled. The operation is usually followed by considerable loss of vitreous. Beer left the wound open and bandaged the eye. The great disadvantage of this is that the wound heals very slowly, and before the scar attains its proper strength it may give way again. It is necessary, therefore, that a pressure bandage should be worn, often as long as four or five months; the open wound is also apt to become infected, as the vitreous is

Fig. 166



Beer's ablation of a staphyloma. First step.

Fig. 167

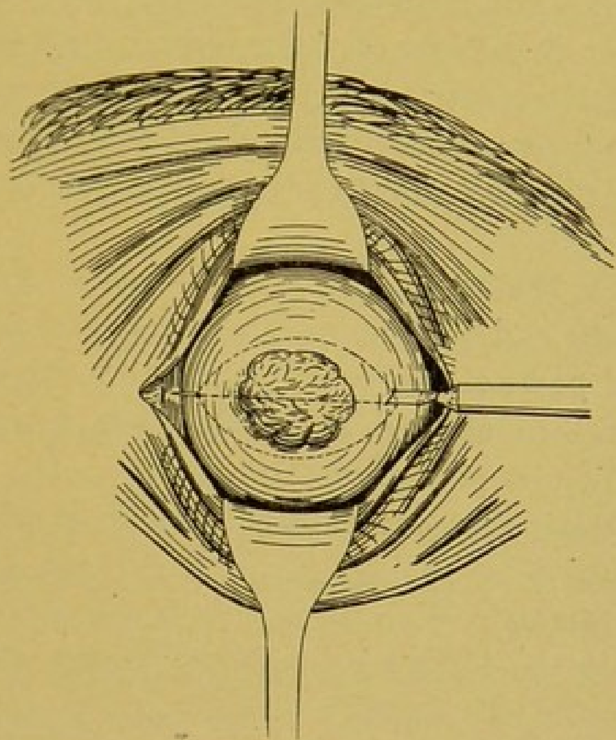


Beer's ablation of a staphyloma. Second step.

exposed, leading to a panophthalmitis. The long convalescence, together with the danger of infection, is the reason that other operations which close the wound, have been substituted.

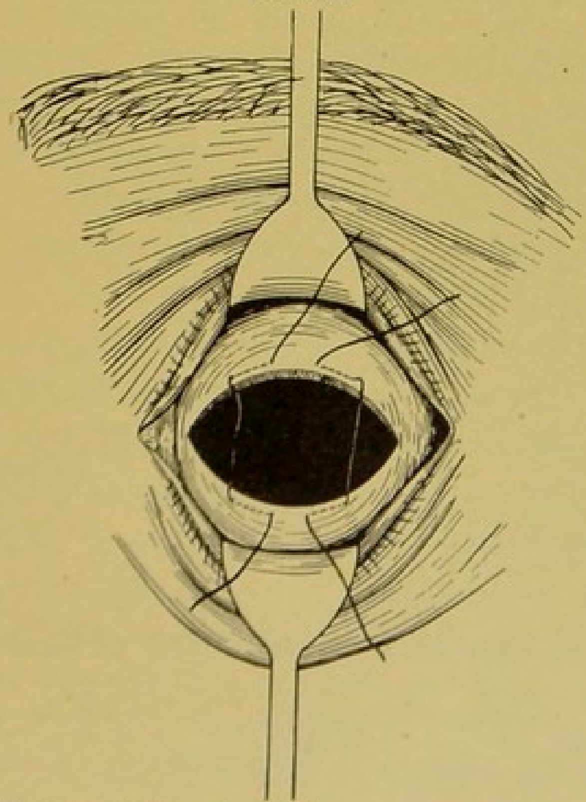
Knapp's Method.—Before ablation of the staphyloma, two sutures are passed through the conjunctiva and superficial layers

Fig. 168



Knapp's ablation of a staphyloma. First step.

Fig. 169



Knapp's ablation of a staphyloma. Second step.

of the sclera. One needle is entered at the upper end of the vertical meridian of the cornea, and carried horizontally for a distance of about 4 mm., where it is brought out. It is then reinserted about 4 mm. from the lower end of the vertical meridian and brought out at the foot of the meridian itself (Figs. 168 and 169). One suture is inserted on the temporal side and the other in the same manner on the nasal side of the vertical meridian. The staphyloma is then ablated according to Beer's method, and the sutures tied.

De Wecker's Method.—The conjunctiva is first separated from the limbus and undermined back as far as the equator, after which a purse-string suture is passed through it. The staphyloma is then ablated as in the Beer method, and the wound closed by tying the purse-string suture. The disadvantage of this operation is that the suture often gives way a few days after the operation.

Czermak's Method.—For the above reason Czermak advises the combination of the Knapp and De Wecker methods using, catgut sutures for the sclera.

ABRASION OF THE CORNEA

This small surgical procedure gives very good results in small superficial ulcers of the cornea as often found in dendritic keratitis. It may also be advocated in removing rust from the cornea after foreign bodies or the ring of infiltration that surrounds them, if they are left in the eye too long. Lime, lead, or gunpowder may also be removed by this method.

The eye is cocainized, the speculum is inserted, and the eye fixed below. The ulcer is then scraped out thoroughly with a Meyhöfer curette, and generously irrigated with hot boric acid solution. Iodoform or argyrol ointment, 10 per cent., is applied, and the eye bandaged.

CAUTERIZATION OF THE CORNEA

Cauterization consists in applying to the cornea a heated metal instrument for the purpose of destroying its superficial layers.

Indications.—1. Ulcer of cornea; in order to destroy the bacteria and thereby checking its progress. Cauterization is indicated in all forms of progressive ulcer irrespective of their origin when they do not respond to routine treatment. It is necessary to cauterize well the edges and base.

2. After injuries or operations, if the wound is infiltrated, to check further progress of the infection.

3. Relapsing abrasion of the cornea; to stimulate the epithelium.

4. Fistula of cornea; to secure closure. The cauterization should be done when there is some anterior chamber present. It is often necessary to repeat the operation several times.

5. In cases of cystoid scar and keratocele to produce a firm, flat scar.

6. For the same reason, in ablation of an old prolapse of the iris. In these cases often simple cauterization without ablation is sufficient.

7. After removal of pterygium, and after the removal of tumors, to destroy all remaining tissue.

8. Keratoconus. The apex of the cone is cauterized deeply, but without puncture. The result will be a solid scar which will check the ectasia of the cornea. As the opacity lies over the pupil it is necessary to do tattooing, and later an iridectomy. This is so far the most satisfactory method of treating keratoconus. The excision or trephining of the cone gives no better results, and it is far more dangerous, inasmuch as the opening of the anterior chamber predisposes to prolapse of the iris and infection.

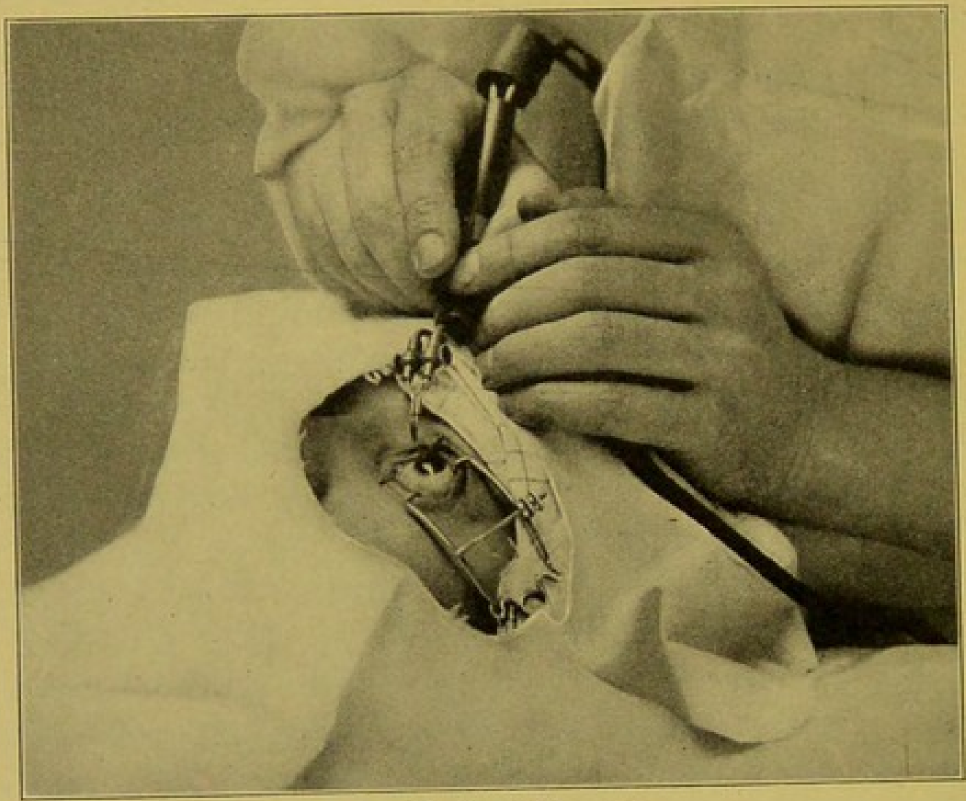
Preparation.—The eye is cocainized and washed out, and the pupil dilated with atropine.

Instruments.—Speculum, fixation forceps, cautery. Galvano- or thermocautery with special corneal tips should be used. In case of emergency a strabismus hook or probe heated over an alcohol lamp or gas flame answers the purpose.

Operation.—The speculum is inserted and the eyeball fixed below. On an inflamed eye, or in quiet patients, the fixation may be omitted, as it is very painful.

The tip of the cautery is heated to a "cherry red" and applied lightly to the edges and base of the ulcer. In cases where other results than disinfection are to be produced, the site of the cauterization is self-evident (Fig. 170).

Fig. 170



Cauterization of the cornea.

The perforation of the cornea in ulcers as well as in other cases is to be avoided, so far as possible, on account of the danger of prolapse of the iris and the resulting anterior synechia. If perforation occurs, however, the deeper tissues of the eyeball are not injured, as the escaping aqueous cools the cautery. In ulcers where a perforation is necessary, it is better to do it a few days afterward with a keratome or Graefe knife.

After-treatment.—The eye is bandaged and the usual treatment continued. If during the following days the ulcer is still progressive, the cauterization must be repeated. The bandage is to be worn until a strong solid scar has formed at the site of the cauterization.

TATTOOING OF THE CORNEA

Tattooing consists in impregnating the corneal tissue with India ink either for cosmetic or optical purposes, or both.

Indications.—1. Leucoma of the cornea, when large enough to be disfiguring.

2. Complicated cataracts, when extraction is not to be attempted.

3. Keratoconus, after cauterization has been performed.

4. Macula of cornea, when vision is considerably reduced through the diffusion of light.

5. Aniridia and albinism, to produce an opaque diaphragm, thereby reducing dazzling.

Contraindications.—1. Adherent leucoma, especially when it is thin. In such cases the operation may produce an iridocyclitis, with a possible sympathetic inflammation of the other eye. Infection may also follow the operation, and in these cases the infective material, being directly inoculated into the iris, spreads very rapidly into the interior of the eyeball, causing panophthalmitis.

2. In cases of complicated cataract, if the eyeball is degenerated, an iridocyclitis may result.

Preparation.—Very careful preparation is as necessary as for the most delicate eye operations. Cocaine anesthesia is used.

Instruments.—Speculum, fixation forceps, tattooing-needle, spatula, India ink.

Operation.—The speculum is inserted and the fixation forceps are not to be used if the patient remains quiet. If restless, however, the eyeball is to be fixed above, as a tattoo mark may be made where the forceps break the conjunctiva. In using the forceps above, the mark, if produced, will be covered by the upper lid. To avoid this complication it is better to use forceps that have no teeth.

The superficial layers of the cornea are now repeatedly pricked with the tattooing-needle held obliquely, until the whole area which is to be made black is abraded. The India ink is now placed on the cornea with a spatula, and massaged into the corneal tissue. After rubbing in the ink it is well to wash it off with sterile salt solution to see how much of the cornea is tattoed. If necessary the tattooing is to be repeated several times until the area is black.

The ink itself should be of the finest quality of India ink, and requires special preparation. It is to be sterilized at 150° C. in a dry sterilizer, after which it is rubbed up with bichloride of mercury, 1 to 1000 solution, until a thick black paste is formed.

Czermak advises outlining the area that is to be tattooed with a trephine, and then to strip off the epithelium with a keratome, and tattoo with the needle.

Dimmer modified Czermak's method. He outlined the area with a trephine, and cut into the corneal tissue for about ½ mm. Then the flap was dissected up with a keratome, leaving it adherent to one edge like a trap-door. The India ink is rubbed into the excavation, and the small flap of corneal tissue closed down upon it. This operation is of no value in dense leucoma, as the corneal flap covering the ink is opaque. Excellent results can be obtained when the cornea is clear or only slightly cloudy.

After-treatment.—After tattooing a bandage is to be worn until the eye is white and the epithelium completely restored.

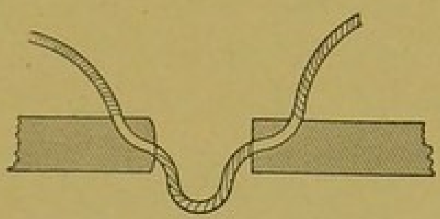
It is seldom that a perfect result follows the first operation, and usually the operation has to be repeated several times at intervals of two or three weeks until the area acquires the desired color. A blackened area retains its color for several years, after which it begins to fade and becomes gray. This necessitates a repetition of the operation.

SUTURING OF THE CORNEA

Suturing of the cornea is rarely necessary, as corneal wounds usually close well without interference. Large wounds, especially when the edges are irregular or when the wound extends through the limbus into the sclera, may gape. These wounds, if there is any hope of saving the eye, may be sutured, but usually in these cases the injury is so extensive that enucleation must be performed in order to avoid the possibility of sympathetic ophthalmia.

If the cornea is to be sutured it is first thoroughly cocainized, or in children a general anesthetic is given. The eye is then washed, and all shreds of iris, lens capsule, or vitreous are removed. A silk suture with a small needle is employed. The needle is introduced about 2 mm. from the edge of the wound, taking in only the superficial layers of the cornea. The needle is made to come out through the lip of the wound, and is introduced again at a point exactly opposite in the other lip. From here it is brought out about 2 mm. away from the edge, and the suture is tied (Fig. 171).

FIG. 171



Suturing of wound of cornea, cross-section.

The silk suture should never enter the anterior chamber, as this will favor infection. After suturing, the cornea is dusted with iodoform powder, and the eye is bandaged. Silk is well borne by the cornea, and causes no reaction.

CHAPTER V

OPERATIONS ON THE SCLERA

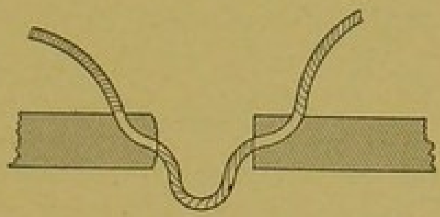
In this chapter the operations on the sclera and the operations for detachment of the retina are dealt with. Anterior sclerotomy, which is usually described under this heading, is to be found in the chapter on the Iris under Substitute Operations for Iridectomy in Glaucoma, for the reason that the incision of the iris angle reduces the intra-ocular pressure rather than the section of the sclera. Posterior sclerotomy as performed for glaucoma (see p. 193) differs slightly in technique from the way it is performed for detachment of the retina. For this reason the operation is described under both headings, and to avoid confusion, posterior sclerotomy as applied to detachment of the retina is termed paracentesis of the sclera.

SUTURING OF SCLERAL WOUNDS

Wounds of the sclera may be meridional or at right angles to the direction of the fibers. They may penetrate all coats of the eyeball, including the conjunctiva, or the conjunctiva may be intact. Wounds that run in the same direction as the fibers coapt well, and no intervention is necessary when they are covered with conjunctiva. Suturing in such cases is of no advantage, on the contrary it favors intra-ocular infection. If, however, the conjunctiva is opened it is advisable to close the conjunctival wound after cutting off the prolapsed vitreous or choroid. The sutures, in such cases, take in the conjunctival and episcleral tissue. Wounds that lie at right angles to the scleral fibers always gape to a great extent, and if let alone will not heal properly, and the result will be the adhesion of the choroid and vitreous to the scar, forming a retracted or ectatic cicatrix.

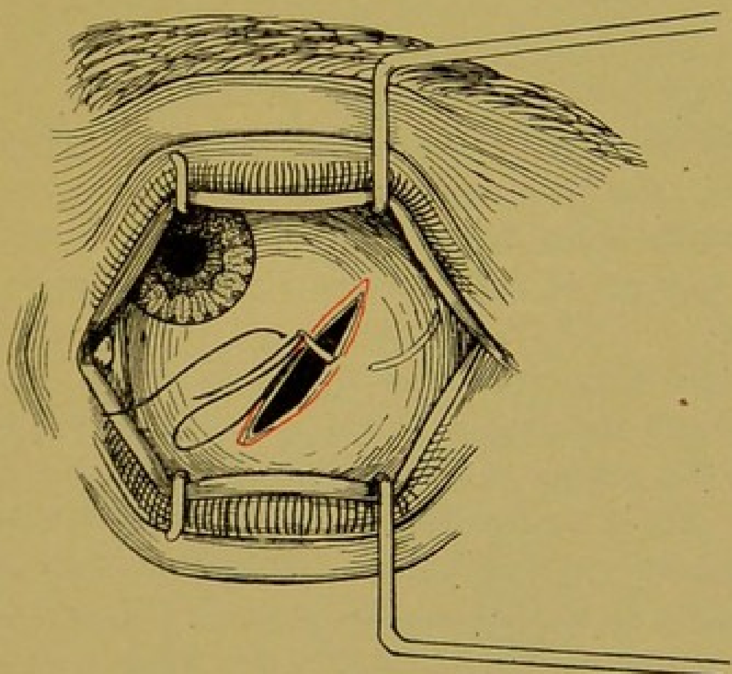
Under such conditions the suturing of the sclera is necessary, even if the wound is covered with intact conjunctiva. It, however, should not be done where there is great loss of vitreous followed by collapse of the eyeball, or where there are signs of a beginning infection. In such cases enucleation of the eyeball is indicated.

Fig. 172



Suturing wound of sclera, cross-section.

Fig. 173



Suturing wound of sclera.

The suturing of the sclera may be done under cocaine, but a general anesthetic is to be preferred. The eye is washed out, and the speculum inserted, the edges of the wound are carefully trimmed, and if there is any prolapsed choroid or vitreous present, it is excised. The sutures are inserted so as to take in one-half of the thickness of the sclera. It is better to follow Lawson and Pooley, who advise the insertion of the needle from within outward, and employ a double-armed suture, which is passed through the edges of the wound while they are steadied with the forceps (Figs. 172 and 173). As the wound of the conjunctiva should be sutured separately and the scleral sutures buried, it is evident that the latter should be of catgut.

OPERATIONS FOR DETACHMENT OF THE RETINA

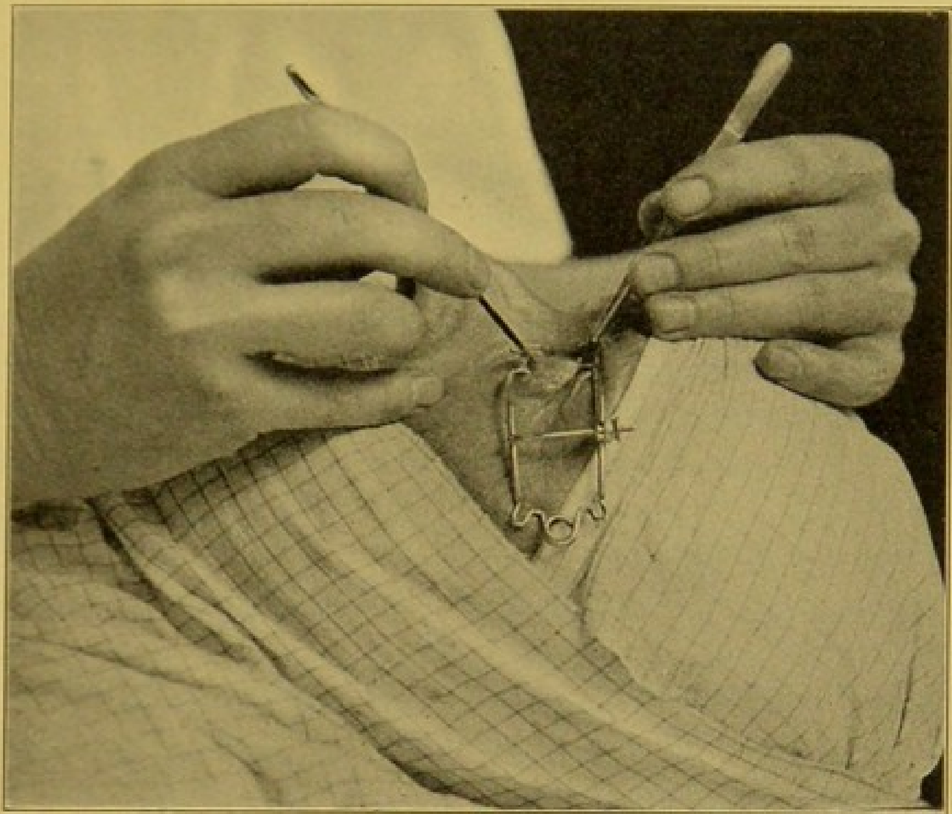
The cause of detachment of the retina is so far unknown. Various theories have been advanced, and in accordance with these, various operations devised. It may safely be said that up to the present time there is no operative interference which yields satisfactory results, and therefore many ophthalmologists refrain from all operations and treat the detachment medically. The operations that are most commonly used are: (1) Paracentesis of the sclera; (2) Deutschmann's operation; (3) Deutschmann's injection of calf and rabbit vitreous; (4) Müller's resection of the sclera; (5) cauterization of the sclera.

Paracentesis of the Sclera.—The idea of the operation is that by the evacuation of the subretinal fluid the retina may become reattached.

After the eye has been washed and cocainized, the speculum is inserted and the patient is told to look in the direction that will bring the portion of the sclera that is over the detachment into view. The eye is fixed at a point in the limbus that is nearest the detachment. Before making the incision a fold of conjunctiva is caught on the point of the knife and drawn to one side, so that the opening in the conjunctiva may not lie over the opening in the sclera (Figs. 174 and 175). A Graefe knife is now thrust meridionally through the sclera and choroid for a distance of about 4 or 5 mm., after which it is rotated so as to pry apart the scleral fibers. The escape of subretinal fluid can be detected by the appearance of a vesicle under the conjunctiva near the wound. The escape of fluid may be facilitated by having the assistant raise the conjunctiva, as this movement causes a slight aspiration of the wound.

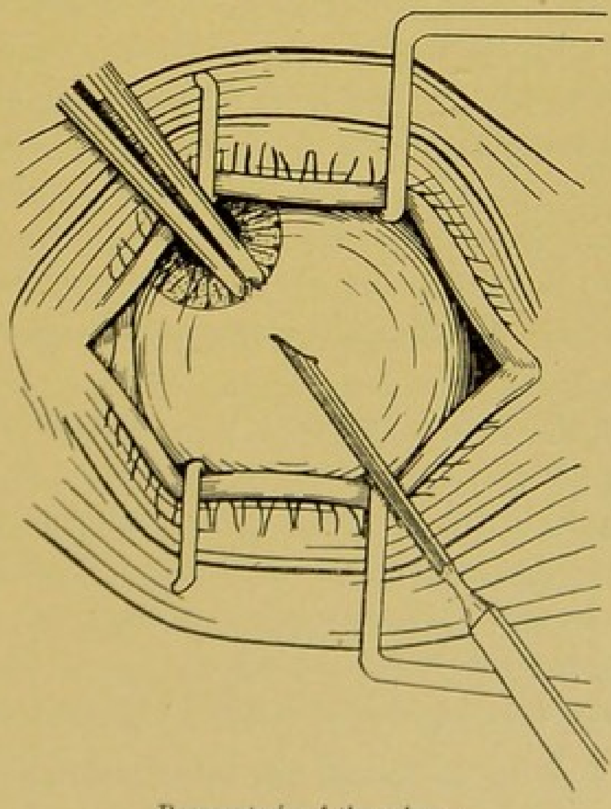
After operation atropine is instilled, both eyes are bandaged,

Fig. 174



Method of holding the Graefe knife in paracentesis of sclera.

Fig. 175



Paracentesis of the sclera.

and the patient lies quietly in bed from eight to fourteen days. The immediate result is the reattachment of the retina, but later it again becomes detached.

Deutschmann's Operation.—It is, in fact, a modified and somewhat more extensive operation than the paracentesis. The pupil is dilated to the maximum and cocaine instilled. The patient looks up and the incision is made near the lower cul-de-sac either with a straight or bayonet-shaped knife that has a cutting edge on both sides. The eyeball is completely transfixed, the knife passing through all the coats and the vitreous to the opposite side, where again all the coats, except the conjunctiva, are pierced. The knife is now rotated as in paracentesis and withdrawn. A bandage is now applied to both eyes, and the patient remains quietly in bed on his back for eight days. The operation is repeated until a permanent result is obtained; this sometimes necessitates twenty to thirty punctures.

If this operation does not give the desired result an injection of calf or rabbit's vitreous may be tried. A rabbit or calf's eye is enucleated and the vitreous carefully removed and mixed with normal salt solution.[1] The needle of the syringe is introduced into the vitreous, Deutschmann's transfixation is repeated, and 1 to 2 minims of the preparation are injected. After the injection, on the next day, there is usually severe reaction with increased tension, pain, and sometimes iritis; in certain cases a yellow exudation in the vitreous appears that is absorbed only after several months. Deutschmann's idea is to increase the volume of the vitreous, thereby pressing the retina against the choroid. Owing to the severe reaction and uncertain results, Deutschmann has found very few followers.

Resection of the Sclera (Müller).—In 1903, Müller advanced this operation for the cure of detachment of the retina. He explains the cause of the detachment by a disproportion between the coats of the eyeball and its contents; the former being too large for the latter. By excising a section of the sclera he attempts to correct this disproportion.

Müller begins this operation with Krönlein's resection, but

[1] The prepared solution may be obtained from Dr. W. Mield's drug store, Hamburg, Germany.

according to Czermak this is not absolutely necessary, as, especially in prominent eyes, a canthotomy is sufficient. The external rectus is seized, two sutures inserted, and the muscle severed between them. An elliptical space of about 20 mm. in length and 10 mm. in width is now outlined on the sclera. The anterior border of this area is behind the insertion of the external rectus and the posterior border toward the equator. The elliptical incision is now carried half-way through the thickness of the sclera, and five fine catgut sutures are inserted, using double-armed threads, and suturing from within out. The sutures are raised out of the way, and the posterior border of the incision is carried through the entire thickness of the sclera, taking great care not to injure the choroid. To avoid this it is better practice to penetrate at one point with the knife, and afterward to enlarge the incision with the scissors. The choroid is then separated from the sclera, and by drawing the sutures together the scleral flap is pushed into the pocket between sclera and choroid. Before tying the last suture the choroid is punctured. The sutures in the external rectus are now tied, and the wound closed. Atropine is instilled, and the patient remains on his back eight days.

Blaskovics' modification tends to make this otherwise difficult operation easier. After circumscribing the elliptical area and having penetrated one-half of the thickness of the sclera, he removes the superficial layers of the flap. The insertion of the sutures is thereby greatly facilitated, and the introduction of the flap between sclera and choroid is made easier.

Cauterization of the Sclera.—At the site of the detachment an incision is made through the conjunctiva and Tenon's capsule, both being carefully dissected from the sclera. With the galvanocautery, having a needle point, five or six applications are made to the sclera, deep, but not through it. Before or after cauterization a paracentesis of the sclera is to be performed. The conjunctiva is then sutured and a bandage applied.

The idea is to produce, by heat, a circumscribed inflammation which will cause adherence between choroid and retina. De Wecker goes entirely through the sclera, believing a better drainage of the subretinal space is thereby obtained.

CHAPTER VI

OPERATIONS ON THE IRIS

IRIDECTOMY

THE operation consists of an incision, in either the sclera or cornea, through which the anterior chamber is entered with a forceps, a fold of iris grasped, drawn out, and excised. An iridectomy is performed for the following purposes:

1. To improve vision (optical iridectomy).

2. To reduce tension (antiglaucomatous iridectomy).

3. To cure chronic inflammations of the uveal tract (antiphlogistic iridectomy).

4. Preceding a cataract extraction, to render it safer and easier, or to ripen an immature cataract (preliminary iridectomy).

Although the above division is a clinical grouping which is used in almost all text-books, it is rather better to divide iridectomies into two classes according to the size of the coloboma: (*a*) Small iridectomy; (*b*) large iridectomy, as either one may serve two or more of the above purposes.

Small Iridectomy.—Indications.—1. Central macula of the cornea if totally opaque. In semitransparent maculæ the vision is reduced not so much by the cutting off of the rays of light as by the diffusing of them. This condition, of course, produces a dazzling, which would only be increased by an iridectomy. In such cases an iridectomy would be indicated only after the macula has been made completely opaque by tattooing. A better vision than $\frac{20}{50}$ cannot be expected after an iridectomy, as the coloboma is in the periphery, and the refraction of the rays of light is less favorable to good vision than in the pupillary area. The improvement in vision can be approximately estimated by examining the visual acuity before and after atropine instillation.

2. Occlusion membrane in the pupillary area.

3. In keratoconus after cauterizing the apex and tattooing it.

4. Stationary central opacity of the lens, such as very large anterior polar cataracts, and with certain surgeons, stationary perinuclear cataracts. It must be remembered that perinuclear cataracts, even if they show no signs of progression at the time of the iridectomy, sooner or later become total, necessitating extraction. In such an event a coloboma in the palpebral fissure will greatly disturb the patient's sight. It is therefore better practice to place the coloboma above outside, or above inside, so that it will be partially covered by the upper lid, or it is better still to do no iridectomy at all, but to remove the lens.

Contraindications.—1. Diffuse semitransparent opacities of the cornea, as a coloboma will only increase the dazzling without improving the sight.

2. If visual acuity is better than $\frac{20}{50}$ or cannot be considerably improved by dilating the pupil.

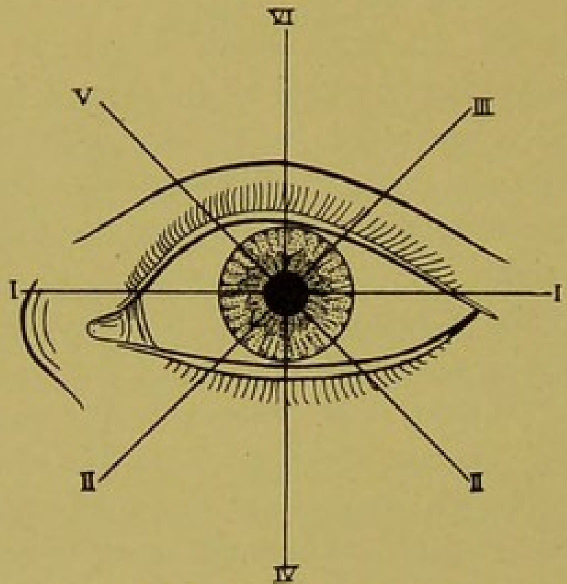
Preparation.—The general preparation is the same as for any eyeball operation. Cocaine anesthesia is used in all adult patients who are not unruly. A general anesthetic is employed in children and in restless adults. The pupil must be contracted with pilocarpine. In cases of cocaine anesthesia pilocarpine is alternated with the cocaine to avoid dilatation of the pupil.

Instruments.—Speculum, fixation forceps, angular keratome, iris forceps, iris scissors, Tyrrell hook, iris spatula.

Operation.—The operation consists of three steps: Incision, excision of the iris, and toilet.

I. Step: Incision.—The speculum is inserted and the eyeball is fixed opposite the site of incision. The site of the incision should lie where the coloboma is to be placed. The position of the coloboma is often determined by necessity, in other cases where the cornea is equally transparent throughout the periphery, the site may be chosen, and consequently it should be known which position gives the best result. From a physiological as well as an anatomical standpoint the best site for the coloboma is directly inward or directly outward, as well as inward and downward, or outward and downward (Fig. 176). Less favorable in sequence is a coloboma outward-upward, directly downward, and upward-inward. The poorest site is directly upward, as such a coloboma will be covered by the upper lid. A coloboma for optical purposes should only be made in this last position from necessity alone, namely, in cases where there is no other transparent part on the cornea, and the other eye is blind. In such cases it is necessary to do a tenotomy of the superior rectus following the iridectomy, in order to bring the coloboma into the palpebral fissure.

FIG. 176

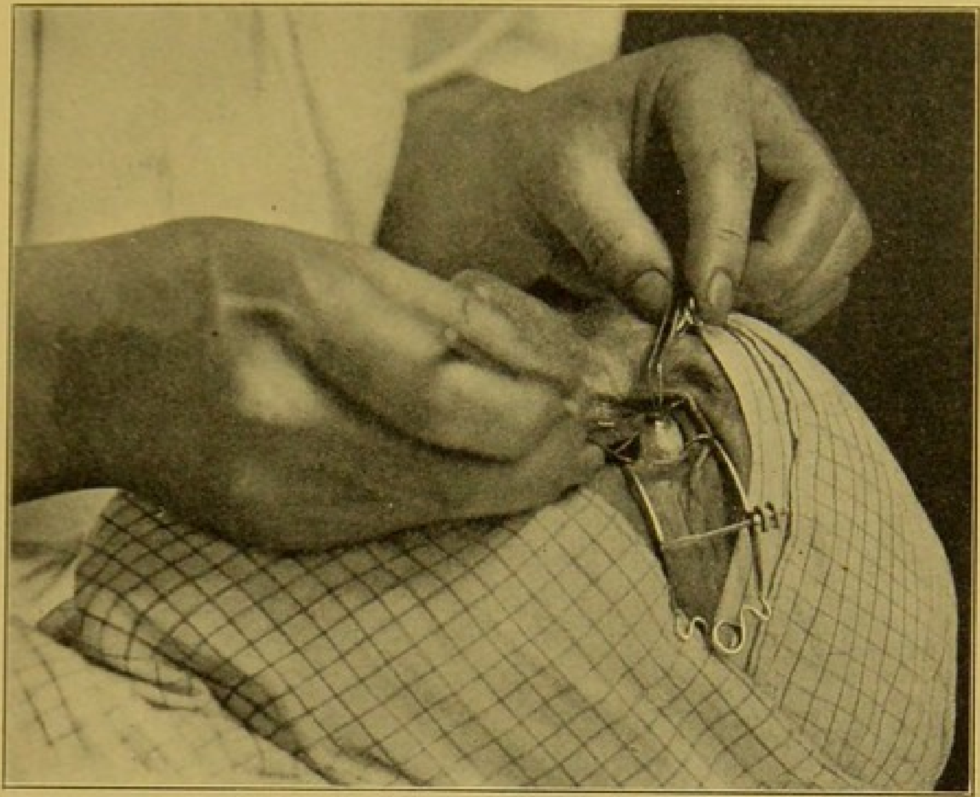


Order of preference in the choice of site for small iridectomy. (After Blaskovics.)

An incision is made with an angular keratome which is held in the usual manner in the right hand for all incisions, changing our position according to necessity (Figs. 177 and 178). The incision is made in the limbus at the chosen site, taking care to mark the point of entrance by some conjunctival bloodvessel or corneal opacity, as the eyeball often rotates after fixation, and there is danger of misplacing the coloboma. The keratome is applied rather perpendicularly to the cornea, and pushed forward with gentle pressure, until the point enters the anterior chamber (Fig. 179). The handle is now depressed until the blade is parallel to the plane of the iris, and pushed forward until the wound is of the desired length, which is usually 4 or 5 mm. (Fig. 180).

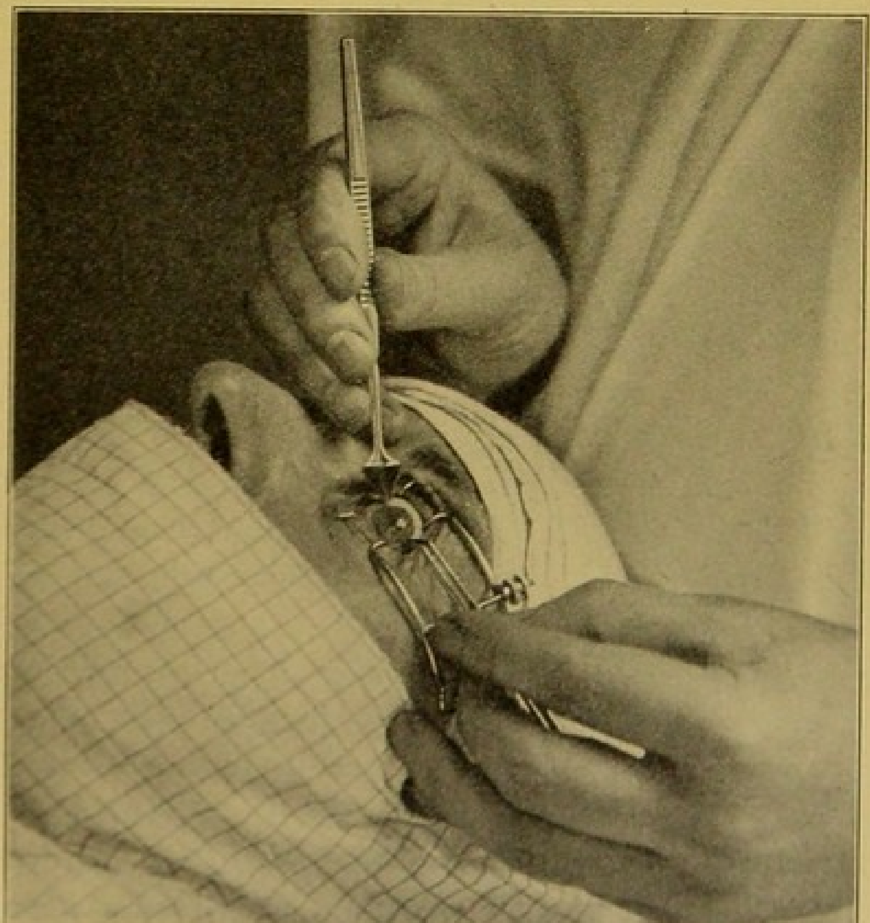
The withdrawal should be slow, depressing the handle, so that the point comes in contact with the cornea. A sudden withdrawal may cause a prolapse of the iris.

Fig. 177



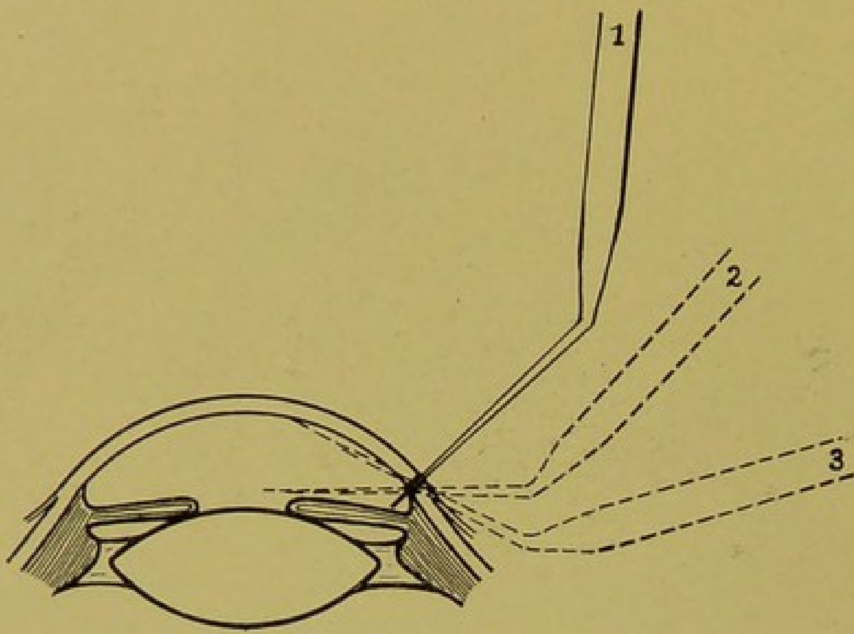
Method of using keratome downward and outward.

Fig. 178



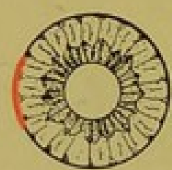
Method of using the keratome, nasal position.

Fig. 179



Cross-section showing position of keratome during incision.

Fig. 180

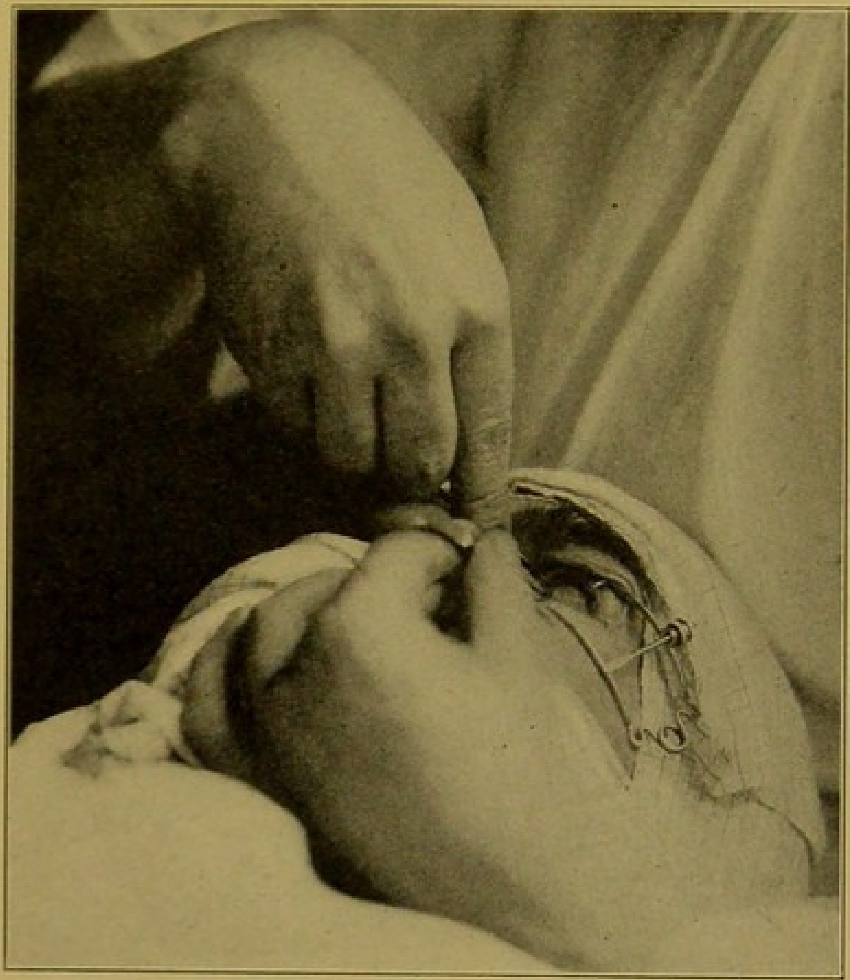


Site and size of incision for small iridectomy.

II. Step: Excision of the Iris.—When the incision is completed the assistant takes the fixation forceps, the operator holds the iris forceps in his left hand and the iris scissors in his right. In every sensitive or unruly patient it is advisable to make the wound gape slightly and to instil a few drops of sterile cocaine directly on the iris, and then to wait a few moments before doing the excision. Before the introduction of the forceps into the anterior chamber, the scissors, held in the proper manner with open blades, are placed close to the wound, in readiness to excise the iris the moment that it appears outside the wound.

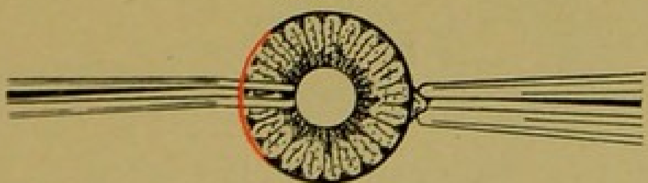
The forceps are held between the thumb, index and middle fingers, the other fingers resting on the patient's face. The blades, in closed position, are placed at right angles in the centre of the posterior lip of the wound, which is slightly depressed, and while still closed, the forceps are slipped into the anterior chamber, keeping close to the posterior surface of the cornea. They are pushed forward until they reach the margin of the pupil, but never farther. The blades are opened for a distance

Fig. 181



Excision of the iris.

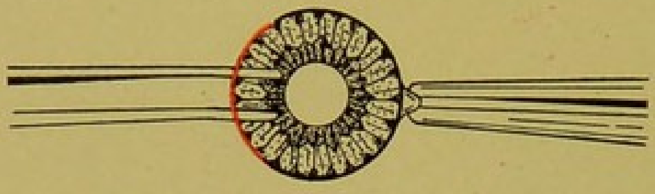
Fig. 182



Small iridectomy, introduction of iris forceps.

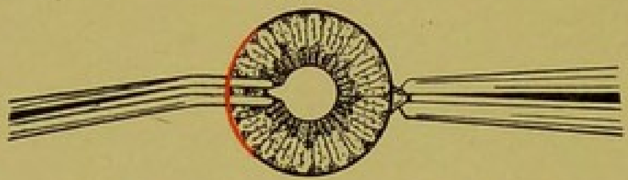
of about 1.5 to 2 mm., and with a very light pressure backward, are closed again, thereby grasping a small fold of the iris (Figs. 182 to 186). The iris is then pulled out of the wound and excised with one sweep of the scissors. It is advisable during excision to press the scissors slightly on the sclera. This causes a slight depression in the sclera which disappears after the pressure is relieved. This movement of the sclera tends to prevent a

Fig. 183



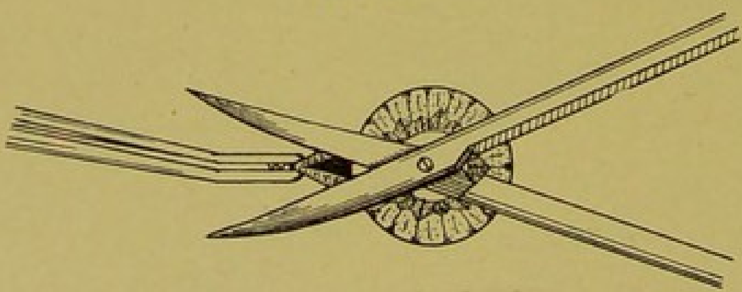
Small iridectomy, opening of forceps.

Fig. 184



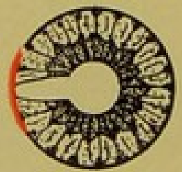
Small iridectomy, grasping of a fold of iris.

Fig. 185



Excision of iris in small iridectomy.

Fig. 186

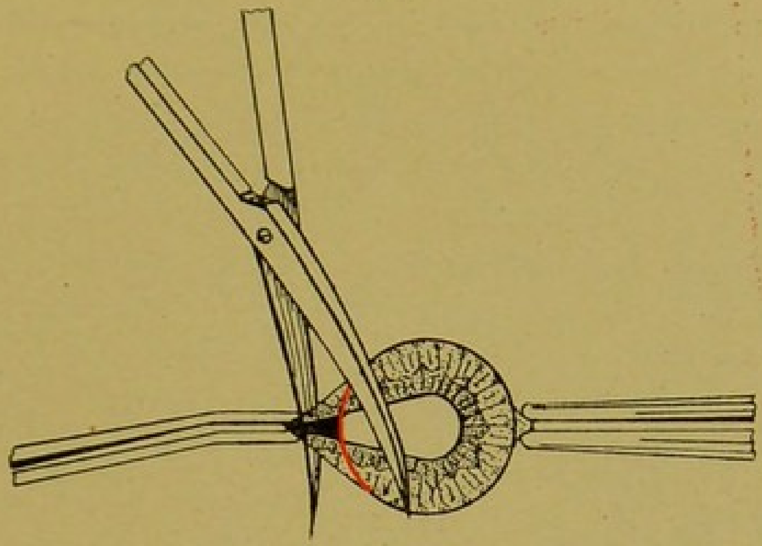


Result of small iridectomy.

wedging of the pillars in the wound. The size of the coloboma may be regulated to a certain extent by the position of the scissors during excision. If the intention is to make a very small coloboma, the scissors are held at right angles to the wound (Fig. 185).

In case a larger coloboma is desired the scissors are held parallel (Fig. 187) to the wound.

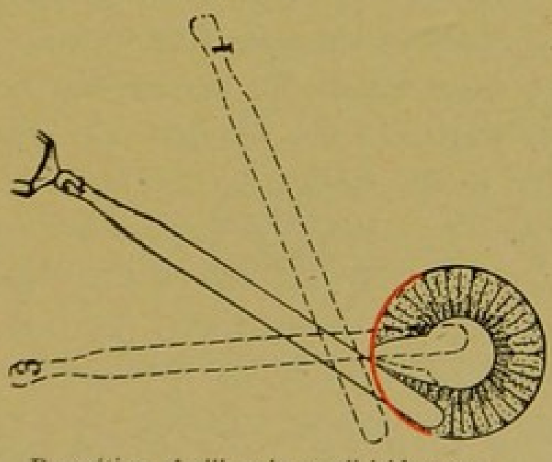
Fig. 187



Small iridectomy, holding scissors parallel to wound.

III. Step: Toilet.—After the excision of the iris the eye is examined to see if the pillars of the coloboma are free. If they are free the wound is smoothed over with a spatula, and the blood clots are removed with a forceps or wipes. If the iris is

Fig. 188

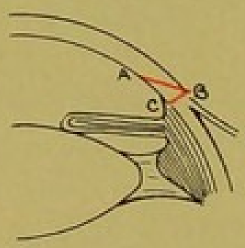


Reposition of pillars in small iridectomy.

caught it is well to press on the posterior lip of the wound with a Daviel spoon or spatula. The gaping which is thus produced often liberates the iris. If this maneuver is unsuccessful the anterior chamber is entered with a spatula at the end of the wound, and it is pushed forward until the tip of the spatula is visible on the periphery of the iris near the pillar of the coloboma. Gentle stroking movements toward the pupil will easily liberate the incarcerated pillar (Fig. 188). When the pillars are free it will be noticed that the bases are the same height, and lie exactly in the circle which would be formed by the intact pupil. If there is much blood in the anterior chamber the posterior lip of the wound is depressed with a spatula, and at the same time the cornea is stroked with a Daviel spoon. This allows the blood to escape.

Complications during Operation.—1. Oblique Wound.—This may be either an intralamellar incision or an incision that lies partly in the cornea and partly in the sclera. The first is produced when the blade of the keratome is not held perpendicularly enough to the cornea (Fig. 189).

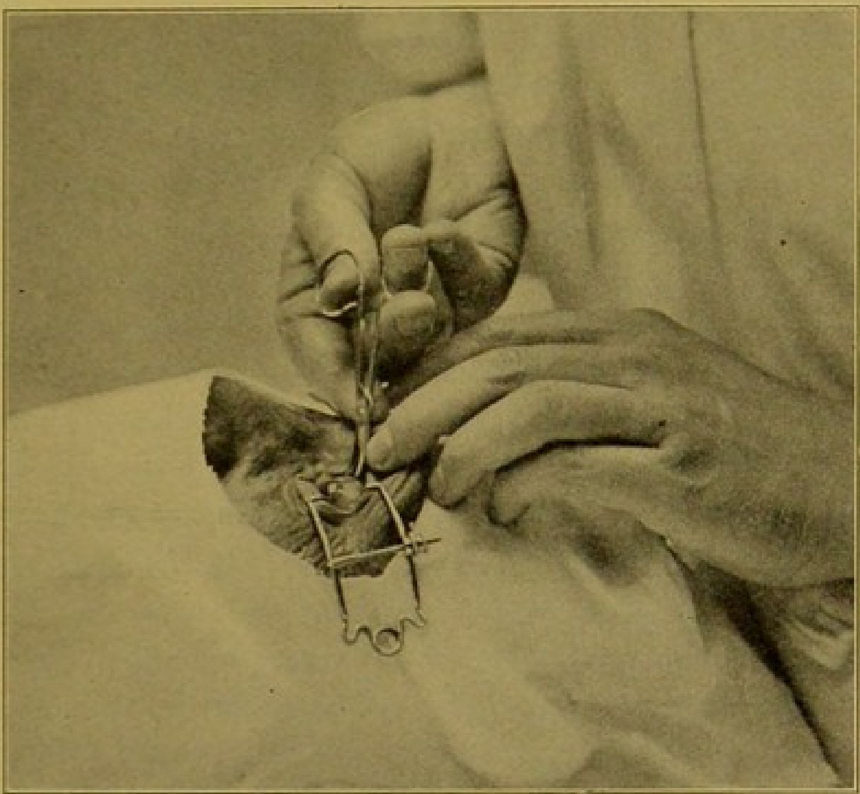
Fig. 189



Intralamellar incision (*A B*) and correct incision (*B C*) with keratome.

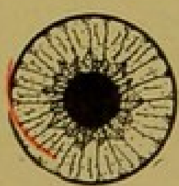
In a keratome incision the part of the blade of the keratome which appears in the anterior chamber has the same luster as the rest of the blade that has not entered the cornea; the part of the blade engaged in the corneal wound has a peculiar dull gray lusterless appearance, and in a properly made incision this part is but little wider than the thickness of the cornea itself. In an intralamellar incision, on the contrary, the engaged part of the keratome is much wider. In exaggerated cases of this error it is possible that the keratome may separate the layers of the cornea without entering the anterior chamber at all. Attention to this is called by the fact that there is no escape of aqueous and, under these circumstances, a fresh incision must be made, preferably in another site. If the anterior chamber is entered by the point only, it is hard to grasp the iris and to pull it through this long wound canal. Even if the attempt is successful, the iris is likely to be torn, and to remain wedged in the wound. In such cases, if the incision is very small and the point of entrance very central, it is better to bandage the eye and postpone the operation for a few days. Otherwise the incision may be enlarged with the scissors (Fig. 190).

FIG. 190



Enlarging wound with scissors.

FIG 191



Oblique wound with keratome.

If the wound is partly in the cornea and partly in the sclera, the iris easily becomes wedged in the corneal end of the wound. Vision will also be diminished by this complication, as the scar will be directly over the coloboma and a high degree of astigmatism will result (Fig. 191).

2. UNTIMELY ESCAPE OF AQUEOUS.—This is usually due to restlessness on the part of the patient or to awkwardness of the

operator. If there is only a partial escape of aqueous the incision can be completed by pushing the keratome forward, but in total loss this cannot be done without injury to the iris and lens. In such cases, therefore, the keratome must be withdrawn, and the wound will not be of sufficient length. The endeavor, however, may be made to obtain a longer incision by pressing the cutting edge of the keratome into one end of the wound, during withdrawal, or else enlarge the incision with the scissors.

3. Injury to the Iris during Incision.—This is always dangerous, as the keratome may injure the lens capsule at the same time. It is also painful, making the patient restless, and is often attended with hemorrhage, which obscures the field of operation. It may also become disturbing and dangerous during the second step of the operation, for in introducing the iris forceps it may easily happen, especially when the field is obscured by hemorrhage, that the forceps will pass behind the iris through the opening made, instead of in front of it. In such cases, instead of grasping the iris, the capsule of the lens is seized, and a traumatic cataract is produced.

If this accident occurs the keratome should not be pushed forward any farther, but immediately withdrawn. If the incision is not of sufficient length to allow the performance of the iridectomy, the wound must be enlarged. This can be accomplished with the aid of the scissors, or else by pressing the keratome against one end of the wound during withdrawal.

4. Prolapse of the Iris after the Incision Has Been Completed.—This complication may be due to sudden withdrawal of the keratome or to restlessness of the patient. This is not a serious complication, as the iris can be grasped and cut off, but the resulting coloboma is apt to be larger than was intended, or irregular.

5. Iridodialysis.—This occurs when the point of the keratome engages in the iris, and instead of piercing it, pushes it on before it, thus tearing the iris away from its scleral attachment. It may also occur during the second step. The grasping and withdrawing of the iris from the anterior chamber is always more or less painful. Patients that lack sufficient self-control are apt at this point suddenly to move their eye, and if the surgeon is

not on his guard he is apt to produce an iridodialysis by not releasing the iris. To forestall this, the operator should always inform the patient before introducing the forceps that this step may be somewhat painful, but as it is the most important step of the operation, he should remain quiet at all cost. If, in spite of this precaution, the patient moves his eye, the operator should release the iris at once. Iridodialysis causes pain and severe hemorrhage, thus obscuring the field of operation and making the grasping of the iris with the forceps, without injury to the lens, extremely difficult.

6. Injury to the Lens Capsule.—Besides the causes already mentioned, this may be also due to the grasping of the lens capsule instead of the pupillary margin of the iris, by advancing the forceps too far. This is the most serious of all complications, as a traumatic cataract results.

7. Making a Bridge Coloboma.—Sometimes the iris is grasped too near the periphery, and after the iridectomy is completed a narrow band of the iris tissue is found left behind, with the pupil intact. This is not a serious complication, in fact in certain cases it is desirable and purposely made (coremorphosis). To break the bridge of tissue it is grasped with a Tyrrell hook, drawn out, and incised.

After-treatment.—Both eyes are bandaged after the operation for twenty-four hours, and the patient remains quietly in bed. After that the unoperated eye may be left open and the patient may sit up in an arm chair. The operated eye is washed twice daily, and may be left open under a Fuchs mask or Snellen cup on the third day. Recovery is complete on the eighth day, when the patient may leave the hospital.

Postoperative Complications.—These are extremely rare, as the smallness of the wound promotes rapid healing. Rupture seldom occurs, and then only after direct violence. Infection may follow the operation, but it is hardly ever seen.

Large Iridectomy.—**Indications.**—1. Glaucoma (antiglaucomatous iridectomy); (*a*) primary glaucoma; (*b*) secondary glaucoma.

2. Fistula of the cornea.

3. Chronic iritis, iridocyclitis, and iridochoroiditis (antiphlogistic iridectomy).

4. To remove foreign bodies and tumors from the iris.
5. Before cataract operation (preliminary iridectomy).

Glaucoma. — PRIMARY GLAUCOMA. — Primary glaucoma is a disease of the eyeball in which there is an increase of tension, the cause of which is not definitely known. There are two forms of primary glaucoma: Inflammatory and simple.

Inflammatory Glaucoma.—In this form of the disease the eyeball shows symptoms of inflammation in consequence of the increased tension. These symptoms may appear as an acute inflammation (acute inflammatory glaucoma) or a chronic inflammation (chronic inflammatory glaucoma).

In both cases, however, the inflammatory symptoms are preceded by the so-called "prodromal stage," during which the patient complains of transient obscuration of vision lasting for several hours at a time, and recurring at irregular intervals. The obscuration is accompanied by the appearance of halos (colored rings) around lights and often slight headache, and an indefinite sensation of fullness in the eye. On examining the eye during such a state the cornea is found somewhat steamy, the anterior chamber shallow, the pupil slightly dilated, and the tension increased. In the intervals between the attacks the eye is seemingly sound. The vision, however, will be reduced, and the field of vision is contracted in proportion to the duration of the disease. The prodromal stage may last for several months, when it may suddenly be interrupted by an attack of acute inflammation (acute inflammatory glaucoma), or it may pass slowly into the chronic inflammatory condition (chronic inflammatory glaucoma).

An attack of acute inflammatory glaucoma is characterized by a sudden severe neuralgic pain on the side of the affected eye, accompanied often by nausea, vomiting, and slight elevation of temperature. The eye shows the following changes: The eyelids are swollen, ciliary injection, the cornea is hazy and insensitive, the anterior chamber shallow, the iris discolored, the pupil is dilated, and does not react to light, the vitreous is cloudy, and the fundus indistinct. The tension is always increased, and the vision reduced sometimes to perception of light only. The duration of such an attack may vary from a few days to two or three weeks. After this the eye may return to an almost normal condition, but in most cases the anterior chamber remains shallow, and the pupil somewhat dilated, with sluggish reaction. The tension always remains more or less increased. The vision may become normal or it may remain reduced according to the severity and duration of the attack.

The prognosis, as to the sight, can be approximately foretold if the patient's vision was known before the attack. In typical cases there is usually little permanent impairment of vision before the end of the second week. In consequence, if the tension can be reduced by treatment or operation before this time, we may expect the return of vision that the patient had before the attack; otherwise the sight will be impaired. After the attack is over the patient will have a period of rest from pain. The sight, however, slowly decreases, and the head of the optic nerve becomes excavated from the continuous increased tension. After a shorter or longer period of rest a fresh attack sets in. These attacks follow each other at irregular intervals. The eye slowly loses its sight entirely, and passes into the state of an absolute glaucoma.

Chronic inflammatory glaucoma is, in fact, nothing else but the increase of the symptoms of the prodromal stage without an acute attack. The patient complains of gradual loss of sight, accompanied by headaches and often dull ocular pain. The eye shows large tortuous veins on the bulbar conjunctiva. The cornea is clear, but the anterior chamber is shallow, and the pupil is dilated, and its reaction sluggish. The optic disk is pale and more or less excavated. The tension is increased, and the vision as well as the field of vision is reduced. If no treatment is given to the patient this type also slowly passes into the stage of absolute glaucoma.

In absolute glaucoma the eye is completely blind, having no perception of light. There are dilated veins on the ocular conjunctiva, the cornea is clear but insensitive, the iris is grayish and atrophic, the pupil is large, the optic disk pale and deeply excavated, and the arteries as well as veins are very thin. Later, degenerative changes, such as ulcers of the cornea, cataractous degeneration of the lens, etc., develop in these eyes.

Simple Glaucoma.—This is characterized by the absence of inflammatory symptoms. The patient complains of gradual loss of vision. The eye, if examined, will present the following conditions: The cornea, anterior chamber and iris are normal, the pupil reacts but sluggishly, the optic disk shows marked cupping. The tension upon palpation appears normal, the tonometer, however, always shows an increase. The vision is reduced, and the field of vision is contracted, especially on the nasal side. The latter is a very important symptom, and it often can be detected before the cupping of the optic disk becomes noticeable.

The treatment of the primary glaucoma is medicinal and surgical. The medicinal treatment consists in the instillation of miotics, of which pilocarpine (1 to 2 per cent.) and eserine (0.5 to 1 per cent.) are used. They may be combined with each other or with dionin 5 to 10 per cent. solution.

The surgical treatment consists in performing an iridectomy or one of its substitutes.

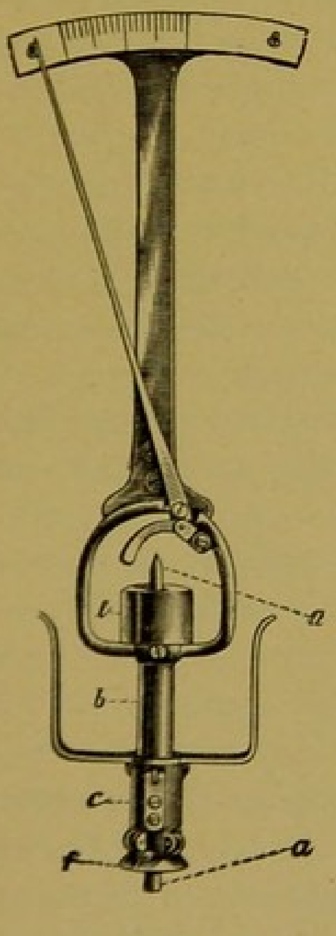
Iridectomy was first advocated for the cure of glaucoma by von Graefe in 1856, and is still the most valuable of all operations for glaucoma. It reduces the tension, but of course cannot have any effect on the atrophy of the optic nerve which has been produced by the increased tension. In consequence the operation should be performed as early as possible in the course of the disease. Before operating, the sight, the field of vision, and the tension should be examined.

The sight is examined by the usual subjective method. All errors of refraction should be carefully corrected in order that the patient's full vision may be known.

For the examination of the field of vision the perimeter is used. The patient is seated with his back to the window and one eye covered. The uncovered eye fixes the white object at the centre of the arc of the perimeter. The test object, which is usually a white or colored ball 1 cm. in diameter, mounted on a black rod, is now carried along the arc from the end, and the point where the patient notices it is read off and marked on the chart. By turning the arc of the perimeter around, each meridian is examined in turn. During examination the patient's eye must be carefully watched, as any movement will give inaccurate results. In examining the field for color, a blue, red, or green ball must be substituted for the white and the point where the patient will first detect the color is noted.

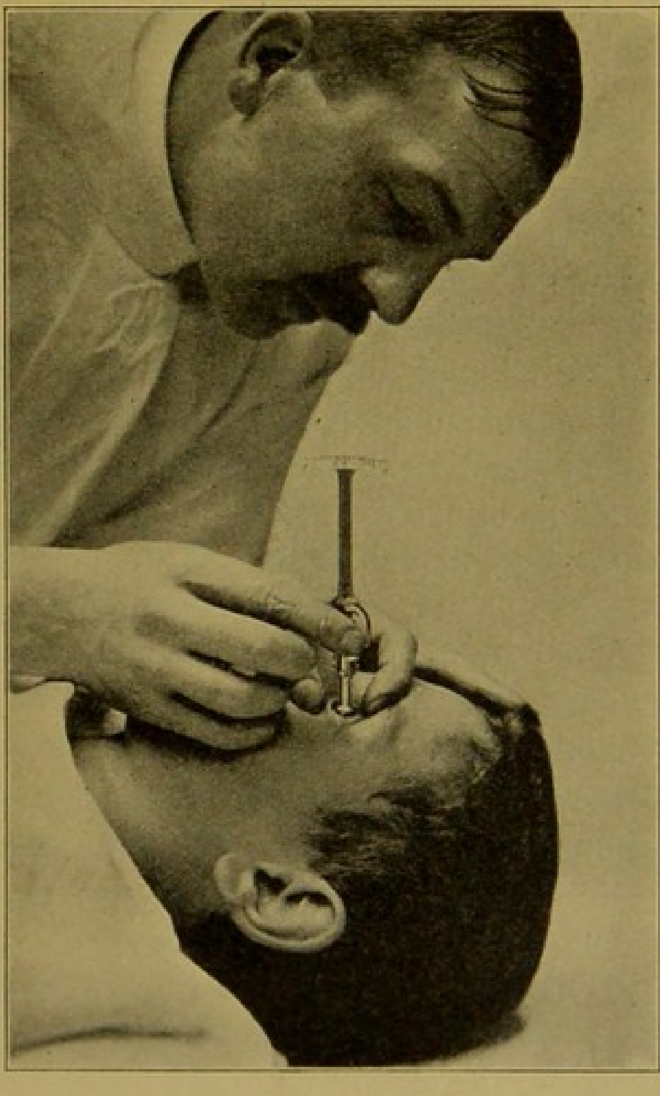
The tension is taken by palpation. The patient is directed to look downward and both index fingers are placed on the upper lid, touching the eye near the equator. The globe is now palpated in the same manner as a cyst or abscess. By comparing one eye with the other increase in tension is determined.

Fig. 192



Schiötz tonometer.

Fig. 193



Method of taking the tension with the tonometer.

More accurate information can be had by the use of a Schiötz tonometer. This instrument (Fig. 192) consists of a stylet which is fitted into a metal cylinder (*b*). The blunt end (*a*) of the stylet (which comes in contact with the cornea) projects out of the cylinder and the pointed end (*d*) on which the weights (*e*) are placed is in connection with the short arm of a lever. The long arm of this lever is an indicator that shows on a millimeter scale the degree of movement of the stylet. The lower end of the cylinder is hollowed out to conform to the curvature of the cornea, and on it is placed a grip by which the instrument is steadied. The instrument is accompanied by a chart, weights (5.5 gm., 7.5 gm., 10 gm., 15 gm.), and a convex model.

The tonometer should first be tested on the convex model to see if the indicator stands at the first mark of the millimeter scale. The eye is anesthetized with a few drops of a 2 per cent. holocaine solution, and the patient is placed on an operating table. His head should be inclined slightly backward, and his eyes directed to the ceiling. Both lids are retracted with the fingers of the left hand without pressure on the eyeball (Fig. 193). The tonometer, held in the right hand, is placed in position on the cornea, and the excursions of the indicator read off. The chart is now taken and the reading of the millimeter scale is changed to millimeters of mercury. Schiötz advises the taking of an average of three readings. According to his findings the normal intra-ocular pressure varies from 15.5 to 25.5 mm. of mercury.

The purpose of the iridectomy is to reduce the tension and to save the eye from further damage. It is self-evident that any permanent destruction, *i. e.*, excavation of the optic disk and atrophy of the nervous elements cannot be remedied by the operation. The result as to the sight immediately after operation, therefore, will depend upon the previous duration of the disease.

In acute inflammatory glaucoma, if the operation is performed in time, the improvement will be considerable, often restoring the sight to normal. The reduction of the vision in these cases is due to the cloudiness of the media and to circulatory disturbances in the retina which pass away when the tension is reduced. Later, however, pressure atrophy of the optic nerve fibers develops, and constitutes a permanent impairment of vision. Experience has shown that this atrophy seldom develops before the end of the second week. Operation before this period has ended is, therefore, absolutely necessary. This is likely to bring about the return of the sight that the patient had previous to the attack. To operate during an attack is very difficult on account of the shallow anterior chamber and the dilated pupil. For this reason we must try to decrease the tension and contract the pupil as much as possible before performing the operation. This is affected by instilling hourly eserine oil, 1 per cent. solution, and at the same time, if the attack is very severe, applying 4 or 5 leeches on the patient's temple. If this treatment does not reduce the tension and contract the pupil within a few days paracentesis of the cornea or posterior sclerotomy should be done. This usually reduces the tension, the pupil now contracts under miotics, and the anterior chamber becomes deeper. Iridectomy may follow five or six days later.

In chronic inflammatory glaucoma and in simple glaucoma the reduction of vision is permanent, owing to cupping of the optic disk and atrophy of the nerve fibers. In these cases, of course, no improvement in vision can be expected after operation. The only purpose of the iridectomy is to save, if possible, such sight as the patient may have at the time of operation. *In absolute glaucoma* there is no sight, and all that can be done is to relieve the pain and to save the eye from further degeneration.

As to the ultimate result, experience has shown that the prognosis greatly depends on the form of glaucoma. The best results are obtained if the patient is operated on in the *prodromal stage*. Pilocarpine or eserine in many instances will check all symptoms for the time being, but eventually the glaucoma will break out. It should, therefore, be the rule with every surgeon not to depend upon these drugs, but to try to persuade the patient to submit to an operation even when all prodromal symptoms have disappeared under miotics and the eye is apparently sound.

If the glaucoma has already developed, an operation in an *acute inflammatory attack* will give the most satisfactory results. Statistics show that tension remains reduced in about 80 to 85 per cent. of all cases. The prognosis *in chronic inflammatory glaucoma* is decidedly less favorable, and greatly depends on the field of vision and condition of the iris. If the field is only slightly contracted and atrophy of the iris not marked, the prognosis may be considered favorable. If, on the contrary, the field is greatly contracted and its confines approach the macula, there is little to be hoped for. In such cases the iridectomy may even have a deleterious effect, as the blind portion of the field may pass beyond the point of fixation and the centre of vision be lost. Many surgeons for this reason do not do an iridectomy in such cases, but resort to anterior sclerotomy or cyclodialysis. *Simple glaucoma* gives the least favorable prognosis, as in most cases the iridectomy cannot check the progress of the disease, and the eye ultimately becomes blind. This form of glaucoma, together with the chronic inflammatory glaucoma, offers the widest field for the substitutes for iridectomy.

The mode of action of an iridectomy is not understood. The explanation of the action of the iridectomy has varied with the different theories of the cause of glaucoma. The retention theory is the one commonly accepted and the most plausible one. It explains the increase of tension as due to the obstruction of Schlemm's canal by the root of the iris. Pathological examinations of glaucomatous eyes show that in most cases the spaces of Fontana are obstructed. The obstruction, extending around the entire circumference of the cornea, is caused by the root of the iris which is either in close contact with the posterior surface of the cornea, being pressed against it, or it is firmly adherent to it. The former condition is usually found in acute inflammatory glaucoma and the latter in chronic glaucoma. The antiglaucomatous action of the iridectomy as well as the results obtained may be easily explained by this fact.

The iridectomy reduces the tension by the removal of the root of the iris, thereby opening Schlemm's canal. For this reason the incision, in cases of glaucoma, must enter the anterior chamber at its periphery (2 mm. behind the limbus) so as to permit access to the root of the iris; the iris should not only be cut with the scissors, but it is absolutely necessary to secure a firm hold of it and to tear the root of the iris while pulling it from one end of the wound to the other. Only by following these rules can satisfactory results be obtained. In acute inflammatory glaucoma where in most cases the root of the iris is only pressed against the posterior surface of the cornea an iridectomy performed in accordance with the above rules will, in most instances, reduce the tension permanently.

In chronic inflammatory glaucoma, however, where the root of the iris is adherent to the posterior surface of the cornea, an iridectomy, even if performed according to the above rules, will but seldom suffice. The iris is usually cut and torn off in front of the adhesion, and in spite of a seemingly peripheral iridectomy the canal of Schlemm will remain obstructed. Tonometry shows that in chronic glaucoma, even after an apparently successful operation, the tension almost always remains increased, and experience has taught that iridectomy in chronic glaucoma but seldom checks the progress of the disease. In the comparatively small percentage of cases, where an iridectomy in chronic glaucoma has resulted in a cure, it seems plausible to suppose that the effect of the operation was due either to the successful removal of the root of the iris or to the fact that the incision was carried through the pectinate ligament. The incising of the pectinate ligament causes its trabeculæ to retract and thus results in a permanent opening in Schlemm's canal.

The poor results following an iridectomy in chronic glaucoma has caused many substitute operations to be devised. Those most commonly substituted are anterior sclerotomy, posterior sclerotomy, cyclodialysis, trephining of the sclera, and the Lagrange sclerecto-iridectomy. The mode of action in some of these operations consists in the opening up of Schlemm's canal, in others the production of a filtrating scar in the sclera, and in others again the combination of both. The anterior sclerotomy opens up Schlemm's canal by incising the pectinate ligament, after which the trabeculæ retract and Schlemm's canal remains open. Trephining of the sclera acts by producing a filtrating scar in the sclera; La Grange's sclerecto-iridectomy reduces the tension by the combination of the above in addition to the action of a peripheral iridectomy. Cyclodialysis effects its antiglaucomatous action by opening the iris angle by detaching the root of the iris from the posterior surface of the cornea; and finally the posterior sclerotomy reduces the tension by opening the vitreous chamber and in some cases by the formation of filtrating scar.

Secondary Glaucoma.—Secondary glaucoma is a disease in which the increase of tension is the result of an evident pathological condition of the eye. Pathological conditions where the increase of tension may be remedied by an iridectomy are:

(*a*) Secondary glaucoma due to seclusion of the pupil. In such cases the iridectomy establishes a communication between the anterior and posterior chamber. It is not only indicated when the secondary glaucoma has already set in, but also where there are many posterior synechiæ present, and there is danger that an attack of glaucoma may develop.

(*b*) Secondary glaucoma due either to luxation or swelling of the lens. The lens may cause secondary glaucoma by swelling after injury or by subluxation or luxation. In the former case a paracentesis must be done and only after this operation has been repeated several times do we resort to an iridectomy. In subluxation and luxation of the lens, although iridectomy is being practised, extraction, if possible, is the proper operation. The iridectomy in all these cases gives only temporary relief.

(*c*) Secondary glaucoma due to adherent ectatic scar, also in cases of ectasia of the cornea following ulcer, pannus, or keratitis and in partial staphylomata of the cornea and sclera. The iridectomy in such cases reduces the tension. Although the flattening of the ectasia cannot be expected, nevertheless further extension may be prevented. In partial staphylomata of the cornea an iridectomy followed by ablation and Kuhnt's conjunctival keratoplasty may produce a flat scar.

(*d*) Secondary glaucoma due to chronic iridocyclitis or iridochoroiditis.

(*e*) Secondary glaucoma following detachment of retina, except when the detachment is caused by tumor, in which case enucleation is indicated.

Fistula of Cornea.—In such cases an iridectomy, especially if it is successful in removing that part of the iris which hinders closure of the opening, may accomplish a cure.

Chronic Relapsing Iritis, Iridocyclitis, and Iridochoroiditis.—In chronic relapsing iritis, iridocyclitis, and iridochoroiditis with deposits on the posterior surface of the cornea and exudation in the posterior chamber and vitreous body, iridectomy has undoubtedly a beneficial influence when done in the interval between attacks.

Foreign Bodies of the Iris and Tumors.—These may be removed in combination with an iridectomy. Although in tumors the relapses are very frequent, if they are small, their removal must be attempted by an iridectomy before enucleation. Such eyes must remain under close observation for at least one and a half to two years and in case of a relapse must be immediately enucleated.

Cataract Operations.—Before cataract operation as a preliminary iridectomy in cases of: (*a*) Immature cataracts combined with Förster's ripening. (*b*) Complicated cataracts.

Contraindications.—Hemorrhagic Glaucoma.—In such cases an iridectomy is not only of little service but often deleterious as the intra-ocular hemorrhage increases and often expulsive hemorrhage results. Posterior sclerotomy in such cases is indicated.

Absolute Inflammatory Glaucoma.—In absolute inflammatory glaucoma if the iris is highly atrophic. Posterior sclerotomy or cyclodialysis may be attempted, if this is of no avail, and the eye is very painful, enucleation is best, for in such cases a proper iridectomy cannot be done. If the patient does not submit to enucleation, opticociliary neurectomy may be considered.

Buphthalmos.—Buphthalmos or infantile glaucoma is a congenital disease. In such cases the eye increases in all dimensions. The diameter of the cornea is increased, and the anterior chamber becomes very deep. The lens and iris are often tremulous. The tension is increased and there is marked cupping of the optic disk. Iridectomy in such cases may result in prolapse of the vitreous, luxation of the lens, and detachment of the retina. Anterior sclerotomy or cyclodialysis are the operations that are indicated.

Secondary Glaucoma.—In secondary glaucoma due to ectatic scar and staphyloma, where the light perception has been lost through repeated attacks of increased tension, an iridectomy may result in a spontaneous intra-ocular hemorrhage or sometimes even an expulsive hemorrhage due to rupture of the degenerated bloodvessels. In such cases enucleation or one of its substitutes should be resorted to.

Secondary Glaucoma due to Intra-ocular Tumors.—In such cases enucleation is the only operation.

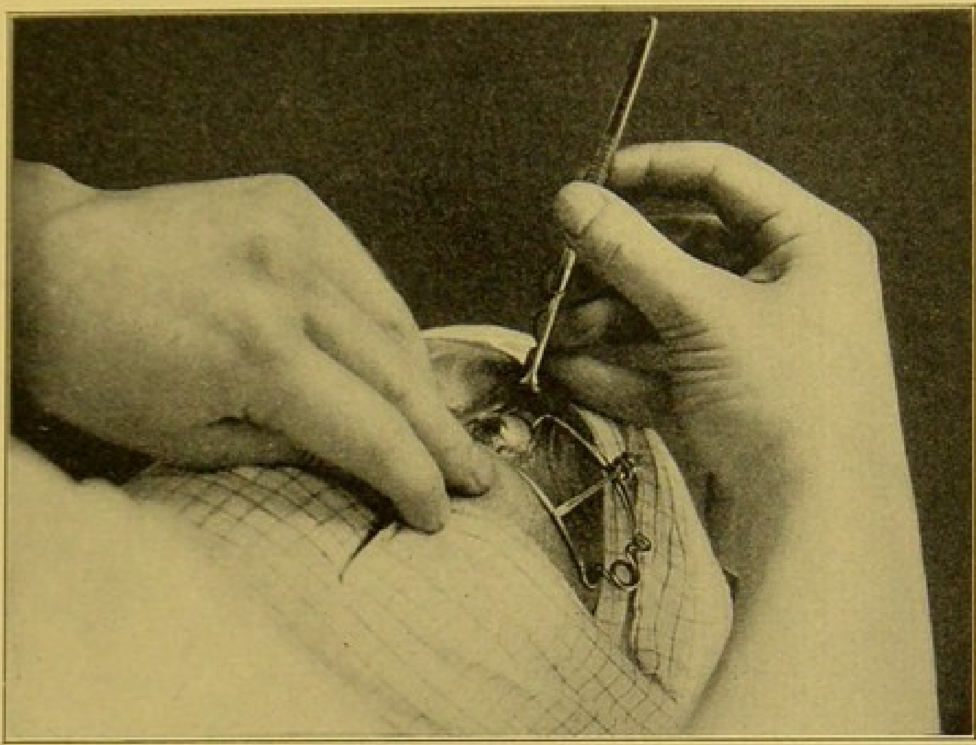
Preparation.—The preparation of the patient is the same as for eyeball operations in general. In glaucoma the sight and field of vision of both eyes must be taken and eserine or pilocarpine instilled in each eye. The operation may be done under local anesthesia except in children. In an acute attack of glaucoma the operation is very painful in spite of good local anesthesia, therefore it is always advisable to employ a general anesthetic. As the operation is one of the most difficult of the bulbar operations it is essential that the patient remain absolutely quiet, as any movement on his part is apt to complicate matters seriously.

Instruments.—The instruments are the same as for small iridectomy. Speculum, fixation forceps, angular keratome, iris forceps, iris scissors, Tyrrell hook, iris spatula.

Operation.—The operation is performed in three steps: (1) The incision; (2) the excision of the iris and the (3) toilet.

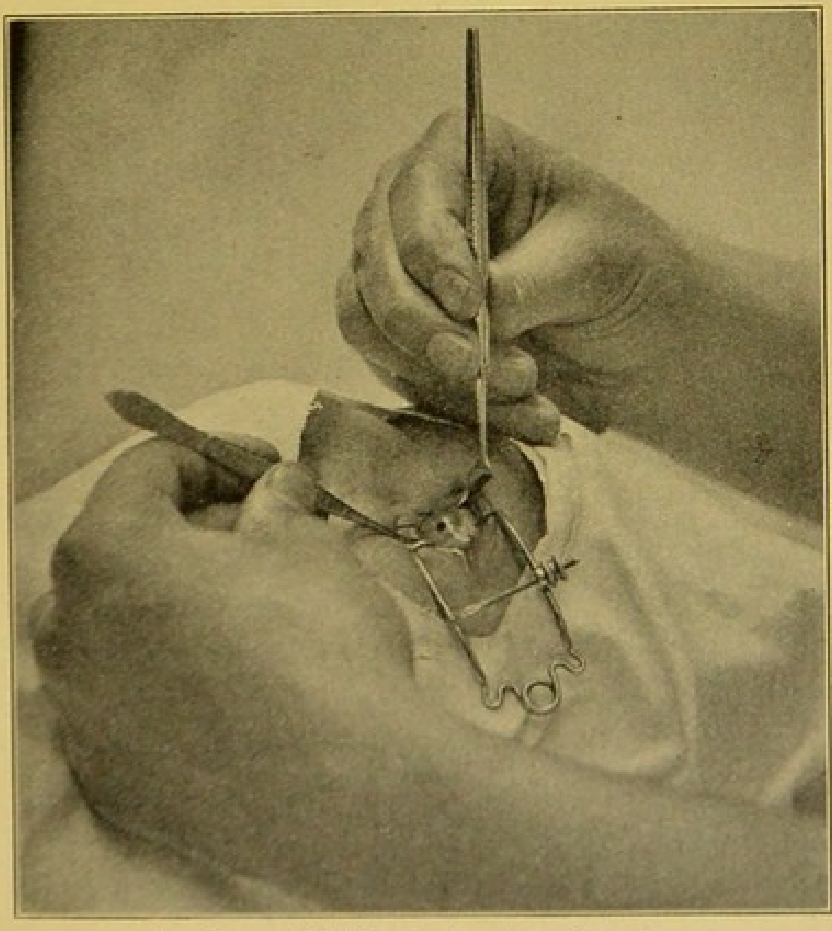
I. Step: Incision.—After the speculum has been inserted, the eye is fixed with the fixation forceps opposite the site of incision, which is usually above, so that the coloboma will be covered by the upper lid. In absolute glaucoma where the iris is atrophic above, the incision is made where the iris is in the best condition. The incision is usually made with the keratome. In certain cases, especially when the anterior chamber is very shallow, Graefe's knife is used instead. It is generally considered easier to make an incision with a Graefe knife, but the wound does not heal so readily and it is more apt to gape than the keratome wound. Therefore it is better to use a keratome, for with a little practice it can be safely used even in a very shallow anterior chamber without injury to the lens or iris. As the incision is to be long it is necessary to use a keratome with a broad blade. The keratome is held in the right hand and is introduced rather perpendicularly at about 2 mm. behind the limbus (Figs. 194 and 195). After the point has entered the anterior chamber the handle is depressed, so that the blade is parallel to the plane of the iris, and in this position it is pushed forward until the wound is about 7 or 8 mm. in length (Fig. 196).

Fig. 194



European method of using keratome from above.

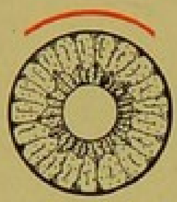
Fig. 195



American method of using keratome from above.

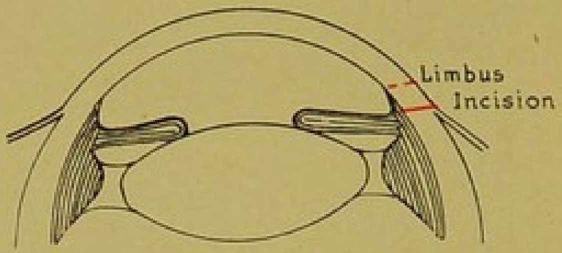
As the anterior chamber is shallow the point of the keratome often touches the posterior surface of the cornea before the wound is of sufficient length. The point may be disengaged by slightly raising the handle, thereby gaining a little space so that the keratome can be advanced a little farther. (The Graefe knife is used in the same manner as in the cataract extraction, but the wound should not be longer than the width of the coloboma.)

Fig. 196



Large iridectomy, site and size of incision.

Fig. 197

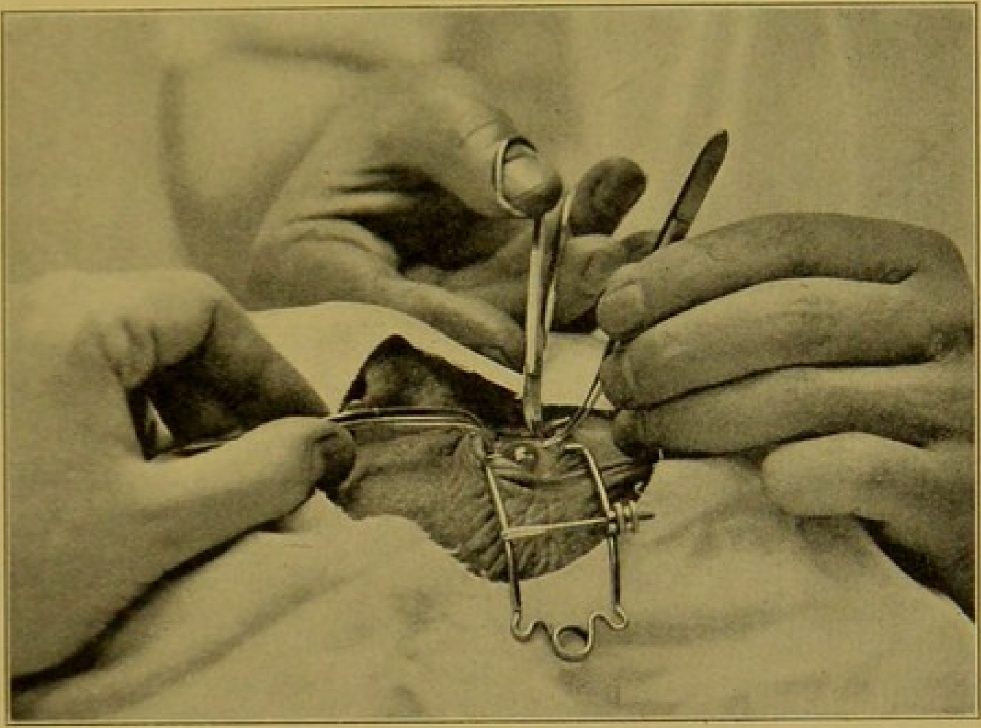


Incision for large iridectomy, cross-section.

The keratome must be withdrawn cautiously and very slowly as the sudden escape of aqueous not only washes the iris out, but in cases of glaucoma the sudden advance of the lens produces a tugging on the ciliary body, which is very painful. At the same time the sudden decrease in tension may cause subluxation of the lens by rupture of the zonule, as well as rupture of the hyaloid membrane and prolapse of the vitreous. There is also danger of intra-ocular hemorrhage.

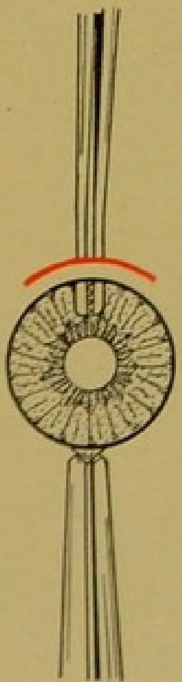
II. Step: Excision of the Iris.—The technique of the iris forceps and scissors is the same as in the small iridectomy with the exception that after entering the anterior chamber with the forceps they are advanced only to a point about midway between the root and the pupillary margin (Fig. 198). Here the forceps are opened wider so as to secure a larger fold of the iris. On withdrawing the iris from the chamber, the fold is cut first at the angle which lies toward the right hand, holding the scissors parallel to the wound and slightly depressing them on the sclera (Figs. 199 to 203). The fold of iris is now pulled to the left hand end of the wound, where it is excised with slight pressure on the sclera. While pulling the fold of iris from one end of the wound to the other slight traction should be exerted in order to tear it from the root.

FIG. 198



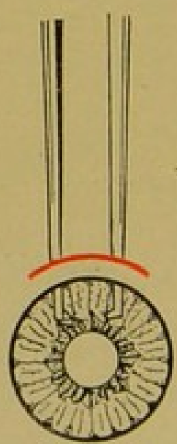
Excision of the iris.

FIG. 199



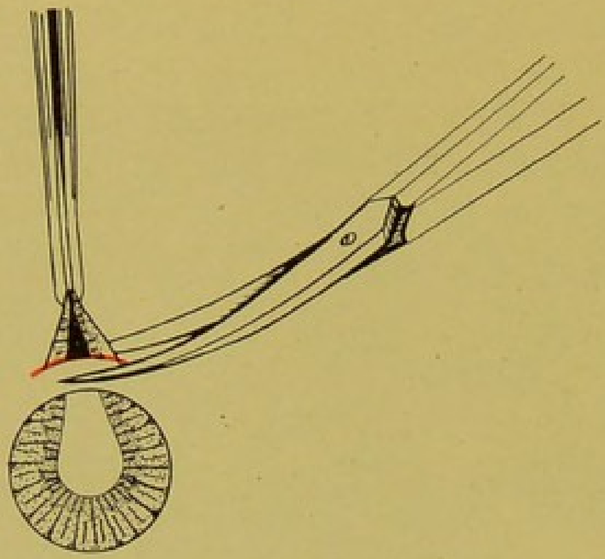
Large iridectomy, iris forceps in anterior chamber.

FIG. 200



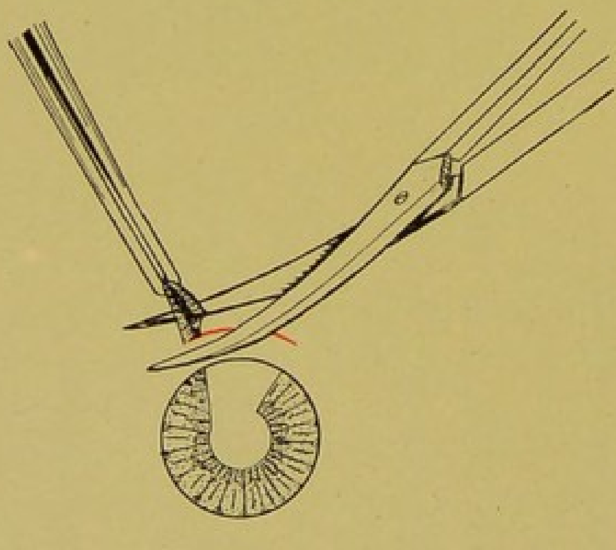
Large iridectomy, grasping fold of iris.

Fig. 201



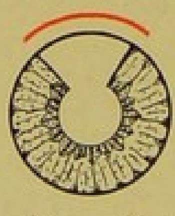
Large iridectomy, excising fold of iris. First position.

Fig. 202



Large iridectomy, excising fold of iris. Second position.

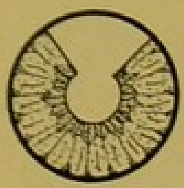
Fig. 203



Result of large iridectomy.

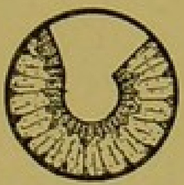
III. Step: Toilet.—After the excision has been completed the eye is examined to see if the pillars of the coloboma are free or not and also to make sure there are no shreds of tissue left in the wound (Figs. 204 to 206). If the pillars are wedged

Fig. 204



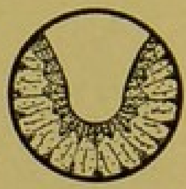
Coloboma of large iridectomy. Both pillars free.

Fig. 205



Coloboma of large iridectomy. One pillar free.

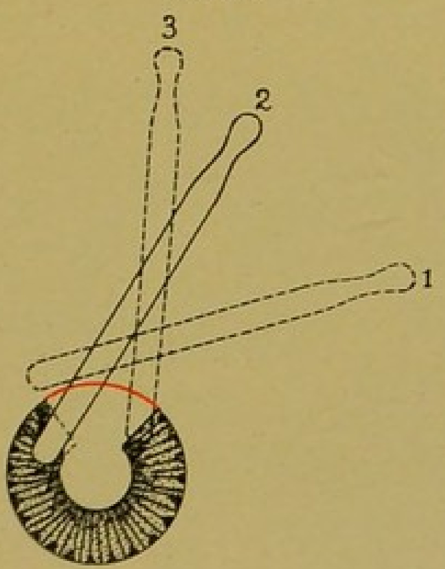
Fig. 206



Coloboma of large iridectomy. Both pillars incarcerated.

in the wound they should be replaced. In replacing the pillars of the coloboma double care should be exercised, as in such cases it is a much more delicate maneuver than usual, for sometimes even touching the lens may cause a rupture of the

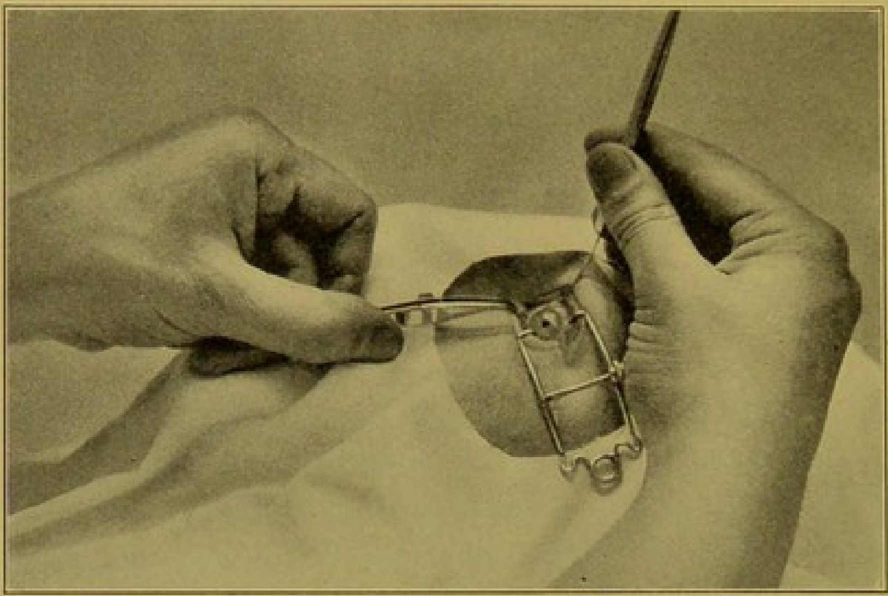
Fig. 207



Large iridectomy, replacing pillars of coloboma.

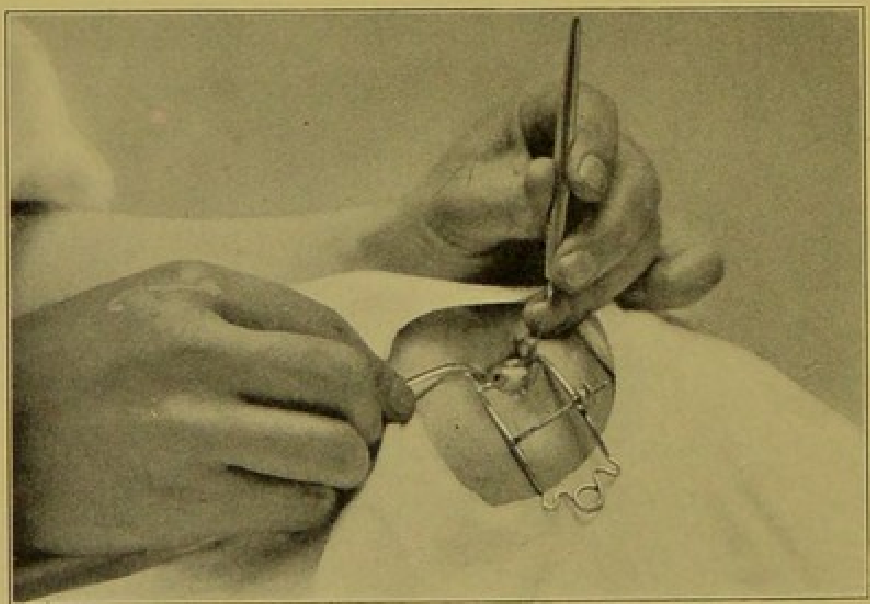
anterior capsule (Figs. 207 to 209). In glaucomatous eyes as well as in cases of chronic iritis considerable hemorrhage is likely to follow an iridectomy. As absorption of blood from the anterior chamber is very slow it is necessary to evacuate all blood if possible. This is done by depressing the posterior lip of the wound with a spatula and stroking the cornea gently with a Daviel spoon. After operation all blood clots are to be removed from around the wound and the eye is then closed and bandaged.

Fig. 208



Method of using iris spatula in replacing nasal pillar.

Fig. 209



Method of using iris spatula in replacing temporal pillar.

Complications during Operation.—Besides the complications mentioned under the small iridectomy the following may be encountered:

Tearing of Iris.—In cases of chronic iritis with posterior total synechiæ, in attempting to perform the iridectomy, the forceps may tear off the anterior layers of the iris, leaving the posterior or pigment layer adherent to the lens capsule. When this condition is diagnosticated before operation it is to be considered a contraindication for iridectomy. It also may happen that it is impossible to extract the iris, because when the attempt to withdraw it is made the fold in the forceps is torn out. In such cases repeated entries must be made and successive small portions of the iris torn out until a coloboma is formed. This method is termed iridorrhexis.

Hemorrhage.—Hemorrhage may occur in the anterior chamber during operation. The blood should be removed as described, with spatula and Daviel spoon. If it again collects the attempt may be made to stop the hemorrhage by closing the eye and putting sterile ice compresses on the closed eyelids for two or three minutes. In glaucoma operations retinal hemorrhages occur as a rule, but usually are not noticed as they absorb rapidly, and when the eye is examined ophthalmoscopically the first time after operation nothing is to be seen. In exceptional cases, as in absolute glaucoma, even expulsive hemorrhage may occur, necessitating immediate enucleation.

Luxation of the Lens.—Luxation of the lens sometimes occurs after the incision. Owing to the sudden decrease in intraocular pressure, the upper margin of the lens may become wedged in the iris angle. In such cases the anterior chamber often does not reform for some time after operation and the tension remains high or even increases (malignant glaucoma). If this complication occurs the attempt may be made to replace the lens according to A. Weber's method. Weber's operation is to be performed ten to fifteen days after the iridectomy in order to allow the wound to heal firmly. A posterior sclerotomy is first made, and while the knife is still in the wound pressure is exerted on the upper limbus in the direction of the centre of the globe. The pressure is at first light but then is slowly increased. It is necessary to wait at the height of the pressure for about one to two minutes so as to give the anterior chamber time to reform.

Rupture of Zonule and Hyaloid Membrane.—The zonule and the hyaloid membrane may rupture when the aqueous escapes suddenly or the patient is unruly. It may also happen when these membranes are atrophic. The consequence is luxation of the lens and prolapse of the vitreous. If it occurs before iridectomy the forceps cannot be used, but the iris is to be drawn out with Tyrrell's hook. If it happens after iridectomy the speculum is removed immediately, the vitreous cut off, and the eye bandaged.

Collapse of Cornea.—In cases where there is a shrunken organized exudation around the lens, after incision the lens does not advance but the cornea collapses. This is always a bad sign and an iridectomy is impossible in such cases.

After-treatment.—Both eyes are bandaged and the patient remains in bed for twenty-four hours. On the second day he may sit up in a chair with the unoperated eye left open. The operated eye may be left open under a mask on the fifth or sixth day, at the same time the patient may be allowed to walk around. He may leave the hospital on the tenth or eleventh day. During after-treatment the eye is washed and bandage changed daily and treated according to the disease that necessitated the iridectomy. It is not absolutely necessary to instil pilocarpine in glaucomatous eyes. Some surgeons, as for instance Czermak, absolutely condemn it, saying that it interferes with judgment as to the result of the operation. It is, however, absolutely necessary to instil pilocarpine or eserine at least once daily in the sound eye, after all iridectomies for primary glaucoma. Experience has shown, that following an iridectomy on a glaucomatous eye, during healing or sometimes even a few hours after operation, an acute attack may set in the sound eye, which had previously shown no symptoms whatsoever.

Postoperative Complications.—The wound is usually closed after a few hours and the anterior chamber restored. The sclera is somewhat injected around the wound for a few days, and the anterior lip of the wound is somewhat swollen and grayish in appearance. All this, however, disappears in a few days.

Complications during after-treatment are rare. Sometimes the wound does not close. The anterior chamber in such an event is not restored and the wound appears as a dark line. It more often occurs after an incision made with a Graefe knife, especially when the conjunctival flap, iris, or vitreous is wedged in the wound. Sometimes, however, it may be due to the fact that the tension is still raised. If, in addition to the increase of tension, injection and pain are present, we are dealing with what is called malignant glaucoma, and usually the eye is lost. In other cases it sooner or later closes and the result is satisfactory. The interposition of a conjunctival flap or iris in the wound often lays the foundation for a cystoid scar. Wound infection as well as infection in the interior of the eyeball is extremely rare.

OPERATIONS FOR GLAUCOMA THAT ARE SUBSTITUTES FOR IRIDECTOMY

These operations are:

1. Anterior sclerotomy (De Wecker).
2. Posterior sclerotomy (MacKenzie).
3. Sclerectomy and sclerecto-iridectomy (La Grange).
4. Cyclodialysis (Heine).
5. Trephining of the sclera (Elliot).

Anterior Sclerotomy.—De Wecker explains the action of the iridectomy by saying that not the iridectomy is important but the wound in the sclera. The resulting scar, according to his theory, produces a thinned portion of the ocular coats through which the intra-ocular fluids filtrate underneath the conjunctiva and from there they are drained away by the lymph channels. To be able to produce as large an incision in the sclera as possible, with least danger of prolapse of the iris, De Wecker advises his anterior sclerotomy. Although for a long time many surgeons have used only this operation for glaucoma, experience has taught us that it is less efficacious than iridectomy and it is nowadays performed only as a substitute operation for iridectomy. The mode of action of this operation, as it is understood nowadays, does not coincide entirely with De Wecker's theory, and the opinion at present is that the production of a scar in the sclera plays only a secondary role and that the incision of the iris angle is the more important. The incision of the pectinate ligament causes its trabeculæ to retract and thus opens up Schlemm's canal and produces a communication between the latter and the anterior chamber.

Definition.—A Graefe knife is passed through the anterior chamber as for a flap extraction and carried upward with sawing movements. The incision is not completed but a scleral bridge of about 3 or 4 mm. is left. The knife is removed and during withdrawal the angle of the iris is incised.

Indications.—1. Simple glaucoma.

2. Chronic glaucoma, where the field of vision is very much contracted, iridectomy in such cases being dangerous.

3. Hemorrhagic glaucoma.

4. Absolute glaucoma, where the iris is so atrophic that an iridectomy cannot be performed and the patient does not consent to enucleation.

5. Buphthalmos or juvenile glaucoma. Iridectomy in such cases may result in prolapse of the vitreous, luxation of the lens or detachment of the retina.

6. Relapsing glaucoma, where iridectomy has been repeatedly performed without success.

7. Glaucoma in aphakic eyes after combined extraction.

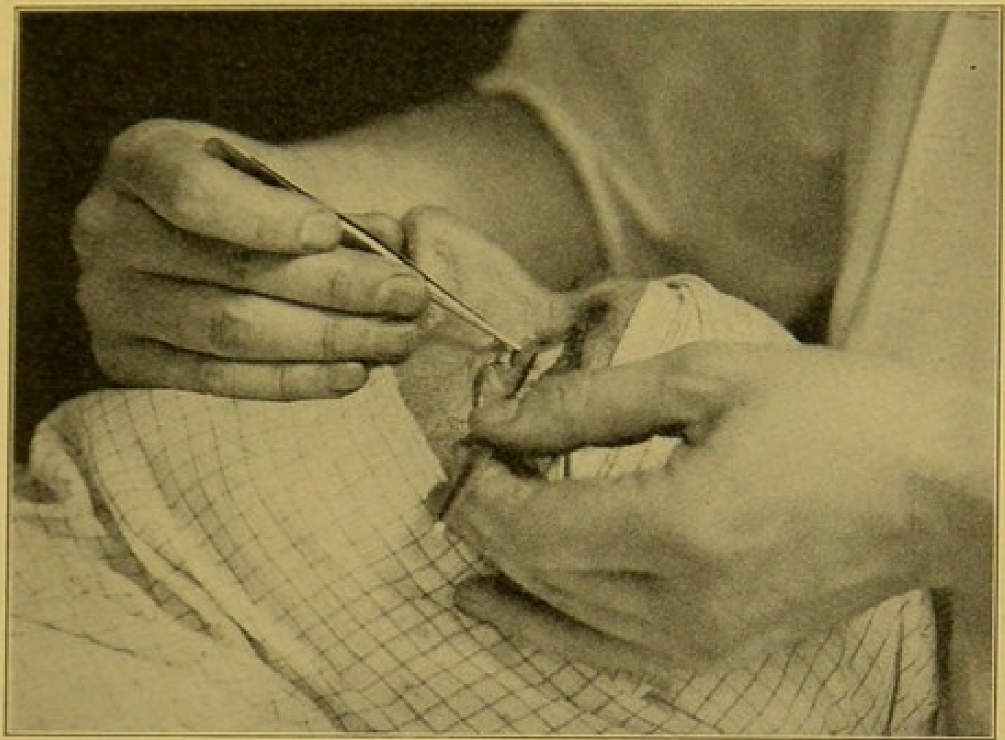
8. Secondary glaucoma after dislocation of the lens. Iridectomy in such cases is very difficult and dangerous on account of prolapse of the vitreous.

Preparation.—As for any eyeball operation. Pupil at maximum contraction with pilocarpine. Cocaine is instilled for one or two minutes before operation so that its mydriatic effect shall not be felt.

Instruments.—Speculum, fixation forceps, Graefe knife, spatula, iris forceps, and scissors.

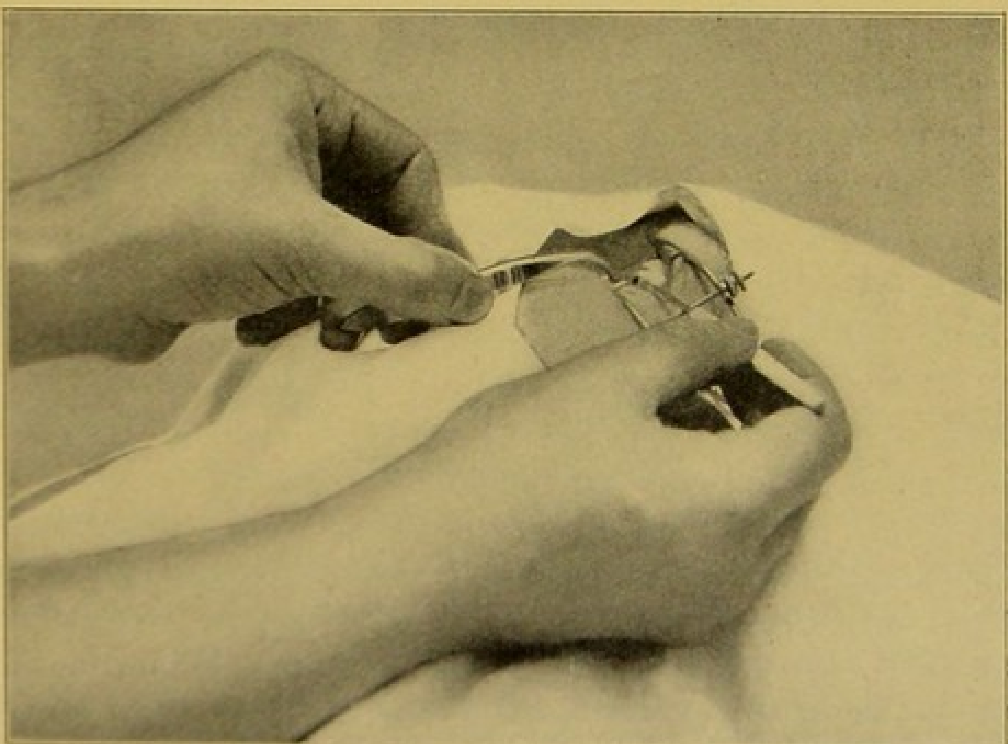
Operation.—The speculum is inserted and the eye fixed below. Graefe's knife is held, in the proper manner with its edge up, in the hand that corresponds to the side of the eye that is to be operated upon (Figs. 210 and 211). The other hand holds the fixation forceps. The site of puncture is 1 mm. behind the limbus and the flap should take in a little less than the upper third of the cornea if it were to be completed. The knife is pushed through

Fig. 210



American method of holding the Graefe knife for anterior sclerotomy.

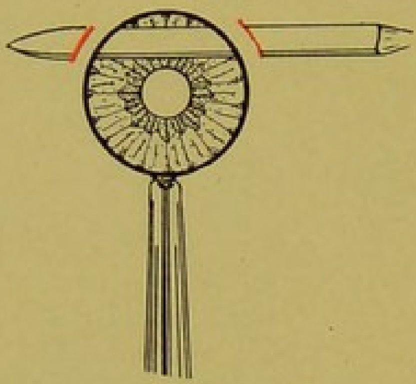
Fig. 211



European method of holding the Graefe knife for anterior sclerotomy.

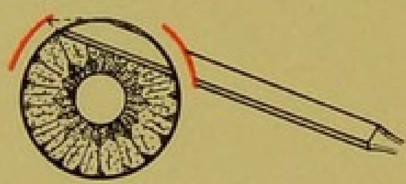
the anterior chamber slowly and the counter-puncture is made at the other side of the cornea at a point corresponding to the point of entrance (Figs. 212 to 214). The point of emergence should be apparently at the limbus; this will bring the point about 1 mm.

Fig. 212



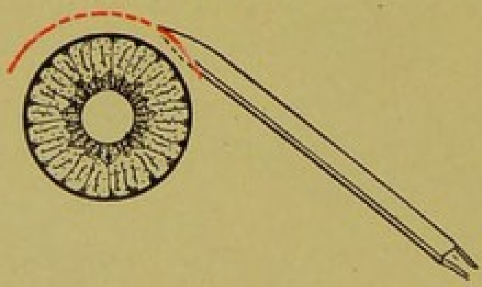
Anterior sclerotomy. First step.

Fig. 213



Anterior sclerotomy. Second step.

Fig. 214



Anterior sclerotomy. Third step.

behind it. After counter-puncture the knife is carried with sawing movements upward until there is an incision of about 4 mm. in length on each side of the cornea. Then without completing the flap the knife is withdrawn. During withdrawal the handle is depressed so that the point comes in contact with the iris angle and cuts it. The fixation forceps and the speculum are now removed and bandage applied.

Complications during Operation.—INJURY TO THE IRIS WHILE MAKING THE INCISION.—This is of little significance as the wound of the iris usually heals without showing a trace of injury. It is, however, unpleasant and painful, the patient becomes restless and hemorrhage ensues.

THE IRIS MAY BE WEDGED IN THE WOUND.—This is noticed by the fact that after the removal of the knife the pupil is drawn either above or toward one side of the wound. The iris should be replaced with a spatula so that the pupil is round; if this is unsuccessful, it must be excised.

PROLAPSE OF THE IRIS MAY OCCUR.—In such cases no attempt at replacement should be made but the prolapsed fold excised.

After-treatment.—One drop of eserine is instilled immediately after operation and the operated eye alone is bandaged. The patient remains in bed for one day. The following day he may sit in an arm chair and may walk around on the third or fourth day. The dressing is changed daily until the third day, when a mask or aluminum cup is substituted. Healing is complete on the seventh or eighth day.

Postoperative Complications.—These are extremely rare. After trauma there may be a prolapse of the iris, which should be excised.

Posterior Sclerotomy.—Posterior sclerotomy was originally devised by MacKenzie in 1830 as an operation for glaucoma.

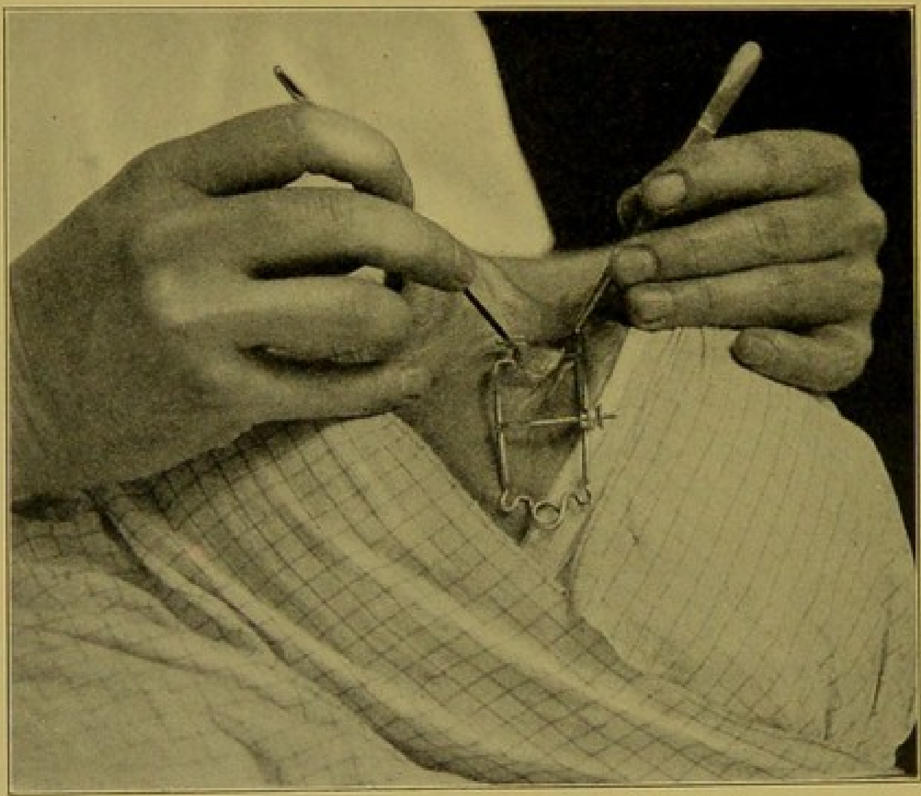
Definition.—The operation consists in making a small scleral incision between the ciliary body and equator of the eyeball.

Indications.—The operation is indicated in acute glaucoma where the anterior chamber is so shallow that an iridectomy cannot be performed. After the sclerotomy the tension is decreased, the anterior chamber becomes deeper, and the pupil contracts; an iridectomy may follow the operation in a few days. It is also indicated in cases of chronic glaucoma where an iridectomy or one of the other substitutes has given no results. In absolute glaucoma it may be also tried if the eye is painful and other operations have given no relief and the patient refuses enucleation or opticociliary neurectomy. Terson and others warmly recommend it in hemorrhagic glaucoma. Its action, however, is not reliable in these latter cases and the relief obtained is, in most instances, only temporary. The mode of action is the opening of the vitreous chamber; in those cases where permanent reduction of tension is obtained it is to be supposed that a filtrating scar has developed.

Preparation.—The usual preparation for eyeball operations. Cocaine anesthesia.

Instruments.—Speculum, fixation forceps, Graefe knife.

Fig. 215

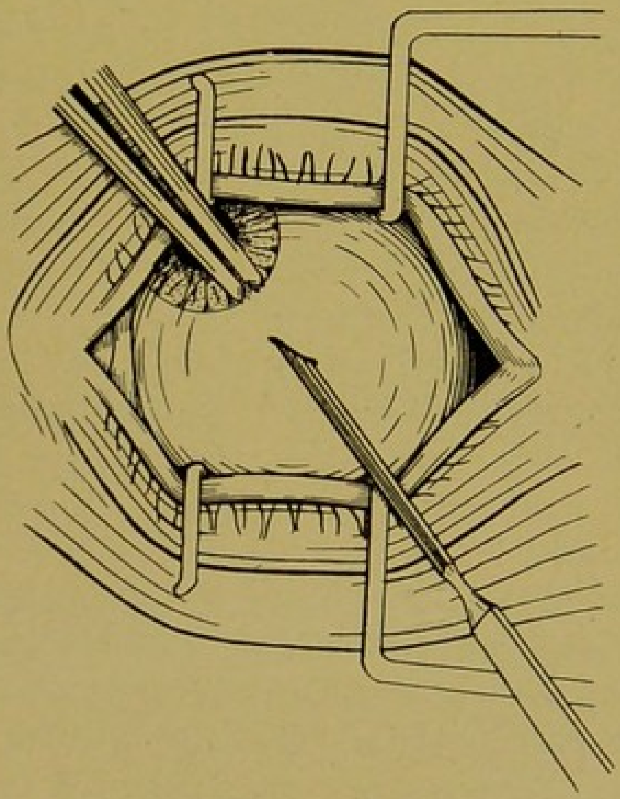


Method of holding the Graefe knife in posterior sclerotomy.

Operation.—After the speculum has been inserted the patient is told to look upward and inward as the incision is made downward and outward between the inferior and external recti muscles. The eyeball is fixed below and outward close to the corneal margin (Fig. 215).

Before making the incision the conjunctiva is caught on the point of the blade and drawn slightly to one side so that the opening in the conjunctiva shall not lie directly over the wound in the sclera. The knife is pointed toward the centre of the eyeball with its trenchant edge toward the equator. The incision is made meridionally at about 9 mm. from the limbus in order to avoid the ciliary body. The knife is now thrust quickly through the coats of the eyeball and into the vitreous for a distance of 1 cm. and the incision is extended backward until it is about 4 or 5 mm. in length. The knife is then withdrawn. Parinaud makes, after this meridional incision, another one at right angles

Fig. 216



Posterior sclerotomy.

to it so as to form a T-shape incision. In these cases a large gaping wound is produced which heals with extensive cicatrization. The scar thus formed allows a certain amount of filtration; so this procedure seems to be indicated in cases of chronic, absolute, and hemorrhagic glaucoma.

After-treatment.—The operated eye alone is bandaged for two days, the patient remaining in bed the first day.

Sclerectomy and Sclerecto-iridectomy (**Lagrange**).—Lagrange, in 1906, devised these operations, his idea being to form a filtrating cystoid scar by incomplete closure of the wound.

In sclerectomy he excises a piece of the sclera only without performing an iridectomy; in sclerecto-iridectomy an iridectomy is made in addition. According to his experiences he advises the sclerecto-iridectomy in cases of chronic glaucoma with a constant increase of tension; the sclerectomy in cases of simple chronic glaucoma where the increase of tension is intermittent.

Preparation.—The eye is prepared as for any eyeball operation; eserine is instilled one-half hour before the operation in order to secure a contraction of the pupil. A well-contracted pupil is necessary for the operation, because in this instance the iris angle is free for the passage of the knife and the iris will not interfere when the sclera is excised. Immediately before operation a few drops of cocaine and adrenalin are instilled to secure a good anesthesia and ischemia.

Instruments.—Speculum, fixation forceps, Graefe knife, iris forceps, iris scissors, fine mouse-tooth forceps, strong and well-curved scissors for the sclera, iris spatula.

Operation.—The operation is performed in three steps, the incision, the excision of the sclera, and the iridectomy.

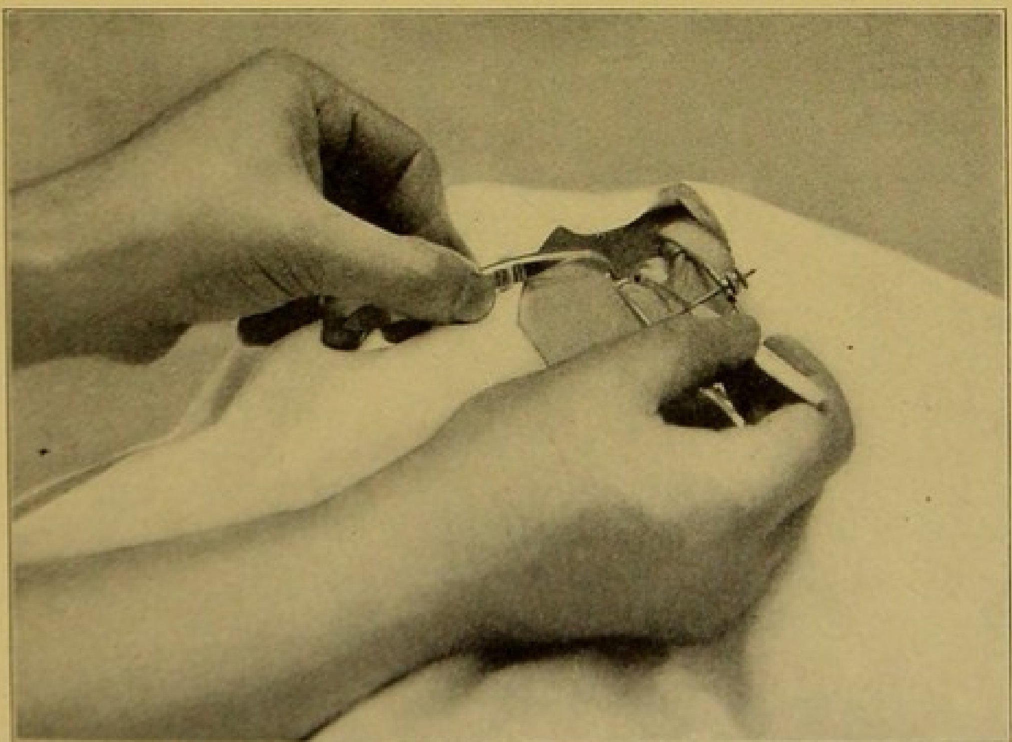
I. Step: Incision.—After the speculum has been inserted the eyeball is fixed below at the limbus. The Graefe knife is entered at a point 1 mm. from the limbus, carried through the anterior chamber and brought out at a point opposite. With sawing movements the section is completed which takes in the upper fourth of the cornea. The knife during the incision is held so that its cutting edge is directed at a point about 2 mm. behind the limbus and the incision should be carried through the iris angle. At the same time as large a scleral flap as possible should be secured (Fig. 219). A conjunctival flap is made at the same time by carrying the knife backward after completing the scleral incision.

II. Step: Excision of the Sclera.—The end of the conjunctival flap is grasped with the mouse-tooth forceps held in the left hand and the flap is turned back over the cornea. The strong well-curved scissors are taken in the right hand and held parallel to the direction of the incision. The blades are placed astride of the scleral flap and by slight downward pressure a piece of the sclera is excised (Fig. 220). If the excised piece of the sclera does not seem large enough a second one may be removed by the same maneuver. During the excision of the sclera care

FIG. 217

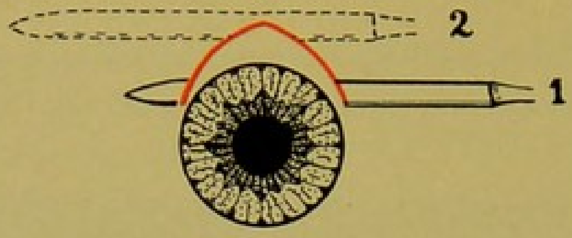
American method of holding the Graefe knife for Lagrange's operation.

FIG. 218



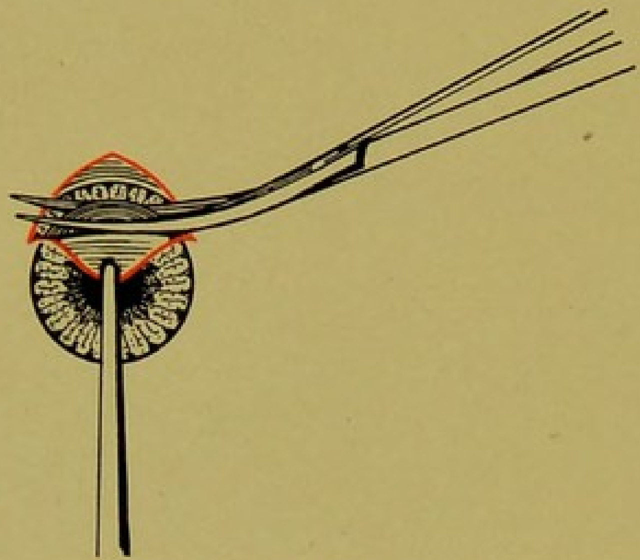
European method of holding the Graefe knife for Lagrange's operation.

Fig. 219



Lagrange operation, incision.

Fig. 220



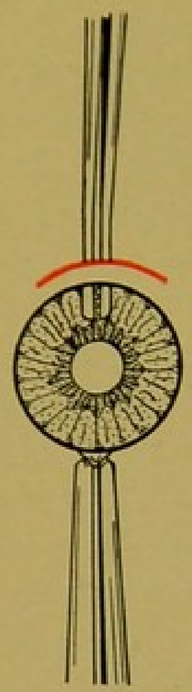
Lagrange operation, sclerectomy.

Fig. 221

Lagrange operation, dissection of conjunctival flap.

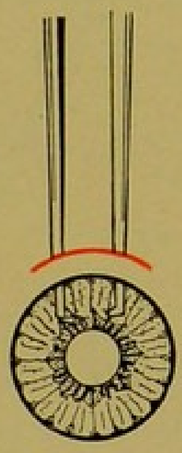
should be taken not to injure the conjunctival flap. If the scleral flap is not large enough to permit removal of a sufficiently large

Fig. 222



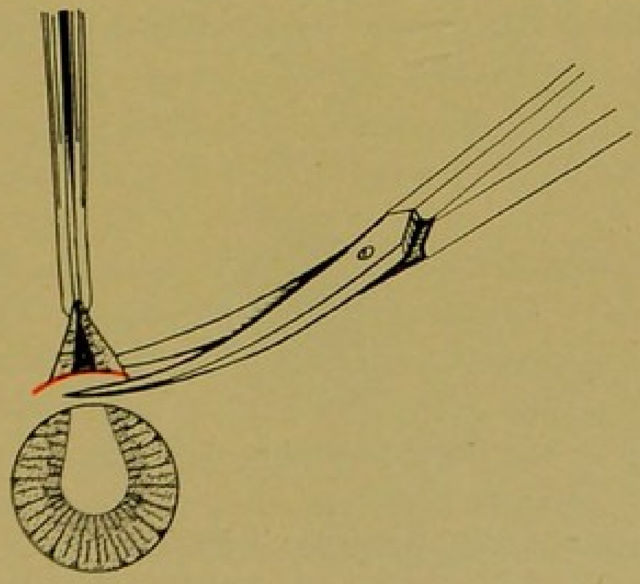
Large iridectomy, iris forceps in anterior chamber.

Fig. 223



Large iridectomy, grasping fold of iris.

Fig. 224

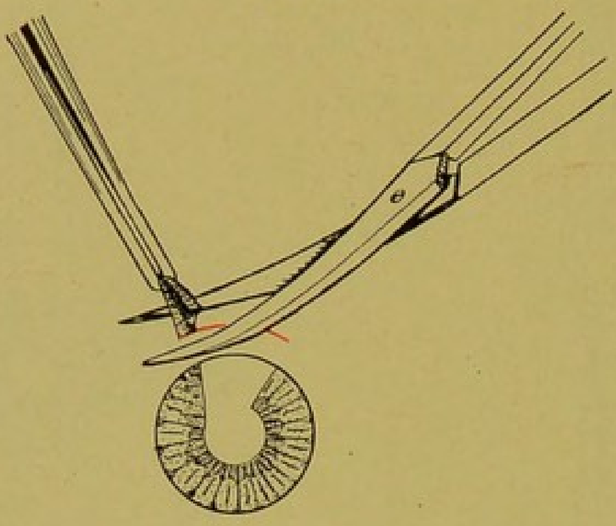


Large iridectomy, excising fold of iris. First position.

piece without injury to the base of the conjunctival flap, the conjunctiva should be dissected away with the scissors (Fig. 221).

In this case the conjunctiva held with forceps is put on the stretch and the dissection is made with the point of the scissors, which is held at right angles to the incision. If a simple sclerectomy is done the operation is now completed.

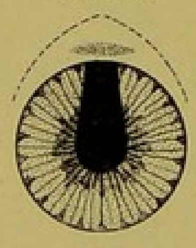
Fig. 225



Large iridectomy, excising fold of iris. Second position.

III. Step: Iridectomy.—The iris forceps and scissors are taken and a large peripheric iridectomy is performed (see p. 183). The conjunctival flap is smoothed out and a bandage is then applied (Figs. 222 to 225).

Fig. 226



Lagrange operation. Result.

Complications during Operation.—Besides the complications that may occur while making the incision with the Graefe knife (see p. 66) and performing the iridectomy (see p. 186), the most unpleasant complication is the hemorrhage which follows the scleral incision. Although unpleasant and disturbing, it is of no serious consequence. If it is severe it can be checked with sterile ice pads. The sclera is very dense and resistant, so in making the sclerectomy the scissors used should be well curved and very sharp. In excising a piece of the sclera the blades of the scissors should be pressed downward slightly, as otherwise the edge of the scleral flap will slip from between the blades. If the scissors are not held at right angles to the flap and are not held firmly in position it may happen that the incision is not carried through the entire thickness of the sclera but only the superficial layers of it are excised. In such a case, although an apparently large piece of sclera has been removed, the operation will not be successful and no cystoid scar will form. Great care should be taken during the excision not to seize the base of the conjunctival flap with the blades of the scissors, as otherwise a buttonhole is made in the mucous membrane which will lie directly over the opening into the anterior chamber.

After-treatment.—After operation both eyes are bandaged and the patient put to bed. The following day he may sit up and at the same time the unoperated eye may be left open. The operated eye should be cleansed daily and it may be left open under a Fuchs mask or a Snellen cup on the fourth or fifth day.

Postoperative Complications.—The postoperative complications are the same as those following an iridectomy (see p. 188).

If the operation is successful there is a small darkish opening in the sclera visible through the conjunctiva, around which the latter forms a small cyst-like elevation indicating that the aqueous is filtering through the opening.

Cyclodialysis (Heine).—Heine endeavored to produce a new channel for the drainage of the aqueous by connecting the anterior chamber with the suprachoroidal space.

Definition.—Posterior to the ciliary body an incision is made in the sclera through which a spatula is pushed forward between the sclera and choroid into the anterior chamber. The root of the iris is now detached and the spatula withdrawn.

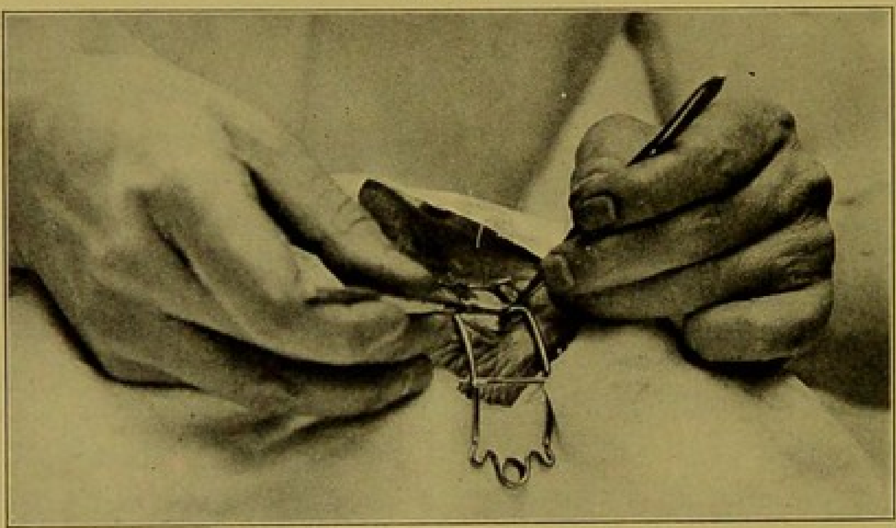
Indications.—The operation was introduced in 1905 and the indications are not as yet clear. According to Czermak it is an excellent operation in cases of glaucoma, where iridectomy cannot be performed on account of the pronounced atrophy of the iris; as a second operation when a previous iridectomy has had no effect; in simple glaucoma; and in buphthalmos.

Preparation.—After the regular cleansing of the eye cocaine-adrenalin is instilled.

Instruments.—Speculum, fixation forceps, fine-tooth forceps, small scissors, keratome or small scalpel, iris spatula, fine sutures, and needle-holder.

Operation.—The conjunctiva is first incised about 5 or 6 mm. from the limbus, at any point easily accessible to the operator. The conjunctival incision should be about 1 cm. in length. The conjunctiva is dissected up from the sclera and retracted.

Fig. 227

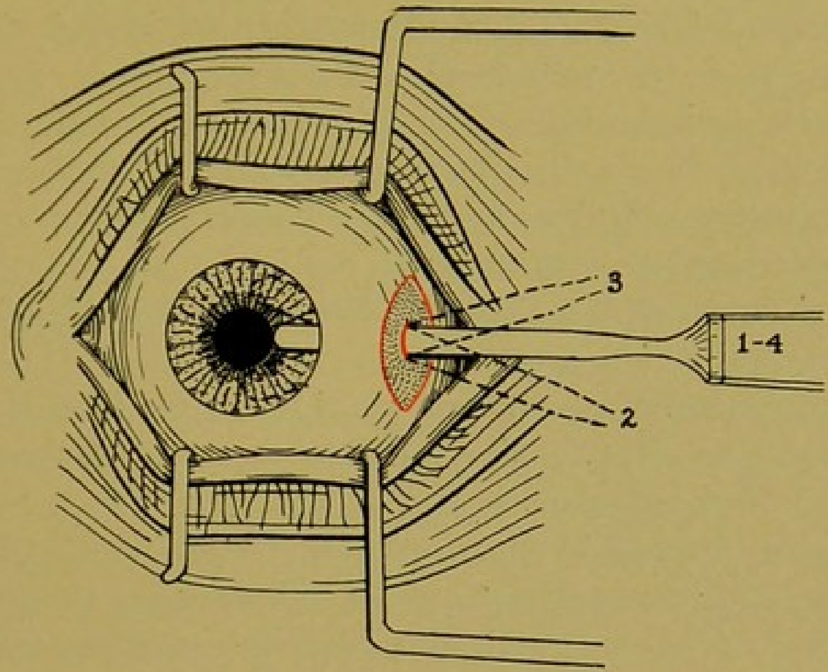


Cyclodialysis. Method of making the incision with the keratome.

The incision in the sclera should be about 3 or 4 mm. in length, parallel to the limbus of the cornea and about 9 mm. posterior to it (Figs. 227 and 228). The incision is made with a keratome or scalpel, and it is slowly deepened until a lack of resistance is felt, indicating that the sclera has been passed through. Care should be taken not to incise the choroid. (There is less danger of this accident if, when cutting, the edge rather than the point of the knife is used.)

After having reached the choroid the incision may be enlarged with the scissors. The spatula is introduced directed toward the cornea and kept close to the sclera, and is slowly advanced until its point appears in the anterior chamber. By lateral movements of the handle of the spatula the root of the iris and ciliary body are detached for a few millimeters. The spatula is withdrawn and conjunctival sutures taken (Fig. 228).

Fig. 228



Cyclodialysis. (Heine.)

Complications during Operation.—Incomplete incision may cause some slight trouble. It is recognized by the fact that the spatula will not advance. The incision must be deepened in such cases. In some cases the choroid is incised, especially when the point of the knife instead of the cutting edge has been used. It is followed by prolapse of the vitreous which is to be cut off and the conjunctival sutures taken. A few days later the cyclodialysis may be attempted again at a different point.

In case of an atrophic iris there is often hemorrhage into the anterior chamber following the dialysis. This is of no importance as it is readily absorbed.

After-treatment.—Both eyes are bandaged for twenty-four hours and patient is kept in bed. The second day the unoperated eye can be left open and the patient may sit up. A mask can be worn over the operated eye on the sixth day, when the sutures may be removed.

In some cases the tension is subnormal for several days or even weeks. In others, where there was no escape of aqueous, the tension is not reduced until several days following the operation.

Anatomical examination of eyes that were operated on have shown that the ciliary body became again firmly attached to the sclera. Therefore it would appear that Heine's theory was incorrect, as no permanent connection between the anterior chamber and the suprachoroidal space can be effected by the operation. The antiglaucomatous action of the cyclodialysis in consequence cannot be explained in any other way than by the detachment of the root of the iris.

Trephining of the Sclera (**Elliot**).—The following is Elliot's description of his operation:

The operation may be performed under the local influence of cocaine and adrenalin dropped into the sac. If there is much pain or congestion, or if the patient is unruly, a hypodermic injection of morphine may be given twenty minutes before the operation. In recent cases we have been using subconjunctival injections of cocaine and adrenalin, with excellent results.

The patient looks down, and a large triangular flap of conjunctiva is dissected up from above the cornea, the attached base of the triangle lying at the sclerocorneal margin. Experience has shown the importance of dissecting this flap right up to the limbal attachment of the conjunctiva. The flap is turned down on the cornea. The spot selected for the trephining should be as close to the limbus as possible, and should be prepared by using the scissor points freely, either cutting or scraping, or both, down to the scleral coat. It is important that no conjunctiva be left, as otherwise it will catch in the trephine and tend to draw the flap into the latter as it is working. We never pull the flap, but simply steady the globe by pressing on the cornea through the down-turned flap; we find this quite sufficient to effect the purpose of keeping the eye at rest in the proper position. The trephine is used with quick light movements and care is taken that its first application suffices to bite into the sclera, before it is raised to see the progress made. Once a clean ring is thus started it is very easy to replace the trephine in it.

At first the operator feels the need of frequently removing the trephine to watch progress, but he soon learns to know by the feel when he is through. As soon as the anterior chamber is tapped aqueous fluid wells up alongside the trephine, and even apart from this, there is a curious sucking sensation which indicates that the trephine is through. Moreover, the patient often helps by a slight movement due to the pain (seldom severe) which attends the completion of the section.

The conjunctival flap is replaced *in situ* to see whether the iris is in position or not. If it is, and if there is no bulging of its base into the wound, the eye is at once closed. It sometimes happens that the iris bulges into the section the moment the disk is cut through. If this occurs it is snipped with scissors to let the aqueous fluid escape, and it then often goes back itself. If it does not, then an iridectomy is performed. As a rule, a very small and peripheral section of the membrane suffices; more rarely it is necessary to make the iridectomy complete. We instil eserine drops into the eye after operation if for any reason we fear a prolapse may take place. As a rule, no drops whatever are used immediately after the operation.

IRIDOTOMY

Iridotomy, although a very old operation, was not universally used until De Wecker, in 1873, revived it, at the same time working out the technique as it is today. He performs the operation with his pince-ciseaux on eyes with or without lens.

Iridotomy in Eyes with Lens.—**Definition.**—An incision is made in the cornea opposite the point where the iris is to be incised; the pince-ciseaux is introduced into the anterior chamber and one blade is passed through the pupillary opening behind the iris and the blades closed.

Indications.—Large Central Opacities of the Cornea.—The operation is supposed to have the advantage of having the scar, from the corneal incision, on the opposite side of the cornea and not over the coloboma. Nevertheless nowadays the simple iridectomy is done, as there is considerable danger of injuring the lens by the iridotomy.

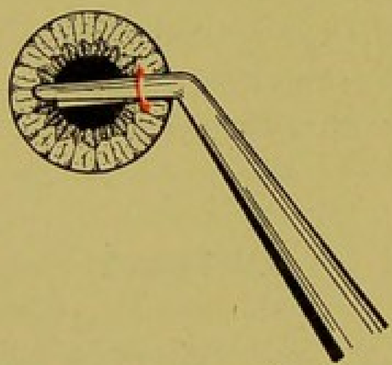
Subluxation of a Cataractous Lens.—In such cases iridectomy is very difficult, as after incision the vitreous prolapses, which makes it often impossible to grasp the iris and draw it forward. In iridotomy the incision is made in front of the subluxated lens, and the incision of the iris can easily be made without great loss of vitreous and without the slightest danger of injuring the lens.

Preparation.—The eye is cleansed in the usual manner. General anesthesia is the rule unless we are certain that the patient will remain quiet.

Instruments.—Speculum, fixation forceps, keratome, pince-ciseaux, iris spatula, iris forceps.

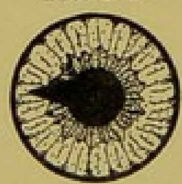
Operation.—The operation consists of two steps, the incision and the section of the iris.

Fig. 229



Iridotomy with lens. Pince-ciseaux in anterior chamber.

Fig. 230



Iridotomy with lens, showing result.

I. Step: Incision.—After the insertion of the speculum the eye is fixed near the limbus at the point where the iris is to be incised. The point of entrance should be about 2 mm. in front of the limbus opposite the fixation forceps. The incision is made with the keratome and should be about 4 mm. in length. The technique is the same as in iridectomy. After the incision is completed the fixation forceps are removed.

II. Step: Section of the Iris.—The pince-ciseaux, with both blades blunt, is introduced closed and pushed to the opposite pupillary margin, where the blades are rotated and then opened. One of the blades is now passed through the pupillary opening behind the iris and pushed forward until the incision of desired length can be made. The blades are closed and the instrument is withdrawn quickly, but with care. The speculum is removed, the eye bandaged, and atropine instilled (Figs. 229 and 230).

Complications during Operation.—The most serious complication is the injury of the lens which causes a traumatic cataract with all its unpleasant sequelæ. Another complication is that the blade may push the iris in front of it without gliding behind it. In such cases the length of the incision cannot be judged and its edges become irregular. It sometimes occurs that the iris on the side of the corneal incision prolapses; under these conditions it should be replaced.

After-treatment.—The after-treatment is the same as for an iridectomy. If the operation has been successful there is a V-shaped opening at the point of incision of the iris. The opening is small and therefore gives a better result than an iridectomy, but not enough better to subject the patient to narcosis and danger of injury to the lens.

Iridotomy in Eyes without Lens.—See p. 284, under operations on the lens.

OPERATIONS FOR ANTERIOR SYNECHIA

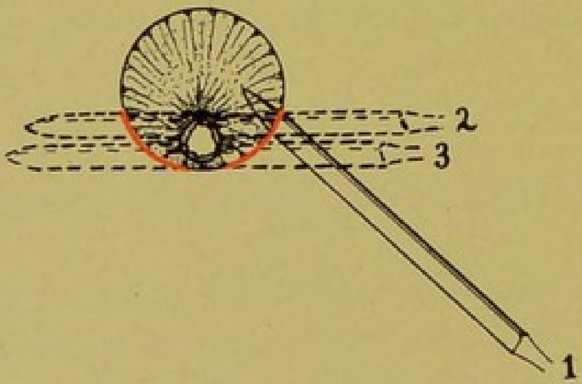
Anterior synechia, especially when the scar is ectatic, is always dangerous to the eye, as it may cause secondary glaucoma, repeated attacks of iridocyclitis, and also intra-ocular infection, which may lead to panophthalmitis (spontaneous panophthalmitis). These sequelæ can never be excluded with certainty. Therefore it is advisable to liberate the iris from the scar in all cases where the operation promises success. If the scar lies in the centre of the cornea it impairs the sight to a great extent and in such cases iridectomy is the only operation. If, however, it lies in the periphery and interferes with vision but slightly, iridectomy will be of no advantage; on the contrary, it may diminish the patient's vision by dazzling. The following operations are the ones most commonly used in such cases:

Sphincterotomy (Schulek).
Sphincterolysis (Schulek).
Staphylotomy (Abadie).
Iritomy (De Wecker).
Iridolysis (Lang).

Sphincterotomy (Schulek).—Schulek uses a specially devised instrument called a sphincterotome, which is a fine sickle-shaped needle with its cutting edge on the convexity. The shaft is so graduated that it completely fills the corneal wound.

Before operation the pupil is contracted with pilocarpine and cocaine is instilled. The needle is introduced in the limbus and the fibers of the iris cut. If they are too elastic and are not easily severed the sphincterotome is turned and while cutting the fibers they are pressed against the posterior surface of the cornea. The operation is indicated only where a few fibers of the iris are adherent to the scar. For larger anterior synechia Schulek devised the sphincterolysis anterior.

Fig. 231

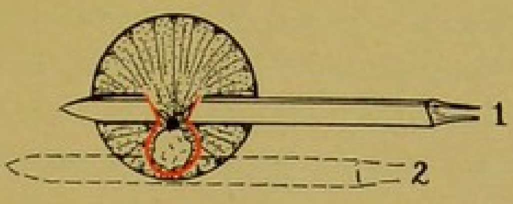


Anterior sphincterolysis. (Schulek.)

Sphincterolysis (Schulek).—After pilocarpine and cocaine have been instilled a Graefe knife is introduced at one edge of the scar and is pushed forward to the pupil. An arc of 100 degrees or 120 degrees is now described with the handle, the point thus encircling the synechia after which the counter-puncture is made on the other side of the scar. With sawing movements the synechia is cut and the knife removed without completing the corneal section. Blaskovics modified the operation by placing the puncture and counter-puncture in the limbus (Fig. 231).

Staphylotomy (Abadie).—A Graefe knife is entered above the scar, pushed between iris and cornea, through the anterior chamber to the point of exit, which is exactly opposite the point of entrance. With sawing movements toward the limbus the synechia is cut, but the section through the cornea is not completed, leaving a small bridge of conjunctival tissue at the limbus, as the iris is on the stretch it usually retracts when cut, giving a free coloboma (Fig. 232).

Fig. 232



Staphylotomy. (Abadie.)

Iritomy (De Wecker).—Between the limbus and scar he makes an incision with the keratome, plunging it through the synechia and transfixing the latter. Then with a pince-ciseaux he cuts both pillars, thus produced, separately.

Iridolysis (Lang).—Lang uses for the division of an anterior synechia two Knapp knife-needles. One is the regular needle and the other is blunt. With the sharp needle he enters the anterior chamber through the cornea at a distance from the scar. The needle is then withdrawn and the blunt pointed one introduced through the original opening. The needle is then advanced across the chamber and the anterior synechia is divided. The opening in the cornea should be placed at such a distance from the scar that the manipulation of the second, when in the anterior needle chamber, shall not be impeded.

EXCISION OF PROLAPSE OF THE IRIS

A prolapse of the iris leads to an anterior synechia and all its unpleasant sequelæ. It is necessary, therefore, to try, if possible, to liberate the iris from the wound. The reposition should never be attempted, as there is too great a danger of infection. In very recent cases (one or two days) it is usually sufficient to grasp the iris with the forceps, put it on the stretch and ablate with the scissors, slight pressure being exerted by them on the cornea. In older cases where there is a firmer adhesion between iris and cornea the iris must be detached from the edge of the wound before excision. If the adhesion is strong and already organized (which occurs after the eighth day) the liberation cannot be accomplished. The breaking up of the adhesions and the ablation of the prolapse in early cases (before the eighth day) is done according to Leber's method. It should be borne in mind that if the prolapse is due to a perforated ulcer we should wait until all signs of infiltration have disappeared, as there is danger of infection in operating before. The following is Leber's method:

As the eye is usually inflamed and painful the patient had better be given a general anesthetic. A speculum is then inserted and the eye drawn into proper position with the fixation forceps. The prolapse is now caught with an iris forceps, gently pulled out, and while on the stretch it is liberated from its adhesions with a probe. Beginning at one point we work around the circumference of the wound, completely freeing the iris. It is advisable after this to bend the probe at an angle at about 2 mm. from its end and enter the anterior chamber and circumscribe the prolapse, thus making sure that the iris is free everywhere. The prolapse is now caught with the iris forceps, put on the stretch, and is cut off with the scissors, at the same time pressing the latter gently against the cornea. The iris usually retracts and a coloboma with free pillars results. If this should not occur the anterior chamber may be entered with an iris spatula, if the wound is large enough, or with a probe, if the wound is small and the iris is smoothed out. Great care must be taken in the latter case not to injure the capsule of the lens. Atropine is instilled and a bandage applied.

The operation may be followed by covering the defect with a conjunctival flap according to Kuhnt's method (p. 140).

OPERATION FOR IRIS CYST (EVERSBUSCH)

Cysts of the iris when of large size cause secondary glaucoma, thereby endangering the eye. Eversbusch's operation is similar to a De Wecker iridotomy.

The pupil is well contracted with pilocarpine and the eye cocainized. The incision is made in the cornea near the limbus with a keratome. The site of the incision is on the side opposite the cyst. After making an incision of about 4 to 5 mm. in length the keratome is passed into the cyst, and then slowly withdrawn. De Wecker's pince-ciseaux is introduced, one blade passing through the pupil behind the iris the other over the cyst. The blades are closed and the cyst with the iris is incised. The edges of the wound in the iris separate so there is no possibility of the reforming of the cyst. If atropine is instilled for several days following the operation the edges of the cyst are kept well apart.

CHAPTER VII

OPERATIONS ON THE LENS

THE operations on the lens are of two types, (*a*) discission, (*b*) extraction.

Pathological conditions which necessitate surgical interference are:

1. Cataract.
2. Subluxation and luxation of the lens.
3. High degree of myopia.
4. Foreign body in the lens.

CATARACT

A cataract is a pathological change in the lens substance or its capsule which leads to an opacity.

Classification.—Although cataracts are classified from various points of view, from the surgeon's standpoint it is important to know whether the cataract is soft or hard, partial or total.

Hard and Soft Cataracts.—The division of cataracts into soft and hard is based upon the physiological change in the lens which is called sclerosis. Until the twenty-fifth year the lens is uniformly soft. After this age, due to the physiological sclerosing, the central part of the lens becomes hard. This hardened, central portion is called nucleus, while the soft peripheral portion is called cortex. The transition from nucleus to cortex is gradual. The nucleus increases in size and the cortex diminishes as the years advance until at about the sixtieth year of life the cortex has entirely disappeared. At this age the lens is totally sclerosed, forming a large hard nucleus. Cataracts occurring before the sclerosing process has begun (before the twenty-fifth year of age) are called soft cataracts, while those occurring later are called hard cataracts. This distinction is of great importance in regard to choice of operation. If there is no nucleus present it is possible for the lens to become totally absorbed, so a discission will suffice. If a nucleus is already present the lens can never be wholly absorbed, so the removal of the lens by means of extraction must be resorted to. A linear extraction is employed if the nucleus is small and a flap extraction if it is large.

Partial and Total Cataracts.—As the name indicates this classification is based upon the extent of the opacity. In total cataracts the whole lens has lost its transparency, while in partial cataracts the opacity involves only certain portions of the lens. A partial cataract may remain stationary or it may later extend, thereby becoming progressive.

Total cataracts always demand surgical interference, while partial cataracts do so only when they are of such size as to interfere with vision or have become progressive. The most common partial cataracts are the *anterior* and *posterior polar*. As both of these are stationary they seldom call for operation. If, however, they are large enough to interfere with vision an iridectomy is usually all that is required.

The anterior and posterior cortical cataracts are progressive, partial cataracts, which are usually due to some underlying condition most commonly choroiditis, and are, therefore, often called choroidal cataracts. They may be stationary for years and then become progressive. The operative interference depends upon the vision, the progressiveness, and the underlying cause. It may be either iridectomy or extraction.

Perinuclear (zonular lamellar) cataracts form a connecting link between the stationary and progressive cataracts. They are usually present in children who have had rachitis or convulsions. As the name indicates the opacity lies between the transparent central (nuclear) and the peripheral (cortical) portions of the lens. Whether to operate or not depends upon the size and density of the opacity and the interference with vision. When the vision is below $\frac{1}{3}$ of the normal for distance and the patient cannot read Jaeger test type No. 5, the operation is indicated. If the patient's vision is better than this and the operation is performed the improvement in vision will not compensate for the loss of accommodation. The choice of operation lies between an iridectomy and a removal of the lens, depending on whether the cataract is progressive or not. The progressiveness is indicated by the presence of the so-called "outriders," which are spoke-like opacities in the periphery of the lens. If the opacity is small and the transparent zone in the periphery broad and no "outriders" present an iridectomy may be performed.

The value of an iridectomy may be approximately determined by testing the visual acuity with the pupil contracted and then after its artificial dilatation with atropine. It is always better to make the iridectomy above and inward or above and outward and not in the palpebral fissure. In this case the upper lid will not cover the coloboma entirely and the patient will be benefited. Should the cataract later become progressive and require extraction the coloboma will be in the proper position. A coloboma in the palpebral fissure after the removal of the lens is usually disturbing to most patients. Iridectomy seldom gives satisfactory results in these cases, so lately it is rarely performed and by most surgeons it has been completely abandoned.

The removal of the lens is the proper method to employ. It is absolutely indicated in cases where the central opacity is large, dilatation of the pupil not improving the sight to any great extent, and there are signs of progressiveness present, *i. e.*, "outriders." The operative procedure in young individuals should be discission, in older, extraction.

Senile Cataracts.—Senile cataracts are the most common and typical progressive cataracts. They always begin as partial cataracts, the opacity slowly spreading until the whole lens is completely involved except the nucleus, which always remains transparent to a certain degree. As the name indicates, the senile cataract develops in elderly people, affecting both eyes either simultaneously or first one and then the other. The cause of its development is not known, the age of the patient being only a state which favors the onset.

Stages of Senile Cataracts.—In its course four stages are distinguished:

Incipient Cataract.—In this stage the opacities in the lens are usually in the periphery and appear by focal illumination as grayish wedge-shaped lines which are arranged radially. By transillumination these opacities appear as black lines in the uniformly red pupil. Later these opacities coalesce, forming larger ones irregular in shape.

Immature Cataract.—In this stage the whole lens is uniformly opaque and bluish white in color, with a marked silky luster of the surface. The anterior chamber is shallow, as the lens has increased in volume from imbibition of fluid, and the iris throws a shadow on the lens by focal illumination, part of the cortical substance being still transparent.

Mature Cataract.—In this stage the anterior chamber is of normal depth, since the swelling of the lens has subsided. The iris casts no shadow by focal illumination and the lens has lost its silky luster, having a dull gray or yellowish color.

Hypermature Cataract.—In this stage the lens undergoes degenerative changes. It may liquefy or dry up and shrink. If the cortex liquefies the lens is of a uniformly white color and in its lower portion can be seen a brownish shading which is bordered above by a crescentic line that represents the upper border of the dark nucleus (Morgagnian cataract). If, on the contrary, the lens dries up, the anterior capsule becomes thickened by proliferation of the epithelial cells which appear as whitish spots on the grayish or brownish lens. The zonule often undergoes atrophy and the attachment of the lens becomes imperfect so that the lens vibrates with movements of the eye. Cholesterin or lime salts are often deposited in the lens mass. These can be recognized as glistening yellowish-white points in the opaque lens (calcareous cataract).

Most Favorable Time for Operation.—The best stage to operate in is the mature stage. At this time the lens has separated from the capsule and comes out in one mass, consequently the best result is obtained. In the immature stage portions of lens cortex remain behind adherent to the capsule, and these absorb slowly. They not only delay the return of good vision but act as an irritant in the eye, causing traumatic iritis and may possibly produce glaucoma. In such cases very often a thick secondary cataract is the result.

If the cataract is hypermature the removal is more difficult than in the mature stage and is often accompanied with unavoidable complications which may prove fatal to the eye. In Morgagnian cataract with a fluid cortex the removal of the small nucleus is often difficult, as it may not present properly in the wound. In shrunken cataracts, the zonule being atrophic, prolapse of vitreous will be a frequent complication.

The maturity of the cataract is, therefore, to be ascertained before operation by the symptoms just indicated. They may, however, be misleading as sometimes a clinically mature cataract is found during operation to be immature or even hypermature. On the other hand there are some cataracts which do not present the clinical symptoms of maturity, yet they are nevertheless ripe for operation. These are so-called sclerosed cataracts. The lens in these cases has an amber hue and the vision is markedly impaired, although the lens is still somewhat transparent. The opacity is usually a fine uniform cloudiness, through which the fundus can be seen indistinctly with the ophthalmoscope. These cataracts never become gray or totally opaque as the sclerosis prevents the cataractous degeneration of the lens. Such a cataract is ready for operation at any time.

Another variety of clinically immature cataracts, that are ready for operation, is the so-called nuclear cataract. In these cases a diffuse opacity usually develops at the centre of the lens and extends toward the periphery very slowly. In many cases these cataracts are ripe for operation before the lens is totally opaque. Of course the sclerosis plays an important part here also as the progression of the central opacity is so slow that the periphery scleroses before it can undergo cataractous degeneration. Schweigger and Hirschberg have expressed the opinion that the maturity of a cataract depends on the age of the patient and not the clinical appearance. At the age where accommodation has disappeared (sixty years or over) all lenses can be extracted even when the larger part of the lens is transparent.

Unequal Development in Two Eyes.—The cataract often develops with greater rapidity in one eye than in the other, so that it is rare to see mature cataracts in both eyes at the same time. If two mature cataracts are present in the same individual operation should never take place on both at one sitting, for should there be an infection both eyes will be involved and the sight lost. If one eye is operated on at a time this possible complication can be avoided and the surgeon is enabled to study the patient's temperament. If some unpleasant complication arises during the first operation, owing to the patient's behavior, it can be forestalled in the second operation. If one cataract is mature and the other hypermature it is always better policy to operate on the mature cataract first, as this is the eye from which the better result may be expected. With mature cataract in one eye the other being normal the cataract should be removed in order to increase the field and to restore stereoscopic vision, also to give the patient a reserve eye in case accident befalls the good one. One of the unpleasant consequences attending the operation in this condition is the high degree of anisometropia that is produced. The patient often complains of discomfort and in some cases diplopia. It is better therefore to explain carefully to the patient, beforehand, what he can expect so that he will not be dissatisfied with the result.

Test for Functional Capacity of Retina and Optic Nerve.—In all cases of cataract operation useful vision is to be expected only where the retina and optic nerve are normal. It is highly essential that their function be tested in regard to perception of light and localization. This test is made as follows:

The patient is placed in an absolutely dark room, one eye being covered with a handkerchief or bandage, the other is opened and his gaze directed forward. A lighted candle is held at a distance of about 6 feet, it is raised and lowered and then placed to the right and left of the patient. If the patient is able to locate the light at these various points without movement of the head or eye it is to be assumed that his localization or projection is intact. The light is now placed at 20 feet and is alternately covered and uncovered. If the patient is able to detect the change in illumination, light perception is to be considered good.

In young children this test cannot be carried out and we must be satisfied with the reaction of the pupil to light. If any posterior synechia be present we must resort to the consensual reaction. (Contraction of the pupil when the light is thrown in the other eye.) In cases where the light perception and localization are faulty we cannot hope to give the patient useful vision. It is necessary, therefore, to explain carefully to the patient what he can expect after the operation. Where perception of light and projection are wanting, no vision can be expected and the operation is only to be performed for cosmetic purposes, if the patient so desires.

Aphakia.—After the removal of the lens the condition known as aphakia exists. With loss of the lens accommodation is lost and the refraction of the eye is changed. Generally if the eye was previously emmetropic it will require a +10 D. lens for distant vision. If the patient was hyperopic usually a 10 D. lens must be added to his former distance glass. In myopia the change of refraction depends on the degree of myopia and can be approximately determined by Hirschberg's formula, which is explained in the section on Removal of Lens in High Myopia. There is always a certain degree of astigmatism present after the operation, owing to the fact that the coats of the eye being elastic the ends of the wound are in contact but the edges are not perfectly coapted. This produces a change in the curvature of the cornea; the curvature will be increased in a direction parallel to the wound and decreased at right angles to it. The resulting astigmatism will depend on the size of the wound and consequently will be larger after a flap extraction than after a linear extraction. In the latter case it is seldom higher than 2 D., while in the former it may be as high as 6 to 8 D. or more. Later when the scar tissue contracts the wound edges approach each other and the astigmatism diminishes. After a linear wound the astigmatism often disappears entirely but after a flap extraction usually 1 or 2 D. remain.

As the accommodation has been lost by the removal of the lens the patient will need convex glasses in addition to his distance lens for near work. The strength of these additional lenses will naturally depend upon the distance at which the patient does his work. For usual reading and writing distance (33 cm.) the addition of a 3 D. lens will be required. In prescribing glasses the sight of the unoperated eye must always be taken into consideration. If the patient has an incipient cataract in the unoperated eye, glasses are prescribed for the eye that has the better vision.

If for instance the patient has a vision of $\frac{20}{80}$ in the unoperated eye and with correction $\frac{20}{40}$ in the aphakic eye cataract glasses will not be prescribed. If, on the contrary, the aphakic eye has the better vision the cataract glass is to be prescribed. If the unoperated eye has normal vision the cataract glass is not prescribed, as the difference in size of the retinal images causes untold discomfort to the patient.

Development of Secondary Cataract.—After removal of the lens there often develops an after or secondary cataract which impairs the vision to a great extent, necessitating a second operation (discission). This operation, however, is sometimes necessary in cases where no secondary cataract develops, but the capsule wrinkles (usually at right angles to the capsular incision), causing so much metamorphopsia as to interfere with vision considerably.

Causes of Secondary Cataract.—The causes of the development of a secondary cataract according to Terrien are as follows:

1. Retention of cortex between the anterior and posterior capsule of the lens. This usually occurs in the removal of soft and immature cataracts.

2. Proliferation of the capsular epithelium. After the removal of the lens, the anterior and posterior capsule come in contact with each other, forming an invisible membrane which does not interfere with vision. Later on, sometimes in a few months, sometimes in a few years, by proliferation of the epithelium the formerly invisible membrane becomes a cobweb-like curtain, impairing the vision to various degrees.

3. If an inflammatory process of the iris or ciliary body follows the extraction the capsule becomes adherent to the iris and the pupillary area is filled with an exudate which later becomes organized, forming in this manner a thick opaque membrane reducing vision to a minimum.

These three different types of secondary cataracts require different operative interference. For the first type an extraction is the best; in the second a discission, while in the third De Wecker's iridocapsulotomy will give the best result.

Congenital Cataracts.—These require special attention in regard to the time of operation. It is best not to wait too long before operating as the retina does not develop properly and an amblyopia ex anopsia with nystagmus will be the result. The operation can be performed as early as the fifth month.

Traumatic Cataract.—Traumatic cataracts are the results of injury to the eyeball or lens and present various pictures. In young individuals the traumatic cataract will present the same appearance as that which follows a discission of the lens capsule, namely, the lens swells up and becomes more or less absorbed resulting either in a black pupil or a membranous cataract. In older patients, on the contrary, the absorption is always incomplete. Surgical interference should never take place until all inflammatory symptoms following the trauma have subsided except in those cases where secondary glaucoma develops. This may necessitate immediate surgical interference to save the sight. The surgeon has the choice of several operations according to the case and the age of the patient. They are paracentesis of the cornea, discission, iridocapsulotomy, and linear or flap extraction.

Complicated Cataracts.—Complicated cataracts are those that result from or are accompanied by some disease of the eyeball (ocular complication) or the system at large (systemic complication).

Systemic complications may be diabetes, nephritis, etc.; ocular complications, choroiditis, retinitis, glaucoma, posterior and anterior synechia, etc.

A careful examination of the light perception and projection should always be made before operation, and even if found good the prognosis should be guarded. Often floating opacities in the vitreous or choroidal changes are found after operation which, although not interfering with perception of light and projection, will impair the vision to a great extent. In operating on a complicated cataract a preliminary iridectomy is always advisable, as it makes the cataract operation easier and safer, and from the reaction following this operation it may be judged how the eye will support the larger operation.

The extraction may be a linear or a flap extraction according to the case, except when there is a total adherence of the iris. In such cases the only operation that can be performed is the Wensel-Wecker extraction, which is as follows: An incision is made with a Graefe knife, but on entering the anterior chamber the iris is pierced with the point of the blade. The knife is passed behind the iris to the opposite side and then brought out. The incision is now completed with sawing movements, making thereby a flap in the iris as well as in the cornea. If the opening in the capsule is large enough the lens is expressed with a Daviel spoon, if not, it should be enlarged before expression. The flap of iris is then grasped with the forceps and excised by two converging incisions, which are made with the pince-ciseaux.

SUBLUXATION AND LUXATION OF THE LENS

The diagnosis of luxation of the lens is made when the lens leaves the fossa patellaris of the vitreous, while in subluxation the lens is only tilted and remains in place. Luxation or subluxation may be spontaneous or traumatic; in spontaneous luxation or subluxation the zonule of Zinn is atrophic or imperfectly developed, in those of traumatic origin it is ruptured. Both of these conditions may cause a secondary glaucoma. Surgical interference in all these cases is very difficult and seldom satisfactory. Each case presents its individual features and taxes the surgeon to the utmost to overcome them.

Luxation.—Luxation may be:

1. Subconjunctival luxation when the lens leaves the eyeball completely and appears under the conjunctiva.
2. Luxation into the anterior chamber.
3. Luxation into the vitreous.

Subconjunctival Luxation.—The removal of the lens is not to be attempted until the hemorrhage has been absorbed. A simple incision of the conjunctiva will be sufficient for the purpose. If the scleral wound is found gaping it can be closed with one or two sutures.

Luxation into the Anterior Chamber.—The lens should be extracted. The extraction is usually accompanied with loss of vitreous, however. It is difficult to make the incision, as the lens is usually in the way of the knife. It is better, therefore, to make a small incision and enlarge it with the scissors. The extraction of the lens itself is accomplished either with a Snellen loop, a Daviel spoon helping from outside or with a Reisinger double tenaculum. Before extraction eserine is of use in contracting the pupil, thereby preventing the slipping back of the lens into the vitreous chamber.

Luxation into the Vitreous.—An attempt may be made to bring the lens into the anterior chamber from which it is to be extracted in the manner just described. The patient is turned on his face in the hope that the lens will gravitate into the anterior chamber where it can be held by contracting the pupil with pilocarpine. If the attempt is not successful it is better not to interfere with the eye, as groping in the vitreous for the lens may bring about evacuation of everything from the interior of the eyeball but the lens itself. Where iridocyclitis or glaucoma is produced by its presence, medicinal treatment should first be tried. If it is ineffectual the eyeball must be enucleated.

Subluxation.—Subluxation of the lens is readily recognized from the symptoms which are: Partial iridodonesis, inequality in depth of anterior chamber, irregular shape of pupil, diplopia, and if the pupil is dilated the edge of the lens may be seen. Surgical interference is also difficult and complicated. If secondary glaucoma sets in, medicinal treatment is to be resorted to first; if this is of no avail, then iridectomy, anterior or posterior sclerotomy, or cyclodialysis should be tried. The removal of the lens should be the last resort.

In young individuals a discission with two needles (Bowman) may be tried. It is, however, advisable to make a short incision in the lens capsule and repeat the operation several times, rather than make a large incision. A large incision causes a sudden swelling of the lens which may produce a secondary glaucoma. This condition necessitates a paracentesis of the cornea which is dangerous, as the zonule is defective and it may be complicated by a prolapse of vitreous. In older individuals extraction may be attempted. When the lens is partially subluxated into the anterior chamber the incision should be made opposite the portion of the lens which is in the anterior chamber, so that a spoon or Reisinger double tenaculum can easily be passed behind it. The extraction should be a flap extraction irrespective of the age of the patient.

MYOPIA

The lower degrees of myopia give no trouble if properly corrected. The patient sees well for both distance and near. The higher degrees (15 D. or over), on the contrary, cause considerable disturbance. Although the patient sees well for near, his distant vision is hardly sufficient to enable him to get about safely, especially on steps. If he lives in a large city he is always in danger from passing vehicles. This condition cannot be remedied by glasses. A lens of 12 to 15 D. or over cannot be worn, and even if tolerated, in a myope of 25 to 30 D. it will hardly improve the vision. The reason that strong concave glasses are so troublesome to the patient that he is unable to wear them is that they not only diminish the objects in size but also displace them and have a certain prismatic effect. The displacement of objects together with the prismatic effect causes false projection and in consequence dizziness, headache, nausea, etc. Besides these unpleasant effects the glasses will also cause symptoms of muscular asthenopia by compelling the myope, who has a poorly developed ciliary muscle, to use his accommodation.

Many people on account of this are unable to make their living and others are obliged to leave positions that they have advanced to by years of hard work. To improve this condition of the high myope has been the subject of deep thought for many years. Boerhaave (1708) was the first who suggested that this condition could be improved by the removal of the lens. Weber, in 1858, was the first who actually performed the operation. Although his results were satisfactory no one followed up his work until 1889, when Fukala, in Vienna, and at the same time Vacher, in France, revived the idea.

Effect of Removal of Lens.—The removal of the lens diminishes the refractive power of the eye so that a patient with a high degree of myopia becomes less myopic, emmetropic, or even hyperopic as the case may be. He will be able to see without a glass or with only a weak plus or minus lens for distance, better than he could see before with the strongest glass he could wear. For near he will be able to see well either without a glass or with a weak plus glass. Though it is true that with the operation the patient loses his accommodation, the loss is only theoretical, as on one hand high myopes do not use their accommodation at all and, on the other hand, part of it is replaced by a pseudo-accommodation.

The elongation of the anteroposterior diameter of the eye is of less refractive value in an aphakic eye than in an eye that possesses its lens. In the latter a lengthening of 1 mm. corresponds to 3 D., while in the former to not more than about 1.4 D. This explains the fact that while in an emmetropic eye removal of the lens causes the refractive power to be diminished by 10 D., in myopia the diminution is much larger. To calculate approximately the refraction to be expected after removal of the lens in high myopia, Hirschberg's formula is employed in which

$$\text{R. (refraction)} = 10 - \frac{\text{myopia}}{2}.$$

If the myopia is 20 D., R. $= 10 - \frac{20}{2} = 10 - 10 =$ E., or if the myopia is 24 D., R. $= 10 - \frac{24}{2} = 10 - 12 = -2$ D., or if the myopia is 18 D., R. $= 10 - \frac{18}{2} = 10 - 9 = 1$ D. That is, in the first example there is emmetropia; in the second, a myopia of 2 D.; and in the third, a hypermetropia of 1 D.

If the case is properly selected the result of the operation is highly satisfactory and gives great comfort to the patient. For instance, if the patient was formerly obliged to use a very strong glass, after the operation no glass at all, or at most a very weak one, will be required. He will not only be relieved from the very distressing effects of the strong concave glass but his visual acuity will also be sometimes greatly increased and will be better than could be obtained with the best correcting glass. This may be explained by the fact that the strong concave glasses diminish the size of the objects to such an extent that the visual acuity found with them does not correspond to the true power of the retina. For near work, if there remains a small degree of myopia, the patient will need no glass at all, while if the refraction is turned to emmetropia or hypermetropia he will need a weak plus lens.

The operation should be performed only in high degrees of myopia (18 D. or over). If the operation is performed in a lower degree of myopia than this more harm than good is done, because the patient changes his concave for a convex glass of about the same power, at the same time losing his good sight for near without glasses. If he wishes to see a near object after the operation he must put on a still stronger convex glass.

The fundus of the eye should be in good condition. If there are retinal hemorrhages, detachment of retina, or pronounced changes in the macula the operation is not to be performed. Less grave changes constitute no contraindication.

The operation has no influence in checking the progress of the myopia or arresting the myopic changes in the fundus. Certain authors (Schmidt-Rimpler) claim that the operation is likely to favor changes in the fundus and leads to detachment of the retina. This has never been definitely established, but it is well to take it into consideration before operating. It is also well to remember that even in this aseptic era an infection occasionally occurs, in which the patient loses an eye with which he was previously able to see. For this reason Czermak advises operating only in case of necessity and in patients that have been enlightened as to the dangers that may follow. Patients that have only one eye should never be operated on for high myopia. A patient's second eye should not be operated on before the first is totally out of danger, and at least two years should elapse between the two operations.

Whether to operate on both eyes or only one depends greatly upon the patient. Many are satisfied with one eye, using the operated eye for distant vision and the other for near. Others have trouble from the resulting high anisometropia, which causes great discomfort from the difference in the size of the two retinal images.

Indications and Contraindications.—Indications and contraindications are, according to Czermak, as follows:

Indications.—1. The patient should be helpless either because he cannot wear his strong glasses or because the myopia is so high that it cannot be satisfactorily corrected.

2. Myopia of at least 18 D.

Contraindications.—1. Myopia of less than 18 D.

2. Anisometropia.

3. Vision less than 0.1 ($\frac{1}{10}$)

4. Fresh changes in the fundus.

5. If the patient has only one eye.

FOREIGN BODY IN THE LENS

This will be considered in the chapter on Removal of Foreign Bodies from the Eye, p. 469.

DISCISSION OF LENS CAPSULE

Discission is done for the purpose of incising the anterior lens capsule. By incising the anterior lens capsule the aqueous is allowed to come in contact with the lens substance, which consequently becomes opaque, swollen, disintegrated, and finally absorbed. The absorption takes place through the canal of Schlemm and the anterior ciliary veins.

Definition.—The anterior chamber is entered with a knife-needle which is pushed into the pupillary area, and by proper manipulations the anterior capsule is incised.

Indications.—1. Cataracts in lenses which have no nucleus *i. e.*, in adults under twenty-five years (soft cataracts).

2. All kinds of cataracts in children and infants.

3. High degree of myopia under twenty-five years of age.

Contraindications.—1. Cataract with thickened capsule, as it cannot be easily incised.

2. Subluxation or luxation of the lens, because the lens moves with the needle and the capsule cannot be opened.

3. Patients over twenty-five years, because a nucleus is present which cannot be absorbed.

4. Posterior synechia, because the pupil cannot be dilated and the swelling of the lens produces traction on the iris, thus causing a recurrence of the iritis.

5. Calcareous degeneration of the capsule or lens, because the lime salts cannot be absorbed.

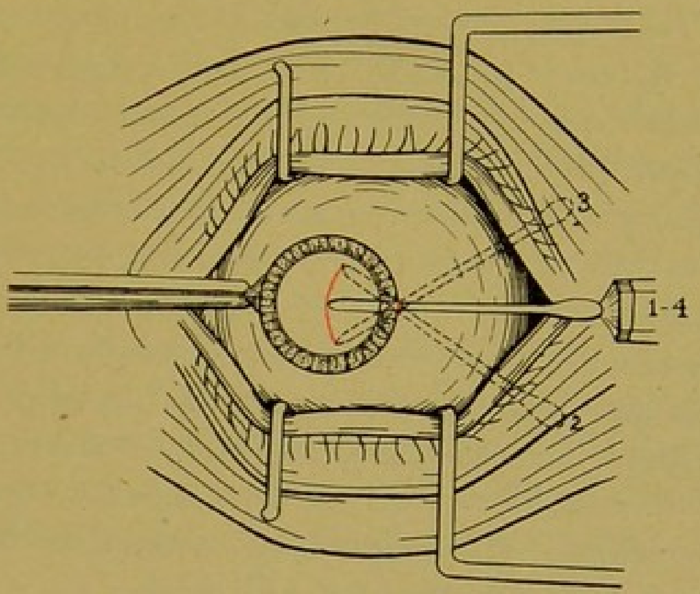
Preparation.—Besides the general preparation for an eyeball operation the pupil must be at maximum dilatation by atropine. In children a general anesthetic is employed, in adults local anesthesia with cocaine is sufficient.

Instruments.—Lid speculum, fixation forceps, Knapp's knife-needle.

Operation.—The operation consists of three steps: (1) The entrance of the needle; (2) the laceration of the capsule and lens; (3) the removal of the knife-needle.

I. Step: Entrance of the Needle.—After the lid speculum is inserted in the proper manner the eye is fixed with the fixation forceps opposite the point of entrance of the needle, that is, at the nasal end of the horizontal meridian of the cornea.

Fig. 233



Discission of the lens capsule

The operator takes the knife-needle in the hand which corresponds to the temporal side of the eye that is to be operated on, *i. e.*, when standing behind the patient the left hand for the left eye and the right hand for the right eye, and *vice versa* standing in front of the patient. The fixation forceps is held in the other hand and the knife is entered with the cutting edge downward, in the limbus at the temporal end of the horizontal meridian.

Some operators make the knife enter through the cornea proper. In this case the point of entrance should be in the lower outer quadrant opposite the edge of the dilated pupil. (The eye is then fixed above and inside.) The knife-needle is held perpendicularly to the cornea until lack of resistance indicates that it has entered the anterior chamber. The handle is then lowered toward the horizontal plane, so that the blade will be parallel to the plane of the iris in order to avoid injuring it, and is pushed forward to the centre of the pupil.

It is always better to make the puncture in the limbus, as wounds close and heal more rapidly in this position. There is less danger of escape of the aqueous and other complications, such as adherence of the iris or lens capsule, and infection.

II. Step: Laceration of the Capsule and Lens.—When the centre of the pupil is reached the blade of the instrument is raised by depressing the handle until the point is within 1 mm. of the upper margin of the pupil. By bringing the handle forward the point sinks below the plane of the iris and comes in contact with the capsule, which is pierced. The handle is now raised and the blade thus makes a curved incision in the capsule from above downward to within 1 mm. of the margin of the pupil. If an extensive opening in the capsule is desired the needle is brought to the midpoint of the pupil and then pushed across to within 1 mm. of the nasal margin. By raising the handle of the needle and at the same time slightly withdrawing it a cross-incision is made. This second incision is seldom necessary as the first is usually sufficient. While making the second incision there is always danger that the aqueous will escape.

III. Step: Removal of the Knife-needle.—After the completion of the incision the blade of the knife is again brought back to the horizontal plane, returned to the position in which it was entered, and withdrawn by a quick movement.

Complications during Operation.—1. If the knife-needle enters too obliquely the wound canal is too long, thereby restricting the free movements of the knife.

2. The aqueous may escape during puncture if the introduction of the needle is not smooth. This complication necessitates the postponement of the operation.

3. The iris may be injured immediately after the knife's entrance in the chamber. It usually occurs while pushing the needle toward the pupil if the blade is not held parallel to the iris; also by making the incisions in the capsule too long. This accident causes pain, the patient becomes restless, hemorrhage follows, which obstructs the field of operation, and if the operator is not

careful he may even tear the iris from its root, producing an iridodialysis. As a late sequela traumatic iritis may ensue.

4. If the incision in the lens is too deep there is danger of injuring the posterior capsule and the hyaloid membrane. The unfortunate consequences of this complication will be seen later when it is necessary to do a paracentesis of the cornea, as there will be a prolapse of the vitreous.

5. If the capsule is too resistant or the lens substance too hard the lens will follow the movements of the needle and the capsule will not be incised; in addition, the zonule may rupture and the lens be dislocated.

After-treatment.—After the operation a light monocular bandage is put on and the patient remains in bed for twenty-four hours. On the following day he may get up and walk around. Small children should have their hands tied at their sides so that they cannot disturb the bandage. The bandage may be removed on the fourth day. The after-treatment usually lasts eight to ten weeks, this period being required for complete absorption of the lens substance. All this time the patient should be under medical supervision and the pupil kept at maximum dilatation by the use of atropine or scopolamine, the tension being carefully watched.

The patient may leave the hospital when the greater part of the lens is absorbed, and the danger of secondary glaucoma has passed. This condition is recognized by a deep anterior chamber, a partially black pupil, and by the beginning of the improvement of vision.

Postoperative Complications.—Sometimes the incision in the capsule is not successful as the wound closes, thus absorption of the lens does not take place. This is shown by the absence of swelling of the lens by the third or fourth day. In such cases the operation is to be repeated, but only after the eye is completely free from irritation.

The most frequent of postoperative complications is secondary glaucoma. After the third or fourth day the lens becomes swollen, opaque, and the anterior chamber is filled with disintegrated lens substance. If the swelling of the lens is too rapid and absorption too slow, an increase of tension will follow. The first symptoms of secondary glaucoma are pain, irritation, and haziness of the cornea, which make their appearance before the increase of tension can be detected by palpation. If the glaucoma does not respond within a few hours to ice compresses and rest in bed, a paracentesis of the cornea must be made. Eserine or pilocarpine should not be given, as they will not reduce the tension, but by contracting the pupil will interfere with the paracentesis when it is done; first by increasing the danger of prolapse of the iris; second by making the removal of the lens substance more difficult. During this second operation it is not necessary to insist upon the removal of the whole lens, as too great a pressure may cause a prolapse of the vitreous. It is sufficient if $\frac{1}{2}$ to $\frac{2}{3}$ of the lens substance is expressed as the remaining portion is readily absorbed and will not cause a second attack of glaucoma.

Wound infection as well as iridocyclitis or panophthalmitis may occur but are extremely rare.

EXTRACTION

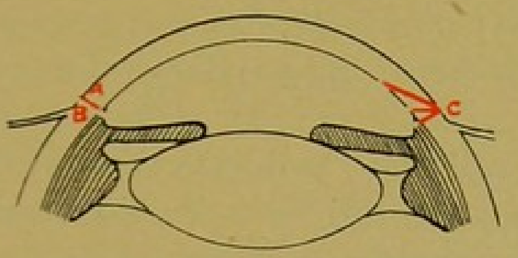
Extraction consists in removal of the lens. It is divided according to the instrument that is used in making incision, into linear extraction, when the incision is made with the keratome and flap extraction, when the Graefe knife is used. A further distinction is made between simple extraction, when no iridectomy is performed, and combined extraction, when an iridectomy is done.

Linear Wound.—Keratome wounds are those that are usually called linear, although they are not in the strict sense of the word, as they always lie obliquely in the cornea or sclera. A true linear incision if continued would divide the globe into two equal parts, while a keratome wound would cut off a segment. As the keratome wound lies obliquely in the tissues a wound canal is formed whose length depends upon the obliquity of the incision. The wound canal has an outer and inner opening, the outer being longer owing to the triangular shape of the keratome. It also has two lips, an anterior and posterior, which overlap.

The linear wound is short and does not gape readily and therefore only allows small masses to pass through. Owing to the overlapping the aqueous presses the lips together, securing a firm and rapid closure. Increased intra-ocular pressure only makes the closure more firm, therefore rupture of linear wounds is rare and only occurs after severe trauma.

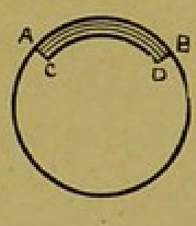
Lobular Wound.—By a lobular wound is meant an incision that has been made with a knife. In reality it does not differ from a keratome wound except in length, this, of course, increasing the size of the flap. As the wound is large it gapes readily so that large masses will pass through it easily, but it does not close so readily and firmly as the linear wound and is more apt to rupture.

Fig. 234



Linear wound (cross-section). *A*, anterior lip of wound; *B*, posterior lip of wound; *C*, wounds of various lengths.

Fig. 235



Linear wound showing wound canal. *A B*, outer opening; *C D*, inner opening; *A B C D*, wound canals.

Combined and Simple Extraction.—Whether the combined or simple extraction is the better procedure has been the subject of discussion before the medical profession for many years, and even at this date the question has not been settled. Some surgeons perform the combined only, others are eclectic, doing the simple extraction in cases where they expect no complications and using the combined for others.

There are a great many points that have been advanced pro and con, the simple as well as the combined extraction. Among the more important advantages of the simple extraction are: The cosmetic effect of the round pupil, the elimination of the postoperative dazzling, less danger of incarceration of iris and capsule in the wound, and the fact that postoperative sympathetic ophthalmia is less frequent. The more important disadvantages of the simple extraction are: The larger wound that is necessary and, therefore, its more frequent postoperative rupture attended with prolapse of the iris; the fact that the expression of the lens and cortex is more difficult and consequently there is a greater frequency of secondary cataracts and the necessity of secondary operations.

The advantages of the combined extraction as opposed to the simple are: The smaller incision that is necessary to remove the lens and the consequent slighter danger of postoperative rupture of the wound; the easier removal of the lens and cortex and infrequency of secondary cataract; the elimination of postoperative prolapse of the iris; the greater safety as to infection. The disadvantages on the other hand are: The disfigurement and the possible dazzling from the coloboma; the pain caused by the excision of the iris; the frequency of incarceration of the pillars of the coloboma and capsule; the more frequent occurrence of postoperative glaucoma, iritis, iridocyclitis, and sympathetic ophthalmia.

It would take too much time and space to discuss the subject at length, as there is a great deal to be said for and against each point mentioned. Taking into consideration the advantages and disadvantages of both operations, especially the fact that postoperative glaucoma and sympathetic ophthalmia are more frequent following the combined extraction, there is no doubt that the simple extraction will appear in a better light. However, it cannot be denied that the combined extraction is the easier operation and that the chances of a postoperative glaucoma and sympathetic ophthalmia can, by careful technique, be reduced to a minimum. On the other hand the dreaded postoperative prolapse of the iris so frequent after a simple extraction, which may be the source of a postoperative infection and necessitate a difficult second operation under a general anesthetic, is eliminated. *For this reason it seems advisable to perform the combined extraction as a routine operation, leaving the simple extraction for exceptional cases.*

Combined Linear Extraction.—Definition.—An incision is made in the upper limbus with an angular keratome, an iridectomy is performed, and after the capsule has been opened the lens substance is expressed.

Indications.—1. Soft and fluid cataracts in patients under thirty-five years of age.

2. Traumatic cataracts either after injury or discission in patients under thirty-five years.

3. High myopia.

Contraindications.—1. A luxated or subluxated lens is a contraindication, as it cannot be delivered by pressure owing to the defective zonule. Under this circumstance there is sure to be a prolapse of vitreous which will necessitate the delivery of the lens with aid of the spoon. As the handling of the spoon is rendered difficult because of the small wound, either of these conditions are to be considered an absolute contraindication for linear extraction. Flap extraction is the operation to be resorted to.

2. Fluid vitreous is also an absolute contraindication, as too great a pressure is required in delivering the lens and in consequence there is danger of excessive loss of vitreous. As the lens must be delivered with a spoon, the handling of which is difficult because of the size of the wound, a flap extraction is to be performed.

Preparation.—The patient is prepared for operation in the same manner as in any eyeball operation. Cocaine is used, except in children or restless adults, when it is better to employ a general anesthetic.

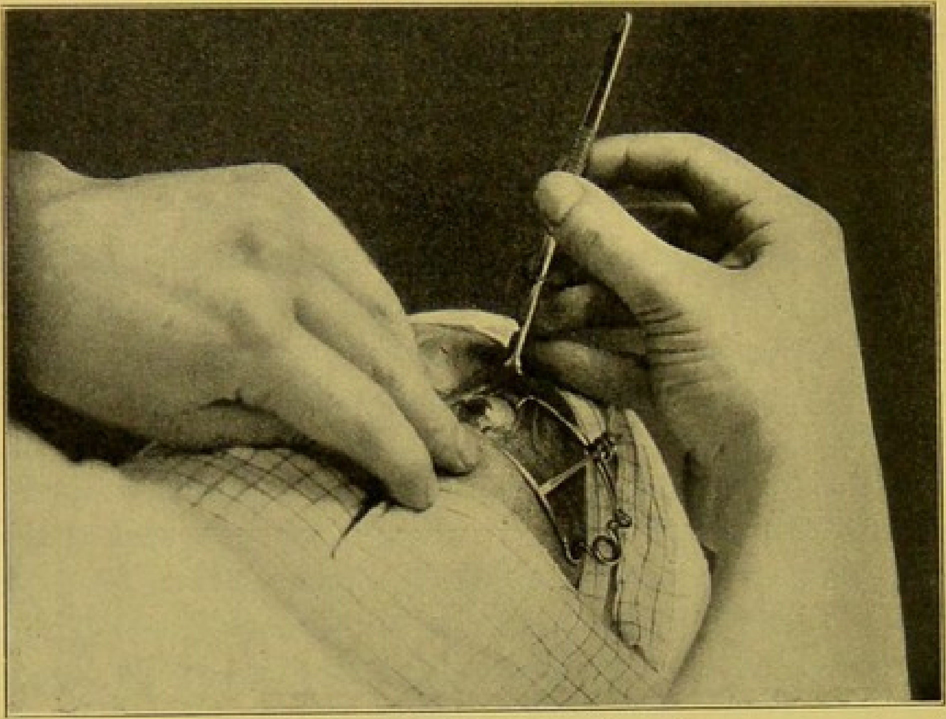
Instruments.—Speculum, fixation forceps, angular keratome, capsule forceps, cystotome, iris hook, 3 or 4 Daviel spoons, iris forceps, iris spatula, iris scissors, Snellen's loop.

Operation.—The operation consists of 5 steps: incision, iridectomy, capsulotomy, expression, and toilet.

After inserting the speculum the eyeball is fixed near the limbus at the lower extremity of the vertical meridian of the cornea. The fixation forceps are held with the left hand and the keratome with the right, the little finger resting on the forehead.

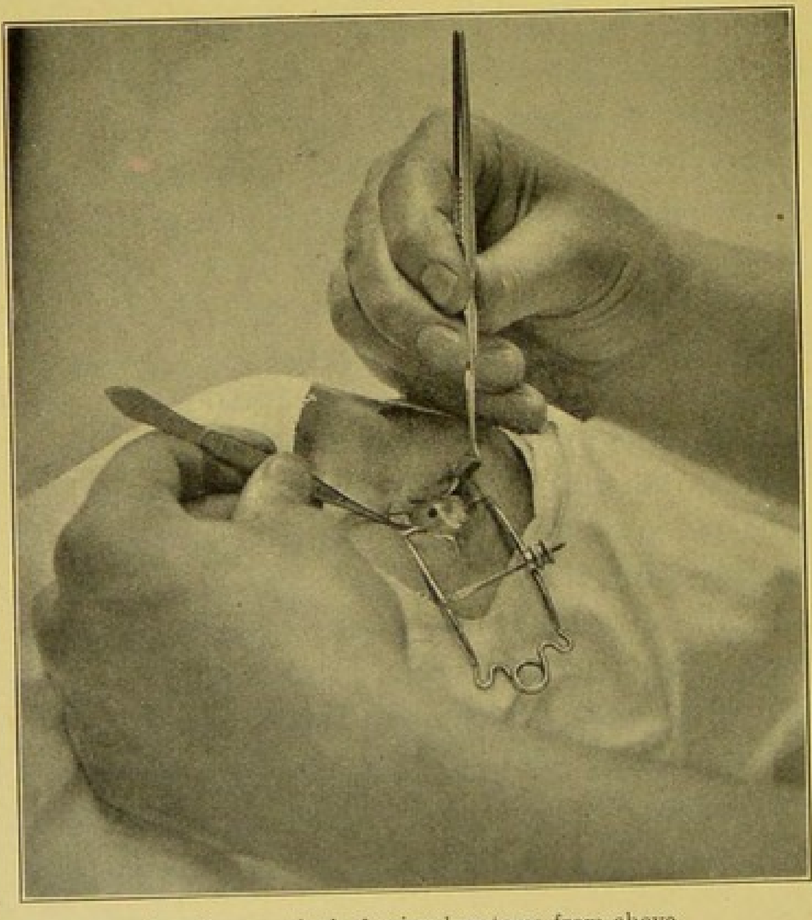
I. Step; Incision.—The incision is made exactly in the limbus at the upper extremity of the vertical meridian of the cornea. The blade is held rather perpendicularly until it has entered the anterior chamber, then the handle is depressed so that the blade is parallel to the plane of the iris. It is now slowly pushed forward until the incision is about 8 to 10 mm. long. The handle is further depressed so that the point of the blade comes in contact with the posterior surface of the cornea. The keratome is held in this

FIG. 236



European method of using keratome from above.

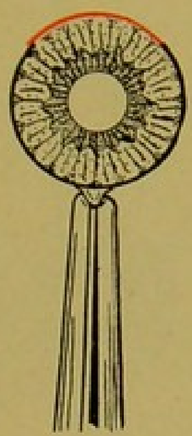
FIG. 237



American method of using keratome from above.

position, and is slowly withdrawn. In this manner the ecsape of aqueous can, to a certain extent, be controlled, thus preventing a prolapse of the iris.

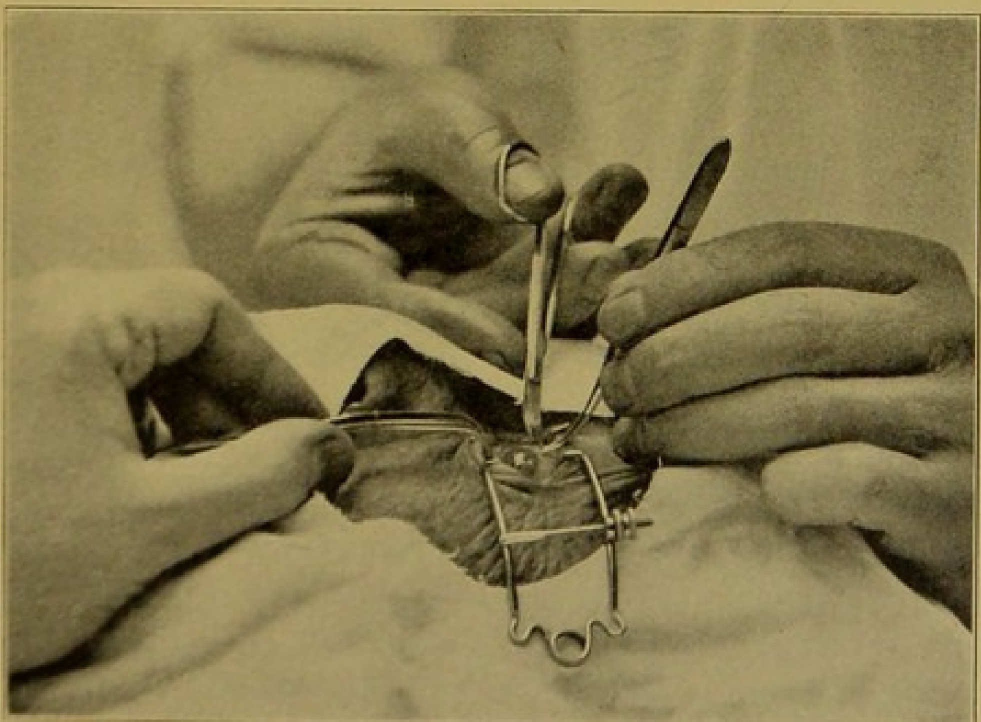
Fig. 238



Combined linear extraction, site and size of incision.

II. Step: Iridectomy.—Iridectomy is performed in a similar manner to the optical (small) iridectomy (see p. 158). The iris forceps are introduced closed, the iris is grasped near the pupillary margin and withdrawn. The piece of iris is now excised with one

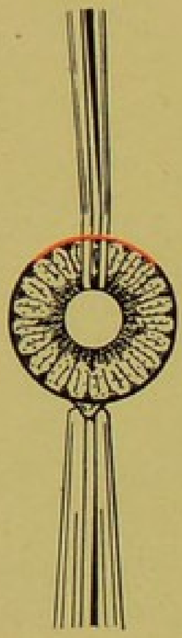
Fig. 239



Excision of the iris.

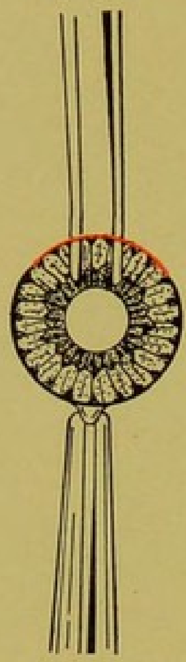
sweep of the scissors. The pillars are then replaced with an iris spatula before the third step is undertaken. When posterior

Fig. 240



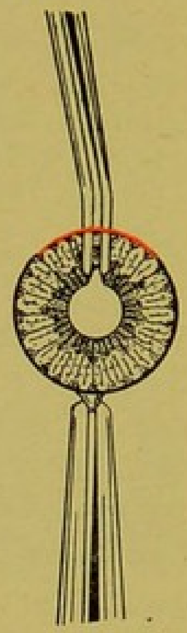
Small iridectomy, introduction of iris forceps.

Fig. 241



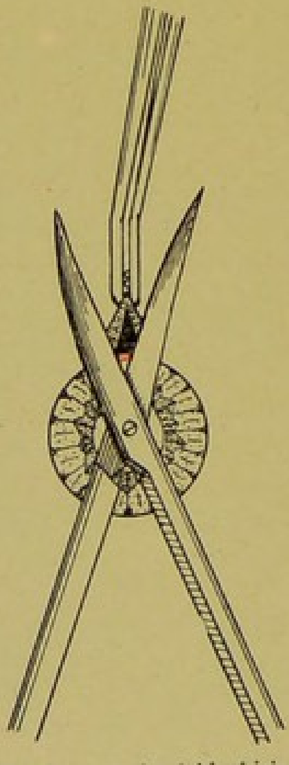
Small iridectomy, opening of forceps.

Fig. 242



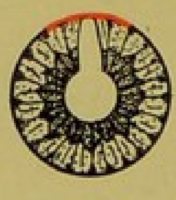
Small iridectomy, grasping a fold of iris.

Fig. 243



Excision of the fold of iris.

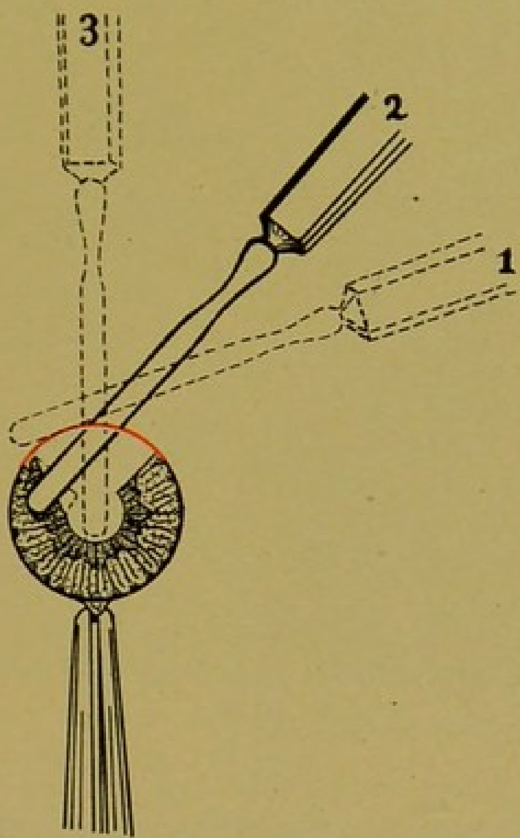
Fig. 244



Result of small iridectomy.

synechia are present they should be broken down with the spatula by passing it between the iris and the lens. If many synechia are present it is necessary to make a complete circuit of the pupillary margin.

Fig. 245

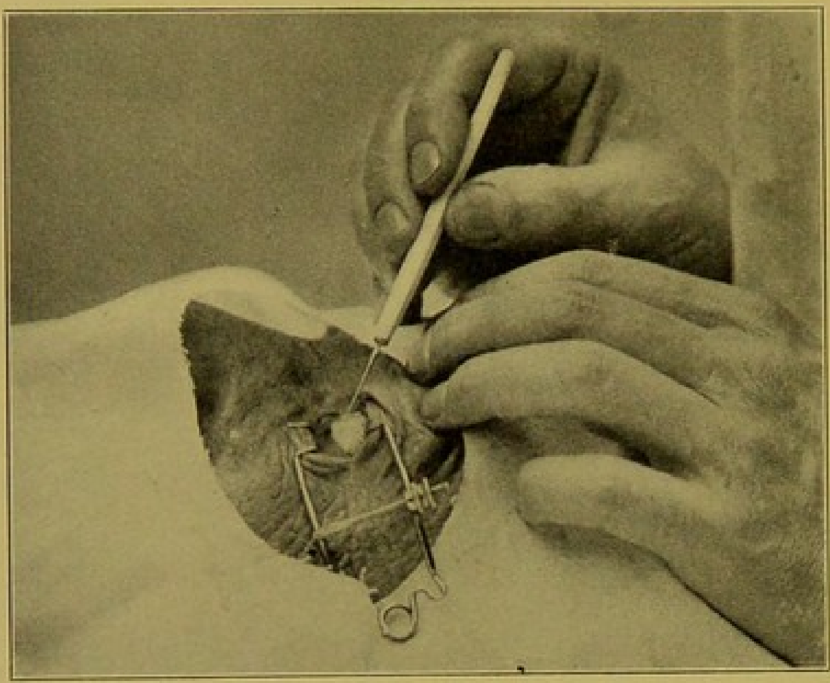


Combined linear extraction, reposition of pillars of coloboma.

III. Step: Capsulotomy.—This may be accomplished either with a cystotome or capsule forceps.

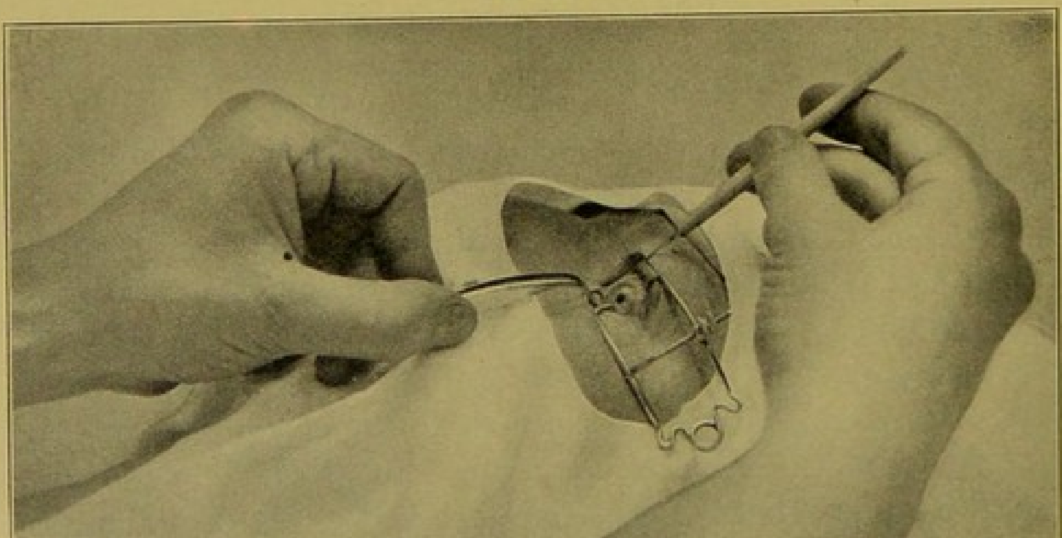
Cystotome.—The cystotome is introduced flat with the convexity downward and pushed to the lower edge of the pupil. The instrument is now rotated so that the cutting point is against the capsule. The first incision is near the lower margin of the pupil and horizontal, passing from one side to the other. The second extends upward vertically to the upper margin of the pupil, the third is horizontal and parallel to the first. The cystotome is again rotated and withdrawn with convexity upward. Knapp makes a single peripheric incision in the capsule above. The cystotome is introduced with the convexity downward from the temporal end of the wound. The cystotome is now rotated so that its cutting edge is turned toward the lens and an incision is made in the upper part of the capsule parallel with the corneal section about 6 or 7 mm. in extent.

Fig. 246



American method of using cystotome.

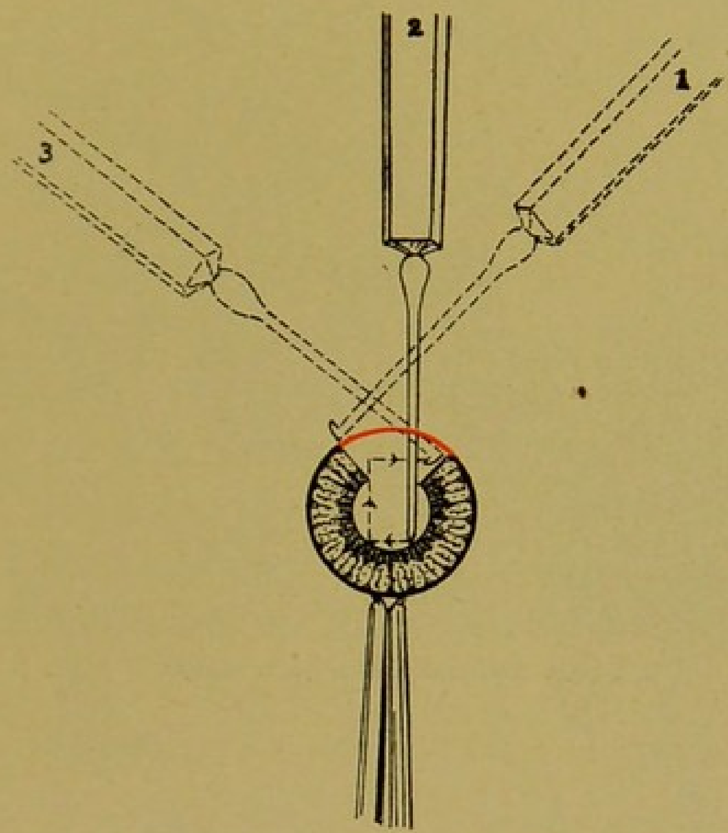
Fig. 247



European method of using cystotome.

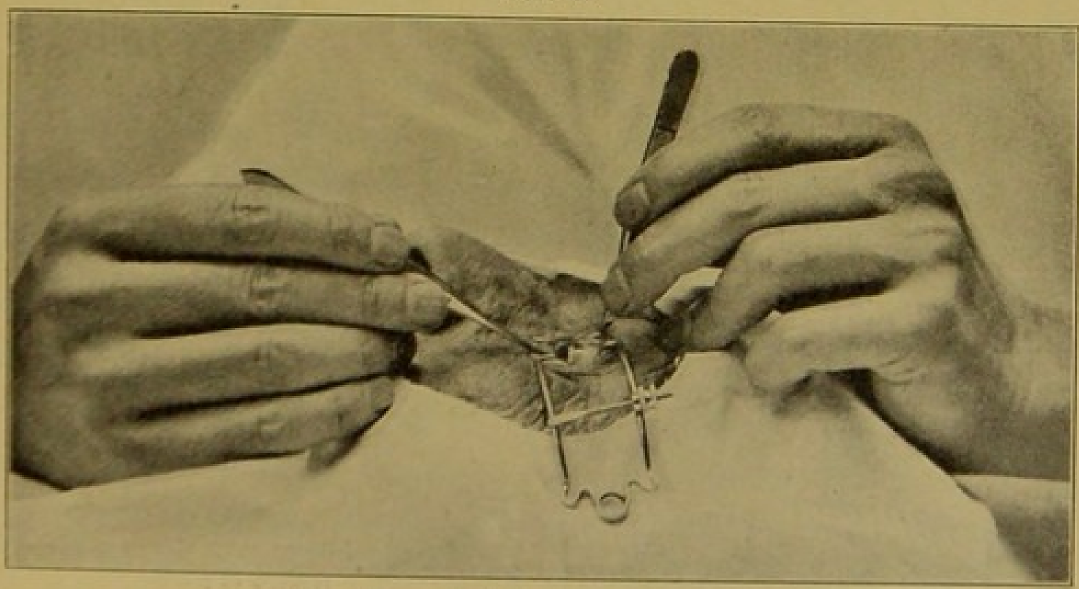
Capsule Forceps.—The capsule forceps, with blades closed, are placed perpendicularly on the posterior lip of the wound, which is gently depressed to produce a slight gaping, as then the forceps slip easily into the anterior chamber. They are pushed down to the lower margin of the pupil, taking care to avoid the iris.

Fig. 248



Use of cystotome. Combined linear extraction.

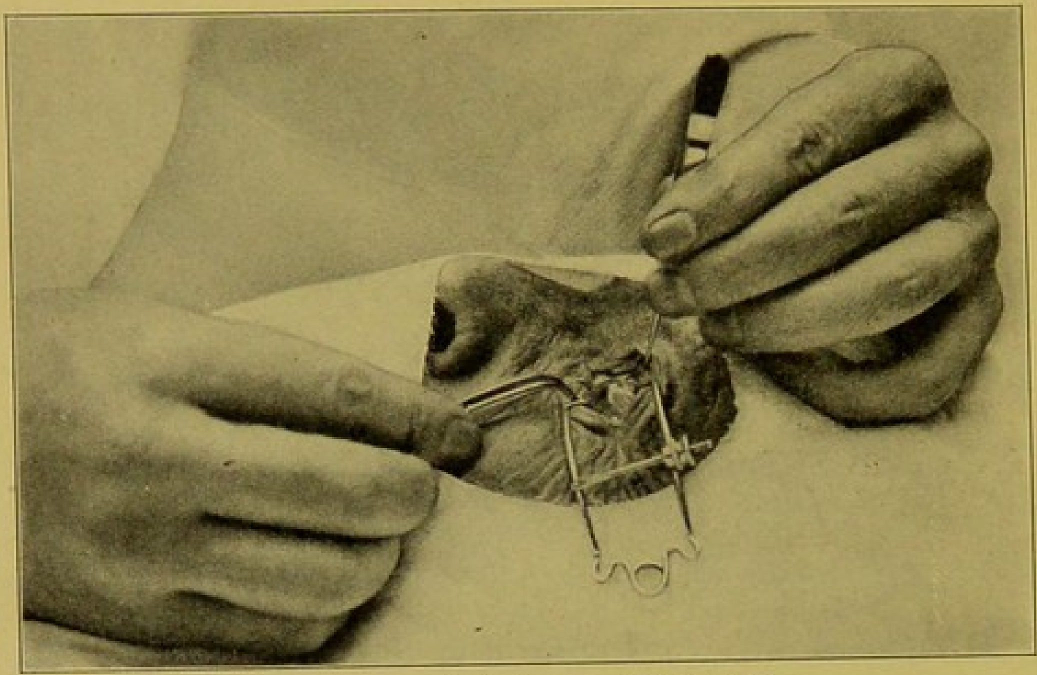
Fig. 249



American method of using capsule forceps.

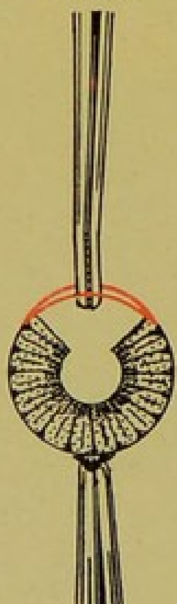
The handle is slightly raised so that the blades come in contact with the capsule. They are now gently opened and with a slight

Fig. 250



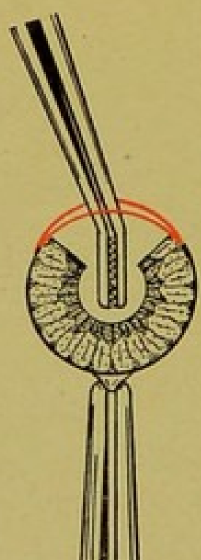
European method of using capsule forceps.

Fig. 251



Combined linear extraction; capsule forceps about to enter the anterior chamber.

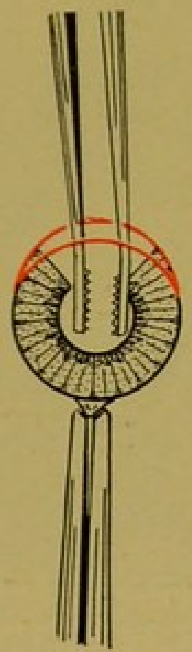
Fig. 252



Combined linear extraction; capsule forceps in place.

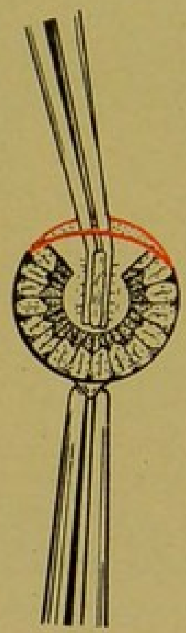
pressure a fold of the capsule is grasped. The forceps still closed are slowly pushed downward for a short distance in order to rupture the capsule above and then withdrawn with a to-and-fro motion. Sometimes with a thickened capsule there is no rupture, and as the zonule gives away the lens is delivered while still in the capsule.

Fig. 253



Combined linear extraction; opening of capsule forceps preparatory to grasping capsule.

Fig. 254



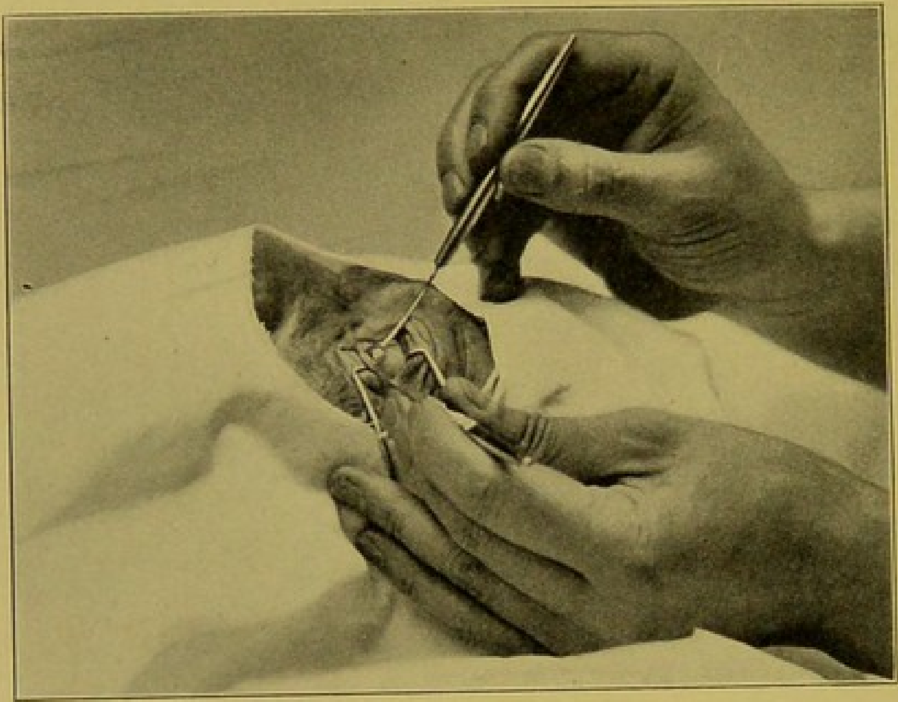
Combined linear extraction; grasping the capsule.

IV. Step: Expression of the Lens.—A Daviel spoon is taken in each hand, one being placed on the posterior lip of the wound at right angles to it so that it slightly enters the anterior chamber. The posterior lip is now pressed backward while the other spoon is placed on the lower part of the cornea horizontally, and the lens masses are removed by a gentle pressure toward the centre of the eyeball. Continuous pressure is of less value than alternating the pressure on the two spoons. After a greater portion of the lens has been removed the spoon is taken away from the margin and the masses that are present are cleared away. It is often of advantage to rest a few moments and wait until the anterior chamber has partially reformed, as the fresh aqueous loosens the remaining cortex, and when it escapes it carries out some of the lens masses.

16

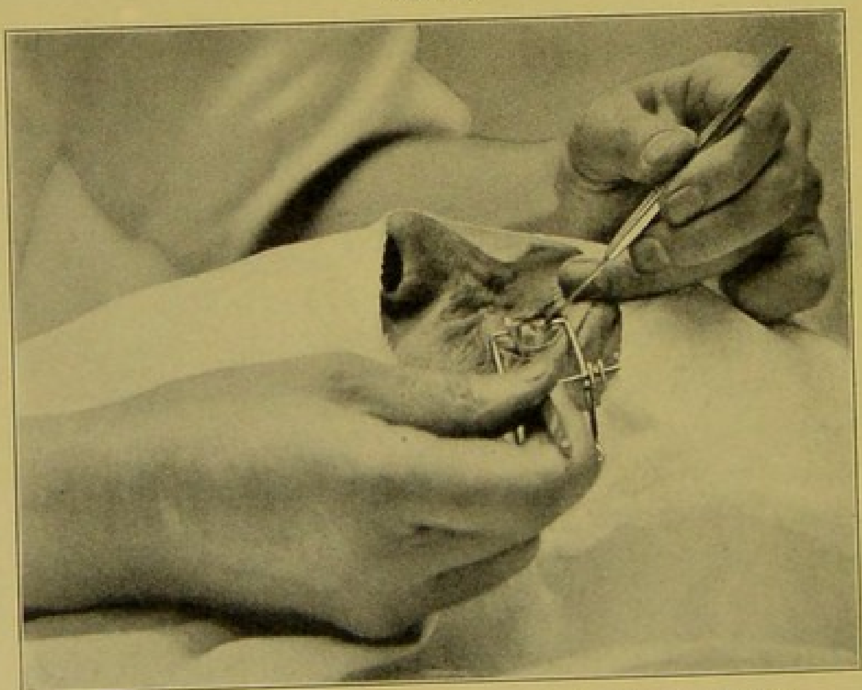
Taking clean spoons the maneuver just described is repeated, but with the difference that instead of pressing with the spoon toward the centre of the globe it is gently massaged from below

Fig. 255



American method of using two Daviel spoons in delivering the lens.

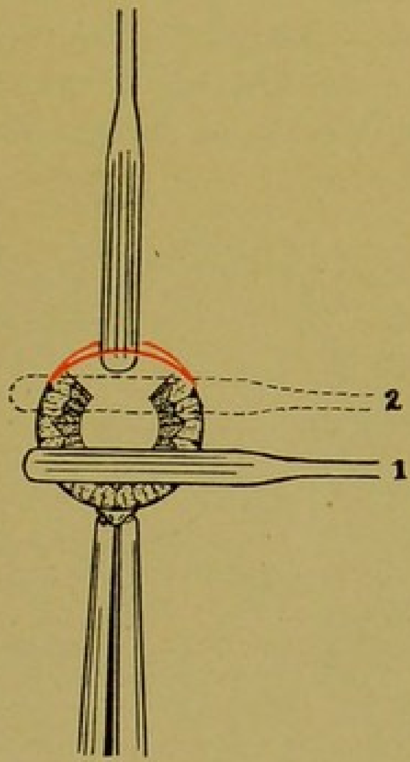
Fig. 256



European method of using two Daviel spoons in delivering the lens.

upward, care being exercised not to slip into the anterior chamber, which may easily occur if the spoon does not reach across the cornea. It is not necessary to remove all of the lens as the

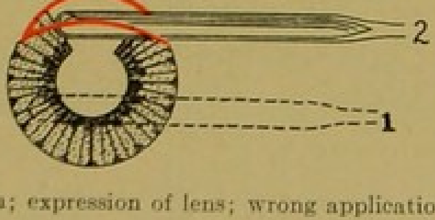
Fig. 257



Combined linear extraction, expression of the lens.

remaining masses are usually absorbed, leaving a clear black pupil. In cases, however, where there is a nucleus present it should be removed without fail, as it will not be absorbed.

Fig. 258

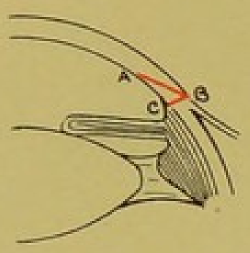


Combined linear extraction; expression of lens; wrong application of Daviel's spoon.

V. Step: Toilet.—After expression of the lens a careful examination is made to see whether the pillars of the coloboma are free and whether any shreds of capsule are wedged in the wound. If the iris is caught it is replaced with a spatula; if shreds of capsule are present they are removed with the forceps. The wound is now smoothed over, blood clots are removed, and a bandage is applied.

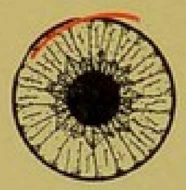
Complications during Operation.—*The incision may be either too short or oblique.*—The wound will be too short if there is an early escape of aqueous because the knife cannot be advanced further through fear of injuring the iris. The wound under these circumstances may be lengthened by pressing the keratome against one edge of the wound during withdrawal, or by enlarging it with the scissors.

Fig. 259



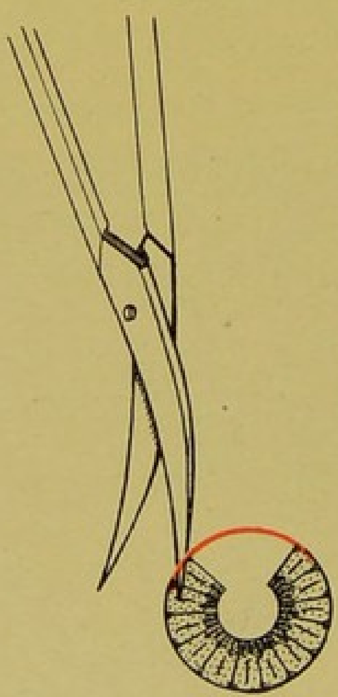
Intralamellar incision (*A B*) and correct incision (*B C*) with keratome.

Fig. 260



Oblique wound with keratome.

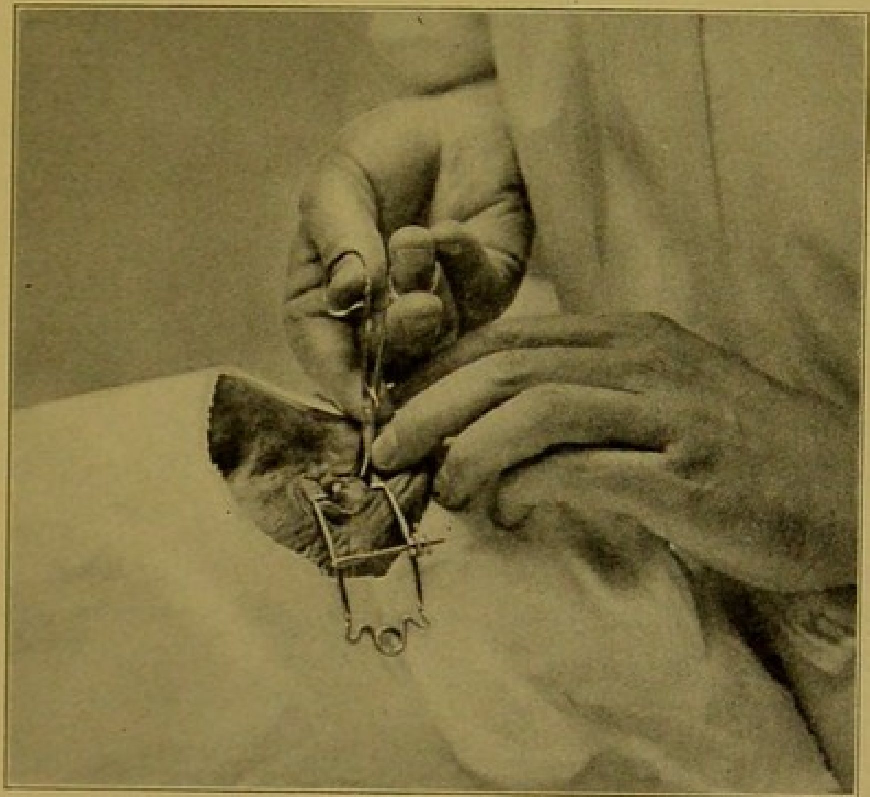
Fig. 261



Combined linear extraction; enlarging keratome incision with scissors.

The incision is oblique if one edge of the keratome is in the sclera and the other in the cornea; it is also oblique if an intralamellar incision has been made. The first complication causes a high degree of postoperative astigmatism and there is also a greater danger of adherence of the iris to the wound. The second will interfere with the iridectomy and expression of the lens; the inner opening of the wound canal being so small that all of the subsequent steps of the operation are greatly interfered with or impossible. In exaggerated intralamellar incision the anterior chamber may not be opened at all. If the inner opening is very

Fig. 262



Enlarging wound with scissors.

small or the chamber has not been opened it is better to postpone the operation for a few days, otherwise the incision is to be enlarged with scissors.

Injury to the Iris.—During the incision the iris may be injured with the keratome. This complication is of no great significance, as the part that is usually injured is removed by the iridectomy. However, this causes considerable pain to the patient, and he is apt to become restless; furthermore, hemorrhage may occur which may greatly interfere with the succeeding steps of the operation.

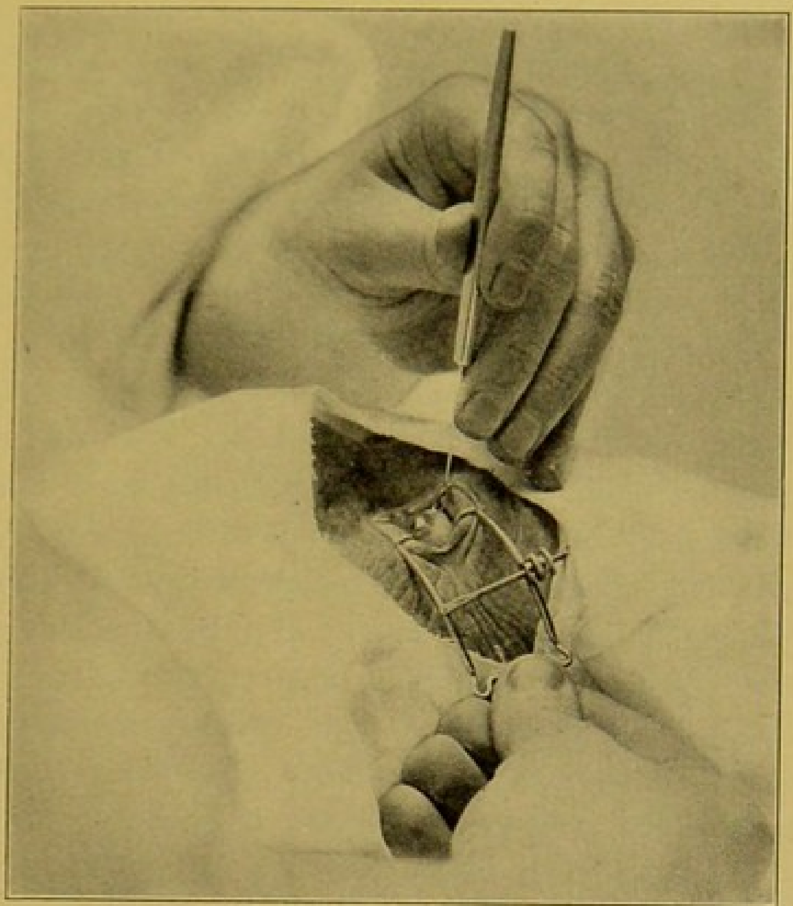
Atrophy and Friability of the Iris.—The iris may be atrophic and friable so that it is impossible to bring it into the wound without tearing it. In such cases a regular iridectomy cannot be performed and the attempt is made to form a coloboma by tearing out small pieces of iris until a large enough opening is made to facilitate the other steps of the operation.

Insufficient Opening of the Capsule.—If the lens masses do not present in the wound after gentle pressure, it usually means that the opening in the capsule is not sufficiently large. If this occurs it is better to stop and do a second capsulotomy, as an increase in pressure may cause a prolapse of the vitreous.

Sclerosis of Lens.—Sometimes the lens is found sclerosed even in young patients. As it is impossible to deliver this lens through a small incision as the linear, the incision must be lengthened with the scissors.

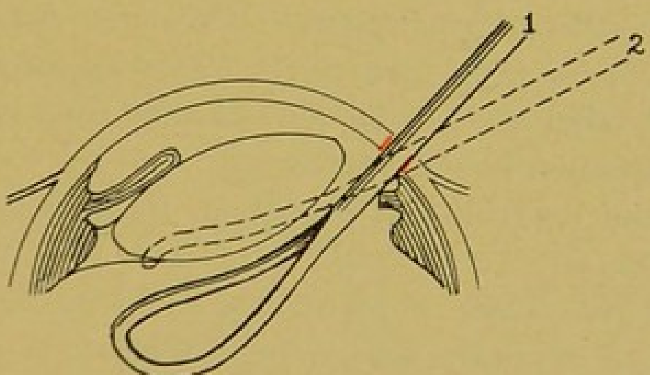
Prolapse of Vitreous.—This may occur at any stage of operation. If the eye is normal and a prolapse occurs it is safe to assume that it is the fault of the surgeon. In other cases, as for instance in traumatic cataract, there may have been a rupture of the posterior capsule or zonule. The first symptom of this complication is either a sudden deepening of the anterior chamber or the appearance of a transparent bubble of vitreous in the wound. As soon as the vitreous prolapse is noted all pressure is removed from the eyeball immediately by taking out the speculum or by having the assistant raise it up. If further interference is deemed advisable the lids are to be retracted by an assistant's fingers. If an iridectomy has not yet been performed the attempt at least should be made to perform one, although under these circumstances it is very difficult. In cases in which there is a nucleus or where prolapse appears before capsulotomy a Snellen loop must be passed behind the lens and pressed up against the posterior surface of the cornea, counterpressure being made on the outer surface of the cornea with a Daviel spoon (Figs. 263, 264, 265). In this manner withdrawal of the lens from the anterior chamber is made possible. When there is no nucleus present and a capsulotomy has been performed, after the prolapse, the instruments are withdrawn and the eye is bandaged without making an

Fig. 263



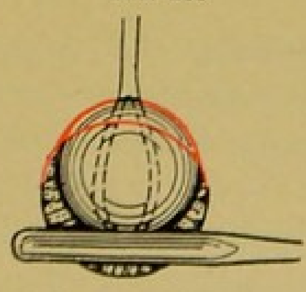
Combined linear extraction. Method of using Snellen's loop; assistant raising speculum.

Fig. 264



Combined linear extraction; use of Snellen's loop in prolapse of vitreous.

Fig. 265



Combined linear extraction; extraction of lens with Snellen's loop.

attempt to free the pillars of the coloboma. The remaining lens masses will be absorbed, although very slowly.

After-treatment.—Both eyes are bandaged and the patient is put to bed for twenty-four hours. The next day the eye is cleansed and inspected. A drop of atropine is then instilled and the operated eye alone is bandaged. At the same time the patient may be allowed to sit up in an arm chair. The eye is cleansed daily and a drop of atropine is instilled. After the fourth day he is allowed to wear a Fuchs wire mask or a Snellen aluminum shell. By the middle of the second week the mask is discarded and at the end of this week he may leave the hospital.

Postoperative Complications.—Postoperative complications are usually due to infection, which is very rare after this operation in this day of aseptic surgery. If, however, it does occur it is usually of a mild type and responds to treatment as outlined on p. 59. Rupture of wound, after a linear extraction, is very rare, as increased intra-ocular pressure closes the wound more firmly. Prolapse of iris does not occur after this operation.

Simple Linear Extraction.—**Definition.**—An incision is made with an angular keratome in the cornea, the capsule is opened and the lens expressed.

Indications and Contraindications.—The simple linear extraction is indicated in the same cases as the combined linear extraction, but it is contraindicated under the following conditions:

1. Numerous posterior synechia.
2. Large nucleus, which is sometimes found in patients under thirty-five years.
3. Rigid pupil, which is sometimes found in congenital cataracts, the pupil remaining small even after the repeated instillation of atropine, although there are no posterior synechia present.
4. Luxated or subluxated lens.
5. Fluid vitreous.

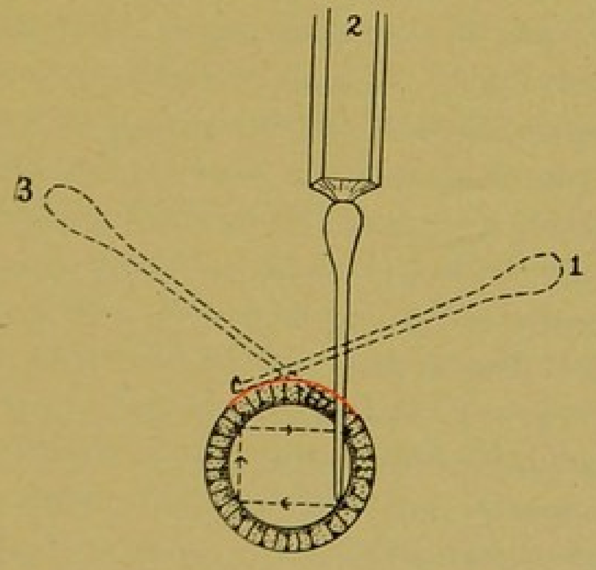
Preparation and Instruments.—The preparation and instruments are the same as in the combined linear extraction, with the exception that the pupil is to be dilated with a few drops of atropine before operation.

Operation.—The operation consists of four steps: Incision, capsulotomy, expression, and toilet.

After inserting the speculum the eyeball is fixed near the limbus at the lower extremity of the vertical meridian of the cornea. The patient is directed to look downward while the surgeon holds the fixation forceps in his left hand. The keratome is held in the right hand, with the little finger resting on the patient's forehead.

I. Step: Incision.—The incision is made in the corneal tissue about 1 mm. from the limbus at the upper extremity of the vertical meridian of the cornea and should be about 8 to 10 mm. in length. Recently, however, many surgeons have made the incision in the limbus instead of in the cornea, as limbal wounds heal more promptly on account of the better blood supply. The incision is made with the angular keratome in a similar manner as described under the combined linear extraction. The withdrawal of the knife is done slowly so as to control, to a certain extent, the escape of aqueous which if rapid often causes a prolapse of the iris.

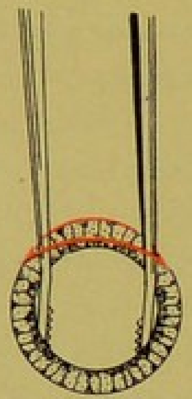
Fig. 266



Simple linear extraction. Use of cystotome with round pupil.

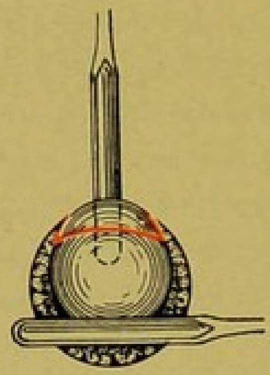
II. Step: Capsulotomy.—The capsulotomy is performed either with the cystotome or capsule forceps. Special care must be taken in using these instruments, as the iris is easily wounded, especially in using the forceps. After introducing the forceps they are pushed down to the lower margin of the pupil or even behind the iris, so that the heel of the forceps is clear of the upper pupillary margin. Otherwise this step is identical with that described under the preceding operation. There are especially devised forceps for this step which have no teeth at the heel of the blade (Schulek, Müller, Smith).

Fig. 267



Simple linear extraction. Use of capsule forceps with round pupil.

Fig. 268



Simple linear extraction; expression of the lens.

III. Step: Expression of the Lens.—A Daviel spoon is taken in each hand, one being placed on the posterior lip of the wound, at right angles, so that it slightly enters the anterior chamber. The posterior lip is now pressed backward while the other spoon is placed horizontally on the lower part of the cornea and the lens masses are removed by a firm pressure directed toward the centre of the eyeball (Fig. 268). Continuous pressure is of less value than alternating pressure on the two spoons. After the greater portion of the lens mass and the nucleus have been removed the spoons are removed and the debris that has collected around the wound margin is cleared away. It is often of advantage to rest a few moments and wait until the anterior chamber has partially reformed, as the incoming aqueous often washes down some of the remaining cortex.

Taking fresh spoons the same movements are repeated, with the difference, however, that instead of pressing with the spoon toward the centre of the eyeball the anterior chamber is entered with one spoon while with the other the remaining masses are removed by stroking the cornea from below upward. Care should be taken to have the spoon lie completely across the cornea. If this is not done it may easily happen that the spoon slips into the anterior chamber on completing the upward stroke (Fig. 258). It is not necessary to remove all of the lens, as the remnants are usually absorbed in a short time leaving a clear black pupil.

IV. Step: Toilet.—After expression of the lens the wound is examined carefully to see if the iris or pieces of the capsule are wedged in it. If the iris is caught it is liberated with a spatula. If any shreds of capsule are present they are removed with the forceps. One drop of atropine is instilled and a binocular bandage applied.

Complications during Operation.—*The incision may be too short or oblique.* See Combined Linear Extraction, p. 244.

Injury to the Iris.—This may occur during the incision, or any step of the operation. To avoid further trouble it is better to do an iridectomy.

Prolapse of the Iris.—Prolapse of the iris may occur at any stage of the operation. If it happens immediately after incision the iris is replaced with a spatula before capsulotomy. If it prolapses during expression it is replaced and the attempt is made to hold it in its proper position with the Daviel spoon by pushing it into the anterior chamber for a short distance. If this is unsuccessful and the iris is bruised it is better to do an iridectomy. An iridectomy must also be performed, after expression of the lens, if the pupil is not round and the iris cannot be replaced with the spatula, as this indicates incarceration of the iris. It is not easy to grasp the iris with the forceps at this stage as the lens is wanting and there is no support. It is better, therefore, to use the iris hook for pulling out the iris.

Insufficient Opening of the Capsule. See Combined Linear Extraction, p. 246.

Sclerosed Lens.—See Combined Linear Extraction, p. 246.

Prolapse of the Vitreous.—Prolapse of the vitreous occurs under the same conditions as under Combined Linear Extraction, and it must be dealt with in the same manner. The only difference is that an iridectomy should be performed if possible. Under these circumstances this, however, is very difficult, and cannot be accomplished with an iris hook, but a Tyrrell hook must be used for withdrawing the iris.

After-treatment.—See Combined Linear Extraction, p. 248

Postoperative Complications.—If postoperative complications occur, they are the same as those after Combined Linear Extraction, with the exception that if the wound ruptures there may be a prolapse of the iris. It is not wise to attempt to replace it but rather ablate. This secondary operation is usually difficult, as cocaine does not give a good anesthesia on an inflamed eye and the patient, being restless, there is danger of a prolapse of the vitreous. Therefore, it is better to employ a general anesthetic.

Combined Flap Extraction.—**Definition.**—After the anterior chamber is opened by a lobular incision in the upper limbus, an iridectomy is made, after which the capsule is incised and the lens expressed.

Indications.—1. Mature and hypermature cataracts in patients over thirty-five years.

2. Immature cataracts in cases where both eyes are involved and vision is so poor that the patient cannot get about.

3. Sclerosed lens which can be operated on at any time if vision is less than $\frac{1}{10}$ (0.1).

4. Luxated or subluxated lens at any age.

5. Cataracts, in cases where the vitreous is fluid at any age.

Contraindications.—Contraindications are divided into permanent and temporary.

Permanent.—Cataracts where there is no light perception, except in cases where the patient wishes to have it removed for cosmetic purposes.

Temporary.—1. Danger of infection from diseased conjunctiva, margin of lid or dacryocystitis (see p. 26).

2. Acute glaucoma; under this condition an iridectomy is to be done and after the attack has subsided the lens is extracted.

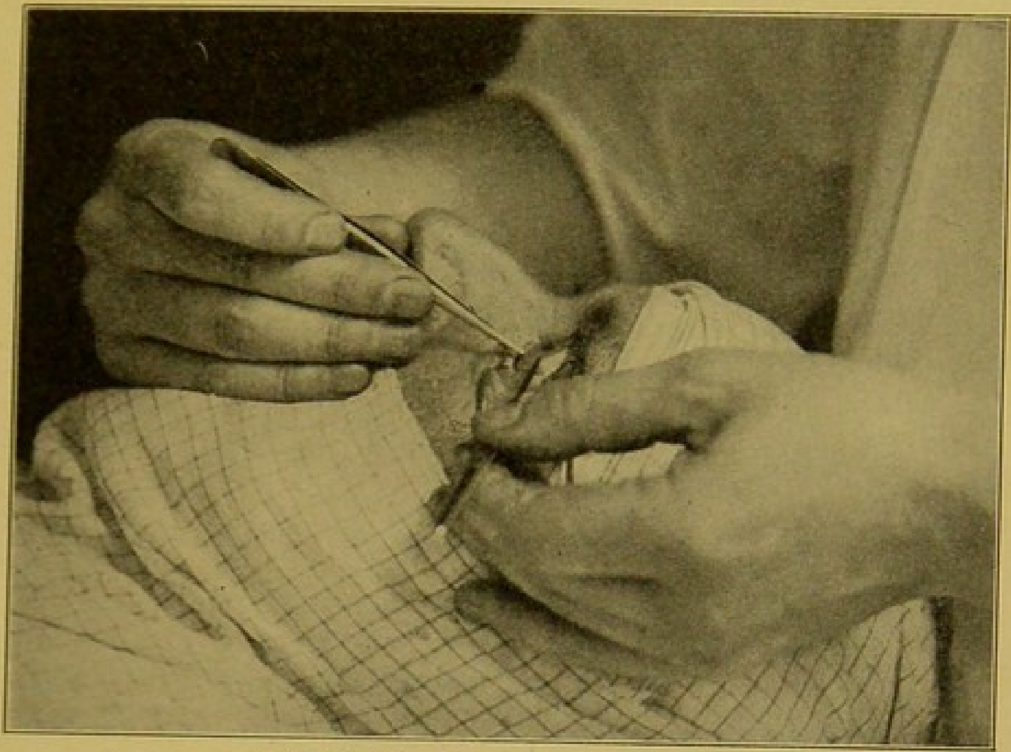
3. General diseases: diabetes, bronchitis, etc. (see p. 25).

Preparation.—The general preparation is the same as for any eyeball operation. One drop of cocaine is instilled every five minutes during fifteen to twenty minutes preceding the operation. General anesthesia is required in unruly patients.

Instruments.—Speculum, fixation forceps, Graefe knife, iris forceps, iris scissors, iris spatula, Daviel spoon, capsule forceps, cystotome, Snellen's loop, Reisinger's tenaculum.

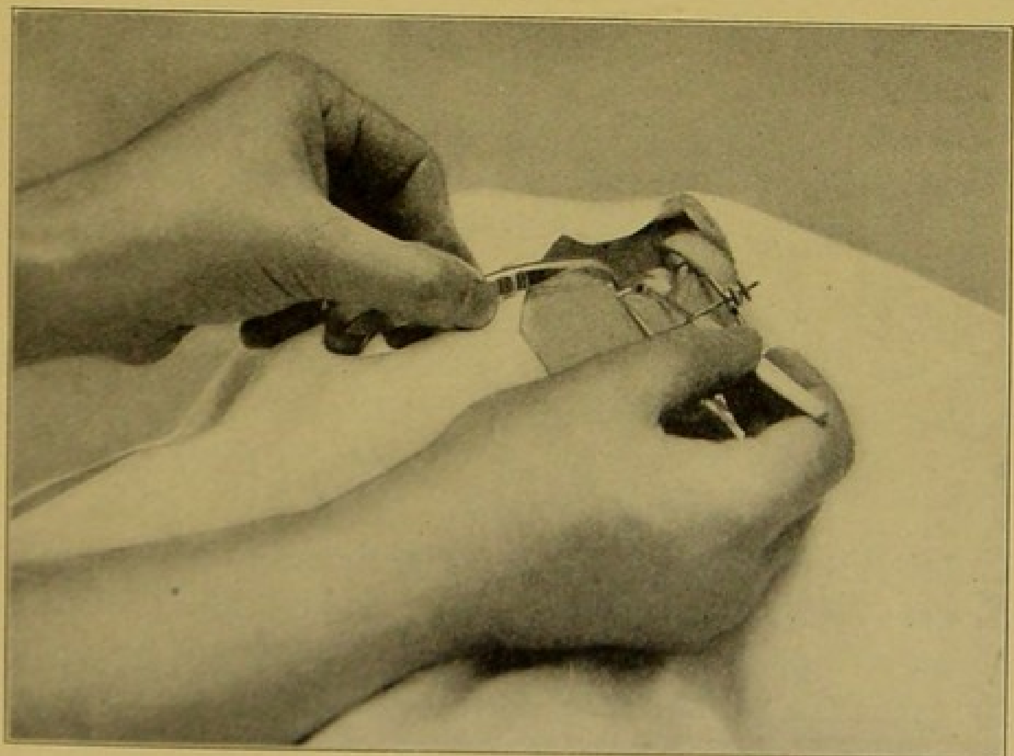
Operation.—The operation consists of five steps: Incision, iridectomy, capsulotomy, expression of the lens, and toilet.

Fig. 269



American method of holding the Graefe knife in cataract extraction.

Fig. 270



European method of holding the Graefe knife in cataract extraction.

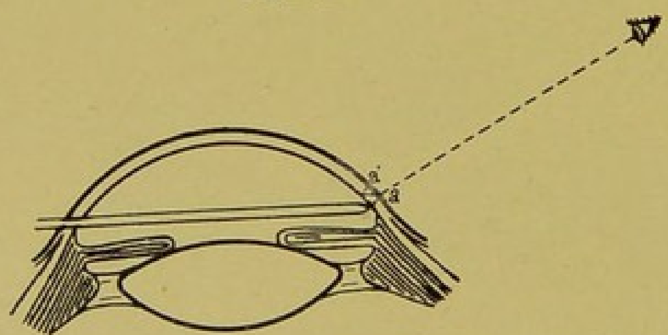
I. Step: Incision.—After the introduction of the speculum the eyeball is steadied, with the fixation forceps at the lower end of the vertical meridian of the cornea. The knife is held in the hand that corresponds to the temporal side of the eye while the other hand holds the fixation forceps. The knife is held with

Fig. 271

Combined flap extraction, site and size of incision.

its cutting edge upward in the proper manner while the little finger is steadied against the cheek bone. The blade is parallel to the iris and the puncture is made about 2 mm. above the horizontal meridian exactly in the limbus. The knife is pushed

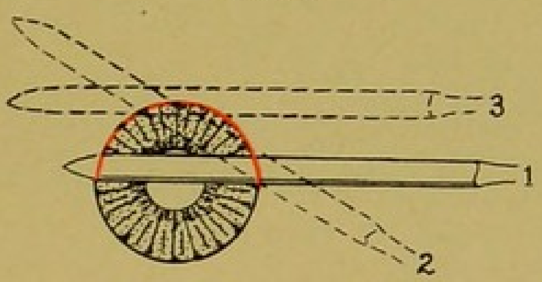
Fig. 272



Optical illusion showing the point of the knife in the limbus although appearing 1 mm. in front of it. (After Terrien.)

slowly but steadily through the anterior chamber and the counter-puncture is made exactly at the corresponding point in the nasal limbus. While the knife is passing through the chamber the point should always be carefully watched to see that it does not engage in the iris. When making the counter-puncture the refraction of the cornea and the aqueous must be taken into consideration, and accordingly it is necessary to pierce the cornea apparently 1 mm. in front of the limbus. This will cause the counter-puncture to lie exactly in the proper point. After the counter-puncture is made the knife is pushed forward to the end of its cutting edge, and at the same time the handle is lowered toward the cheek. By this maneuver the cornea is incised from the point of the counter-puncture to the upper limbus. By raising the handle and at the same time withdrawing the knife it is sometimes possible to incise the remaining portion of the limbus. If the incision is not completed by this maneuver or one finds difficulty in doing it the incision may be made by gentle sawing movements, without pressure, the knife always being held in the same plane and following the limbus closely. When completing

Fig. 273

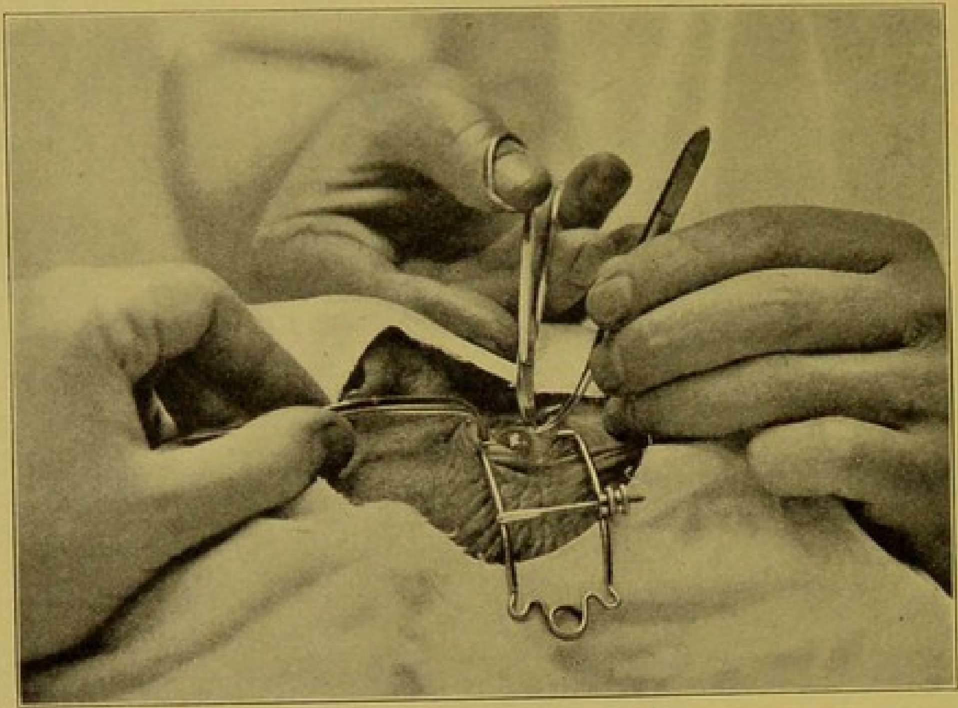


Incision of cornea with Graefe knife.

the incision the attempt is made to secure a small conjunctival flap. For that purpose the knife is brought upward under the conjunctiva, at about 3 or 4 mm. from the limbus, then the knife is rotated 45 degrees so that the cutting edge is forward and the handle is now raised, thereby severing the conjunctiva. The flap is now turned back on the cornea so that it will not be in the way.

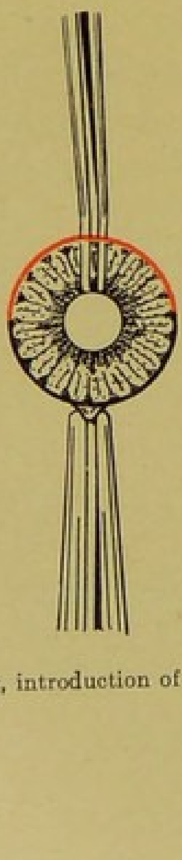
II. Step: Iridectomy.—The iris forceps are held closed in the left hand and the scissors slightly open in the right, close to the incision. The forceps are gently pressed on the posterior lip of the wound, at right angles to it, to cause a slight gaping, and then are slipped into the anterior chamber. When they reach the margin of the pupil a small fold of the iris is grasped and slowly withdrawn. As soon as a small portion of the iris is outside of the wound it is excised at once with one sweep of the scissors, which are held at right angles to the wound and are gently pressed against the sclera. This procedure gives a small coloboma, which suffices. In cases in which a larger one is desired, as when

Fig. 274



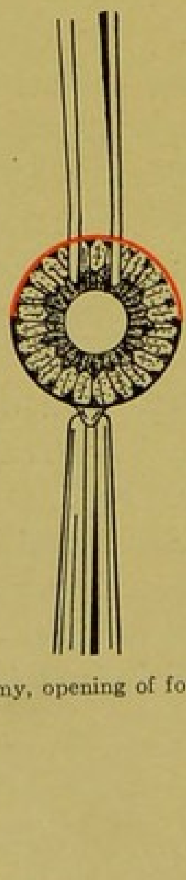
Excision of the iris.

Fig. 275



Iridectomy, introduction of iris forceps.

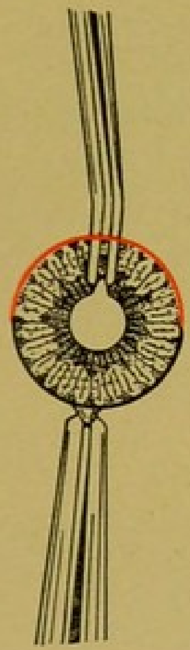
Fig. 276



Iridectomy, opening of forceps.

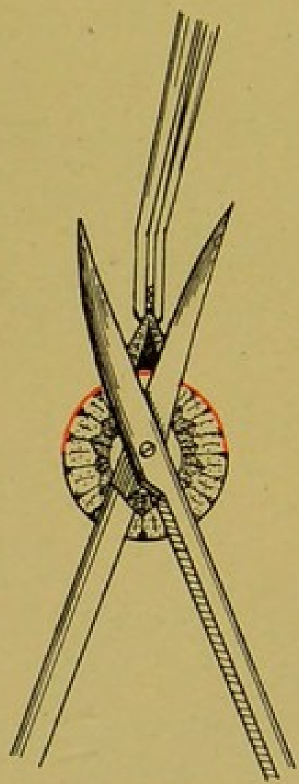
complications are feared (*i. e.*, fluid vitreous, very large nucleus, etc.), the scissors are held parallel to the wound, by which a larger portion of iris is excised. Immediately after the iridectomy the iris usually withdraws and the pillars are free, if not, they should be replaced with a spatula before the capsulotomy.

Fig. 277



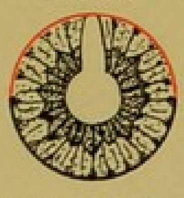
Iridectomy, grasping fold of iris.

Fig. 278



Iridectomy, excising iris.

Fig. 279



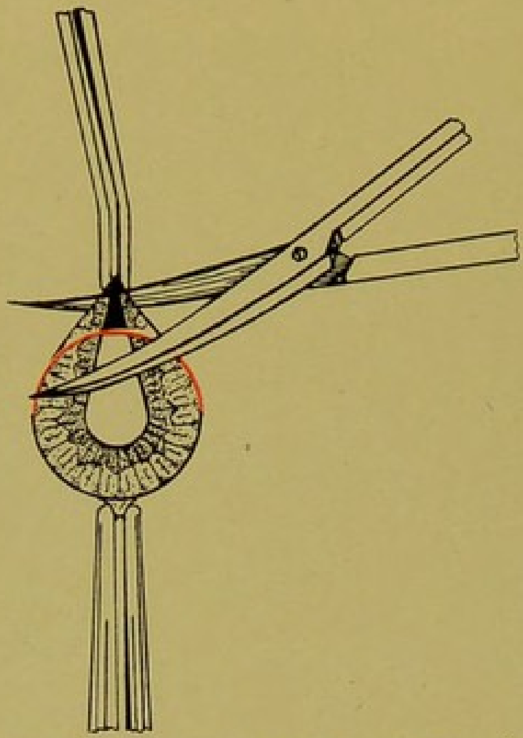
Result of iridectomy.

III. Step: Capsulotomy.—Capsulotomy may be performed either with a capsule forceps or a cystotome.

Capsule Forceps.—Capsule forceps should be given the preference, as with them the larger part of the anterior capsule is removed and there is less liability of an after cataract.

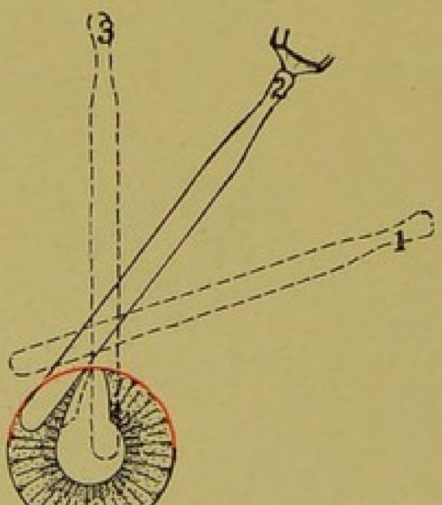
The closed capsule forceps are held in the right hand and are slowly introduced into the anterior chamber. They are now advanced down through the pupillary area to the lower edge.

Fig. 280



Iridectomy, holding scissors parallel to the wound.

Fig. 281

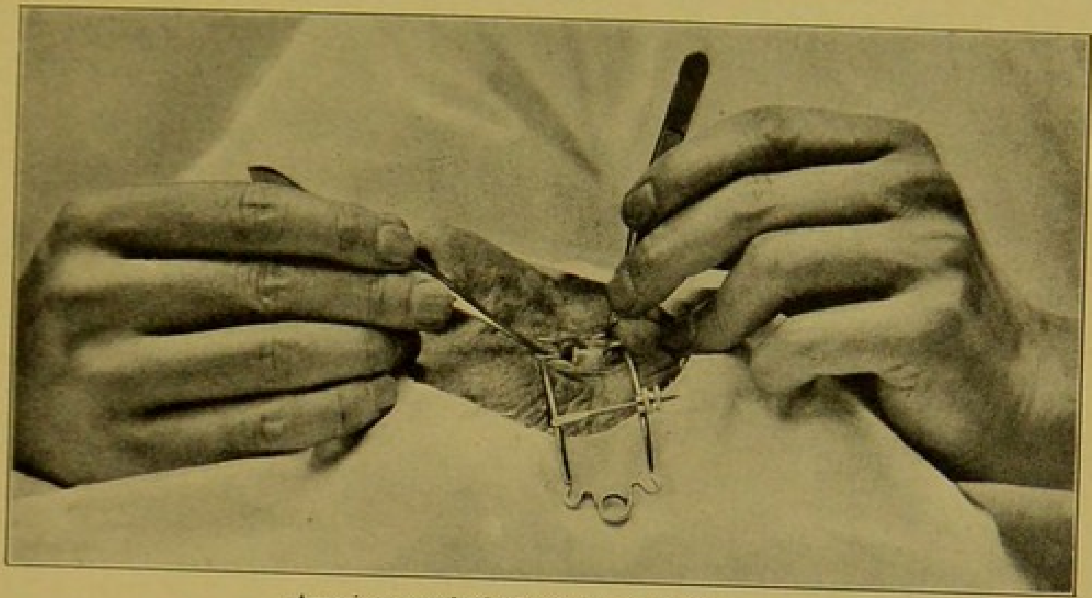


Reposition of pillars.

The blades are then opened until they reach either side of the pupillary margin and are pressed against the capsule and closed.

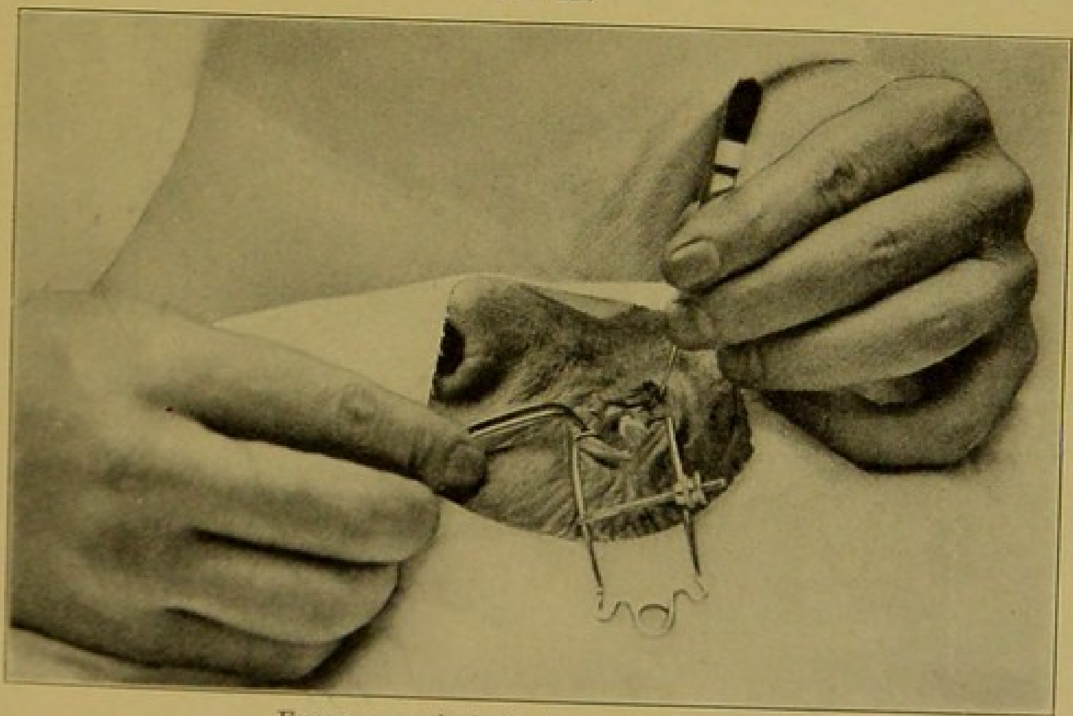
The forceps are pushed downward to rupture the upper fold of capsule and then are withdrawn with a pendulum movement.

Fig. 282



American method of using capsule forceps.

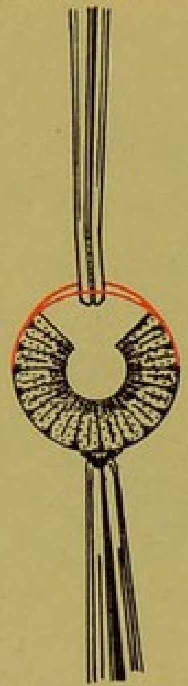
Fig. 283



European method of using capsule forceps.

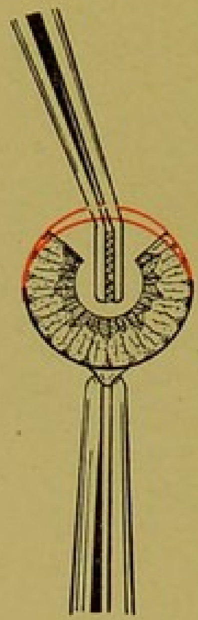
If a portion of the transparent capsule is found in the forceps it indicates that the capsulotomy has been accomplished. In some cases the capsule is so tough that it does not rupture and the whole lens moves with the capsule. If the zonule is weak it may even rupture and the lens is extracted in the capsule.

Fig. 284



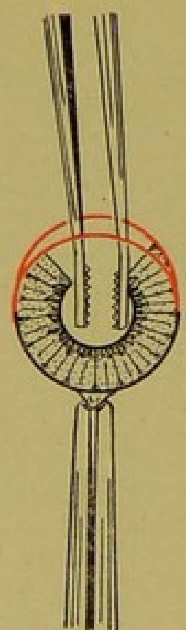
Combined flap extraction, capsule forceps about to be introduced into anterior chamber.

Fig. 285



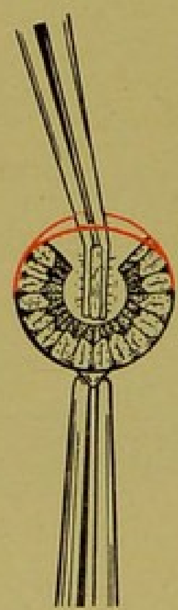
Combined flap extraction, capsule forceps inserted.

Fig. 286



Combined flap extraction, opening of capsule forceps preparatory to grasping capsule.

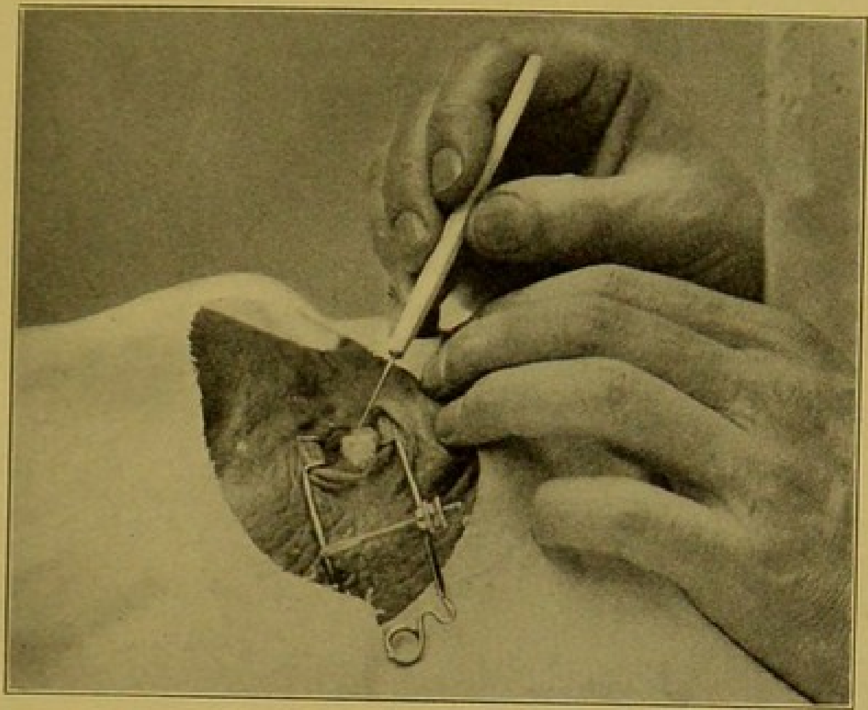
Fig. 287



Combined flap extraction, grasping the capsule.

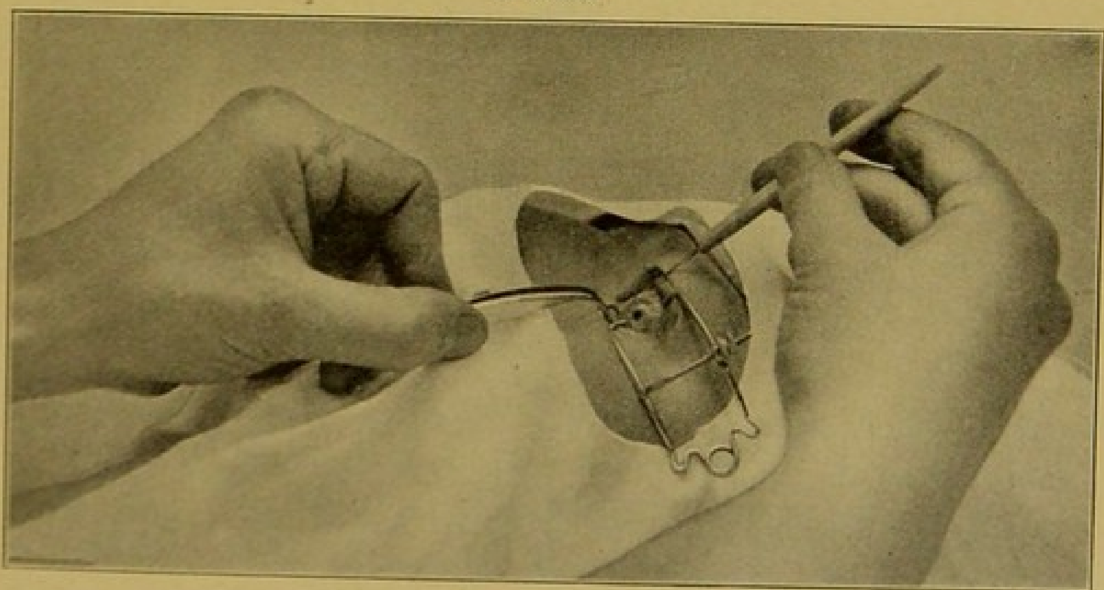
In fluid cataracts (Morgagnian) the capsule cannot be caught with the forceps so a cystotome must be used.

Fig. 288



American method of using cystotome.

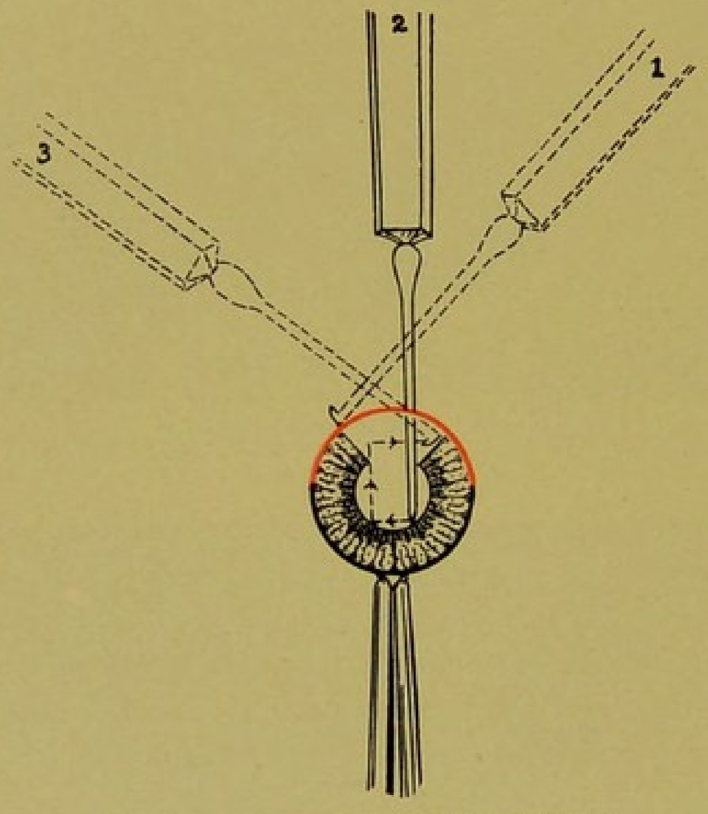
Fig. 289



European method of using cystotome.

Cystotome.—The cystotome held in the proper manner is introduced flat with the convexity downward. It is pushed into the pupillary area where the cutting surface is brought in contact with the capsule and a cross or, better, Y-incision is made. Czermak advises two horizontal incisions, one near the upper margin and one below. Knapp makes a single peripheric incision above in the following manner: The cystotome is introduced with convexity downward from the temporal end of the wound, care being taken not to drag the conjunctival flap into the anterior chamber. The cystotome is now rotated so that its cutting edge is turned toward the lens and an incision is made in the upper

Fig. 290

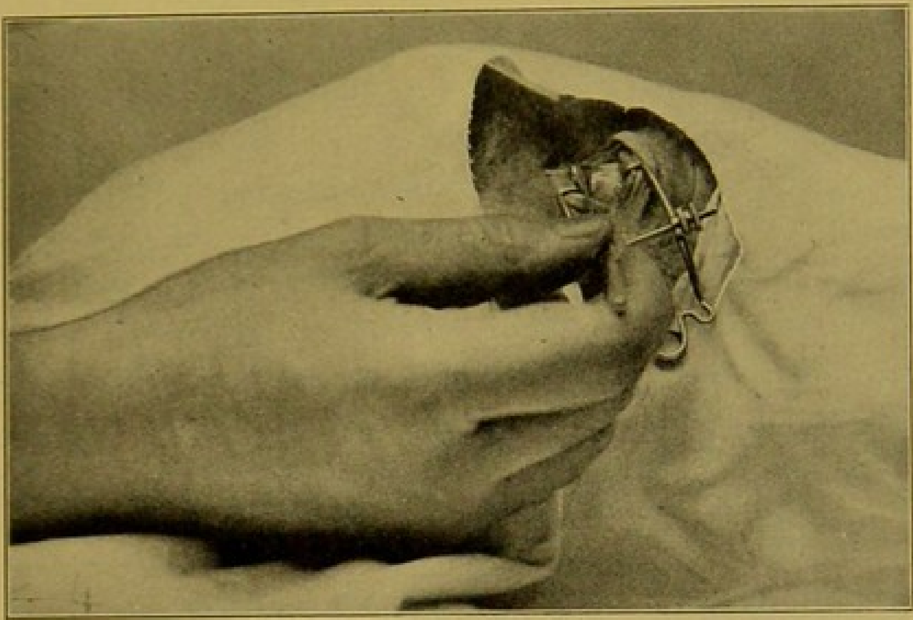


Use of cystotome. Combined flap extraction.

part of the capsule parallel with the corneal section about 6 or 7 mm. in extent. In making the incision care should be taken not to rupture the zonule or to dislocate the lens.

IV. Step: Expression of the Lens.—Expression of the lens is accomplished with a Daviel spoon, which is applied on the lower portion of the cornea in a horizontal direction. Pressure is made toward the centre of the eyeball, thus causing a gaping of the wound and tilting of the lens, the upper margin of which presents in the wound. When the larger part of the lens has engaged, the pressure still being continued, we follow up with the spoon and assist in the delivery. After the expulsion of the lens removal of such remnants of the cortex as are left behind is attempted. This is accomplished by stroking movements on the anterior surface

Fig. 291

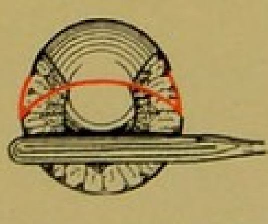


European method of using Daviel's spoon in delivering the lens.

of the cornea from below upward. Too much pressure cannot be used as there is danger of causing prolapse of the vitreous.

V. Step: Toilet.—After the lens has been delivered and the remnants of the cortex removed from the anterior chamber the eye is examined to see if the pillars of the coloboma are free. If not, entry is made with an iris spatula and the iris is gently

Fig. 292



Expression of lens in combined flap extraction.

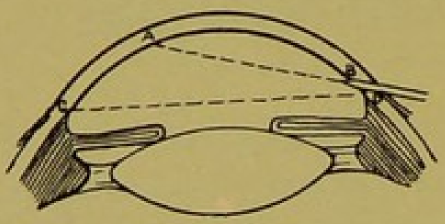
stroked. By this maneuver the pillars are liberated from the wound. If the iris is in its proper position and there is no capsule in the wound the blood clots and lens substance are removed from the neighborhood and the wound is covered with the conjunctival flap. The speculum is now removed and bandage applied.

Complications during Operation.—*Friability of Conjunctiva.*—Sometimes the conjunctiva is friable and the fixation forceps tear out. Under these circumstances a fresh hold must be secured in the neighborhood of the first one or else a Schweigger fixation fork must be used.

Introduction of Knife with Cutting Edge Downward.—There are two remedies for this complication. The first is withdrawal of the knife and postponement of the operation to a later date. The second is to rotate the knife quickly so that the cutting edge is directed upward. If there is no loss of aqueous the operation may be continued.

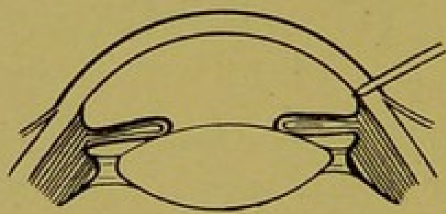
Intralamellar Incision.—Sometimes the blade instead of entering the anterior chamber passes in between the layers of the cornea, thus producing an intralamellar incision. If the anterior

Fig. 293



Entry of knife when improperly held. (After Terrien.)

Fig. 294



Entry of knife when properly held. (After Terrien.)

chamber has not been opened the knife can be withdrawn and a new incision started. If the anterior chamber has been entered and wound canal is very long it is better to postpone the operation for a few days.

Injury of Iris. (*a*) Injuring the iris immediately after puncture cannot be remedied, as in this position the knife cannot be withdrawn without escape of aqueous, which would prevent the completion of the incision.

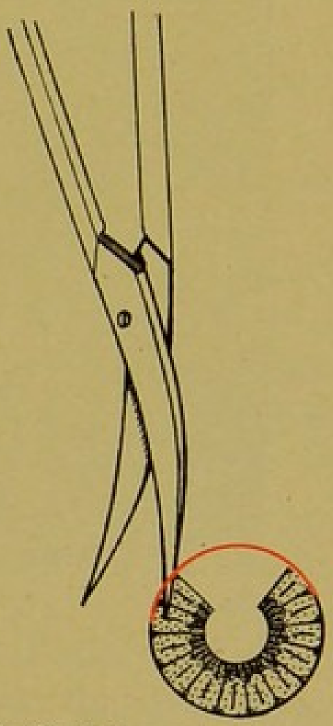
(*b*) If the iris is injured just before the counter-puncture is made the knife can be withdrawn slightly to disengage it.

(*c*) If the iris falls before the knife after counter-puncture there is nothing to be done but complete the incision. Sometimes a clean-cut coloboma can be secured with the knife and then all that is necessary is to go in with the iris forceps and remove the piece excised. If the coloboma is imperfect and incomplete it must be completed with the scissors.

These complications are always painful and disturbing. As the patient becomes restless there is considerable hemorrhage and the field of operation is obscured.

Too Short Incision.—In some cases it is found that the incision is too short. This is indicated by the fact that the lens refuses to pass through the wound. It is therefore necessary to lengthen the incision with the scissors. In making the counter-puncture the knife may pass through the sclera instead of the limbus. This complication always causes considerable hemorrhage and also favors prolapse of the vitreous.

Fig. 295



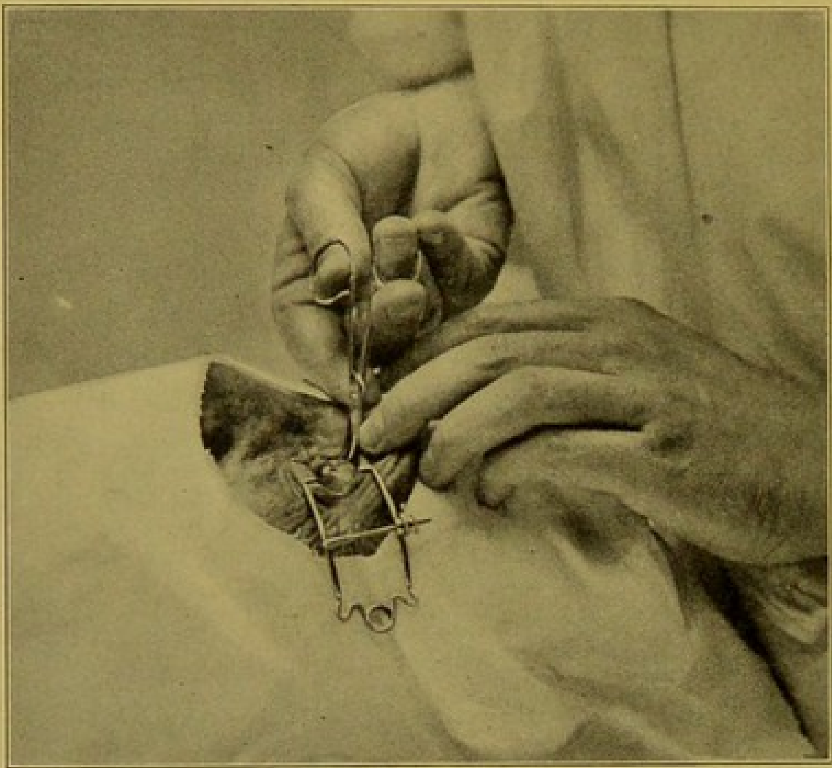
Combined flap extraction, enlarging incision with scissors.

Collapse of Cornea.—Collapse of cornea occurs usually in elderly people and is due to loss of elasticity. There is nothing serious in this complication in itself, as it often disappears when the speculum is removed.

Air Bubble in Chamber.—Sometimes, after evacuation of the aqueous, an air bubble appears in the chamber. It is of no significance and can easily be driven out with a Daviel spoon by stroking the cornea. If it remains, however, it will be readily absorbed.

Iridodialysis.—After the iris has been grasped with the forceps, if the patient suddenly moves his head or eye and the hold on the iris cannot be released, it may be torn from its attachment to the ciliary body (iridodialysis). If the iris is diseased or atrophic it is impossible to withdraw it from the anterior chamber as the forceps tear through the tissue. Under these circumstances it is necessary to tear out enough of the iris to give a good coloboma. If the iris is grasped too far from the margin of the pupil, after performing the iridectomy, it is found that the sphincter is left behind intact, thus forming a bridge coloboma. This in itself is of no consequence. To break it up a Tyrrell hook is introduced and the sphincter is brought out and severed.

Fig. 296



Enlarging wound with scissors.

Dislocation of Lens.—In performing the capsulotomy too great pressure on the lens may cause its dislocation. It is then necessary to enter with the spatula and replace it if possible. If the capsulotomy is not successful a second entry must be made and the capsule incised more freely.

Failure of Presentation of Lens in Wound.—If the lens does not present in the wound it is usually due to one of the following causes: (1) The incision may be too small, and when this occurs it is necessary to lengthen it with the scissors; (2) the capsulotomy may be incomplete, but this can be remedied by doing a second and larger discission; (3) the lens may be dislocated. The last is the most serious complication. The dislocation may occur during capsulotomy or expression. The lens may be dislocated in any direction during capsulotomy, but during expression it will usually be dislocated upward behind the wound or into the vitreous. A slight dislocation may easily be remedied by replacing the lens with a spatula and removing it in the usual way, care being taken, however, as the zonule being ruptured there is a greater danger of prolapse of the vitreous.

A dislocation of the lens upward behind the wound may be due to a corneal incision. During the attempt to express the lens it does not present but slips up behind the wound, a complication that is rather often met with in Morgagnian cataract, even if the incision is perfect. To bring the lens down to its proper position and remove it in the usual manner is always difficult and dangerous. When the lens is not too far out of place effort is made to return it to its proper position with the spatula. If this is unsuccessful Knapp advises the following method for delivery:

A Daviel spoon is placed on the sclera over the upper margin of the lens. Pressing gently and slowly advancing toward the wound causes a tilting of the lens so that the lower margin is elevated. The second spoon is placed on the cornea close under the lower margin of the lens and pressed gently backward. By this manipulation the lens turns on itself and the lower margin presents in the wound from which it can be delivered. If the lens is not rotated by this method but slips farther up its extraction must be attempted with the Reisinger tenaculum, according to Czermak, as follows:

The patient is directed to look upward and the tenaculum introduced obliquely from one end of the wound. It is pushed upward behind the lens and hooked into it. The lens is delivered by slowly raising the handle of the instrument, thereby turning the lens on itself; at the same time pressure is exerted on the sclera above with the Daviel spoon. As soon as the lens comes into the anterior chamber and partly presents in the wound it can be expressed in the usual way. The delivery by this method is very difficult and requires considerable skill to accomplish it.

A dislocation of the lens into the vitreous may occur when the vitreous prolapses, as the advancing vitreous pushes to one side the lens which slips into the vitreous chamber. It may also follow the unskilful manipulation of some instrument in extraction.

If the lens disappears into the vitreous and cannot be seen it is better to stop the operation and bandage the eye. In some cases the lens returns to its normal position in a few days when another attempt at extraction can be made which, however, is usually attended with considerable loss of vitreous.

Prolapse of Vitreous.—Prolapse of vitreous may occur at any stage of the operation. It is dangerous not only on account of infection but if a considerable quantity is lost it may cause a detachment of the retina at some later date. Prolapse of vitreous may be due:

(*a*) *To the Eye.*—Atrophy or rupture of zonule, a condition commonly met with in high myopia, hypermature cataract, and chronic iridochoroiditis.

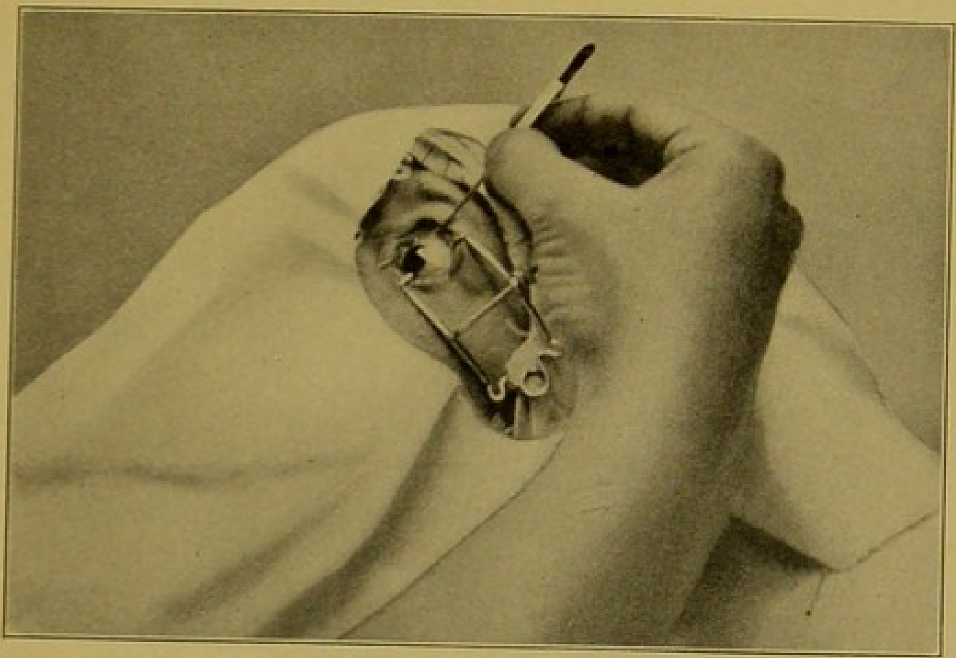
(*b*) *To the Patient.*—If the patient is unruly and restless and squeezes his lids together, thereby pressing the speculum against the eyeball.

(*c*) *To Error in Technique.*—Some of the common errors that predispose to prolapse of vitreous are: Scleral incision, too great a pressure with the fixation forceps, subluxation of lens at any time during the operation, too great a pressure in extraction of the lens, especially if capsulotomy is incomplete or the wound is too small. It may also occur after expression in trying to remove the remnants with either a spoon or forceps. The symptoms of this complication vary, and depend on whether the vitreous is fluid or normal. If it is fluid it may be mistaken for aqueous and a large quantity may escape before the loss is noted resulting in a collapsed eyeball. If it is normal it presents at the wound opening as a round transparent mass similar in consistency to the white of an egg. The earlier the prolapse occurs in the operation the more difficult it is to complete it. At the first sign of vitreous prolapse all pressure should be removed from the eyeball. This is accomplished by removing the fixation forceps and speculum; the removal of the latter is not necessary if the assistant holds it up from the eyeball. The subsequent procedure is governed by the step at which the prolapse occurs.

If the iridectomy has not been performed it should at least be attempted. As the iris usually prolapses with the vitreous it is grasped with the forceps and ablated. If, on the contrary, the iris is pushed back by the vitreous and a hold cannot be secured with the iris forceps a Tyrrell hook is to be used. After introducing the hook it is pushed into the pupillary area, the iris caught, withdrawn, and excised.

If the prolapse occurs before the lens has been extracted the usual method of expressing the lens is not to be tried. In this case the extraction can be accomplished either with a Reisinger tenaculum or a Snellen loop. When the tenaculum is used it is introduced, closed, and pushed down behind the lens below the posterior pole. It is then opened, hooked into the lens substance,

Fig. 297



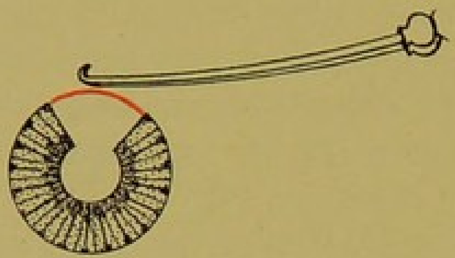
Method of using Reisinger's tenaculum.

and the lens withdrawn. When the nucleus is not sufficiently hard a Snellen loop or a Pagenstecher spoon is used. Both are introduced obliquely into the vitreous behind the cataract and the handle depressed, thereby bringing the lens up against the posterior surface of the cornea. The cataract while held in this position is slowly withdrawn, and counter-pressure on the outer surface of the cornea is made with a Daviel spoon.

If prolapse of vitreous occurs after the extraction of the lens it should be cut off and a bandage applied without attempting to free the pillars of the coloboma.

Expulsive Hemorrhage.—Expulsive hemorrhage is a very rare complication, but when it does occur we are powerless to prevent it (see p. 56).

FIG. 298

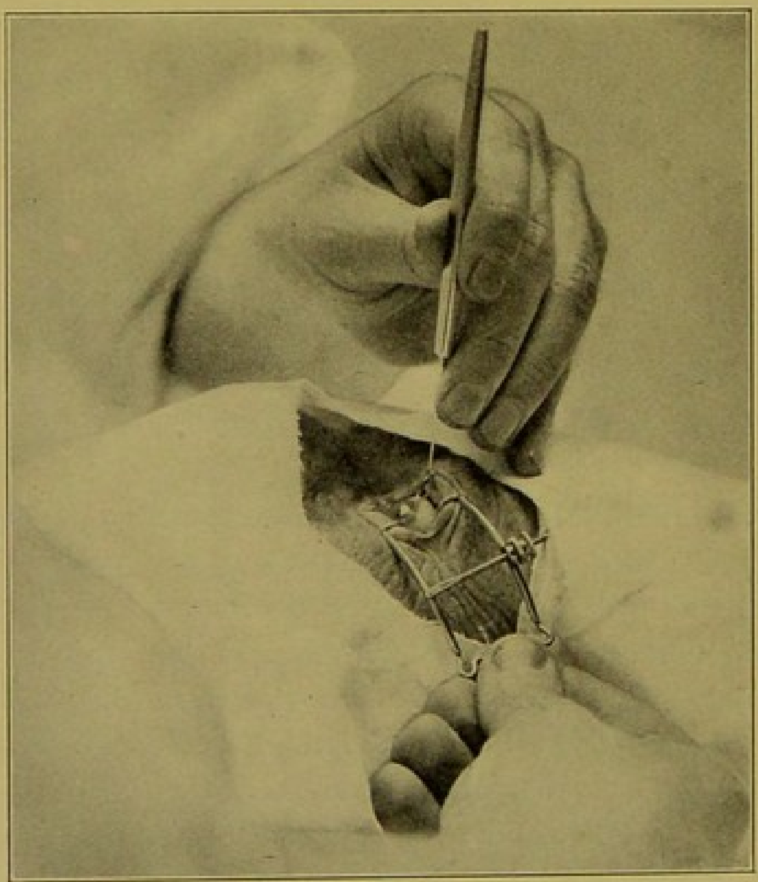


Method of using Reisinger's tenaculum. First step.

FIG. 299

Method of using Reisinger's tenaculum, showing position of instrument. Second step.

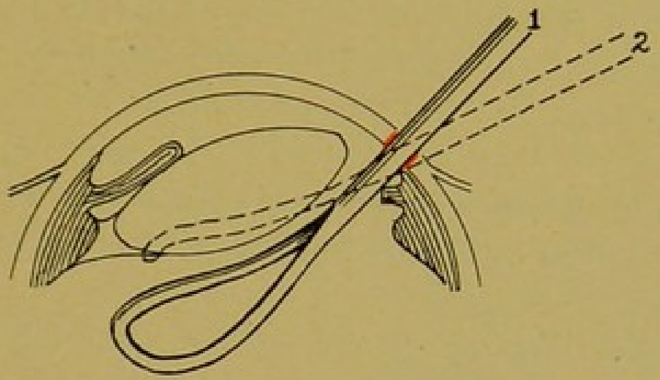
FIG. 300



Method of using Snellon's loop, assistant raising speculum.

Turning Back of Corneal Flap.—With a prolapse of the vitreous the corneal flap may be turned back on itself. It should be replaced by carefully raising the upper lid without pressure on the eyeball and reposited in its proper position with an iris spatula and the lids again closed.

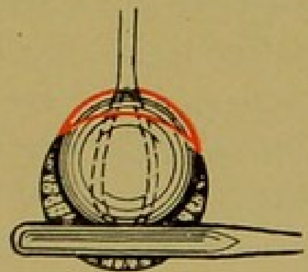
Fig. 301



Combined flap extraction, use of Snellen's loop in prolapse of vitreous.

After-treatment.—It is important that the patient should rest well the first night; it is therefore advisable to give chloral hydrate or morphine. Both eyes are to be bandaged for twenty-four hours when the non-operated eye may be left open. The operated eye is to be bandaged until the fourth day, after which Snellen's

Fig. 302



Combined flap extraction. Extraction of lens with Snellen's loop.

cup or a Fuchs mask may be worn for seven to eight days. On the third day the patient may sit up in an arm chair and on the sixth or seventh he may walk around the room. Very old people and those having asthma or chronic bronchitis may be allowed to sit up in bed on the first day if necessary.

On the first two days the eye is washed once daily, at the same time instilling one drop of atropine in the cul-de-sac. After the third day the eye is washed twice daily and the atropine is continued if necessary. The patient may leave the hospital two weeks after the operation if the healing has been without complication. Five or six weeks later he may be examined, glasses prescribed, and about the same time he may resume his occupation.

Postoperative Complications.—The postoperative complications are fully discussed in Chapter I, so that only brief mention will be necessary here.

Imperfect Closure of Wound.—This may be due to irregular section or presence of capsule or iris in the wound. It also occurs in patients suffering from some systemic condition, as diabetes, etc.

This condition is not usually serious, as a carefully applied bandage will usually produce closure. Sometimes the closure is delayed for several days.

Striated Keratitis.—At the first dressing a condition known as striated keratitis may be noticed. It has the appearance of grayish lines which run parallel to the vertical meridian of the cornea and is caused by a wrinkling of Descemet's membrane. It is of no consequence and usually passes away in a few days.

Rupture of Wound.—This is one of the more serious complications, although not of as serious a nature as when it occurs after a simple extraction. The blood usually absorbs in a few days, but if it does not a paracentesis of the cornea should be done to allow its escape. Prolapse of the vitreous is very rare, occurring only in cases of severe trauma. Under these circumstances the vitreous is to be excised and the eye bandaged so long as the anterior chamber is not formed.

Wedging of the Pillars of the Coloboma in the Wound.—This may occur after imperfect closure or rupture of the wound, and also after failure on the part of the surgeon to free the pillars during operation. In these cases there is little to be done save to allow the pillars to heal in the wound.

Infection.—This is one of the most serious complications, but in these days of asepsis it is rare, especially after the combined extraction. It appears sometimes as an infection of the wound itself, and sometimes as an iridocyclitis or as a panophthalmitis.

The Rarer Forms of Postoperative Complications Are.—*Glaucoma.*—Glaucoma is a very serious complication and the cause of it is not yet clear. It often follows the incarceration of the iris or capsule in the wound, but it sometimes occurs with no discoverable cause. The condition itself is very hard to cope with, and even with the best efforts a very poor result follows. Anterior and posterior sclerotomy, iridotomy, and cyclodialysis are the operations to be considered.

Postoperative Insanity.

Detachment of Choroid.—The symptoms consist of sudden loss of anterior chamber without rupture of the wound. The eyeball becomes soft and on examination a brownish mass is found in the vitreous. Usually the fluid is absorbed so the choroid falls back into place and becomes reattached.

Cystoid Scar.

Detachment of Retina.—This usually follows considerable loss of vitreous during operation. It may occur at once, but sometimes months or years intervene before this condition puts in its appearance. The cause seems to be the shrinking of the vitreous.

Simple Flap Extraction.—Definition.—A lobular incision is made in the upper limbus, the anterior chamber is entered, and the capsule incised, after which the lens is expressed.

Indications.—Uncomplicated mature cataracts in patients over thirty-five years of age.

Contraindications.—1. Complicated cataracts.

2. Immature and hypermature cataracts: In the immature cataract, because the cortex cannot be easily removed, and in the hypermature cataract, because there may be a rupture of the zonule causing a prolapse of the vitreous.

3. Patients with prominent eyeballs, as there is greater danger of prolapse of the iris following the operation.

4. A nervous or unruly patient, as he is sure not to obey instructions during the operation.

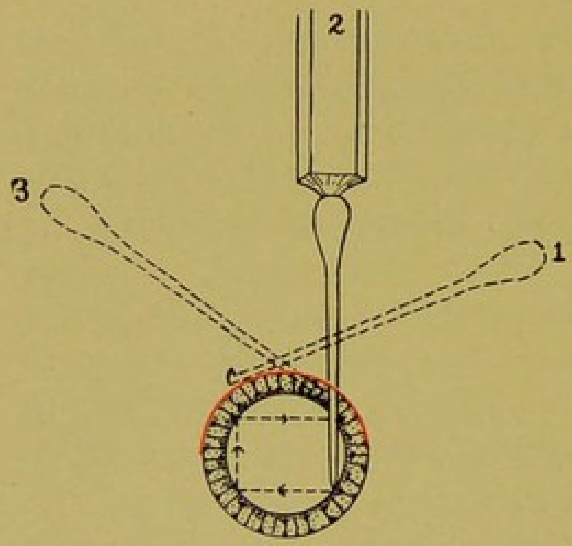
5. Bronchitis, asthma, or any systemic conditions that will make the patient restless after the operation.

Preparation and Instruments.—These are the same as in the combined extraction.

Operation.—The operation consists of four steps: Incision, capsulotomy, expression of the lens, and toilet.

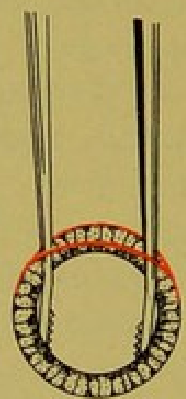
I. STEP: INCISION.—The incision is made in the same manner as in the combined extraction, only the wound is somewhat longer. The puncture is made at the temporal end of the horizontal meridian of the cornea or 1 mm. above and the counter-puncture is made at a symmetrical point on the other side of the cornea.

FIG. 303



Simple flap extraction, use of cystotome with round pupil.

FIG. 304



Simple flap extraction, use of capsule forceps with round pupil.

II. STEP: CAPSULOTOMY.—As in the combined extraction the capsulotomy may be done with either a capsule forceps or a cystotome.

These instruments are used in a similar manner as in the combined extraction. Greater care is necessary to avoid injuring the iris, especially if the capsule forceps are used.

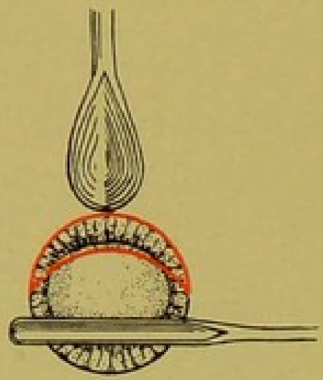
The technique in using the capsule forceps here differs slightly from the preceding operation. The forceps are pushed through the anterior chamber with the blades always in contact with the posterior surface of the cornea. When the lower margin of the pupil is reached the forceps are opened until the blades touch the nasal and temporal margin of the pupil. In closing them they are gently pressed down on the capsule, and at the same time the handle is raised so as to avoid entangling the upper margin of the pupil in the heel of the forceps. After closure the forceps are pushed downward and the iris is examined to see if it has been caught. If it is caught we let it go and secure a fresh hold on the capsule, but this time raising the handle a little higher. To avoid this complication forceps that have no teeth at the heel of the blade or where the heels do not come in contact during closure may be employed.

III. Step: Expression of the Lens.—The expression is performed with two Daviel spoons, one is applied on the posterior lip of the wound at right angles to the incision, and the other on the lower third of the cornea in a horizontal direction. The first spoon is passed into the anterior chamber for a distance of 3 or 4 mm., in order to prevent the prolapse of the iris, and at the same time light pressure is exerted with it so as to cause a gaping of the wound. With the second spoon, pressure is exerted toward the centre of the eyeball until the lens rotates around its horizontal axis and the upper margin presents in the pupil. The pressure is then gradually increased, and as the lens advances in the wound it is followed up with the spoon until it is delivered on the conjunctiva. The attempt is made to remove the remaining cortex by stroking motions from below upward. This is usually not very easy as the iris, is in the way.

If it is impossible to expel the cortex masses in this manner a Graefe spoon is introduced and the iris is pressed gently backward, and at the same time the cornea is stroked with a Daviel spoon. In this manner the remnants can be driven through the pupil on to the spoon and, by withdrawing it, removed. It is not advisable to attempt a complete removal of the remaining cortex, as there is danger of prolapse of vitreous from too much manipulation and small quantities are absorbed without causing complications. On account of these difficulties, irrigation of the anterior chamber has been advised by many surgeons, such as McKeown, Lippincott, Elliot, and others. For this purpose various syringes are employed with solutions either of sterile water, normal salt solution, or 3 per cent. boric acid solution.

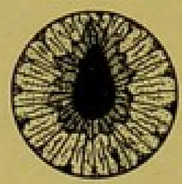
After removal of the lens the iris often appears in the wound. If the pupil is not round but slightly oval in the vertical direction, even if there is no visible prolapse of the iris, it is a sure sign that the iris is entangled in the wound, and a spatula must be introduced and the iris replaced. If, after several attempts, a round pupil cannot be produced the iris is to be excised.

Fig. 305



Simple flap extraction, expression of lens.

Fig. 306



Incarceration of iris.

IV. Step: Toilet.—The lens remnants as well as all blood clots are now removed from the neighborhood of the wound. The conjunctival flap is smoothed out into place and the speculum removed.

Complications during Operation.—The complications during the incision are identical with those met with in combined extraction. The iris may prolapse immediately after the incision is completed. If it does not retract it must be replaced with the spatula before capsulotomy. If it will not remain in place an iridectomy is performed. During capsulotomy, in addition to the complications of this step in combined extraction, the iris may be seized with the capsule forceps. This is usually not noticed until removal of the forceps is attempted, when the iris is found entangled in the blades. The iris should be released immediately and a new hold on the capsule should be secured. The same complications may occur with the cystotome. Under these conditions when the iris has been considerably bruised it is better to excise a piece of it.

During expression, if the lens does not present in the wound, besides a small incision, incomplete capsulotomy, and subluxation of the lens, in this operation a fourth cause presents itself, that is, a too rigid pupil. An increase of pressure will not advance the lens through the pupil but may produce a prolapse of the vitreous. Further pressure therefore should be discontinued and an iridectomy performed.

Prolapse of the vitreous occurs from the same causes as in the combined extraction, but perhaps it is less frequent as the iris offers a certain amount of protection. If it occurs, however, it constitutes a more serious complication, as the iris almost always prolapses and becomes adherent to the wound.

After-treatment.—Immediately after the operation sterile eserine or pilocarpine (one drop) is instilled and both eyes are bandaged. It is better for the patient to remain in bed for at least three days and to keep absolutely quiet. On the fourth day the non-operated eye may be left open. The bandaging of the operated eye must continue for at least six to seven days, after which a Fuchs mask or a Snellen cup is to be worn until the end of the second week. The eye should be washed daily for the first three or four days, after that twice daily. It is not necessary to use atropine except when the eye becomes irritated. The patient may leave the hospital at the end of the third week and glasses are prescribed six to seven weeks after operation.

Postoperative Complications.—The most dreaded complication is rupture of the wound, with subsequent prolapse of the iris. This always involves the danger of infection, because the iris prolapse comes in contact with the conjunctiva of the eyelid, which is swarming with bacteria. For this reason a reposition is a dangerous course to pursue. The only rational procedure is excision of the prolapsed iris under a general anesthetic. This is done as follows: The eyelids are held apart by a speculum and the eyeball fixed below. The prolapsed iris is grasped with a forceps drawn gently outward and excised with scissors which are gently pressed on the sclera. Otherwise the complications are the same as following the combined extraction.

OPERATIONS FOR MEMBRANOUS AND SECONDARY CATARACTS

In dealing with membranous or secondary cataracts the object of the operation is to remove the obstruction, which prevents the rays of light from reaching the retina. This can be accomplished by (*a*) making an artificial pupil in the membrane (discission), (*b*) extracting the membrane.

Discission of a membranous or secondary cataract may be performed with:

1. Knapp's knife-needle.
2. De Wecker's pince-ciseaux.
3. Ziegler's knife-needle.

DISCISSION WITH THE KNAPP KNIFE-NEEDLE

Definition.—Knapp's knife-needle is entered at the limbus parallel to the plane of the iris. The membranous cataract is pierced and with sawing movements the opening is enlarged.

Indications.—1. Secondary cataracts that are not too dense and the patient's vision is less than $\frac{20}{40}$.

2. Congenital membranous cataracts.

3. Secondary cataracts following trauma where there are only a few posterior synechiæ present.

Contraindications.—1. Very thick and dense membranous and secondary cataracts, because the thick membrane cannot be incised.

2. Membranous cataracts where numerous posterior synechiæ are present, because the traction exerted on the ciliary body may produce an iridocyclitis.

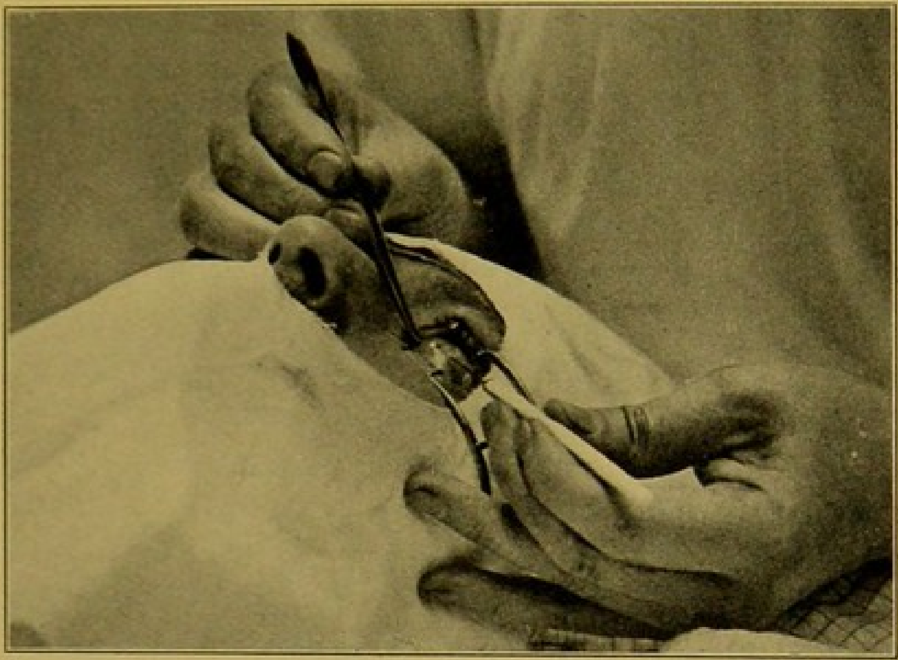
Preparation.—As in discission of the lens capsule atropine, cocaine anesthesia or, if necessary, a general anesthetic. A careful examination by focal illumination and loupe should be made to ascertain the direction of the fibers of the cataract.

Instruments.—Speculum, fixation forceps, knife-needle.

Operation.—The operation is divided into three steps: The first step is the entrance of the knife-needle, the second the incision of the membranous cataract, the third the removal of the knife-needle.

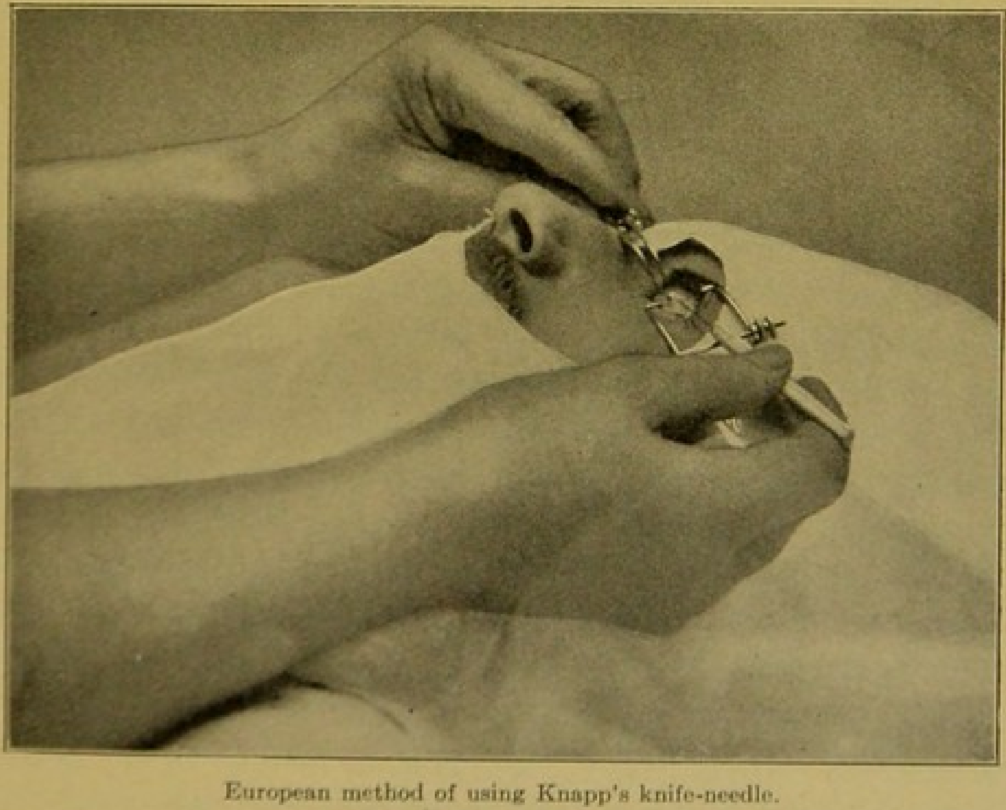
I. Step: Entrance of the Knife-needle.—The knife-needle is held between the first two fingers and thumb; the little finger rests on the patient's face, the other hand holds the fixation forceps and steadies the eye (Figs. 307 and 308). The cutting edge of the blade is directed downward, and, as it enters the anterior chamber,

Fig. 307



American method of using Knapp's knife-needle.

Fig. 308

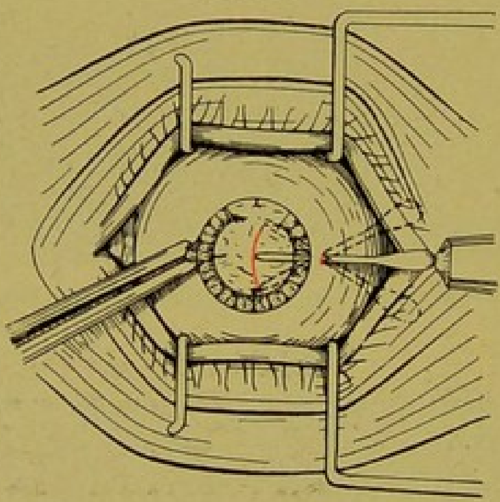


European method of using Knapp's knife-needle.

the blade is held parallel to the plane of the iris. The point of entrance lies in the sclera at a distance of about 1 mm. from the limbus. It is usually at the temporal end of the horizontal meridian of the cornea. This may vary, however, as it is necessary to cut the fibers at right angles, and so any point on the limbus where this may be most easily effected may be selected.

After the needle has entered the anterior chamber it is pushed forward toward the pupil, and at the same time the handle is lowered until the point arrives at the upper margin of the pupil or lower margin of the coloboma.

Fig. 309



Discission of membranous cataract. Knapp's knife-needle.

II. Step: The Incision of the Membranous Cataract.—The handle of the instrument is brought slightly forward until the needle comes in contact with the membrane, which is transfixed. The incision is enlarged by sawing movements to within about 1 or 2 mm. of the lower margin of the pupil. The sawing movements should be made lightly and without pressure while the hand is steadied on the patient's face. A single incision is usually insufficient, and in most instances two incisions should be made. These may meet, forming the letter T, or one may cross the other at an acute angle.

Knapp's crucial incisions will in many cases furnish a very good pupil. This is performed as follows: The needle is first pushed across the pupil and a horizontal incision of about 4 or 5 mm.

is made. The point of the needle is then raised toward the cornea, pushed upward, and a vertical incision is made downward as far as the horizontal incision. After this the point of the needle is again raised toward the cornea, pushed downward, and a third incision is made from below upward to meet the horizontal incision. The three incisions form a crucial opening.

The discission of a secondary cataract must be well planned beforehand in order to get a sufficiently large opening. Knapp believes "that the greatly varying character of the capsule requires a great many deviations from the general plan. Each case has to be studied by itself, and the incisions have to go through the softest parts of the capsule; hard and inelastic bands and patches should not be attacked, and in case we err in our judgment, finding that such and such a band offers too great a resistance to be severed, we have to cut above and below, to the right and left, as the case may be, creating free pupillary space sufficient for good sight."

III. Step: The Removal of the Knife-Needle.—The knife should assume its original position, *i. e.*, the blade parallel to the plane of the iris and then withdrawn with a sudden jerk. If the maneuver is skilfully performed there is very little if any loss of aqueous.

If the fibers have been cut in the proper direction they retract, making a large black cleft in the membrane.

Complications during Operation.—1. Escape of aqueous during puncture. If only a part is lost the operation may proceed, total loss necessitates the postponement of the operation. This complication may be due either to unskilful manipulations or an imperfect instrument, where the shaft is too small for the blade.

2. If the limbus is perforated too obliquely, or a knife with a shaft too large for the blade is used, the free movements of the knife will be impeded. A knife-needle should not be sharpened too often, as the width of the blade is reduced so that the incision is not large enough for the shaft. In this event the shaft is held firmly in the wound and causes the complication.

3. Injury to the iris may occur immediately after the knife's entrance in the chamber, when the blade is not held parallel to the iris, and also later during the sawing movements, when

the incision is prolonged too far. It causes hemorrhage and also pain and restlessness on the patient's part. A large hemorrhage may become organized, thus closing the opening.

4. If the fibers of the membrane are very dense they cannot be cut with the knife-needle. The membrane may be pierced yet no permanent opening made, as the membrane moves with the knife during the sawing movements. Even in cases where two incisions have been made there may be no gaping and the result is negative. Under these circumstances it is necessary, at a later date, to resort to De Wecker's capsulotomy or extraction.

5. Sometimes after the withdrawal of the knife a small strand of vitreous is seen to follow it. This occurs more often when the point of the entrance lies in the cornea, as practised by some surgeons. To avoid this complication the entrance of the knife-needle should be in the sclera. If this complication arises Haab advises the cutting of the strand, followed by cauterization.

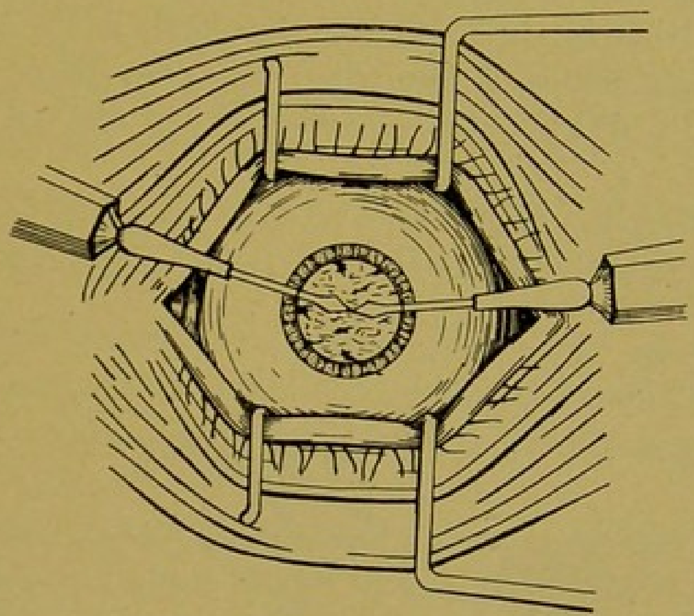
After-treatment.—A light monocular bandage is applied and the patient remains in bed for twenty-four hours. Next day the patient may get up and the bandage is removed. Atropine is instilled one drop daily. If healing is undisturbed the patient may leave the hospital on the eighth day.

Postoperative Complications.—In this day of asepsis and antisepsis we very rarely have any complications, and if there be any present they are usually very slight. This operation may almost be considered dangerless in regard to wound infection and panophthalmitis. In cases where there has been an escape of aqueous after the operation an anterior synechia may result. When a strand of vitreous follows the knife this may produce an irritation of the eye, eventually wound infection, and even iridocyclitis. In such an event hot compresses, atropine, sweats, salicylates, subconjunctival injections of cyanide of mercury may prove beneficial.

In some cases there may be a slight rise of tension after the discission. Sometimes this responds to pilocarpine; if not, an iridectomy or paracentesis of the cornea is always effectual.

Bowman's Discission.—Bowman's discission was originally performed with his stop-needles. Knapp's knife-needles, however, are to be preferred for this purpose. Both needles are entered one after the other or at the same time about 2 or 3 mm. from opposite sides of the limbus in the corneal tissue. Both transfix the membrane at the centre of the pupil at the same point and the handles are brought together. By this movement the points are separated, thus producing an opening in the membrane without any traction on the iris or ciliary body. The opening may be enlarged in the vertical direction by separating the needles in the same manner up and down. This method may be used to advantage in thickened and adherent membranous cataracts.

Fig. 310



Bowman's incision.

Kuhnt's Discission.—Kuhnt makes the discission subconjunctivally, using one of his own knife-needles. The blade forming an angle with the shaft of the instrument can be used from any position. The knife is introduced under the conjunctiva about 5 mm. from the limbus. It is then pushed forward under the conjunctiva until it reaches the corneal margin where the anterior chamber is entered. The membrane is transfixed and incised with sawing movements. The advantage of this procedure lies in the fact that the wound is in vascular tissue and closes quickly. There is also less danger of prolapse of vitreous or infection as the wound is covered with conjunctiva.

DISCISSION WITH DE WECKER'S PINCE-CISEAUX

The following operations are described in this section:

Iridotomy, capsulotomy, irido-capsulotomy, with De Wecker's pince-ciseaux.

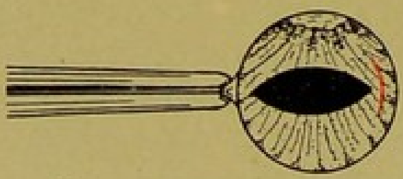
Irito-ectomy.

Iritodialysis.

All these operations may be properly classed under operations on the iris, but as they, in a sense, deal with after-cataracts they are placed in this section. All of this group have one purpose in common, that is, the formation of a pupil in an aphakic eye where the obstruction is due either to a very dense secondary cataract or a diaphragm composed of iris and an organized exudate.

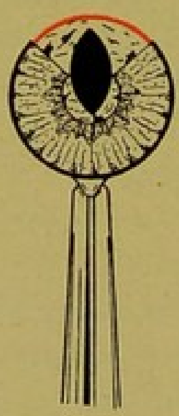
This diaphragm is formed in cases where there has been a plastic iridocyclitis following a cataract extraction or trauma.

Fig. 311



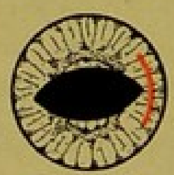
Iridotomy.

Fig. 312



Capsulotomy.

Fig. 313



Iridocapsulotomy.

Iridotomy, Capsulotomy, Iridocapsulotomy with De Wecker's Pince-ciseaux.—**Definition.**—These are operations in which a linear incision is made with a keratome, the pince-ciseaux is introduced and the membrane is cut either with a single or two V-shaped incisions. The operation is termed iridotomy, capsulotomy, and iridocapsulotomy, according to whether the iris alone, capsule alone, or both membranes are incised.

Indications.—1. This operation is indicated in cases of membranous cataracts that are too dense to be incised with Knapp's knife-needle or too firmly adherent to the iris to be extracted.

2. In an eye that has lost its lens through trauma or operation, and where the pupil has become obstructed by a membranous exudate, or where the iris is partially or totally adherent to the wound. It is, however, necessary that the iris should retain some of its elasticity so that the edges of the wound retract after incision. It is needless to state that the eye should not be operated upon for at least six to eight months after all signs of previous inflammation have disappeared.

Contraindications.—1. Hypotony, which often accompanies atrophic iris and fluid vitreous. In these cases, however, if perception of light is good Ziegler's iridotomy may be attempted.

2. In cases where the membrane is dense and the iris atrophic, because the incision will not gape and the operation will be without result. In these cases irito-ectomy and iritodialysis are indicated.

Preparation.—Besides the preparation used in all eyeball operations atropine is instilled to dilate the pupil as much as possible. Cocaine anesthesia is usually sufficient except in small children.

Instruments.—Speculum, fixation forceps, angular keratome, De Wecker's pince-ciseaux, iris scissors, iris spatula.

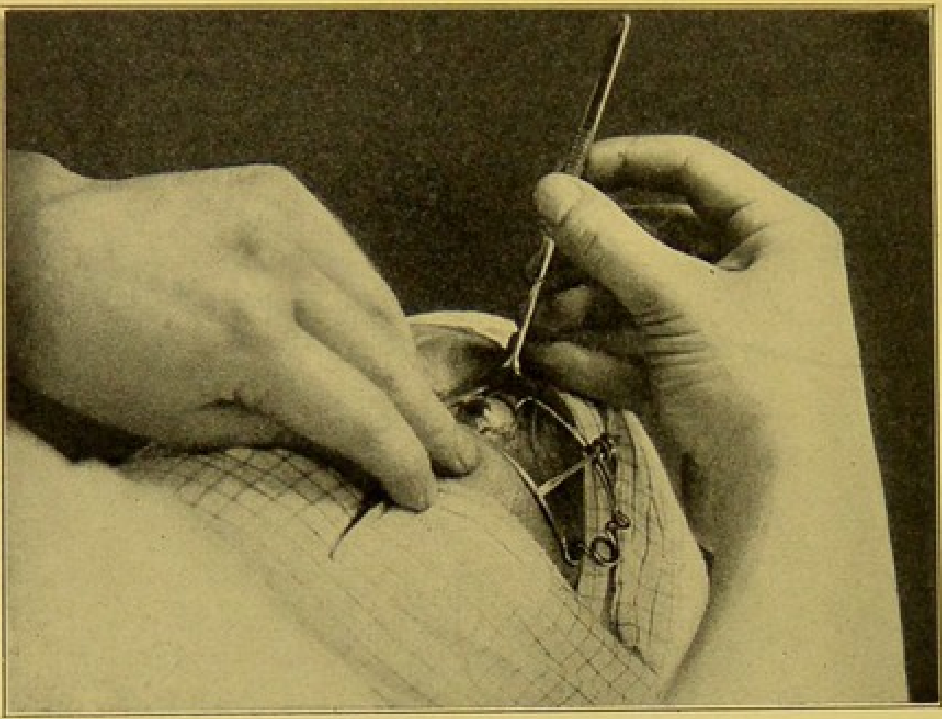
Operation.—The operation is performed in two steps: First step, incision of the cornea; second step, incision of the membrane.

I. Step: Incision of the Cornea.—After the speculum has been inserted in the proper manner the eye is fixed opposite the proposed site of the incision (Figs. 314 and 315). The site of the incision should be chosen so that the fibers that are producing the greatest traction will be cut at right angles, thus causing a sufficient gaping of the wound. As the wound in cataract operations is usually above and the iris is drawn upward the incision should lie in most cases at the right hand end of the horizontal meridian about 1½ mm. in front of the limbus.

In cases of a simple secondary cataract the incision may lie above in the old scar.

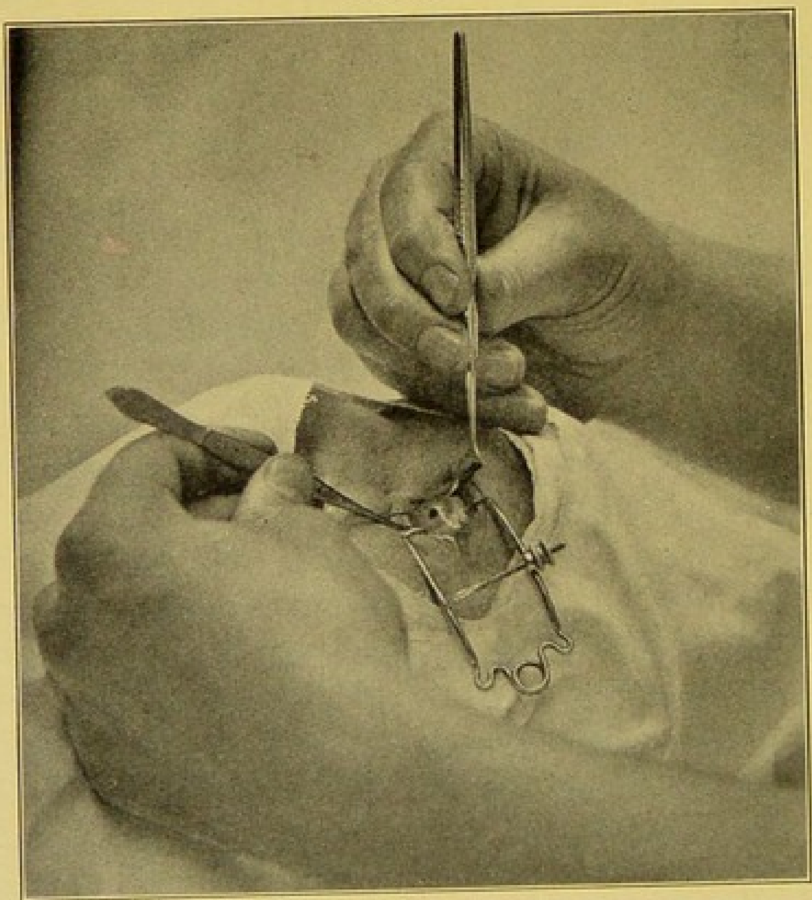
After the point of entrance has been chosen, the keratome,

Fig. 314



European method of using keratome from above.

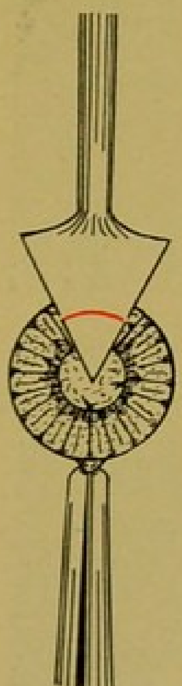
Fig. 315



American method of using keratome from above.

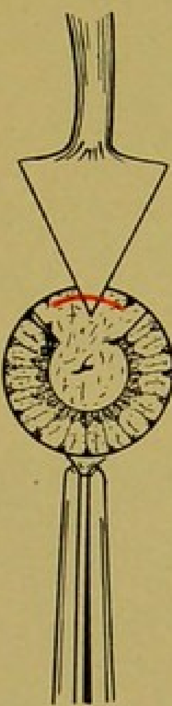
held in the proper manner with the right hand, is passed perpendicularly through the cornea. When the point appears in the anterior chamber the handle is slightly depressed so that the blade is parallel to the plane of the iris (Figs. 316, 317, and 318). It is now pushed forward until there is an incision about 5 mm. in length. After the incision is of proper length the handle is further depressed until the point of the blade comes in contact with the posterior surface of the cornea and the keratome is

Fig. 316



Capsulotomy. Incision of cornea with angular keratome.

Fig. 317



Capsulotomy. Withdrawal of keratome preparatory to incision of capsule.

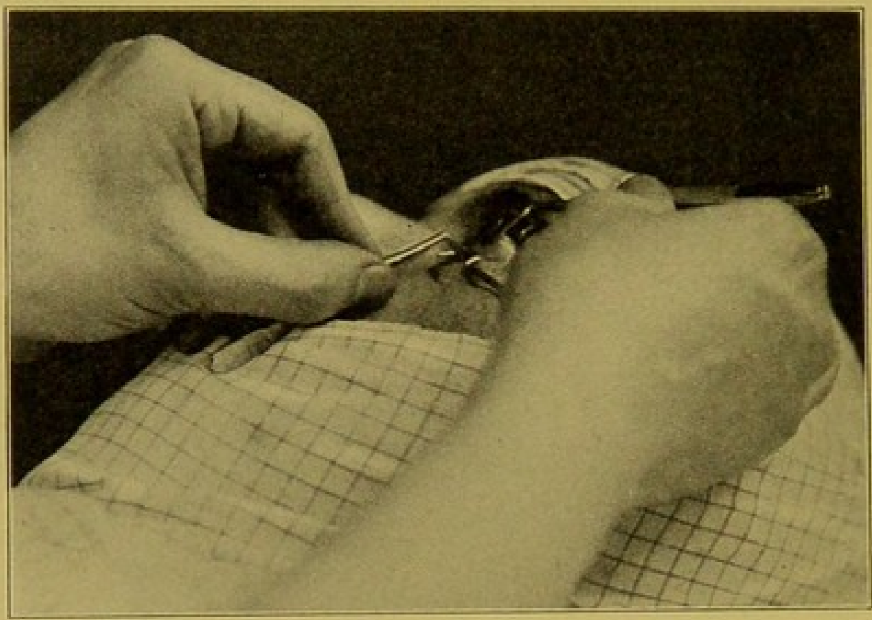
Fig. 318

Capsulotomy. Incision of capsule with angular keratome.

slowly withdrawn. By this maneuver the aqueous is allowed to escape slowly and the membrane comes forward against the cornea. Before entirely removing the keratome the handle is raised and the point plunged through the membrane and then removed. This latter movement is not necessary if the membrane is thin and a pince-ciseaux with one blade pointed is used.

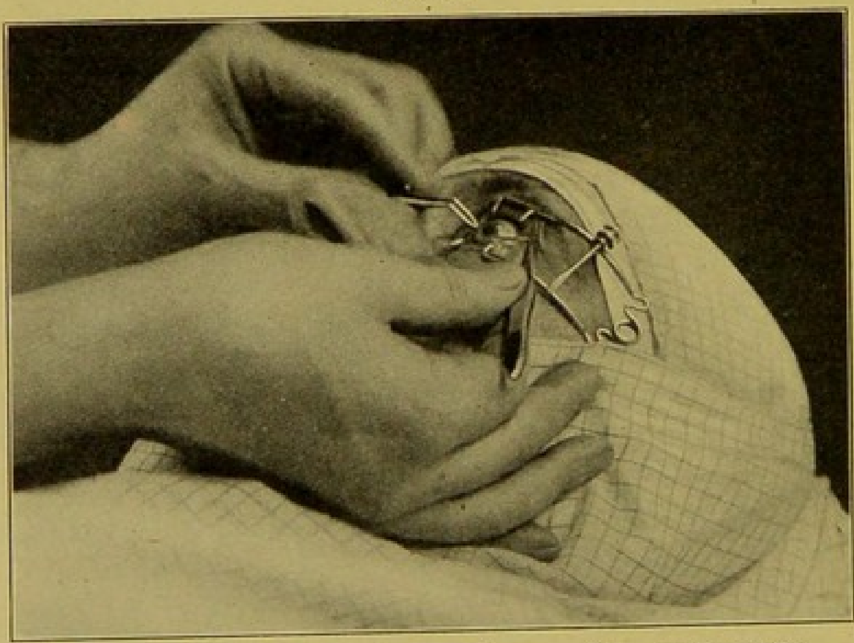
II. Step: Incision of the Membrane.—The pince-ciseaux is entered with blades closed (Figs. 319 and 320). When the opening in the membrane is reached the blades are slightly opened and the sharp one is passed through the opening behind the membrane. If no opening has been previously made with the keratome the

Fig. 319



Method of using De Wecker's pince-ciseaux. From above.

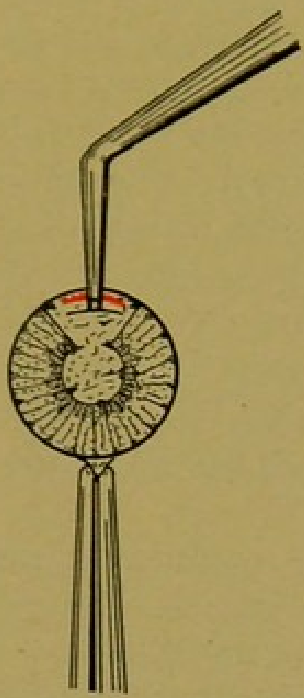
Fig. 320



Method of using De Wecker's pince-ciseaux. From temporal side.

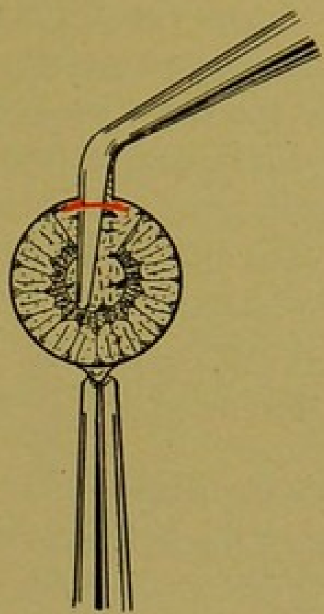
pointed blade is pushed directly through the membrane into the vitreous (Figs. 321, 322, and 323). The blades are now closed and the instrument removed. If one incision does not produce a sufficiently large opening the blades are rotated slightly and

Fig. 321



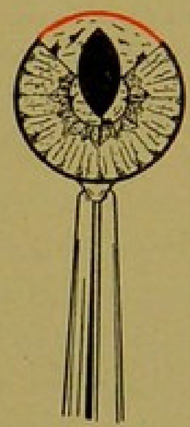
Insertion of De Wecker's pince-ciseaux.

Fig. 322



Incision with De Wecker's pince-ciseaux.

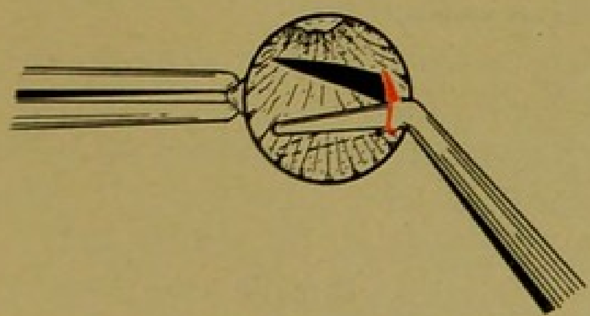
Fig. 323



Capsulotomy. Result.

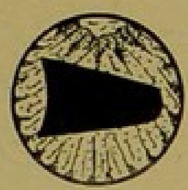
a second incision is made at an angle to the first; a V-shaped incision is thus produced. At the time of the introduction of the

Fig. 324



Second incision for V-shaped incision.

Fig. 325



Discission with De Wecker's pince-ciseaux. V-shaped incision completed.

pince-ciseaux the assistant raises the speculum so that there is no pressure on the eyeball, and it is also good policy to remove the fixation forceps at this time.

Complications during Operation.—The only complication is loss of vitreous, which usually appears after the membrane has been pierced. Loss of a large amount of vitreous is usually due to its fluid condition or to undue pressure exerted during operation. Loss of a small amount is of no consequence. If there is a prolapse of the vitreous the eye is closed for a few moments after operation to allow it to retract; if this has no result it is excised. If, however, the operation is performed with an average amount of skill and without pressure on the eyeball the loss of vitreous is insignificant or often entirely absent.

After-treatment.—The patient remains in bed for twenty-four hours with a light monocular pressure bandage. On the second day he is allowed to sit in a chair. Walking is not permitted before the fourth day, when the bandage is left off. Atropine is instilled daily.

Postoperative Complications.—After the operation there is usually a 4 to 6 mm. wide opening in the membrane which cannot close again. This is due to the retraction of the fibers.

Besides the complications of wound infection there may be a return of the iritis due to operative trauma. The outcome is usually favorable, but it may lead to closure of the opening. In cases of iritis the usual remedies are to be used.

Irito-ectomy and Iritodialysis.—These operations were devised by De Wecker for those cases in which the membrane was very dense and the iris atrophic. The iridotomy with the pince-ciseaux will give no result, as the incision will not gape.

Irito-ectomy.—The operation consists in the removal of part of the membrane, thereby supplementing the loss of retractibility of the iris. The operation is usually resorted to when several iridotomies have been done with no result. It may be performed either with the keratome or the Graefe knife.

Irito-ectomy with Keratome.—An incision is made with the keratome in the upper limbus of the cornea of about 6 to 8 mm. in length. After the aqueous escapes the keratome is passed through the membrane making an opening in it of nearly the same length as the corneal incision and is then removed (Fig. 326). The pince-ciseaux is introduced closed, at one end of the wound, the pointed blade passing through the opening in the membrane. An incision is made running from the opening in the membrane to a point somewhere below the centre of the cornea. The pince-ciseaux is withdrawn and reintroduced at the other end of the corneal incision. A second incision is made so as to meet the first one at its lower extremity. It is often necessary while making the second incision to grasp the iris flap with the iris forceps and put it on the stretch. By means of these three incisions a triangular piece of iris is excised, the base of which corresponds to the corneal incision, the apex lying somewhat below the centre of the cornea. This triangular piece of iris is removed with an iris forceps.

Fig. 326

Irito-ectomy with keratome.

Irito-ectomy with the Graefe Knife—An incision is made with the Graefe knife cutting edge downward in the lower third of the cornea. The point of entrance is in the limbus at the junction of the middle and lower third of the cornea. When the point appears in the anterior chamber the knife is rotated slightly so as to allow the aqueous to escape, then it is plunged into the membrane and carried behind the iris over to the other side

Fig. 327

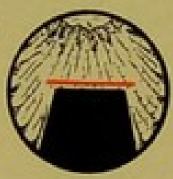
Irito-ectomy with Graefe knife.

until the point of exit, which is opposite the point of entrance, is reached. Rotating the blade so that the cutting edge is forward the incision is finished by cutting through the cornea (Fig. 327). The section will now lie $1\frac{1}{2}$ mm. in front of the lower limbus. There is now a large flap of the cornea and membrane. A triangular flap of the membrane is excised with the pince-ciseaux, as in the preceding operation, and removed with the iris forceps. The flap, however, will be much larger than in the former operation.

Iritodialysis.—This operation is especially indicated in cases in which not only the pupil and coloboma are obstructed, but the iris is also pushed forward and partly adherent to the posterior surface of the cornea.

The incision should be made at a place where some anterior chamber is left (Fig. 328). This is usually in the centre of the coloboma. After a corneal incision of about 5 or 6 mm. in length has been made with an angular keratome the keratome is withdrawn slightly and the aqueous is allowed to escape. The keratome is again pushed forward and plunged into the membrane.

Fig. 328



Iritodialysis.

Two incisions are now made with the pince-ciseaux from the two ends of the incision in the membrane so that the lower ends diverge; a quadrangular area of iris is thereby outlined, the lower edge of which is still attached to the sclera. The flap is now caught with an iris forceps and with gradually increasing traction it is torn from its attachment.

The two operations just described are usually accompanied with considerable hemorrhage from the atrophic iris and loss of vitreous. It is remarkable, however, how these eyes can withstand this severe manipulation. The optic result, that is, the making of an opening in the membrane, is usually successful; nevertheless the sight is always poor on account of opacities of the vitreous and degeneration of the optic nerve and retina.

DISCISSION WITH ZIEGLER'S KNIFE-NEEDLE

This operation is in reality an iridotomy and is therefore indicated under the same conditions as the operation with

De Wecker's pince-ciseaux. As, however, no keratome incision is made, it may be performed in cases of fluid vitreous also, where De Wecker's operation is contraindicated.

Ziegler performs the iridotomy with his knife-needle in four steps: (1) Is the entrance of the knife-needle; (2) is the first incision; (3) is the puncture for the second incision; (4) is the second incision.

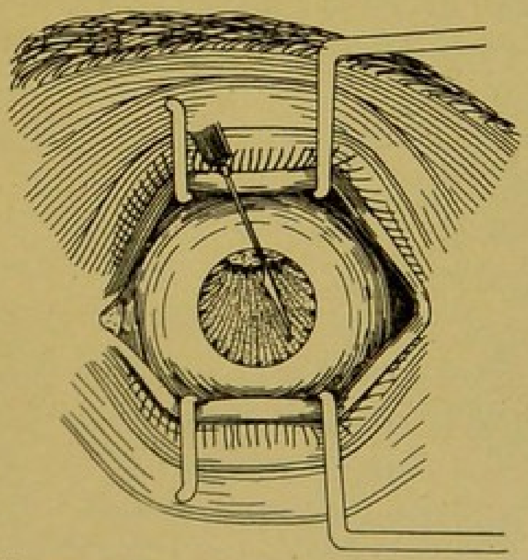
Preparation.—The eyeball is prepared as for any eyeball operation. Cocaine anesthesia is employed.

Instruments.—Speculum, fixation forceps, 2 Ziegler's knife-needles, keratome, sharp iris hook, iris scissors, and iris spatula.

Operation.—After the speculum has been inserted the eyeball is fixed below.

I. Step: Entrance of Knife-needle.—The knife-needle is entered at the limbus above with the cutting edge parallel to the margin of the cornea. It is pushed downward to a point 3 mm. from the limbus and 3 mm. laterally from the vertical meridian, where it is rotated so that the cutting edge is toward the iris (Fig. 329).

Fig. 329

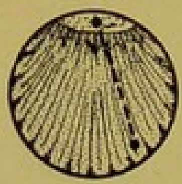


Ziegler's V-shaped iridotomy. Knife-needle entered through cornea. (After Ziegler.)

II. Step: First Incision.—The point is quickly thrust through the iris and without pressure an incision is made with sawing movements obliquely upward to a point near the entrance of the knife-needle. During this manipulation a loss of aqueous is to be avoided (Fig. 330.)

III. Step: Puncture for the Second Incision.—The vitreous entering the wound causes a gaping and a slight displacement of the edges. The knife is raised above the level of the iris, rotated on the flat, and swung across the anterior chamber to a point which lies 3 mm. from the limbus and 4 mm. laterally from the vertical meridian of the cornea. At this point the cutting edge is turned toward the iris and the membrane pierced by a quick thrust.

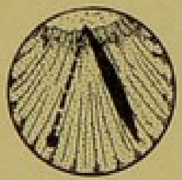
Fig. 330



Ziegler's V-shaped iridotomy. Place of first incision. (After Ziegler.)

IV. Step: The Second Incision.—With sawing movements the incision is carried upward to meet the upper end of the first, Care must be taken that the second incision should end a trifle inside the extremity of the first in order that the last fiber may be severed and thus allow the apex of the flap to fall down behind the lower part of the iris membrane. If the flap does not roll back of its own accord it may be pushed downward with the point of the knife (Fig. 332). After this the knife is again turned on the flat and quickly withdrawn.

Fig. 331



Ziegler's V-shaped iridotomy. First incision completed. Place of second incision. (After Ziegler.)

Fig. 332

Ziegler's V-shaped incision, showing pupil resulting. (After Ziegler.)

Complications during Operation.—1. The iris membrane may be so stiff that the apex of the flap will not retract. In these cases the attempt may be made to push it back with the knife-needle; if unsuccessful, the tip of the knife is plunged through the base of the flap and with sawing movements the fibers are cut across so that the flap falls back as though on a hinge. If this is of no result, and it is definitely established that the vitreous is not fluid, a keratome incision is made in the cornea below the base of the triangle and the flap is drawn out with a sharp iris hook and excised. The base is replaced with a spatula.

2. If the membrane is torn from its base during the first incision the knife-needle must be withdrawn and entered at the lower limbus. In this case the second incision is made from above downward, or a second knife-needle transfixes the loosened edge of the membrane and the second incision is made in the usual manner.

3. In case the apex of the flap is not entirely freed and it is impossible to incise the remaining fibers because of the poor leverage, the knife-needle is withdrawn and reintroduced at a proper distance from the apex in order to secure a good leverage and the fibers are then incised.

4. Loss of aqueous may either follow the use of a poor knife-needle or unskilful manipulation. If this occurs during the first incision the operation is to be postponed.

5. Puncture or injury to the ciliary body may occur. This is due to carelessness, besides causing pain it may produce a post-operative glaucoma or iridocyclitis.

After-treatment.—Both eyes are bandaged and the patient is put to bed for twenty-four hours, after which the unoperated eye may be left open. The patient may sit up in an arm chair on the second day and the operated eye is bandaged for five days.

Postoperative Complications.—These are infrequent. Besides an infection and iridocyclitis a glaucoma may develop. If any of these should occur the routine treatment as outlined in the general part is to be followed.

Iridocystectomy.—This operation, devised by Knapp, is indicated in the same cases as the iridotomy. He describes it as follows:

"Under cocaine anesthesia a Beer's cataract-knife pierces the cornea about 3 or 4 mm. above the lower corneal margin, opposite the scar from the extraction, and transfixes the iris or pupillary pseudomembrane, making an opening 3 or 4 mm. long. The knife is withdrawn. With a blunt hook the lower lip of the iris wound is seized, drawn out of the eye, and abscissed close to the cornea. Eye bandaged. There are scarcely any accidents worth mentioning. The healing is usually prompt, and yields most surprisingly good visual results."

EXTRACTION OF A MEMBRANOUS OR SECONDARY CATARACT

This is in reality a linear extraction, but it is placed here in order to produce a proper sequence in the operations.

Definition.—The operation consists in making a linear incision with a keratome, after which the membrane is grasped with a hook or a pair of forceps and drawn out.

Indications.—Membranous cataracts which are too dense for discission.

Contraindications.—1. Numerous posterior synechiæ.

2. A membranous cataract which is very thin, as it tears easily and cannot be extracted.

3. Fluid vitreous.

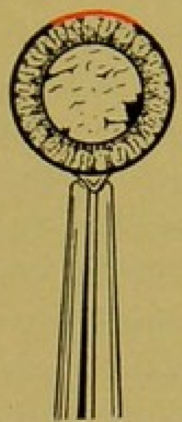
Preparation.—The general preparation is the same as for any eyeball operation. The pupil should be at maximum dilatation with atropine. Cocaine anesthesia, except in small children where general anesthesia is employed.

Instruments.—Speculum, fixation forceps, angular keratome, capsule, iris or Panas forceps, iris scissors, sharp hook, iris spatula, pince-ciseaux.

Operation.—The operation consists of two steps: First step, the incision; second step, the extraction.

I. Step: Incision.—The speculum is inserted and the eyeball fixed below. If the operation is performed for an after cataract the incision is made in the old cicatrix or a little in front of it; in the case of a membranous cataract the site chosen for the incision is the limbus above (Fig. 333). The left hand holds the fixation forceps and steadies the eye; the right hand holds the keratome in the proper manner. The keratome is pushed slowly into the anterior chamber, the blade being held parallel to the plane of the iris. It is slowly advanced until the point is in the pupillary area, thus making the incision about 5 mm. in length. The handle is now depressed until the point of the blade comes in contact with the posterior surface of the cornea, and in this position it is slowly withdrawn.

Fig. 333



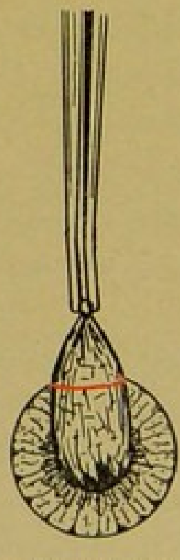
Extraction of membranous cataract. Incision.

II. Step: Extraction.—The extraction may be made with a sharp hook or with a forceps (Panas or capsule forceps). The hook is introduced into the anterior chamber by a gentle sliding

Fig. 334

Extraction of membranous cataract with hook.

Fig. 335



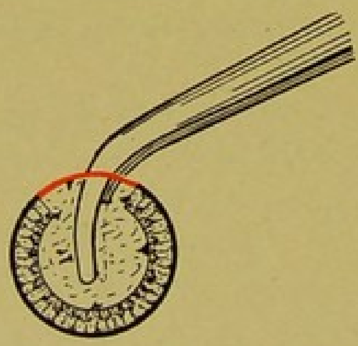
Extraction of membranous cataract with capsule forceps.

movement, point upward, thus avoiding entanglement in the lips of the wound. It is passed down into the pupillary area where it is rotated so that the sharp point is backward (Fig. 334).

The membrane is now pierced. The handle of the instrument is rolled between the fingers in order to secure a better hold on the membrane. By a gentle circular movement it is liberated from the zonule and with slow movements to the right and left (pendulum movements) the membranous cataract is extracted.

If the capsule forceps are used they are introduced with the blades closed. They are first placed on the posterior lip of the wound and slowly pressed downward, thus causing a gaping of the wound, which facilitates the introduction (Fig. 335). The forceps, still closed, are pushed down to or behind the margin of the iris, but under all circumstances they must be pushed far enough to avoid catching the iris at the upper margin, providing there is no coloboma present. The forceps are now opened and with a slight pressure the membrane is grasped and with slow circular movements first liberated from the zonule and then extracted with pendulum movements.

Fig. 336



Extraction of membranous cataract with Panas' forceps.

The Panas forceps may be used in the following manner: After introducing them into the anterior chamber with blades closed and the curve directed toward the right hand they are opened (Fig. 336). The sharp-pointed blade pierces the membrane entering the vitreous, the other remains in the anterior chamber. The blades are now closed, with the membrane between them. Extraction is made as above. If in any of the foregoing methods of extracting the cataract the membrane does not separate from the ciliary body after it is pulled out it is necessary to cut it off with the pince-ciseaux.

Complications during Operation.—1. Complications during incision are the same as in the linear extraction as there described.

2. During extraction with the hook the hold in the membrane may tear out and the membrane is left in the wound. In such case it is to be extracted with the forceps. If it drops back into the anterior chamber the hook is introduced again. In extraction with the forceps the piece grasped may tear out leaving a large portion of the membrane behind. This piece may be wedged in the wound or may remain in the anterior chamber. In the former case it is grasped with a second pair of forceps, using the two forceps, one in each hand, alternately and pulling out the membrane by the same maneuver as pulling a rope hand over hand. In the latter event the forceps are introduced again and a fresh hold is secured.

3. If the membrane is adherent to the iris or ciliary body no force should be used, as otherwise an iridodialysis or cyclitis may be caused. In such cases the membrane is pulled partly out of the wound and then cut off with the iris scissors, or it is better still, if this complication is discovered during operation, to discontinue the extraction and to do an iridocapsulotomy.

4. Prolapse of the vitreous is rare with uncomplicated extractions but quite common with the complications described. If the vitreous presents it is to be cut off. In cases where no iridectomy has been done the iris under these circumstances is pushed up into the wound and its reposition is often very difficult or unsuccessful and consequently it must be excised. When it is likely that the extraction will not be smooth it is better to do an iridectomy beforehand.

After-treatment.—A monocular bandage is applied and the patient put to bed for twenty-four hours. The second day the bandage is changed, one drop of atropine instilled, and the unoperated eye is left open; the patient may sit in a chair. It is advisable to change the bandage daily until the fifth day, when it is discontinued. The patient may leave the hospital on the eighth or ninth day.

Postoperative Complications.—In a smooth extraction there is very little to be feared except a possible infection.

ARTIFICIAL RIPENING

Under certain circumstances it is necessary to remove cataracts which are not ripe. Patients who have only one eye and an immature cataract present in it, or patients who have an immature cataract in each eye, are in a pitiful condition. Unable to get around, they cannot earn their livelihood, if they must depend upon their own efforts. In such cases the removal of an unripe cataract is indicated. This operation, however, is more dangerous than the extraction of a mature cataract, and the results obtained are usually less satisfactory. The cause of this is that the remaining cortex by swelling often produces a severe inflammation or even a secondary glaucoma. These remnants also offer a good medium for the growth of bacteria, and thereby increase the liability to infection. The results obtained are less satisfactory, not only because the patient regains his sight sometime after the operation, but also because there often develops a dense secondary cataract. In order to avoid these unpleasant complications, if the necessity of extraction of an immature cataract arises, resort is made to what is known as ripening. There are several methods advanced for this purpose, such as discission, iridectomy, simple or combined with massage, intracapsular injections of salt solution or aqueous, and artificial heat.

Foerster's Maturation.—The only method that has stood the test of time is the iridectomy combined with massage of the lens known as Foerster's maturation. The operation is performed as follows:

The eyeball is prepared as for any eyeball operation, the speculum is inserted and the eye fixed below. An incision is then made with the angular keratome in the upper limbus about 6 mm. in length and an iridectomy is performed in the usual manner. After this a Daviel spoon is taken and placing it horizontally on the cornea the lens is massaged through it with a firm pressure for about two or three minutes. The movements in massaging are partly circular and partly radial. The speculum is then removed and both eyes are bandaged. The after-treatment is the same as after an iridectomy. During the operation, besides the complications that may accompany an iridectomy, there may be a rupture of the zonule and dislocation of the lens if too great a force is used in the massaging. This complication will show later by a prolapse of vitreous which will occur during the expression of the lens.

The effect of this operation is the rapid maturation of the cataract, which may be extracted six to eight weeks later.

The maturation takes place according to Schirmer's and Hess' experiments by the change in the epithelium of the capsule and in the lens fibers which separate and disintegrate.

A modification of this method consists in the direct massage of the lens with iris spatula or Daviel spoon after an iridectomy has been performed.

CHAPTER VIII

OPERATIONS ON THE EYELIDS

SURGICAL ANATOMY OF THE EYELIDS

The eyelids cover the anterior portion of the eyeball and at the same time form, when closed, a wall which covers the orbital cavity. When the lids are open there is a horizontal fissure between them. This is known as the palpebral fissure and is bounded by the margins of the upper and lower lid. Each lid margin has an anterior and posterior lip; the former is somewhat round and contains the eyelashes, the latter is sharp and is in close contact with the globe. Between these two lips there is a dark line which extends the whole length of the lid, and is known as the intermarginal line.

The eyelid itself may be divided into two layers: an anterior, composed of skin, subcutaneous tissue, and muscles, and a posterior, formed by the tarsus, tarso-orbital fascia, and conjunctiva. The tarsus forms the framework of the lid and gives it its form; the tarsus of the upper lid is somewhat larger than that of the lower. Both tarsi are elastic and moulded to the form of the globe, each having an anterior somewhat convex surface and a posterior concave. They are attached at either end to the margin of the orbit by the canthal ligaments.

The muscles of the lid are the levator palpebræ superioris, the orbicularis, and the non-striated muscle of Müller. The levator has its origin at the apex of the orbit, from here it passes forward, close to the upper wall of the orbit, to its insertion in the tarsus, pretarsal fascia, and skin. Contraction of this muscle not only elevates the lid but also draws it backward toward the orbit.

The orbicularis covers the surface of both lids and is the muscle which closes the eye. A certain portion of the fibers run along the posterior lip of the margin and is known as the subtarsal muscle or the muscle of Riolani. This muscle, although small, has an important function to perform, that is, the keeping of the lid margin in contact with the eyeball. Besides these striated muscles there are two non-striated, one in the upper and one in the lower lid. They are known as Müller's muscles or the superior and inferior tarsal muscles. The origin of these muscles is in the neighborhood of the fornix, from here they pass forward and are inserted in the edge of the tarsus.

The eyelids are opened by the levator raising the upper lid, while the lower lid sinks down from its own weight, although the non-striated muscle of Müller may assist. In slight closure of the palpebral aperture only the muscle of Riolani contracts; in forced closure of the lids, however, as in squeezing the lids together, the whole orbicularis acts. The closure always spreads in a wave-like motion from the outer to the inner canthus.

OPERATIONS FOR ECTROPION

An ectropion is an eversion of the lid which may affect either the upper or lower lid to a various degree. In milder cases there may be only a slight eversion of the lid margin, in more serious cases, however, there may be a complete eversion of the entire lid. An ectropion of the lower lid causes epiphora and irritation of the exposed conjunctiva, while if the upper lid is involved a lagophthalmos is produced, which, if marked, may lead to a loss of the eye.

Types of Ectropion.—From a surgical standpoint ectropion may be divided into three groups:

(*a*) Mechanical.

(*b*) Non-cicatricial.

(*c*) Cicatricial.

Mechanical Ectropion.—This is caused by the pushing away of the lid from the globe (large staphyloma, ectasia of the eyeball, and tumor). This group does not require any of the so-called ectropion operations, as the eversion of the lid is corrected by the removal of the cause that produced the ectropion.

Non-cicatricial Ectropion.—This condition usually affects the lower lid and, according to the causes that produce it, it may be divided into:

Senile Ectropion.—This is due to flabbiness of the skin and loss of tone of the muscle. It usually begins as a slight eversion of the lid margin, due to the fact that the lid sinks of its own weight. Later, as the ectropion increases from the epiphora and chronic catarrh, the orbicularis slips behind the inferior border of the tarsus, thus increasing and maintaining the ectropion.

Paralytic Ectropion.—Paralytic ectropion is caused by a paralysis of the orbicularis. The mechanism of its development is similar to that of the senile ectropion.

Spastic Ectropion.—This condition is due to a spasm of the orbicularis after the lid has been pushed away from the globe by some inflammatory swelling of the conjunctiva. It is a common occurrence in children affected with phlyctenular keratitis, and an ectropion operation is seldom required to bring about a cure. Proper treatment of the keratitis and, if necessary, a canthotomy will, in most cases, suffice. If this treatment is of no avail an ectropion operation must be resorted to.

Luxuriant Ectropion.—This is a term that is often used in cases where the conjunctiva of the everted lid is thickened, hypertrophied, and presents an appearance similar to granulation tissue. This hypertrophy of the conjunctiva may be the cause as well as the result of an ectropion of other origin. In certain conjunctival diseases, as trachoma, the hypertrophic conjunctiva pushes the eyelid away from the eyeball, and if the ectropion increases the peripheric fibers of the orbicularis slip behind the posterior border of the tarsus, increase, and maintain the eversion. In all cases of ectropion the conjunctiva becomes inflamed and thickened wherever it is exposed to the air. This accordingly increases the ectropion and supports it, forming a vicious circle.

Ectropion Intermediary between Non-cicatricial and Cicatricial.—A connecting link between the non-cicatricial and the cicatricial ectropion is a form which is often found in cases of chronic catarrhal conjunctivitis and blepharitis of long standing and also with disorders of the lacrimal apparatus. Here the ectropion is due, partly, to the loss of elasticity of the skin and the thickening of conjunctiva and tarsus, and partly to the contraction of the skin that results from the eczema of the lid caused by epiphora. In operative interference the thickening of the conjunctiva and tarsus as well as the contraction of the skin must be taken into consideration.

Cicatricial Ectropion.—While the non-cicatricial ectropion, that usually occurs on the lower lid, is only distorting and unpleasant to the patient on account of lacrimation, the cicatricial, especially if it affects the upper lid, may have a deleterious effect on the eyeball. In these cases the skin of the lid has been partly or totally destroyed and replaced by scar tissue which contracts, slowly pulling the eyelid away from the globe. This causes improper closure of the palpebral fissure (lagophthalmos) with all its dangerous sequelæ. The lagophthalmos is especially marked if the cicatrix is adherent to the bony wall of the orbit.

The ectropion may be corrected either by section of the scar, placing the lid in the proper position and fixing it there, or by excising the scar. In the latter case the defect produced by the loss of tissue is to be covered, otherwise the scar would reform. This can be accomplished by using some of the healthy tissue in the vicinity or by doing a blepharoplasty.

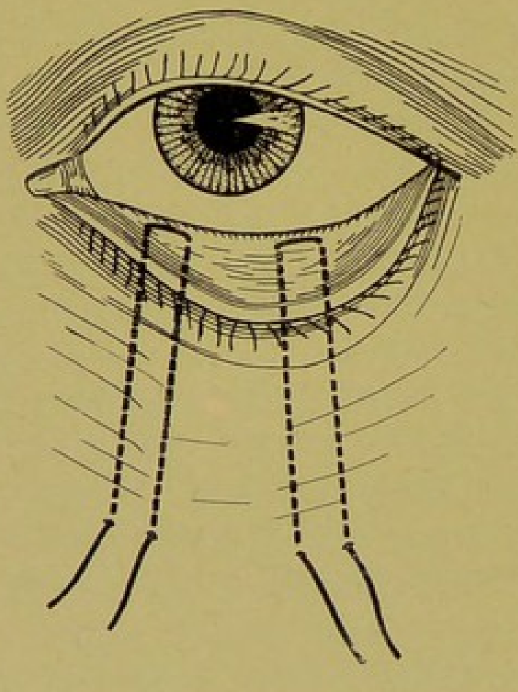
Operations for Non-cicatricial Ectropion.—**Snellen's Ligature.**—The instruments used are 3 double armed heavy silk sutures. The needles should be curved and about 3 or 4 cm. in length.

A few drops of 5 per cent. cocaine solution is instilled in the cul-de-sac and an injection of cocaine-adrenalin is given in the tissues of the lower lid.

A strong silk suture, armed at both ends with a heavy curved needle, is then taken and the first needle is passed through the conjunctiva behind the inferior border of the tarsus. It is then carried down underneath the skin for a distance of about 2 cm. and brought out. The second needle is inserted in a similar manner about 3 or 4 mm. from the first and parallel to it. Two or three such sutures are introduced at regular intervals, after which the free ends are tied over a small roll of gauze tight enough to produce a slight entropion. The dressing is now applied and covered with a slight pressure bandage (Fig. 337 and 338).

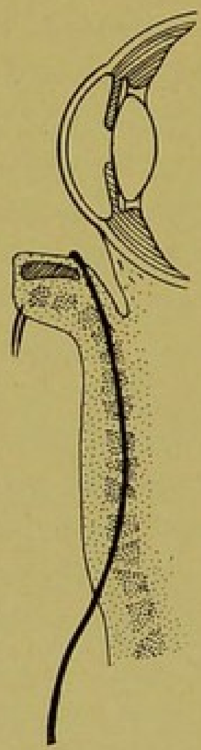
These sutures are allowed to remain in place for two or three weeks until scar tissue has formed along the wound channel. After removal of the sutures the new tissue will keep up the traction and hold the lid in its new position. This operation corrects the ectropion by pulling the inferior border of the tarsus downward and forward, thus rotating the tarsus so that the margin of the lid is brought in contact with the eyeball. The operation, however, does not give permanent results as the fibrous bands that form later give way and the ectropion returns. For this reason it is to be employed in senile ectropion of a slight degree or spastic ectropion.

Fig. 337



Snellen's ligature for ectropion.

Fig. 338



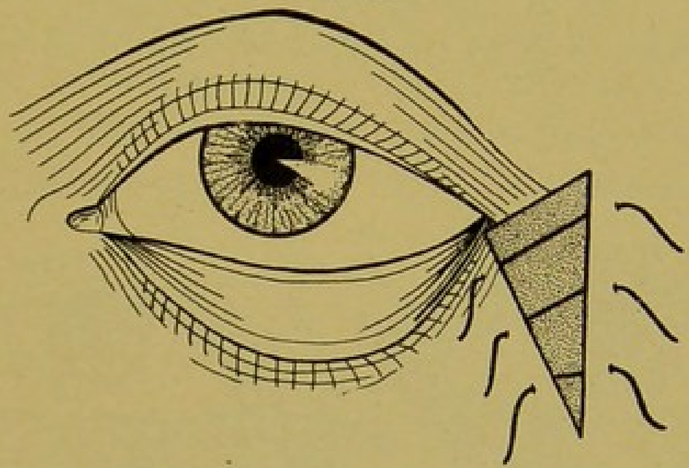
Snellen's ligature for ectropion. Cross-section.

Blepharorrhaphy or Tarsorrhaphy (p. 353).—This operation consists in shortening the palpebral fissure by suturing the eyelids together. This shortening produces an elevation of the lower lid, thereby correcting the ectropion. If the elevation alone is not sufficient the effect of the operation may be increased by making the incision on the lower lid longer than on the upper lid (Blaskovics). This slight modification will not only elevate the lower lid but will also draw it toward the outer canthus. The operation may be performed to an advantage in paralytic ectropion at the outer canthus as well as at the inner.

Szymanowski's Operation.—The instruments used in this operation are: Horn plate, scalpel, curved and straight scissors, mouse-tooth forceps, needle-holder, and fine silk sutures.

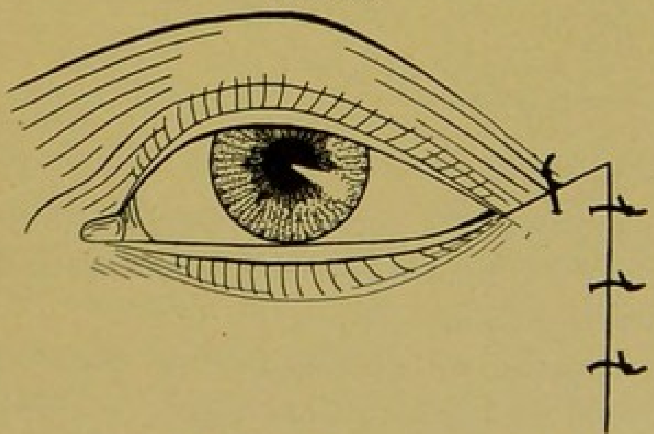
Cocaine is instilled in the cul-de-sac, after which the area to be operated on is rendered anesthetic with cocaine-adrenalin injection.

Fig. 339



Szymanowski's operation for ectropion. First step.

Fig. 340

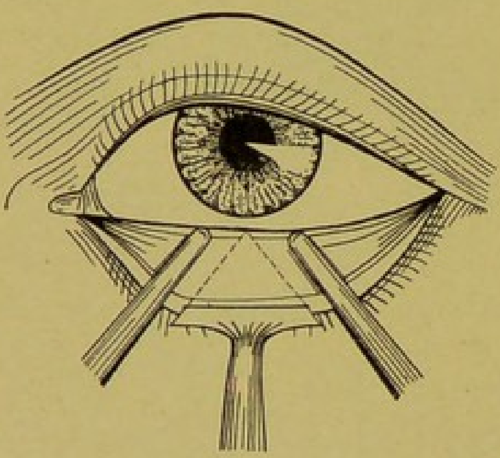


Szymanowski's operation for ectropion. Result.

A triangular flap of skin near the outer canthus is then excised. The first incision extends from the outer canthus upward and outward, its length being determined by the degree of ectropion present (Figs. 339 and 340). The second incision extends downward from the outer canthus for a distance equal to twice that of the first. The ends of these two incisions are connected and the triangular flap of skin thus outlined is removed. An intermarginal incision is now made on the lower lid extending inward from the outer canthus for a distance equal to the length of the first. The skin of the lid is then undermined and sutures are taken uniting the sides of the triangle. By this operation the lower lid is pulled outward and upward. This operation gives good results in senile and paralytic ectropion.

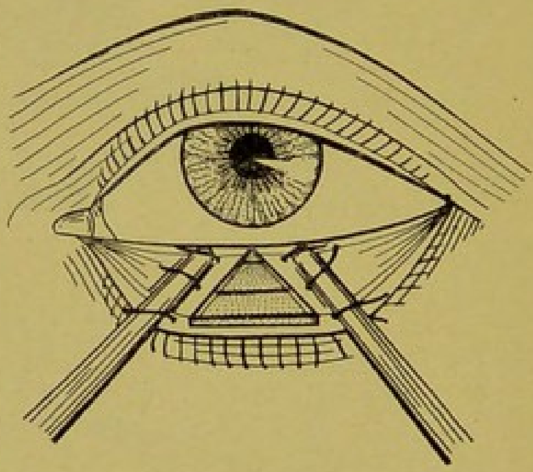
Kuhnt's Operation.—The instruments used are: Knapp's lid clamp or 2 artery clamps, angular keratome, scalpel, mouse-tooth forceps, straight scissors, needle-holder, and silk sutures.

Fig. 341



Kuhnt's operation for ectropion. First step.

Fig. 342



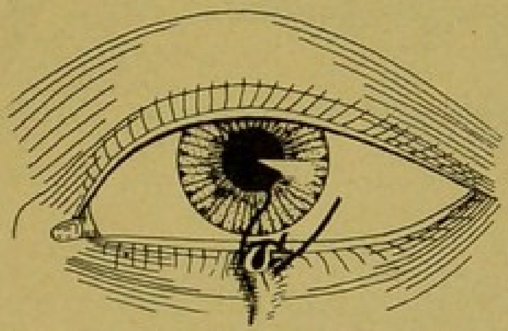
Kuhnt's operation for ectropion. Second step.

A few drops of 5 per cent. cocaine are instilled in the conjunctival sac and the lid rendered anesthetic by a subcutaneous injection of cocaine-adrenalin solution.

The lid is steadied with a Knapp's lid clamp, the skin being in contact with the plate or with a pair of artery clamps, the points of which meet in the fornix (Czermak).

The lid is now well everted and the margin split with an angular keratome, which is thrust into the intermarginal line at the mid-point dividing the lid into two layers. The tarsus is now grasped with a forceps and, by two converging incisions toward the fornix, a triangular piece of cartilage and conjunctiva is excised. The base of the triangle corresponds to the intermarginal incision and should be about ½ to 1 cm. in length according to the amount of tarsus that it is necessary to excise in order to correct the ectropion. Three sutures are now passed through the tarsus, bringing the cut edges together. The first is taken at the apex of the triangular defect; the second midway between the apex and the base (Figs. 341, 342, and 343), and the third, which is the most important, is at the margin of the tarsus in the intermarginal line (Blaskovics). The lid is now released and the sutures knotted in the same rotation as they were inserted. After suturing a fold of skin remains which is grasped with the forceps, sutured, and knotted above. This fold of skin gradually smooths out producing no cosmetic defect. This operation can be employed in all cases of ectropion where the lid is elongated, as in senile ectropion. It also gives excellent results in luxuriant ectropion.

Fig. 343



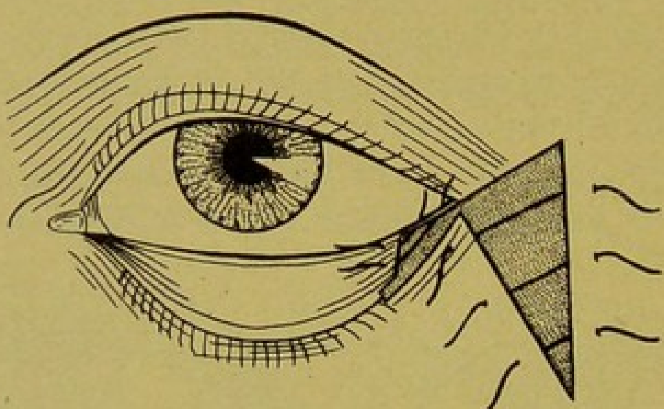
Kuhnt's operation for ectropion. Result.

Elschnig's Operation.—This operation is a combination of the Kuhnt and the Szymanowski operation.

The instruments employed are: Knapp's lid clamp or 2 artery clamps, angular keratome, scalpel, mouse-tooth forceps, straight scissors, needle-holder, and silk sutures.

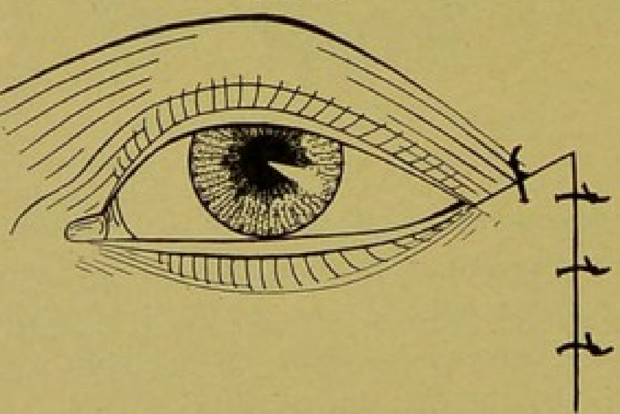
After anesthetizing the conjunctival sac and lid an intermarginal incision is made with an angular keratome near the outer canthus in the lower lid (Fig. 344). The incision should be made a little longer than the piece of tarsus that is intended to be excised. Szymanowski's triangle is now outlined in the skin and the flap dissected out. The skin of the lid, by deepening the intermarginal incision, is separated from the underlying tissues as far down as the margin of the orbit. The hair follicles are removed with a pair of scissors for a distance equal to the intermarginal incision (Fig. 345). A triangular piece of cartilage is then removed according to Kuhnt's method, care being taken that the lateral tarsal incision shall lie exactly at the outer canthus. Tarsal sutures are now inserted after the Kuhnt method and the skin sutures as in the Szymanowski operation. Fuchs modified this procedure by removing the tarsal section from the middle third of the lid.

Fig. 344



Elschnig's operation for ectropion. First step.

Fig. 345

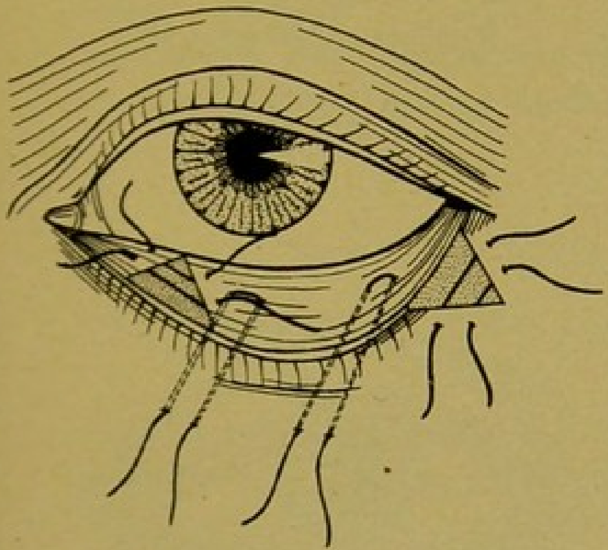


Elschnig's operation for ectropion. Result.

Sattler-Blaskovics' Operation.—The instruments are: Horn plate, angular keratome, scalpel, mouse-tooth forceps, straight scissors, needle-holder, and silk sutures, single and double armed.

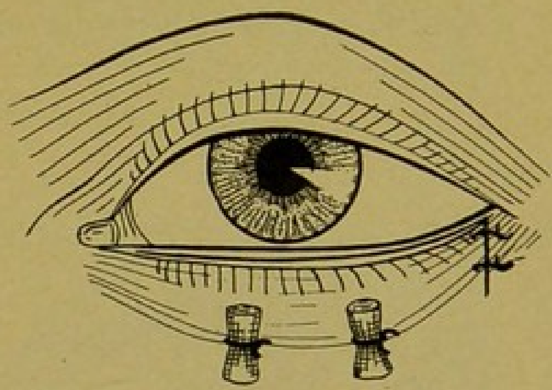
After cocaine has been instilled in the conjunctival sac and a cocaine-adrenalin injection given locally an intermarginal incision for the entire length of the lower lid is made with a keratome (Figs. 346 and 347). The incision is carried downward as far as the margin of the orbit, thus dividing the whole lid into two layers. A small triangular flap is excised, at the inner third of the eyelid, from the tarsus and at the outer canthus from the skin. The tarsal defect is then sutured with one or two sutures. If the tarsus is very much thickened it is to be thinned with scissors and forceps. Two mattress sutures are anchored in the tarsal tissue and brought out obliquely through the skin, so that, when they are tied over a roll of gauze, the skin of the lid

Fig. 346



Sattler-Blaskovics' operation for ectropion. First step.

Fig. 347



Sattler-Blaskovics' operation for ectropion. Result.

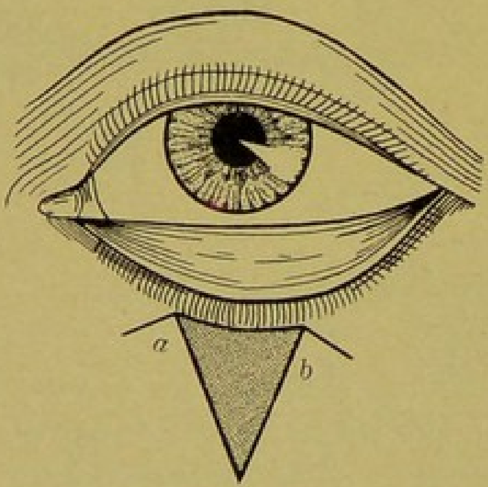
is drawn toward the outer canthus. The edges of the triangular skin defect are now brought together. This operation gives very good results in cases of ectropion following blepharitis and conjunctivitis where the conjunctiva is thickened.

Operations for Cicatricial Ectropion and Blepharoplasty.—A small cicatricial ectropion can be corrected either by the subcutaneous section of the scar or by the excision of it. In the latter case the resulting defect must be covered by skin from the adjacent parts. In cases where the scar is more extensive the ectropion cannot be corrected by any of these methods. Here the scar is to be extirpated and the resulting defect covered by means of a plastic operation (blepharoplasty). The latter operation (blepharoplasty) is also to be resorted to in cases where the whole or part of the eyelid has been removed for tumor.

Operations for Cicatricial Ectropion.—Subcutaneous Section of the Scar.—A subcutaneous section of the scar can only be used in cases of small sharply defined cicatrices. The incising of the scar is accomplished with a scalpel or tenotome. After the lid is replaced in its proper position recurrence may be avoided to a certain extent by massage. If the lid is elongated it is better to do a tarsorrhaphy or a Kuhnt's excision of a triangular piece of the tarsus. Czermak states that in some cases the combination of the subcutaneous section with paraffine injections (Müller) gives excellent results.

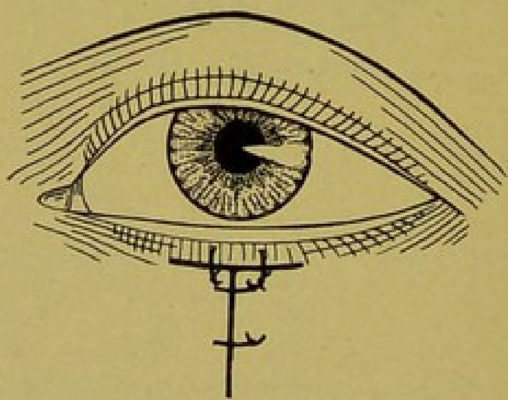
Dieffenbach's Operation.—The instruments are: Horn plate, scalpel, straight scissors, mouse-tooth forceps, needle-holder, and silk sutures.

Fig. 348



Dieffenbach's operation for cicatricial ectropion. First step.

Fig. 349



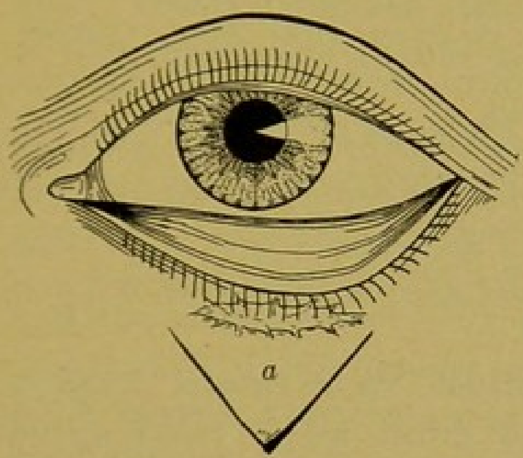
Dieffenbach's operation for cicatricial ectropion. Result.

Dieffenbach excises the scar by three incisions, which form a triangle the base of which is parallel to the lid margin. The base of the triangle at both ends is prolonged downward and outward (Figs. 348 and 349). The two flaps *a* and *b* are now undermined and the edges brought together and sutured in the shape of a *T*.

Wharton-Jones' Operation.—The instruments are: Horn plate, scalpel, straight scissors, mouse-tooth forceps, needle-holder, and silk sutures.

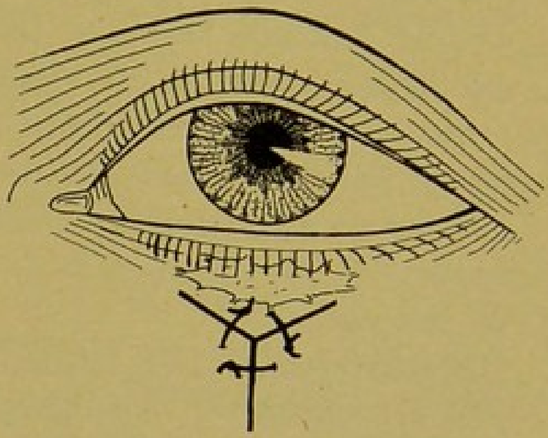
The scar is outlined by two incisions forming a letter *V* apex downward. The flap *a* with scar is dissected up and the eyelid replaced in proper position. The edges of the wound are now sutured together so as to form a letter *Y* (Figs. 350 and 351).

Fig. 350



Wharton-Jones' operation for cicatricial ectropion. First step.

Fig. 351



Wharton-Jones' operation for cicatricial ectropion. Result.

These operations can only be employed in cases where the eyelid is not greatly elongated. As, however, in cicatricial ectropion the eyelid is lengthened to a considerable extent, these operations must often be combined with a tarsorrhaphy, Kuhnt's or Kuhnt-Szymanowski's operation.

BLEPHAROPLASTY

Blepharoplasty is an operation which is employed to correct severe cases of cicatricial ectropion, or to cover a defect caused by the removal of a tumor or injury. In the former the defect usually involves only the superficial layers of the lid and the blepharoplasty follows immediately the extirpation of the scar. In the latter the defect usually involves the entire thickness of the lid, and the blepharoplasty may immediately follow the removal of the tumor (primary blepharoplasty) or sometime later (secondary blepharoplasty).

In all cases the defect is covered by a "flap." The flap may be either pedunculated or non-pedunculated (the latter is also called "skin grafting"). The connecting link between these two plastic operations is known as the Italian method. In this method a pedunculated flap is made on the arm of the patient and it is placed in position on the eyelid by bandaging the arm to the head with a special corset. After the flap has become adherent to the lid the pedicle is severed from the arm. In this manner the pedunculated flap later becomes non-pedunculated. This method, however, has been almost entirely abandoned, as it is too great a strain on the patient.

Blepharoplasty is an operation in which no hard and fast rules can be followed. Each case presents its individual features, and the surgeon's skill and ingenuity is brought into play in deciding which is the best method to use and what modifications of it will be necessary.

Blepharoplasty with Pedunculated Flap.—General Rules.—*Primary Defect.*—1. The primary defect on the eyelid should have a simple geometrical form.

2. All scar tissue should be thoroughly removed. In cases of tumor the incision should, at all points, be in healthy tissue.

3. Bleeding should be checked but no ligatures are to be applied, as they prevent proper union of the flap.

Flap.—1. The flap should consist of normal skin as far as possible and should be taken from the temple if no scar tissue is present there.

2. The flap should be one-third larger in all directions than the defect and exactly the same shape. It should not be too thin but should have a small amount of subcutaneous fat, as this favors a good blood supply.

3. The pedicle should be broad in order to nourish the flap well. It should, however, not be too broad, as such a pedicle is apt to interfere with the blood supply of the flap. In rotating the flap into position there will be a considerable torsion and pressure on the vessels, interfering with nutrition.

4. After the flap is placed in position it should completely fill the defect and remain in place without sutures, this indicating that the flap is not on the stretch. In cases, however, where

there is an entirely new eyelid to be formed, the edge of the flap that is to form the new margin of the lid must have a certain degree of tension. This tension must be equally distributed throughout the entire flap, because if it is more marked on one edge than the other an ectropion or entropion may develop.

5. The flap must be sutured accurately in position.

Secondary Defect.—This is to be closed as far as possible by bringing the edges of the wound together. This produces a linear scar and consequently the best cosmetic result. If the wound cannot be completely closed by sutures the remaining defect is to be covered with a skin-graft.

The three main types of operation are:

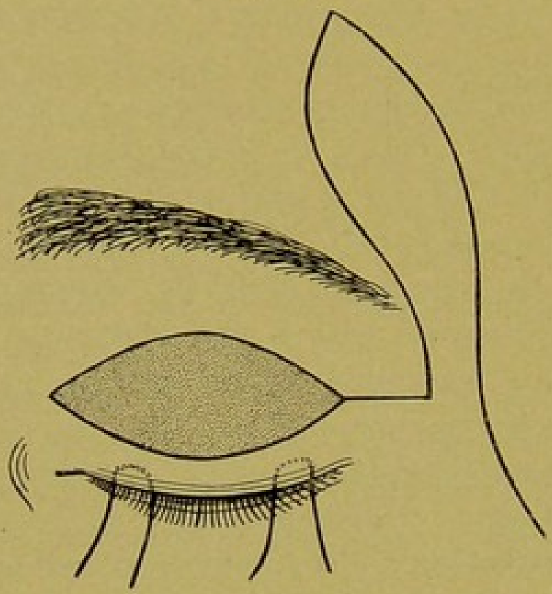
1. Fricke's blepharoplasty.
2. Dieffenbach's blepharoplasty.
3. Celsus-Knapp's blepharoplasty.

Fricke's Blepharoplasty.—The instruments used are: Horn plate, scalpel, curved and straight scissors, mouse-tooth forceps, rat-tooth forceps, sharp wound retractors, artery clamps, epilator, needle-holder, silk sutures, single and double armed and sterile rubber tissue.

This operation may be used in restoration of either the upper or lower lids or for cicatricial ectropion. The following description is one where the Fricke plasty is performed for the relief of a cicatricial ectropion of the upper lid.

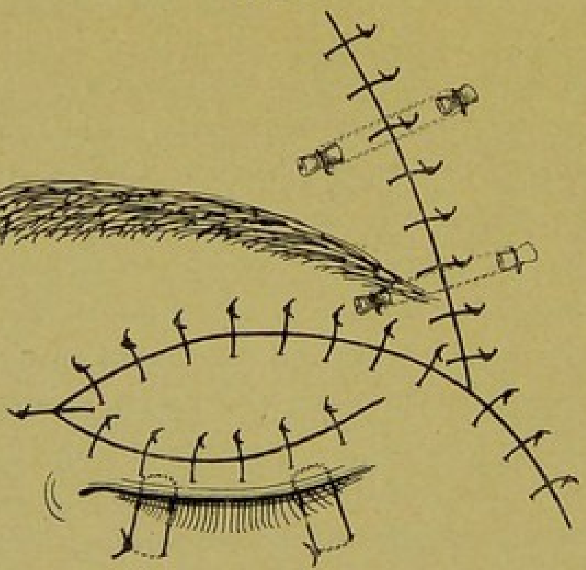
The first incision is made parallel to the lid margin and about 3 or 4 mm. from it. The skin of the edges of the wound is then undermined above and below, all scar tissue being removed with scissors and forceps. The palpebral fissure is now closed. This can be effected in two ways: (1) By suturing the edges of the upper and lower lids together in the same manner as described under tarsorrhaphy, abrading of the lid margins being unnecessary (Figs. 352 and 353); (2) by drawing the upper lid down on the cheek and anchoring it there in the following manner: After the cilia of the lower lid have been epilated one needle of a double armed suture is passed behind the lower edge of the wound and brought out in the intermarginal line; the other needle is passed in the same manner and brought out ½ cm. from the first. An anchorage is now taken in the skin of the cheek parallel to the lid margin and the suture tied. Often two or three such sutures are necessary.

Fig. 352



Fricke's blepharoplasty. First step.

Fig. 353



Result of Fricke's blepharoplasty. (After Blaskovics.)

The defect in the lid is usually oval in shape and a pattern of it is to be made out of sterile rubber tissue. The pattern is then placed on the temple, one end of it being in contact with the defect. The outer edge of the flap should be somewhat longer than the inner in order to allow an easier rotation of it;

this also produces a smaller fold of skin at the pedicle. Then the end of the inner incision is connected with the defect by a horizontal incision. The flap outlined is now dissected up and placed in position over the defect. After this the temporal edge of the secondary defect is undermined and the edges brought together. The nasal edge should never be undermined, as the lid might be displaced outward when the sutures are inserted. If there is any difficulty in coapting the edges of the secondary defect mattress sutures are to be employed (Fig. 353). After the secondary defect has been closed the flap is carefully sutured to the edges of the primary defect.

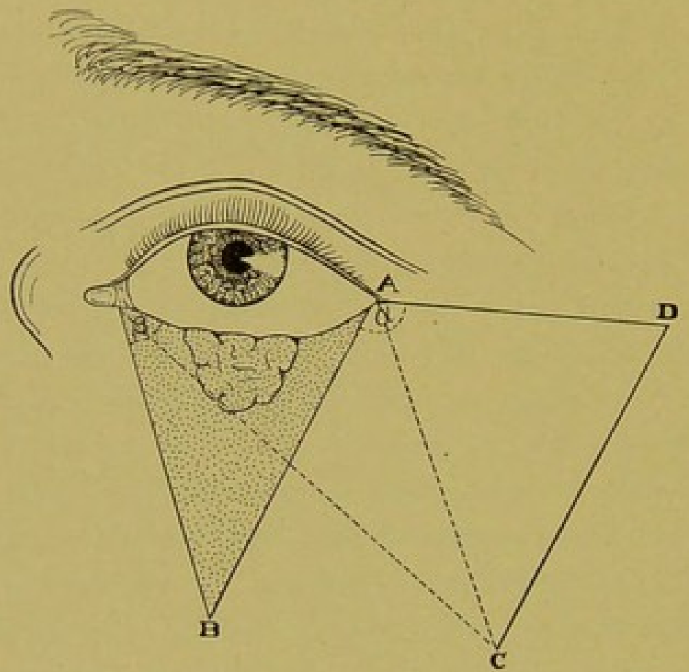
If the whole lid is to be removed, as in case of carcinoma, the upper cul-de-sac is pulled forward to form the base of the new lid. Its edges are sutured to the lower margin of the flap and it is held in position by one or two mattress sutures.

Eversbusch, in such cases, operates in two sittings. First he outlines the flap and after dissecting it up covers with a Thiersch graft both the secondary defect and the posterior surface of the flap. After this he waits until the healing of the graft is complete and then extirpates the lid. The edge of the flap is freshened and it is placed in position to form the new lid and is sutured there. In this manner a new lid has been formed which is lined with epithelium and not mucous membrane. Instead of epithelium, however, the posterior surface of the lid may be covered with mucous membrane of the lip of the patient or from the mucous membrane of the pharynx of a rabbit.

Dieffenbach's Blepharoplasty.—The instruments used are: Horn plate, scalpel, curved and straight scissors, mouse and rat-tooth forceps, wound retractors, artery clamps, needle-holder, and silk sutures, single and double armed (Figs. 354 and 355).

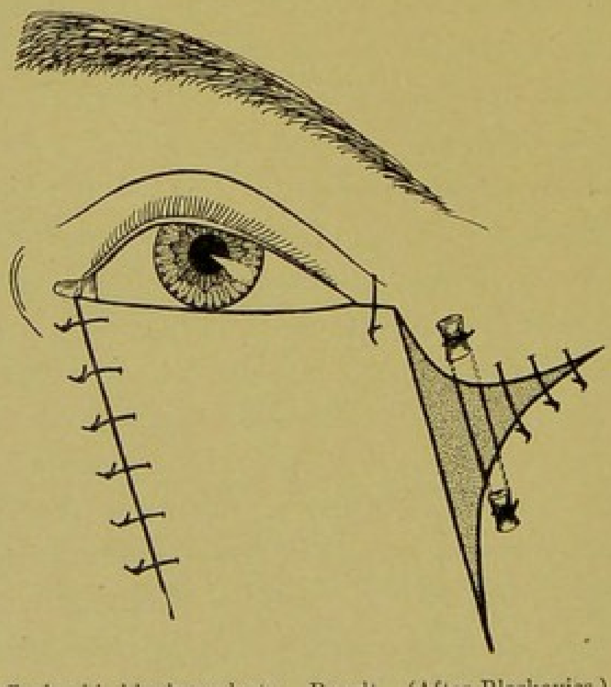
The Dieffenbach plasty is especially well suited for the restoration of the lower lid. The lid is extirpated with two incisions which form the letter *V*. One incision starts from the inner, the other from the outer canthus, outlining thereby a triangle, the base of which is formed by the free margin of the lid. The portion of the eyelid within this area is then extirpated with scissors and forceps. A horizontal incision is then made from the outer canthus toward the temple, which is about 1 cm. longer than the palpebral fissure. From the outer end of this incision another incision is carried downward parallel to the outer side of the defect. The flap, thus outlined by these two lateral incisions, is dissected

Fig. 354



Dieffenbach's blepharoplasty. First step.

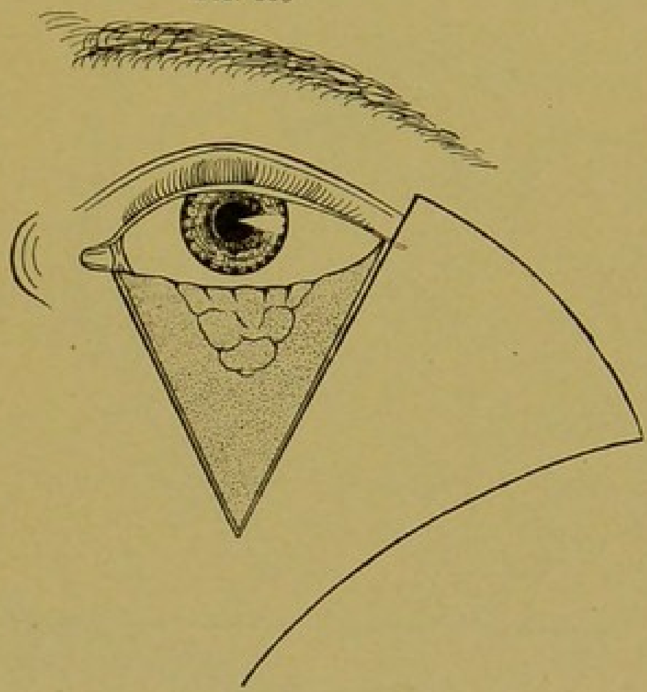
Fig. 355



Dieffenbach's blepharoplasty. Result. (After Blaskovics.)

off and drawn over the defect in the lid where it is sutured to its inner edge; and if necessary one or two sutures are inserted near the outer canthus. The triangular secondary defect is closed so far as possible by bringing its edges together with mattress sutures (Fig. 355). The partial defect that remains may be covered with a Thiersch graft later.

Fig. 356

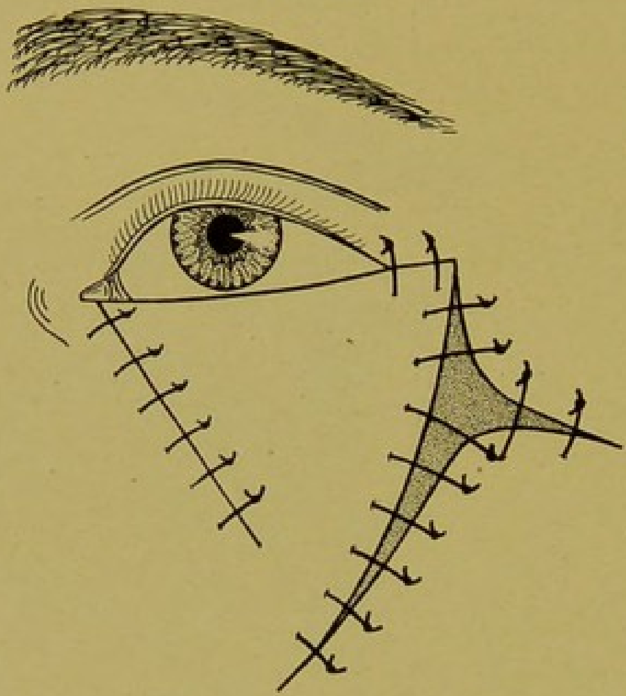


Arlt-Blaskovics' modification of Dieffenbach's blepharoplasty. First step.

This method gives the best results with the modification of Arlt-Blaskovics (Figs. 356 and 357); because (1) the secondary defect is smaller; (2) the angle α is similar to the angle β; (3) the pedicle is narrower, allowing easier rotation; (4) the flap is not on the stretch, thereby correcting the main defects in the original Dieffenbach blepharoplasty (Figs. 354 and 355). Both methods can be combined to an advantage with the transplantation of a piece of cartilage of the ear in the flap, as done in the Vienna clinics (Meller). A small portion of the cartilage of the ear, with the skin attached, is dissected out; the size of the cartilage is the same as the tarsus and the attached skin is somewhat larger. This section of the cartilage is sutured to the flap with mattress sutures at its margin so that the epithelial surface will be turned toward the globe.

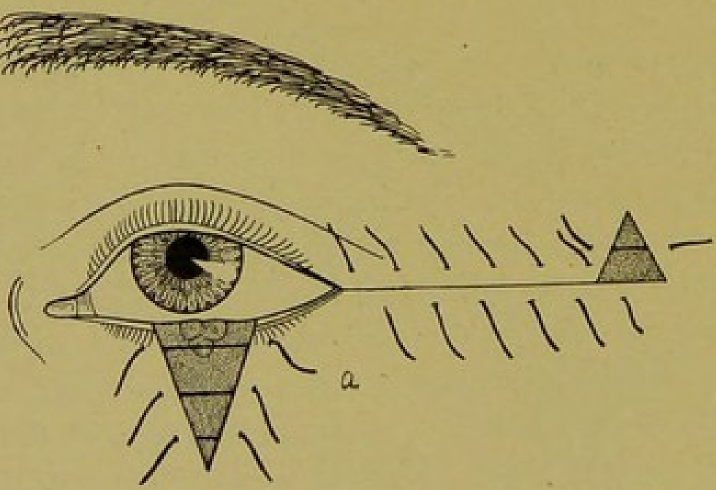
For partial defects on the lower lid the Burrow modified plasty as well as the Landolt plasty give good results. The latter operation may be applied to both lids.

Fig. 357



Arlt-Blaskovics' modification of Dieffenbach's blepharoplasty. Result.

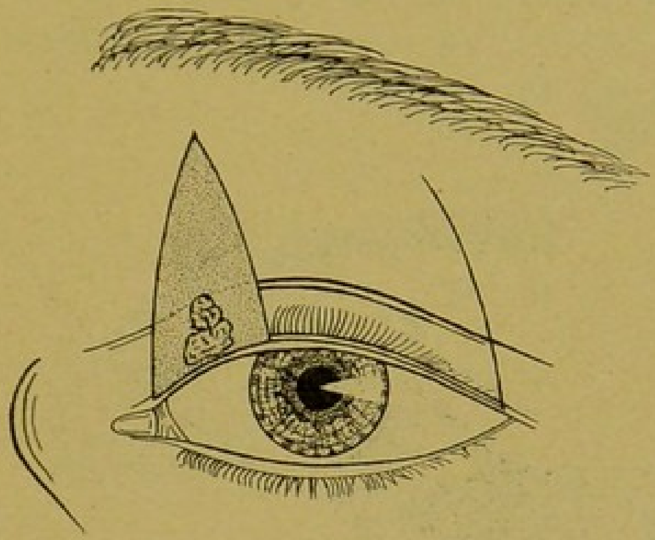
Fig. 358



Burrow's blepharoplasty (modified).

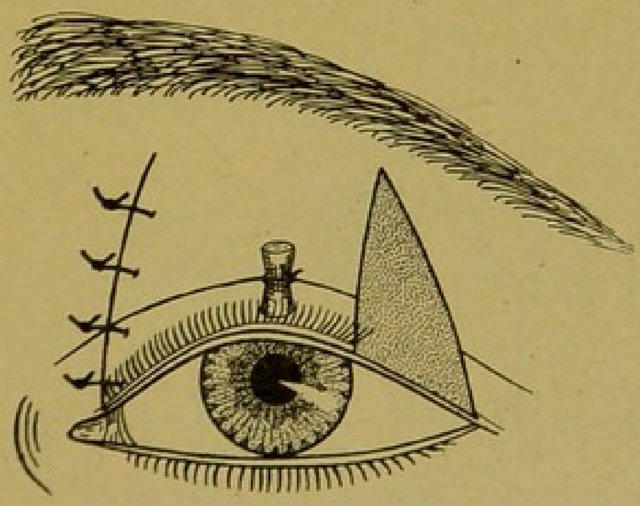
Burrow's Plasty (Modified).—The growth is extirpated by two incisions as in the Dieffenbach operation (Fig. 358). A horizontal incision is carried out from the outer canthus to the hairline. At the outer end of the incision a triangular piece of skin with its base on the incision is excised. The whole skin flap (*a*) is dissected up and sutures are taken both in the primary and secondary defects.

Fig. 359



Landolt's blepharoplasty. First step.

Fig. 360



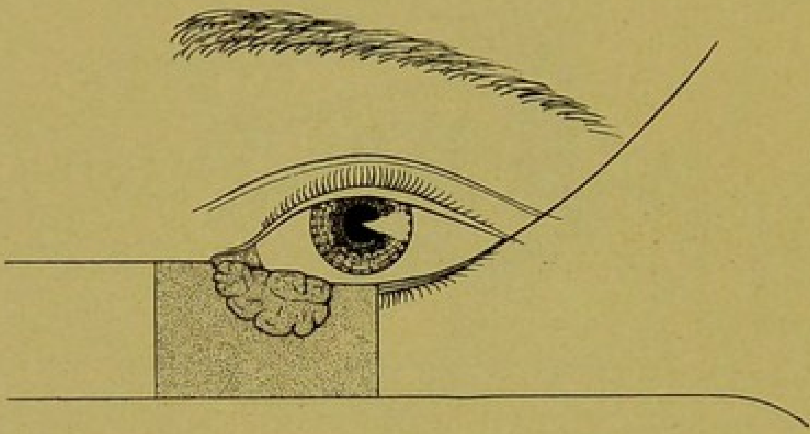
Landolt's blepharoplasty. Result.

Landolt's Plasty.—The instruments are: Horn plate, angular keratome, scalpel, mouse and rat-tooth forceps, straight and curved scissors, wound retractors, artery clamps, needle-holder and sutures, double and single.

Landolt makes an intermarginal incision in the healthy tissue of the lid and then excises the tumor with two curved incisions surrounding the growth. The third incision is curved and parallel to the first running upward from the canthus (Figs. 359 and 360).

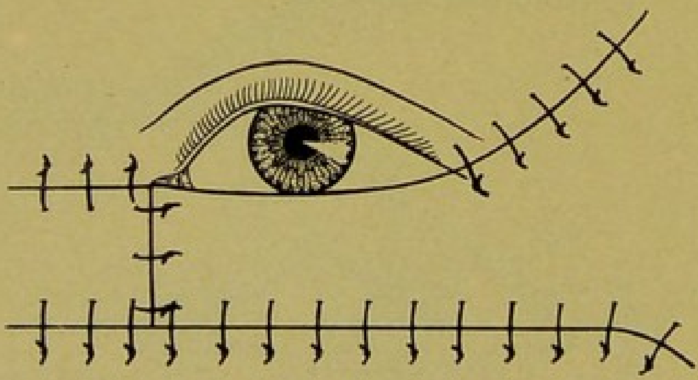
The quadrangular flap thus formed is dissected up from the intermarginal incision, slid over the defect and sutured, leaving a secondary defect at the outer canthus. Mattress sutures are used to hold the flap in place.

Fig. 361



Celsus-Knapp's blepharoplasty. First step.

Fig. 362



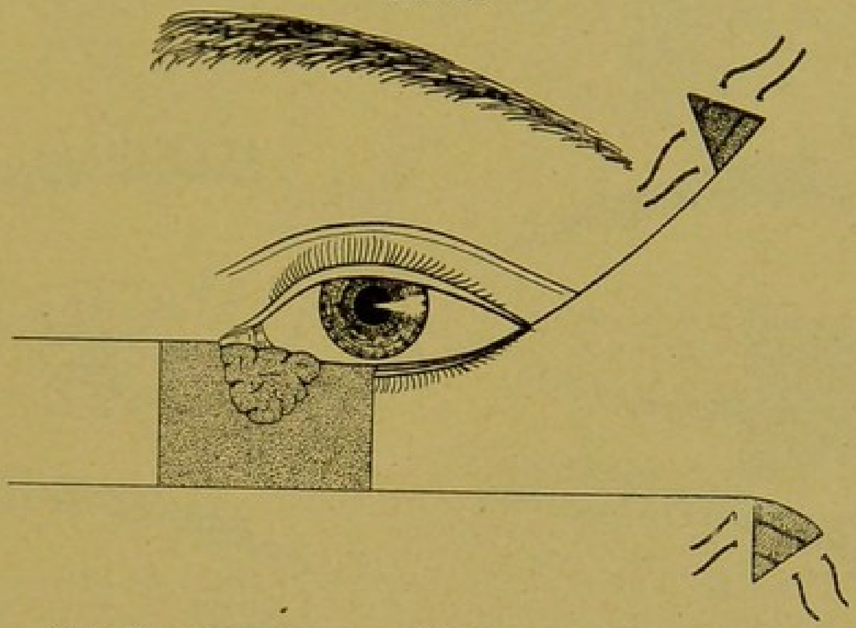
Celsus-Knapp's blepharoplasty. Result.

Celsus-Knapp's Blepharoplasty.—The instruments are: Horn plate, scalpel, curved and straight scissors, mouse and rat-tooth forceps, wound retractors, artery clamps, needle-holder, silk sutures.

This method differs from the preceding methods in that the flaps are not rotated but are stretched into the new position.

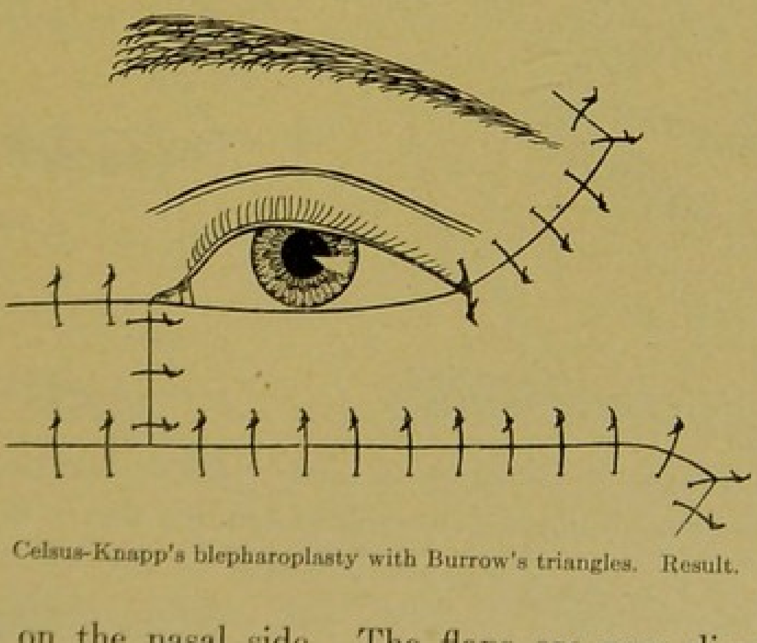
The growth is excised so that the defect will be quadrangular (Figs. 361 and 362). Then the upper and lower incisions are prolonged laterally, the temporal incisions diverging somewhat. Two flaps are thereby formed, the temporal one being longer

Fig. 363



Celsus-Knapp's blepharoplasty with Burrow's triangles. First step.

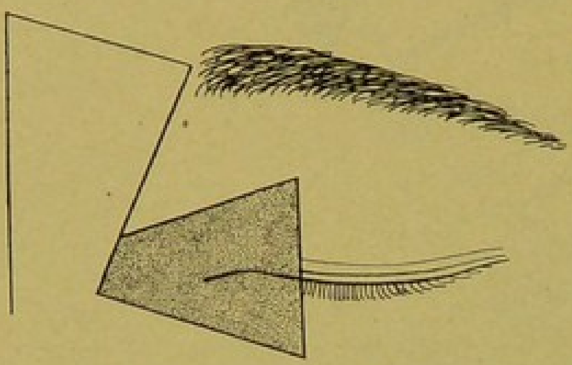
Fig. 364



Celsus-Knapp's blepharoplasty with Burrow's triangles. Result.

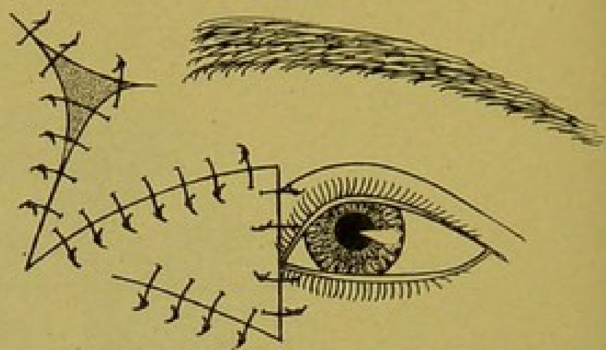
than one on the nasal side. The flaps are now dissected up, drawn into apposition, and sutured. The main disadvantage of this operation is that the flaps are on the stretch. To relieve the traction on the inner end of the flap, Blaskovics advises the drawing of the flap into position and the insertion of a suture on the upper border near the outer canthus which passes through the skin, temporal ligament, and periosteum. A similar suture is inserted in the lower border of the flap opposite the first. Traction may also be relieved by combining Knapp's plasty with the excision of Burrow's triangle as shown in Figs. 363 and 364.

Fig. 365



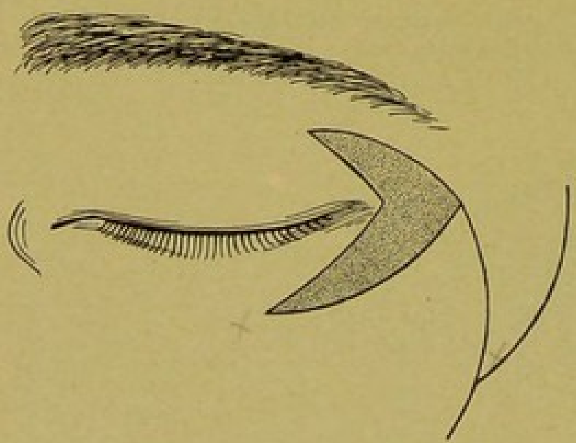
Blaskovics' plasty. First step.

Fig. 366



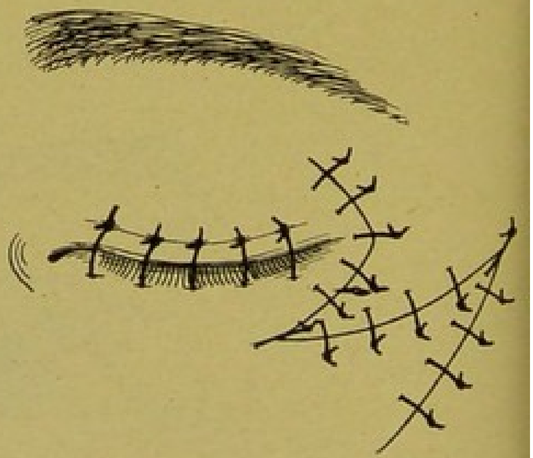
Blaskovics' plasty. Result.

Fig. 367



Richet's plasty. First step.

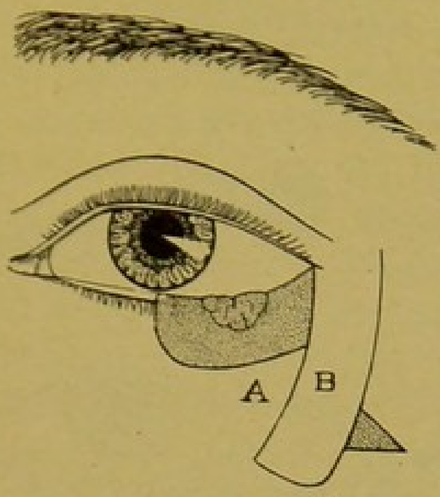
Fig. 368



Richet's plasty. Result.

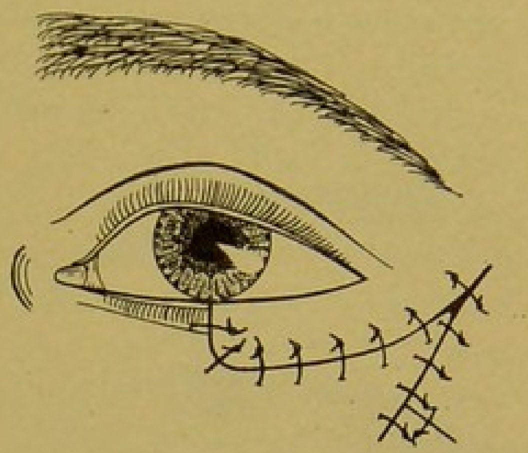
After-treatment of the Eyelid Plasties.—After operation a slight pressure bandage is applied covering the wound first with iodoform gauze. To prevent the gauze adhering to the wound a little sterile borated vaseline is used. The dressing remains in place until the third day, when it is removed, after saturating it with warm salt solution. In taking the dressing off it is always well to remove it from the pedicle toward the free end of the flap; this reduces the chances of detaching the flap. The sutures may

Fig. 369



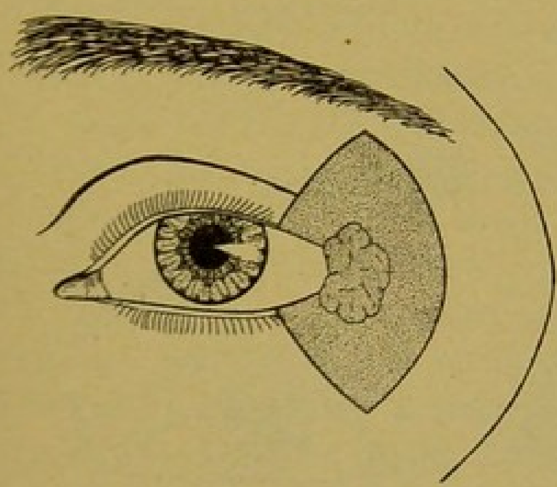
Modified Richet's plasty for lower lid.
First step. (After Blaskovics.)

Fig. 370



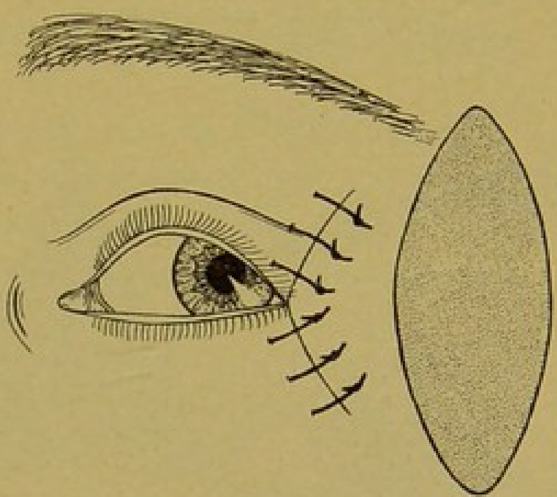
Modified Richet's plasty for lower lid.
Result. (After Blaskovics.)

Fig. 371



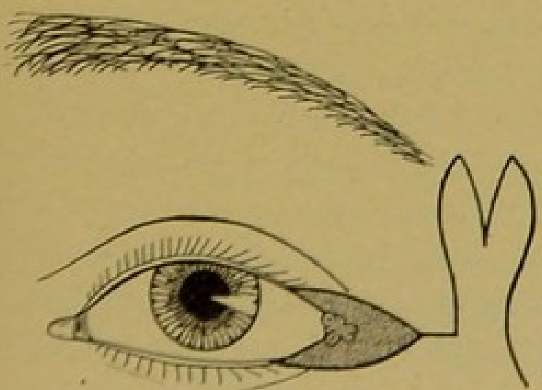
Kovacs' plasty. First step.

Fig. 372



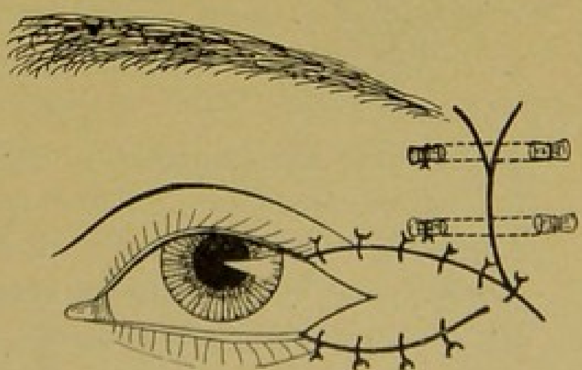
Kovacs' plasty. Result.

Fig. 373



Hasner's plasty. Outer canthus.
First step.

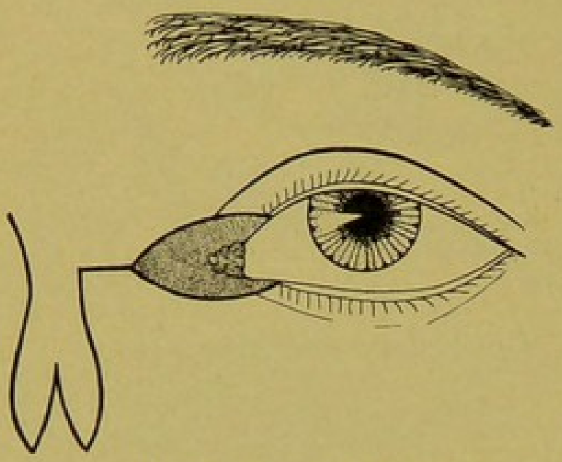
Fig. 374



Hanser's plasty. Outer canthus.
Result.

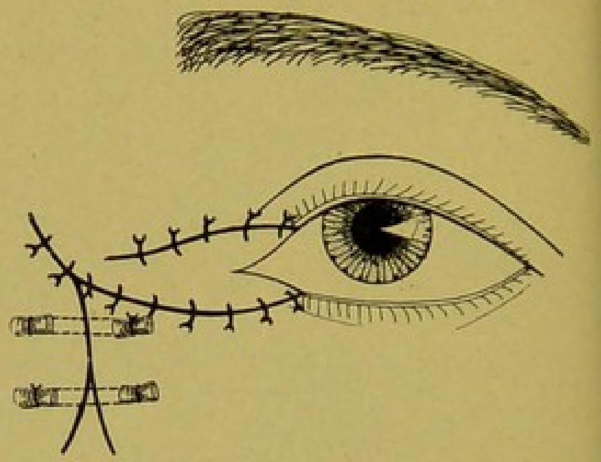
be removed on the eighth or tenth day. Three weeks after operation massage may be begun in order to gain mobility of the lid.

Fig. 375



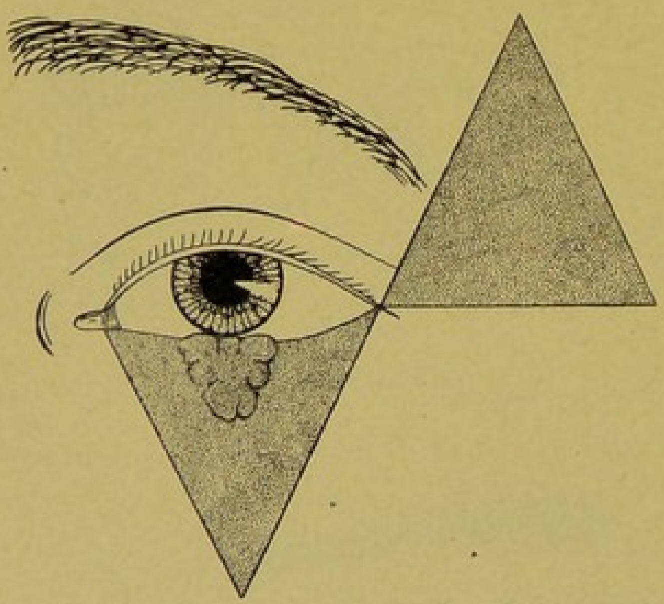
Hasner's plasty. Inner canthus. First step.

Fig. 376



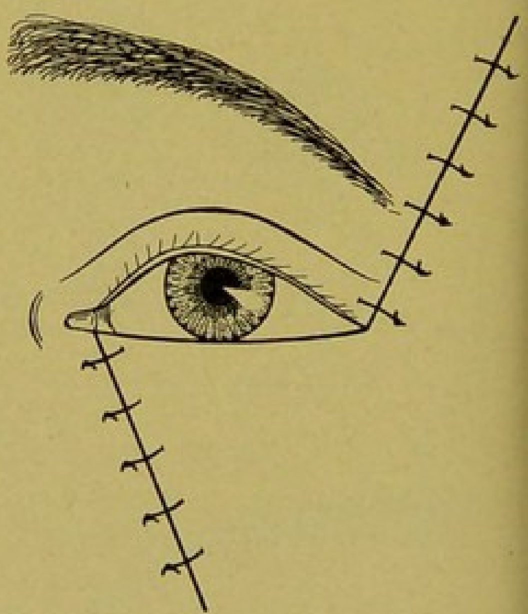
Hasner's plasty. Inner canthus. Result.

Fig. 377



Burrow's plasty. First step.

Fig. 378



Burrow's plasty. Result.

Complications may arise from sloughing; even then there should be no hurry with the removal of the sloughing parts, for often only the superficial layers die and a fair result may still be obtained. If the whole flap should slough, after all inflammatory symptoms have disappeared, a second plasty may be attempted.

Infection may occur as a simple stitch abscess or as suppuration under the flap; in the first case the suture is to be removed; in the second, drainage is to be secured.

Blepharoplasty with Non-pedunculated Flaps (Skin Graft).—In these operations the flap is usually taken from the inner surface of the arm or thigh. The flap may consist of the entire thickness of the skin (Wolfe) or only the epithelium (Thiersch). As in the pedunculated operations great stress should be laid on the preparation of the area from which the graft is to be taken and the primary defect. The former is accomplished by careful cleansing of the skin, the latter by the excision of all scar tissue.

This method of operating, if properly performed, gives better cosmetic results than the pedunculated plasty doing away with the disfiguring scar from the secondary defect. The flap in most cases becomes adherent; only in patients suffering from some systemic disease, as lues, tuberculosis, arteriosclerosis, diabetes, etc., is there danger of failure.

Wolfe Graft.—The instruments used are: Horn plate, scalpel, curved and straight scissors, mouse and rat-tooth forceps, wound retractors, artery clamps, needle-holder, silk sutures, single and double armed, sterile rubber tissue, and sterile saline solution.

This operation is especially suited in cases of cicatricial ectropion. Although it can be performed under a local anesthesia, a general anesthetic is preferable. The operation begins with an incision parallel to the lid margin and about $\frac{1}{2}$ cm. from it. After dissecting the skin down to the margin of the lid and upward to the eyebrows all scar tissue is carefully removed with scissors and forceps. The palpebral fissure is then closed in a manner similar to that described under the Fricke plasty. After this a pattern of the defect is made of rubber tissue and is placed on the skin from where we intend to take the flap. The flap is then outlined about one-third larger than the pattern and dissected off with as little subcutaneous fat as possible. If there is any fat left it is to be removed with the scissors. During this manipulation the flap is constantly flooded with warm saline solution. The flap is then placed in position, and its edges are slipped under the edges of the defect (Kuhnt). If the flap is too large its edges are trimmed with the scissors. It is not necessary to insert sutures to hold the flap in place. While the flap is being placed in position the assistant closes the secondary defect by undermining the edges, drawing them together and suturing them.

After-treatment.—The eyelid is covered with a thick layer of iodoform gauze on which sterile borated vaseline has been applied. Both eyes are bandaged and the patient is put to bed, where he remains for at least three days. On the fourth day the dressing is changed and the unoperated eye is left open. Before removal of the dressing it is well to saturate it with warm sterile salt solution, as usually the gauze is adherent to the flap and the solution will free it. After the flap has been cleansed a fresh dressing is applied in a manner similar to the first. From now on the dressing is changed every third day until the tenth day, when the sutures closing the eyelid may be removed. The healing is complete in about three weeks. It will be noticed at the first dressing that the flap has already lost its pale color that it had at operation. The epithelium is usually exfoliating and is being thrown off. At the following dressings the surface of the flap becomes pinkish and moist. This, however, quickly disappears and the flap becomes covered with new epithelium.

Thiersch Graft.—The instruments used are: Sharp retractors, razor, 2 or 3 probes, and warm sterile salt solution.

This operation is of less value in covering defects on the eyelid following excision of a cicatrix than the Wolfe graft, as the secondary contraction is more marked. It can be used in covering the granulation surface after burns. In such cases the closure of the palpebral fissure by a temporary blepharorrhaphy should be performed at the same time. It is also an excellent method for covering secondary defects following other plasties. The operation may be done on fresh defects as well as on those that are already covered with granulation tissue. In the former case the hemorrhage must be checked before the flap is applied; in the latter the granulation tissue must be removed with a curette. The flaps may be taken either from the inner surface of the arm or thigh. The skin is first put on the stretch with sharp retractors and then the superficial layers are shaved off with a razor. While the flap is still on the blade it is carried to the defect. With a probe the edge of the graft is applied to the side of the defect and held there, then the razor is slowly withdrawn so that the fold of epithelium will slide into position on the defect. A second probe is taken and the flap is smoothed out into position. It is usually necessary to take several grafts to cover the wound surface completely.

The dressing and after-treatment is the same as for a Wolfe graft.

ENTROPION AND TRICHIASIS

Entropion is a rolling inward of the lid.

Types of Entropion.—From the standpoint of the surgeon it may be divided into: (*a*) Spastic (muscular), and (*b*) cicatricial.

Spastic Entropion.—Spastic entropion is due to a spasm of the orbicularis muscle. Its development is favored by any condition that causes pressure of the lid against the eyeball, such as blepharophimosis, enophthalmos, bandage, etc. If from any of these conditions the edge of the lid comes into an oblique position, contraction of the subtarsal muscle turns the edge entirely inward so that the eyelashes irritate the cornea. This irritation in turn causes blepharospasm, which increases and maintains the entropion. Although spastic entropion may occur at any age the loss of elasticity of the skin of the lid predisposes to it, and thus it is found most often in elderly people.

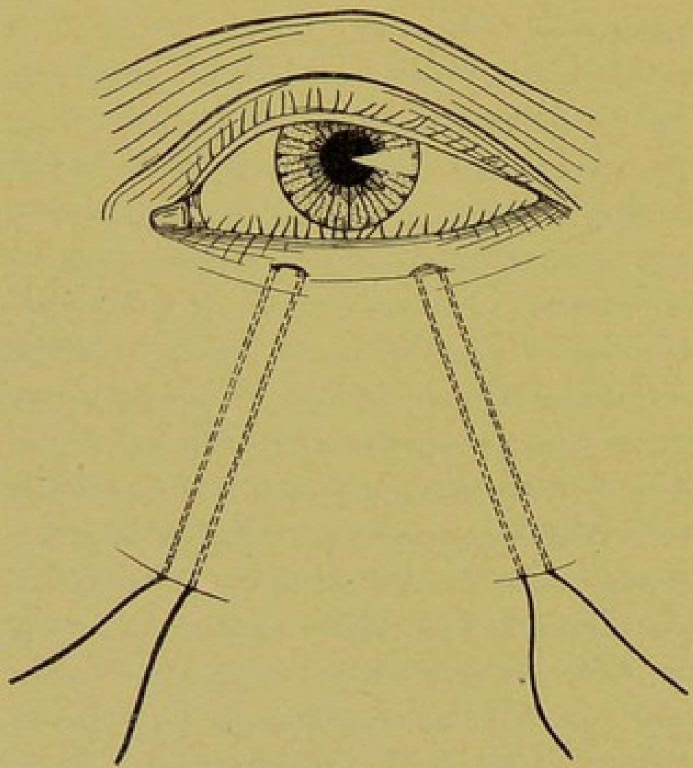
Cicatricial Entropion.—Cicatricial entropion occurs after trachoma, chronic blenorrhea, burns of the conjunctiva, etc. It is due to cicatricial contraction of the conjunctiva and tarsus and the subsequent deformity of the latter. This deformity is not "boat-like," as described in most books, because the tarsus is bent at a sharp angle and is not curved. The angle can be noticed on everting the lid by the white line of scar tissue which runs parallel to the lid margin about 2 mm. from it.

Trichiasis.—Trichiasis is a condition in which the eyelashes are misdirected. It may either follow an inflammation of the lid margin (blepharitis) or a trachoma. This difference is important from an operative point of view, as in the former the tarsus is normal while in the latter it is diseased and deformed.

Entropion and trichiasis usually occur together, so no sharp line can be drawn between operations for the correction of entropion and trichiasis. An operation directed against one also corrects the other. For this reason the operations for the correction of both are treated together in this section.

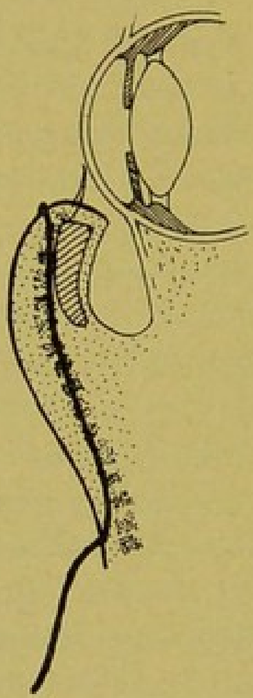
Operations for Spastic Entropion.—The Gaillard-Arlt Ligature.—A strong suture is taken, armed at both ends with a large curved needle. One needle is introduced at about 3 mm. from the edge of the lid through the skin, carried down and brought

Fig. 379



Gaillard-Arlt's ligature.

Fig. 380



Gaillard-Arlt's ligature, showing cross-section.

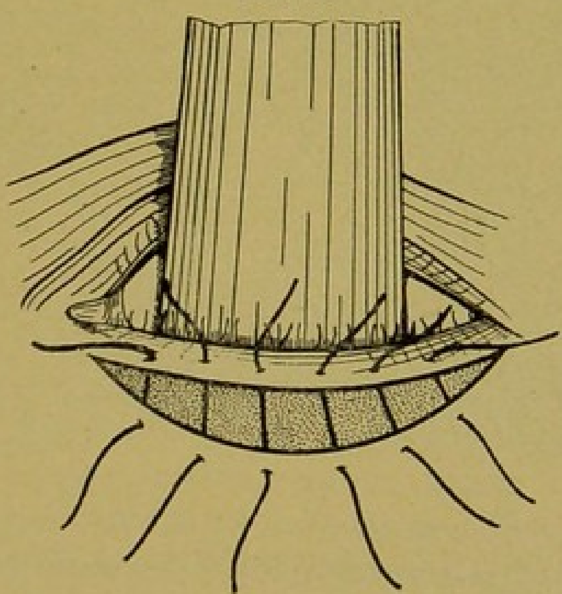
out about 2 or 3 cm. below. The other needle is inserted in a similar fashion about 2 mm. away from the first and carried down parallel to it (Figs. 379 and 380). Two such sutures are inserted, one at the junction of the inner and middle third of the eyelid the other at the junction of the outer and middle third. They pass down diverging slightly and are knotted over a small roll of sterile gauze. The sutures are allowed to remain in for several days up to two to three weeks according to necessity. If the sutures are left in for the above period, cicatricial bands form along the wound channel which to a certain extent continue the action of the sutures after they are removed.

The entropion is corrected in this operation by pulling the edge of the lid downward. Although the result is good, as long as the sutures remain in, the entropion usually returns shortly after the sutures are withdrawn. It may be therefore employed only in slight cases of spastic entropion where the inward turning of the eyelid is only temporary. It can, for instance, be used to an advantage in cases where the eyelid turns in from wearing a bandage.

Celsus' Operation.—Anesthesia is obtained by injecting cocaine subcutaneously and instilling a few drops in the conjunctival sac.

The instruments used are: Horn plate, scalpel, scissors, forceps, needle-holder, and sutures.

Fig. 381



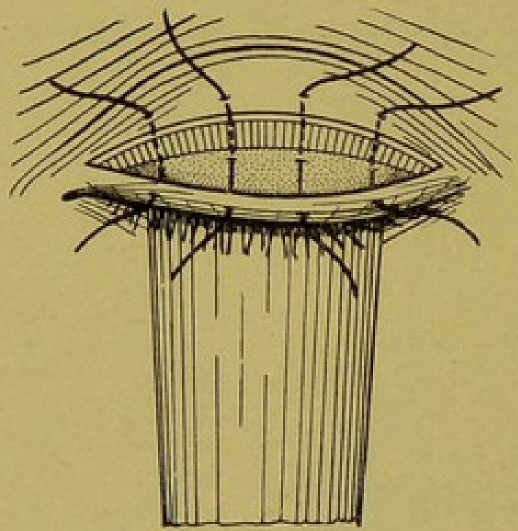
Celsus' operation.

A horn plate is inserted in the lower cul-de-sac and the skin of the lid stretched over it. An incision is carried parallel to the lid margin at about 3 mm. from it. A second incision, slightly curved, is made meeting the ends of the first incision (Fig. 381). A semilunar flap of skin is thereby outlined, the width of which varies according to the entropion. This can be approximately judged beforehand by taking up a fold of skin in the forceps. The flap is now removed with subcutaneous tissue and fibers of the orbicularis muscle. Sutures are now taken closing the defect in a horizontal line. This operation gives good and fairly permanent results. The effect can be increased by taking Hotz sutures, taking care not to produce an overcorrection.

Operations for Cicatricial Entropion and Trichiasis.—Anagnostakis-Hotz's Operation.—The purpose of this operation is to anchor the skin to the tarsus so that the traction thus produced will raise the cilia from the cornea.

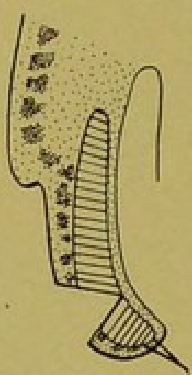
The instruments used are: Horn plate, scalpel, scissors, forceps, needle-holder, and sutures.

Fig. 382



Anagnostakis-Hotz's operation for cicatricial entropion and trichiasis.

Fig. 383



Streatfield's excision of a wedge-shaped piece of the tarsus.

Cocaine-adrenalin is injected under the skin and the conjunctiva is anesthetized with a few drops of 5 per cent. cocaine. A horn plate is placed under the lid and steadied with the hand. An incision is made parallel to the lid margin, 2 mm. from it for the entire length of the lid. The incision should be carried down through the muscle to the tarsus. The edges of the incision are undermined above and below, and then retracted (Fig. 382). The fibers of the orbicularis are grasped with the forceps, pulled away from the tarsus, and excised. The edges of the wound are closed with three or four sutures that are inserted in the following manner: The needle is passed through the upper edge of the wound, then through the tarso-orbital fascia and upper edge of the tarsus and out through the lower edge of the wound. The eye is bandaged for three or four days, after which the sutures are removed and the eye left open. The operation may be performed as well on the upper as on the lower lid. It gives good and permanent results in spastic entropion as well as in trichiasis. The results in cicatricial entropion will be satisfactory and permanent only when the deformity in the tarsus is not marked. In cases where there is marked deformity of the tarsus Hotz advises combining this operation with the excision of a wedge-shaped piece of the tarsus (Streatfield).

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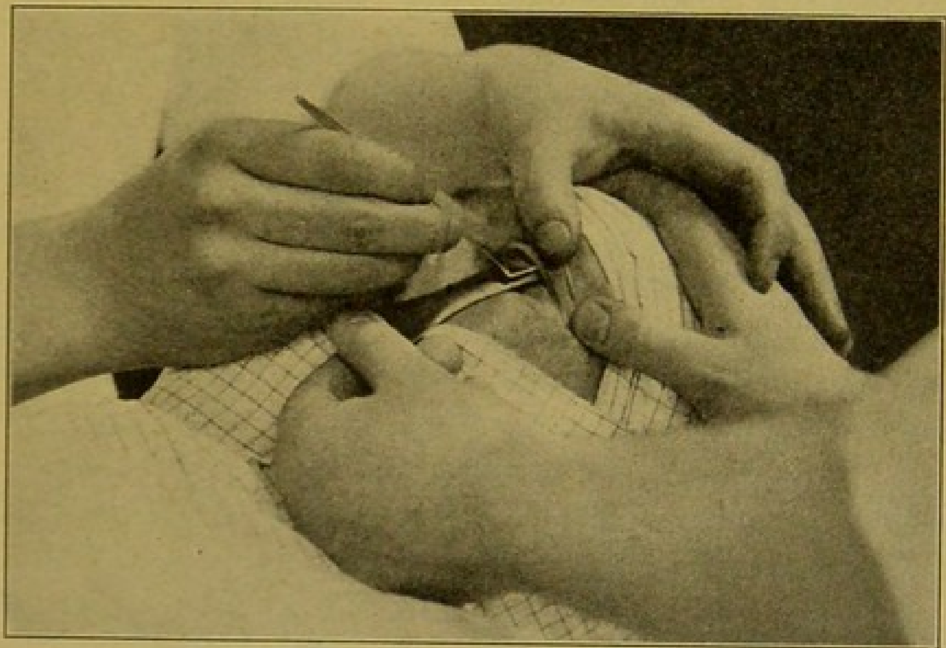
Fig. 384



Method of making intermarginal incision.

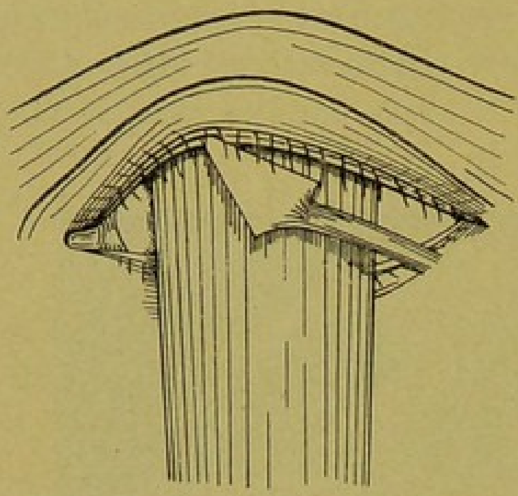
Jaesche-Arlt's Operation (Waldhauer's Modification).—This operation tends to correct the trichiasis by sliding the skin containing the cilia upward. A subcutaneous injection of cocaine-adrenalin is given under the skin and a few drops instilled in the cul-de-sac.

The instruments used are: Horn plate, angular keratome, scalpel, forceps, scissors, needle-holder, sutures, sterile rubber tissue, and salt solution.

The lid is placed on a horn plate and put on the stretch by pulling the lid toward the temple and an incision is made along the intermarginal line with an angular keratome or scalpel.

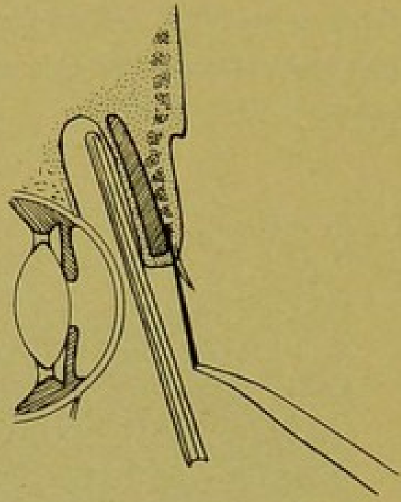
This is done as follows: After the assistant has put the lid on the stretch the operator pulls the skin of the lid slightly upward with the thumb of his left hand. By this maneuver the cilia are raised and the intermarginal line comes into view. The intermarginal incision is made by tracing this line with the keratome or scalpel from one canthus to the other (Figs. 385 to 388).

Fig. 385



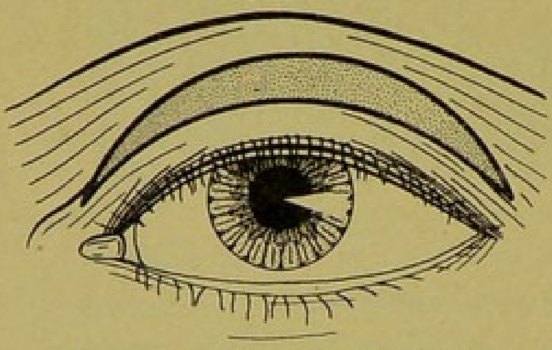
Jaesche-Arlt's operation. Waldhauer's modification. First step.

Fig. 386



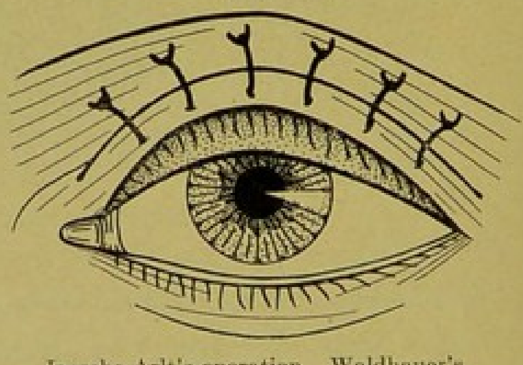
Jaesche-Arlt's operation. Waldhauer's modification. Cross-section.

Fig. 387



Jaesche-Arlt's operation. Waldhauer's modification. Second step.

Fig. 388



Jaesche-Arlt's operation. Waldhauer's modification. Result.

The knife is held parallel to the plane of tarsus (Fig. 386). It is better to make the first sweep lightly and to deepen the incision with several sweeps, each extending from canthus to canthus. The intermarginal incision must be about 3 or 4 mm. deep. The second incision is made parallel to the margin of the lid and about 3 mm. away from it. The third incision is 3 or 4 mm. above the second and is curved, both of its ends meeting the first incision. Both of these incisions go through the skin only. The crescentic flap of skin between the first and second incision is removed and placed in a bowl of warm salt solution. The intermarginal incision is deepened until it connects with the defect. Sutures are passed through the edges of the defect and tied; by so doing the cilia are drawn upward for a distance equal to the width of skin removed. The flap of skin is now taken out of the salt solution and, after the hemorrhage has been checked, it is placed on the margin of the lid and smoothed out, special care being taken that it should be in proper position at the inner and outer canthus. No sutures are necessary.

A piece of sterile rubber tissue is covered with sterile vaseline and put over the edge of the lid as follows: The rubber tissue should be of the same length as the palpebral fissure. After it has been covered with vaseline it is slipped under the upper lid, then turned upward over the margin and the usual dressing is then applied. The bandage is changed every other day for a week or ten days, keeping the edge of the lid covered with vaseline. Sutures are removed on the sixth or seventh day.

Machek-Blaskovics' Operation.—The instruments are: Horn plate, angular keratome, scalpel, 2 forceps, scissors, needle-holder, and sutures, single and double armed.

The Jaesche-Arlt operation gives a very good result except from a cosmetic point of view, for the flap of skin placed at the lid margin is broad and therefore disfiguring. The Machek-Blaskovics operation overcomes this defect by transplanting a narrow flap of skin (Figs. 389 to 395). Local anesthesia is employed as in the preceding operation. A horn plate is then inserted under the lid and an intermarginal incision is made along the entire length of the lid, that is, from lacrimal punctum to the outer canthus. A second incision is now made parallel to the lid margin and about 3 or 4 mm. from it. This incision is about 1 or 2 mm. longer at each end than the intermarginal incision. The third incision is made 1 mm. above the second while the skin of the lid is retracted. This is exactly as long as the intermarginal incision, its ends connecting with the second.

The second and third incisions are carried down to the tarsus. The intermarginal incision is deepened until it connects with

Fig. 390

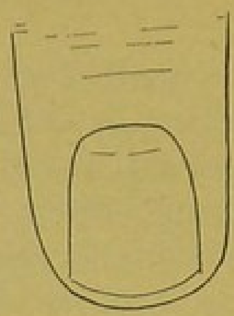
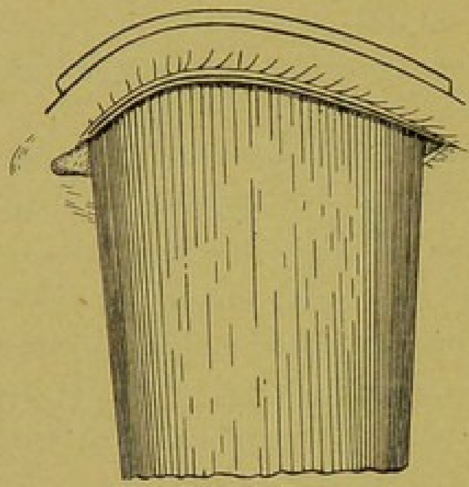
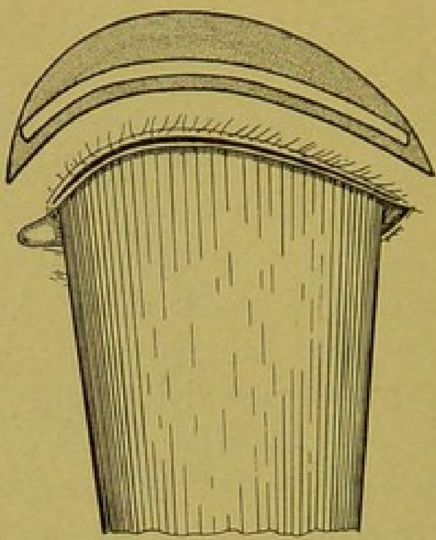


Fig. 389

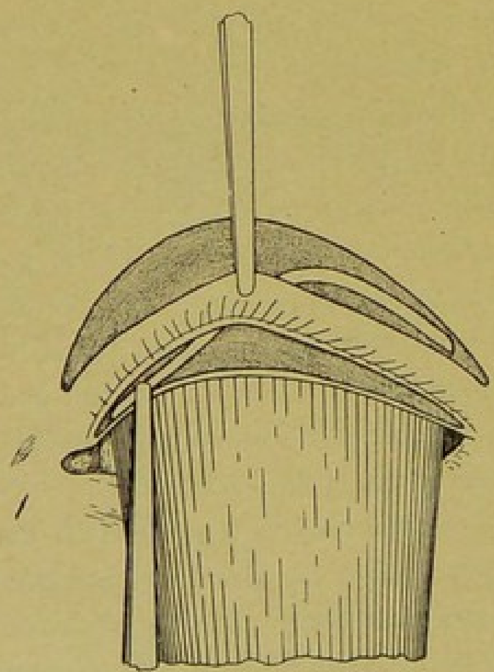


Machek-Blaskovics' operation.
First step.



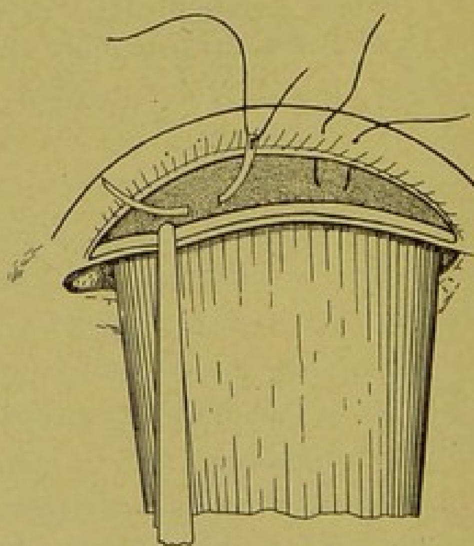
Machek-Blaskovics' operation.
Second step.

Fig. 391



Machek-Blaskovics' operation.
Third step.

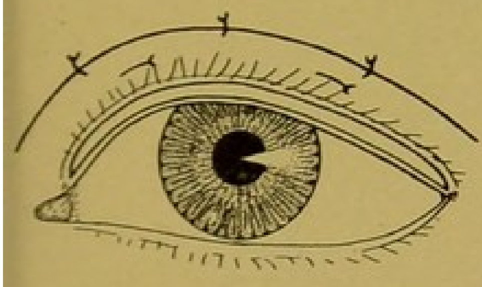
Fig. 392



Machek-Blaskovics' operation.
Fourth step.

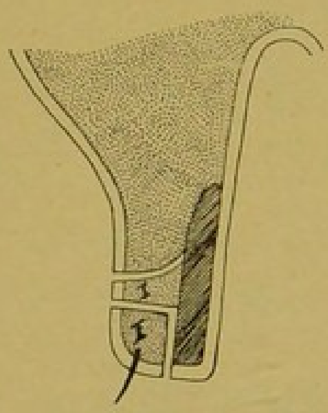
the second, and a bridge-like flap of skin is freed from the underlying tissues. The bridge of skin is now grasped with a pair of forceps and raised up, and a second pair enters the intermarginal incision and seizes the narrow pedunculated flap. The position of the two flaps is now interchanged so that the pedunculated flap is brought down to the lid's margin, where it is smoothed out and placed in position. It is then anchored to the tarsus by two mattress sutures. These sutures are inserted as follows: The lid margin with the pedunculated flap is grasped with a forceps and pulled down. One needle of a suture, armed at both ends, is passed horizontally above the flap through the pedicle into the tarsus and brought out again. Both of the needles

Fig. 393



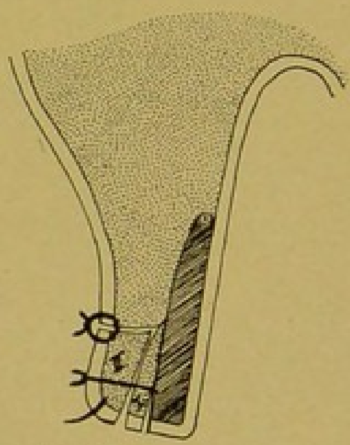
Machek-Blaskovics' operation. Result.

Fig. 394



Machek-Blaskovics' operation. Cross-section.

Fig. 395



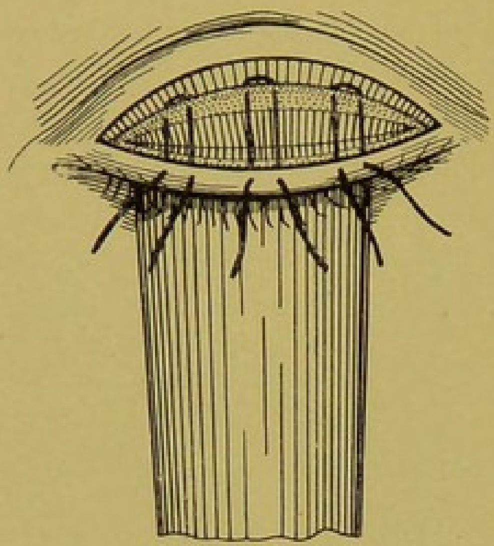
Machek-Blaskovics' operation. Cross-section.

are passed through to the bridge flap, coming out behind the cilia about 2 mm. from each other. These sutures are inserted at each end of the middle third of the lid. The upper wound is closed with several sutures and a bandage applied. Sutures are to be removed on the fourth or fifth day.

Snellen's Operation.—Snellen's operation corrects the trichiasis by bending the lid margin with the cilia outward. Local anesthesia is employed. The instruments used are: Horn plate, scalpel, scissors, forceps, needle-holder, sutures, double and single armed, and glass beads (Figs. 396, 397, and 398).

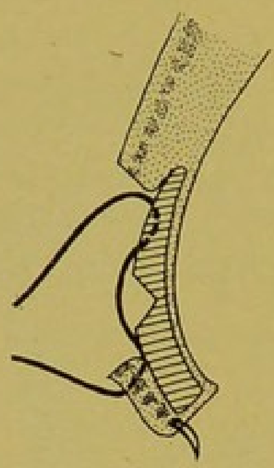
A horn plate is inserted under the lid and an incision is made through the tissues of lid down to the tarsus about 2 mm. above the margin of the lid. The edges of this incision are undermined in both directions, and then a 2 mm. strip of the fibers of the orbicularis is removed with the scissors and forceps so that the

Fig. 396



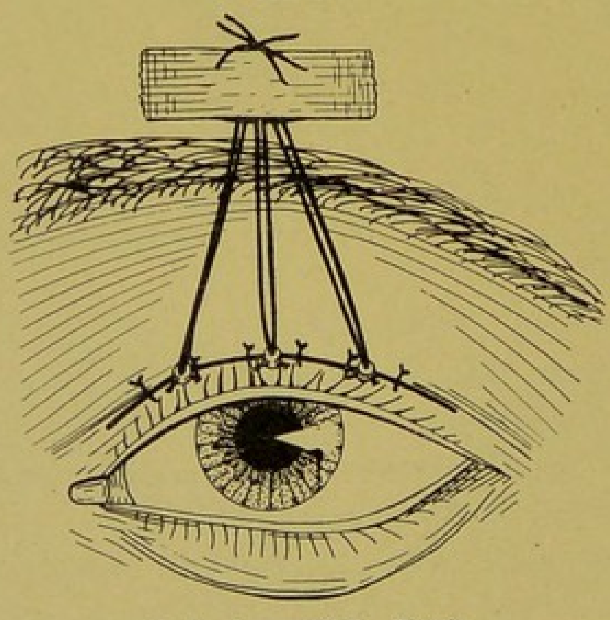
Snellen's operation.

Fig. 397



Snellen's operation, showing cross-section.

Fig. 398

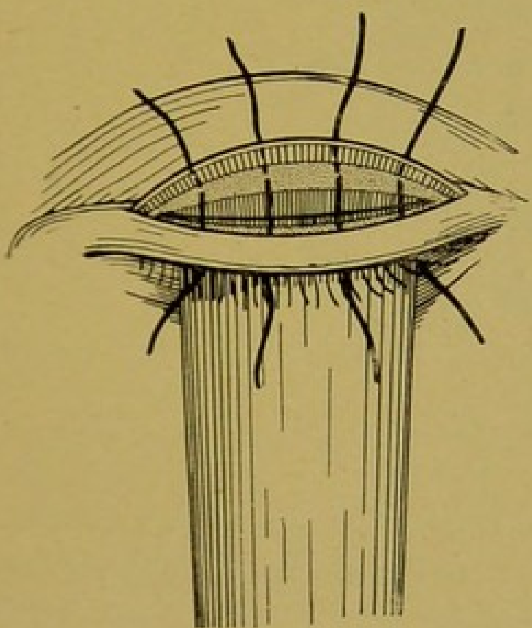


Snellen's operation Result.

tarsus will be exposed. A wedge-shaped piece of the tarsus is removed with the scalpel throughout its whole length and thickness. Care should be taken not to pierce the conjunctiva, although such an accident is of no great moment.

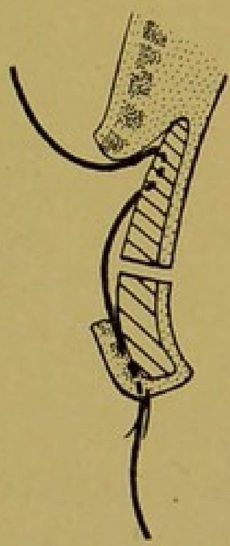
Sutures are now passed in the following manner: A double armed suture is taken, one needle is passed through the tarso-orbital fascia and upper margin of the tarsus, carried down over the tarsus and brought out at the lid margin behind the cilia. The second needle is passed in a similar fashion about 2 mm. from the first. Two or three sutures are inserted and tied through a glass bead. The edges of the sutures are not cut off but are fastened to the forehead with adhesive strappings. The edges of the skin wound are now sutured and a bandage applied. Sutures may be removed on the third or fourth day.

Fig. 399



Panas' operation.

Fig. 400



Panas' operation, showing cross-section.

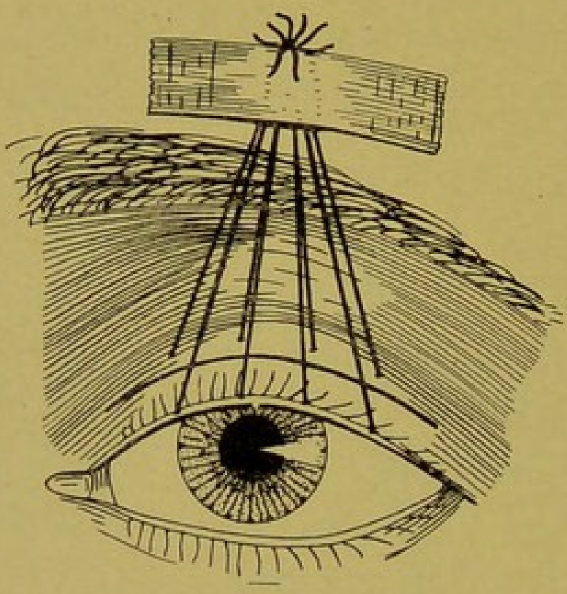
Panas' Operation.—Panas' operation is similar to Snellen's, but more radical.

The instruments are: Horn plate, scalpel, scissors, forceps, needle-holder, and sutures.

After local anesthesia the lid is supported by a horn plate and an incision is made through the skin and muscle down to the tarsus, about 3 mm. from the lid margin and parallel to it. The whole tarsus is now freed from overlying tissues and an incision is made through tarsus and conjunctiva in the line of the cutaneous incision (Figs. 399, 400, and 401). Sutures are inserted as follows:

A needle is passed through the tarso-orbital fascia and upper margin of tarsus, and is carried down and brought out at the lid margin behind the cilia. Four or five sutures are passed in a similar manner, and after tying them the ends are not cut off but carried up and fastened to the forehead. No sutures are taken in the skin wound. Sutures are removed on the fourth or fifth day.

Fig. 401



Panas' operation. Result.

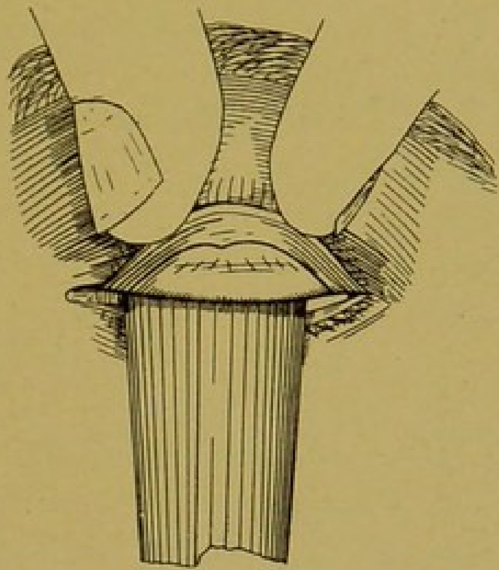
Kuhnt's Tarsectomy.—As the entropion and trichiasis following trachoma is due to the shrinking of conjunctiva and especially the tarsus, all of the preceding operations give in most cases only temporary relief. The cicatricial shrinkage continues and often the cilia are pulled down again. The operation, which completely removes the underlying cause (bent tarsus) and therefore makes the recurrence of the condition impossible, is Kuhnt's tarsectomy.

The instruments are: Horn plate, scalpel, straight and curved scissors, 2 forceps, needle-holder, and double armed sutures.

After a few drops of a 5 per cent. cocaine solution have been instilled a subcutaneous injection of cocaine-adrenalin is given. In order to produce a more thorough anesthesia it is well to inject a few minims in the upper cul-de-sac.

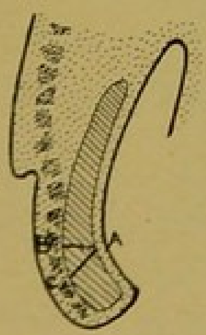
The upper lid is everted, supported on a horn plate, and held in position with the fingers. An incision is made with the scalpel parallel to the lid margin, about 2 or 2 ½ mm. from it, for the entire length of the lid, except at the midpoint of the lid, where it should curve inward for a short distance. The incision is carried through the conjunctiva and tarsus at right angles to the portion of the tarsus that is left behind; that is, the part that forms the

Fig. 402



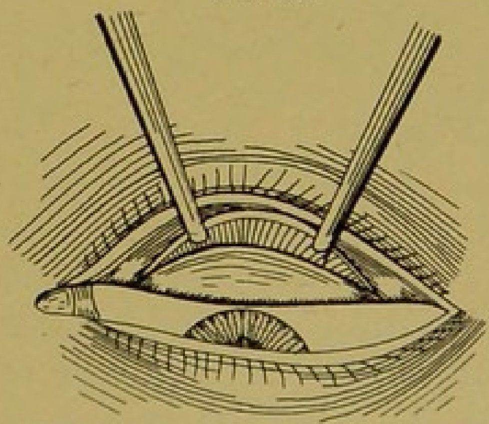
Kuhnt's tarsectomy of upper lid. Incision.

Fig. 403



Cross-section showing correct (a–c) and incorrect (a–b) incision. (After Blaskovics.)

Fig. 404



Kuhnt's tarsectomy of upper lid. Holding tarsus with two forceps.

lid margin (Blaskovics) (Figs. 402, 403, and 404). In Fig. 403 *a–c* is the correct incision while *a–b* is the incorrect one. It shows distinctly that in the case where the *a–b* incision is made the bent part of the tarsus is left behind and consequently the operation will be unsuccessful. By blunt dissection the orbicularis is separated as far as possible from the anterior surface of the tarsus. The horn plate is now removed and the edge of the tarsus is grasped with two forceps, care being taken not to include conjunctiva, and pulled outward while the patient looks down (Fig. 404).

One of the forceps is held by the assistant and the other by the operator. The conjunctiva is now shaved off of the tarsus with long sweeping strokes of the scalpel until the whole tarsus is bare. The separation of the conjunctiva from the tarsus is often difficult at the start, as it is firmly adherent to the tarsus along the horizontal line of scar tissues that can be seen near the lid margin. It is therefore necessary to remove in this place the superficial layers of the tarsus with the conjunctiva. To avoid this difficulty Blaskovics advises making a second incision through the conjunctiva just at the border of the scar and to dissect the conjunctiva from this point. The tarsus is still connected with the tarso-orbital fascia and the muscle fibers at its upper border. These are now severed with a straight scissors and the tarsus removed. Sutures are not necessary to hold the conjunctiva in place. If, however, it is desired to insert sutures they should be taken as follows: A mattress suture is taken at the edge of the conjunctiva and brought out through the lid behind the remaining portion of the tarsus and knotted over a small roll of gauze, three sutures being usually inserted. After the operation a bandage is applied, which may be removed the next day. If sutures are inserted they may be removed on the third day.

The operation if properly performed gives good results. The cilia come into proper position and are not irritating to the cornea. Sometimes a few cilia still cause trouble, but these can be removed by electrolysis, or if they are numerous a Machek-Blaskovics operation may be done.

Operations for Partial Trichiasis.—If there are only a few cilia turning inward they may be removed by:

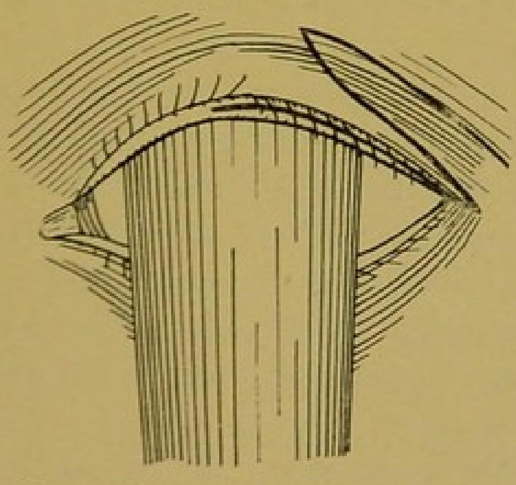
Epilation.—This is done with a cilia forceps. The removed cilia grow again, so this only gives temporary relief, and is only to be done with patients that refuse operation.

Electrolysis.—The electric needle is connected with the negative pole, while the positive pole with the usual sponge electrode is placed on the patient's forehead. The eye is cocainized with a 5 per cent. solution and a black horn plate is placed under the lid. It is essential to have a good light and also a Berger loupe to see the fine white hairs which usually give the most trouble and are easily overlooked. The lid is slightly everted, as in making an intermarginal incision, and the needle is inserted in the hair follicle. The current of ½ to 1 milliampère is turned on for about one-half minute. The electrolysis can be noted by the appearance of bubbles around the needle. If the electrolysis has destroyed the follicle the hair can be easily removed with a cilia forceps. This operation is very painful; the pain may be, however, somewhat deadened by a local cocaine injection.

If there are many cilia turning in at the middle of the lid the Machek-Blaskovics operation, extending only over the affected area, gives very good results.

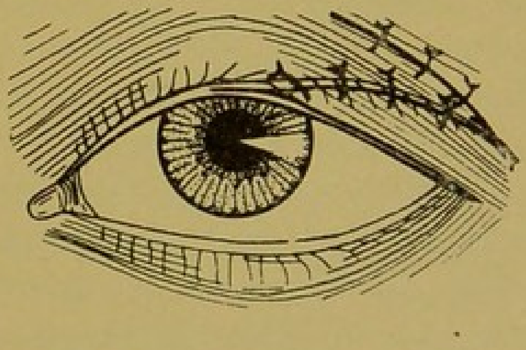
For partial trichiasis at the outer or inner canthus Spencer-Watson's operation may be employed to an advantage.

Fig. 405



Spencer-Watson's operation for partial trichiasis. First step.

Fig. 406



Spencer-Watson's operation for partial trichiasis. Result.

Spencer-Watson's Operation.—The instruments are: Horn plate, angular keratome, scalpel, scissors, forceps, needle-holder, and sutures.

After the horn plate has been inserted an intermarginal incision is made with an angular keratome or scalpel. The length of the incision depends upon how far inward the trichiasis extends. It should be about 2 or 3 mm. longer than the area in which the cilia are misplaced. A second incision is made parallel to the first about 3 or 4 mm. from it, the canthal end of which is connected with the intermarginal. The third incision is parallel to the second and is connected with its end. Both of the latter incisions should be 2 or 3 mm. longer than the first. The two flaps thus formed are dissected free and then interchanged. Sutures are now inserted to hold the flaps in place. Bandage is applied and sutures removed on the fifth day.

Operations for Entropion and Trichiasis on the Lower Lid.—The operations for trichiasis and entropion which have been described are less suitable on the lower lid than the upper. Owing to the anatomical construction of the lower lid (small tarsus) all operations that endeavor to remedy the condition by bending the tarsus (Panas and Snellen) cannot be performed. The plastic operations (Jaesche-Arlt, Machek-Blaskovics, Spencer-Watson) are less satisfactory here, as the fine hairs of the skin flap irritate the cornea as much as the cilia did before operation. As the eyelashes on the lower lid are few in number and the protection to the eyeball offered by the eyelashes is almost *nil*, conservative procedure does not play an important part. As most of the eyelashes are wanting in trichiasis, and the few that remain are white and almost invisible, the extirpation of the layer containing the hair roots may be performed (Flarer). When the trichiasis is accompanied by a well-marked entropion, as after trachoma, Flarer's operation will give satisfactory results only when followed by a transplantation of mucous membrane of the lip. Otherwise the skin that becomes adherent to the lid margin will irritate the cornea.

From a cosmetic standpoint this operation is objectionable, as the contrast between the skin and the mucous membrane is always noticeable. Kuhnt therefore recommends extirpation of the tarsus on the lower lid in order to correct the defect totally and permanently.

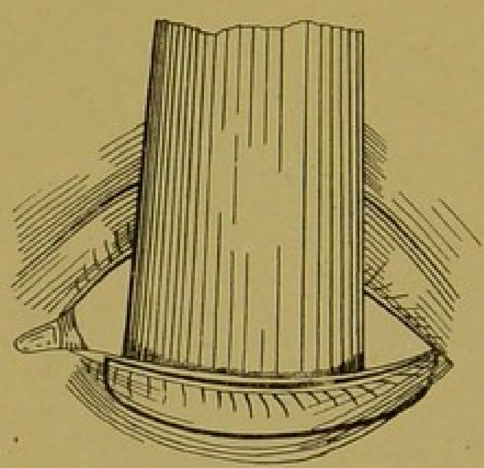
Flarer's Operation.—The instruments are: Horn plate, angular keratome, scalpel, straight and curved scissors, forceps, and sterile rubber tissue.

A horn plate is placed in the lower cul-de-sac after the conjunctiva has been anesthetized by instilling a few drops of 5 per cent.

cocaine solution. A subcutaneous injection of cocaine-adrenalin is also given.

An intermarginal incision is now made the entire length of the lid and carried to a depth of about 2 mm. A second incision is made parallel to the lid margin and about 2 mm. from it and connected with the intermarginal incision at both ends. This flap is now grasped at the temporal end with a forceps and ablated with the scissors. After the flap has been removed the wound surface is thoroughly examined to see if any of the hair follicles remain behind, and if any are left they are excised with the scissors.

Fig. 407



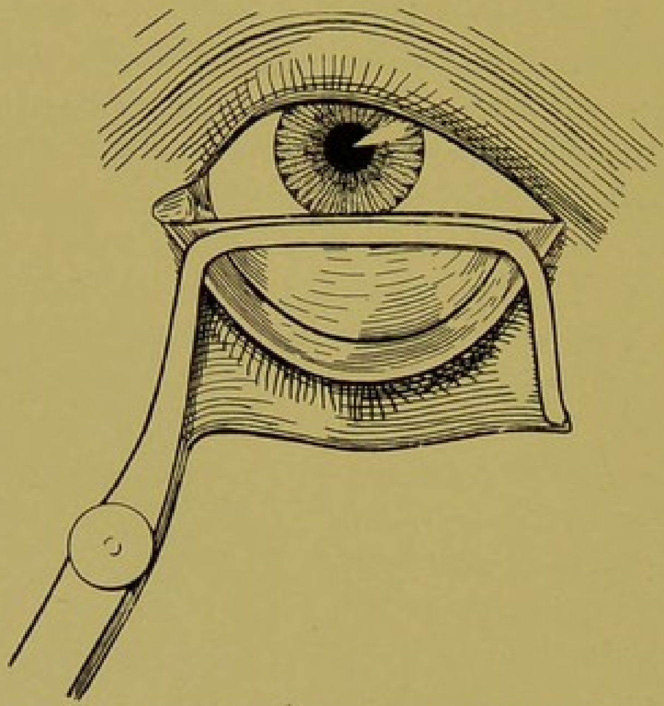
Flarer's operation.

After anesthetizing the mucous membrane of the lower lip a flap, identical in shape with the defect but larger, is first outlined and then dissected off. The flap is placed in warm sterile salt solution and fat and shreds of tissue are removed. The defect is now covered with the flap, which is smoothed out into place. No sutures are necessary, but the wound is covered with sterile rubber tissue on which has been applied sterile boric vaseline. The eye is bandaged and remains so for three days. The bandage may be left off on the fifth day.

Kuhnt's Tarsectomy on the Lower Lid.—The instruments are: Lid clamp, scalpel, scissors, 2 forceps, needle-holder, double armed sutures.

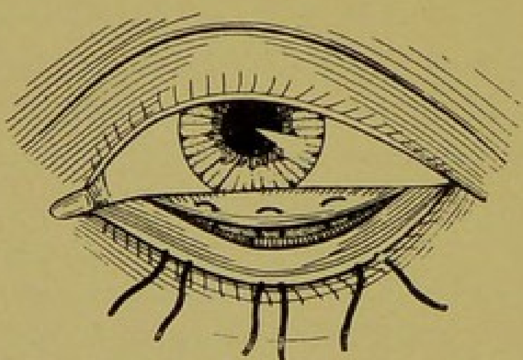
After cocaine anesthesia the eyelid is taken in a lid clamp and an incision is made on the inner surface of the lid through the conjunctiva and tarsus. This incision extends from the lacrimal punctum to the outer canthus and is about 2 mm. behind the lid margin. The conjunctiva is dissected from the tarsus with the scalpel and the outer surface of the tarsus is freed from its attachment to the muscle as in extirpation of the tarsus in the upper lid (Figs. 408, 409, and 410). Sutures are passed in the following manner: The two needles of a double-armed suture are passed through the edge of the conjunctiva from within out at about a distance of 2 mm. from each other. The needles are then carried out on the anterior lip of the lid margin passing in front of the remaining portion of the tarsus. Two or three such sutures are

Fig. 408



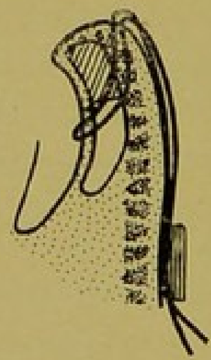
Kuhnt's tarsectomy for entropion of lower lid. First step.

Fig. 409



Kuhnt's tarsectomy for entropion of lower lid. Second step.

Fig. 410



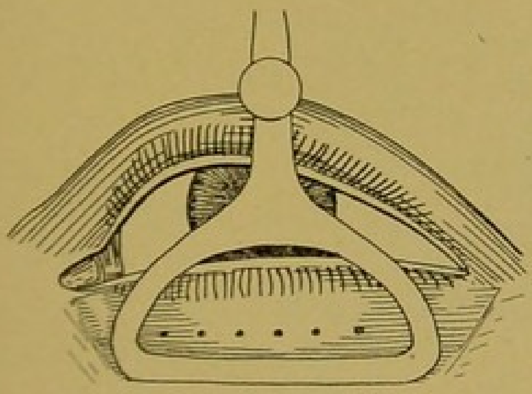
Kuhnt's tarsectomy for entropion of lower lid, showing cross-section.

inserted. The sutures are not tied but are brought down and fastened with adhesive straps on the skin over the lower margin of the orbit, sufficient traction being exerted to draw the lid margin into its proper position.

Ziegler's Galvanocautery Puncture.—Local anesthesia is employed by instillation of cocaine in the cul-de-sac and subcutaneous injection.

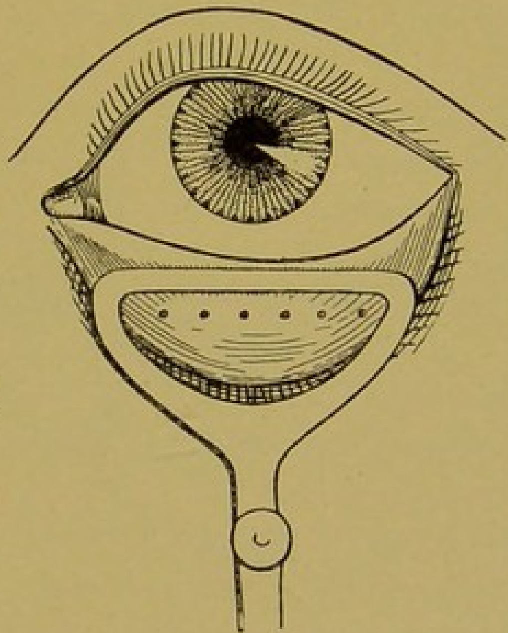
The instruments are: Lid clamp (Ziegler's), galvanocautery. "The lid clamp is adjusted with its straight bar 6 mm. from the lid margin. The galvanocautery point is applied to the surface with considerable pressure, the button on the handle is pressed down to turn on the current while the point is quickly pushed through the cartilage and as quickly withdrawn. The punctures are made 4 mm. from the lid margin, and separated from each other by an equal interval of 4 mm. (Fig. 411)."

Fig. 411



Ziegler's galvanocautery puncture for entropion.

Fig. 412



Ziegler's galvanocautery puncture for ectropion.

The reaction after operation is very slight; the charred eschar of the cautery usually clears off in about one week. If the result is not satisfactory the operation may be repeated two or three times at intervals of from two to four weeks.

The operation may be employed for ectropion (Fig. 412) as well as for entropion, with the difference, however, that in the former case the punctures are made on the conjunctival surface.

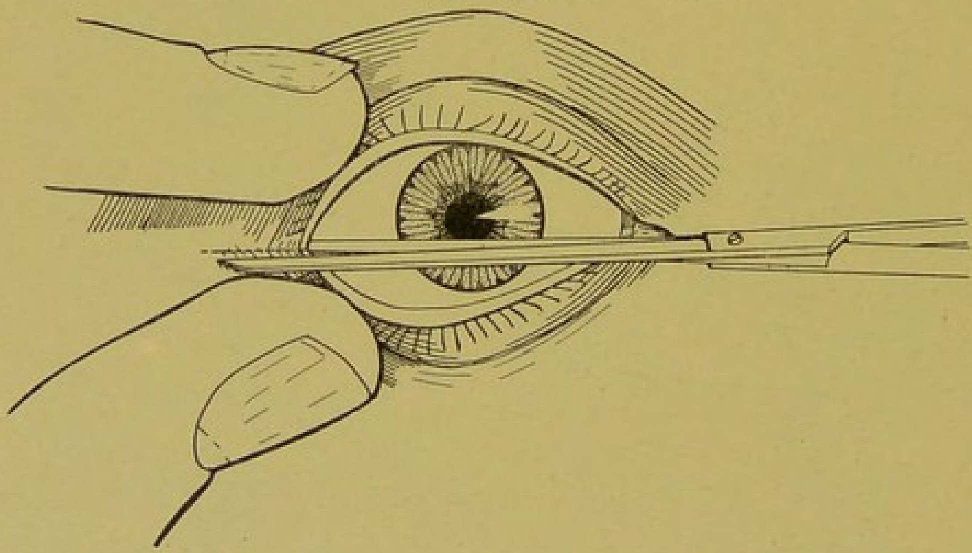
CANTHOTOMY AND CANTHOPLASTY

Both operations consist in elongating the palpebral fissure. The elongation may be temporary (canthotomy) or permanent (canthoplasty).

Canthotomy.—**Indications.**—1. Blepharospasm is often found in patients afflicted with phlyctenular or trachomatous pannus and ulcer. In these cases the blepharospasm is due to the corneal condition and the corneal condition is maintained by the blepharospasm, thus forming a vicious circle.

2. In cases of gonorrheal conjunctivitis, during the first stage, to relieve the swelling and to enable proper cleansing of the eye.

Fig. 413



Canthotomy.

3. In cases of ectropion where the eversion of the lid is due to a swollen conjunctiva. In such cases the irritation of the exposed conjunctiva often causes a blepharospasm by reflex action, which in turn, by strangulation of the conjunctiva, increases its edema and maintains the ectropion (paraphimosis, Czermak).

4. As a preliminary operation before enucleation, if it appears that the eyeball is too large to pass through the palpebral fissure.

5. As a preliminary operation to exenteration of the orbit, if the eyelids are to be left behind.

Instrument.—Blunt straight scissors.

Operation.—The operation is performed as follows:

After cocaine anesthesia the skin over the outer canthus is put on the stretch with the index finger and thumb of the left hand. The fold of skin must also be drawn slightly toward the inner canthus. A strong blunt straight scissors is placed astride the fold of skin, one blade being in the palpebral fissure the other on the skin of the temple (Fig. 413). By closing the scissors, skin, conjunctiva, and canthal ligament are simultaneously severed. The incision should extend to the margin of the orbit and be in line with the palpebral fissure. A slight pressure bandage is applied for a few hours, and the wound heals in three or four days.

Canthoplasty.—**Indications.**—1. In cases where the upper lid is adherent to the lower lid (ankyloblepharon). This is often the result of burns or it may be a congenital anomaly.

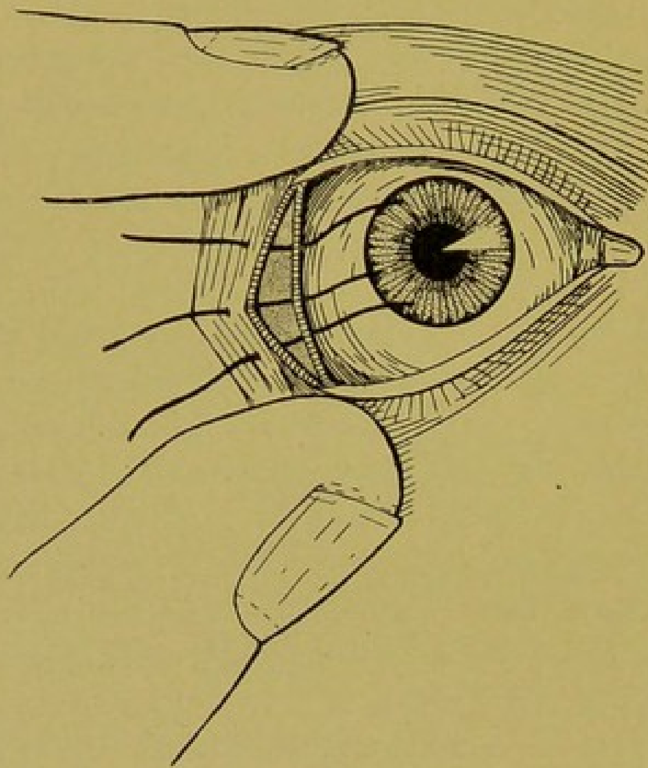
2. In cases where the outer canthus is covered by a fold of skin and the palpebral fissure therefore appears shortened (blepharophimosis). This is commonly found in patients suffering from chronic inflammations of the conjunctiva (trachoma, chronic conjunctivitis, and blepharitis), and is often accompanied by entropion.

Ammon's Canthoplasty.—The instruments used are: The blunt straight scissors, mouse-tooth forceps, curved scissors, needle-holder, and fine silk sutures.

After making a canthotomy as described above, the conjunctiva is sutured to the skin to prevent closure of the wound. This is done as follows:

After the incision the assistant retracts the edges of the wound with his thumbs in a vertical direction. Three sutures are inserted from within outward, passing through the conjunctiva and skin. The first suture is exactly at the midpoint, the second above, and the third below it (Fig. 414). The sutures are knotted and a bandage is applied. Sutures may be removed on the fifth or sixth day. This operation is difficult and does not give satisfactory results when the conjunctiva is shortened as in trachoma, or when it is very thin or friable as in elderly patients. The sutures in such cases will tear out. To prevent this complication, Heuse (Czermak) advises dissection of the conjunctiva after canthotomy from the sclera as far as the limbus The sutures are then inserted as described and a vertical incision is made in the conjunctiva midway between the outer canthus and cornea. In this manner after the sutures are knotted the conjunctiva is relieved of all tension. There is a gaping conjunctival defect on the eyeball which, however, heals up within a short time.

Fig. 414



Ammon's canthoplasty.

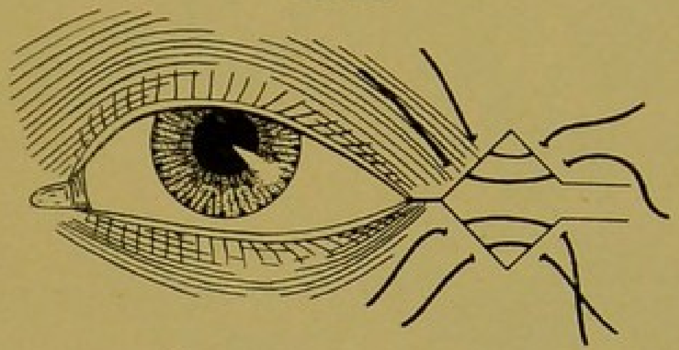
In some cases following Ammon's canthoplasty the result is not permanent, because the edge of the conjunctiva rolls on itself and does not become adherent to the edge of the skin. This is noticed by the fact that the canthus slowly moves inward until a condition similar to that before operation results.

Kuhnt's Canthoplasty.—The instruments are: Horn plate, scalpel, mouse-tooth forceps, straight and curved scissors, needle-holder, silk sutures, single and double armed.

Kuhnt devised two operations for enlarging the palpebral fissure. In both he forms a pedunculated flap of skin which is transplanted into the outer commissure to prevent union.

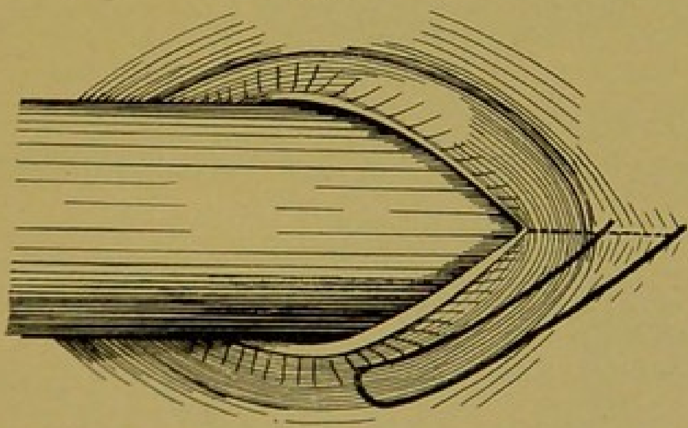
(*a*) The eyelid and the conjunctival sac are anesthetized in the usual way and a horn plate is pushed under the outer commissure. A rhomboid pedunculated flap is made near the outer canthus. The flap is dissected off and then the canthal ligament is incised. The incision is performed according to Agnew's method by first making the horizontal incision as in the preceding operation. After this the upper lid is grasped with index finger and thumb and pulled inward and upward. A straight scissors

Fig. 415



Kuhnt's canthoplasty. (*a*)

Fig. 416

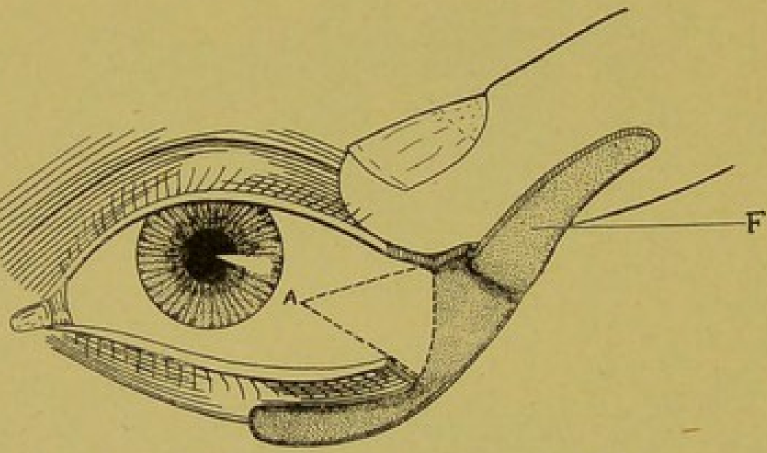


Kuhnt's canthoplasty (*b*). First step. (After Meller.)

is introduced in the wound so that one blade will be under the conjunctiva and the other under the skin, and the tarso-orbital fascia with the fibers of the orbicularis are severed in a direction at right angles to the bone. A similar incision is made in the lower lid. The bulbar conjunctiva is undermined, the cutaneous flap is tucked under it, and its apex united with the conjunctiva by a mattress suture. The edges of the defect are brought together and sutured as in Fig. 415.

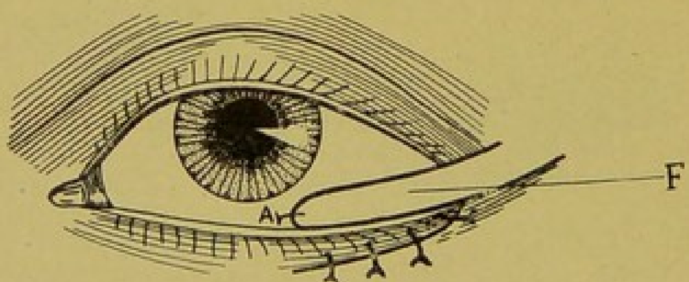
(*b*) The skin over the canthus is steadied with the index finger and thumb, and a flap is cut out from the skin of the lower lid, which is about 2 mm. wide and a little over 1 cm. in length. This flap is now dissected off and turned up. The outer canthus is now incised according to Agnew's method, so that the flap will remain in contact with the upper edge of the wound. The conjunctiva is dissected off of the sclera as far as the limbus and then the edges of the defect are united with three or four sutures while the flap is tucked under the conjunctiva (Figs. 416, 417, and 418).

Fig. 417



Kuhnt's canthoplasty (*b*). Second step. (After Meller.)

Fig. 418

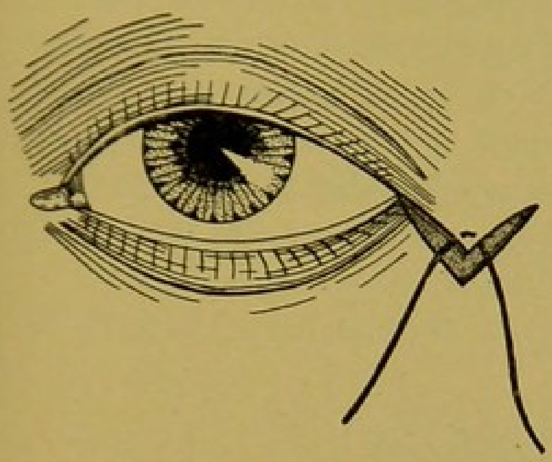


Kuhnt's canthoplasty (*b*). Result. (After Meller.)

Blaskovics' Canthoplasty.—The instruments are: Horn plate, scalpel, straight and curved scissors, mouse-tooth forceps, needle-holder, silk sutures, single and double.

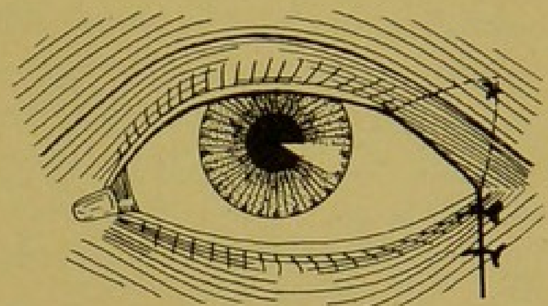
Blaskovics makes a *V*-shaped incision near the outer canthus, apex down. The flap thus outlined is dissected from the underlying tissues and a mattress suture passed through its point from without inward. Agnew's canthotomy is then performed and the edges of the *V*-shaped defect are united (Figs. 419 and 420). The flap is turned under the upper lid and the sutures are brought out through the skin.

Fig. 419



Blaskovics' canthoplasty. First step.

Fig. 420



Blaskovics' canthoplasty. Result.

After-treatment.—The after-treatment in these operations consists in bandaging the eye. The dressing should be changed daily and the sutures may be removed on the fifth or sixth day.

TARSORRHAPHY OR BLEPHARORRHAPHY

This operation is the opposite of the canthoplasty, as it consists in shortening the palpebral fissure. It may be either permanent or temporary, and the latter is at the same time total as the whole palpebral fissure is closed.

Temporary Tarsorrhaphy.—**Indications.**—1. After burns of the skin of the lid to prevent cicatricial deformity. The palpebral fissure should be left closed in these cases until the contraction of the scar tissue has been completed.

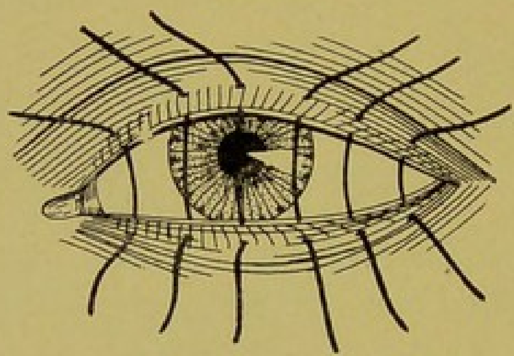
2. As a preliminary operation before plastic operations on the lid to secure immobility.

Instruments.—Curved scissors, needle-holder, mouse-tooth forceps, silk sutures.

Operation.—The operation is done as follows:

After instilling 5 per cent. cocaine solution in the cul-de-sac and injecting cocaine-adrenalin subcutaneously the upper eyelid is everted and the inner lip of the lid margin is trimmed off with a pair of curved scissors from the lacrimal punctum to about 2 or 3 mm. from the outer canthus. The lower lid is then trimmed in a similar manner. Sutures are now inserted so that the needle is entered through the skin of the upper lid behind the cilia and brought out on the wound surface of the lid margin; the needle is then passed through the lower lid in the same manner, but reversed. Five or six such sutures are passed, the ends knotted, and a bandage applied. The sutures may be removed in four or five days.

Fig. 421



Temporary tarsorrhaphy.

Later when the lids are to be opened a grooved director is passed behind them through the opening at the outer and inner canthus and the adhesions are divided with a knife. Boric ointment is applied but no bandage.

Permanent Tarsorrhaphy.—**Indications.**—1. Lagophthalmos due to paralysis of the facial nerve. In such cases the operation should be done only when the paralysis cannot be expected to improve.

2. In exophthalmos, when it is so marked that the eyelids cannot protect the cornea, as sometimes found in Graves' disease.

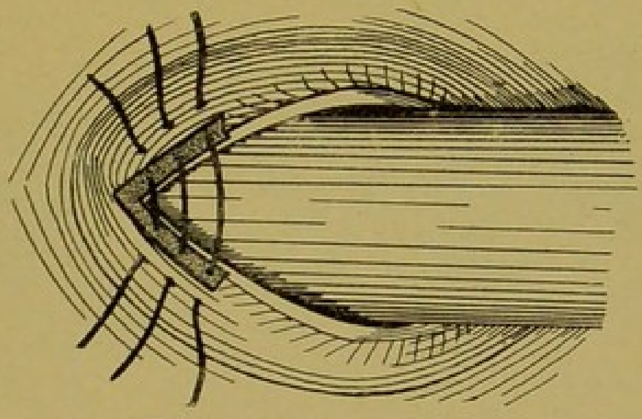
3. In ectropion, when the lid is stretched; a tarsorrhaphy combined with some ectropion operation will put the lid in a proper position.

4. In cases of anophthalmos, when the palpebral fissure is so wide that an artificial eye cannot be retained.

Walther-Graefe's Tarsorrhaphy.—The instruments used are: The horn plate, scalpel, angular keratome, straight and curved scissors, mouse-tooth forceps, needle-holder, silk sutures.

Local anesthesia is employed as in other operations on the lid. Before operation the lids at the outer canthus are pinched together with a forceps and at the same time the patient opens and closes his eyes. By this manipulation we are able to judge approximately how far in the lids are to be sutured. A horn plate is now introduced under the outer commissure and an intermarginal incision is made with the keratome on the upper as well as on the lower lid as far as is necessary. The two intermarginal incisions are united at the outer canthus. A second incision is made parallel to the intermarginal incision and 2 mm.

Fig. 422



Walther-Graefe's tarsorrhaphy.

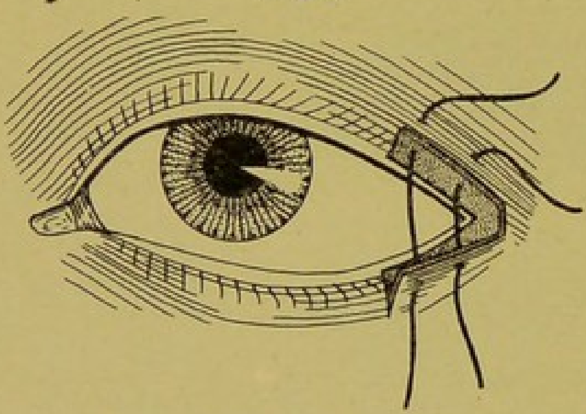
from it. The flap of skin thus outlined is now grasped with the forceps and dissected off (Fig. 422). It is well to trim the edges of the exposed tarsi in order to procure a firmer union. The wound edges are now united with two or three sutures which are passed through the skin and epitarsal tissue of both lids. Dressing is applied, changed daily, and sutures may be removed on the sixth or seventh day.

This operation may be performed on the inner canthus also (Arlt). In this event special care must be taken to avoid injuring the lacrimal puncta and canaliculi.

Fuchs' Tarsorrhaphy.—The instruments are: Horn plate, angular keratome, scalpel, straight and curved scissors, mouse-tooth forceps, needle-holder, silk sutures, single and double armed.

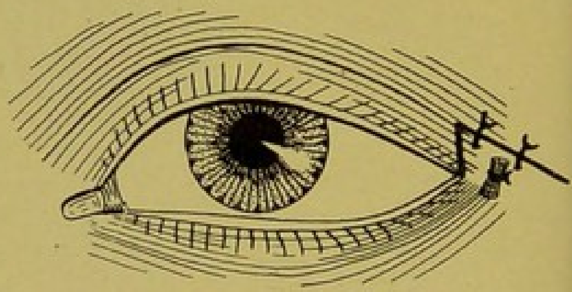
After cocaine anesthesia and insertion of a horn plate an intermarginal incision is made on the lower lid extending from the outer canthus nasally as far as necessary. From the inner extremity of this incision a second one is made downward perpendicular to the lid margin for a distance of 4 mm. A triangular flap is thus outlined which is dissected up. The same incisions are made on the upper lid (intermarginal and perpendicular), after which the upper end of the perpendicular incision is connected with the canthal end of the intermarginal, this incision being slightly curved. The flap thus outlined on the upper lid is grasped with the forceps and removed with the scissors (Figs. 423 and 424). A double armed suture is now taken and both needles are passed through the upper eyelid from within out.

Fig. 423



Fuchs' tarsorrhaphy. First step.

Fig. 424



Fuchs' tarsorrhaphy. Result.

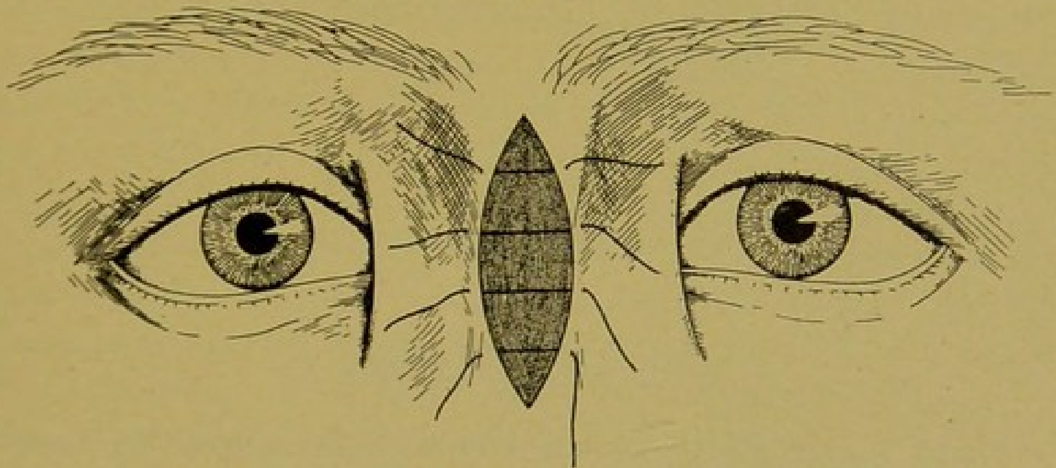
The needles are about 3 mm. distance from each other and 2 mm. from the lid margin. The needles are then passed through the base of the flap on the lower lid and tied over a roll of gauze. The edges of the flap are united by sutures with the edges of the defect of the upper lid. Dressing is applied and sutures removed on the fourth or fifth day.

OPERATION FOR EPICANTHUS

Epicanthus is a congenital anomaly consisting of a fold of skin which covers the inner canthus to a greater or less extent. It is caused by an excess of cutaneous tissue over the dorsum of the nose. It is often accompanied by other aberrations as ptosis and ankyloblepharon. As this condition may improve as the nose develops no operative interference should be attempted before the twelfth year. When the epicanthus is accompanied by ptosis and ankyloblepharon the operation for ptosis should be the last one, as the operation for epicanthus and the canthoplasty may affect the degree of ptosis.

Ammon's Operation.—The instruments are: The rat-tooth forceps, mouse-tooth forceps, scalpel, curved and straight scissors, needle-holder, and silk sutures.

Fig. 425



Ammon's operation for epicanthus.

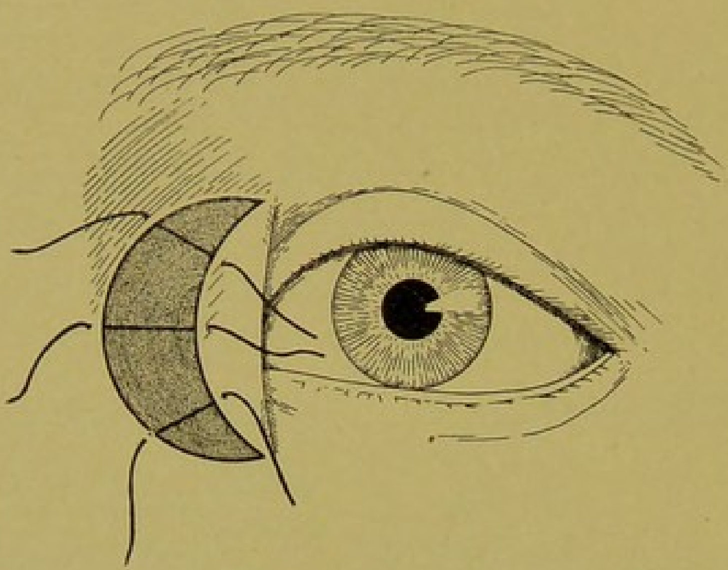
After cocaine anesthesia the skin on the dorsum of the nose is pinched up to see how much is to be removed. This fold of skin is now circumscribed by two curved incisions which meet at both ends. The elliptical flap of skin is removed, and after undermining the edges of the wound they are sutured together (Fig. 425). Dressing is applied and sutures are removed on the eighth day.

This operation gives very good results, but is objectionable from a cosmetic standpoint, as the resulting scar is always conspicuous, especially so when a primary union is not obtained.

Some surgeons advise injections of paraffin to correct the defect. This, however, is attended with some danger, as the skin is flaccid and it is not always possible to control the position of the paraffin. There is always some danger of causing an embolism.

For the correction of the epicanthus Blaskovics advises removal of a crescentic flap of skin from the side of the nose. This operation may also be used in cases of unilateral epicanthus (Fig. 426).

Fig. 426



Blaskovics' operation for epicanthus.

PTOSIS OPERATIONS

Ptosis is a condition in which there is a drooping of the upper lid. The drooping may be of various degrees and it is due to weakness of or entire loss of action of the levator palpebræ superioris muscle. The term ptosis is improperly applied to conditions where the drooping is the result of the increased weight of the lid (mechanical ptosis). This is found in trachoma where there is an hypertrophy of the conjunctiva and tarsus, and in new-growths of the lid. This condition is not dealt with in this section.

Ptosis may be congenital or acquired. Congenital ptosis is either due to absence or deficient development of the levator muscle. It is usually bilateral, and is often accompanied by other congenital anomalies, such as absence or deficient development of the superior rectus muscle, epicanthus, and congenital ankyloblepharon. Acquired ptosis is caused by the disease of the oculomotor nerve as well as by disease or injury of the muscle itself.

Operative interference is indicated both in congenital and acquired ptosis. Congenital ptosis can be operated on at any time, as operation is the only hope of improvement; operative interference in acquired ptosis should occur only after medical treatment has failed and the ptosis has remained stationary for at least one year. If these cases were operated on earlier, later should the paralysis improve lagophthalmos would result. Acquired ptosis is often accompanied by paralysis of the other extrinsic mûscles of the eye. A ptosis operation under this condition will cause considerable inconvenience from the diplopia which would occur if the lid were raised. This circumstance should always be taken seriously into consideration before operating.

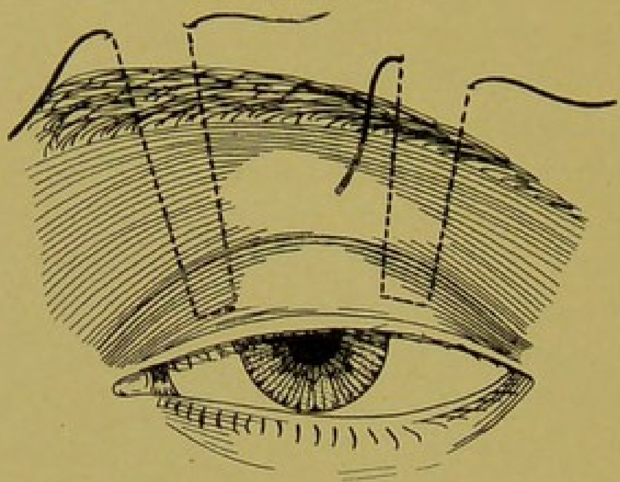
The choice of operation should depend on whether action of the muscle is lost entirely or only partially. The condition of the muscle can be ascertained by having the patient close his eye first and then pressing the skin of the lid against the upper margin of the orbit. By this manipulation the action of the frontalis muscle is excluded, and if the patient is able to raise his lid at all it is wholly done by the action of the levator muscle. If the levator has retained some of its action the correction of the ptosis can be accomplished either by advancement of its insertion or by resection of the muscle itself. If, however, the action of the levator is completely absent the operation must consist in transferring the action to some other voluntary muscle. A great number of operations have been devised to correct this condition but so far none give thoroughly satisfactory results.

The operations that are generally used are:

Pagenstecher's Operation.—The instruments are: Horn plate and 2 heavy silk sutures armed at each end with needles 3 or 4 cm. in length.

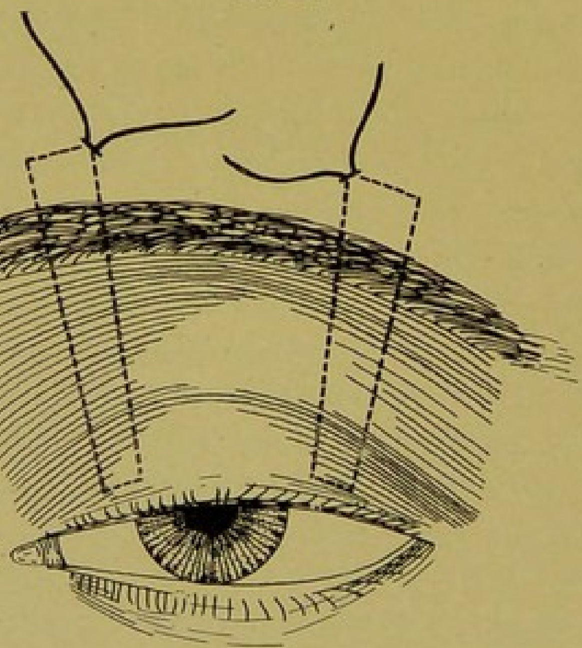
By this operation an attempt is made to transfer the action of the frontalis to the lid. A subcutaneous injection of cocaine-adrenalin is given to secure anesthesia of the parts. A heavy silk suture armed at both ends with large curved needles is introduced as follows: One needle pierces the skin about 2 or 3 mm. from the lid margin and is brought out above the eyebrow. The second needle is entered at the same point as the first, is carried horizontally and brought out about 3 mm. from the point of entrance (Fig. 427). It is then reinserted at the same point that it emerged from and carried upward parallel to the first suture. Two such loops are inserted one at either end of the middle third

Fig. 427



Pagenstecher's operation for ptosis.

Fig. 428



Koster's operation for ptosis.

of the lid. The loops diverge slightly toward the eyebrow. The ends of both are then tied over a roll of gauze and tightened until the lid is in its proper position. A bandage is now applied which can be removed the next day. If during the following days the sutures become loosened they may be tightened. The sutures remain in for two or three weeks, and during this time scar tissue forms along the wound channels which take up the action of the sutures when they are removed. If suppuration takes place the sutures are removed earlier.

Pagenstecher's operation may be performed with the sutures buried (Koster).

The eyebrow is first shaved off and two incisions about 4 or 5 mm. long are made where the sutures emerge. The two loops are now inserted and brought out through the incision where the ends are knotted (no gauze roll being used). The edges of the wound are now sutured. The sutures, thus buried, are allowed to remain in place (Fig. 428.)

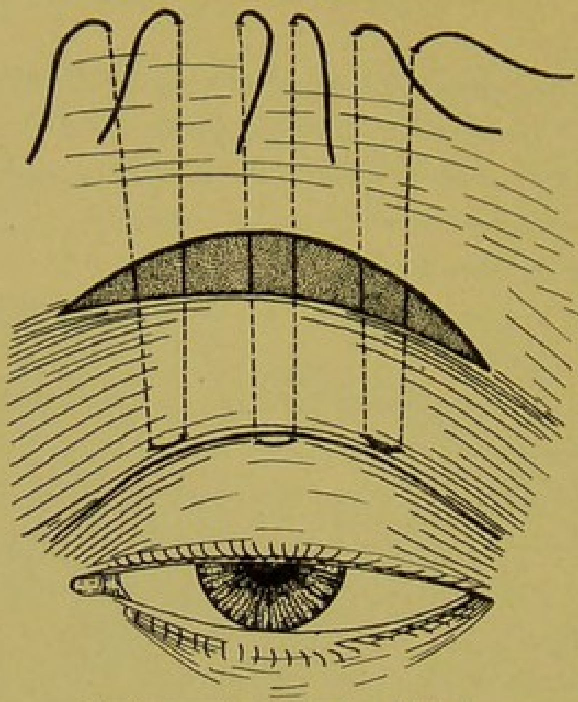
Hess' Operation.—The instruments are: Horn plate, scalpel, scissors, mouse-tooth forceps, needle-holder, silk sutures, single and double armed, and Buller's shield.

This is a modification of Pagenstecher's sutures. The eyebrow is shaved and cocaine-adrenalin injected. An incision is made over the orbital margin and the skin of the lid is undermined to the lid margin. Three mattress sutures are inserted in the following manner. A needle of the suture is passed through the skin about 1 cm. from the lid margin and brought out through the incision. Then it is reintroduced, emerging about 2 cm. from the orbital margin. The other end of the suture is passed in a similar manner parallel to it and 3 mm. away from it. One suture is passed at the midpoint of the lid, the other sutures on both sides of the first slightly diverging (Figs. 429 and 430). The ends of the sutures are knotted over rolls of gauze and tied with sufficient traction to produce a slight lagophthalmos. The incision is now closed with several sutures. A Buller's shield is applied under which the eye is left open. The sutures are left in for two or three weeks, but the skin sutures are to be removed on the fourth day.

Panas' Operation.—The instruments are: Horn plate, scalpel, curved and straight scissors, mouse-tooth forceps, wound retractors, needle-holder, silk sutures, single and double.

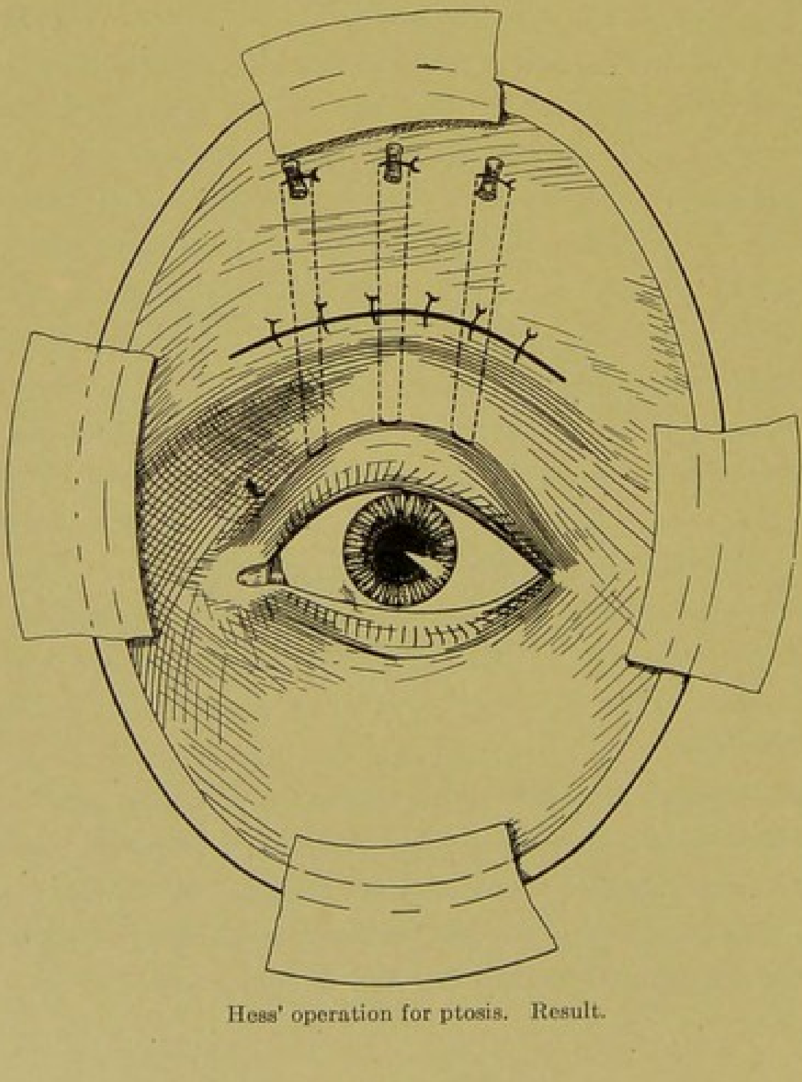
Panas attempts to transmit the action of the frontalis to the lid by the medium of a skin flap.

Fig. 429



Hess' operation for ptosis. First step.

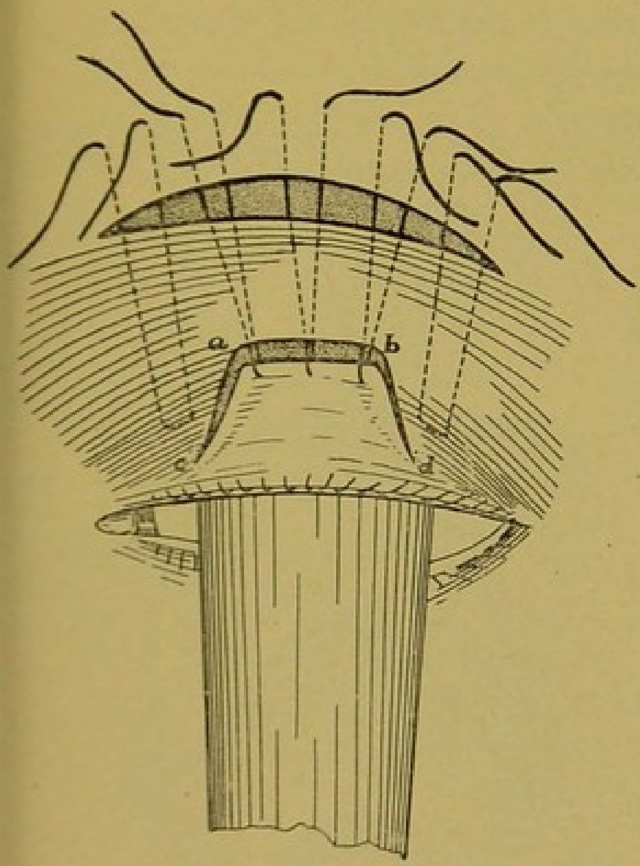
Fig. 430



Hess' operation for ptosis. Result.

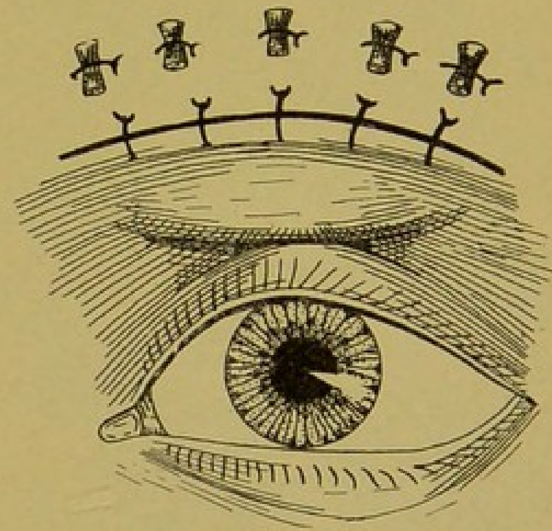
After anesthetizing the lid with cocaine-adrenalin the eyebrow is shaved and a few drops of 5 per cent. cocaine are instilled in the conjunctival sac. A horn plate is introduced and a quadrangular pedunculated flap is outlined on the lid, the base of which is near the lid margin (Fig. 431). The incision *a–b* should be a little above the midpoint between the lid margin and eyebrow

Fig. 431



Panas' operation for ptosis.

Fig. 432

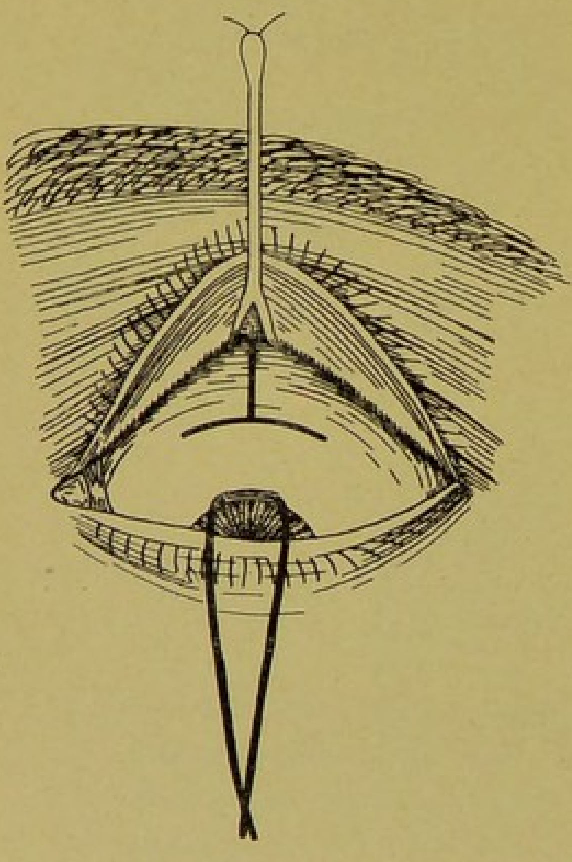


Panas' operation for ptosis. Result.

and about one-third of the length of the lid margin (Figs. 431 and 432). The incisions *a–c* and *a–d* should be slightly curved outward. The quadrangular flap together with the fibers of the orbicularis is dissected up to the pedicle. An incision 3 cm. long is made above the eyebrow down to the bone. The bridge of tissue between this incision and the flap is now undermined. A double armed suture is passed through the edge of the flap and both needles are carried under the bridge of tissue and brought out under the upper lip of the incision above about 1 mm. from each other.

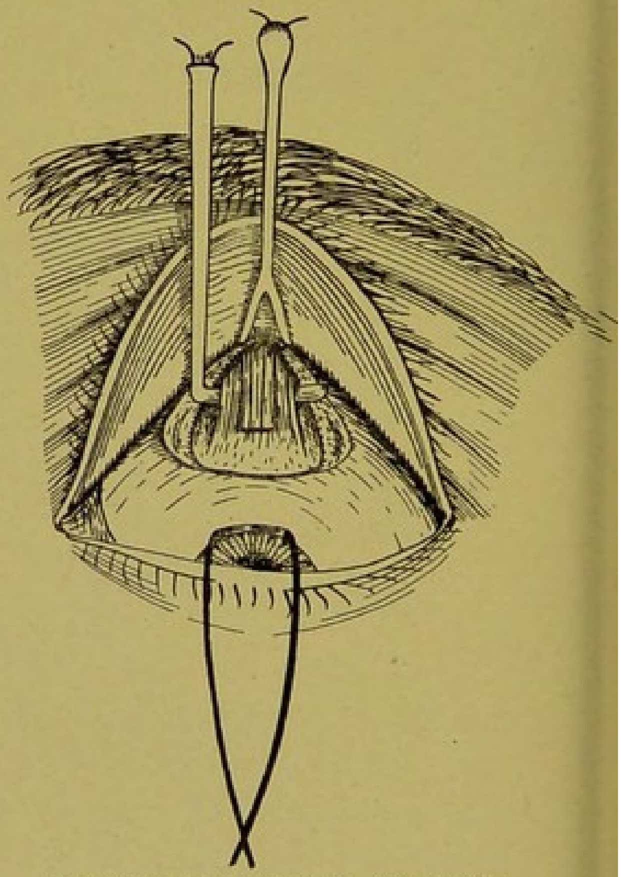
Three such sutures are inserted and the flap is pulled up sufficiently to correct the ptosis. If the correction is found insufficient the sutures are removed, the flap shortened slightly, and the sutures are again reinserted. The ends of the sutures are knotted over gauze rolls and the incision in the eyebrow is closed with several sutures. If a slight ectropion is produced two more mattress sutures are inserted on each side of the quadrangular flap. These are inserted in the upper edge of the tarsus and carried upward subcutaneously in a manner similar to the others. A dressing of borated vaseline is applied and the sutures may be removed on the sixth or seventh day. The operation gives good results, but it is disfiguring, causing an unsightly folding of the skin of the lid.

Fig. 433



Motais' operation for ptosis. First step.

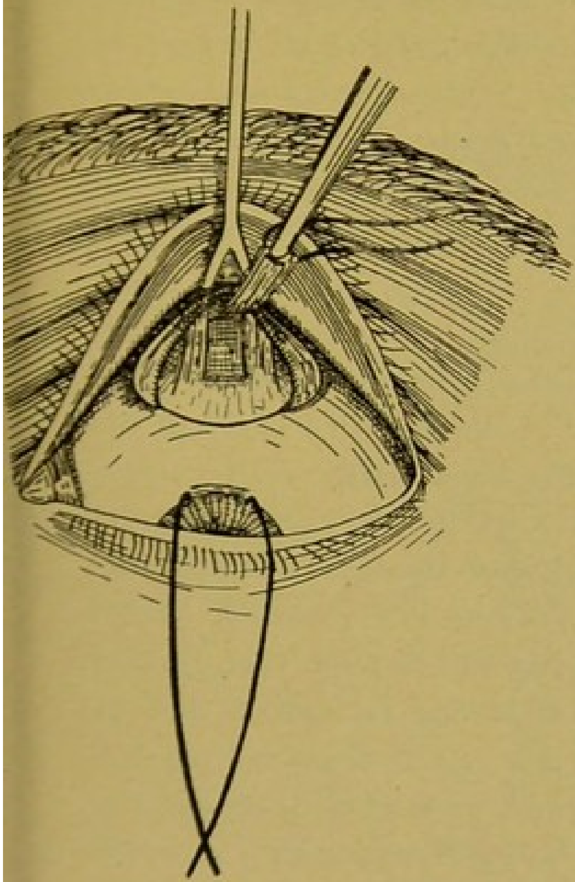
Fig. 434



Motais' operation for ptosis. Second step.

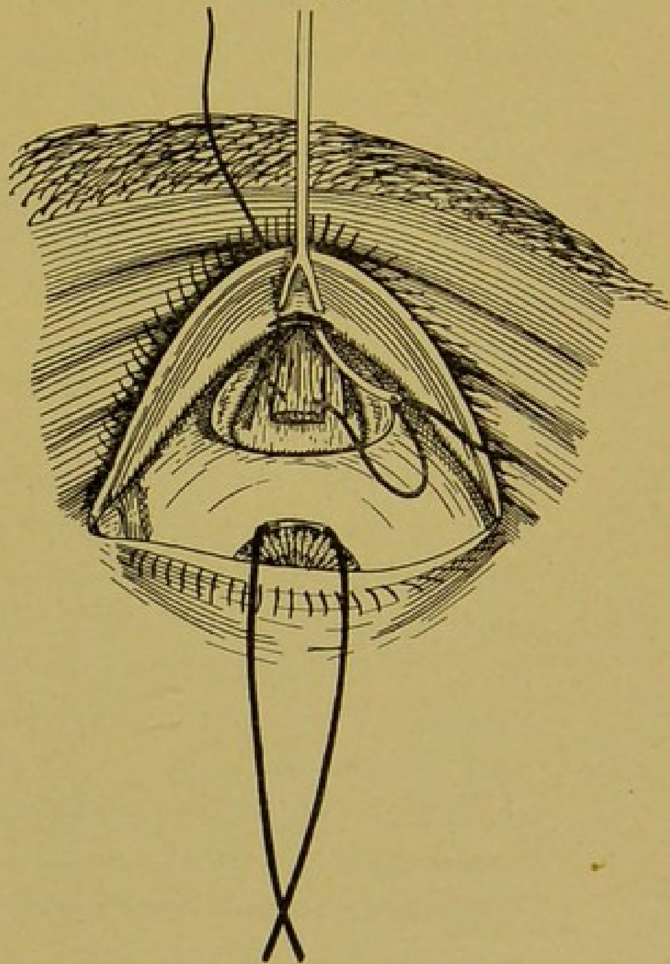
Motais' Operation.—Motais transmits the action of the superior rectus muscle to the lid. It is contraindicated in those cases of congenital ptosis where the superior rectus muscle is absent or poorly developed, and also in acquired ptosis where the superior rectus is affected. The operation gives from a cosmetic as well as functional standpoint good results. The disadvantages of the operation, however, are the extreme difficulty of its performance and the fact that from the weakening of the superior rectus muscle occasionally diplopia develops. The diplopia, however, usually passes off in time.

Fig. 435



Motais' operation for ptosis. Third step.

Fig. 436



Motais' operation for ptosis. Fourth step.

The instruments used are: Sharp retractors, two fine mouse-tooth forceps, small curved scissors, small straight scissors, strabismus hook, needle-holder, fine double armed silk sutures, a single armed strong suture.

Cocaine is instilled in the conjunctival sac and a cocaine-adrenalin injection is given. The strong suture is passed through the conjunctiva horizontally, near the upper limbus, and with it the eye is pulled down and held in this position (Figs. 433 to 436).

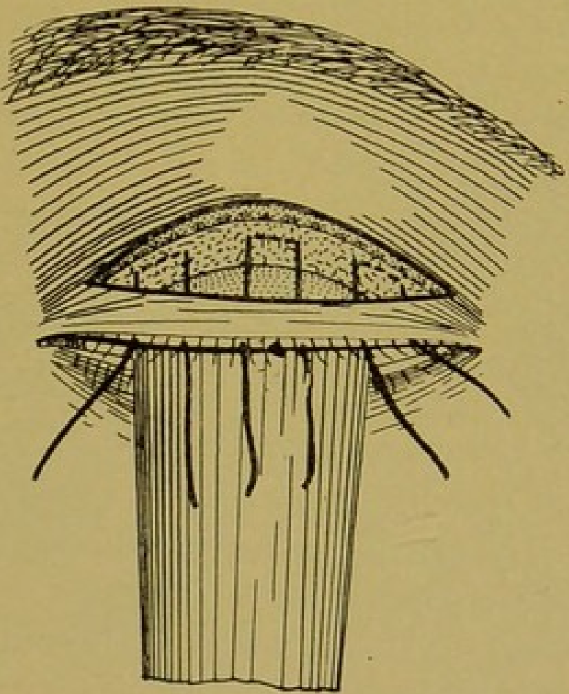
The upper lid is then everted, the sharp retractor hooked into the superior border of the tarsus, and by traction the conjunctiva of the upper cul-de-sac is put on the stretch. After this an incision, 10 to 12 mm. long, is made with the curved scissors horizontally, about 6 or 7 mm. above the limbus. From the midpoint of this incision another one at right angles is made which extends up to the superior border of the tarsus. The edges of this incision are dissected up exposing the tendon of the superior rectus muscle, which is seized with a forceps and a strabismus hook is passed under it from the inner side. The middle third of the tendon is then grasped with the forceps about 3 mm. from its insertion and a transverse incision 3 mm. long is made between the forceps and the insertion of the muscle. From each end of this incision another one is made, running backward for a distance about 1 cm. parallel to the muscle fibers. A tongue of muscle is thus formed that is 3 mm. wide and 1 cm. long. The tongue is now grasped with the forceps and the two needles of a suture are passed through it from within out. A button-hole incision is then made in the conjunctiva and levator muscle at the upper border of the tarsus and parallel to it. Through this opening the curved scissors are introduced and the anterior surface of the tarsus is separated from the underlying tissue down to within 5 or 6 mm. of the lid margin. The two needles are now passed through this opening and brought out about 5 or 6 mm. from the lid margin through the skin. The sutures are knotted over a roll of gauze. By this means the tongue of muscle is brought in contact with the anterior surface of the tarsus to which it becomes adherent. It is not necessary to suture the conjunctival wound. Both eyes are now bandaged and the patient put to bed. The dressing is changed daily, both eyes are to remain bandaged for three days, when the sutures may be removed.

Eversbusch's Operation.—Eversbusch's operation is a shortening of the levator muscle and is therefore indicated in those cases where all of the action of the muscle has not been lost.

The instruments are: The scalpel, horn plate, two fine mouse-tooth forceps, curved scissors, needle-holder, three double armed sutures, several sutures for the skin.

Cocaine is instilled in the conjunctival sac and a cocaine-adrenalin injection is given. After the horn plate is inserted, an incision is made parallel to the lid margin midway between the lid margin and the brow. This incision should extend the entire length of the lid and pass through the skin and orbicularis down to the tarsus. The edges of the incision are now undermined in both directions so that the upper edge of the tarsus and tendon of the levator are exposed. A double armed suture is then passed through the levator horizontally about 4 or 5 mm. above the upper border of the tarsus. The needles are carried

Fig. 437



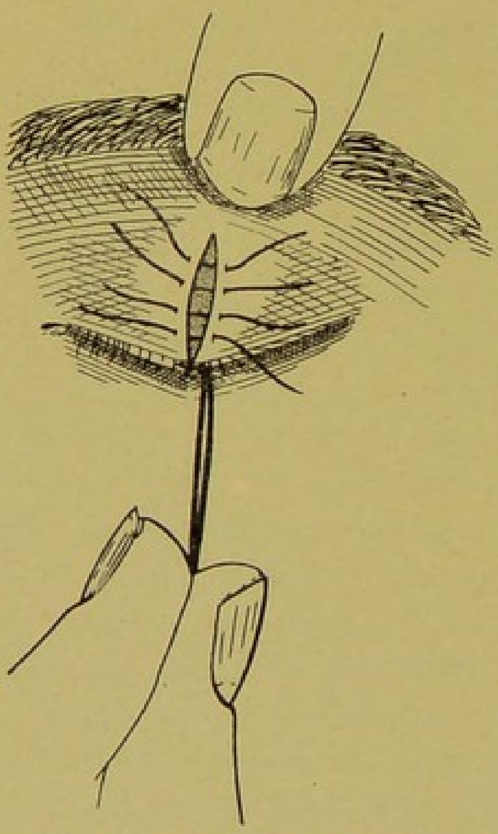
Eversbusch's operation for ptosis.

down under the skin and emerge in the intermarginal space about 3 mm. from each other (Fig. 437). One suture is inserted in the middle of the lid and one on each side. The ends of the sutures are passed through a glass bead and knotted, sufficient traction being exerted to give the lid a proper position. The skin wound is now closed with several sutures and a bandage applied over both eyes. The non-operated eye may be left open on the second or third day while the operated eye is bandaged until the sutures are removed about the seventh or eighth day. This operation shortens the levator by folding the muscle on itself.

MINOR OPERATIONS ON THE EYELID

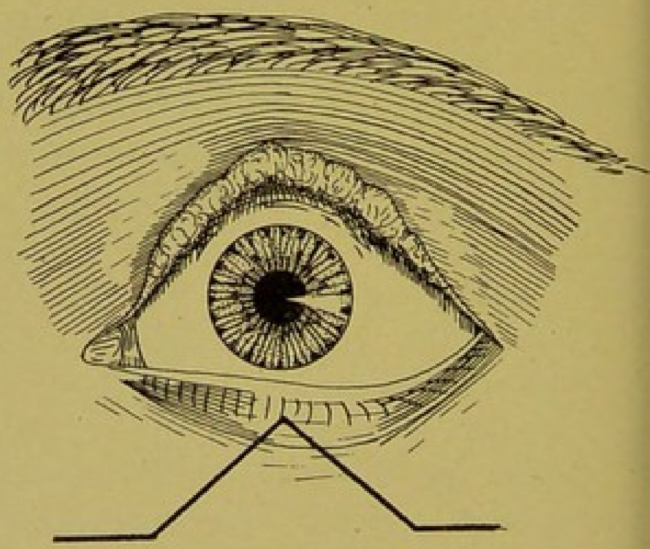
Injuries to the Eyelid and Coloboma of the Lid.—In recent injuries the wound is cleansed thoroughly, the edges are trimmed and united with sutures. The first suture should always be placed at the lid margin or rather intermargin. After this the wound is stretched so as to bring the edges together and sutures are inserted. If the injury goes completely through the lid, catgut should be used to suture the tarsus (Fig. 438).

Fig. 438



Method of suturing wound of lid. (After Blaskovics.)

Fig. 439



Wicherkiewicz's plasty for coloboma of lid.

In coloboma of the lid either congenital or following trauma, the edges of the defect are freshened and if possible united. In small defects this can be easily accomplished, in larger ones, however, the sutures often give way on account of the great strain that is put upon them. To lessen the strain a canthotomy with Agnew's modification (see p. 351) is advised. If the coloboma is so large that its edges cannot be approximated, Landolt's plasty (see p. 321) or Wicherkiewicz's plasty (Fig. 439) may be tried. Wicherkiewicz makes a V-shaped incision through the whole thickness of the lower lid, the base of which is down at the margin of the orbit. This flap is turned back and after making two lateral incisions horizontally the defect of the lower lid is closed. The edges of the coloboma are now freshened and the lids sutured together. The flap of the lower lid is placed in the coloboma and sutured in position. Dressing is applied, and after union has taken place, which is usually six or seven days, the base of the flap is cut off and lids opened. The small defect from the base of the flap is sutured.

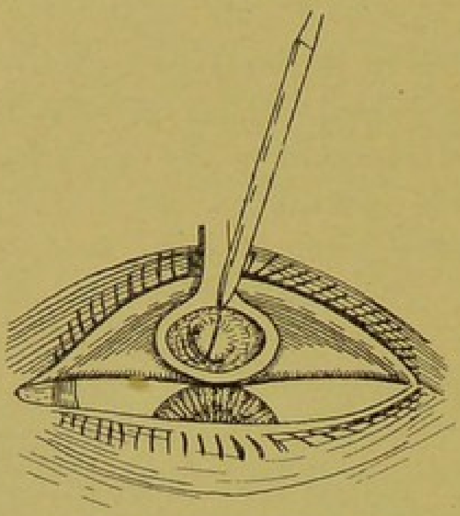
Ankyloblepharon.—Ankyloblepharon is a condition where the upper lid is adherent to the lower lid along the lid margin. It is usually the result of severe burns, particularly with acids or alkalies. It may also be congenital or produced artificially (total blepharorrhaphy). Ankyloblepharon following burns is often accompanied with a symblepharon (an adhesion of the lid to the globe). The operative interference in these cases will depend upon the degree of the symblepharon. If it is so extensive that there is no hope of freeing the lid from the globe it is better not to incise the ankyloblepharon. To ascertain the degree of symblepharon we pass in a probe behind the lid through the opening from which the tears escape. If the skin of the lid has been replaced by scar tissue a blepharoplasty should be done preceding the solution of the ankyloblepharon. The solution is accomplished by passing a grooved director behind the lid and incising the adhesion in the palpebral fissure. In congenital ankyloblepharon, which is always partial and is usually located at the outer canthus, a canthoplasty will bring about a cure.

Chalazion.—Chalazion is a cystic tumor of the Meibomian glands. It may be removed from the conjunctival side or through the skin.

The instruments used are: Chalazion forceps, bistoury, Meyhöfer curettes.

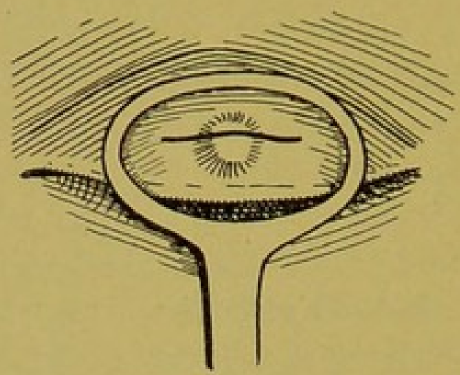
Cocaine is instilled and a chalazion forceps is applied to the lid, the plate being against the skin (Fig. 440). The lid is everted and the tumor incised with a bistoury in a direction perpendicular to the lid margin and the contents of the sac are curetted with a Meyhöfer's curette. The lid clamp is then released and

Fig. 440



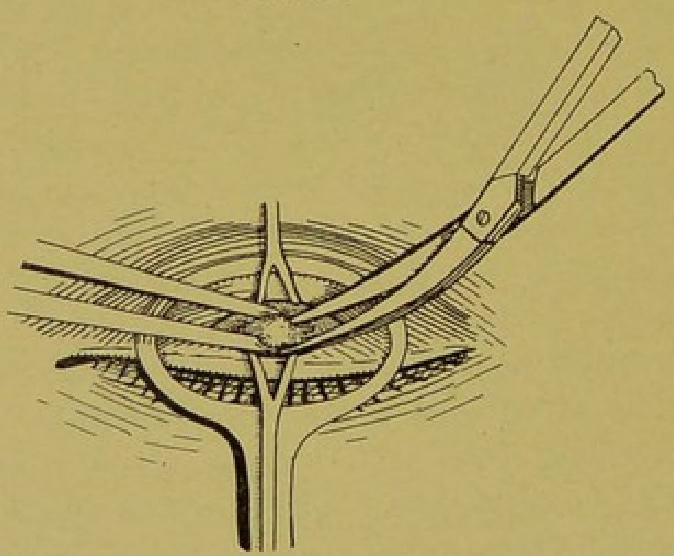
Chalazion operation from within.

Fig. 441



Chalazion operation from without. First step.

Fig. 442



Chalazion operation from without. Second step.

the lid placed in proper position, after which cold compresses are applied to check the hemorrhage.

In the other method the instruments are: The Desmarres lid clamp, scalpel, sharp retractors, forceps, scissors, needle-holder.

The former operation can only be applied in recent cases where the contents of the tumor are soft. In cases where the chalazion has been present some time and its contents are hard we must remove it through the skin (Figs. 441 and 442). Cocaine is instilled in the sac and a subcutaneous injection is given. A lid-clamp (Desmarres) is applied and an incision, parallel to the lid margin, is made over the tumor. The edges of the incision are undermined and then retracted. After excising the fibers of the orbicularis the tumor is removed with scissors and forceps together with the superficial layers of the tarsus. Sometimes we pass through the conjunctiva which, of course, should be avoided; if it does occur, however, it is of little importance. Two or three sutures are taken in the skin, the lid clamp removed and the bandage applied. Sutures may be removed on the third or fourth day.

Hordeolum, Abscess of Lid, Furuncle, and Anthrax.—Hordeolum, abscess of lid, and furuncle are to be incised with an incision that runs parallel to the lid margin. The after-treatment is the same as that used in general surgery. A free and deep incision is to be made in anthrax. If there is considerable loss of tissue a blepharorrhaphy is to be performed.

Tumors of the Lid.—Small encapsulated growths should be excised in their capsule. The incision should always be parallel to the lid margin, as then the resulting scar will be less noticeable. Warts, papilloma, and adenoma are to be ablated with the scissors and the wound surface cauterized either with the silver nitrate stick or actual cautery. Xanthelasma or nevus may be excised, and after excision the wound edges are brought together. Great care should be exercised on the lower lid so as not to produce an ectropion. Angioma, if small, may be excised and the wound edges sutured; if, however, very large a blepharoplasty is to be performed to cover the defect.

Malignant tumors, as carcinoma or sarcoma, are to be excised, the incision which circumscribes the growth should be, at all points, in healthy tissue. The resulting defect is to be covered by pedunculated or non-pedunculated skin flaps (see Blepharoplasty). Small angioma as well as carcinoma and sarcoma may be treated by *x*-rays, radium or carbon dioxide snow.

CHAPTER IX

OPERATIONS ON THE LACRIMAL ORGANS

SURGICAL ANATOMY OF THE LACRIMAL ORGANS

The lacrimal organs consist of the lacrimal gland and the lacrimal passages.

Lacrimal Gland.—The lacrimal gland has two divisions—the orbital or superior lacrimal gland and the lid division or inferior (accessory) gland. The orbital gland lies in the upper and outer angle of the orbit in a depression of the bony wall. Its excretory ducts, six to ten in number, pass downward and empty into the outer half of the upper cul-de-sac. The lid division or accessory lacrimal gland is formed of one or two lobules that lie around the excretory ducts of the upper gland. Krause's glands that lie underneath the conjunctiva in the upper and lower cul-de-sac scattered between the outer and inner canthus also belong to the lacrimal organs.

Lacrimal Passages.—The lacrimal passages begin with the two lacrimal puncta that are situated near the inner canthus on the posterior lip of the lid margin, there being one on the upper and one on the lower lid. They form the beginning of the lacrimal canaliculi, which for a short distance, about $1\frac{1}{2}$ to 2 mm., run almost at right angles to the lid margin; that is, directly upward on the upper lid and downward on the lower. Then they bend toward the inner angle of the eye and empty into the lacrimal sac either separately or by forming a common trunk. The length of this part of the canaliculus is about 7 or 8 mm. The lacrimal sac, which is the widest part of the lacrimal passages, lies in a depression of the lacrimal bone (lacrimal fossa). This depression is formed by the orbital process of the superior maxillary bone and the crest of the lacrimal bone, the former forming its medial, the latter its lateral edge. The two branches of the canthal ligament have their insertion on the crest. The lacrimal sac joins the nasal duct below, showing at the junction a marked contraction. The direction of the nasal duct is downward, backward, and outward, opening beneath the inferior turbinated bone by vertical or oblique slit. The two ducts diverge slightly downward and their length and curvature greatly depend upon the formation of the face and the size and shape of the nose. The conveyance of tears from the eye into the nose is accomplished as follows:

The closure of the lids spreads in a wave-like motion from the outer to the inner canthus, driving the tears toward the inner angle of the eye. Since the closure of the lids is water tight the tears cannot escape but are driven by the pressure of the orbicularis into the canaliculi. From here they enter the sac partly in consequence of the pressure of the following tears, partly from the aspiratory effect of the sac, which dilates a little when the orbicularis contracts. From the sac the tears are carried into the nose by gravity and the contraction of the elastic sac.

Obstruction of Lacrimal Passages.—Obstruction in any part of the lacrimal passages will cause lacrimation (epiphora) with all its unpleasant sequelæ. If the obstruction, as is most frequently the case, lies below the sac, chronic dacryocystitis will develop after a time. In all cases of epiphora our aim should be to remove the cause of obstruction. In most cases the cause lies in a pathological condition of the nose. Inflammations of the nasal mucous membrane, as well as atrophy and cicatricial contraction of the latter, may obstruct the nasal duct. Polypi, syphilitic and tubercular affections, inflammations of the accessory sinuses, especially those of the anterior ethmoidal cells, etc., are the most common nasal affections found conjointly with lacrimal obstruction. In all cases of obstruction of the lacrimal passages, proper examination of the nose and treatment of the nasal condition should be the first step. In some cases the lacrimal passages will become patent after the proper nasal treatment. Where the affection is so deeply situated and has progressed so far as to cause permanent damage to the mucous membrane or bony wall of the lacrimal passages (and these are the most common cases) they must be treated conjointly with the affection of the nose. The operations on the lacrimal organs may be divided:

(*a*) Operations on the lacrimal glands.

(*b*) Operations on the lacrimal passages.

OPERATIONS ON THE LACRIMAL GLANDS

The operations performed on the lacrimal gland consist of the extirpation of the orbital lacrimal gland, the extirpation of the accessory lacrimal gland, or the extirpation of both glands.

The removal of one or both of the lacrimal glands has no bad effect on the eye, as Krause's glands and the conjunctiva itself, as a mucous membrane, produce enough moisture to lubricate the eye properly.

Indications.—1. Tumors of the lacrimal gland.

2. Tuberculosis of the lacrimal gland.

3. In cases of dacryops (cystic distention of a duct).

4. Fistula of lacrimal gland that cannot be otherwise cured.

5. In cases of epiphora that do not yield to treatment.

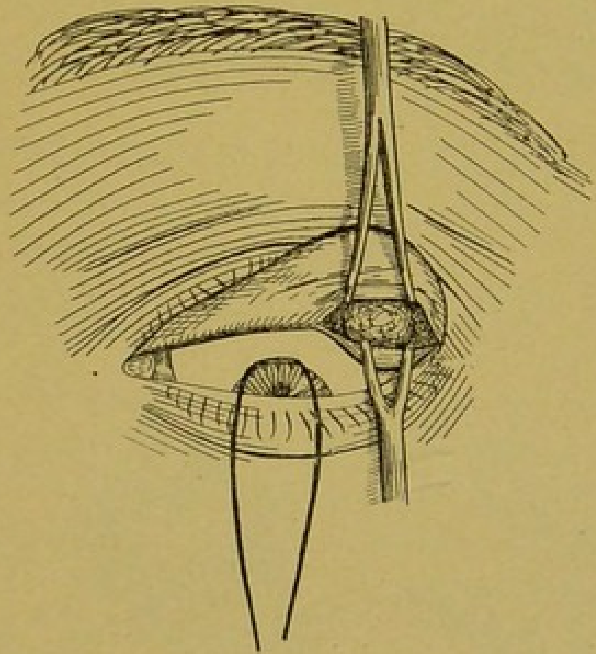
After extirpation of the lacrimal sac the lacrimal passages are permanently obstructed. In some cases a few months after the operation the epiphora will be so slight that it will not discommode the patient at all. In most cases, however, the lacrimation remains and then the only way to stop it is to remove the gland. It is advisable first to remove only the accessory gland, and if this is ineffectual to resort to the extirpation of the orbital gland. Lacrimation caused by the hypertrophy of the lacrimal gland as well as the lacrimation when the lacrimal passages are patent but the lacrimal sac is distended and has lost its elasticity, cannot be remedied by treatment, and the gland should be removed.

Extirpation of the Accessory Lacrimal Gland (De Wecker).—The instruments used are: Sharp retractors, scalpel, fine curved scissors, fine mouse-tooth forceps, needle-holder, sutures, artery clamps.

After the conjunctival sac has been anesthetized with a 5 per cent. cocaine solution, an injection of cocaine-adrenalin is given in the outer part of the upper cul-de-sac.

A suture is passed through the bulbar conjunctiva, above and outside in the limbus, with which the eyeball is pulled downward and inward. The upper lid is then everted and the retractors are inserted in the superior border of the tarsus. By pulling the lid upward the gland presents. Near the upper border of the tarsus a conjunctival incision of about 10 to 15 mm. is made. The incision should be parallel to the border of the tarsus and should pass through the conjunctiva alone. The conjunctiva is dissected up and retracted. The gland can easily be recognized from its lobulated appearance (Fig. 443). It is grasped with the forceps

Fig. 443



Extirpation of accessory lacrimal gland.

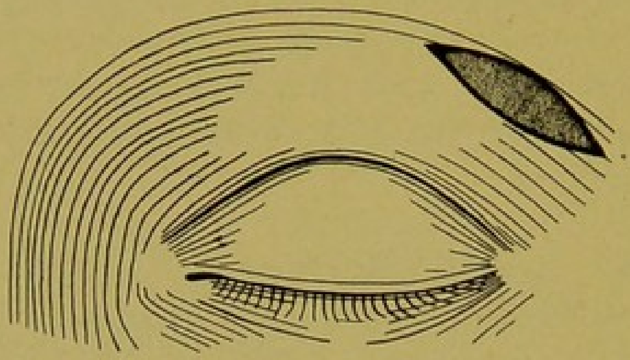
and dissected out as far as possible by blunt dissection. It is better to work from within outward, as at the temporal end of the gland several small arteries are encountered which if severed early in the operation cause an annoying hemorrhage. Several sutures are put in the conjunctiva and the lid closed. A slight pressure bandage is applied for two or three days, sutures being removed on the fifth day.

Extirpation of the Orbital Gland.—This operation should be done under a general anesthetic, although it may be done under local. The eyebrow should be shaved off before operation.

The instruments are the same as for the preceding operation, with the addition of a few catgut sutures.

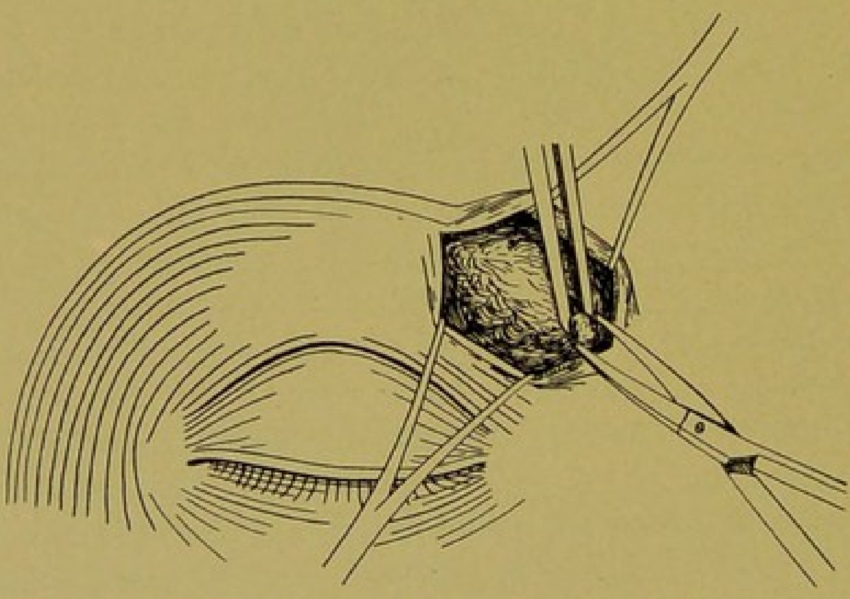
The incision is made along the margin of the orbit from midpoint outward for a distance of 2 or 3 cm. After retracting the wound edges the tarso-orbital fascia is incised close to the

Fig. 444



Incision for extirpation of orbital lacrimal gland. First step.

Fig. 445



Extirpation of orbital lacrimal gland. Second step.

orbital margin (Figs. 444 and 445). In doing this special care must be taken not to extend the incision too far inward, as then the elevator muscle may be injured, resulting in a ptosis. After the incision the gland is exposed to view, grasped with a forceps and pulled out as far as possible. It is then dissected free by blunt dissection. The severing of the lacrimal artery during operation causes considerable hemorrhage. The artery should be caught with an artery clamp and ligated in order to avoid orbital hemorrhage. The tarso-orbital fascia is sutured with catgut to the margin of the orbit and the skin sutures taken. A slight pressure bandage is applied and sutures may be removed on the fifth day.

OPERATIONS ON THE LACRIMAL PASSAGES

Slitting of the Canaliculus (Lower Lid).—**Indications.**—1. Stricture or obstruction of the canaliculus. The causes of this condition are manifold. Among the more common are congenital atresia, foreign body (fungus concretion, lime, etc.) or scar tissue formation following trauma, especially probing without slitting the canaliculus.

2. Eversion of the lacrimal punctum. Here the slitting will transform the canaliculus into an open groove through which the tears will be conducted to the nose.

3. At the beginning of an acute dacryocystitis to make an exit for the pus.

4. Previous to syringing and probing of the lacrimal duct.

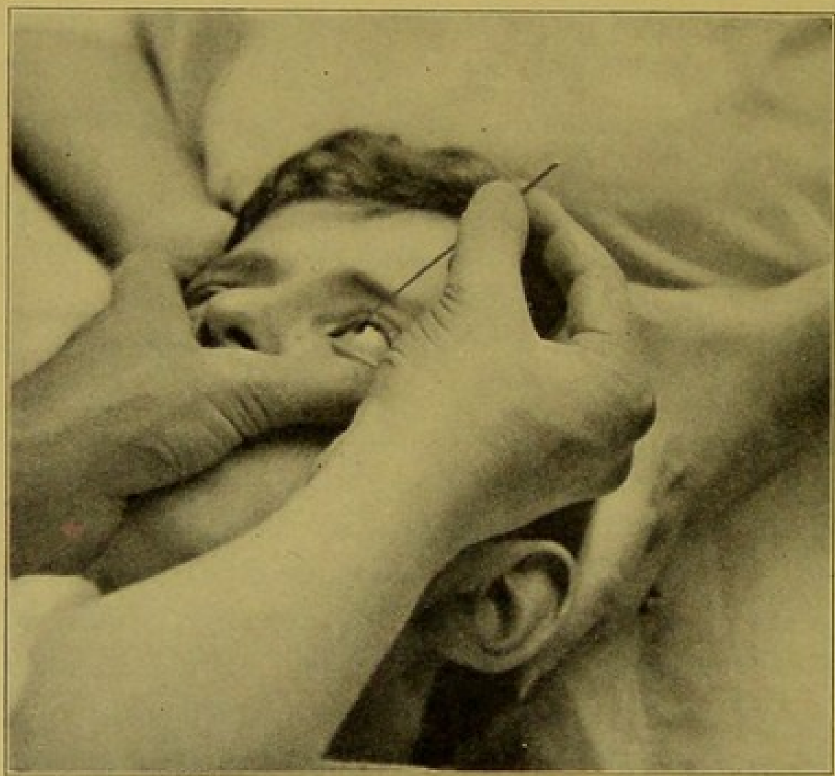
Instruments.—Conical probe and Weber's knife.

Operation.—It is not necessary to put the patient on the operating table. It is sufficient if an assistant stands behind him and steadies the head. A few drops of a 5 per cent. cocaine solution is instilled in the conjunctival sac. The patient is directed to look upward and the lower lid is slightly pulled downward and outward. By this manipulation the lacrimal punctum becomes visible and the canaliculus is put on the stretch and straightened out.

The conical probe, held between the index finger and thumb of the hand that corresponds with the patient's temple, is entered in the punctum perpendicularly to the lid margin. Sometimes the punctum is occluded and cannot be found. In such cases it is advisable (Haab) to feel with the probe, which is held perpendicularly to the lid margin on the lacrimal papilla. In this way it is often possible to find it. If, however, this is unsuccessful it is necessary to incise the canaliculus by making an incision at right angles to it with the scissors. This incision should be about 2 mm. deep and of course placed inside lacrimal papilla. On the wound surface it will be easy to find the opening of the canaliculus (Figs 446 and 447).

After the probe has entered it is rotated 90 degrees temporarily, so that it is parallel to the lid margin and in the line of direction of the stretched canaliculus. It is then slowly advanced toward the lacrimal sac, the lid still being kept on the stretch in order to keep the mucous membrane of the canaliculus free from folds.

Fig. 446



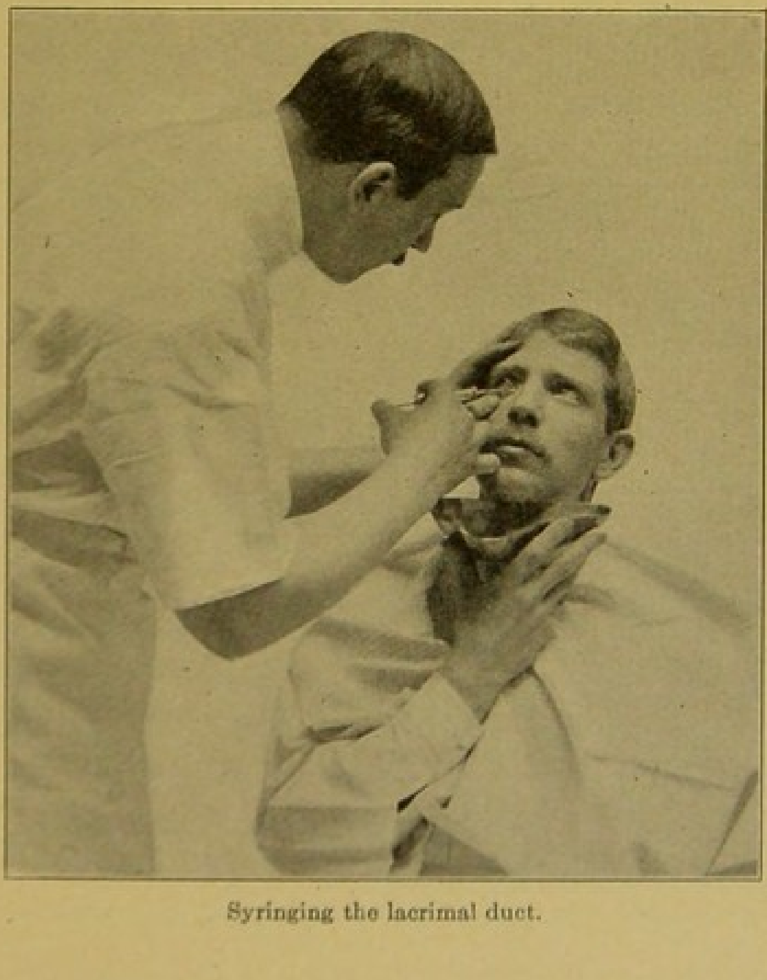
Dilating canaliculus with conical probe. First step.

In advancing the probe it should be rolled between the fingers and pushed into the lacrimal sac The bony resistance (lacrimal bone) encountered indicates that the lacrimal sac has been entered; if no entry has been made an elastic resistance is felt. This means that the probe is caught in a fold of mucous membrane. If the probe is pushed forward under this condition a false passage is likely to result, and so the probe must be withdrawn a little, and after altering its directions slightly, advanced again.

Fig. 447

Dilating canaliculus with conical probe. Second step.

Fig. 448



Syringing the lacrimal duct.

When the probe has reached the lacrimal sac it is left in position for a few moments and then rolling it between the fingers it is withdrawn.

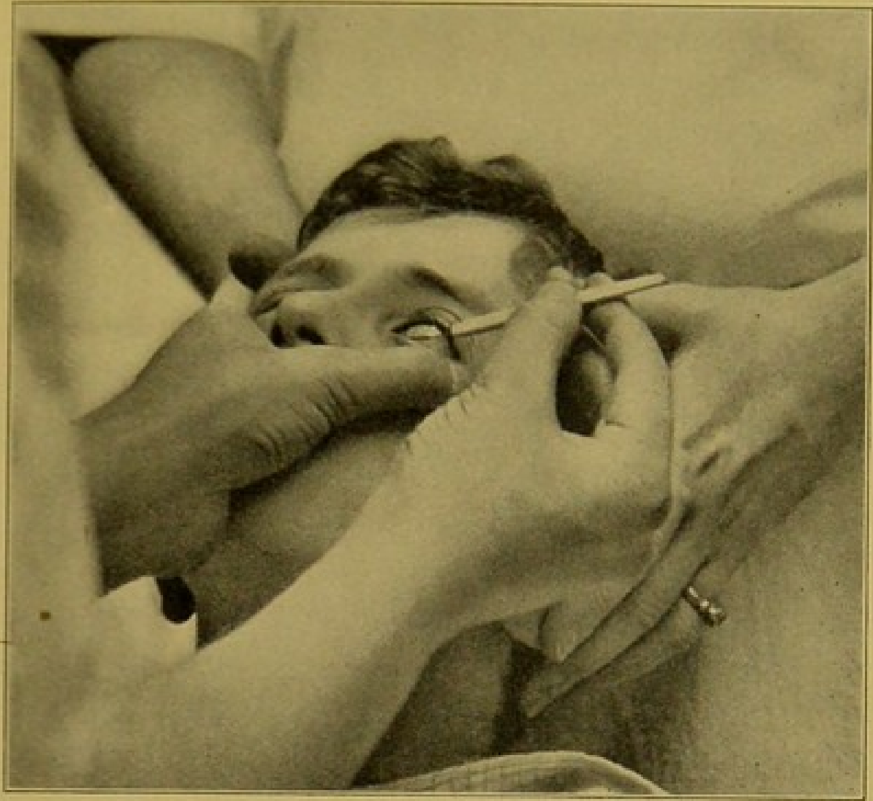
If the patency of the nasal duct is to be tested, as often before cataract operation, the point of the Anel syringe is introduced into the dilated canaliculus. The patient sits in his chair bending his head forward, at the same time holding a pus basin under his chin (Fig. 448). The contents of the syringe, usually sterile water or normal saline solution, are slowly driven into the lacrimal sac. If the nasal duct is patent, the solution runs out from the nose; if, on the other hand, the duct is obstructed the solution either runs out through the other canaliculus or remains in the sac; in this case it is impossible to empty the syringe.

As the dilatation of the canaliculus is the first step in the slitting of it, after withdrawal of the conical probe Weber's knife is taken. The knife is held in the same hand as the conical probe before, with its cutting edge directed upward and toward the posterior lip of the lid margin. It is then introduced in a similar manner to the conical probe and pushed forward until the point reaches the lacrimal bone (Figs. 449 and 450). Still holding it in contact with the bone the handle is raised 90 degrees, thus slitting the canaliculus throughout its whole length. During the incision the lid must be well stretched downward and slightly outward or else the slitting will be insufficient.

The dilatation and slitting of the upper canaliculus is accomplished in a similar manner, with the difference, however, that the patient is to look downward and the upper lid is to be drawn upward and outward. In using the Weber knife the cutting edge is directed downward and backward, and of course the handle is depressed 90 degrees instead of raising it. Following the slitting, which in spite of cocaine is somewhat painful, there is a slight hemorrhage that is easily checked with sterile cold compresses. A bandage is not necessary. On the following day the canaliculus is closed again and should be reopened with a probe. In two or three days the wound edges are covered with epithelium and the opening is permanent.

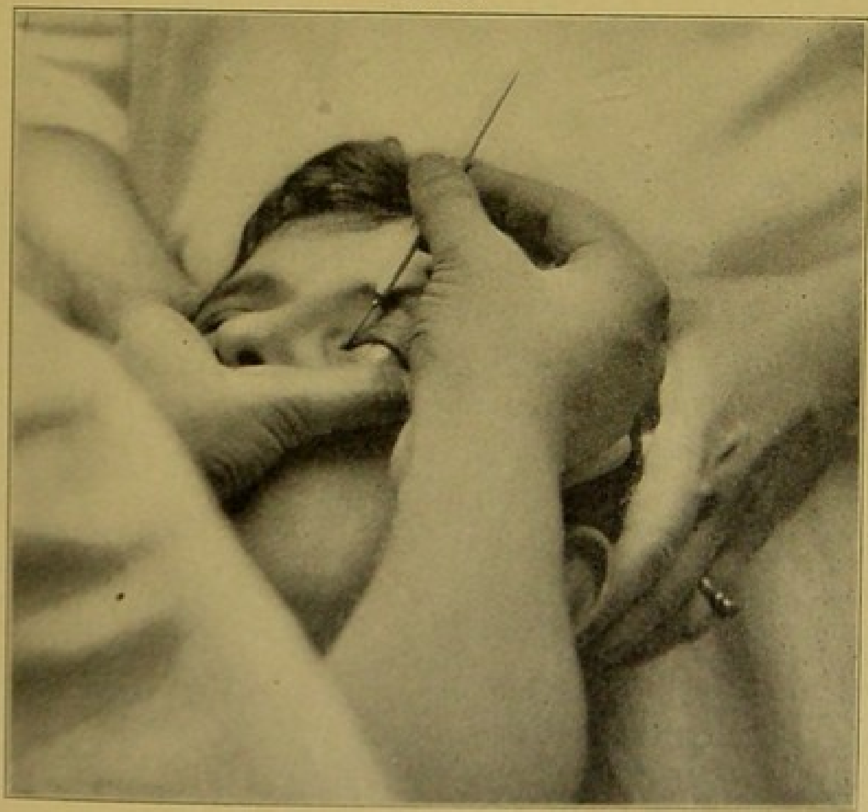
Complications during Operation.—These consist in making a false passage with the probe; this is an error that cannot be easily

FIG. 449



Slitting of canaliculus with Weber's knife. First step.

FIG. 450



Slitting of canaliculus with Weber's knife. Second step.

corrected. It occurs when a fold of mucous membrane is caught on the point of the probe, and instead of withdrawing it, it is pushed forward. It also occurs when the lid is not held in the proper position.

Probing of the Nasal Duct (Lower Lid).—Indications.—Stricture of the nasal duct (epiphora, chronic dacryocystitis, etc.).

Contraindications.—1. Acute dacryocystitis, as probing may increase the inflammation.

2. Bony strictures.

3. Syphilitic and tubercular affections of the bone or sac.

4. Polypoid degeneration of the mucous membrane and strictures due to tumors.

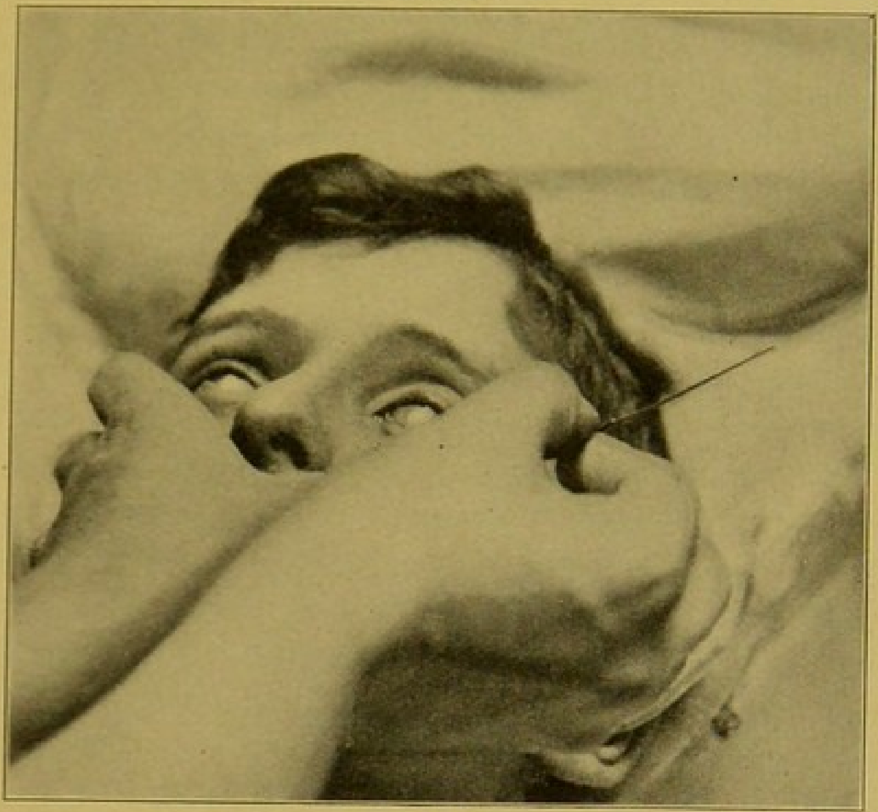
5. In cases where the sac is atonic, as in such cases the epiphora will persist even if the nasal duct is permeable.

Instruments.—Bowman's probes.

Operation.—The patient sits in a chair and his head is steadied by an assistant. Cocaine is instilled in the cul-de-sac, and it is also well to inject a few drops of cocaine solution, 3 per cent. to 5 per cent., into the lacrimal sac with the Anel syringe. The probe is now taken in the hand that corresponds with the patient's temple while the other hand pulls the lower lid downward and outward. The patient is asked to look upward and the probe is placed in the groove made by the slitting of the canaliculus (Figs. 451 and 452). It is slid along the anterior wall of the groove until the lacrimal bone is met. Keeping the point in contact with the bone the lower lid is released and the probe raised about 90 degrees. Closely following the anterior inner wall of the sac the probe is passed by gentle pressure down into the nasal duct. Probing through the upper canaliculus is carried out in a similar manner, but instead of the patient looking up he looks down, the upper lid being slightly raised and drawn outward.

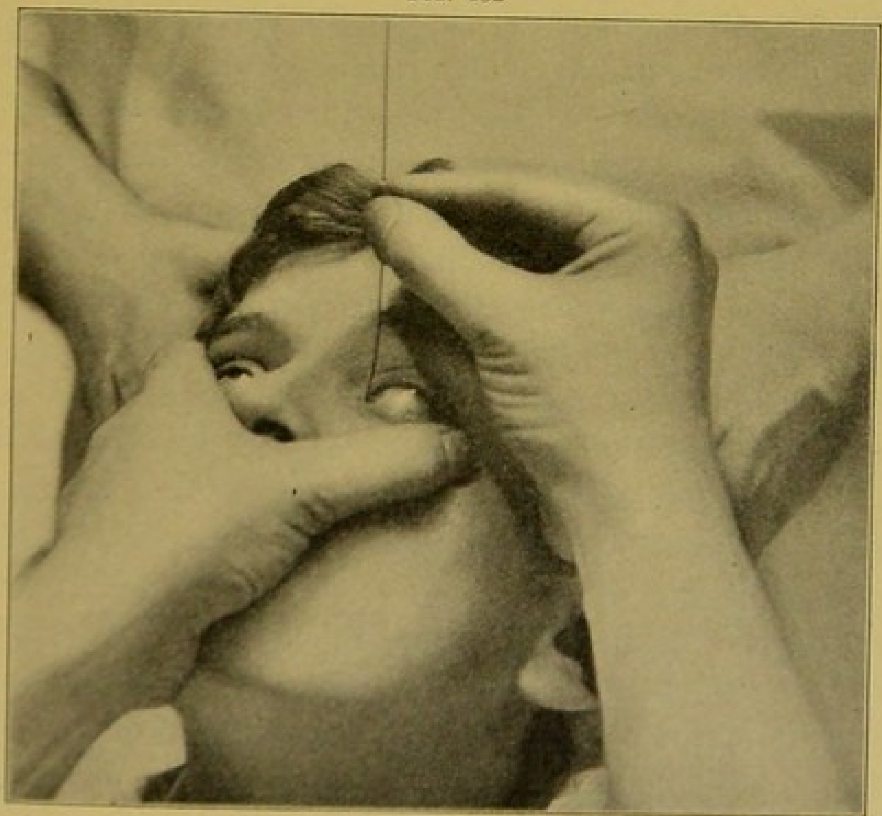
After the probe has entered the nasal duct it is pushed downward with gentle pressure. If the probe meets with firm resistance the pressure may be increased slightly, as the resistance is due to a stricture. However, if the resistance is elastic it means that a fold of mucous membrane has been caught. Such folds are usually met with around the stricture where the mucous membrane often forms a cul-de-sac. In such cases the pressure should not be

Fig. 451



Probing of nasal duct. First step.

Fig. 452



Probing of nasal duct. Second step.

increased, but the probe should be slightly withdrawn and then advanced in an altered direction. Too much force should never be employed, so if the probe does not pass easily it should be removed entirely and one of smaller caliber tried. If this is not successful this method of treatment had better be abandoned. The fact that the probe has passed through the nasal duct can be noted from the position of the plate of the probe, which should be at the eyebrow and facing outward and downward. The patient can also feel the probe in the nose.

The probe is usually left in the duct for about ten to fifteen minutes and then removed. This should be done slowly without exerting too much force. After removal the sac and the nasal duct are syringed out with an astringent or antiseptic solution. The solutions most commonly used are: Zinc sulphate $\frac{1}{2}$ per cent., or 1 per cent.; bichloride, 1 to 5000; protargol, 5 per cent.; silver nitrate, 1 per cent. If on removal the probe is held too tightly by the mucous membrane it is left in for a shorter time at the next sitting.

It is better to start with Bowman's probe No. 3, because there is less danger of making a false passage. When this cannot be passed a smaller one is used. Probing must be done every day in the beginning, and later it is gradually reduced. The size of the probe is gradually increased until Bowman No. 6 is reached; this usually requires several weeks. Even after No. 6 has been passed easily the patient is not necessarily cured, and he should return at least once a month to have the probe passed.

Complications during Operation. — 1. *Injury to the mucous membrane of the duct.* This occurs when the probe is pushed downward too roughly or withdrawn suddenly. The mishap is noticed by pain and hemorrhage. If the injury is extensive the stricture increases later by the formation of scar tissue.

2. *False Passage.* This is always due to carelessness on the part of the operator as he should know at all times where the instrument is. It may happen more easily with the smaller probes than the larger. False passages are usually made by injuring the mucous membrane and passing in behind it, or by passing into the nasal fossa or orbit through bone, especially when it is diseased.

Systematic Probing.—Systematic probing should always be done through the slit canaliculus. To probe through an unslit canaliculus is apt to lead to injury of the mucous membrane, which later may result in a stricture or even total obstruction. For this reason the practice of certain ophthalmic surgeons to probe through a dilated but unslit canaliculus is not to be followed, especially when the fact is taken into consideration that the slitting of the canaliculus does not interfere with the conduction of tears, and that it is not objectionable from a cosmetic point of view. If the slitting is performed properly, on the posterior lip of the lid margin, it is not visible. The passing of the probe through the unslit canaliculus is, however, permissible when the probe has to be passed once or may be twice. These cases are dacryocystitis found in infants that is due to a membranous atresia of the duct, or an epithelial agglutination of the mucous membrane; also the cases where the syringing of the duct for diagnostic purposes left doubt as to whether there was an obstruction or not, and a probe is passed to ascertain the exact condition of the duct.

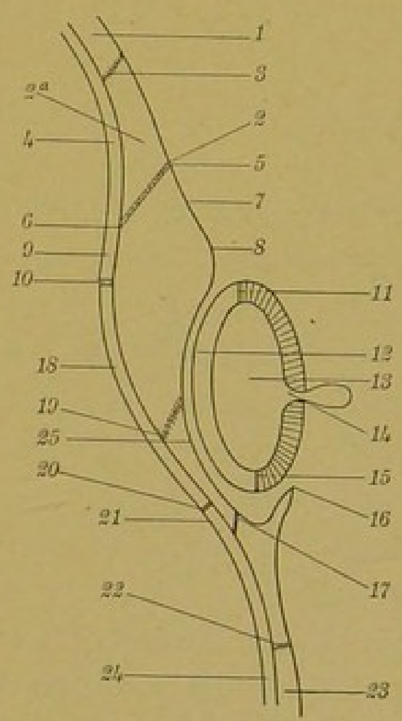
Systematic probing does not give the best results. Permanent cure can only be had where the obstruction is due to a swollen mucous membrane, as it is often found following acute inflammatory conditions of the nasal mucous membrane. Also in cases where the obstruction is membranous, as in the dacryocystitis of infants where often the passing of the probe once will result in a permanent cure. In cicatricial stricture of the nasal duct systematic probing in many cases will improve the patient's condition, but after the cessation of probing the dilated cicatrix contracts again and the condition is the same as it was previously. Fuchs believes that a permanent cure with probing is one of the rarest exceptions. Taking this into consideration, and the fact that the probing is rather painful, that it always takes several weeks of constant treatment to which many patients cannot or will not submit, it is readily understood why nowadays many surgeons limit the indications of probing to the above-mentioned cases and extirpate the sac in all cicatricial strictures and dacryocystitis.

The unsatisfactory results from probing will also explain the reason for so many modifications of probing with Bowman's probes and also the advancing of other operative procedures which strive to restore the drainage of the tears into the nose. None of them, however, give better and many of them poorer results. No method which aims at forced dilatation of the stricture of the nasal duct as the stricturotomy (Weber, Stilling) or rupture of the stricture by the introduction of a very thick probe (Theobald) can result in permanent cure. They may produce temporary relief, but after the wound thus produced heals and the scar tissue contracts the condition of the patient will be surely worse than it was before. This is also true of the probe introduced and left for a certain time in the nasal duct. Any number of different probes have been recommended varying in shape and material. Experience shows that there may be temporary improvement with these methods in some cases, but in many not even that can be accomplished. The permanent probes often produce ulcers of the mucous membrane of the duct, due to pressure, and this, instead of improving the condition, makes it worse.

The impossibility of restoring the patency of the nasal duct has led to the idea of discarding the nasal duct entirely and making a new duct for the tears through the bony wall of the nose. This idea has occupied the surgeons for some time past, but until recently the operations advanced met with no success. The opening made through the nasal wall has never been permanent until Toti in 1904 suggested his dacryocysto-rhinostomia, by which a permanent drain could be established between the lacrimal sac and the nose.

Toti's Operation.—The operation is usually performed under general anesthesia. The incision of the skin is crescentic, its concavity encircling the internal angle of the eye. The length of the incision is about 3 or 3½ cm., and runs about 3 mm. in front of the anterior extremity of the insertion of the orbicularis. The incision of the subjacent tissues must follow the cutaneous incision perfectly throughout, and at the same time be perpendicular to the bony surface. The periosteum is then detached. The detachment should be made exclusively on the posterior ocular side of the periosteal incision. After the detachment of the periosteum it is advisable to dry rapidly the base of the lacrimal fossa and cover it with adrenalin 1 to 1000 and cocaine 20 to 100 tampon. Cocainization and adrenalization of the nose follows. The bone is to be resected as follows: First the edge of the orbit is resected at the extension of the fossa sacci lacrimalis, then an oval piece of the bone is resected, which is bordered by the crista lacrimalis posterior posteriorly, the ductus nasolacrimalis inferiorly, and the elongation of the crista lacrimalis posterior superiorly. Care must be taken not to injure the nasal mucous membrane. If the resection is made exactly as described above,

Fig. 453



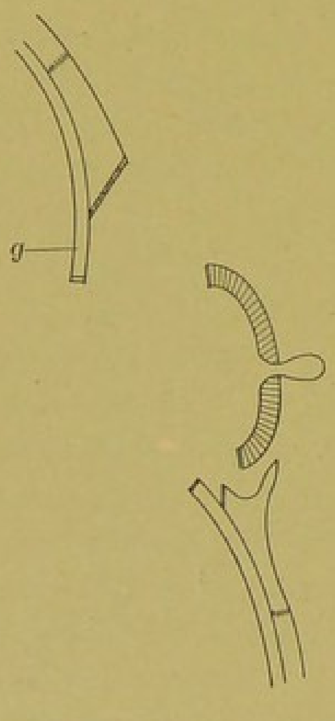
Cross-section of nasolacrimal region (schematic). 1, nasal bone; 2, site of skin and periosteal incision; 2a, ascending apophysis in front of the bone to be resected; 3, suture between nasal bone and ascending apophysis; 4, nasal mucous membrane covering inner surface of ascending apophysis; 5 and 6, facial and nasal end of line where ascending apophysis is resected; 7, point of insertion of orbicularis; 8, anterior lacrimal crest; 9, nasal mucous membrane; 10, line where nasal mucous membrane is to be resected anteriorly; 11, line where external wall of lacrimal sac is to be resected anteriorly; 12, internal wall of lacrimal sac; 13, cavity of lacrimal sac; 14, external wall of lacrimal sac with the common duct of the canaliculi; 15, line where the external wall of the lacrimal sac is to be resected posteriorly; 16, posterior lacrimal crest; 17, line in which the unguis is to be resected; 18, nasal mucous membrane which is to be resected from 10 to 20; 19, suture between unguis and ascending apophysis; 21, mucous membrane of the middle meatus; 22, suture between unguis and os planum; 23, os planum; 24, mucous membrane of middle meatus; 25, portion of unguis that is to be resected. (After Toti.)

the way directly into the nose is usually found. Exceptionally some ethmoidal cells may be found behind the anterior segment of the piece of bone to be resected; behind the superior segment some of the inferior frontal cells may be encountered, or behind the posterior segment some of the lacrimal cells. They may be resected.

The resection of the internal wall of the lacrimal sac is the next step in the operation, and it must be removed in its whole extent.

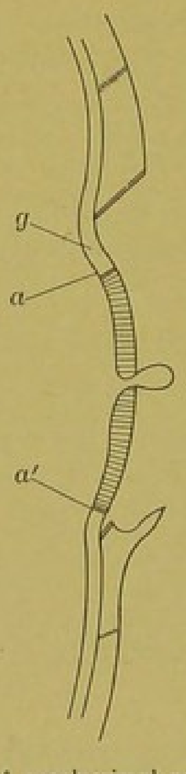
The resection of the nasal mucous membrane is next in order. The opening in the mucous membrane must correspond in size to the external wall of the lacrimal sac. Before making the opening it is advisable to push the nasal mucous membrane forward through the bony defect, at the same time pushing the flap with the external wall of the sac in the opposite direction, just to see whether or not they can be easily brought together. If there be some difficulty in doing this the opening in the bone must be enlarged. To succeed in the resection, the membrane is to be stretched either by introducing the little finger into the nose, or probe or cotton applicator and then making the excision with a pointed scalpel (Figs. 454 and 455).

Fig. 454



Cross-section of nasolacrimal region (schematic). After resection of bone; nasal mucous membrane and internal wall of sac. (After Toti.)

Fig. 455



Cross-section of nasolacrimal region (schematic), showing result of operation. The external wall of the lacrimal sac filling in the defect caused by the resection of the nasal mucous membrane. (After Toti.)

After smoothing the edges of the bony opening the wound of the skin is closed with sutures, taking in as little skin and as much of the underlying tissues as possible. If there be some inflammation in the tissues surrounding the sac the wound may be allowed to heal by secondary intention. After completion of the suture, slight pressure bandage is applied, and, if necessary, the middle turbinated bone removed; but often it is advisable to remove the middle turbinated bone beforehand. A very important part in the operation is the tamponade of the nose by which the two mucous membranes are brought and kept in contact. For this purpose strips of iodoform gauze, 2 by 6 to 8 cm., are used.

After-treatment.—The patient must remain quiet, at rest, and not be allowed to blow his nose. If no complication arises the tampon may be removed on the fourth day. If crusts form in the nose they are removed with a slight tamponade of a few hours' duration, followed by insufflation of sodium borate and sugar of milk powder. If there be some hypersecretion of the nose without formation of crusts, bismuth powder may be used after thoroughly drying the nose.

The external bandage and sutures may be removed on the eighth day.

If Toti's operation is performed properly there is none or very little lacrimation after operation. In the New York Ophthalmic and Aural Institute we performed this operation in 9 cases; the result in 6 cases was perfect (no epiphora), in 2 cases there was moderate lacrimation; and in one case the result was equal to an extirpation of the sac (no secretion from the lacrimal sac, but drainage was not affected). Similarly good results have been reported by Salus of Elsching's clinic, Holth of Christiania, and Schirmer of Strassbourg.

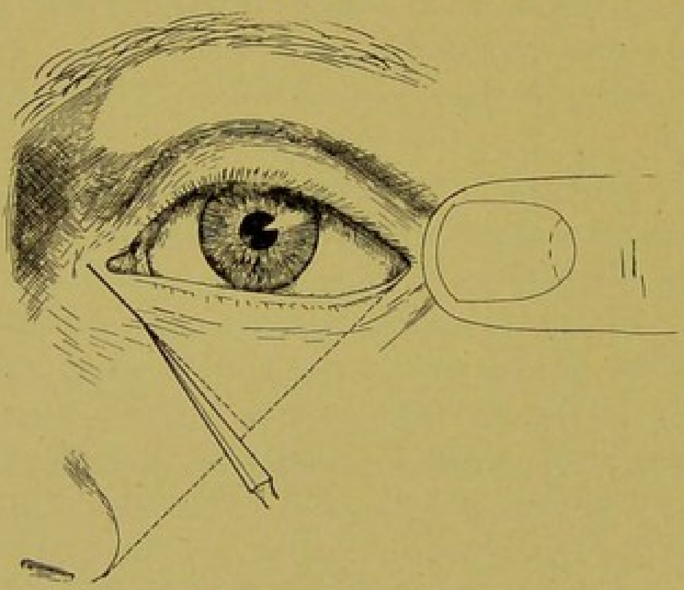
Incision of the Lacrimal Sac (Petit-Arlt).—**Indications.**—1. In cases of acute dacryocystitis to make an exit for the pus, stop the pain and check the progression of the suppuration.

2. To remove foreign bodies from the lacrimal sac.

If an abscess of the sac (acute dacryocystitis) is incised, cocaine injection is useless and the operation is to be performed either without an anesthetic or general anesthesia is employed; gas or freezing with ethyl chloride may also be beneficial in these cases. In case of foreign bodies in the sac an injection of cocaine is given locally.

Operation.—If the operation is performed for the removal of a foreign body the thumb of the left hand is placed on the outer canthus, which is drawn toward the temple. By this maneuver the internal canthal ligament is put on the stretch, and comes into view. A bistoury is taken in the right hand and is thrust through the skin down to the bone immediately below the ligament, the cutting edge of the knife being directed downward and outward. Too great a force should not be used in making the incision, as there is danger of entering the ethmoidal cells with the point of the knife (Fig. 456). The incision made should be about 8 or 9 mm. in length and on a line that is perpendicular to one that is drawn from the outer canthus to the nose. If the sac is to be opened throughout its entire length the knife is turned at 180 degrees, so that the cutting edge is directed upward and

Fig. 456



Incision of lacrimal sac.

inward and the ligament is cut through. After the foreign body has been removed the wound is closed by two or three sutures. If the incision is performed for an abscess of the sac the direction of the incision will be the same. The point of entrance of the knife should be where the pus presents. After the escape of pus a small drain of gauze is inserted and the wound is dressed daily. After all inflammatory symptoms have subsided the wound is allowed to heal and the lacrimal sac is later removed.

Extirpation of the Lacrimal Sac.—Indications.—1. Extirpation of the sac is indicated in all cases where probing is contra-indicated, that is:

(*a*) In bony strictures.

(*b*) Syphilitic and tubercular affections of the bone, or sac.

(*c*) Polypoid degeneration of the mucous membrane and in strictures due to tumors.

(*d*) In cases where the sac is atonic.

(*e*) Following acute dacryocystitis, when all inflammatory symptoms have subsided.

2. In cases where systematic probing gives no results or where after the cessation of the probing, lacrimation returns.

3. In all cases where the patient cannot afford the time to undergo the treatment with probes.

4. Preliminary to eyeball operations where there is a stricture of the duct or a chronic dacryocystitis present, as the extirpation of the sac is the method that is most apt to insure us against infection.

5. In infected ulcer of the cornea where there is a chronic dacryocystitis present. Extirpation of the sac should be the first step in the treatment of the ulcer.

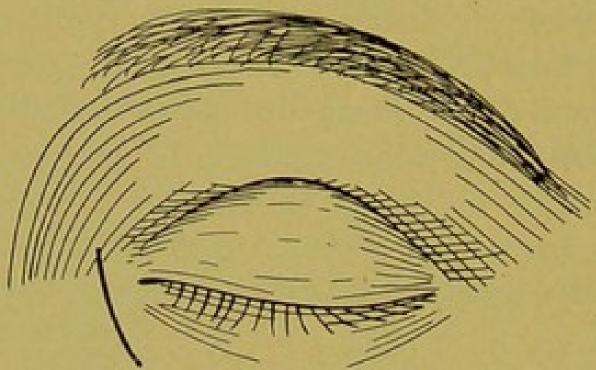
6. Trachoma of the lacrimal sac. It is often found in trachoma that there is a viscid discharge from the sac and its thickened mucous membrane can be felt through the skin. The disease of the sac in these cases is a true trachoma that cannot be treated in any other manner and which often is the cause of relapses after the trachoma of the conjunctiva has been apparently cured.

Instruments.—Scalpel, Müller's speculum, small sharp retractors, 2 fine forceps, sutures, 1 large forceps, curved scissors, small elevator, curette, needle-holder, hemostat, blunt retractors.

Operation.—Cocaine-adrenalin is injected superficially and deep in the neighborhood of the sac, massaging it afterward so that the solution will be disseminated. It is not necessary to instil cocaine in the conjunctival sac; in fact it is dangerous, as the cornea may be abraded during operation, leading to an infected ulcer. To avoid this complication, which may occur even when there is no cocaine instilled, the eye is to be kept closed with adhesive straps during operation.

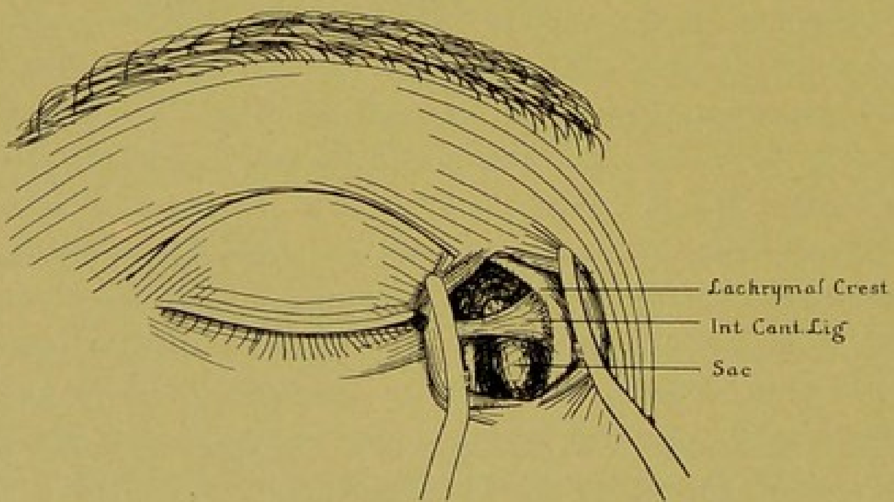
After locating the anterior lacrimal crest, which is easily felt with the finger, an incision 2 cm. in length is made. The direction of the incision should be downward and outward, and its upper third should cross the end of the canthal ligament. The edges of the incision are undermined for a short distance and Müller's speculum is inserted. There may be a slight hemorrhage at this point, but the insertion of the speculum usually checks it (Figs. 457 and 458). The fibers of the orbicularis are separated and

Fig. 457



Incision for extirpation of lacrimal sac.

Fig. 458



Extirpation of lacrimal sac. Second step.

then the deep fascia covering the sac is exposed. This is torn from its attachment to the anterior lacrimal crest with the blunt elevator. The opening is carried upward to the insertion of the canthal ligament. As the sac lies immediately under the ligament, injuring it can be avoided by blunt dissection. With sharp retractors the fascia is drawn to the temporal side, thus bringing into view the lacrimal sac, which is covered, at its upper end, by the canthal ligament. The sac may be easily recognized by its bluish color.

The lacrimal sac is now separated from its attachment to the surrounding tissues. As the sac is loosely attached medially, above and posteriorly this region is dissected up first by blunt dissection with the elevator. Some difficulty may be encountered above, and as the internal canthal ligament may be in the way, it is often necessary, therefore, to incise it. On the temporal side, where the sac is more adherent, it is grasped with the forceps, put on the stretch, and dissected off with small snips of the scissors; great care must be taken not to open the sac. The sac is now freed on all sides except below, pulling it upward and outward and pressing the scissors in the nasal duct as far as possible its lower attachment is cut. The mucous membrane of the nasal duct is now curetted with a sharp curette, throughout its whole extent, to give drainage. The wound edges are sutured with three or four sutures and a pressure bandage applied. To obliterate the lacrimal cavity and prevent hemorrhage, an iodoform gauze ball, about the size of a hazel-nut, is applied over the edges of the wound. This is covered with loose gauze and cotton and is held in place by an adhesive strap placed so as to press directly on the lacrimal fossa and not on the eye. In bandaging great care should be taken that the eye is closed, and it is also good practice to place a little boric vaseline in the conjunctival sac. The dressing is changed every other day for eight days, after which the sutures may be removed and the eye left open.

Complications during Operation.—*Hemorrhage.*—This is the most unpleasant complication, as the wound cavity is full of blood and the parts are obscured. As the hemorrhage usually comes from very small vessels it is almost impossible to seize them with the hemostat, and if they can be grasped the hemostats cannot be left in place, as they take up too much room. The best way to check a hemorrhage in a case like this is to moisten a piece of gauze with adrenalin and hold it firmly against the bleeding surface for a few minutes. The most disturbing hemorrhage that is likely to occur is met with in dissecting around the cupola of the sac. For this reason some surgeons leave this area to the last in freeing the sac.

Injury of the Sac.—During excision the sac may be injured either with the scissors or forceps. This is of no importance if noticed and no portions of the sac are left behind. If, however, the sac is distended with secretion this complication may lead to infection.

Injury of Lacrimal Bone.—If the sac is not hugged closely during the dissection the operator is apt to pass through the lacrimal bone into the nasal cavity or through the orbital fascia into the orbital fat. The former usually occurs when the bone is diseased, and in that case it is advisable to remove all the diseased parts with a sharp curette. If the operator passes into the orbital fat the prolapse of the fat is annoying. It is useless to attempt to cut it off, as it will prolapse again, so the assistant must keep it out of the way with a blunt retractor. Injury to the bone is of no serious consequence, but a prolapse of the orbital fat may lead to an orbital cellulitis if infection is present.

Retention of Remnants of Sac.—In cases where there have been several attacks of acute dacryocystitis the sac is surrounded with dense fibrous tissue which is adherent to it. This makes the dissection very difficult and some of the sac is apt to be left behind. Blunt dissection is, of course, impossible, and as it is impossible to distinguish between the sac and scar tissue the whole mass should be removed with scissors and forceps.

Retention of Remnants of Mucous Membrane.—Small portions of the mucous membrane of the sac may be left behind, and if not removed lead to continued discharge through the canaliculus or a fistula. This complication may follow injury of the sac during excision or a profuse hemorrhage obstructing the field of operation, making accurate dissection impossible; it also happens in cases where the sac is imbedded in scar tissue. For this reason it is a good routine practice to examine the sac after it has been removed to see if it is complete. This can be easily ascertained by introducing a probe into it through the opening of the canaliculus or nasal duct. If any part of the sac is found wanting the lacrimal fossa is to be thoroughly curetted.

Postoperative Complications.—If the pressure bandage is not properly applied the wound cavity fills up with blood and wound secretion. In opening the dressing the region of the sac is found slightly bulging, and by pressure bloody serum and secretion will empty into the conjunctival sac through the canaliculi. With properly applied pressure bandage the wound cavity can usually be obliterated.

If a piece of mucous membrane has been left behind a muco-purulent discharge comes out of the canaliculi at the end of three or four days. If this is left alone the proliferation of the mucous membrane forms a small cavity, which may become attached to the canaliculi; in which event the mucopurulent discharge empties into the conjunctival sac. It may also empty through the wound, forming a fistula. If signs of retained mucous membrane are present the wound is to be reopened and, if possible, the piece of mucous membrane is to be found and removed or the whole cavity thoroughly curetted.

Besides a stitch abscess a general infection of the wound and its surrounding tissues may occur. In such cases the neighboring parts are swollen and edematous. The patient complains of pain, and upon pressure pus will exude from the wound cavity. If this complication is found the abscess should be opened, thoroughly cleansed, and packed with iodoform gauze, leaving it to heal by secondary union.

If the cornea has been injured during operation a corneal ulcer may follow.

After the operation there remains a slight depression, which later gradually flattens out. Only where the lacrimal fossa is exceptionally deep will there be any cosmetic defect. The scar can hardly be noticed after several months.

The epiphora in some cases gradually subsides, so that in six to eight months after the operation it is hardly noticeable. Often, however, lacrimation persists, and, if it causes the patient much annoyance, it can be corrected by extirpation of the lacrimal gland.

Fistula of the Lacrimal Sac.—Fistula may be the result of dacryocystitis or it may be congenital. In the former case the treatment consists in extirpation of the lacrimal sac together with the fistulous tract. In the latter Elschnig's operation may be performed. He introduces a hard rubber probe into the fistula and makes an elliptical incision surrounding it. After excising the fistulous tract he closes the wound with two or three sutures.

CHAPTER X

OPERATIONS ON THE CONJUNCTIVA

In this chapter the operations for trachoma, symblepharon, pterygium, and the minor operations on the conjunctiva, such as subconjunctival injection, the removal of tumors, etc., are dealt with.

OPERATIONS FOR TRACHOMA

The treatment of trachoma may be divided into medical, mechanical, and surgical. The medical treatment, which consists in the application of various silver, copper, and mercury preparations in the form of solutions, ointments, or crystals, is usually combined with the mechanical treatment (bichloride rubbing), and is the most important. It is the only one which in certain cases results in an ultimate cure. The surgical treatment is only an aid to the medical, and its purpose is to shorten the course of the disease. Any surgical interference therefore must be followed by systematic medical after-treatment if satisfactory results are to be obtained.

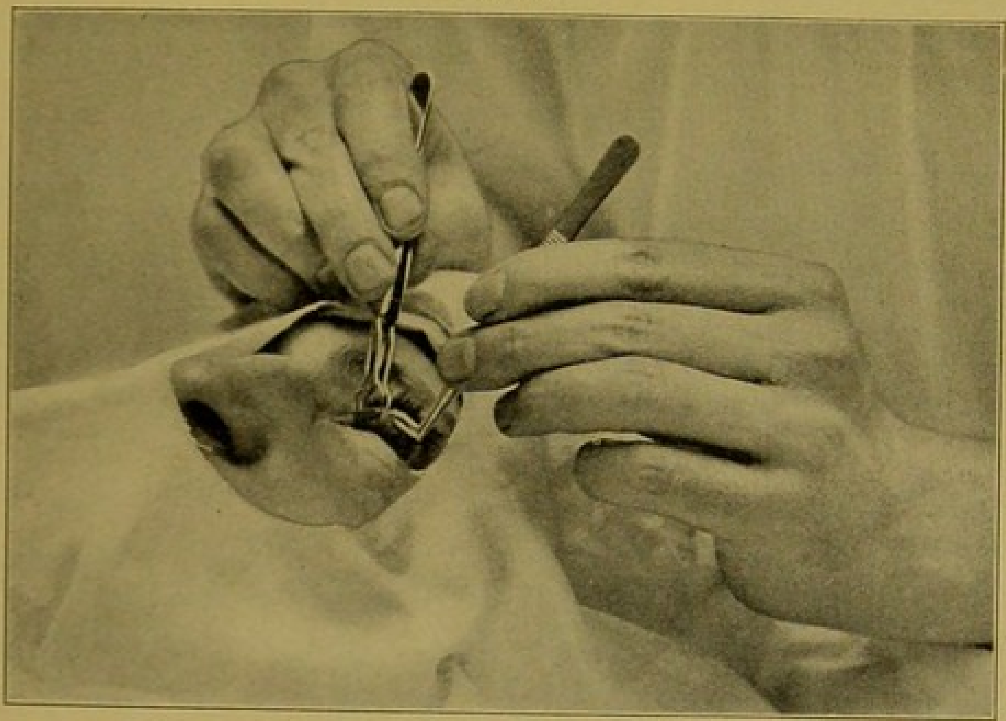
The operations for trachoma that are most commonly used are:

1. Expression of the follicles.
   (*a*) Knapp's method.
   (*b*) Kuhnt's method.
2. Excision of the fornix.
3. Combined excision of the tarsus and fornix.

[4. The excision of the tarsus (tarsectomy) is usually grouped with the trachoma operations. This operation is not a true trachoma operation but rather one for entropion and trichiasis, and is described under that heading, p. 340.]

Expression of the Follicles.—The operation may be performed in all cases of trachoma. It gives good results especially in light cases of follicular trachoma. In severer cases, however, the excision of the fornix or the combined excision of the fornix and tarsus are of more value. In very severe cases, again, where the bulbar conjunctiva is involved or the fornix is very much shortened, and the excision operations are contraindicated, expression of the follicles is the only operation which can be employed. In cases of trachoma, where the papillary hypertrophies are very marked and few follicles are present, expression is of little value.

Fig. 459



Expression with Knapp's roller forceps.

Knapp's Expression with the Roller Forceps.—The operation is usually performed under a general anesthetic, as it is very painful. In some patients, however, an instillation of 5 per cent. cocaine followed by a subconjunctival injection of cocaine-adrenalin solution in the cul-de-sac is sufficient to produce a fairly good anesthesia.

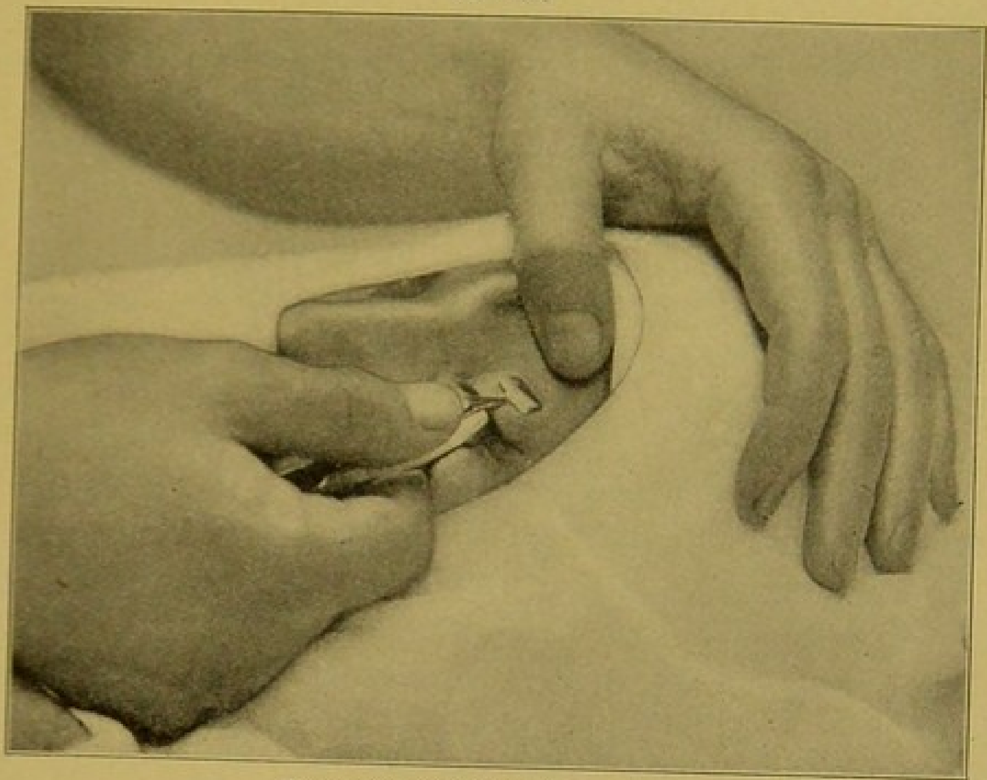
The upper lid is everted and the upper edge of the tarsus is grasped with a roller forceps and pulled away from the eyeball so that the entire cul-de-sac is exposed to view. A second roller forceps is taken and one cylinder placed in the cul-de-sac the other on the tarsal conjunctiva. The lid is held doubly everted with the first roller forceps and the second is compressed with moderate pressure and slowly drawn forward. The trachoma granules are crushed by the revolving cylinders and their gelatinous contents appear on the surface of the conjunctiva (Fig. 459). Alternately using the two forceps, one fixing the lid in everted position the other expressing the follicles, the entire conjunctiva is covered in this manner. The conjunctiva is at first thick and resistant, but when all infiltrated substance is expressed it appears as a thin membrane between the forceps. On the lower lid the expression is done in a similar manner, but it is not necessary here to use two forceps or to evert the lid doubly. It is enough if the lower lid is pulled down and the eyeball is pressed backward in the orbit. In this manner the conjunctiva is completely exposed to view. Some difficulty may arise in expressing the follicles on the edge of the lower lid and at the outer and inner canthus. To express the follicles in these positions the forceps may be applied so that one cylinder passes over the outer (skin) and the other over the inner (conjunctiva) surface of the lid. If the expression is properly performed the entire conjunctival surface should be free from the granules and the conjunctiva itself should appear deep red and covered with a number of small red dots which are the cavities of the granules, filled with blood.

Immediately after the operation the conjunctiva is rubbed briskly with a tampon saturated in bichloride of mercury solution 1 to 500.

After operation the eye is left open and cold compresses are applied for one-half hour. The first few days the conjunctiva is covered with a membrane, which, however, is later thrown off. While this membrane is present no treatment should be applied other than cleansing the eye with lukewarm boric solution. After it has disappeared the routine medical treatment is followed up.

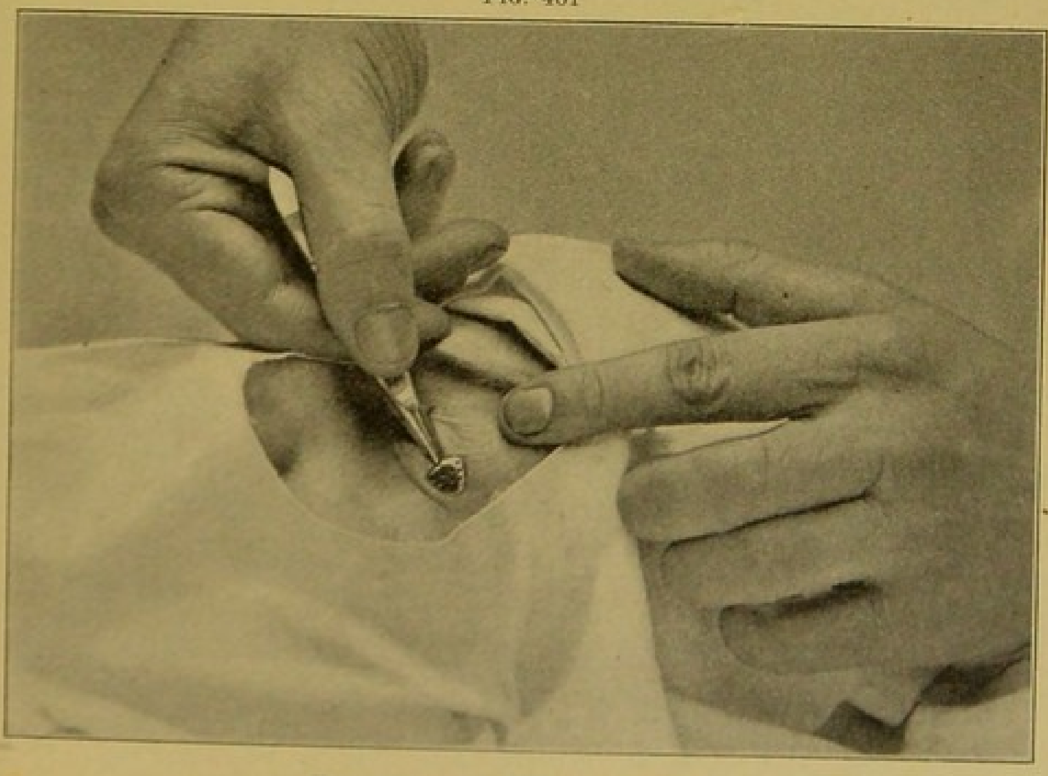
Kuhnt's Expression.—Kuhnt uses his special forceps (page 94) in the following manner: The upper lid is grasped by the cilia and drawn away from the eyeball. The fenestrated blade of the square forceps is introduced under the lid deep into the cul-de-sac, the non-fenestrated blade is placed on the skin of the lid. The two blades are pressed together with sufficient force to express the granules (Figs. 460 and 461). The position of the forceps is changed so that a fresh area of conjunctiva can be expressed. In

Fig. 460



Expression with Kuhnt's expressors.

Fig. 461



Expression with Kuhnt's expressors.

this fashion the entire conjunctiva of the lid is slowly worked over. After completing the upper lid the lower one is treated and the expression is carried out in a similar manner. The forceps are then introduced under the outer canthus in a vertical direction and the follicles that are present are expressed. The spade-shape forceps are used to express the follicles on the semilunar fold and caruncle. It is also employed for follicles that are present on the bulbar conjunctiva and for those that remain in the cul-de-sac. Deeply situated follicles on the tarsal conjunctiva must be opened, before the use of the forceps, with a Graefe knife or knife-needle. This operation is less painful than the one with the roller forceps and can therefore be performed with very little pain under the local anesthesia. The after-treatment is the same as following the roller forceps.

Excision of the Fornix.—This operation, first recommended by Walther, never found much favor until it was revived and modified by Kuhnt.

The operation is indicated in severe cases of trachoma where the cul-de-sac is infiltrated and contains a great number of granules, especially when they are large and succulent but do not involve the entire cul-de-sac. It is also indicated when the cul-de-sac is hypertrophic and does not yield readily to medical treatment.

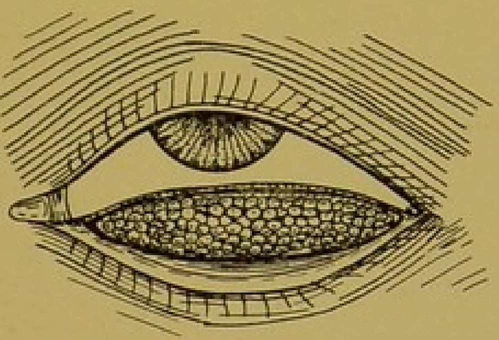
It is contraindicated if the entire cul-de-sac is involved or shortened and in cases where there are many follicles on the tarsal as well as the bulbar conjunctiva. It is also contraindicated in all recent cases of trachoma.

It is usually performed on the lower cul-de-sac and seldom on the upper, as here the tarsus is usually involved and should be removed at the same time.

The instruments used are: Forceps, small scissors, and scalpel.

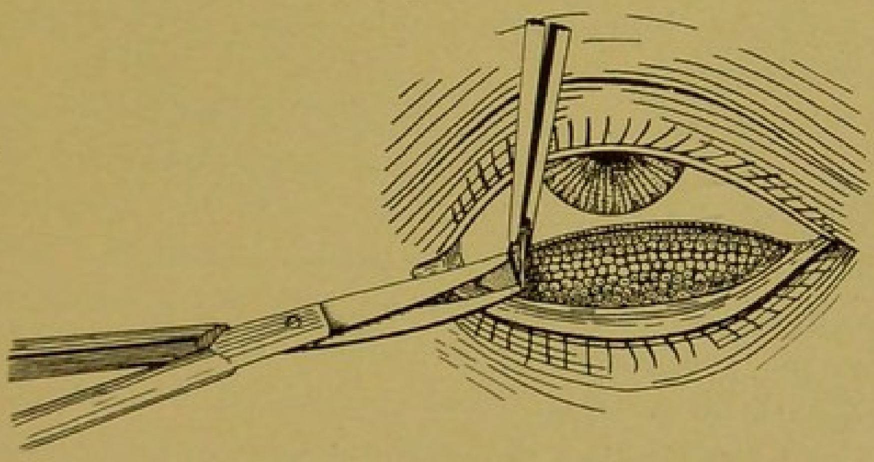
Cocaine is instilled in the cul-de-sac and followed by a sub-conjunctival injection of cocaine-adrenalin solution, which causes the conjunctiva of the cul-de-sac to roll outward. The line of demarcation between the apparently normal and diseased conjunctiva can be plainly seen (Fig. 462 and 463). The first incision is made with the scalpel, behind the line of demarcation and parallel to it, for the entire length of the cul-de-sac. The second incision is carried along the inner border of the tarsus and the two incisions are connected at each end. The flap of conjunctiva between the incisions is grasped with a forceps at one end and is dissected up with small snips of a scissors leaving behind as much of the underlying tissues as possible. No sutures are necessary.

Fig. 462



Excision of the fornix. First step.

Fig. 463



Excision of the fornix. Second step.

Immediately after operation a pressure bandage is applied which can be removed the next day and the eye left open. The routine treatment of the trachoma may be resumed one week after operation.

Combined Excision of the Fornix and Tarsus.—**Indications (Blaskovics).**—1. In all cases of severe trachoma where the cul-de-sac is studded with follicles and the tarsus is thick and infiltrated.

2. In cases where there are few follicles present, but there is a marked papillary hypertrophy of the tarsal conjunctiva.

3. Also in cases where the cul-de-sac is in fairly good condition, but tarsus is thickened, infiltrated, and there is a pannus present.

4. In less severe cases if the trachoma does not yield to medical treatment and there is pannus or ptosis present.

Contraindications.—1. If the cul-de-sac is very much shortened, because in these cases an excision would be followed by a lagophthalmos.

2. If the bulbar conjunctiva is involved, because the bulbar conjunctiva can never be excised. In such cases, first the expression of the follicles and medical treatment must be resorted to. If under this treatment the bulbar conjunctiva has regained its normal appearance and the tarsus is thickened and infiltrated the combined excision may be performed.

3. If the trachoma is recent.

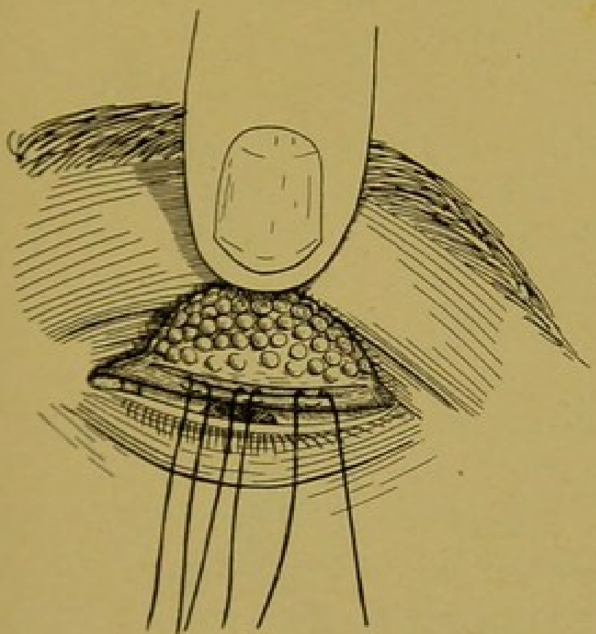
Instruments.—Scalpel, forceps, curved scissors, straight scissors, Panas' eyelid forceps, horn plate, double hook, needle-holder, double armed silk sutures.

Operation.—The operation is performed on the upper lid only. The lid is everted and an injection of cocaine-adrenalin is given subconjunctivally in the cul-de-sac, as in the previous operation. This injection together with the instillation of 5 per cent. cocaine solution gives, in most cases, sufficient anesthesia. In restless or too sensitive patients, however, this will not be sufficient and a general anesthetic must be employed. If a general anesthetic is given an injection of sterile salt solution with a few drops of adrenalin is introduced into the cul-de-sac immediately before the operation, in order to produce a bulging forward of the conjunctiva.

If this injection produces the desired result (bulging forward of the cul-de-sac) the line of demarcation is plainly visible. When the cul-de-sac does not fill out properly after injection, the double hook must be applied to bring the cul-de-sac into view. This is then inserted behind the upper border of the tarsus and the cul-de-sac put on the stretch.

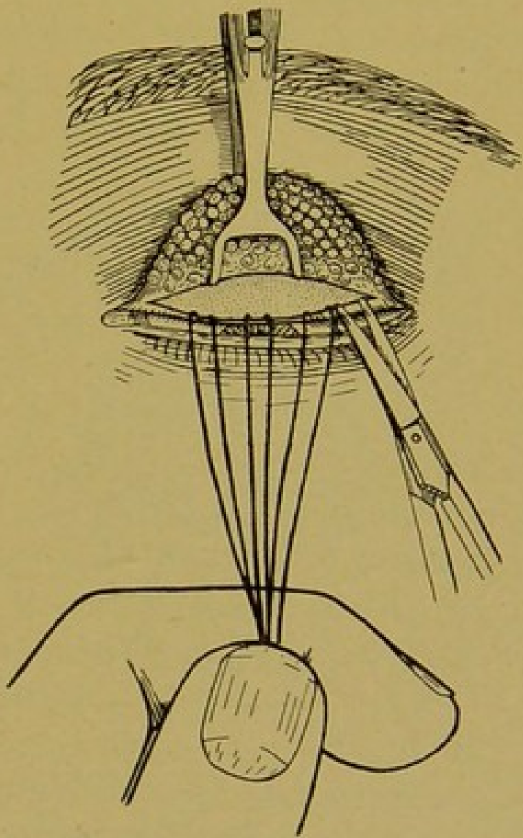
The first incision is made with the scalpel along the line of demarcation in apparently normal tissue and the conjunctiva is dissected up to the border of the tarsus. The Panas lid forceps are then introduced, one blade being in the wound under the tarsus, the other one on the tarsal conjunctiva. They are then closed, locked, and the lid is doubly everted. The lower edge of the incision is now grasped with a forceps and mattress sutures are passed through it, so that the loop will lie on the ocular surface of the conjunctiva (Fig. 464). Three such sutures are inserted, one in

Fig. 464



Combined excision of the fornix and tarsus. First step.

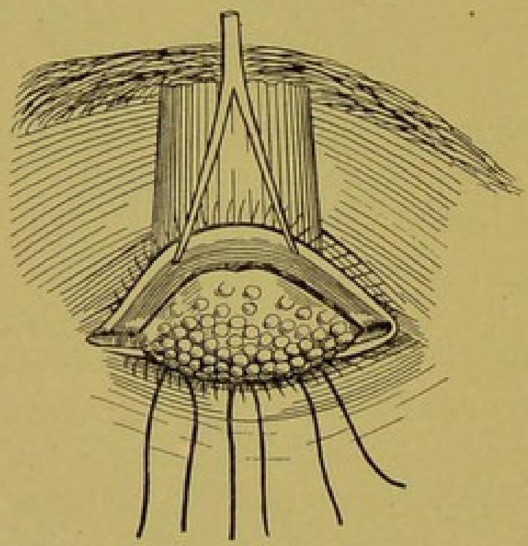
Fig. 465



Combined excision of the fornix and tarsus. Second step.

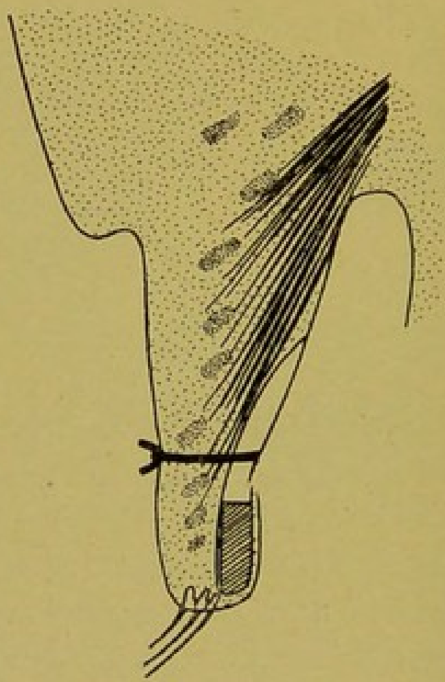
the middle and the others near the ends of the incision. The ends of the sutures are now grasped with the left hand and retracted. The edge of the conjunctiva is undermined with the scissors, keeping close to the conjunctiva, until the limbus is reached. If this flap is large enough to cover the cornea (about 1 cm.) there will be no danger of a postoperative lagophthalmos (Fig. 465). Panas' forceps are removed and the lid is supported on the horn plate; at the same time Imre's hook is caught in the tarsus to steady it. The knife is now taken in the right hand and an incision is made through the conjunctiva and tarsus, about 2 mm. from the lid margin. The incision is made parallel to the lid margin everywhere except at the midpoint of the lid, where it should curve inward slightly for a short distance (5 or 6 mm.), running here about 3 mm. from the lid margin (Fig. 466). This will prevent the bow-like deformity of the lid margin at the centre of the lid, which sometimes appears after this operation. The tarsus is now grasped with the forceps and

Fig. 466



Combined excision of the fornix and tarsus. Third step.

Fig. 467



Combined excision of the fornix and tarsus. Cross-section.

dissected free from its attachment on its outer surface and removed with a few snips of the scissors. The horn plate is then removed and the lid returned to its normal position. The lid is grasped by the cilia and gently pulled downward, this maneuver smoothing out the conjunctiva into place.

The sutures are then disentangled and allowed to hang down on the cheek; the points are then noted where they touch the lid margin, as it is here that the sutures are to be passed. The sutures are brought out through the skin about 1 mm. behind the remaining portion of the tarsus. They are loosely tied over a roll of gauze and a slight pressure bandage is applied (Fig. 467).

Complications during Operation.—These are of no importance as long as injury of the levator muscle has been avoided.

After-treatment.—The bandage is worn for two days and the sutures are removed on the third day. The routine trachoma treatment should not be resumed until one week after the operation.

Postoperative Complications.—The operation is usually followed by little reaction. Occasionally, however, the eyelids may become moderately swollen, the discharge increases, and a fresh eruption of pannus may occur; or if it was present before operation it may become worse. In such cases hot applications are indicated followed by argyrol 25 per cent., two to three drops daily.

In very rare cases, postoperative hemorrhage may occur. This can usually be checked by a pressure bandage. If during operation the levator muscle was injured a ptosis may ensue, and if the conjunctiva was too short and was not properly freed as far as the limbus, a lagophthalmos or a restriction of the movements of the eyeball may result. An unpleasant deformity, from a cosmetic point of view, sometimes found after the operation, is the appearance of the lid margin which somewhat resembles a Gothic arch. This is caused by a weakness of the tarsus at the midpoint, and can be avoided by leaving the tarsus a little wider at the centre of the lid (Fig. 466).

OPERATIONS FOR SYMBLEPHARON (RESTORATION OF THE CUL-DE-SAC)

Symblepharon is a condition where the conjunctiva of the eyelids is adherent to the bulbar conjunctiva or cornea. It may result from trauma or burn, although in rare cases it may be congenital. The term symblepharon is also applied to denote a condition which results from a cicatricial shrinking of the cul-de-sac as found in trachoma and pemphigus of the conjunctiva (degenerative symblepharon).

The adhesion varies from small cicatricial bands to a total adhesion of the lid. When the cul-de-sac is free, which is ascertained by the fact that a probe can be introduced and passed under the adhesion between eyelid and eyeball the condition is called anterior symblepharon (symblepharon anterius). If the adhesion involves the fornix also the condition is known as a posterior symblepharon (symblepharon posterius). In total symblepharon (symblepharon totale) the lids are everywhere adherent to the globe, and this is often accompanied by ankyloblepharon (adherence of the lids to each other).

Pronounced symblepharon is disfiguring, it also hinders the movements of the eye, causes a diplopia, and keeps up a constant irritation by traction. If it occurs in patients that have a shrunken eye or anophthalmos, an artificial eye cannot be worn.

The distinction between an anterior and posterior symblepharon is important from an operative standpoint. An anterior symblepharon may be in most cases easily remedied, while the operations for posterior symblepharon (restoration of the cul-de-sac) are difficult and rarely successful.

It should therefore be the aim whenever there are wound surfaces on the eyeball and eyelid to prevent the formation of adhesions. This can only be done successfully when the wound surfaces are the result of a trauma. In such cases the wound edges of at least one wound must be closed by sutures. It is always easier to unite the wound of the bulbar conjunctiva, as it is but loosely adherent to the sclera and is therefore easily undermined. If the palpebral wound is to be sutured care must be taken especially at the edges of the eyelids, as the knots of the sutures may rub on the cornea and produce an abrasion or even an ulcer.

There is less chance of preventing the formation of adhesions when the wounds are caused by burns from heat or chemicals. In such cases the patient is advised to draw his eyelid away from the eyeball several times daily and to interpose small pieces of linen soaked in oil or some ointment between lid and eyeball. This, however, will rarely prevent symblepharon as a portion of the conjunctiva necroses and if the eschar extends as deep as the cul-de-sac the adhesion takes place, extending from the cul-de-sac to the upper end of the wound surface. If a symblepharon has developed no operative interference should be attempted before all inflammatory symptoms have disappeared. The method of operating will vary according to the case and no definite rules to be followed can be given. The operation, however, must consist in dividing the adhesions and preventing their recurrence by covering the ocular, lid, or both wound surfaces. This can be accomplished by:

A. Drawing the wound edges together.

B. Covering the wound surfaces with pedunculated or non-pedunculated mucous membrane flaps.

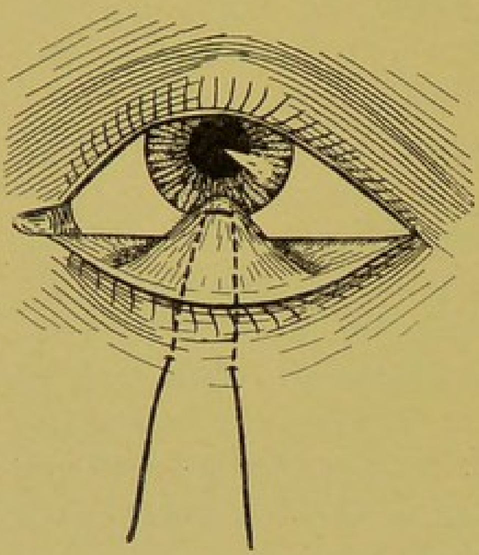
C. Covering the wound surfaces with pedunculated or non-pedunculated skin flaps.

Drawing the Wound Edges Together.—A small anterior symblepharon, especially a congenital one, can be easily remedied by severing the adhesion and suturing the wound edges of the bulbar conjunctiva, after having undermined them in both directions.

Arlt's Operation.—The instruments used in this operation are: The fine forceps, scalpel, fine scissors, needle-holder, double armed sutures, and several conjunctival sutures.

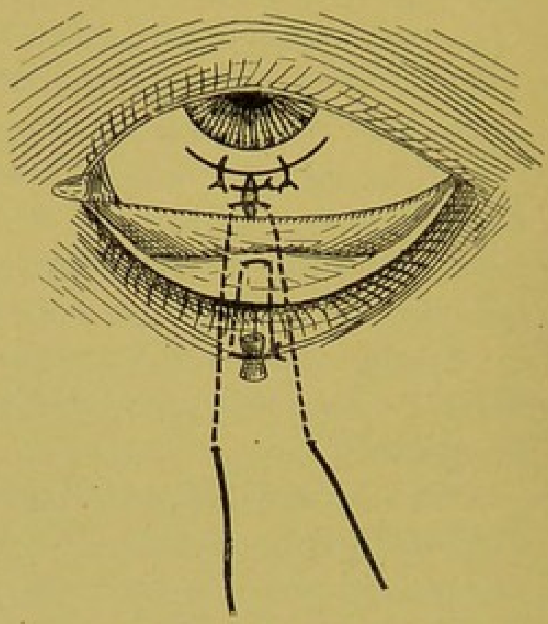
This operation may be used for a posterior symblepharon that is not broader than a third of the lid. A few drops of a 5 per cent. cocaine solution are instilled in the cul-de-sac and an injection of cocaine-adrenalin is given. The band of conjunctiva is then grasped with a fine forceps and dissected off the eyeball with a small scalpel down to the fornix. All the scar tissue is now carefully removed. At the apex of the band a mattress suture is passed. The two needles are then carried down through the fornix, brought out through the lid, and tied over a roll of gauze. The edges of the wound in the bulbar conjunctiva are brought together in a vertical line with a few sutures (Figs. 468 and 469). If the edges cannot be easily coapted an incision in the conjunctiva should be made parallel to the corneal margin. This will relieve the tension on the flaps. Special care must be taken in inserting the sutures in the fornix in order to produce a deep cul-de-sac. Blaskovics advises using for the lowest suture on the bulbar conjunctiva one that is double armed. The needles are passed through each side of the wound and brought out through the lid below the first mattress suture. The ends of the suture are then tied over a roll of gauze. This not only coapts the wound edges but also insures a deep cul-de-sac by drawing the conjunctiva downward. A bandage is then applied which is changed daily. Sutures are to be removed on the fifth or sixth day.

Fig. 468



Arlt's operation for symblepharon. First step.

Fig. 469



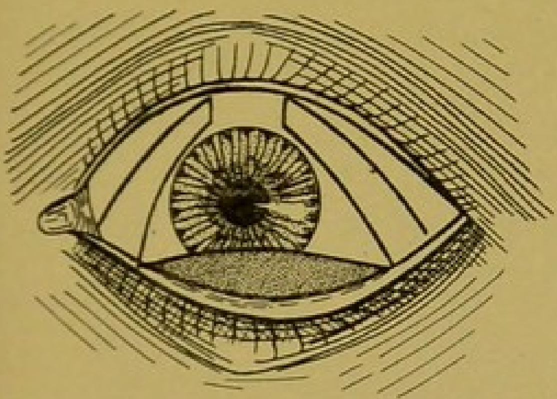
Arlt's operation for symblepharon. Second step.

Czermak's Operation for Narrow Posterior Symblepharon.—The instruments used are: The angular keratome, scalpel, forceps, scissors, needle-holder, silk sutures, double and single armed.

Cocaine is instilled in the cul-de-sac and a cocaine-adrenalin injection is given.

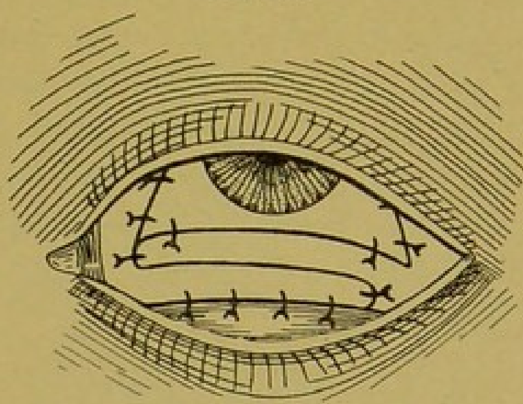
Czermak makes an intermarginal incision the width of the symblepharon. It is prolonged on either side so that the total length of the incision is three times the width of the cicatricial band. The tarsus with the adherent symblepharon is excised with two incisions which converge toward the fornix. The wedge-shaped piece of tarsus is now attached to the eyeball, from which it is carefully dissected off, leaving behind as much of the conjunctiva as possible. After undermining the edges of the bulbar conjunctiva they are united with sutures. Care should be taken to make a deep fornix. Here again the Blaskovics suture can be used, as in the preceding operation, for the deepest suture in the cul-de-sac. The cut edges of the tarsus are approximated and three sutures are inserted, beginning in the fornix. The skin of the lid is thrown into a fold after the tarsal sutures are tied. This is grasped with the forceps and a suture passed through it and knotted above (see Kuhnt ectropion operation). A bandage is then applied and changed daily. The sutures may be removed on the fifth or sixth day.

Fig. 470



Teale's operation for symblepharon. First step.

Fig. 471



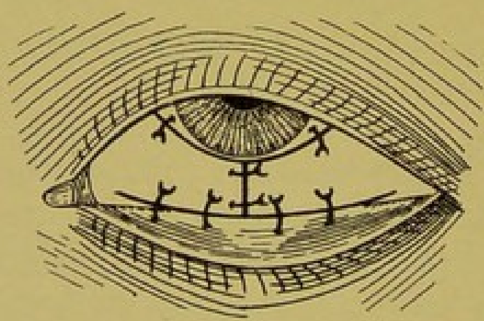
Teale's operation for symblepharon. Result.

Covering the Wound Surfaces with Pedunculated or Nonpedunculated Mucous Membrane Flaps.—Teale's Operation.— After dissecting the symblepharon from the eyeball as far as the cul-de-sac the wound surface on the bulbar conjunctiva is covered with pedunculated conjunctival flaps. For this purpose a flap is outlined on each side of the cornea with its base toward the canthus. The flaps are dissected off and turned down to cover the defect in the bulbar conjunctiva. The inner flap is used to cover the lower portion of the defect, the outer the upper portion; they are then sutured in place. The secondary defects can be closed with a few sutures (Figs. 470 and 471).

Knapp's Operation.—After dissecting off the symblepharon from the eyeball he makes two quadrangular horizontal flaps and undermines them. The edges of the flaps are then coapted and sutures are inserted. The lower borders of the flaps are united with the submucous tissue of the fornix in order to procure a deep cul-de-sac (Fig. 472).

Wolfe's Operation.—Wolfe covered the defect with non-pedunculated flaps of mucous membrane taken from a rabbit's eye. First the symblepharon is dissected off the eyeball and the scar tissue is thoroughly removed. The hemorrhage is now checked and the wound covered with tampons soaked in sterile salt solution. The rabbit is then anesthetized and the conjunctival sac thoroughly irrigated. The flap of conjunctiva greatly in excess of the area that is to be covered is then outlined. Four sutures are passed through the margin of the flap that is outlined and tied so that the knots will lie on the epithelial surface. This helps to identify the epithelial surface, which is almost impossible to do after the flap is removed. The flap is now dissected off and placed over the bulbar defect. Its edges are sutured, care being taken to keep them from rolling in. One or two mattress sutures are passed deep in the fornix and brought out through the skin, where they are knotted over a roll of gauze.

Fig. 472



Knapp's operation for symblepharon.

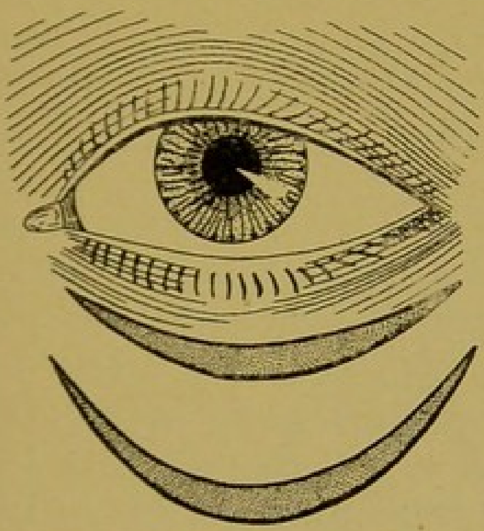
Both eyes are bandaged for two days. The operated eye is bandaged until the sutures drop out.

Besides the conjunctiva of a rabbit, the conjunctiva of dogs and the mucous membrane of the lip and vagina has been tried, but with only indifferent success. The transplanted mucous membrane flaps, in most cases, shrink to such an extent as to make the result of the operation almost *nil.* Better results, however, can be obtained by transplanting:

Pedunculated or Non-pedunculated Skin Flaps.—Pedunculated skin flaps were first employed by Taylor, who made the flap from the skin of the lid that was adherent to the eyeball. The base of the flap was on the nasal side. Near the base of the flap he made a button-hole in the lid, through which he passed the flap, and turning it 180 degrees he brought the two wound surfaces together. The flap was sutured in place and the defect in the skin was closed with sutures.

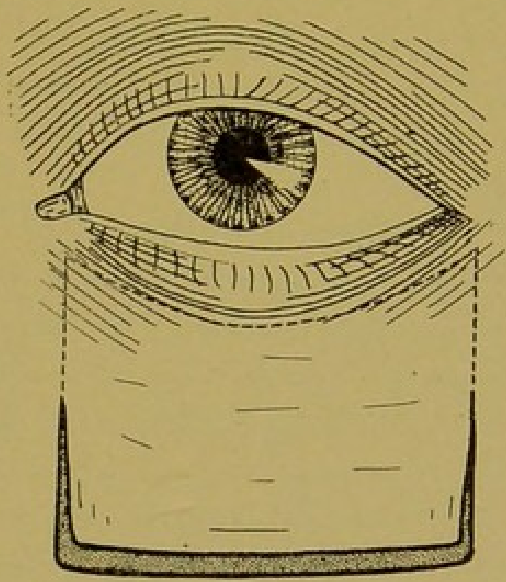
Harlan made two incisions after the lid was dissected from the globe. One was parallel to the lid margin, on a level with the lower border of the cul-de-sac, and penetrated the fornix. The second incision was crescentic in shape, placed a little below the first and passed only through the skin (Fig. 473). The flap

Fig. 473



Harlan's operation for symblepharon.

Fig. 474



Rogman's operation for symblepharon.

between the two incisions was dissected from the underlying tissue, rotated on itself and slipped through the first incision and sutured to the inner surface of the lid; the epithelium of the flap being in contact with the globe. The defect in the skin was closed with sutures.

Rogman makes a quadrangular flap, the base of which is on a level with the lower border of the cul-de-sac. The flap is dissected up and a button-hole made in the fornix for its entire length. The flap is then turned on its base and slipped through the opening in the fornix. It is then drawn up into position on the lid and sutured there, covering the palpebral surface of the wound. A bandage is applied after the skin defect is closed. Three or four weeks later all scar tissue is removed from the eyeball (Fig. 474). An incision is then made parallel to the lid margin at the middle of the lid and its two ends connected with the two ends of the button-hole. The base of this flap is connected with the flap that covers the inner surface of the lid. The second flap is now dissected off, passed through the button-hole, and sutured over the defect on the eyeball. The outer defect and the button-hole are closed.

These operations are very complicated and produce disfiguring cicatrices on the face. They are seldom used nowadays, having been displaced by the non-pedunculated flap operations.

In using the non-pedunculated skin flaps, Thiersch or Wolfe grafts may be employed.

The best method for restoring the cul-de-sac with a Thiersch graft is that which has been described by May and Hotz at about the same time.

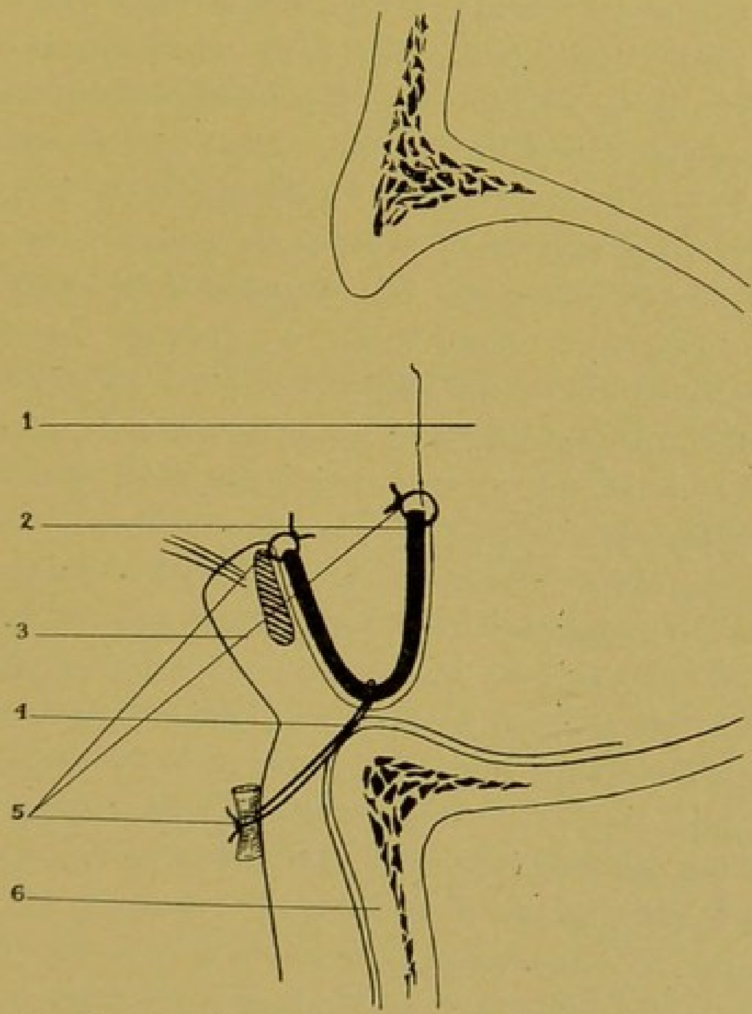
May-Hotz's Operation.—The lid is freed from its attachment to the eyeball, all scar tissue is removed, and the fornix is enlarged as much as possible. The hemorrhage is checked and a tampon is placed over the wound surface. The plate on which the graft is to be placed is then fitted and a Thiersch graft is taken from the inner surface of the arm and placed over the plate, with the wound surface inward. The plate with the graft on it is placed in position behind the lid. The lids are sutured and a bandage applied over both eyes. Bandaging is continued for four or five days when the plate is removed, but the eye is bandaged for a few days longer.

The plate may be of porcelain, lead, celluloid, hard rubber, etc. When the eyeball is present the plate must have an opening in the centre corresponding to the size of the cornea to avoid injury to it.

In using Wolfe grafts the operation described by Weeks, of New York, gives good results in cases where there is an anophthalmos.

Weeks' Operation.—The outer canthus is first incised as far as the orbital margin. An incision is made through the conjunctiva parallel to the lid margin several millimeters from it. The lid is dissected off from the cicatricial orbital tissue, so that the tarsus and orbicularis muscle will remain with the lid. The lid is freed as far as the orbital margin from one canthus to the other. In an operation on the upper lid during this dissection the tendon of the levator palpebræ superioris must be severed. After this dissection has been completed the orbit is packed with sterile gauze moistened with saline solution. The plate that is to be used is now fitted; for this purpose dental gutta-percha is employed.

Fig. 475



Weeks' operation for restoration of the cul-de-sac. 1, orbital tissue; 2, flap; 3, lid; 4, periosteal tissue; 5, sutures; 6, bone of orbit. (After Weeks.)

The gutta-percha is first dipped in hot water and then moulded into the desired form, and the edges are trimmed with a pair of scissors. After this the plate is dipped into cold water to give it proper consistency. If the edges are roughened they may be smoothed by rubbing vaseline on them and then treating them with a hot strabismus hook. The plate should fill the cavity exactly and snugly, but should exert no pressure on the tissues.

After the plate has been fitted a pattern of the wound surface is made of rubber tissue. The pattern is placed on the inner surface of the arm and the flap, which is about one-third to one-half larger, is then outlined. The flap is now dissected free from the subcutaneous tissue and is placed in warm sterile saline solution. The flap is freed from remaining subcutaneous tissue and is then folded on itself so that the epithelial surfaces are in contact. Three double armed sutures are passed through the bottom of the fold from the epithelial surface. One suture is passed through the midpoint of the fold and the others 1 cm. on either side of it. The loops of the sutures which lie on the epithelial surface should be about 2 mm. in length. The flap is placed on the forehead, if the lower lid is operated on, or on the cheek if the operation is performed on the upper lid. The sutures are now passed through the apex of the groove and brought out through the periosteum of the orbital margin on the forehead or cheek respectively. By traction on the three sutures at the same time the flap is drawn into place and the sutures tied over a roll of gauze. The edges of the flap are now sutured with single sutures and the plate is slipped into position behind the lids. Before inserting the plate it is thoroughly cleansed in water, alcohol, and bichloride, after which it is covered with bichloride ointment 1 to 5000. The lids are then closed and covered with rubber tissue which has been anointed with vaseline. Both eyes are now bandaged in the usual manner. If no untoward symptoms appear the eye remains bandaged for three or four days, after which it is inspected. If no signs of infection are present the eye is again bandaged for another three days, and then the sutures at the edges of the flap may be removed. The periosteal sutures are kept in place for ten days. The plate remains for ten days or two weeks. As the flap shrinks somewhat it is necessary to reduce the size of the plate slightly during the after-treatment. An artificial eye may be worn three weeks after operation.

OPERATIONS FOR PTERYGIUM

A pterygium is a fold of conjunctiva that is adherent to the cornea. It appears on either the temporal or nasal side of the cornea in the palpebral fissure and is usually triangular in shape. The apex of the triangle which is on the cornea is called its head. The portion corresponding to the limbus its neck and the base its body. A pterygium may be progressive or stationary. A progressive pterygium is succulent, red, abundant in vessels, and at its head there is a grayish, slightly raised zone on the cornea. A stationary pterygium is thin, has a tendinous appearance, contains only a few vessels, and the grayish zone at its apex is flat, resembling a scar on the cornea. Pterygium usually occurs in elderly people that are exposed to wind, dust, etc. It is in itself a harmless condition, but its removal is often necessary, as it may grow and project into the pupillary area interfering with vision. It may also cause constant irritation of the eye; it is disfiguring, and if large it may restrict the mobility of the eye.

The pterygium should be removed before it reaches the pupillary area because those portions of the cornea that were occupied by it always remain opaque.

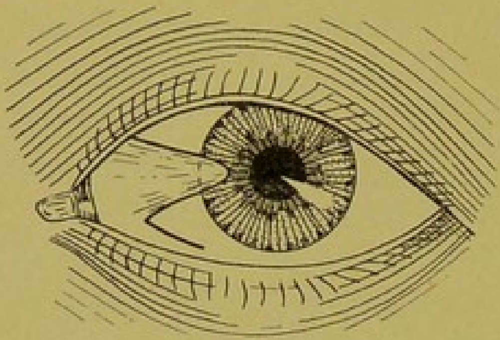
Operative interference is indicated in all cases of pterygium. In a progressive pterygium the operation should be performed as soon as possible to avoid permanent damage to vision. In a stationary pterygium it does no harm to temporize, if the patient can be constantly under medical supervision; but if this is not possible, it is better to remove it, as it is impossible to foretell when it will become progressive.

Desmarres' Operation.—The instruments used in this operation are: The speculum, fine forceps, small angular keratome, curette, fine curved scissors, needle-holder, and sutures.

Cocaine is instilled three or four times before operation. The neck of the pterygium is grasped with the forceps and the keratome is slipped under it. With sawing movements the keratome is advanced toward the centre of the cornea until the head is completely freed (Figs. 476 and 477). The area occupied by the head of the pterygium is now gently curetted. The pterygium is then undermined to its base and turned back on itself and an incision 10 to 15 mm. in length is made downward parallel to the limbus and about 4 mm. from it. The pterygium is then rotated and placed in the defect caused by the gaping of this wound. It is anchored in position with a suture through its apex. Near the limbus there remains a small defect which is covered by bringing the edges of the conjunctiva together in a horizontal direction.

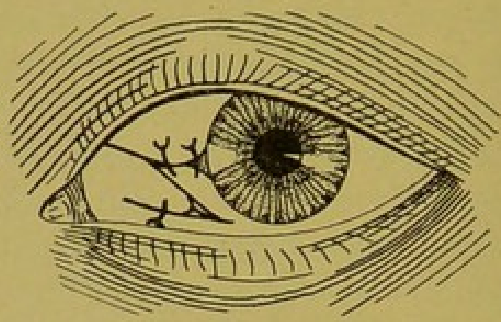
After operation a monocular bandage is applied which is changed daily for five days. After this the sutures can be removed and the eye left open.

Fig. 476



Desmarres' operation for pterygium. First step.

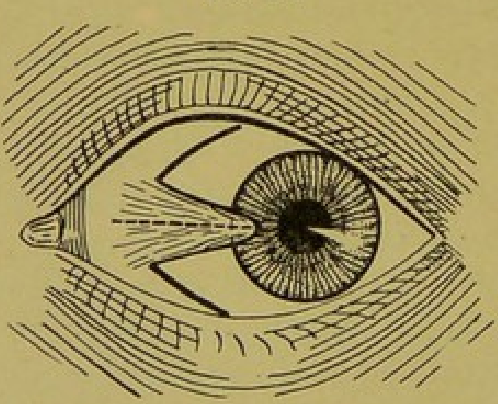
Fig. 477



Desmarres' operation for pterygium. Result.

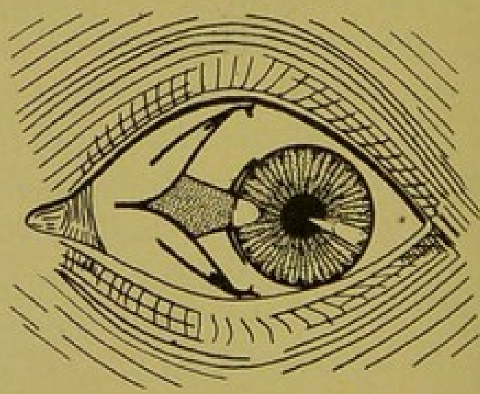
Knapp's Operation.—The instruments used are: The speculum, forceps, angular keratome, curved scissors, needle-holder, and silk sutures.

Fig. 478



Knapp's operation for pterygium. First step.

Fig 479



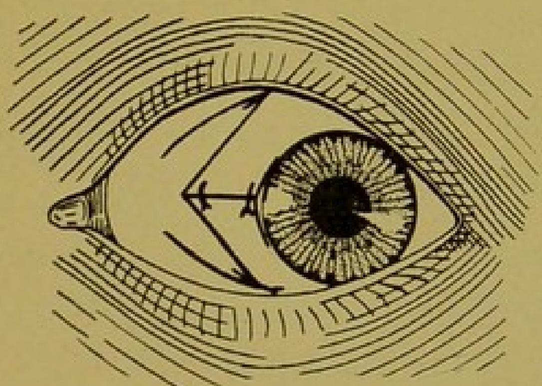
Knapp's operation for pterygium. Second step.

Knapp's operation is of special value in cases of pterygium with a broad head. The head is ablated and undermined to its base in a similar manner as in the preceding operation, after which two incisions are made parallel to the cornea about 4 mm.

from it. Both incisions are about 10 to 15 mm. in length, one being directed upward and the other downward. The head is then severed and the pterygium is split horizontally into two halves with the scissors. Each half is placed in the corresponding defect in the conjunctiva and anchored there with a suture passed through the apex of the flap. The defect near the limbus is covered by two quadrangular conjunctival flaps (Figs. 478, 479, and 480). These are made as follows: Two incisions are made in the conjunctiva near the limbus, one upward and the other downward. The conjunctiva is then undermined and the two flaps sutured together over the defect.

A bandage is applied for five days, after which it may be left off and the sutures removed.

Fig. 480

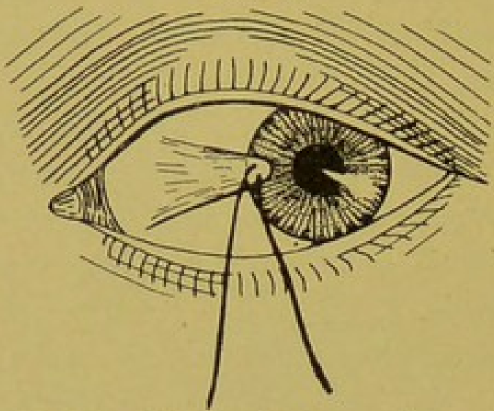


Knapp's operation for pterygium. Result.

MacReynolds' Operation.—The instruments are: The speculum, forceps, angular keratome, curved scissors, needle-holder, and double armed silk or catgut suture.

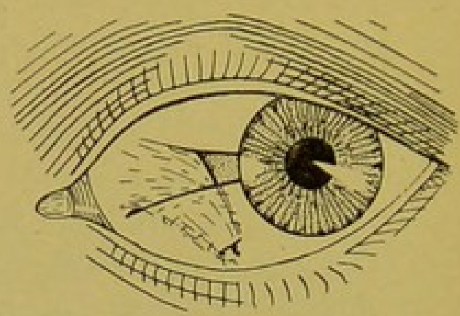
The pterygium is removed as in the preceding operation and freed down to its base. An incision is made in the conjunctiva along its lower border from the neck to its base. The conjunctiva below the incision is then well undermined. A double armed mattress suture is passed through the head of the pterygium from within outward, after which the needles are passed under the undermined conjunctiva and brought out near the lower cul-de-sac. The conjunctiva is now raised with the forceps and by traction on the sutures the pterygium is drawn under the conjunctiva. The two ends of the suture are then knotted and a bandage applied. On the fourth or fifth day the suture may be removed. If the suture is of catgut it will save the trouble of removal.

Fig. 481



MacReynolds' operation for pterygium. First step.

Fig. 482



MacReynolds' operation for pterygium. Result.

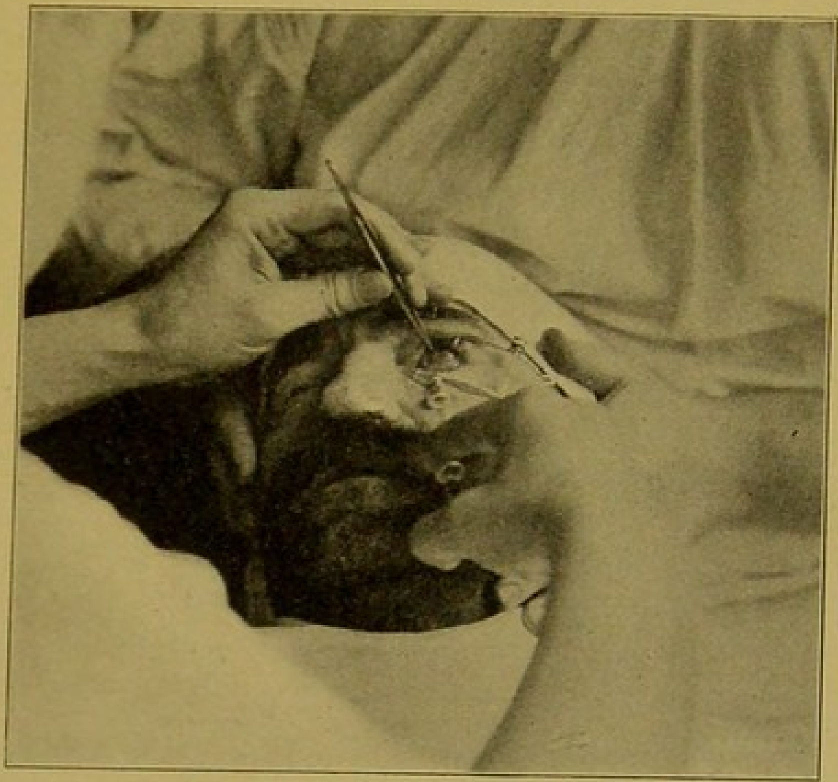
MINOR OPERATIONS ON THE CONJUNCTIVA

Subconjunctival Injections.—Subconjunctival injections may be given to produce local anesthesia or for therapeutic purposes. For anesthesia $\frac{1}{2}$ per cent. to 1 per cent. solution of cocaine or one of its substitutes may be used. For therapeutic purposes sodium chloride 2 per cent. to 10 per cent., mercury cyanide 1 to 5000, sodium salicylate 2 per cent., etc., are given. As all therapeutic injections are more or less painful it is well to add one or two drops of acoine 1 per cent solution. Therapeutic injections have been recommended for ulcers of the cornea, choroiditis, chronic iridocyclitis, detachment of the retina, opacities of the vitreous, etc.

In giving the injection the conjunctival sac is anesthetized with a few drops of a 5 per cent. cocaine solution, after which a speculum is inserted. A fold of conjunctiva is grasped with the forceps and raised; the needle is inserted under the fold and the injection is given (Fig. 483). If the injection is given for therapeutic purposes 5 to 10 minims are given at one sitting and the site of the injection should be the upper outer equatorial portion of the eyeball. The second injection should not be given until the swelling of the first injection has disappeared.

Pseudopterygium.—Pseudopterygium, which is usually the result of a burn, never advances and requires operative interference only when it restricts the mobility of the eye or for cosmetic purposes. If it is small it may be removed in the same manner as a true pterygium. Larger ones usually recur after these operations, therefore the defect near the cornea must be covered with pedunculated conjunctival flaps (Hirschberg).

Fig. 483



Method of giving subconjunctival injections.

Tumors of the Conjunctiva.—Benign tumors (lipoma, cysts, polyps, dermoids, etc.) are usually removed without any difficulty. The attempt should be made to save as much conjunctiva as possible, and if any of these tumors are adherent to the sclera or limbus special care must be taken not to penetrate the eyeball. After extirpation the edges of the conjunctival wound should be united.

Malign tumors (sarcoma, carcinoma) should be first circumscribed 3 or 4 mm. from the tumor and then dissected off the sclera. The base should then be cauterized. If they recur they may be removed again, although in such cases there is little hope of saving the eyeball. If the tumor infiltrates the sclera or limbus deeply the eye should be enucleated.

CHAPTER XI

OPERATIONS ON THE GLOBE

In this chapter enucleation, opticociliary neurectomy, and exenteration of the eyeball are dealt with.

ENUCLEATION OF THE EYEBALL

This operation consists in shelling the eyeball out of Tenon's capsule.

Indications.—1. Expulsive hemorrhage from the eye following operations or injuries. Such hemorrhages occur in eyes with degenerated bloodvessels, such as ectactic, glaucomatous, or staphylomatous eyes where the light perception has been lost. The enucleation is indicated because the hemorrhage usually cannot be checked in any other way. Even if it is stopped the eye should be removed, as such eyes generally remain painful from iridocyclitis and endanger the other eye through sympathetic inflammation.

2. Malign tumors that cannot be removed with conservation of the eyeball. Intra-ocular tumors, sarcoma of the choroid and ciliary body, or glioma of the retina, require immediate enucleation, while a sarcoma of the iris, if it does not involve the ciliary body, can be removed by an iridectomy. Enucleation must be resorted to in the latter case also when there is a relapse following the iridectomy. In epibulbar tumors, such as sarcoma and carcinoma, enucleation is indicated only when they have deeply infiltrated the scleral tissue or they have relapsed after having been previously removed.

3. In cases of cellulitis of the orbit when meningitis threatens, and when, by enucleation and a broad opening of the orbit, there is hope of saving the patient's life.

4. In cases of tubercular growth of the iris, ciliary body, or choroid when tuberculin injections have failed.

5. To prevent sympathetic inflammation. For this reason all eyes that according to experience are liable to produce a sympathetic inflammation in the other eye must be removed. Such eyes are:

(*a*) Eyes that have suffered penetrating injuries, especially when the wound involves the ciliary region (danger zone) or there is a foreign body in the eye. If the injury to the globe is so extensive that the greater part of the vitreous is lost immediate enucleation is indicated. This operation not only saves the patient from the danger of a sympathetic inflammation, but also from long suffering, as an iridocyclitis terminating in a phthisis bulbi invariably sets in. In cases of less extensive injury we may wait. If the eye responds to treatment, and the inflammation subsides, the enucleation may be postponed, if the patient remains under observation. Enucleation is only indicated when repeated attacks of iridocyclitis have followed. If, however, the iridocyclitis does not respond to treatment after the injury, light perception becomes extinct and the eye begins to shrink, enucleation should be performed.

If there is a foreign body in the eye it should be removed. If the attempt at removal is unsuccessful, enucleation should be performed at once; if successful, it does no harm to temporize. In cases where there is only a moderate reaction, following the extraction, which clears up in two or three weeks, the eye may be left *in situ* if the patient is for some time under constant observation. Should repeated attacks of iridocyclitis follow it is better to enucleate. However, if there is a serious iridocyclitis, especially one with plastic exudate following the extraction, which does not respond to treatment within two or three weeks, enucleation must be performed.

(*b*) Eyes that are suffering from a chronic iridocyclitis following a perforation of the ocular coats. The perforation may be due to injury or operation as well as to perforation of a corneal ulcer.

(*c*) Eyes that have an adherent scar in the sclera or cornea, or both. If these scars by contraction irritate the ciliary body and cause repeated attacks of iridocyclitis there is danger of sympathetic inflammation and the eye should be enucleated.

(*d*) All cases of atrophy or phthisis bulbi that are sensitive to touch or are inflamed and painful should be enucleated.

6. To favor the course of a sympathetic inflammation if already present. In such cases the exciting eye should be immediately enucleated if totally blind. If, however, this eye retains some vision a temporizing policy should prevail, as cases have been reported where the sympathizing eye became blind and there was some sight left in the exciting eye. If the exciting eye is to be removed the condition of the sympathizing eye should not deter us, as the enucleation has nothing but a good influence upon the inflammation.

7. To allay pain in all cases of blind eyes that are subject to repeated attacks of inflammations and pain, which cannot be relieved in any other way. Such eyes are those that have:

(*a*) Absolute glaucoma.
(*b*) Detachment of retina.
(*c*) Luxation and subluxation of the lens.
(*d*) Marantic corneal ulcers.
(*e*) Chronic iridocyclitis.
(*f*) Intra-ocular cysticercus.

8. In cases where after exenteration of the eyeball or an optico-ciliary neurectomy the stump or eye becomes again painful.

9. To allow the wearing of an artificial eye (cosmetic indication) in cases of blind eyes that are too large. Such eyes are:

(*a*) Ectatic eyeball.
(*b*) Staphyloma.

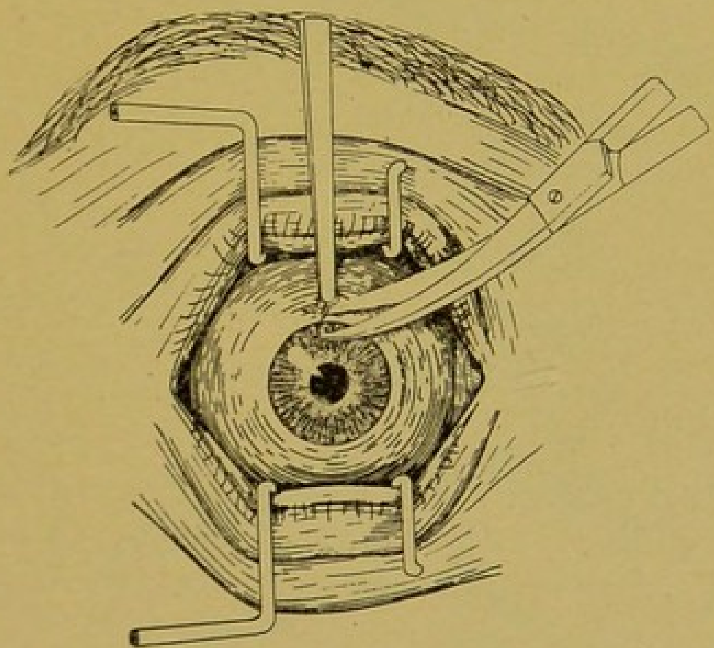
10. In cases of lagophthalmos due to destruction of the eyelids where the lids cannot be replaced by a plastic operation. Enucleation is indicated to save the patient from the following painful ulcer and ultimate destruction of the eye.

11. In cases of panophthalmitis. Many surgeons oppose enucleation in panophthalmitis, believing that a meningitis may ensue. Such cases have been repeatedly reported. The opening of the lymph and blood channels in the orbit does favor the possibility of the septic material reaching the cavernous sinus and the meninges. Examinations, however, have shown that the

bacteria which produced the panophthalmitis are never found in the orbit. The inflammation of the orbit, therefore, may be looked upon as due to the toxins of the intra-ocular bacteria and not to the bacteria themselves (Haab). So if the enucleation is properly performed without puncture of the sclera the danger of a subsequent meningitis is slight.

Preparation.—The eyeball is prepared for operation in the usual way. A careful examination of the lacrimal sac should be made. If a dacryocystitis is present the extirpation of the sac is indicated, or if time is lacking there should be temporary obliteration of the canaliculi with the cautery. A general anesthesia is to be employed, as usually local anesthesia is not satisfactory.

Fig. 484



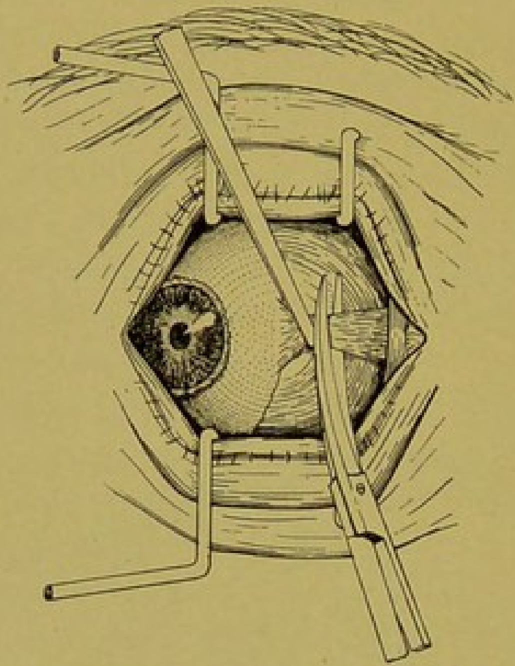
Enucleation of eyeball. Dissection of conjunctiva.

Instruments.—Speculum, fine forceps, small curved scissors, strong curved scissors, strabismus hook, strong forceps, needle-holder, and silk sutures.

Operation.—If the eye is very large and ectatic a canthotomy should precede the enucleation.

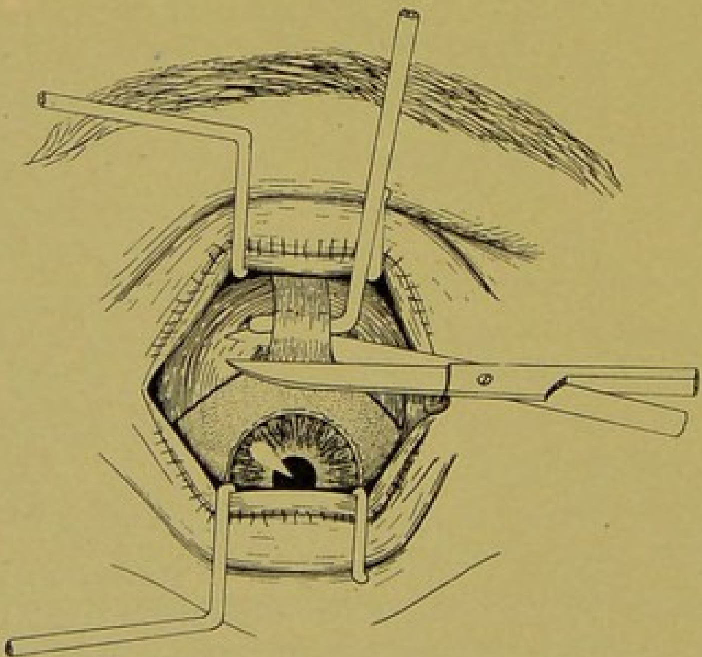
After the speculum has been inserted the conjunctiva is freed from its attachment around the limbus with curved scissors and forceps (Figs. 484, 485, and 486). It is then undermined back beyond the insertions of the muscles. Tenon's capsule is now incised near the insertion of one of the recti muscles and a strabismus hook is passed underneath it. The muscle is then drawn away

Fig. 485



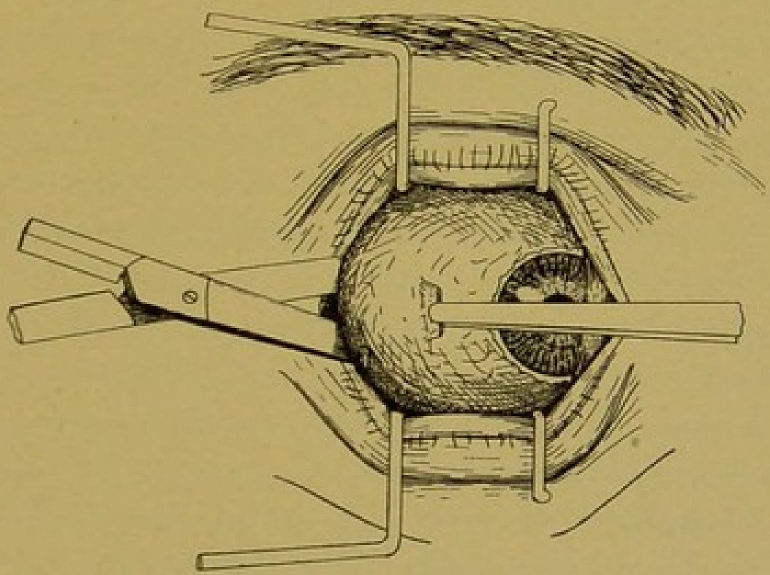
Enucleation of eyeball. Section of internal rectus.

Fig. 486



Enucleation of eyeball. Section of superior rectus from the eyeball and the insertion is severed with the scissors, close to the sclera. Sliding the hook under the second muscle this is raised and detached in a similar manner to the first. In like fashion the two other recti muscles are detached. The stump of the external rectus tendon, which should be left a little longer than the others, is now grasped with the strong forceps and the eyeball is pulled out of the orbit and toward the nose, putting the optic nerve on the stretch. The closed enucleation scissors are pushed in behind the globe from the temporal side, keeping close to the sclera. The optic nerve can be felt as a strong cord running backward toward the apex of the orbit. When this cord is felt with the scissors the blades are opened and slightly with-

Fig. 487



Enucleation of eyeball. Section of the optic nerve.

drawn and then advanced open so that the nerve will pass into the jaws of the scissors. By closing the scissors, and at the same time pressing them against the sclera, the optic nerve is severed close to the eyeball (Fig. 487).

The eyeball is pulled out of the orbit and the two oblique muscles as well as the other remaining adhesions are severed with the scissors close to the sclera. The speculum is now removed and a sterile gauze tampon is placed over the lids. Exerting slight pressure we wait a few moments until the hemorrhage is checked. The cavity is now flushed out with cold bichloride solution 1 to 5000 and a pressure bandage is applied. Suturing of the conjunctiva may be done, but it is not absolutely necessary. If one wishes to suture the conjunctiva after the orbit has been flushed, two strabismus hooks are placed in the opening in the conjunctival sac and by slight traction the edges of the wound are brought together, when they may be sutured in a horizontal direction.

In cases of glioma of the retina there is a slight difference in the section of the optic nerve. As the glioma is apt to infiltrate the optic nerve as much of it as possible should be removed. For this reason the scissors, after the nerve is between the blades, are pushed away from the sclera toward the apex of the orbit, before closing. Knapp's method of severing the optic nerve can also be used to an advantage in cases of glioma. After the muscles have been detached a curved artery clamp is introduced and the optic nerve grasped a few millimeters behind the eyeball. The optic nerve is then severed between the artery clamp and the eyeball. After enucleation the eyeball is examined, and if the stump of the optic nerve is diseased a larger portion of the optic nerve is removed. This can be readily done, as the optic nerve cannot retract, being held fast in the artery clamp.

Complications during Operation.—1. The undermining of the conjunctiva may be difficult in cases where there are adhesions between the conjunctiva and sclera.

2. The sclera may be perforated with the scissors. This occurs usually when the eyeball is soft. It is of no serious consequence except in cases where there is infectious material in the eyeball (plastic iridochoroiditis and panophthalmitis). In these cases infection of the orbit may follow.

3. If the stump of the tendon is too short the forceps will not hold and the eye cannot be rotated into a proper position to sever the nerve. In such cases an attempt must be made to secure a hold in the scleral tissue. This will be easy if the eyeball is soft. If it is hard, however, the stump of one of the other muscles must be grasped.

4. The attempt to sever the optic nerve may be unsuccessful if the scissors are not in the proper position. No cutting should be done with the scissors until it is certain that the nerve is

between the blades. Blind cutting in the orbital tissue will only cause severe hemorrhage, which is hard to check.

5. In severing the optic nerve the posterior pole of the eyeball may be cut off. This complication occurs when the eyeball is soft or the bulb has been ruptured or perforated. This is a very unpleasant complication, and when it has taken place there is no remedy for it, as the optic nerve with the scleral tab retracts into the orbital fat and cannot be found. To avoid this in severing the optic nerve the scissors must not be pressed against the sclera in enucleating soft or ruptured eyeballs.

6. Severe hemorrhage may occur during or after enucleation, especially in patients with arteriosclerosis. If the hemorrhage is very profuse a tamponade of the orbit or the actual cautery may be necessary.

After-treatment.—After operation a pressure bandage is applied which is changed daily and the conjunctival sac is irrigated with bichloride solution 1 to 5000. The healing is usually complete in five or six days, after which, if sutures were inserted, they may be removed and the patient leave the hospital.

Postoperative Complications.—The healing is usually uneventful and infection is very rare, but when it occurs it is always of a serious nature, as orbital cellulitis with a consecutive meningitis may develop.

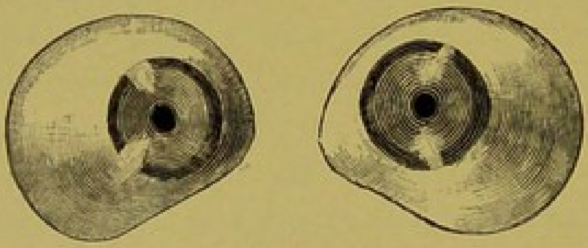
A postoperative hemorrhage sometimes occurs as late as three or four days after the operation. The patient therefore should not leave the hospital before the fifth or sixth day. If such hemorrhage occurs a strong pressure bandage usually checks it; if not a tamponade of the orbit or actual cautery should be resorted to.

At the site of the wound in the conjunctiva there may appear a small knob of granulation tissue which is to be snipped off with the scissors.

Artificial Eyes.—After enucleation, Tenon's capsule and the muscles become adherent to the optic nerve, and on opening the eyelids a cavity lined with conjunctiva is found. The orbit itself becomes smaller in time. This decrease in size, although slight and hardly noticeable in adults, may be marked in children. The orbit without an eyeball does not develop to the same extent as the other one does, so that the face becomes asymmetrical. This can, to a certain extent, be prevented if an artificial eye is worn. For this reason we advise the wearing of an artificial eye even in very small children, aged from fifteen to eighteen months. Artificial eyes should be worn also for cosmetic purposes and to hold the eyelids in proper position, otherwise they will entropionize and cause conjunctival irritation and lacrimation.

The artificial eye is made of glass imitating as nearly as possible the anterior segment of the eye. It is convex anteriorly and concave posteriorly (Fig. 488). It is oval in a horizontal direction, its nasal end being somewhat pointed and the temporal end round. Separate eyes are made for the right and left orbit. To be able to distinguish between right and left eyes it must be remembered that the sclera is broader above than below; the

Fig. 488



Artificial eyes.

nasal end is somewhat pointed; and the temporal end round, the sclera being here the broadest. It may be inserted two or three weeks after enucleation. It should be small at first but its size can gradually be increased. The eye should fit well and cause no pain and the lids should close over it as over a normal cornea. In selecting an artificial eye one that will match the patient's other eye as nearly as possible should be chosen. The points to be noted in matching are: The size of the cornea, color of the sclera and iris, and the size of the pupil.

When an artificial eye is first inserted it usually causes inconvenience and cannot be worn comfortably for longer than a few hours. The patient, however, later becomes accustomed to it. Nevertheless it should be removed at night, washed, dried, and reinserted in the morning. The removal should be done while the patient bends over the bed, so if he drops it, it will not fall to the floor and break. For the same reason it is advisable in children to have the eyes made of celluloid.

The artificial eye often irritates the conjunctiva, causing considerable inflammation and secretion. In such cases it is not to be worn for a few days and the conjunctiva is to be treated with hot applications and nitrate of silver. The irritation is especially marked if the eye has been worn too long, as it usually becomes cracked and roughened. For this reason it should be exchanged for a new one at least once a year.

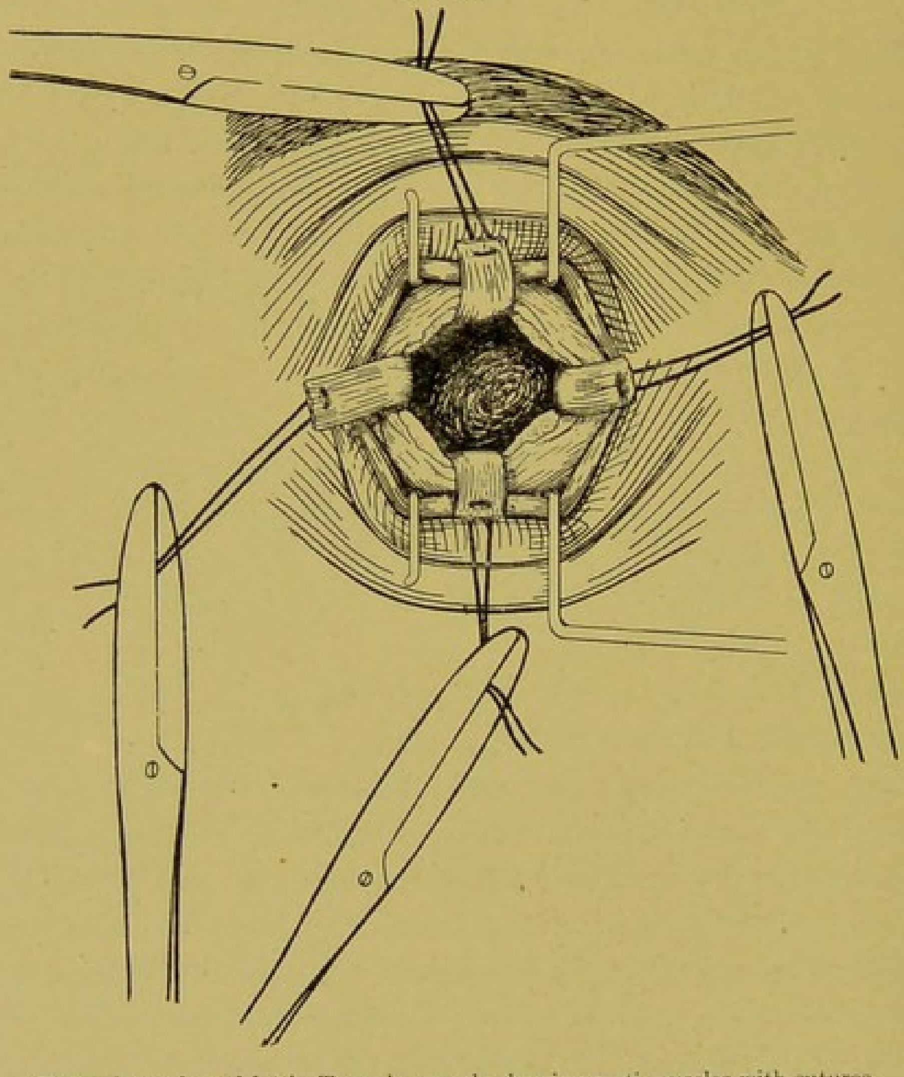
In introducing an artificial eye the upper lid is raised with the thumb of the left hand and the eye is slipped under it, into the cul-de-sac, while the patient looks down. The upper lid is now released and the lower edge of the eye is steadied with the thumb of the left hand while the index finger of the right hand pulls the lower lid down so that the eye will slip behind it. In removing it the lower lid is pulled down with the index finger of the left hand while the patient looks up and a probe or something similar is inserted behind the shell, raising it out of the lower cul-de-sac. The lower lid is now released and the thumb of the left hand presses on the upper lid. The eye slowly slips out and is caught in the right hand.

Since the muscles become adherent to the stump of the optic nerve the latter moves with the other eye and the artificial eye, resting on the optic stump that is covered with conjunctiva, is given some slight motion. This, to a certain extent, makes the disfigurement less marked, although even the best artificial eye can be detected by even a layman, as the upper lid usually sinks in. The disfigurement is less marked and the mobility increased, if the glass eye is worn on a phthisis bulbi. If such eyes are quiet the artificial eye may be worn over them, but the patient must be instructed to leave the glass eye out and return to the physician at once if the shrunken eye becomes inflamed or painful. In such cases the shrunken eye is to be removed or an opticociliary neurectomy performed.

To give the artificial eye a good stump, similar to that of the shrunken eye, fat may be placed in Tenon's capsule after enucleation, or exenteration of the eyeball may be performed instead of enucleation.

Transplantation of Fat in Tenon's Capsule.—The technique of this operation, first devised by Barraquer, is as follows (Lauber): The enucleation is performed in the manner described, but after the section of each rectus muscle a double armed catgut suture is passed through the proximal end. The ends of the sutures

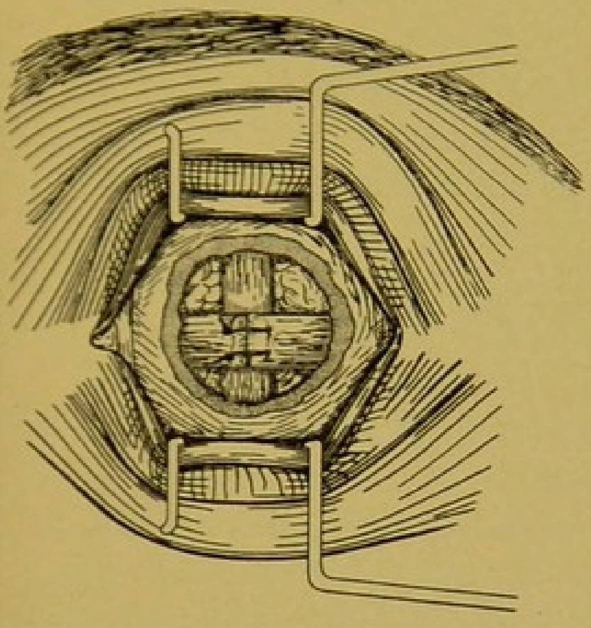
Fig. 489



Transplantation of fat in Tenon's capsule showing recti muscles with sutures after enucleation.

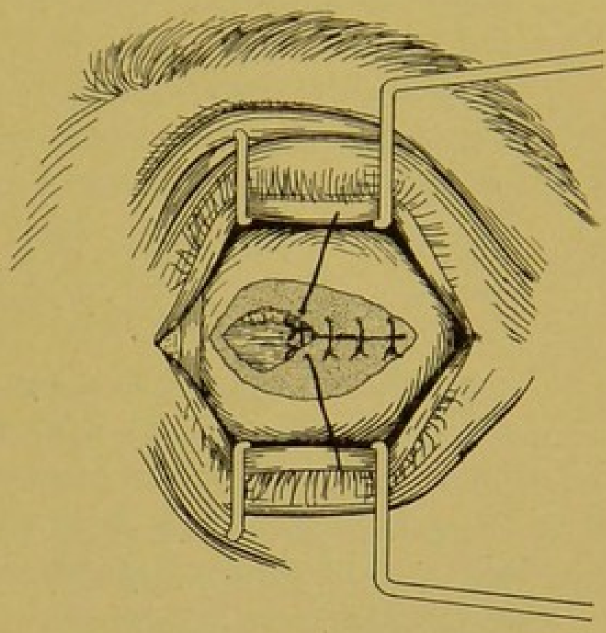
are then caught in an artery clamp and put aside (Figs. 489 to 492). The eye is then removed and a gauze tampon is pressed into Tenon's capsule. Two incisions are made in the abdominal wall, one over the linea alba and the other at right angles to it. A piece of fat large enough to fill Tenon's capsule without distending it is now removed and placed in the capsule. The four recti muscles are then tied crosswise over it and Tenon's capsule is sutured with catgut. Finally the conjunctiva is sutured with

Fig. 490



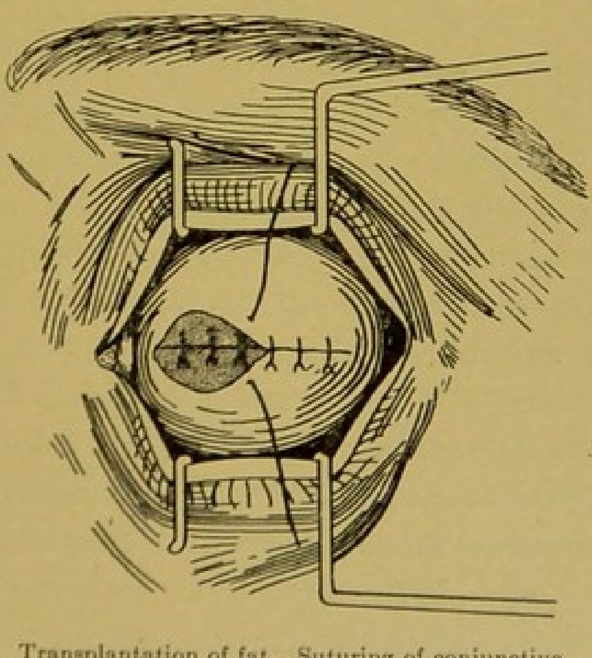
Transplantation of fat. Suturing of recti.

Fig. 491



Transplantation of fat. Suturing of Tenon's capsule.

Fig. 492



Transplantation of fat. Suturing of conjunctiva.

silk. After checking the hemorrhage in the abdominal wall the wound is closed.

The after-treatment is the same as following enucleation except that it lasts a few days longer. The silk sutures are removed eight or ten days after the operation and the artificial eye is inserted three weeks later. For a few days after the operation the lids are slightly edematous, but this later disappears. The implanted fat diminishes in size in the first two or three months, but there always remains enough to produce a good stump. If the fat necroses and sloughs out the result is the same as that following a simple enucleation.

SUBSTITUTE OPERATIONS FOR ENUCLEATION

Exenteration of the Eyeball.—Exenteration of the eyeball may be performed in all cases where enucleation is indicated, except in intra-ocular tumors and cases where the eye is to be removed for sympathetic ophthalmia. Czermak advises its performance in all cases of panophthalmitis, considering it less dangerous than enucleation. It is self-evident that it cannot be performed in cases of phthisis bulbi. The preparation is the same as for enucleation and a general anesthesia is required.

Instruments.—Desmarres' retractors, scalpel, two forceps, curved scissors, curette (Bunge's), needle-holder, and sutures.

Operation.—The eyelids are retracted with Desmarres' lid retractors and the eye is grasped with the forceps in the limbus at the end of the horizontal meridian. The assistant grasps the eye ½ cm. away from the first forceps in the same meridian and steadies it. An incision, parallel to the limbus, is made behind the first forceps with the scalpel, going through the sclera by layers until the ciliary body is reached. One blade of the scissors is introduced in the wound between the ciliary body and sclera, and the incision enlarged. A fresh hold is taken on the edges of the sclera at the end of the incision and the scissors again are introduced and carried farther around the cornea. In this manner the cornea is ablated. Bunge's curette is introduced between the choroid and sclera and by lateral movements all adhesions are broken up as far back as the optic nerve and then the head of the nerve is severed with the curette. The entire contents of the globe prolapses together with the cornea. If any portion of the choroid is still adherent to the sclera it must be scraped off with the curette. When the sclera is clear the cavity is irrigated with bichloride 1 to 5000. The sutures, three to five in number, are now inserted so that they will include the conjunctiva and sclera at the same time, uniting the edges in a horizontal line, after which a bandage is applied.

Complications during operation may arise from rupture of the uveal sac or hemorrhage. The former makes the operative technique more difficult and usually some of the choroid remains behind attached to the sclera. Hemorrhage may be profuse, necessitating the use of the actual cautery or even enucleation.

After-treatment.—After operation both eyes are bandaged from two to four days, then the unoperated eye may be left open. Sutures are removed in five or six days and an artificial eye may be inserted four or five weeks after the operation. The healing is often accompanied with severe pain, headaches, and sometimes slight fever. The scleral cavity is filled with blood and later with granulation tissue. The stump is of considerable size in the beginning, but later it gradually shrinks and in many cases becomes so small that the result is hardly better than that after an enucleation. For this reason many surgeons have attempted to replace the vitreous by various substances. Mules was the first to insert a glass ball in the scleral cavity. Later others substituted balls of metal, ivory, asbestos, silk, etc. However, none of these operations have met with success, as the implanted substance was usually extruded in a shorter or longer period.

Opticociliary Neurectomy.—By this operation the disfigurement of an enucleation is eliminated. Instead of removing the eyeball a portion of the optic and ciliary nerves is resected and the globe is left intact.

The operation may be performed as a substitute for enucleation, in cases of painful blind eyes that are not liable to produce a sympathetic ophthalmia. It may also be resorted to in cases of shrunken eyeballs that become painful after an artificial eye is worn over them. It is self-evident that it should not be done when there is an intra-ocular tumor present. The preparation is the same as for enucleation, a general anesthesia being necessary.

Instruments.—Speculum, forceps, scissors, sharp hook, enucleation scissors, needle-holder, and sutures.

Operation (Schirmer's Method).—An incision is made in the conjunctiva parallel to the corneal margin between the internal and inferior recti muscles. The incision should be about 12 mm. long and placed 4 or 5 mm. from the cornea. The edge of the conjunctiva is undermined and the sharp hook introduced and hooked into the sclera as near the posterior pole as possible. The eyeball is rotated to the opposite side and the scissors introduced into the orbit. The optic nerve is felt for, as in enucleation, and after it is found it is severed as far back as possible. The speculum and all instruments are now removed and the eyeball is strongly pressed backward into the orbit in order to check the hemorrhage. This usually takes a few minutes, after which the speculum is again introduced and the eyeball is completely rotated with hook and forceps so that the optic nerve comes in view. The stump of the nerve together with the ciliary nerves are now severed close to the sclera. The eyeball is allowed to fall back in its place and the conjunctival wound is sutured.

Complications during Operation.—The most serious complication is that of hemorrhage, following the section of the optic nerve. In most cases this can be controlled by pressure, sometimes, however, it is so profuse that it necessitates suturing of the eyelids or enucleation. For this reason the patient's consent to enucleation should always be obtained beforehand.

After-treatment.—The operated eye alone is bandaged with considerable pressure and the patient put to bed for two or three days. The first few days after operation there is slight exophthalmos present, which, however, slowly subsides. The cure is complete in about eight days.

Postoperative Complications.—The most important is hemorrhage, which may be so severe as to expel the eyeball from the orbit necessitating enucleation. An infection may possibly cause an orbital cellulitis.

The cosmetic result after this operation is perfect. The eyeball and cornea are perfectly anesthetic for the time being, but later some sensitiveness returns. Usually from a cosmetic point of view the operation is satisfactory and remains so; in some cases, however, the eyeball becomes atrophic and shrinks and in others the pain returns, necessitating enucleation.

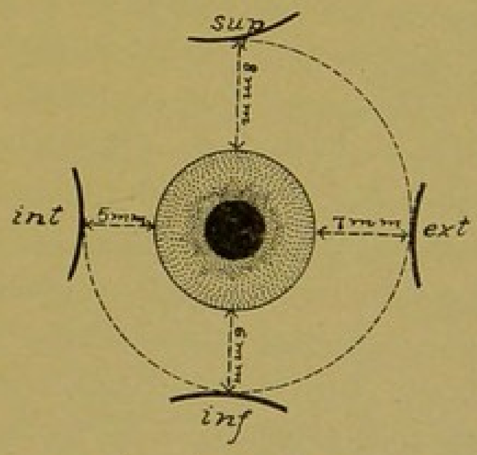
CHAPTER XII

OPERATIONS ON THE MUSCLES

SURGICAL ANATOMY OF THE MUSCLES OF THE EYE

The muscles are seven in number—four recti, two oblique, and the levator. All of them have a common origin at the apex of the orbit except the inferior oblique, which arises at the inner edge of the orbit near the lacrimal sac. The levator runs to the upper lid, being its elevator. The recti are attached to the eyeball near the limbus. The internal rectus is inserted about 5 mm. from it; the inferior rectus about 6 mm.; the external rectus about 7 mm.; and the superior rectus about 8 mm. (Fig. 493). The four muscles form a cone directed toward the apex of the orbit. Through the axis of this cone the optic nerve passes from the optic foramen to the eyeball. The superior oblique arises from the medial side of the optic foramen, passes forward through the trochlea then turns backward, outward, and downward under the superior rectus muscle, and is finally inserted on the upper temporal quadrant of the eyeball 17 or 18 mm. from the limbus.

Fig. 493



Insertion of muscles.

The inferior oblique has its origin at the inner edge of the orbit near the lacrimal sac. It passes backward and outward and a little upward under the inferior rectus and is inserted in the lower temporal quadrant of the eyeball behind the equator about $17\frac{1}{2}$ mm. from the limbus.

These muscles move the eyeball freely in all directions. The external rectus turns the eye outward; the internal rectus inward. The superior rectus turns the eye upward, adducts and rotates it inward. The inferior rectus turns the eye downward, adducts it and rotates the eye outward. The superior oblique turns the eye downward, abducts it and rotates it inward. The inferior oblique turns it upward, abducts it and rotates it outward.

These are the actions of the various muscles. Knowing, however, that all are closely connected with each other by the connective tissue system of the orbit, the more exact physiological interaction, which is not known, must be still more complicated.

OPERATIONS ON THE MUSCLES

Operations on the muscles may be performed for one of two reasons.

1. To weaken the muscle.
2. To strengthen the muscle.

The first may be accomplished by detaching the muscle from its insertion and allowing it to slip back and become attached to the sclera at a point posterior to its orginal insertion (tenotomy).

The second is accomplished either by advancing the insertion nearer to the limbus (advancement) or by rendering the muscle shorter by excision of a piece from its tendon (resection).

Both of the operations are imperfect, as the amount of weakening or strengthening of the muscle cannot be judged during operation, therefore the end-result can never be foretold. This applies more particularly to tenotomy than to the advancement. In tenotomy the result of the operation depends to a great extent on the strength of the antagonist of the detached muscle. However, the strength of the muscle cannot be properly estimated, and so it is impossible to tell how far posteriorly the muscle will become reattached. If the antagonist is stretched and weakened sometimes a large opening in Tenon's capsule will give little result; on the other hand, if the antagonist is strong a tenotomy with a small opening in Tenon's capsule will often produce a great effect.

Although the amount of advancement that is necessary to bring the eye into its proper position can be estimated more definitely, yet even here the end result cannot be foretold.

The reason for this is that as the sutures are placed in soft tissue they almost always yield to a certain extent and at the same time it is impossible to foresee what effect on the position of the eye the subsequent cicatrization will have.

Neither operation has any effect on the vision, and the result is therefore only cosmetic. The restoration of binocular vision is seldom accomplished and amblyopia, if present, remains unchanged.

Conditions Demanding Operation.—The conditions which call for operative interference on the muscles are paralytic strabismus and latent and manifest concomitant strabismus.

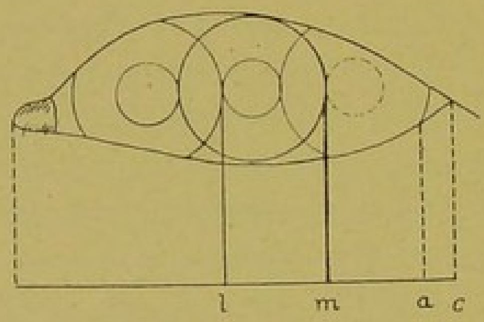
Paralytic Strabismus.—As there is always a possibility of the improvement of the paralysis by medical treatment, operative interference should only be resorted to after treatment has failed and the paralysis has remained stationary for at least one year or longer. Straightening of the eyes is all that can be hoped for in such cases. Neither restoration of the motility of the paralyzed muscle nor fusion of the double images if still present, nor restoration of binocular vision if no diplopia is present, can be expected. Only in exceptional cases as, for instance, a slight paresis of the external rectus (abducens) muscle can the restoration of binocular vision without diplopia be thought of. In such cases the advancement of the paretic muscle sometimes gives enough strength to it to allow it to perform its function in a proper manner. It is self-evident that in paralytic strabismus a tenotomy of the antagonist will give no results. For this reason only the advancement or resection of the paralyzed muscle will be indicated.

Concomitant Strabismus.—CONVERGENT STRABISMUS.—Operation should be done only when all other methods which are apt to improve or cure the deviation of the eye have failed and the patient is at least seven years of age. In marked and confirmed strabismus, however, an advancement of one of the external recti muscles can be safely performed even earlier. In all cases of convergent strabismus the first step should be the accurate determination (with atropine and skiascopy) of the refractive error and the prescribing of the full correction. This may be followed by stereoscopic exercises. This treatment is carried out until the child is seven years of age. After this operation may be considered. The operation is indicated only in patients over seven years who have worn the full correction and have done the stereoscopic exercises for several months or a year.

Before operating the strength of the muscle and its antagonists, as well as that of the corresponding muscles of the other eye, and the degree and variety of squint should be determined. The following is the routine examination.

To determine the strength of the muscles the power of abduction and adduction on each eye is measured separately. This is done by linear mensuration (Graefe) which is as follows (Fig. 494):

Fig. 494



Linear measurement of lateral excursions of the eye. (After Fuchs.)

The patient fixes a point in the distance directly in front of him and the distance between the outer limbus and canthus is measured with the strabometer (*c m*). The distance is also measured when the patient looks as far inward and as far outward as possible (*c l* and *c a*). The difference between these positions indicates in mm. the degrees of abduction and adduction.

In determining the degree of squint a perimeter is used. The patient places his squinting eye in the centre of the arc while he fixes some distant point directly in front of him, the observer's eye being behind the centre of the arc of the perimeter. A lighted candle is moved along the arc until the corneal reflex image of the flame is directly in the middle of the pupil of the squinting eye. The number of degrees on the perimeter is now read off; this indicates the degrees of squint. The variety of the squint is also important. It should be determined whether the same eye squints all the time (monolateral squint) or whether the two eyes squint alternately (alternating squint). It is also of importance whether squinting occurs only at intervals (periodic squint) or whether it is present all the time (constant squint). *In periodic convergent squint* it is best not to operate at all. In constant convergent strabismus the method of operating will depend on whether it is monolateral or alternating. *In monolateral constant convergent strabismus* if the degree of squint is small (15 degrees to 25 degrees) a tenotomy will suffice, providing abduction is normal. In higher degrees if adduction is about the same in both eyes tenotomy on both internal recti muscles may be done. If, however, adduction is increased on the strabismic eye it is better to do, together with the tenotomy of the internal rectus muscle, an advancement or resection of the external rectus muscle. Advancement or resection of the external rectùs muscle must always be done when the abduction is found to be less than normal and it is also preferable to tenotomy even in small degrees of squint when the strabismic eye is already amblyopic.

In alternating constant convergent strabismus, since usually both external recti muscles are weakened, an advancement or resection of the external rectus muscle is always more satisfactory than the tenotomy. It is best in such cases to divide the operation between the two external recti muscles. The two advancements or resections, however, should not be performed at the same sitting but an interval of several weeks or months should be left between the operations.

In all cases of convergent strabismus the operations on the muscles are very delicate procedures. The immediate result following operation may increase, especially in young patients who previously have not worn their correction long enough and later a divergent squint may appear. For this reason it is always a good policy not to correct the entire convergence but to leave 5 degrees to 10 degrees uncorrected. This does not interfere with the cosmetic result and is to a certain degree a safeguard against a postoperative divergent squint.

Divergent Strabismus.—The operation in cases of divergent strabismus is less delicate. There is no need to fear a postoperative convergent strabismus; in fact, the immediate result of operation often diminishes in time. The operation may therefore be done at any age. Tenotomy here is less satisfactory than in convergent squint, as even with a large opening in Tenon's capsule no greater correction than 10 degrees to 12 degrees can be expected after tenotomy of one external rectus muscle.

Advancement or resection of one or both internal recti muscles combined with tenotomy of one or both external recti muscles in accordance with the degree of strabismus will be the method which gives satisfactory results. Knowing the fact that the result often diminishes after operation a slight overcorrection should be aimed at.

Latent Strabismus (Exophoria, Esophoria, and Hyperphoria).—Operative interference is indicated only in high degrees of error when muscle exercises and prisms do not give relief. Exophoria especially is important, as it gives rise to asthenopic symptoms in near work.

Tenotomy, advancement, or resection may be performed.

In esophoria and hyperphoria Stevens advises partial graduated tenotomies on the concerned muscles. He says that the operation should be performed on the eye that has the poorer vision. Therefore in hyperphoria, tenotomy of the superior rectus muscle as well as tenotomy of the inferior rectus muscle may be done according to whether the higher or lower standing eye has the poorer vision. Although graduated partial tenotomies theoretically should give good results, in practice it is often found that the result obtained is only temporary, as the small wound in Tenon's capsule closes again without altering the point of insertion or strength of the muscle.

OPERATIONS TO WEAKEN AN OCULAR MUSCLE

Tenotomy.—Tenotomy consists in detaching the muscle from its insertion and allowing it to slip backward so that it will become reattached at a point posterior to its original insertion. It may be performed on any of the muscles but is most commonly done on the external and internal rectus.

Indications.—Tenotomy of the *internal rectus* is indicated:

1. In monolateral constant convergent strabismus.
2. In alternating convergent strabismus.

3. In combination with an advancement or resection of the external rectus muscle to increase the result or lessen the traction on the advanced or shortened muscle.

Tenotomy of the *external rectus* muscle is indicated:

1. In all cases of divergent strabismus if less than 12 degrees.
2. In cases of exophoria when greater than 10 degrees.
3. In combination with advancement or resection of the internal rectus muscle to increase the result or lessen the traction of the advanced or shortened muscle.

Tenotomy of the *superior rectus* muscle is indicated:

1. In cases of hyperphoria (Stevens).
2. In cases where the sight in one eye is lost and the vision in the other eye can be restored by performing an optical iridectomy above. In such cases a tenotomy of the superior rectus will bring the coloboma down into the palpebral fissure.

Tenotomy of the *inferior rectus* muscle is indicated:

1. In cases of hyperphoria (Stevens).

Tenotomy of the *superior* and *inferior oblique* muscles has been recommended in cases of paralysis of these muscles but it is a procedure of doubtful value and is not practised.

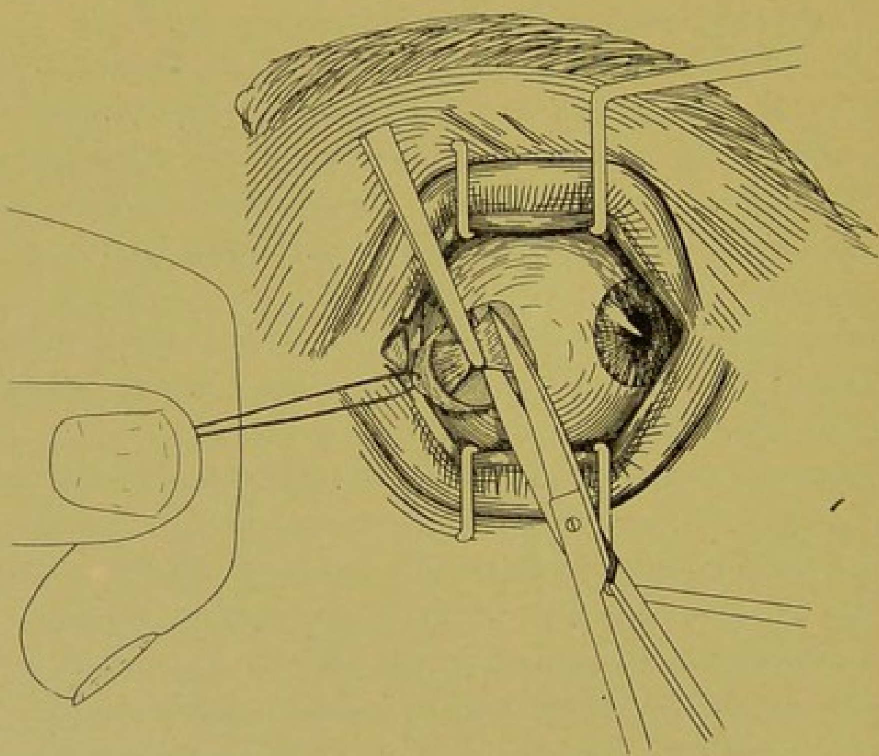
Preparation.—The patient is prepared as for any eyeball operation. Instillation of cocaine-adrenalin is usually sufficient in adults. Only in unruly children is a general anesthetic necessary, but it has its disadvantages, as it prevents examination and judgment of the immediate result of the operation. Some operators inject cocaine around the insertion of the muscle. This produces a perfect anesthesia, but causes an edema which makes the operation a little more difficult.

Instruments.—Speculum, fine forceps, curved scissors, strabismus scissors (Stevens'), two strabismus hooks, needle-holder, conjunctival sutures (fine), muscle sutures (heavier), strabometer. It is also good practice to sterilize a fixation forceps, especially with children, as it may be necessary to pull the eye in an opposite direction to the muscle to be detached if the patient does not do it voluntarily.

Operation.—TENOTOMY OF THE INTERNAL RECTUS.—The operation according to Arlt's method is performed in five steps. First step is the incision of the conjunctiva; second, the detachment of the muscle; third, seeking for lateral insertions; fourth, the examination of the immediate effect of the operation, and the fifth the suturing of the conjunctiva.

I. STEP: *Incision of the Conjunctiva.*—After the speculum has been inserted the patient is told to look in the opposite direction to the muscle that is to be operated on. Holding the forceps in the left hand a horizontal fold of conjunctiva is grasped over the insertion of the muscle. [It is to be remembered that the insertion

FIG. 495

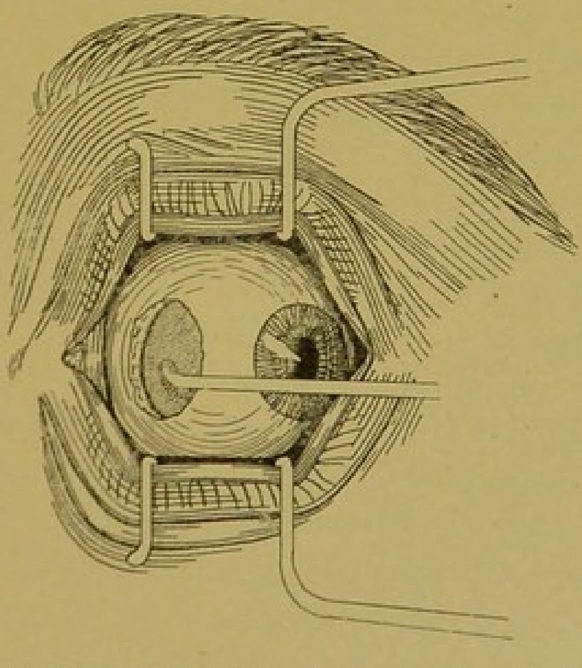


Tenotomy. Detaching muscle.

of the internal rectus is approximately 5 mm. from the limbus of the cornea, the inferior rectus 6 mm., the external rectus 7 mm., the superior rectus 8 mm. (Haab).] The horizontal fold of conjunctiva is now incised, in a vertical direction, with the curved scissors internal to the forceps. Some surgeons make a horizontal incision along the lower border of the muscle and detach it subconjunctivally (buttonhole). The incision is enlarged until it is 1 cm. in length and the conjunctiva is undermined as far as the internal canthus. A fine suture is now passed through the edge of this flap and is given to an assistant to retract toward the inner canthus.

II. Step: *Detachment of the Muscle.*—The forceps are now opened a little way, and keeping close to the sclera are pushed backward behind the insertion of the muscle (Fig. 495). The muscle now lies between the blades of the forceps. To secure a firm hold on it the forceps are rotated toward the nose so that they are almost perpendicular to the sclera. The blades of the forceps are now closed with a firm pressure against the globe and the muscle is pulled slightly forward. A small opening is then made with the Stevens strabismus scissors on the lower border of the tendon. One blade of the scissors is now slipped into the opening behind the insertion. This blade is pressed against the sclera and the muscle is detached by closing the blades. Three or four snips of the scissors are usually necessary to free the muscle completely from the sclera.

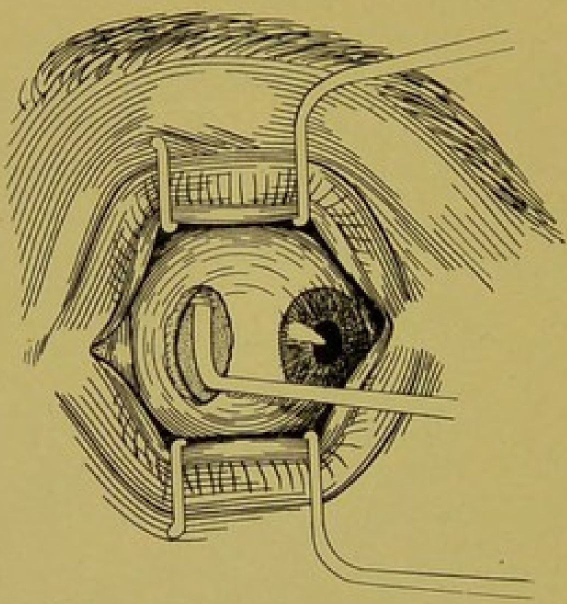
Fig. 496



Tenotomy. Seeking for lateral insertion of internal rectus with strabismus hook. First position.

III. Step: *Seeking for Lateral Insertions.*—The strabismus hook is taken in the right hand and with the point on the sclera it is pushed backward behind the point of insertion. It is now rotated 90 degrees so that the point is upward, still holding it close to the sclera it is pulled forward toward the limbus. If any of the tendon fibers have not been severed they are caught on the hook and offer a firm resistance; these are then divided with the scissors, taking care not to enlarge the wound in Tenon's capsule (Figs. 496 and 497). Tenon's capsule must not be mistaken for tendon fibers. If this becomes caught on the hook it offers only a slight resistance, as it is a delicate membrane. The same maneuver is repeated downward.

Fig. 497



Tenotomy. Seeking for lateral insertion of internal rectus with strabismus hook. Second position.

When the muscle is completely severed the speculum is removed and the eye is closed for a few minutes. After the hemorrhage has ceased the next step is undertaken.

IV. Step: *The Examination of the Immediate Effect of the Operation.*—This is done as follows:

1. The patient is to sit up on the table and with both eyes open is told to fix some object in the distance. In this manner the amount of correction can be estimated.

2. Next the power of convergence is tested by having the patient fix the finger as it is slowly advanced toward his nose.

3. Measuring the power of abduction and adduction with the strabometer (see page 438), or, roughly, by having the patient

follow the movements of our finger which is moved from right to left, or *vice versa*.

By this examination it is possible to determine approximately whether the result is good, overcorrected or undercorrected.

In convergent strabismus the result may be considered *satisfactory* when:

1. There is about 5 degrees to 10 degrees of strabismus left in looking in the distance.

2. Convergence is good for a distance of 12 cm. (5 in.).

3. Adduction is not too greatly interfered with, that is, the inner limbus reaches a line connecting the two lacrimal puncta when the eye is turned inward.

It is to be considered *overcorrected* when:

1. In looking at a distance the eyes are parallel or divergent.

2. The patient is not able to fix at 12 cm. (5 in.) and the eye diverges.

3. The adduction is very much weakened, that is, when the patient cannot rotate his eye inward far enough for the inner limbus to reach the line connecting the two puncta.

It is to be considered *undercorrected* when:

1. There is more than 10 degrees of strabismus left in looking in the distance.

2. In testing the convergence the strabotic eye turns in before the 12 cm. point is reached.

3. Adduction is still excessive, that is, in turning the eye inward the inner limbus passes beyond the line connecting the two lacrimal puncta.

V. STEP: *Suturing the Conjunctiva.*—If the tenotomy is found to be satisfactory the suture that has been placed through the flap is passed through the conjunctiva at the limbus and tied.

If the strabismus is found to be overcorrected the conjunctival suture is removed and a deep one is passed in its place, taking in Tenon's capsule and muscle, and brought out through the episcleral tissue near the limbus.

If there is an undercorrection the connections between the eyeball and Tenon's capsule may be loosened with a strabismus hook by introducing it in a similar manner as in seeking for lateral insertions but somewhat deeper. The hook is rotated upward and then downward, and at the same time pulled toward the cornea. By this maneuver the fine connective-tissue fibers are separated from the sclera, thus loosening Tenon's capsule and causing the wound to gape a little more.

Knapp's suture may be also applied. This consists in thrusting a needle through the superficial layers of the sclera near the temporal limbus in a vertical direction, then through the lid near the outer canthus. By tying the suture the eyeball is drawn to the outer canthus and kept there for a day or two until the tendon has taken its new insertion. The practice of some ophthalmic surgeons to increase the effect of a tenotomy by enlarging the wound in Tenon's capsule should never be followed. Too large a wound in Tenon's capsule is the cause, in most cases, of an exophthalmos or a slipping too far backward of the muscle.

All of these methods are less satisfactory than doing a tenotomy on the other eye or increasing the effect by making an advancement or resection on the antagonist.

Technique for Other Muscles.—The technique is the same as for the internal rectus.

Complications during Operation.—*Injury to the Sclera.*—In detaching the muscle it is possible that the sclera may be injured with the scissors. It can always be avoided if care is taken, and if it does occur it is due to carelessness on the part of the operator.

Hemorrhage.—A certain amount of hemorrhage always accompanies the operation. Sometimes it is very free, but it leads to no bad results. Hemorrhage into Tenon's capsule is met with very rarely.

After-treatment.—After operation the operated eye alone is bandaged. The bandage may be removed on the following day. The patient is given his full correction to wear and at the same time the stereoscopic exercises are continued.

Sutures are removed on the third day. There is often difficulty in removing the sutures in children, so it is better to put them on the table and to insert a lid speculum before attempting to remove them.

Postoperative Complications.—*Recession of the Caruncle.*—This complication quite often accompanies tenotomies, and is due to the fact that the caruncle is in close relationship with the internal rectus muscle, so that when the muscle slips backward it draws the caruncle with it. In order to avoid this complication the conjunctiva should be dissected up to the inner canthus during operation. If this condition develops a vertical incision is made between the limbus and inner canthus and the conjunctiva is dissected up in both directions. One or two sutures are then taken in the conjunctival wound. If necessary a small strip of conjunctiva is removed before taking the sutures.

Enlargement of the Palpebral Fissure and Exophthalmos.—Both are due to too large an opening in Tenon's capsule. It is usually not marked and can hardly be noticed. If it is disfiguring it is best to do a tarsorrhaphy, thereby making the palpebral fissures of equal width.

Recession of Muscle.—If the muscle recedes too far the new attachment gives it no leverage to rotate the eyeball. It will never occur if the tenotomy is carefully made and the eye examined immediately after the operation. If the adduction is very much weakened the deep suture is to be taken. To avoid this complication tenotomy should never be repeated on a muscle that has been tenotomized.

Postoperative Divergent Strabismus.—This usually develops when the convergent strabismus has been overcorrected by the operation. Sometimes this condition does not put in its appearance until several years after the tenotomy. This complication will not occur if: (*a*) Operation is not performed on patients under twelve years of age, (*b*) the patient wears the full correction for at least a year, (*c*) the tenotomy is done carefully and 5 degrees to 10 degrees of convergence are left.

Exuberant Granulation Tissue.—This is sometimes noticed a few days after the operation. It can be avoided if the conjunctiva is properly sutured. If it occurs, however, it is to be excised.

Infection.—This is nowadays very rare and can be avoided by proper surgical sterilization.

Abrasion of the Cornea.—This complication may follow the operation, which, if infected, may lead to corneal ulcer. It may be due to drying of the cornea during operation and the consequent exfoliation of epithelium, or the patient may open his eye under the bandage, causing the dressing to come in contact with the cornea. To avoid this complication the cornea should be kept moistened during the whole operation with sterile salt solution, and when the eye is dressed sterile boric ointment should be put in the conjunctival sac.

Diplopia.—Following operation diplopia sometimes develops. This, however, is to be considered a good sign, as it means that the eye is not totally amblyopic. In such cases it may be hoped that with stereoscopic exercises binocular vision can be obtained.

Examinations of the Effect of the Operation in Divergent Squint and in Heterophoria.—As for the *immediate effect* after tenotomy for *divergent strabismus* an overcorrection need not be feared. The result may be considered *satisfactory* if:

1. In looking in the distance the eyes are straight, or even if there is a slight (about 2 degrees) convergence present.
2. Convergence is good for a distance of 12 cm. (5 in.).
3. Abduction is not much decreased.

It is to be considered *overcorrected* when:

1. In looking in the distance more than 2 degrees of convergence are present.
2. In testing the convergence we have a convergent strabismus at a distance of 12 cm. or before that.
3. Abduction is very much weakened.

It is to be considered *undercorrected* when:

1. In looking in the distance there is a divergence.
2. In testing convergence the eye turns out at 12 cm. or before.
3. Abduction has not been perceptibly weakened.

In the tenotomies of the superior or inferior rectus muscle the immediate examination of the condition of the muscle cannot be made as precisely as that of the lateral recti. The effect, however, is to be considered too great, and it is to be diminished, according to Knapp, when one eye lags behind the other 1 to 2 mm. in elevation or depression and when there is a notable deviation if the patient fixes the finger held 40 cm. from the eye and a little below the horizontal plane.

OPERATIONS TO STRENGTHEN THE ACTION OF AN OCULAR MUSCLE

Advancement, Resection, and Folding Operations. — To strengthen the action of a muscle its insertion may be advanced toward the cornea (advancement), or the muscle may be shortened. Shortening can be accomplished in two ways: (*a*) By folding the muscle on itself; (*b*) by excising a portion of it (resection). The indications for these operations are:

1. Concomitant strabismus.
2. Paralytic strabismus.
3. High degrees of heterophoria.
4. In cases where, after a tenotomy, the muscle has retracted too far and an opposite strabismus has developed.

Advancement and Resection.—Advancement and resection may be performed each separately or the two operations may be combined, namely, the insertion of the muscle may be advanced, and at the same time a section of it excised. In performing either one of the operations the advanced or resected muscle should not be put too much on the stretch. This complication will interfere to a great extent with the action of the muscle, and it is therefore advisable to lessen the strain, either by performing a tenotomy on the antagonist or, by dividing the correction between the two eyes, and making a moderate advancement or resection on each.

The technique of both operations is more complicated and difficult than that of a tenotomy. The most delicate point is the insertion of the sutures, as the end result of the operation depends greatly on the stability of the sutures. Since the sutures are inserted in soft tissue they easily loosen, the muscle slips back, and usually the result is somewhat less than it was immediately after the operation. For this reason the endeavor should be made to obtain a slight overcorrection.

Pathological examination of eyes after advancement has shown. that the advanced muscle becomes adherent to the sclera at its new insertion and the intervening space between this point and its old attachment. So it would seem that the advancing of the insertion of the muscle *per se* was of no value and the improvement obtained by the operation was due to a shortening of the muscle, the same as in resection. The point of leverage in both cases is the original insertion of the muscle.

Advantages of Resection Over Advancement.—The following are the advantages that resection has over advancement:

1. After advancement an ugly fold of conjunctiva, that smooths out very slowly, often remains. In resection it is not present.

2. In advancement the muscle may slip back, thus diminishing the result of the operation, which is not possible in resection.

3. In advancement there is a possibility of getting an oblique insertion (if traction is not equally exerted on both sutures), making the action of the muscle uneven. This does not occur in resection.

4. There is danger of perforating the sclera with the needle during insertion of the sutures in advancement which cannot happen in resection.

5. In the after-treatment both eyes are to be bandaged for five or six days in advancement, while in resection two or three days will suffice.

Folding Operations.—Folding operations consist in folding the tendon on itself, thereby shortening the muscle. Although this operation excludes the possibility of the sutures cutting through and the muscle slipping back it produces a marked disfigurement; the fold causing a decided elevation of the conjunctiva.

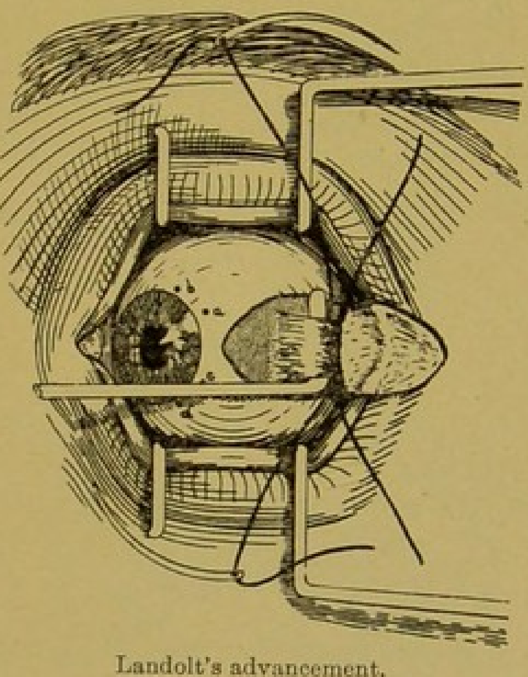
There are a great many modifications advised and recommended for all of the operations, which in most instances differ from each other only in the manner of inserting the sutures. As there is very little choice between many of the operations it seems necessary to describe only those which may be considered classical (Landolt, Schweigger, De Wecker) and those that we have found in practice to be the most serviceable (Worth, Reese).

Preparation.—Preparation of the patient is the same as for tenotomy. Instilling a 5 per cent. solution of cocaine in the conjunctival sac is usually sufficient to produce a good anesthesia. The operation can be performed with very little pain with this method if a few drops of the solution are dropped on the muscle when it is exposed and all traction on it is avoided during operation. Injection of cocaine is not to be used, as it produces an edema and disturbance of relationship. A general anesthesia is necessary only in exceptional cases.

Landolt's Advancement.—**Instruments.**—Speculum, forceps, scissors (curved), two strabismus hooks, fixation forceps, needle-holder, sutures.

Operation.—A curved incision is made in the conjunctiva, near the limbus and parallel to it, on the side of the muscle that is to be advanced and of sufficient length to expose the tendon freely. The flap thus made is dissected off and turned back. Tenon's capsule is now incised with the scissors at the upper or lower border of the tendon and a strabismus hook is passed through the opening beneath the tendon. The hook is now given to the assistant. Two sutures are now passed from without inward through capsule and tendon. These are inserted one near the upper, the other near the lower border of the tendon, each taking

Fig. 498



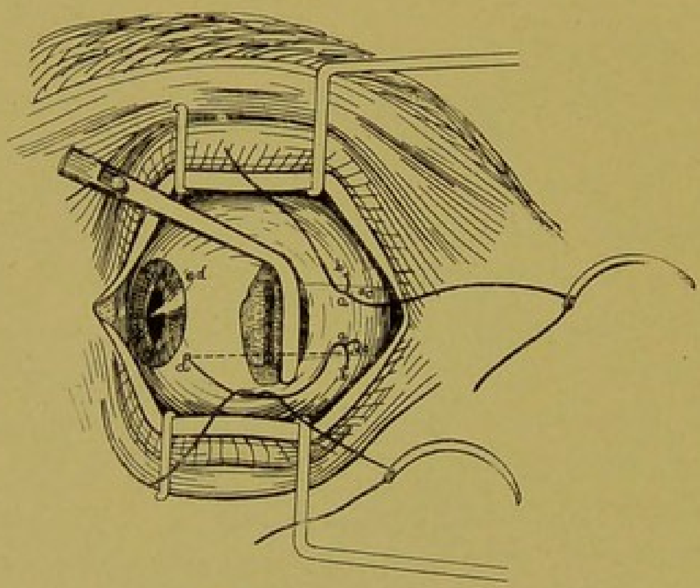
Landolt's advancement.

in about one-third the width of it. Their distance from the insertion of the muscle varies according to the effect which is to be produced. The tendon is now drawn away from the eyeball with these sutures and severed with the scissors in front of the threads. The stump of the tendon is now snipped off. The conjunctiva and episcleral tissue is then grasped near the upper limbus and one end of the upper suture is passed through the episcleral tissue in the direction of *a–b* (Fig. 498). The lower suture is passed in the same way in the direction *c–d*. After the insertion of the sutures the assistant rotates the eyeball with the fixation forceps in the direction of the operated muscle and the sutures are knotted, care being taken to secure equal tension on both sutures.

Both eyes are bandaged for five or six days, changing the dressing and cleansing the eye daily. On the fifth or sixth day the unoperated eye may be left open while the operated eye is kept bandaged until the eighth day when the sutures are removed.

Worth's Advancement. — **Instruments.** — Speculum, forceps, curved scissors, strabismus hook, Prince forceps, needle-holder, sutures, fixation forceps.

Fig. 499



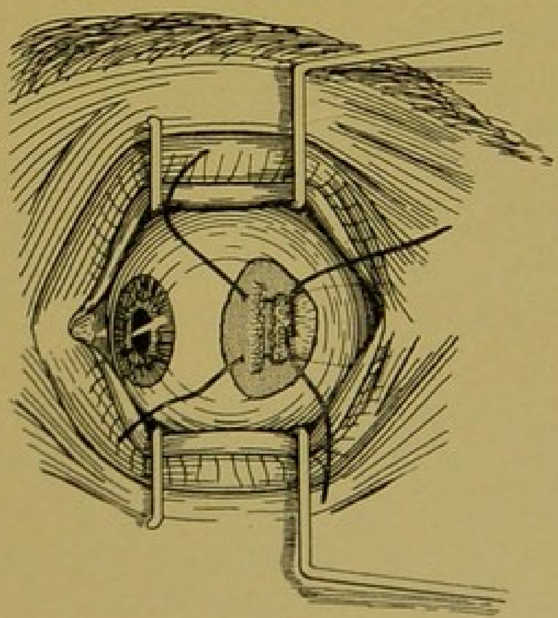
Worth's advancement.

Operation.—A vertical incision 1 cm. long is made in the conjunctiva in front of the insertion of the muscle. Both edges of the incision are undermined as far as the limbus anteriorly and posteriorly far enough to expose the muscle freely (Fig. 499). Tenon's capsule is then incised near the upper border of the tendon and the strabismus hook passed underneath it. Tenon's capsule near the lower border is now incised and the second strabismus hook is introduced. If we are sure that we have all the fibers of the tendon on the hooks one is removed and the Prince forceps substituted for it. When the Prince forceps are in place the second hook is removed. The conjunctival flap is grasped and pulled forward between the jaws of the forceps which are now closed clamping the conjunctiva, Tenon's capsule, and tendon together. The muscle is detached from its insertion and the sutures are inserted as follows:

A needle with a strong silk suture is passed from without inward, through the conjunctiva and tendon at one end of the middle third of its width (*a*) and brought out from within outward through capsule and conjunctiva at the edge of the muscle (*b*) and then tied. The end of the suture that has the needle on it is again introduced from without inward behind the knot (*c*) and carried underneath the tendon to the limbus, where it is passed through the episcleral tissue and brought out at the point (*d*). Two such sutures are introduced, one including the upper third and the other the lower third of the muscle. After the insertion of the sutures the portion of tendon held by the Prince forceps is severed and the two ends of the suture tied.

After-treatment.—Both eyes are bandaged for three or four days, after which the non-operated eye may be left open. Bandaging of the operated eye is to be continued until the eighth day when the sutures are removed.

Fig. 500



Schweigger's resection.

Schweigger's Resection.—**Instruments.**—Speculum, forceps, two strabismus hooks, curved scissors, needle-holder, silk, and catgut sutures.

Operation.—A tenotomy of the antagonist is first performed and then a horizontal incision is made over the insertion of the muscle to be resected.

Tenon's capsule is incised along the upper and lower border of the muscle and two strabismus hooks are introduced beneath the tendon (Fig. 500). One hook is entered from below, the other from above, and separated so that one will be under the insertion and the other behind the point where the sutures are to be inserted.

One needle of a double armed catgut suture is passed underneath the upper border of the muscle taking in a little more than half of its width. The needle is pushed through the muscle from within outward and the suture is then tied. The other suture is inserted in a similar fashion below. The muscle is now severed a little in advance of the insertion of the sutures. The stump at the insertion is also snipped off and the sutures are passed into the episcleral tissue and tied. The edges of the conjunctival wound are brought together with silk sutures. Schweigger believed that if the resection was done following a tenotomy each millimeter of muscle excised produced a similar amount of correction of the strabismus; for this reason he used a specially devised instrument for measuring the exact amount of muscle to be removed.

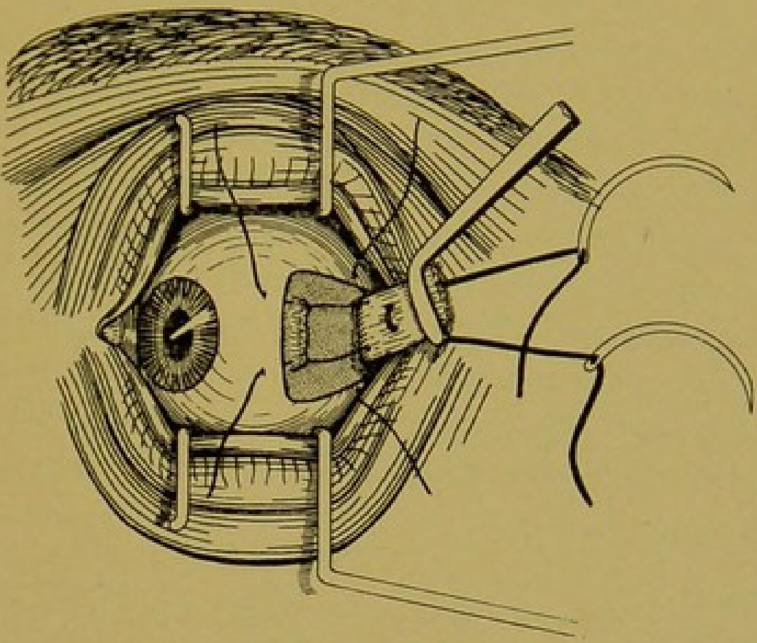
After-treatment.—After operation both eyes are bandaged for three or four days and the operated eye until the eighth day, when the sutures may be removed.

Reese's Resection.—**Instruments.**—Speculum, forceps, scissors, Prince forceps, needle-holder, sutures, fine and heavy, strabismus hooks.

Operation.—A vertical incision 1 cm. in length is made through the conjunctiva about 6 mm. from the limbus. At the upper and lower borders of the muscle Tenon's capsule is incised with the scissors and the strabismus hook is passed under the tendon (Figs. 501 and 502). The conjunctiva is dissected back to the canthus and the muscle is freed from the lateral insertions.

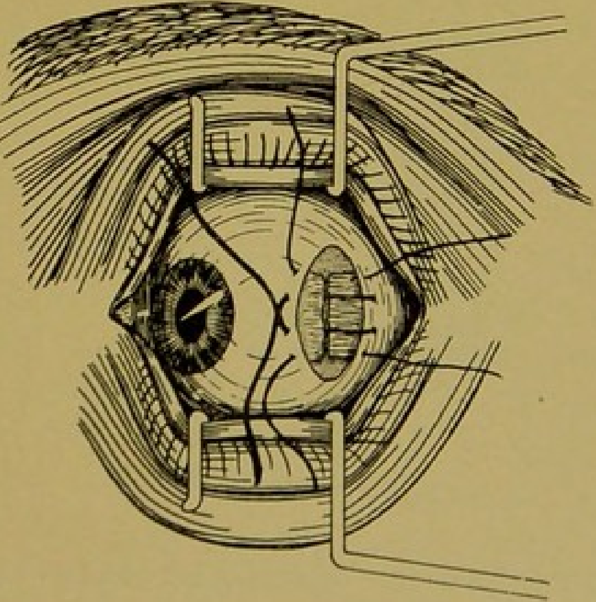
The Prince forceps are introduced, and the muscle alone is clamped at right angles to its fibers. The muscle is then severed about 2 mm. from its attachment to the sclera. The sutures are inserted in the following manner: A heavy double armed suture is first taken and one needle of it is passed through the muscle from within outward at the junction of the middle and

Fig. 501



Reese's resection. First step.

Fig. 502

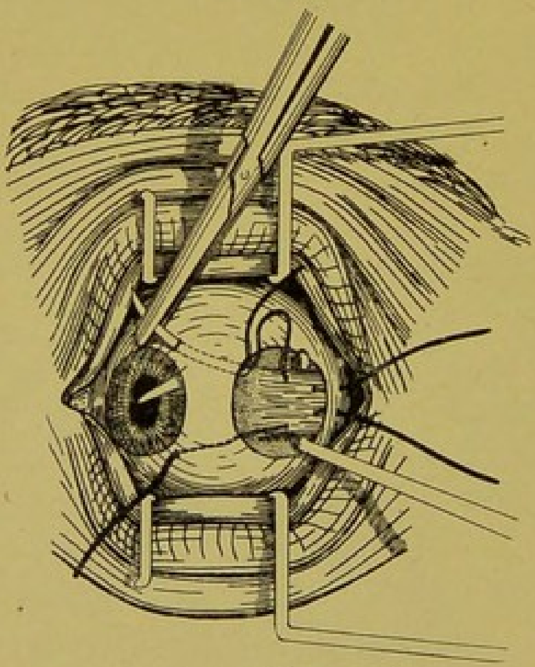


Reese's resection. Second step.

upper third of the muscle, 4 mm. behind the forceps, and brought out through the edge of the conjunctiva. The second needle is passed in a similar fashion at the junction of the middle and lower third of the muscle. The finer sutures are passed through the edge of the conjunctiva, one in the upper and one in the lower border of the muscle, from without inward, slightly posterior to the middle suture. The muscle is now severed about 2 mm. behind the blades of the forceps. The two needles of the middle suture are passed through the scleral stump 2 mm. from each other and brought out through the conjunctiva. The needles of the finer sutures are passed through the upper and lower edge of the scleral attachment including the conjunctiva also. The sutures are now tied, the middle one first.

After-treatment.—After operation both eyes are bandaged for three days, after which the finer sutures may be removed and the unoperated eye left open. The operated eye should be bandaged and the middle suture is left in place for ten days.

Fig. 503



De Wecker's folding operation.

De Wecker's Folding Operation (Avancement Capsulo-musculaire).—**Instruments.**—Speculum, forceps, scissors, strabismus hook, fixation forceps, needle-holder, sutures.

Operation.—A vertical incision 1 cm. in length is made 2 mm. from the limbus and the conjunctiva is dissected up as far as the insertion of the tendon. The tendon is now exposed and

Tenon's capsule is incised along the upper and lower border. The strabismus hook is passed underneath the tendon, great care being taken that the whole muscle should be included (Fig. 503). The tendon is raised from the globe with the hook and then the sutures are passed. One suture is passed through the canthal edge of the conjunctiva from without inward, then through the tendon near its lower edge under the hook, and is brought out through the tendon again in front of the hook. The conjunctiva and episcleral tissue is now grasped with a strong forceps near the lower limbus and the needle is carried underneath the conjunctiva through the episcleral tissue and brought out near the vertical meridian of the cornea, about 2 or 3 mm. away from the limbus. The second suture is passed in a similar manner through the upper edge of the tendon and brought out near the upper limbus. The ends of the sutures are tied, care being taken that equal traction is exerted by both ligatures.

After operation both eyes are bandaged for two or three days, when the non-operated eye may be left open. The sutures are to be removed on the sixth or seventh day.

This operation shortens the muscle by folding the tendon and Tenon's capsule on itself. Immediately after the operation there is an unsightly elevation which slowly flattens out but never entirely disappears.

Complications during Operation.—Complications that may occur during these operations:

1. Hemorrhage may occur during operation, and cause considerable trouble by obscuring the field of operation. It is unpleasant but not serious, as it can be easily checked.

2. Perforation of the sclera may occur in advancement and folding operations while passing the needle through the sclera and episcleral tissue. To avoid this complication it should be remembered that the sclera near the limbus is hardly 1 mm. in thickness, and the needle should always be faintly seen while passing through the episcleral tissues.

3. The sutures may break while tying them. If one suture breaks it can be replaced without much difficulty, but if both give way at the same time (this may happen if the surgeon and assistant tie both sutures simultaneously) the muscle will slip

back out of sight. To avoid this complication the suture should be tested before use, and no suture should be used after it has been sterilized a second time.

Postoperative Complications.—After the effect of cocaine has worn off the eye is apt to be painful, but this only lasts for a few hours. If the pain is so severe that the patient cannot bear it a hypodermic of morphine may be given. An uneventful healing is the rule and complications are of rare occurrence.

CHAPTER XIII

OPERATIONS ON THE ORBIT

SURGICAL ANATOMY OF THE ORBIT

THE orbit forms a bony cavity for the reception of the eyeball, and its muscles, nerves, and vessels. It is pyramidal in shape, having an apex, base, and four sides. Its apex is formed by the optic foramen and its base is outlined by the margin of the orbit. The upper wall is formed by the orbital plate of the frontal bone and the lesser wing of the sphenoid. It is very thin, and in old people is often perforated. It separates the orbit from the anterior fossa of the skull and the frontal sinus, the floor of which it forms. Anteriorly and externally it has a depression for the reception of the lacrimal gland (lacrimal fossa), while anteriorly and internally is the trochlear fossa for the pulley of the superior oblique muscle. The internal wall which is the thinnest is formed by the sphenoid, the os planum of the ethmoid, the nasal process of the superior maxillary, and the lacrimal bone. It separates the orbit from the sphenoidal sinus and the ethmoidal cells. The inferior wall or floor of the orbit is formed by the superior maxillary, the palate, and orbital process of the malar bone. It separates the orbit from the antrum of Highmore. The external wall, which is the thickest, is formed by the greater wing of the sphenoid and the orbital process of the malar bone. It separates the orbit from the temporal fossa anteriorly and from the middle fossa of the skull posteriorly.

The walls of the orbit form a thick bony ring anteriorly, which is called the margin of the orbit. The orbit is lined by the periorbita, which is loosely adherent to the underlying bone. The periorbita is continuous posteriorly with the dura mater and anteriorly with the periosteum covering the bones of the face. The foramina that communicate with each orbit are nine in number. They are the optic foramen, the sphenoidal fissure, the sphenomaxillary fissure, the nasal duct, the malar canals, the anterior and posterior ethmoidal, and the supra- and infra-orbital foramen. The optic foramen transmits the optic nerve and ophthalmic artery. The sphenoidal fissure transmits the third, fourth, and ophthalmic division of the fifth, the sixth, and a branch of the sympathetic nerve, the recurrent lacrimal artery, the orbital branch of the midmeningeal artery, and the ophthalmic vein. The sphenomaxillary fissure, which forms the outer boundary of the floor of the orbit, transmits the superior maxillary nerve, the infra-orbital vessels, and the ascending branches of Meckel's ganglion. The nasal duct which is at the internal-anterior angle of the floor of the orbit connects the orbit with the inferior meatus of the nose. The other foramina are of less importance and transmit small vessels and nerves.

The two orbital cavities diverge anteriorly and are directed downward and outward, their axes passing somewhat below the horizontal plane. The orbit contains the eyeball, muscles, vessels, nerves, glands, fatty and connective tissues.

The eyeball is situated in the anterior part of the orbit but not exactly in its axis, for it is somewhat displaced temporarily. It rests in a bed of orbital fat and is surrounded by a dense connective-tissue capsule, called Tenon's capsule, which is part of a connective-tissue system weaving through the contents of the orbit. This system connects and envelops all muscles, vessels, and nerves of the orbit, and sends trabeculæ into the fatty tissue connecting in some places with the periorbita. Tenon's capsule is the strongest part of this system, and covers the posterior four-fifths of the eyeball with which it is in close relationship. It is not only adherent to the sclera at the point of insertion of the muscles but it is continued forward to the limbus as subconjunctival fascia. Furthermore it is not, as thought before, an acetabulum in which the eyeball moves, but it is everywhere connected to the sclera by very thin and loose connective-tissue fibers. It is also connected with the margin of the orbit by strong connective-tissue bands that are called check ligaments. These check ligaments extend externally from the external rectus muscle to the malar bone, and internally from the internal rectus muscle to the lacrimal bone. Above the check ligament connects the levator with the superior rectus and superior oblique, and is adherent to the upper margin of the orbit. Below the check ligament is the strongest, and after connecting the inferior rectus with the inferior oblique is attached to the floor of the orbit. These check ligaments prevent backward traction of the eyeball and also prevent too wide excursions of the globe.

OPERATIONS ON THE ORBIT

Operations on the orbit consist in (*a*) incision of the orbit, (*b*) Krönlein's temporary resection of the external orbital wall, (*c*) exenteration of the orbit.

The conditions that call for operative interference on the orbit are: Retrobulbar cellulitis and abscess of the orbit, subperiosteal and orbital hemorrhage, foreign bodies and fragments of bones following fracture and tumors of the orbit.

Incision of the Orbit.—Indications.—1. Retrobulbar cellulitis and abscess of the orbit.

2. Hemorrhage into the orbit and under the periorbita.

3. To remove foreign bodies and fragments of bones following fracture.

4. To remove tumors of the orbit.

Operation.—Retrobulbar Cellulitis and Abscess of the Orbit.—These may follow injuries, suppurative periostitis, ethmoiditis, frontal sinusitis, etc.

The incision in such cases should be done as soon as possible, as the suppurative inflammation not only endangers the patient's sight but also his life, as it may lead to a meningitis. The incision should be made where the pus is, the site of which can sometimes be determined from the displacement of the eyeball, impairment of mobility or palpation. Often, however, it is impossible to locate the abscess or it has not yet formed, but the symptoms of the intra-orbital pressure are so marked that entry should be made at once to avoid serious complications. It is best to incise below and outward, as there are no structures here that are liable to be injured. In case the abscess, if already present, is not found the intra-orbital pressure at least has been relieved and an exit has been made for the pus which will find its way to it a few days later.

The operation should be done under a general anesthetic and the incision made with a bistoury. The knife is thrust through skin and tarso-orbital fascia deep into the orbit and the wound enlarged until it is 3 or 4 cm. in length. In making the incision injury of the eyeball and optic nerve as well as the ocular muscles must be avoided. There is no danger of injuring the eyeball if the blade is kept close to the wall of the orbit. The optic nerve may be injured near the apex if the knife is pushed too deeply; to avoid this complication it must be remembered that the depth of the orbit is about 4 or $4\frac{1}{2}$ cm. The two oblique muscles are the ones most likely to be injured by severance. For this reason the inner third of the orbit should be considered a danger zone and no incision should be carried into it.

After the operation an iodoform gauze drain is introduced and a moist dressing applied. This must be changed daily and the wound irrigated with hot boric solution or bichloride of mercury 1 to 5000, until the discharge has ceased and the exophthalmos has disappeared.

Hemorrhage.—Hemorrhage under the periorbita or in the orbit seldom calls for incision, as the blood will readily and quickly be absorbed without any interference. It is, however, necessary to open the orbit in cases where the hemorrhage is so extensive that it endangers the eyeball either from the exophthalmos or from pressure on the optic nerve. The manner of making the incision and after-treatment is the same as for retrobulbar abscess.

Foreign Bodies.—Foreign bodies and fragments of bone following fracture must also be removed by an incision. The site of incision as well as its depth depends on the location of the foreign body. Whenever possible the incision is made through the conjunctiva, parallel to the cul-de-sac, thereby avoiding a cutaneous scar.

Tumors.—Tumors of the orbit can be removed through a simple incision only when they are small and are situated anteriorly. Local or general anesthesia may be employed, but the former is preferable.

The incision may be done through the conjunctiva or through the skin. The former is preferable, but can be used only for very small tumors, especially when they are encapsulated. Incisions through the skin are usually parallel to the orbital margin. After the incision has been made the edges of the wound are retracted and the incision is carried down until the tumor is reached. The tumor is then extirpated as far as possible by blunt dissection. If the tumor is cystic great care should be taken not to rupture its capsule. It is usually not possible to remove the tumor by blunt dissection alone, and the scissors must also be used. They should always be kept close to the tumor to avoid injury of the levator or some ocular muscle. After the tumor has been removed all hemorrhage must be checked, ligating the large vessels if necessary. The wound in the tarso-orbital fascia is sutured with catgut and the skin wound with silk. A bandage is applied and the sutures are removed on the sixth day.

Krönlein's Temporary Resection of the External Orbital Wall.—This operation is indicated in deeply situated tumors of the orbit and where there is a possibility of conserving the eyeball.

As it is impossible to foresee whether or not the eyeball can be saved it is wise to secure the patient's consent to enucleation before beginning the operation.

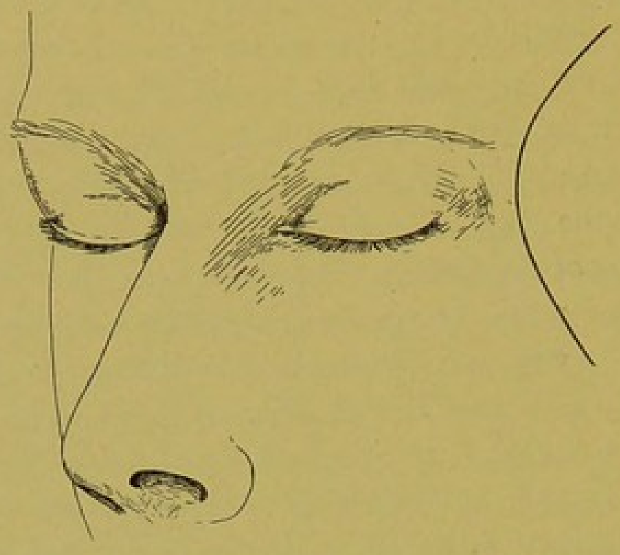
The operation may be also employed in removing foreign bodies (bullets) from the orbit, as a preliminary step in Müller's resection of the sclera, and in the removal of a cysticercus from the posterior pole of the globe.

Instruments.—Scalpel, large curved scissors, blunt straight scissors, forceps of various sizes, hemostats, periosteal elevator, chisels of various sizes, osteotomes of various sizes, mallet, wound retractors, tenaculum, orbital spatula, needle-holder, catgut and silk sutures.

Operation.—Before the operation the eyebrow and hair from the temporal region should be shaved off and the field of operation, after thorough cleansing, should be painted with tincture of iodine. A general anesthetic is necessary and the preparation should be the same as for any general surgical operation.

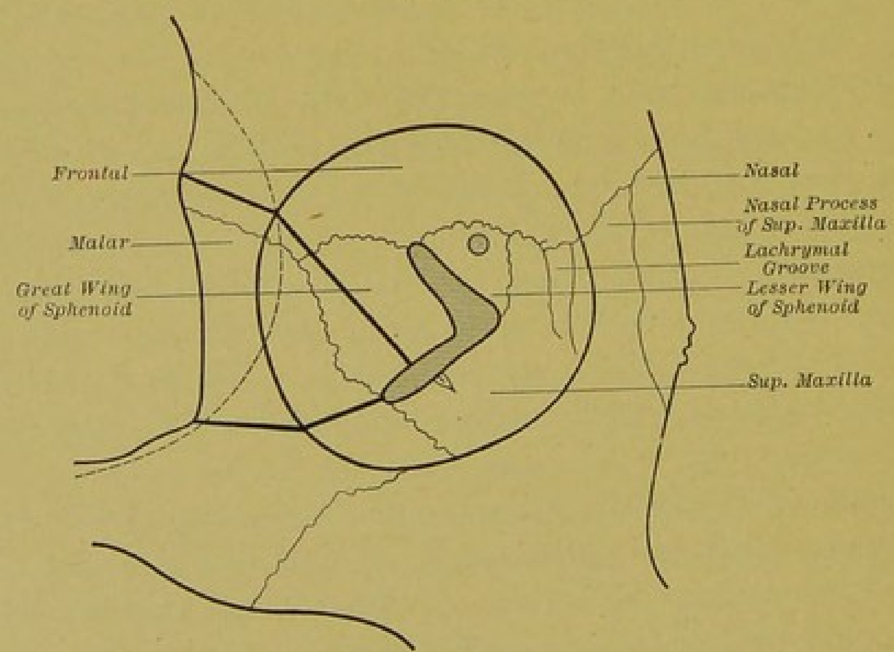
A curved incision, with convexity forward, of about 7 or 8 cm. in length, is made, beginning about 1 cm. above the angular process of the frontal bone and ending on the middle of the zygoma. The ends of the incision are carried through the skin, fascia, and part of the muscle, and in the middle it should reach the bone. The periosteum along the margin of the orbit

Fig. 504



Site of incision for Krönlein's operation.

Fig. 505



Krönlein's temporary resection of the external orbital wall.

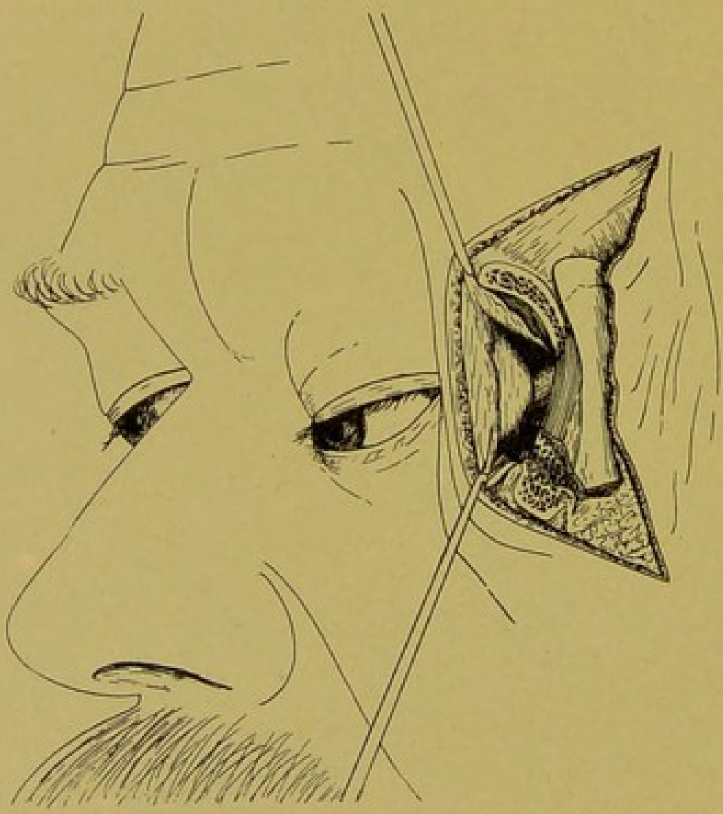
is thoroughly incised and then an elevator is passed into the orbit between the periosteum and bone (Fig. 504). The periorbita of the outer wall of the orbit is dissected up as far back as the sphenomaxillary fissure. The contents of the orbit are retracted with an orbital spatula and the elevator is pushed gently into the sphenomaxillary fissure which is used as a landmark.

Fig. 506

Krönlein's temporary resection of the external orbital wall. Second step. (After Haab.)

A wedge-shaped piece of bone is cut out of the outer wall of the orbit with chisel and hammer. The base of the wedge is formed by the malar process of the frontal and the frontal process of the malar bone and its apex lies behind the anterior end of the spheno-maxillary fissure (Fig. 505). The upper incision through the bony wall begins a little above the orbitomalar suture and is carried backward in a straight line to the periosteal elevator in the sphenomaxillary fissure. The lower incision passes through the base of the frontal process of the malar bone and back to the periosteal elevator. The wedge of bone with soft tissues is now rotated outward, exposing the orbital contents covered with the periorbita. The periorbita is now incised from before backward with the blunt scissors. The edges of the periorbital incision are then retracted, exposing the contents of the orbit for examination (Figs. 506 and 507). This demands good illumination.

Fig. 507



Krönlein's temporary resection of the external orbital wall. Third step. (After Haab.)

If the external rectus is in the way it is drawn to one side. Should this be insufficient it is severed and catgut sutures are passed through each end. This permits free access to the entire orbit and such measures as are necessary can now be performed. After this the hemorrhage is checked, and if the external rectus muscle has been incised the catgut suture taken is tied. The osseous wedge is rotated back into proper position. Two or three catgut sutures are taken in the periosteum and silk sutures in the skin wound. A small drain is placed in the lower end of the wound, and the lids sewed together to prevent exophthalmos and injury to the cornea. An aseptic dressing is applied covering the whole field.

After-treatment.—The dressing may be changed on the third day, and at the same time the drain is removed. The skin sutures may be removed on the seventh or eighth day. The healing is usually uneventful unless infection takes place.

Exenteration of the Orbit.—Exenteration of the orbit consists of removal of the entire contents of the orbit together with the periorbita.

It is indicated in extensive or diffuse malign tumors of the orbit that cannot be removed without the eyeball. Such tumors may be glioma, carcinoma, and sarcoma. They may have their origin in the eyeball (intra-ocular), on the eyeball (epibulbar), and in the orbit, or they are secondary to an involvement of the lids.

Exenteration of the orbit may be also necessary in cases of extensive and diffuse benign tumors, as for instance angioma, if removal in any other way is impossible, or if they have destroyed the eyeball.

Instruments.—Scalpel, straight scissors, wound retractors, forceps, needle-holder, periosteal elevator, large curved scissors, hemostats, cautery, curettes, sutures.

Operation.—The operation is performed under a general anesthesia.

The contents of the orbit may be removed together with the eyelids if they are involved, or without if they have not been attacked by the growth. In the former case the operation begins with an incision through the skin which follows the orbital margin and is carried in the healthy tissue throughout its whole course. In the latter case the operation begins with a canthotomy, and then the eyelids are retracted and the incision around the orbital margin is made through the conjunctiva.

The elevator is now introduced and the periosteum is separated first from the outer wall, then from the upper and lower walls, and at last from the inner wall down as far as the apex of the orbit. The periorbita is easily detached from the underlying bone except at the inner angle where the internal canthal ligament and the check ligament of the internal rectus must be severed with the scissors. In using the elevator great care must be taken not to fracture the bone, which is especially thin on the upper and inner wall. After the detachment of the periosteum the orbital contents are grasped with a strong forceps and the optic nerve is severed with the curved scissors at the apex of the orbit. The whole mass is removed and a tampon placed at the apex to check the hemorrhage. The orbital wall is now carefully examined to see that no tumorous tissue remains behind. Any place which shows invasion of the bone should be curetted and afterward cauterized. If the hemorrhage from the ophthalmic artery is persistent it should be checked with the cautery.

This completes the operation, and the whole cavity is then loosely packed with iodoform gauze and an aseptic dressing is applied. The dressing is changed daily and at the same time the cavity is irrigated with bichloride 1 to 3000 solution. The cavity is slowly filled out with granulation tissue, to which the lids, if present, become firmly adherent. If the lids have also been removed the epithelium spreads in from the margin of the orbit and covers the newly formed tissues. To complete this process takes at least two months To hasten the healing in cases where the eyelids have been removed, a pedunculated skin flap is brought down from the temple, and its edges are united with the edge of the orbit (Küster). If the eyelids have been preserved the conjunctiva is removed from them, together with the hair follicles, and the lids are sutured together, leaving a small opening at the external canthus for drainage. Good results can also be obtained by filling the orbital cavity with Mosetig's iodoform spermaceti mixture (iodoform 60 gm. spermaceti and olive oil, āā 40 gm.). Two or three days after the exenteration the orbital cavity is irrigated with a 1 per cent. solution of formalin and then the cavity is filled with the mixture that has been heated to 60° C. The mixture quickly solidifies, and then the lids are sewed together over it. If the lids are wanting it is covered with a pedunculated skin flap (Polya).

CHAPTER XIV

REMOVAL OF FOREIGN BODIES

Removal from the Eyelid.—Foreign bodies in the lid are removed according to the rules of general surgery. The incision, however, should always be parallel to the lid margin.

Removal from the Lacrimal Apparatus.—Foreign bodies in the lacrimal apparatus are very rare. Eyelashes, with one end projecting through the punctum and irritating the eye, are sometimes found in the canaliculus. They are easily removed with a cilia forceps. Calcareous deposits (dacryoliths) or pieces of instruments are sometimes found in the lacrimal sac. They may be removed by a dacryocystotomy.

Removal from the Conjunctiva.—Foreign bodies on the conjunctiva, such as grains of dust, cinders, small insects, etc., usually lodge under the lid, often in the subtarsal sulcus. They usually cause considerable pain, photophobia, and irritation by being rubbed over the surface of the cornea during the act of winking. The removal is easily accomplished by everting the upper lid and wiping the foreign body off with a moist cotton pledget. If the foreign body should work up into the fornix it may remain there for some time without producing irritation. Later it becomes enveloped in granulation tissue. The removal is accomplished, after cocainizing the eye, by everting the lid doubly and exposing the fornix. It is not necessary to excise the granulation tissue, as atrophy follows after removal. If, however, it is uncertain whether all of the foreign body has been removed the granulations are excised and the wound surface is carefully searched. When lodged under the bulbar conjunctiva a foreign body is best removed by grasping it together with the conjunctiva with the forceps, and excising it. Since the conjunctival wound is small it is not necessary to suture it. Grains of powder usually remain under the bulbar conjunctiva without producing any irritation. Their removal, however, is rather difficult, as they have entered the eye with considerable force and are either lodged in the episcleral tissue or the sclera itself. It is therefore better to allow them to remain in place.

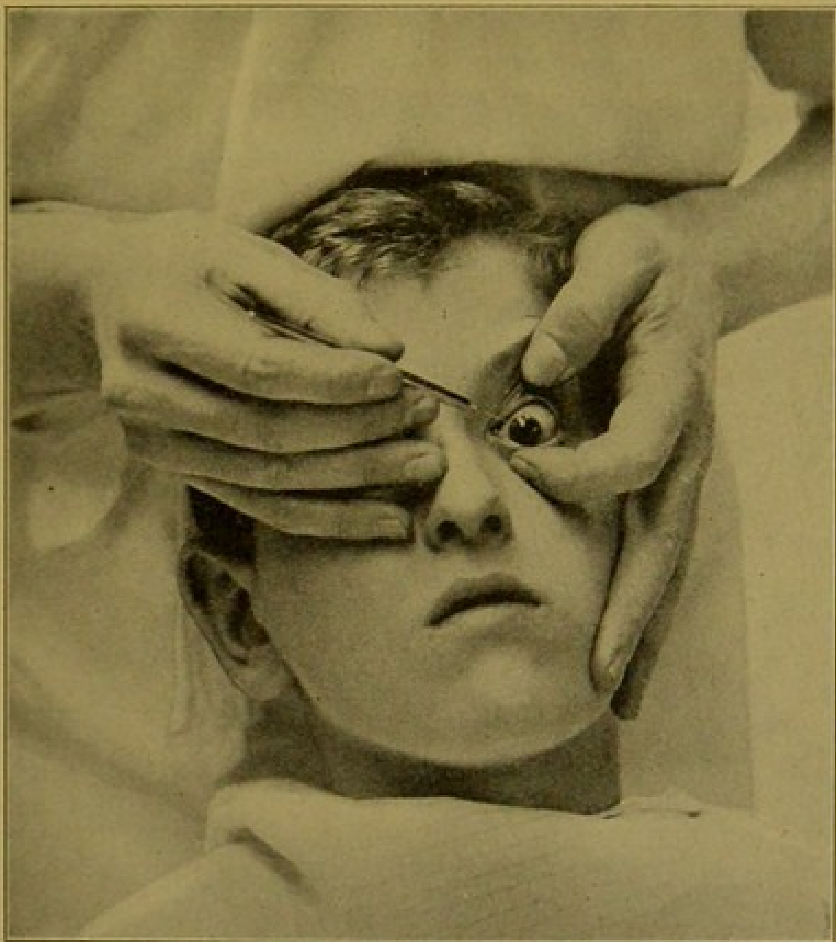
Removal from the Cornea.—Foreign bodies in the cornea are very common, especially among the working class. They may be of various substances, shapes, and sizes. According to the force with which they entered the eye they are found: (*a*) On the surface of the cornea; (*b*) in the deep layers of the cornea; (*c*) they may partially enter the anterior chamber.

Foreign Bodies on Surface of the Cornea.—Foreign bodies on the surface of the cornea often require a thorough search to find them. The cornea should be examined in a dark room with strong focal illumination using also a magnifying glass or Berger loupe. If the bodies are very small their presence can be quickly detected by instilling one drop of the following solution, which stains the point of contact a greenish yellow:

℞—Fluorescein	gr. $\frac{1}{7}$
Sodium carbonate	gr. j
Aqua. destill.	♏xxx

In removing the foreign body, the eye should first be well cocainized and the patient is then seated on a chair with his head resting on the chest of the operator, who stands behind (Fig. 508). The eyelids are retracted with the index and middle fingers of the left hand and the cornea is strongly illuminated. It is better to try and wipe off the foreign body with a wet cotton pledget before using the needle. If unsuccessful in this the needle or spud is taken, its point is placed at the edge of the foreign body, pushed behind it, and the body is lifted out of its bed. Any area of infiltration or rust surrounding it should be gently curetted away. Care should be taken not to abrade the cornea any more than is necessary. After removal of the foreign body the cornea should always be carefully examined to see if any particles remain behind. No matter how small the foreign body is or how superficially it is located the following after-treatment is essential. The eye should be thoroughly cleansed and boric ointment or argyrol ointment 5 per cent. should be placed in the conjunctival sac. The eye is then closed with a bandage which should be changed daily until all signs of irritation have disappeared and the wound is covered with epithelium. Infected ulcer and loss of sight may follow the neglect of these simple precautions.

Fig. 508



Removal of foreign body from cornea.

Foreign Bodies in Deep Layers of Cornea.—If the foreign body is located in the deep layers of the cornea the patient, after cocainization, is placed on the operating table. The speculum is inserted and the eye is fixed with the fixation forceps. If one end of the foreign body is above the level of the cornea it is often possible to grasp it with the forceps and to remove it. During this manipulation care should be taken not to push it into the anterior chamber. If the foreign body is in the substance of the cornea below the level of its surface a Graefe knife or keratome should be used to cut down on it, always cutting toward the point of entrance and not away from it. After the foreign body is reached it is grasped with the forceps and extracted.

Foreign Bodies Partially in Anterior Chamber.—If the foreign body is ready to penetrate or is already partially in the anterior chamber Desmarres' method of extraction should be employed.

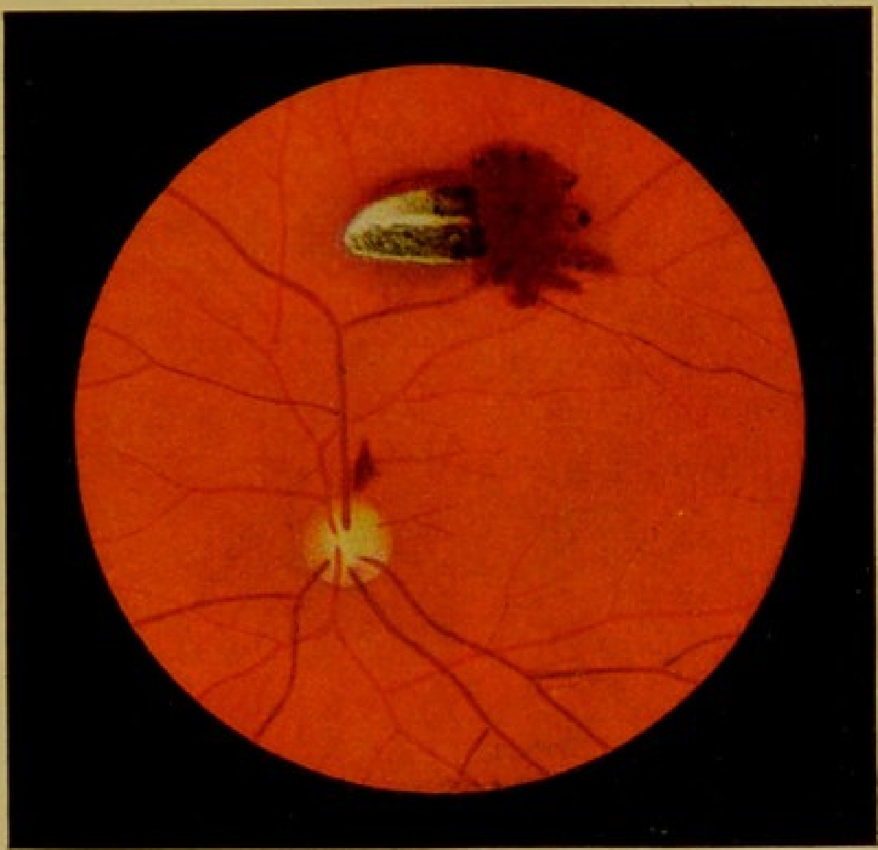
After cocainization the speculum is inserted and the eye fixed. Near the foreign body a small keratome is passed with the left hand into the anterior chamber and pushed forward until it is behind the foreign body. The handle is then depressed until the point is in contact with the posterior surface of the cornea, thereby preventing the foreign body from slipping into the anterior chamber. With the other hand a Graefe knife or keratome is taken and the foreign body is cut down on and extracted with the forceps. Care should be taken during this operation to prevent the escape of aqueous. This is the only danger of the operation, for if the aqueous escapes while the keratome is in the anterior chamber the iris or lens capsule may be injured. To avoid this complication Arlt advises, in cases where the foreign body has not penetrated the anterior chamber the removal of the keratome and the insertion of a Daviel spoon behind the foreign body. Deeply seated pieces of iron or steel should be removed with a magnet after they have been cut down on with a knife.

Removal from the Sclera.—The removal of foreign bodies from the sclera is performed in a fashion similar to the removal from the cornea, with the exception that the bulbar conjunctiva must be incised and retracted. Care should be taken not to push the foreign body into the vitreous. Here, again, if the foreign body is of iron or steel a magnet should be used in preference to any other method.

FOREIGN BODIES IN THE EYEBALL

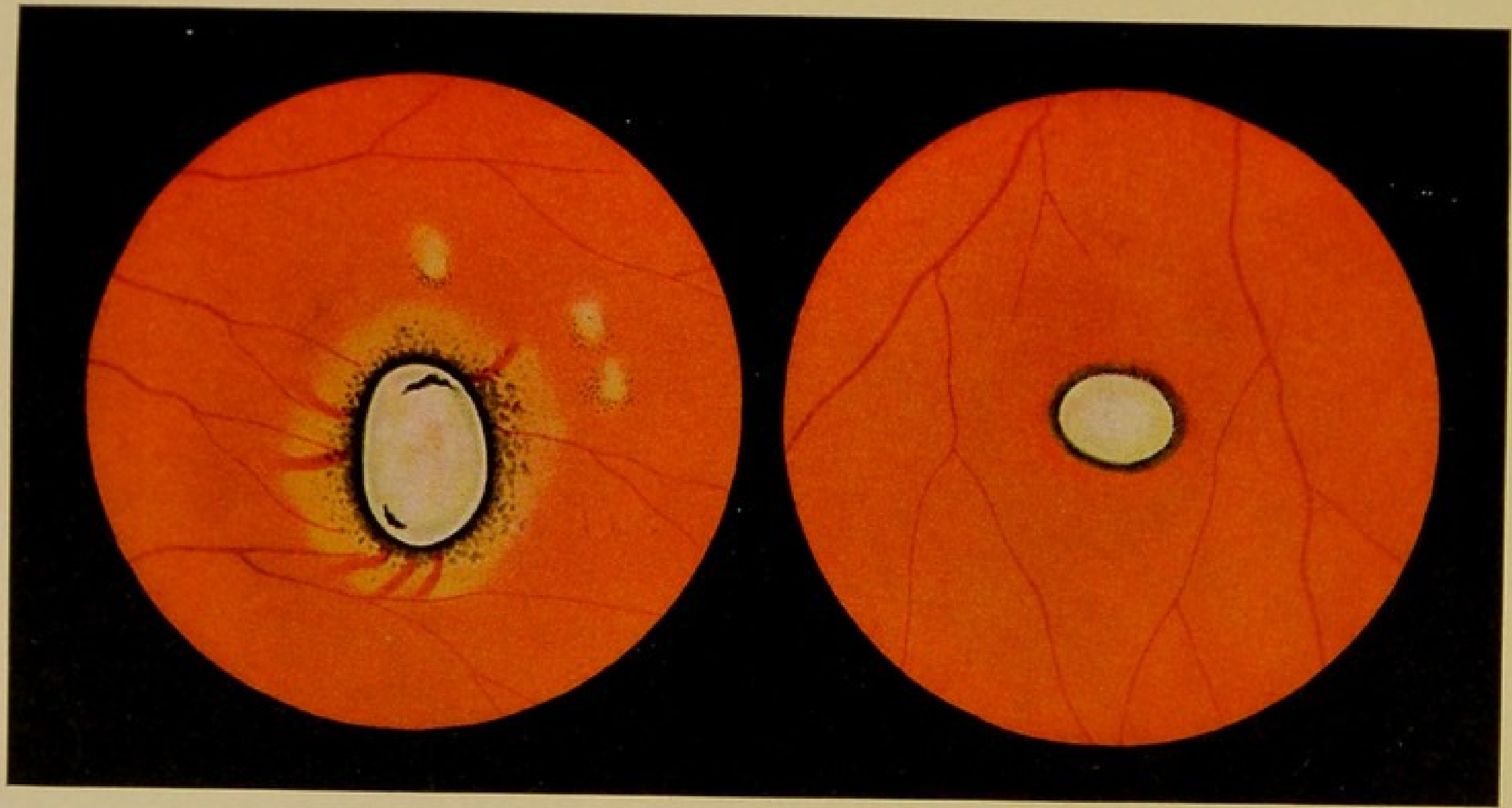
Foreign bodies that have entered the eyeball may find lodgement in any of the tissues. Their removal is of utmost importance because, otherwise, not only complete destruction of the eye will sooner or later ensue, but also because they imperil the other eye through sympathetic ophthalmia.

PLATE I



Recent Injury of Retina from an Iron Splinter.
(After Haab.)

PLATE II



Old Injury of Retina from an Iron Splinter. (After Haab.)

In all penetrating injuries it is of the greatest importance that the eye be thoroughly examined at the earliest possible moment after the accident, and as far as possible it should be ascertained whether a foreign body is present or not. If the foreign body cannot be seen the account of the accident, the position and character of the wound, and, if the patient seeks advice some time after the injury, the subsequent history of the case may suggest the presence of an intra-ocular foreign body. If an eye has been punctured with a pair of scissors or cut with a knife it is unlikely to contain a foreign body, but, on the other hand, when the eye has been injured by an exploding cartridge or struck by a small piece of steel it is quite probable that a foreign body became lodged in it. The appearance of the eye is also of great importance. If the patient is seen a short time after the injury the presence of a foreign body should be suspected if the wound is small, the iris torn or perforated, or the lens capsule injured in a small circumscribed area. If, however, the patient seeks advice some time after the accident, marked ciliary injection, tenderness on pressure over the ciliary region, and other symptoms of a severe iridocyclitis are of diagnostic value.

The nature of the accident, along with its attendant circumstances and the symptoms found at the clinical examination of the eye, may suggest the presence of a foreign substance in the eye, but this suspicion can be confirmed only by actual demonstration.

Localization of Foreign Body.—**Ophthalmoscope.**—When a foreign body is located in the anterior portion of the eyeball and the media are clear it may often be seen with the naked eye by the aid of focal illumination. If it is deeper and the media are transparent the ophthalmoscope and perimeter may be helpful in locating it. In such cases a thorough examination of the eye with the ophthalmoscope, while the pupil is at maximum dilatation, will sometimes reveal the foreign body lodged in the lens, or somewhere in the vitreous or retina. A foreign body that has just entered the eye can be easily recognized. (Plate I.) One that has been in the eye for several weeks is always enveloped in exudate, and if located on the retina greatly resembles an old choroiditic spot. It usually appears as a white sharply defined patch surrounded by a pigment ring. (Plate II.)

It often happens in injuries that in passing through the eye a foreign body strikes the retina and rebounds. It will then lie somewhere in the anterior part of the vitreous and cannot be seen. From a diagnostic standpoint it is of great importance to recognize the place where the foreign body struck the retina. It is usually seen as a whitish round spot, because where the retina and choroid are torn the sclera becomes visible; the edges are tinged with blood and there is more or less hemorrhage around it in the vitreous.

If the foreign body is found with the ophthalmoscope its location on the outer side of the sclera may be ascertained approximately by measuring its distance from the optic disk, using as a unit the diameter of the disk, which equals 1.5 mm. In measuring the distance on the outside of the globe the thickness of the optic sheath (about 1 mm.) should be taken into consideration. When the foreign body therefore is judged to lie about 4 disk diameters (6 mm.) from the optic disk the corresponding point outside on the sclera will lie 5 mm. from the optic nerve.

Perimeter.—The perimeter may also be used advantageously in finding and locating the position of an intra-ocular foreign body. A careful examination of the field of vision will not only reveal the exact meridian in which the foreign body lies, but also its approximate location. Donder's table is convenient for changing degrees on the perimeter into millimeters on the globe.

No. 1.—*Temporal half of the field of vision.*

90 degrees	=	8.0 mm. distance from the inner limbus.
80 degrees	=	9.5 mm. distance from the inner limbus.
70 degrees	=	11.5 mm. distance from the inner limbus.
65 degrees	=	12.0 mm. distance from the inner limbus.
60 degrees	=	13.5 mm. distance from the inner limbus.
50 degrees	=	15.5 mm. distance from the inner limbus.
40 degrees	=	16.5 mm. distance from the inner limbus.
20 degrees	=	19.0 mm. distance from the inner limbus.
0 degrees	=	21.5 mm. distance from the inner limbus.

No. 2.—*Nasal half of the field of vision.*

65 degrees	=	12.0 mm. distance from the outer limbus.
40 degrees	=	17.0 mm. distance from the outer limbus.
20 degrees	=	18.0 mm. distance from the outer limbus.
0 degrees	=	21.0 mm. distance from the outer limbus.

It is, however, only very occasionally that the presence of a foreign body can be detected with an ophthalmoscope or a perimeter. Usually it is rapidly concealed by hemorrhage or hidden by increasing opacity of the lens or by an outpouring of inflammatory exudation. In such cases its presence may be determined by:

(*a*) Sideroscope.

(*b*) Giant magnet.

(*c*) *X*-rays.

Sideroscope.—The sideroscope was devised by Asmus and simplified by Hirschberg. It is an instrument consisting of a magnetic needle suspended by a fine silk thread, attached to which is a mirror which reflects the light from a lamp on to a graduated scale. In this way the slightest movements of the needle can be noted. Before examining the patient all magnetic metals (keys, pocket-knife, etc.) must be removed from the patient as well as the examiner. The injured eye of the patient is now brought up close to the needle, and if any metal be present in the eye the needle will be deflected and the reflected light will travel along the scale. From the extent of the deviation of the needle the size and position of the foreign body may be approximately estimated. Besides iron and steel, nickel and cobalt will attract the magnet, while zinc, tin, lead, copper, and bismuth will repel it. It should be remembered that certain of the new iron compounds like iron manganese have no effect on the needle.

Giant Magnet.—In using the giant magnet the patient is made to approach it slowly. If a particle of magnetic metal is present it is drawn toward the anterior part of the eye. The movement of this particle always causes pain to the patient.

X-rays.—Far more exact data may be obtained by the use of the *x*-rays. While the sideroscope and magnet can only be used for certain metallic bodies, the *x*-rays will reveal the presence of any foreign substances except glass and wood, which do not throw shadows. They also afford the possibility of determining the exact position.

The localization of a foreign body by means of the *x*-rays was worked out by Sweet, of Philadelphia, and simultaneously by MacKenzie-Davidson, of London. A great many modifications of these methods, all of which are based on triangulation, are in use. They require a special apparatus and training. For the description of this apparatus and the method of use special articles should be consulted. (Sweet, *Trans. Amer. Ophth. Soc.*, 1897, MacKenzie-Davidson, *British Med. Jour.* January 1, 1898.)

Removal of Foreign Bodies and Results.—Even after the presence of a foreign body has been positively ascertained and its position located, its extraction from the eyeball is in most cases very difficult, and even if successful the outcome can never be foretold. Since the introduction of the electromagnet by Hirschberg and giant magnet by Haab the prognosis in the removal of magnetic foreign bodies has improved, and the statistics of Hirschberg, Haab, and others show that these instruments are of real value. Removal of a non-magnetic foreign body, however, is rarely successful unless it lies in the anterior chamber or lens, and enucleation, as a rule, is finally required. No definite rules can be laid down for the removal of either magnetic or non-magnetic substances. Each individual case presents its own peculiarities, to which the surgeon must adapt himself, and plans must often be changed during operation.

Even when it is impossible to preserve the function of the eye after the removal the operation is necessary, because a foreign body sooner or later destroys the eyeball, at the same time constantly endangers the other eye. Certain foreign bodies often become encapsulated and may remain harmless for years, and then may suddenly give rise to a severe iridocyclitis which destroys the eye, and its fellow can only be saved by prompt enucleation. Experience shows that chips of metal are especially dangerous, as they always set up a severe inflammation, owing to the chemical reaction between them and the tissues in which they are embedded. Even when the operation has been performed with apparent success, there are many cases in which the sight was completely lost afterward owing to the detachment of the retina, and the eyeball completely destroyed by plastic iridocyclitis. Sometimes the eye seems for several weeks to be doing nicely, but then the cicatrix of the wound begins to contract and at the same time the sight gradually becomes weaker until it is entirely lost as the result of detachment of the retina. Again, a plastic iridocyclitis may set in, the eye remains irritated, the ciliary region is tender on pressure, and the globe slowly shrinks, sometimes to a very small size. Unless they are radically treated, cases like these are especially dangerous on account of the sympathetic ophthalmia which may develop. The stump may remain quiescent for years, but owing to constant pathological changes in them, recurrent attacks of iridocyclitis follow one after the other, causing much suffering, and ultimately exciting a sympathetic inflammation in the other eye. It is therefore better in all cases, even when the removal of a foreign body is followed only by a moderate reaction, which clears up in two or three weeks, to keep the patient under constant observation. Should repeated attacks of iridocyclitis follow it is better to enucleate. If there is a serious iridocyclitis, especially one with plastic exudate, following the extraction, which does not respond to treatment within two or three weeks, enucleation should be performed.

Removal of Foreign Bodies from the Anterior Chamber and Iris.—All foreign bodies in the anterior chamber or iris should be removed at once, and if possible through the original opening. Great care should be taken not to injure the iris or lens.

Magnetic Foreign Bodies.—Magnetic foreign bodies may be best removed with the magnet. The location of the foreign body is of little importance provided it is not held in place by an exudation, as a magnet will pull it into any desired position. In extraction the Haab giant magnet or the Hirschberg hand magnet may be used. If the injury is recent and the wound not yet closed the tip of the giant magnet is placed close to the wound. It sometimes happens that the giant magnet will remove the foreign body through the original opening, which if not large enough may be enlarged with the scissors. Hirschberg's magnet is used in a similar manner; the tip, however, may be passed into the anterior chamber. If it is not strong enough to draw the foreign body through the wound a pair of non-magnetic forceps are used to assist in the delivery. In old injuries where the wound has closed a new opening must be made with a keratome or Graefe knife. The site of the incision should be placed so as to facilitate the extraction. It may be either in the limbus or in the cornea proper, but the cornea immediately over the pupillary area should be avoided. The extraction is then accomplished through the incision with the giant or hand magnet.

Non-magnetic Foreign Bodies.—Non-magnetic foreign bodies are more difficult to remove. The only way to accomplish this is to grasp them with a forceps or other suitable instrument and to extract them. To introduce the instrument either the original wound may be used, enlarging it if necessary, or a new opening may be made. The rule is not to force the extraction through the original wound if it is too difficult. It is better to wait a few days until the wound has closed firmly enough to permit a new incision, which is then placed so as to make the extraction most convenient. A foreign body may be free in the anterior chamber; it may lie on the iris or lens capsule, it may be located in the angle of the anterior chamber, it may be wedged in the iris or lens, or both.

Free Foreign Bodies.—Free foreign bodies in the anterior chamber are very rare (cysticercus). In such cases a paracentesis of the cornea is made. Sometimes the outrushing aqueous washes it out, but if it remains behind a pair of forceps is introduced and an extraction is performed.

Foreign Bodies on Iris or Lens Capsule.—Foreign bodies that lie on the iris or lens capsule are removed with the forceps that are entered through a keratome or knife wound. Knife wounds have a slight advantage in that the wound gapes better and the corneal flap is somewhat larger (Knapp). It is hard to grasp a foreign body which lies on the iris without seizing a fold of iris, and removal without iridectomy is possible only in exceptional cases. If it is wedged in the iris it is grasped together with a fold of the iris, pulled out, and an iridectomy is done. Any attempts to remove the foreign body without iridectomy may lead to further injury of iris or even of the lens capsule.

Foreign Bodies in Angle of Anterior Chamber.—Foreign bodies located in the angle of the anterior chamber must be removed through an opening in the cornea, which is slightly internal to it. Here the use of the Graefe knife is imperative, as a sufficiently large wound cannot be made with the keratome.

Removal of Foreign Bodies from the Lens.—It must be remembered that the lens alone of all tissues of the eyeball tolerates the presence of a foreign body, especially if it is chemically neutral. It often happens that small foreign substances become encapsulated in the lens, producing a slight opacity which remains stationary. If other circumstances, such as too great an injury to the lens, infection, iridocyclitis or glaucoma, do not necessitate immediate interference it is better to temporize. This does not refer to metallic substances, especially iron and copper, which must be removed immediately at all costs.

Magnetic Foreign Bodies.—Magnetic substances are first drawn into the anterior chamber with the giant magnet. If the lens capsule offers resistance to the drawing of the foreign body into the anterior chamber it is to be incised with a knife-needle (Haab). After the foreign body has entered the anterior chamber it is removed in the manner already described.

Non-magnetic Foreign Bodies.—Non-magnetic substances are removed with greater difficulty. If they are located in the capsule and are chemically neutral they may be left in place, otherwise they are removed with the forceps. Deeply situated foreign bodies, if quiescent, are left in place. If, however, the foreign body is large, irritant, or produces a total cataract the lens must be extracted. After the extraction it may be found that the foreign body is not present in the lens but has remained behind in the capsule, from which it must be extracted with a forceps. In young patients Graefe advises doing a discission first, in the hope that the swelling lens masses may drive the foreign body forward so that it can be removed at a later date with a forceps.

Removal of Foreign Bodies from the Posterior Chamber.—**Magnetic Foreign Bodies.**—Magnetic foreign bodies are drawn into the anterior chamber with a magnet and extracted from there.

Non-magnetic Foreign Bodies.—Non-magnetic foreign bodies are almost impossible to remove, as they cannot be seen, and it is only rarely that they can be grasped in working behind the iris. If, however, their exact location is known by a skiagraph an iridectomy may be made in front of them. In such a way they often become visible and may be removed with the forceps.

Removal of Foreign Bodies from the Vitreous Chamber and Retina.—**Magnetic Foreign Bodies.**—Magnetic foreign bodies may be removed with a magnet. The removal may be accomplished:

(*a*) Through the original opening in the sclera or by means of a posterior sclerotomy.

(*b*) By drawing it into the anterior chamber and extracting it from there.

The latter is the milder operation, for it is less irritating; there is no disturbance or loss of vitreous, and there is less danger of infection.

Removal through an Opening in the Sclera.—*Hirschberg's Hand Magnet.*—In using Hirschberg's hand magnet the method is as follows (Hirschberg):

After the foreign body has been located the patient is placed on the operating table and anesthetized. A lid speculum is inserted and a suture is passed through the episcleral tissue in the limbus on the same side as the foreign body. The suture is given to an assistant who pulls the eye with it in the opposite direction. A flap of conjunctiva and Tenon's capsule of sufficient size is dissected up over the area nearest the foreign body. This is then retracted. A posterior sclerotomy is performed, and the edges of the wound are then retracted with silver retractors. The large tip of the magnet is brought up to the wound edges and the current is turned on. If after waiting a few moments the foreign body does not appear on the magnet, a smaller tip is substituted and inserted in the vitreous chamber in the direction of the foreign substance. The current is then closed again, and after a few moments the tip is withdrawn. The withdrawal must be slow, and special care must be taken at the wound edges, as they may brush the foreign body off the magnet. To lessen the danger of the complication a silver forceps or some suitable instrument should be used in delivering the foreign body. If the first attempt is not successful another entry is made in a different direction, the current is turned on, and after a few moments the magnet is withdrawn. This may be repeated several times. If the foreign body is removed the prolapsed vitreous is excised and the conjunctival wound closed. The eye is bandaged for two or three days, after which a Fuchs mask can be worn. The patient may leave the hospital when all signs of irritation have disappeared.

Giant Magnet.—The giant magnet may be used also to remove foreign bodies through a scleral opening. In such cases the tip of the magnet is placed in the opening and the current turned on. Usually the foreign body will strike the tip at once. This operation is especially suitable in cases where the foreign body has entered through the sclera, thus permitting removal through the original opening.

Removal by Drawing into the Anterior Chamber and Extraction.—The eye is prepared as for any eyeball operation, cocaine is instilled, and the pupil is at maximum dilatation by atropine. The patient is now seated before the magnet while the operator stands behind him with the patient's head resting on his chest. The eyelids are retracted with the fingers and a strong light is thrown on the cornea. The patient's head is slowly advanced toward the tip of the magnet, which is directed toward the centre of the cornea. When it is near enough the current is turned on; if a foreign body is present the patient usually feels a sharp pain. The iris should now be carefully watched to see if the foreign body is pushing it forward. As soon as a bulging of the iris is noticed the current is closed, as otherwise the foreing body will become entangled in the iris. The foreign body is brought into the anterior chamber by rotating the head to the side on which the body has presented. The tip of the magnet is then brought close to the opposite side of the cornea and the current turned on again. In most cases the body slips through the pupil into the anterior chamber. The current is now turned off and the body falls to the bottom. From here it is removed through the original wound if possible; if not an incision is made at a convenient site. It is then extracted with the giant or hand magnet.

If the foreign body is covered with an exudate the extraction is not so simple. Although the patient feels pain on turning on the current the foreign body does not advance. Under these circumstances Haab advises the opening and closing of the circuit several times. This often dislodges it. If this is unsuccessful the tip of the magnet is applied near the equator but never over the ciliary body, and the same maneuver is repeated. This often liberates the foreign body, and then it can be drawn into the anterior chamber by applying the magnet to the centre of the cornea. These attempts must be made on successive days if the first trial is unsuccessful. If the attempt to bring the foreign

Fig. 509

Method of using Haab's giant magnet in extracting an iron splinter from the eye. (After Haab.)

body into the anterior chamber is unsuccessful a scleral incision may be tried and the giant magnet applied to the wound or the hand magnet introduced into the vitreous.

Difficulties may sometimes arise from the foreign body becoming entangled in the iris or ciliary body. This usually occurs if the current is not turned off immediately after the iris bulges. In such cases Haab makes an incision in the limbus on the side of the foreign body and grasps the iris with the iris forceps, and pushing it toward the pupil he causes a small iridodialysis through which the foreign body is extracted with the magnet. He also advises introduction of the tip of the hand magnet through the pupil behind the iris and extraction of the foreign body in this manner.

After the foreign body has been removed both eyes are bandaged and the patient is put to bed for two days. The bandage is changed daily and atropine is instilled. The patient may get up on the third day and the bandage is left off the unoperated eye. The after-treatment of the operated eye will depend upon the reaction that follows.

Non-magnetic Foreign Bodies.—Non-magnetic foreign bodies can seldom be successfully removed. The only way to accomplish this is by introducing a pair of forceps through a scleral incision and attempting to extract the body. This is usually accompanied by loss of vitreous, and the reaction which follows is so serious that the eye is lost. For this reason it is seldom advisable to attempt to remove such a foreign body. If the eye does not tolerate it, it is better to enucleate.

The intra-ocular entozoa, of which cysticercus and hydatid cysts are the most common, may also be placed in this group. When the cyst is situated in the anterior chamber it can often be removed by simply opening the chamber, and the escaping aqueous frequently washes it out. If it is not dislodged in this way an anatomical forceps is introduced and the body is extracted. Removal of a cysticercus from the vitreous is exceedingly difficult and seldom accomplished. Subretinal cysticercus gives a somewhat better prognosis. It can be removed by a scleral incision after its position has been located with the ophthalmoscope and perimeter (see page 474). The incision is made in the manner described under the removal of foreign bodies with the hand magnet. In favorable cases the cysticercus may slip out after the scleral incision. If this does not occur the wound edges are retracted and if possible the cysticercus is grasped with the forceps and extracted. When it lies near the posterior pole a Krönlein operation must be made to permit approach to that portion of the eyeball.

Removal of Foreign Bodies from the Orbit.—Foreign bodies that have just entered the orbit and are easily accessible should be removed. Those that have already become encapsulated, if they are deeply situated and cause no disturbance, are better let alone.

If the foreign body is situated in the soft tissues, after cutting down on them, they are grasped with a forceps and drawn out. Greater difficulty is encountered when they have penetrated the bony wall. In such cases they are grasped with a strong forceps and extracted. Great care must be exercised not to break the bone and especially if situated above, not to press them deeper into the bony crevice. If the foreign body is situated deep in the orbit, behind the globe, its position should be first localized with a radiograph. For its removal a Krönlein temporary resection of the temporal wall of the orbit is often necessary.

INDEX

A

ABADIE's staphylotomy, 209
Abducens muscle, 437
Abrasion of cornea, 146
from dressings, 46
Abscess of lid, operation for, 371
of orbit, incision in, indication for, 461
ring, 58
Accommodation, effect of aphakia on, 218
of removal of lens on, 224
Adenoma of lid, operation for, 371
Advancement, capsulo-musculaire, 456
Albinism, tattooing in, indications for, 149
Aluminum cups, 50
Amblyopia, exanopsia result of cataract operation, 220
Ammon's canthoplasty, 349
operation for epicanthus, 357
Anagnostakis-Hotz's operation for cicatricial entropion and trichiasis, 332
Andrews' aluminum cup, 50
Anel's syringe, 117
Anesthesia, general, 32
administration of, 33
preparation of patient for, 33
procedure after, 39
when indicated for adults, 32
for children, 33
local, 33
agents for, 33
instillation of, 33
methods of, 33, 36, 37
procedure after, 38
subconjunctival injection of, 36
subcutaneous injection of, 37
Angelucci's method of applying fixation forceps, 93
Angioma of lid, operation for, 371
of orbit, exenteration in, indication for, 467
Aniridia, tattooing in, indications for, 149
Anisometropia after operation for myopia, 225
Anisometropia, result of cataract operation, 217
Ankyloblepharon, 357, 369
canthoplasty in, indication for, 349
symblepharon and, 405
Anophthalmos, effect of symblepharon on, 406
tarsorrhaphy in, indication for, 354
Anterior chamber of eye, 129
effect of iridectomy on, 188
evacuation of, 132
foreign body in angle of, removal of, 478
hemorrhage into, during iridectomy, 187
luxation of lens into, 221
method of entry in combined flap extraction, 264
removal of foreign bodies from, 477
Anthrax, operation for, 371
Aphakia, 127, 218
lens required for, 218
Aqueous chamber, 126, 129
humor, 129
escape of, during discission of lens capsule, 228
of cataract, 281
iridectomy, 167
in iridectomy, 188
prevention of, in extraction of lens, 235
loss of, in discission of lens with Ziegler's knife-needle, 295
Arteriosclerosis in blepharoplasty, 327
Artificial eyes, 427
method of insertion of, 429
ripening of cataract, 300
Arlt-Blaskovics' blepharoplasty for cicatricial ectropion, 319
Arlt's operation for symblepharon, 407
tenotomy of internal rectus, 441
Armamentarium, 65–108, 119–121
Asthma, contraindication for simple flap extraction, 273

Astigmatism, postoperative, 245
result of extraction of lens, 218
of intralamellar incision, 167
Atresia of lacrimal canaliculus, 377
Atrophy of eyeball, enucleation of, indications for, 422
Axenfeld wound retractors, 96
Axis of eye, 123

B

Bacteria on conjunctiva, 28
in orbit, enucleation of eyeball in, indications for, 423
Bacteriological results of examination, 28, 45
Bandages, 43, 44
application of, 44, 47
for unruly patients, 44, 45
Beer's iris spatula, 104
knife, 66
operation for staphyloma of cornea, 143
Blaskovics' canthoplasty, 352
after-treatment of, 353
method of resection of sclera, 157
modification of sphincterolysis, 209
operation for ectropion, 307
for epicanthus, 358
plasty for ectropion, 323
Blepharitis, 329
as cause of ectropion, 304
of infection, 26
Blepharophimosis, canthoplasty in, indication for, 349
entropion and, 329
Blepharoplasty, 312, 313
after-treatment of, 324
complications of, 326
in ectropion, indications for, 305
effect of systemic disease in, 327
Fricke's operation for, 315
Italian method of, 314
with non-pedunculated flaps, 327
after-treatment of, 328
Thiersch graft in, 328
Wolf graft, 327
with pedunculated flap, general rules, 314
secondary defect of, 315
Blepharorrhaphy for anthrax, 371
for ectropion, 306
Blepharospasm, canthotomy in, indication for, 348
entropion and, 329
Bowman's discission, 282
probes, 116
stop needle, 79
Bronchitis, contraindication for extraction, 252
Bronchitis, contraindication for simple flap extraction, 273
Bunge's curette, 116
Buphthalmos, 179
cyclodialysis in, indication for, 202
sclerotomy in, indications for, 190
Burrow's plasty for cicatricial ectropion, 320

C

Calcareous degeneration of lens, 226
Canaliculi, ligation of, 28
Canaliculus, dilatation of, 378
examination of, 26
lower lid, slitting of, 377
complications during operation, 380
indications for, 377, 380
probing method of, 378
Canthal ligaments, 302
Canthoplasty, Blaskovics', 352
indications in, 349
Kuhnt's, 350
Canthotomy in ectropion, indication for, 304
indications for, 348
operative procedure in, 349
Capsule forceps, manipulation of, in capsulotomy, 257
in simple flap extraction, 274
method of using, for combined linear extraction, 238
of lens, 130
Capsulo-musculaire, advancement, 456
Capsulotomy in combined flap extraction, 257
linear extraction, 237
in dislocation of lens, 266
in simple flap extraction of lens, 274
linear extraction of lens, 249
with De Wecker's pince-ciseaux, 284
Carcinoma of conjunctiva, 419
exenteration of orbit for, indication for, 467
of lid, blepharoplasty for, 317
operation for, 371
Cataracts, anterior and posterior cortical, 213
artificial ripening of, 300
calcareous, 215
classification of, 212
complicated, 220

Cataracts, complicated, ocular and systemic causes of, 220
tattooing in, indications for, 149
congenital, 219
membranous, discission in, indications for, 278
descriptions of, 212
discission in, contraindications for, 226
indications for, 226
extraction of, application of ointment after, 43
conduct of patient after, 50
detachment of choroid in, 63
Graefe's knife in, method of using, 66, 67, 68
iridectomy for, preliminary, 158
lens capsule in, 130, 131
postoperative mania in, 62
protective appliances in, 47, 48, 49, 50
syringes for use after, 118
hard, 212
hypermature, 215, 217
combined flap extraction in, indications for, 252
simple flap extraction in, contraindication for, 273
immature, 215, 300
simple flap extraction in, contraindication for, 273
incipient, 214
inflammatory process of iris after operation, 219
lamellar, 213
lens required for unequal development, 218
mature, 215
combined flap extraction, indications for, 252
simple flap extraction in, uncomplicated indication for, 273
membranous, adherent to iris, 299
artificial pupil in, 280
complications during extraction of lens, 299
discission in, contra-indications for, 278
with De Wecker's pince-ciseaux, indications for, 285
instruments for, 278
preparation for, 278
extraction of, 296
incision with Knapp's knife needle, 280
for iridocapsulotomy in, indications for, 299
operations for, 277
Cataracts, membranous, prolapse of vitreous in, 299
treatment of, after extraction, 299
Morgagnian, 215, 267
nuclear, 216
operations for, iridectomy preliminary to, 179
method testing patency of nasal duct, 380
most favorable time for, 215
place for, 18
partial and total, 213
perinuclear, 213
iridectomy for, 159
proliferation of capsular epithelium in, 219
retention of cortex in, 219
sclerosed, 216
secondary, causes of, 219
development of, 219
discission in, 281
indications for, 278
extraction of, 296
incision in, 285
operations for, 277
result of artificial ripening of cataract, 300
senile, 214
soft, 212
combined linear extraction in, indication for, 232
stationary and progressive, 212
test for functional capacity of retina and optic nerve in, 217
traumatic, 220
iridotomy as cause of, 207
unequal development in two eyes, 216, 218
Wensel-Wecker extraction of, 220
zonular, 213
Cathartics, 51
Cauterization of cornea, 146
after-treatment of, 148
indications for, 147
instruments for, 147
operative procedure in, 147
preparation for, 147
sclera, 157
Cellulitis of orbit, enucleation of eyeball in, indications for, 420
retrobulbar, incision of orbit in, indication for, 461
Celsus-Knapp's blepharoplasty, 322
instruments for, 322
Celsus operation for entropion and trichiasis, 331
Chalazion, operation for, 369
Choroiditis as cause of complicated cataract, 220
therapeutic injections for, 418
Choroid, 126

Choroid, detachment of, after combined flap extraction, 273
postoperative, 63
Ciliary body, 126
puncture of, in discission of lens, 295
tuberculous growth of, enucleation of eyeball in, indications for, 421
margin, 126
Cocaine, disadvantages of, 35
effect of anesthesia by, 34
method of sterilization of, 31
novocaine as substitute for, 38
poisoning, symptoms of, 36
treatment for, 37
postoperative effect of, on eyelids, 42-46
℞ for sterilizing, 31
℞ for subconjunctival injections, 38
Coloboma of eyelid, congenital, 368
traumatic, 368
Wicherkiewicz plasty for, 369
of iris, preferable site for, 159
Leber's method of, 210
making a bridge in, 169
position of, for perinuclear cataract, 214
replacing of pillars in, 185
tearing of iris in, 187
Concomitant strabismus, 437
Conjunctiva, 302
bacteria on, 28
bulbar, expression of, for trachoma, 397
injection of, 36
carcinoma of, 419
as cause of infection, 28
cysts of, 419
dermoids of, 419
diseased, extraction of lens in, contraindication for, 252
effect of antiseptic dressings on, 45
examination of, previous to operation, 28
excision of fornix of, 400
foreign body in, removal of, 469
friability of, 264
hypertrophied, 304
incision in, for tenotomy, 442
irrigating of, 39
lipoma of, 419
operations on, 396
minor, 418
pemphigus of, 405
polyps of, 419
pseudopterygium, 418
pterygium of, Desmarres' operation for, 415, 416
MacReynolds' operation for, 417
Conjunctiva, pterygium of, operations for, 414
sarcoma of, 419
shrinking of, in entropion, 340
subconjunctival injections into, 418
suturing of, in tenotomy, 445
symblepharon of, Arlt's operation for, 407
Czermak's operation for, 408
Harlan's operation for, 411
Knapp's operation for, 409
May-Hotz's operation for, 412
operations for, 405
Taylor's pedunculated skin flaps for, 410
Rogman's operation for, 411
Teale's operation for, 409
Weeks' operation for, 412
Wolf's operation for, 410
trachoma of, combined excision of fornix and tarsus for, 401
operations for, 396
tumors of, 419
Conjunctival keratoplasty, 140
indications for, 140
procedure in, 140-142
membrane, 123
sac, treatment of, after operation, 42
Conjunctivitis, catarrhal, ectropion and, 304
gonorrheal, canthotomy in, indication for, 348
staphyloma of cornea as cause of, 142
Convergent strabismus, 437
Cornea, 125
abrasion of, 146
cauterization of, indications for, 147
postoperative, complicating tenotomy, 447
for removal of foreign bodies, 146
adherent scar of, enucleation of eyeball in, indications for, 421
cauterization of, 146
after-treatment of, 148
instruments for, 147
operative procedure in, 147
preparation for, 147
collapse of, in combined flap extraction, 265
during iridectomy, 188
cystoid scar of, cauterization of, indications for, 147
ectasia of, cauterization for, 147
effect of injuries on, 125
extracting foreign body from, 125
fistula of, cauterization of, indications for, 147

Cornea, fistula of, conjunctival keratoplasty for, 140
iridectomy in, indications for, 178
foreign bodies in deep layers of, 471
partially in anterior chamber, 472
removal of, from surface, 470
incision of, in De Wecker's discission, 285
infiltration of, cauterization of, indications for, 147
iridotomy for opacities of, 205
keratoplasty for opaque tissue, 136
macula of, tattooing in, indications for, 149
marantic ulcer of, enucleation of eyeball in, indications for, 422
paracentesis of, 132
after discission of cataract, 282
for rupture of wound in combined flap extraction of lens, 272
staphyloma of, 142
ablation in, 142
Beer's operation for, 143
conjunctivitis as cause of, 142
Czermak's operation for, 146
De Wecker's operation for, 146
enucleation in, 143
glaucoma as cause of, 142
hemorrhage in, 143
iridectomy in, 143
iridocyclitis as cause of, 142
Knapp's operation for, 145
lagophthalmos and, 142
suturing of, 150
operative procedure in, 151
tattooing of, after-treatment of, 150
contraindications for, 149
indications for, 149
instruments for, 149
operative procedure in, 149
panophthalmitis and, 149
preparation for, 149
trephining of, 137
tumor of, cauterization of, indication for, 147
ulcer of, cauterization of, indications for, 147
infected, extirpation of lacrimal sac for, 391
serpiginous, 135
sluggish, keratoplasty for, 140
Cornea, ulcer of, therapeutic injections for, 418
Corneal flap, replacing of, after prolapse of vitreous, 271
ulcer, paracentesis for, 133
Cyclitis, 126
Cyclodialysis, after-treatment of, 203
complications of, during operation, 203
definition of, 201
for glaucoma, 62
Heine, 189
method, 201
indications for, 201
instruments for, 202
operative procedure in, 202
preparation for, 202
Cyst of conjunctiva, 419
Cysticercus, intra-ocular, enucleation of eyeball in, indication for, 422
paracentesis for removal of, 133
subretinal, removal of, 483
in vitreous, removal of, 483
Cystoid scar, 54
after combined flap extraction, 273
conjunctival keratoplasty for, 140
on cornea, cauterization of, indications for, 147
Cystotome in combined flap extraction, manipulation of, 261
method of incision with, 237
Cysts, hydatid, removal of, 483
Czermak on cyclodialysis, 201
on effect of pilocarpine after iridectomy, 188
method of delivering dislocated lens, 267
of tattooing cornea, 150
of operation for staphyloma of cornea, 146
operation for symblepharon, 408
on resection of sclera, 157
on symptoms of glaucoma, 62

D

Dacryocystitis, 373
acute, incision of lacrimal sac in, 389
canaliculus of, slitting of, indications for, 377
as cause of infection, 27
conjunctival keratoplasty for, 140
extraction of lens in, contra-indications for, 252
probing nasal duct in, indication for, 382

Dacryops of lacrimal gland, extirpation for, indication for, 374
Darier treatment for infection, 58, 59
Daviel's spoon, 101
in expression of lens, manipulation of, 262, 275
method of using, 241
Dermoids of conjunctiva, 419
Desmarres' lid clamp, 114
retractors, 107, 108, 111
operation for pterygium, 415
Detachment of retina, Müller's method of resection for, 156
paracentesis for, 154
Deutschmann's operation for detachment of retina, 156
De Wecker on extirpation of accessory lacrimal gland, 374
De Wecker's anterior sclerotomy, 189
capsulotomy, indications for, 282
discission with pince-ciseaux, 284
folding operation, 456
complications during, 457
postoperative, 458
iritomy, 209
method of cauterization of sclera, 157
operation for staphyloma of cornea, 146
pince-ciseaux, 84
manipulation in incision of membrane, 287
tattooing needle, 79
Diabetes in blepharoplasty, 327
as cause of complicated cataract, 220
as contraindication for extraction, 252
Dieffenbach's operation for cicatricial ectropion, 312, 317
Diet before and after operation, 51
Dimmer's method of tattooing cornea, 150
Diplopia after operation for ptosis, 359
postoperative, complicating, tenotomy, 448
result of, cataract operation, 217
of symblepharon, 405
symptom of subluxation of lens, 222
Discission, Bowman's, 282
in cataracts, contraindications for, 278
De Wecker's pince-ciseaux, 284
after-treatment of, 290
complications during operation, 290
Discission in cataracts, De Wecker's pince-ciseaux, contraindications, 285
incision of cornea in, 285
of membrane in, 287
indications, 285
instruments for, 285
operative procedure in, 285
postoperative complication of, 290
preparation for, 285
indications for, 278
instruments for, 278
with Knapp's knife needle in, manipulation of, 278
operative procedure, 278
preparation for, 278
indications for, 219
with Knapp knife needle, definition of, 278
incision in, membranous cataract, 280
Kuhnt's, 283
of lens capsule, 226
after-treatment of, 229
complications during operation, 228
contraindications for, 226
indications for, 226
instruments for, 226
postoperative complications in, 229
with Ziegler's knife needle, 292
after-treatment of, 295
complications during operation, 294
instruments for, 293
operative procedure in, 293
postoperative complications of, 295
preparation for, 293
in secondary cataract, 281
Donder's table changing perimeter degrees to globe millimeters, 474
Dressings, 43, 44

Dressings in eyeball operations, antiseptic, 45
aseptic, 46
Knapp's, 46
sterilization of, 30
Durr's keratoplasty, 139

E

Ectasia of eyeball, ectropion and, 303
keratoplasty for, 136
Ectatic scar, 54
effects of, 207
in glaucoma, 178
Ectropion, canthotomy in, indication for, 348
cicatricial, 305
blepharoplasty, 313
Arlt-Blaskovics', 319
Celsus-Knapp's, 322
complications after, 326
Dieffenbach's, 312, 317
indications for, 305
Italian method, 314
rules for, 314
treatment after, 324
with non-pedunculated flaps, 327
Burrow's plasty, 320
Frick's operation, 315
Landolt's plasty for, 321
operations for, 311
skin grafting for, 327
subcutaneous section of scar in, 312
Thiersch graft in, 328
Wharton-Jones' operation for 313
Wolf graft in, 327
intermediary, 304
luxuriant, 304
mechanical, 303
non-cicatricial, 304
Blaskovics' operation for, 307
blepharorrhaphy in, 306
Elschnig's operation for, 309
Kuhnt's operation for, 308
Sattler-Blaskovics' operation for, 310
Snellen's ligature in, 305
Szymanowski's operation for, 307
tarsorrhaphy in, 306
operations for, 303
paralytic, 304
senile, 304
spastic, 304
tarsorrhaphy in, indication for, 354
Eczema of lid, ectropion and, 305
Electrolysis for partial trichiasis, 342
Elliot's trephining of sclera, 189, 204
Elschnig's operation for ectropion, 309
for fistula of lacrimal sac, 395
Emmetropia after removal of lens, 224
lens for aphakic eye, 218
Enophthalmos, entropion and, 329
Entropion, cicatricial, Jaesche-Arlt's operation for, 333
Kuhnt's tarsectomy for, 340
Machek-Blaskovics' operation for, 335
Panas' operation for, 339
Snellen's operation for, 337
trichiasis and, operations for, 332
of lower lid, Flarer's operation for, 344
Kuhnt's tarsectomy for, 345
operations for, 344
Ziegler's galvanocautery puncture for, 347
spastic, 329
Celsus operation for, 331
Gaillard-Arlt's ligature for, 330
trichiasis and, 329
types of, 329
Enucleation of eyeball, 420
canthotomy before, 348
in chronic glaucoma, indications for, 187
complications of, during operation, 426
postoperative, 427
luxation of lens in, indication for, 222
operations substituted for, 432
operative procedure in, 423
opticociliary neurectomy substitute for, 433
preparation for, 423
transplantation of fat in Tenon's capsule, 430
during resection of orbital wall, indications for, 463
of phthisis bulbi, indication for, 60
in staphyloma of cornea, indications for, 143
Epicanthus, Ammon's operation for, 357
Blaskovics' operation for, 358
operations for, 356
Epilation for partial trichiasis, 342
Epiphora, 304, 373, 374
indication for probing nasal duct, 382

Esophoria, 440
Evacuation of anterior chamber, operative procedure in, 134
Eversbusch operation for carcinoma of lid, 317
for iris cyst, 211
for ptosis, 366
Exenteration of eyeball, 432
after-treatment of, 433
of orbit, 467
canthotomy preliminary to, 348
Exophoria, 440
Exophthalmos, postoperative, complicating tenotomy, 447
tarsorrhaphy in, indication for, 354
Expression of lens in combined linear extraction, 241
Extirpation of accessory lacrimal gland, 374
of lacrimal sac, 390
complications of, 393
postoperative, 394
of orbital gland, 375
Extraction of lens, 230
combined flap, advantages of, 232
after-treatment of, 271
air bubble in chamber, 265
capsule forceps in, 257, 261
capsulotomy in, 257
collapse of cornea in, 265
complications during operation, 264
postoperative, 272
contraindications for, 252
cystoid scar after, 273
Czermak's method of delivery, of dislocated lens, 267
Daviel spoon, 262
definition of, 252
detachment of choroid after, 273
retina after, 273
disadvantages of, 232
dislocation of lens in, 266
in vitreous 267
Extraction of lens, combined flap, expression of lens in, 262
expulsive hemorrhage in, 270
failure of lens to present in wound, 266
friability of conjunctiva, 264
glaucoma after, 273
incision in, 254
intralamellar, 264
indications for, 252
instruments for, 252
injury of iris in, 264
iridectomy in, 255
iridodialysis in, 265
Knapp's method of delivering dislocated lens, 267
operative procedure in, 253
postoperative infection in, 273
preparation for, 252
prolapse of vitreous after, 269
rupture of wound after, 272
striated keratitis after, 272
toilet in, 262
too short incision, 265
linear, 232
after-treatment of, 248
atrophy and friability of iris, 246
capsule forceps in, 238
capsulotomy in, 237
contraindications for, 233
cystotome in, 237
Daviel spoon in, 241
expression of lens in, 237
incision in, 233
indications for, 232
injury of iris in, 245
instruments for, 233
iridectomy in, 235
keratome in, 233
posterior synechia in, 237
postoperative astigmatism, 245

Extraction of lens, combined linear, postoperative, complications of, 248
preparation for, 233
prolapse of vitreous in, 246
sclerosis of lens in, 246
toilet in, 237
linear and simple, 231
after-treatment of, 299
complications of, during operation, 299
postoperative, 299
contraindications for, 296
definition of, 296
indications for, 296
instruments for, 296
operative procedure in, 296
preparation for, 296
lobular wound in, 231
operative procedure for, 233
simple, disadvantages of, 231
flap, after-treatment of, 277, 282
appearance of iris in wound after, 276
capsule forceps in, 274
capsulotomy in, 274
complications during operation, 276, 281
contra-indications for, 273
Daviel spoons in, 275
definition of, 273
dense fibers complication during discission, 282
expression in, 275
incision in, 274
indications for, 273
instruments for, 274
irrigation of, anterior chamber in, 275
operative procedure in, 274
postoperative complications of, 277, 282
preparation for, 274
removal of knife-needle, 281
Extraction of lens, simple flap, toilet in, 276
linear, 248
capsulotomy in, 249
complications during operation, 251
expression of, 250
incision in, 249
indications and contraindications, 248
instruments for, 248
postoperative complications, 252
preparations, 248
toilet in, 251
Eyeball, atrophy of, enucleation of, indications for, 422
ectatic, enucleation of, indications for, 422
effect of cicatricial ectropion on, 305
enucleation of, 420
artificial eyes in, 427
complications of, during operation, 426
postoperative, 427
indications for, 422
operative procedure in, 423
preparation for operation of, 423
substitutes for, 432
transplantation of fat in Tenon's capsule, 430
evacuation of, result of cataract operation, 222
exenteration of, 432
fibrous coat of, 123
foreign body in, enucleation of, indications for, 421
removal of, 472
malignant tumors of, 420
method of irrigating conjunctival sac, 39
operation, closing of lids in, 46
detachment of choroid in, 63
dressing of, after operation, 45
extirpation of lacrimal sac preliminary to, 391
opticociliary neurectomy, 433
postoperative complications in, 53
procedure after operation, 42
retraction of eyelids in, 107, 113
speculum in, 108
penetrating injuries of, 421
prominent, contraindication of simple flap extraction, 273

Eyeball, shrinkage of, 131
  wound of, prevention of adhesion to lid in, 406
Eyelids, abscess of, operation for, 371
  adenoma of, operation for, 371
  angioma of, operation for, 371
  ankyloblepharon of, 369
  anthrax of, operation for, 371
  carcinoma of, operation for, 371
  chalazion of, operation for, 369
  cleansing of, 32
  coloboma of, 368
  destruction of, enucleation of eyeball in, indication for, 422
  examination of, 26
  foreign body in, removal of, 469
  furuncle of, operation for, 371
  hordeolum of, operation for, 371
  injuries to, 368
  muscles of, 302
  nevus of, operation for, 371
  operations on, 302
    after-treatment of, 50
    dressing of, after operation, 44, 50
    entropion and trichiasis of lower lid, 344
    horn plate in, 105
    keratome in, method of using, 77
    minor, 368
    postoperative complications in, 53
    procedure after operation, 42
  papilloma of, operation for, 371
  plasties of, after-treatment of, 324
    complications of, 326
  sarcoma of, operation for, 371
  skin grafting for, 327
  surgical anatomy of, 302
  symblepharon of, 369
  tumors of, operation for, 371
  warts of, operation for, 371
  wound of, prevention of adhesion to eyeball in, 406
  xanthelasma of, operation for, 371

F

Fascia, tarso-orbital, 302
Fibers, dense, complicating discission of cataract, 282
Fistula of cornea, cauterization of, indications for, 147
    conjunctival keratoplasty, for, 140
    iridectomy for, 178
  of lacrimal gland, extirpation in, indication for, 374
    sac, 395
Flaps, mucous membrane, pedunculated or non-pedunculated, 409
  skin, pedunculated or non-pedunculated for symblepharon, 409
Flarer's operation for entropion and trichiasis of lower lid, 344
Fontana, spaces of, 128
Foerster's maturation, 300
Forceps, 85 to 96
  fixation, application of, 91
    Angelucci's, 93
Foreign bodies in angle of anterior chamber, removal of, 478
  in anterior chamber, removal from, 134, 472
  in conjunctiva, removal from, 469
  in cornea, in deep layers of, 471
    removal from surface of, 470
  in eyeball, enucleation in, indications for, 421
    localization of, 473
    removal from, 472
  in eyelid, removal from, 469
  free, from cornea, removal of, 478
  intra-ocular, removal through sclera, 480
    use of giant magnet for, 475
    use of perimeter for, 474
    use of sideroscope for, 475
    use of x-rays for, 475
  of iris, 179
    removal from, 478
  in lacrimal apparatus, removal from, 469
  on lens capsule, removal from, 478
  magnetic, removal of, from eyeball, 477, 479, 481
  non-magnetic, removal of, from eyeball, 478, 479, 483
  in orbit, incision in, indication for, 462
    removal of, 484
  in posterior chamber, removal from, 479
  removal of, and results, 476
  in sclera, removal from, 472
  in retina, removal from, 479
  in vitreous chamber, removal from, 479
Fornix, excision of, 400
  and tarsus, combined excision of, 401
Fossa patellaris, 130
Fovea centralis, 128

Frick's blepharoplasty, 315
Fuch's mask, 47, 48
 tarsorrhaphy, 355
 transilluminator, 20
Furuncle of lid, operation for, 371

G

Gaillard-Arlt ligature for entropion, 330
Galvanocautery, use of, in eye examination, 28
 Ziegler's puncture, 347
Gerson method of sterilization, 18
Glaucoma, absolute, 171
 inflammatory, 179
 enucleation of eyeball in, indications for, 422
 sclerotomy in, indications for, 190
 posterior, indications for, 193
 acute, anesthetic effect cocaine in, 35
 contraindication for extraction, 252
 sclerotomy, posterior in, indications for, 193
 in aphakic eyes, sclerotomy in, indications for, 190
 after cataract extraction, 60
 as cause of complicated cataract, 220
 chronic, sclerotomy indications for, 190
 posterior, indications for, 193
 cyclodialysis for, 62
 indications for, 176, 201
 cystoid scar, effect of, 195
 ectatic scar, 54
 examination of, with perimeter, 172
 with tonometer, 173
 excision of root of iris, 129
 hemorrhage in, after iridectomy, 185
 expulsive, 187
 hemorrhagic, 179
 sclerotomy in, indications for, 190
 posterior, indications for, 194
 inflammatory, acute, 170, 174
 chronic, 171
 iridectomy for, 172
 effect of, 126, 176, 189
 treatment of, 188
 iridotomy for, 101
 juvenile, sclerotomy in, indications for, 190
Glaucoma, malignant, 187, 189
 paracentesis in, indications for, 132, 175
 postoperative, 55
 complication of, 60
 of combined flap extraction, 273
 on extraction of lens, 232
 primary, 170
 after iridectomy, treatment of, 188
 treatment of, 172
 prodromal stage of, 170
 relapsing, sclerotomy in, indications for, 190
 result of injury to ciliary body, 295
 retinal hemorrhage in, 187
 sclerotomy for, 62
 anterior, indications for, 176
 posterior, indications for, 175
 secondary, 178
 due to ectatic scar, 178, 179
 subluxation of lens, 178
 Kuhnt's keratoplasty in, indications for, 178
 paracentesis in, indications for, 132
 postoperative complication in discission, 229
 result of artificial ripening of cataract, 300
 sclerotomy in, indications for, 190
 seclusion of pupil in, 178
 symptoms of, in discission, 229
 in subluxation of lens, 222
 simple, 172
 cyclodialysis in, indication for, 202
 staphyloma of cornea as cause of, 142
 symptoms of, 61
 treatment of, 61
 trephining in, effect of, 177
Glioma, exenteration of orbit for, indication for, 467
 of retina, enucleation of eyeball in, indications for, 420
Globe, contents of, 128
 enucleation of eyeball, indications for, 420
 malignant tumors of eyeball, 420
 operations on, 420
 opticociliary neurectomy in, 433
 transplantation of fat in Tenon's capsule, 430

Graefe's cystotome, 99
fixation forceps, 91
knife, 66, 67
spoon, 103
strabismus hook, 101
Grafting of skin for cicatricial ectropion, 327
Granulation tissue, 304
exuberant, postoperative, complicating tenotomy, 447

H

Haab's giant magnet, 117, 119
Harlan's operation for symblepharon, 411
Heine's cyclodialysis, 189, 201
theory of cyclodialysis, 201, 204
Hemorrhage after iridectomy, 185
after tenotomy, 446
complicating anterior sclerotomy, 193
De Wecker's folding operation, 457
sclerectomy, 200
during discission of cataract, 282
enucleation eyeball, 427
extirpation of lacrimal sac, 393
iridectomy, 187
expulsive, 56
complicating combined flap extraction, 270
of eyeball, 420
in iridectomy, 187
in staphyloma of cornea, 143
of orbit, incision in, indication for, 462
retinal, 187
stopping of, 187
subconjunctival, 56
Hemorrhagic glaucoma, 179
Hess' operation for ptosis, 361
Heterophoria, 449
examination for result of operation of, 448
Hirschberg's electromagnet, 119
formula for refraction after removal of lens, 224
method of removing foreign body from eyeball, 480
photophore, 20
Holocaine hydrochloride, 35, 36
Hordeola as cause of infection, 26
Hordeolum, operation for, 371
Hyaloid membrane, 131
rupture of, during iridectomy, 188
Hypermetropia after removal of lens, 224
Hypermetropia, lens for aphakic eye, 218
Hyperphoria, 440
Hyphema, paracentesis in, indications for, 132
Hypopyon, postoperative complication, 58
Hypotony, contraindication for discission, 285

I

Imre's double hook, 97
Infection, ablation of staphyloma of cornea and, 144
of wound, symptoms of, 57
Injections, subconjunctival, 418
therapeutic, of conjunctiva, 418
Insanity, postoperative, combined flap extraction and, 273
Intermarginal line of eyelids, 302
Intralamellar incision, 75, 125, 244
complication in combined flap extraction, 264
during iridectomy, 166
Intra-ocular cysticercus, enucleation of eyeball in, indication for, 422
entozoa, removal of, 483
infection, 57
pressure, 55, 129
after extraction of lens, 231
result of, in iridectomy, 187
Iridectomy, 129
after discission of cataract, 282
after-treatment of, 169, 188
for buphthalmos, 179
for chronic iritis, 178
collapse of cornea in, 188
in combined flap extraction, 255
linear extraction, 237
complications during, 166, 186
postoperative, 169, 188
contraindications for, 179, 201
for ectatic scar of cornea, 208
excision of iris in, 162, 182
for fistula of cornea, 178
for foreign body in iris, 179
for glaucoma, 172
hemorrhage in, 187
instruments for, 180
for iridochoroiditis, 178
for iridocyclitis, 178
for keratoconus, 147
large, indications for, 169
for luxation of lens, 187
operative complication in, escape of aqueous, 167
injury to iris, 168
prolapse of iris, 168
procedure in, 180
for perinuclear cataract, 214

Iridectomy, preliminary to cataract operation, 179
preparation for operation, 180
prolapse of vitreous in, 188
purposes of, 158
replacing pillars of coloboma, 185,
rupture of hyaloid membrane in, 188
of zonule in, 188
in sclerecto-iridectomy, 200
sclerotomy, posterior, after, indications for, 193
simple linear extraction in, 251
small, contraindications for, 159
incision in, 159
indications for, 158
instruments for, 159
operative procedure in, 159
preparation for, 159
in staphyloma of cornea, indications for, 143
substitutes for, 189
synechia contraindication, 187
toilet, 165
after operation, 185
for tumor of iris, 179
Weber's method replacing lens in, 187
Iridocapsulotomy, 219
indications for, in membranous cataract extraction, 299
with De Wecker's pince ciseaux, 284
Iridochoroiditis, 178
Iridochoroiditis, symptoms of, 59
treatment of, 59
Iridocyclitis, 178
after ablation of staphyloma of cornea, 143
anterior synechia as cause of, 207
chronic, enucleation of eyeball in, indications for, 421, 422
combined flap extraction, 273
paracentesis to reduce tension in, 132
postoperative complication in, 56, 58
discission of cataract, 282
result of foreign body in eyeball, 473
of intra-ocular foreign body, 476
of lens in vitreous, 222
staphyloma of cornea as cause of, 142
symptoms of, 59
tattooing in, cause of, 149
therapeutic injections for, 418
treatment of, 59
Iridodialysis, complicating discission of lens capsule, 229
Iridodialysis, complication in combined flap extraction, 265
during iridectomy, 168
Lang's, 209
Iridodonesis, 127
symptom of subluxation of lens, 222
Iridorrhexis, 187
Iridotomy, after-treatment of, 207
complications during operation, 207
in eyes with lens, 205
indications for, 205
instruments for, 206
operative procedure in, 206
preparation for, 206
subluxation of cataractous lens in, 206
traumatic cataract, cause of, 207
with De Wecker's pince-ciseaux, 284
Iris, 126
Abadie's staphylotomy of, 209
adherence of, to membranous cataract, 285, 299
anesthetization of, 35
angle, 127
anterior synechia of, 207
appearance in wound after simple flap extraction of lens, 275
atrophic, in cyclodialysis, effect of, 203
atrophy and friability of, 246
capsulotomy with De Wecker's pince ciseaux, 284
cyst of, Eversbusch's operation for, 211
injury of, during discission of cataract, 281
excision of, 182
failure to retract, in discission of lens with Ziegler's knife-needle, 294
foreign bodies in, 179
iridectomy for, 175
removal from, 478
infection from, symptoms of, 58
treatment for, 59
injury of, complication in combined flap extraction, 264
during anterior sclerotomy, 193
extraction of lens, 245
iridectomy, 168
simple linear extraction, 251
iridocapsulotomy with De Wecker's pince-ciseaux, 284
iridocystectomy, 295
iridolysis for, 209
iridotomy, 205

Iris iridotomy with De Wecker's pince-ciseaux, 284
iritodialysis, 284
in combined flap extraction, 265
iritoectomy, 284
iritomy, 209
postoperative infection from, 58
prolapse of, 210
after keratotomy, 136
after simple extraction of lens, 232
cauterization of, indications for, 147
complicating combined flap extraction, 268
discission of lens capsule, 229
sclerotomy, 193
simple flap extraction of lens, 277
during iridectomy, 168
simple linear extraction, 251
excision of, after simple flap extraction of lens, 277
paracentesis as prevention of, 133
removal of foreign body from, 477
replacing pillars of coloboma, 185
sarcoma of, enucleation of eyeball in, indication for, 420
Schulek's sphincterotomy, 208
sphincterolysis, Schulek's, 208
tearing of, during iridectomy, 187
tubercular growth of, enucleation of eyeball in, indications for, 421
tumors of, 179
iridectomy for, 179
wedging of, in scleral wound, 193
Iritis, after combined extraction of lens, 232
chronic, iridectomy for, 178
relapsing, 178
postoperative complication in, 56
result of operative trauma, 290
traumatic, cataract operation as cause of, 215
complicating discission of lens, 229
Iritodialysis, 284, 290, 292
hemorrhage in, 292
Iritoectomy, 284, 290
with Graefe knife, 291
with keratome, 290
Iritomy, De Wecker's, 209
for glaucoma, 61
Irrigation, 39
Italian method of blepharoplasty, 314

J

Jaeger's horn plate, 105
sharp iris hook, 101
Jaesche-Arlt's operation for cicatricial entropion and trichiasis, 333
entropion and trichiasis of lower lid, contraindication for, 344

K

Keratitis dendritic, abrasion of cornea for, 146
phlyctenular, ectropion and, 304
striated, after combined flap extraction, 272
Keratoconus, cauterization of, indications for, 147
as indication for iridectomy, 158
tattooing in, indications for, 149
Keratomes, 69, 70–76
in De Wecker's discission, 287
method of incision with, 233
wound in lens extraction, 230
Keratoplasty, after-treatment of, 138
complete, 136, 137
complications during operation, 138
postoperative, 139
conjunctival, 140
procedure in, 140–142
contraindications for, 137
corneal, 136
dissecting opaque flap in, 138
Durr's, 139
in glaucoma, indications for, 178
incomplete, 136, 137
partial, 137
indications for, 137
instruments for, 137
operative procedure in, 137
placing flap in position in, 138
preparation for, 137
trephining foreign eye in, 138
Von Hippel's incomplete, 137
Keratotomy, Saemisch's, 132
Knapp dressings, 46
on removal of foreign bodies from lens capsule, 478
on symptoms of glaucoma, 62
Knapp's expression with roller forceps for trachoma, 397
iridocystectomy, 295
knife-needle, 77
in discission of cataract, manipulation of, 278
lacrimal syringe, 117
lid clamps, 114

Knapp's method of delivering dislocated lens, 267
of discission for secondary cataract, 281
severing optic nerve in enucleation of eyeball, 426
of using cystotome, 237, 262
needle cystotome, 80
holder, 116
operation for pterygium, 416
for staphyloma of cornea, 145
for symblepharon, 409
roller forceps, 93
suture of conjunctiva in tenotomy, 445
Koster's operation for ptosis, 361
Krönlein's temporary resection of external orbital wall, 463
Kuhnt's canthoplasty, 350
operative procedure in, 351
conjunctival keratoplasty, 140, 141
discission, 283
expression for trachoma, 94, 398
knife-needle, 78
in discission, manipulation of, 283
operation for ectropion, 308
tarsectomy for entropion and trichiasis, 340
on the lower lid, 345
treatment for infection, 58

L

Lacrimal apparatus, disorders of, ectropion and, 304
dressing of, after operation, 44, 50
examination of, 26
foreign body in, removal of, 469
postoperative treatment of, 50
canaliculi, surgical anatomy of, 372
duct, syringing of, 27
gland, accessory, extirpation of, 374
extirpation of, indications for, 374
operations on, 374
orbital, extirpation of, 375
surgical anatomy of, 372
organs, surgical anatomy of, 372
passages, atresia of lacrimal canaliculus, 377
canaliculus of, lower lid, slitting of, 377
Lacrimal passages, complications during extipation of sac, 393
probing nasal duct, 384
dilatation of canaliculus, 378
eversion of punctum, 377
extirpation of lacrimal sac, 390
fistula of lacrimal sac, 395
incision of lacrimal sac, 389
obstruction of, 373
operations on, 377
probing canaliculus, 378
nasal duct, 381
method of, 385
surgical anatomy of, 372
syringing duct, 379
testing patency of nasal duct, 380
Toti's operation on nasal duct, 386
puncta, 372
eversion of, 377
sac, extirpation of, complications of, 393
postoperative, 394
hemorrhage during, 393
for trachoma, 391
for ulcer of cornea, 391
fistula of, 395
Lagophthalmos after combined excision of fornix and tarsus, 402
after operation for ptosis, 359
enucleation of eyeball in, indications for, 422
result of ectropion, 305
staphyloma of cornea, 142
tarsorrhaphy in, indications for, 354
Lagrange's sclerectomy, sclerecto-iridectomy, 189, 195
Lamina cribrosa, 124
Landolt's advancement, 450
plasty for cicatricial ectropion, 321
Lang's iridolysis, 209
Leber's operation for excision of prolapse of iris, 210
Lens, 130
aphakia of, 218
artificial ripening of, 300
capsule, discission of, 131, 226
after-treatment of, 229
contraindications, 226
ciseaux, 284
indications for, 226
postoperative complications in, 229
with De Wecker's pince-
with Ziegler's knife-needle, 292

Lens, capsule, injury to, 169
removal of foreign body, from, 478
cataracts of, description of, 212
contraindications for removal of, in myopia, 224
cortex, 131
nucleus and, 212
dislocated, delivery of, Czermak's method, 267
Knapp's method, 267
dislocation of, in combined flap extraction, 266
in vitreous, in combined flap extraction, 267
escape of, paracentesis to prevent, 133
expulsion of, in operation for staphyloma of cornea, 143
expression of, 250
extraction of, 230
combined flap, 252
after-treatment of, 271
capsulotomy in, 257
collapse of cornea in, 265
complications, 264
postoperative, 272
contraindications for, 252
cystoid scar after, 273
detachment of choroid after, 273
of retina after, 273
dislocation of lens in, 266
expression in, 262
expulsive hemorrhage in, 270
failure to present in wound, 266
glaucoma after, 273
incision in, 254
indications for, 252
injury of iris in, 264
instruments for, 252
iridectomy in, 255
iridodialysis in, 265
operative procedure in, 253
preparation for, 252
prolapse of vitreous in, 268
rupture of wound after, 272
striated keratitis after, 272
toilet in, 262
Lens, extraction of, combined linear, 232
after-treatment of, 248
and simple, 231
astigmatism after, 245
capsulotomy in, 237
contraindications for, 232
expression in, 241
incision in, 233
indications for, 232
injury of iris in, 245
instruments for, 233
iridectomy in, 235
postoperative complications of, 248
preparation for, 233
prolapse of vitreous in, 246
toilet in, 237
in membranous cataract, 297
operative procedure for, 233
simple flap, 273
after-treatment of, 277
capsulotomy in, 274
contraindications for, 273
expression in, 275
incision in, 274
indications for, 273
instruments for, 274
operative procedure in, 274
preparation for, 274
toilet in, 276
linear, 248
capsulotomy in, 249
complications, 251
postoperative, 252
contraindications for, 248
expression in, 250
incision in, 249
indications for, 248
toilet in, 251
keratome wound in, 230
linear wound in, 230
lobular wound in extraction of, 231
luxated and subluxated, 252
luxation of, 127, 187, 221
into anterior chamber, 221
discission in, contraindication for, 226
enucleation of eyeball in, indications for, 422
into vitreous, 222
subconjunctival, 221

Lens, massage of, for artificial ripening cataract, 301
nucleus, 131
operations on, 212
outriders of, 212
pathological conditions of, 212
prolapse of, complication after keratotomy, 136
removal of foreign body from, 478
indications for, 214
in myopia, effect of, 223
indications for, 225
replacing of, Weber's method, 187
sclerosed, 252
sclerosis of, 131, 212
complicating extraction of lens, 246
subluxation of, 206, 221, 222
effect of, in glaucoma, 178
substance, 130
Leukoma, adherent, tattooing in, contraindications for, 149
keratoplasty for, 136
partial, incomplete, 137
tattooing in, indications for, 149
Levator muscle of eyelid, 302
Ligation of canaliculi, 28
Lighting, Fuchs' transilluminator, 20
illuminating field with hand lens, 21
operating room, 19
Priestley-Smith's photophore, 20
Limbus, 125
Linear extraction, definition of, 296
wound of lens, 230
Lipoma of conjunctiva, 419
Lobular wound in extraction of lens, 231
Luxation of lens, 187

M

Machek-Blaskovics' operation for entropion and trichiasis, 335
of lower lid, contraindication, 344
MacKenzies' posterior sclerotomy, 189
MacReynolds' operation for pterygium, 417
Macula lutea, 128
Magnet, giant, locating intra-ocular foreign body, use of, 475
removal of foreign body through sclera by, 481
Magnetic removal of foreign bodies from eyeball, 477, 479
Mania, postoperative, 62
treatment of, 63
May-Hotz operation for symblepharon, 412
Meibomian glands, as cause of infection, 29
Mellinger on glaucoma, 61
Mellinger's lid retractor, 107
Metamorphopsia, 219
Meyhöfer's curettes, 115
Motais' operation for ptosis, 364
Mucous membrane, epithelial agglutination of, 385
polypoid degeneration of, 382
Müller's capsule forceps, 90
method for resection of sclera, 156
muscle of eyelid, 303
speculum, 97
Muscles of eye, advancement of, 449
dilator, 127
examination of, to determine degree of squint, 438
strength of, 438
folding operation to strengthen, 450
Landolt's advancement, 450
linear measurement of, lateral excursions of eye, 438
operations upon, 436
to strengthen, 448
to weaken, 440
resection of, 449
Reese's, 454
surgical anatomy of, 435
tenotomy of, 440
indications, satisfactory results of, 445
of internal rectus of, 441
Worth's advancement in, 452
Muscles of eyelids, 302
sphincter, 127
Museux forceps, 95
Myopia, 223
in aphakic eye, 218
indication for, 233
contraindications for removal of lens in, 224, 225
disadvantages of strong concave glasses in, 223
discission in, indication for, 226
formula for refraction after removal of lens, 224
high, combined linear extraction, removal of lens in, indications for, 223, 224, 225

N

Nasal duct, cicatricial stricture of, 385
complications during probing of, 384

Nasal duct, examination of, 26
probing of, 381
contraindications for, 382
systematic, 385, 391
unsatisfactory results of, 386
stricture of, 382
surgical anatomy of, 373
testing patency of, 380
Toti's operation on, 386
treatment after, 389
Needles, sterilization of, 32
Nephritis as cause of complicated cataract, 220
Nervous coat of eyeball, 128
Neurectomy, opticociliary, enucleation of eyeball in, indications for, 422
substitute for, 193
Nevus of lid, operation for, 371
Non-magnetic foreign bodies, removal of, from eyeball, 478, 479, 483
Novocaine, as substitute for cocaine, 38
Noyes' fixation forceps, 91
Nystagmus, result of cataract operation, 220

O

Ocular muscle, folding of, indications for, 449
Operating in patient's house, 18
room in hospital, 17
in ward of hospital, 18
Operations, conduct of patient after, 57
general physical examination for, 25
method of lighting of, 19
position of patient in, 22
of surgeon, assistants, instruments, accessories in, 22
preparation of patient for, 24
Ophthalmia, sympathetic, after combined extraction of lens, 232
result of foreign body in eyeball, 472, 477
Ophthalmoscope, localizing foreign body in eyeball by, 473
Optic disk, 128
nerve, 124, 128
paracentesis to prevent injury to, 132
test for functional capacity of, 217
Opticociliary neurectomy, 433
complications of, 434
substitute for, 193
Ora serrata, 128
Orbicularis muscle, entropion and, 329
of eyelid, 302
Orbit, abscess of, incision in, 461
angioma of, exenteration in, indication for, 467
carcinoma of, exenteration in, indication for, 467
cellulitis of, enucleation of eyeball in, indications for, 420
dressing of, after operation, 44, 50
exenteration of, 467
foreign bodies in, incision in, indications for, 462
removal of, 484
glioma of, exenteration in, indication for, 467
hemorrhage of, incision in, 462
Krönlein's resection external wall of, 463
operations on, 461
postoperative complications in, 53
treatment of, 50
resection external wall of, after-treatment of, 467
retrobulbar cellulitis of, incision in, 461
sarcoma of, exenteration in, indication for, 467
surgical anatomy of, 459
tumors of, incision in, indication for, 462
Orbital cellulitis, during opticociliary neurectomy, 434
Outriders of lens, 212

P

Pagenstecher's operation for ptosis, 359
spoon, 103
Palpebral fissure, closing of, after eyeball operation, 46
Panophthalmitis, 54
ablation of staphyloma and, 144
after combined flap extraction, 273
enucleation of eyeball in, indication for, 422
exenteration of eyeball in, indication for, 432
postoperative complication, 58
spontaneous, 207
tattooing of cornea as cause of, 149
Panas' extraction forceps, 95
operation for entropion and trichiasis, 339
of lower lid, contraindication for, 344

Panas' operation for ptosis, 361
Papilloma of lid, operation for, 371
Paracentesis, after-treatment of, 135
complications of, during operation, 134
postoperative, 135
of cornea, after discission of cataract, 282
indications for, 132
for rupture of wound in combined flap extraction of lens, 272
for corneal ulcer, 133
diagnostic value of, for foreign body, 133
for glaucoma, 132
for keratocele, 138
preparation for, 133
preventitive of escape of lens, 133
of prolapse of iris, 133
for prevention of injury to optic nerve, 132
to reduce tension in iridocyclitis, 132
for removal of cysticercus, 133
of sclera, operative procedure in, 154
in traumatism, indications for, 132
Paralysis of orbicularis, ectropion, and, 304
Paralytic strabismus, 437
Paraphimosis, canthotomy in, indication for, 348
Parinaud method of posterior sclerotomy, 195
Pectinate ligament, 128
incision of, for glaucoma, 190
Pedunculated or non-pedunculated mucous membrane flap for symblepharon, 409
skin flaps for symblepharon, 410
Pemphigus of conjunctiva, 405
Perimeter, Donders' table changing degrees of, 474
use of, in determining degree of squint, 438
in locating intra-ocular foreign body, 474
Petit-Arlt incision of lacrimal sac, 389
Phthisis bulbi, enucleation eyeball in, indications for, 422
exenteration of, contraindication for, 432
glass eye in, indication for, 429
opticociliary neurectomy in, 429
panophthalmitis and, 60
Pole, anterior, 123
posterior, 123, 128
Polypoid degeneration of mucous membrane, 382, 391
Polyps of conjunctiva, 419
Posterior chamber of eye, 130
removal of foreign body from 479
Priestley-Smith's photophore, 20
Prince's advancement forceps, 94
Probing preparatory to operation, 27
Prolapse of iris, cauterization of, indications for, 147
Pseudopterygia, keratoplasty for, 139
Pseudopterygium, 418
Pterygium, cauterization of, indication for, 147
Desmarres' operation for, 415
Knapp's operation for, 416
MacReynolds' operation for, 417
progressive, 415
stationary, 415
Ptosis, 357
congenital, 358
Eversbusch's operation for, 366
Hess' operation for, 361
Koster's operation for, 361
mechanical, 358
Motais' operation for, 364
operations, 358
Pagenstecher's operation for, 359
Panas' operation for, 361
Pupil, 126
artificial, for membranous cataract, 278, 280
seclusion of, in glaucoma, 178
Pupillary margin, 126, 130

R

Reese's resection to strengthen ocular muscles, 454
Reisinger's tenaculum, 97
Resection, 436
of external orbital wall, Krönlein's, 463
of muscles of eye, indications for, 449
Reese's operation for, 454
Schweigger's operation for, 453
of sclera, Müller's method, 156
Retina, 128
detachment of, after combined flap extraction, 273
operation for myopia, 225
Deutschmann's operation, 156
discission as cause of, 63
due to prolapse of vitreous, 268

Retina, detachment of, enucleation of eyeball in, indications for, 422
Müller's method of resection for, 156
paracentesis for, 154
postoperative, 63
result of, intra-ocular foreign body, 476
therapeutic injection for, 418
foreign body in, removal of, 479
test for functional capacity of, 217
Retinitis as cause of complicated cataract, 220
Retrobulbar cellulitis, incision of orbit in, indication for, 461
Ring's mask, 48, 49
Riolani muscle of eyelid, 303
Rogman operation for symblepharon, 411
Rupture of wound after operations, 55
conduct of patient to prevent, 57
symptoms of, 56
Rust's modification of Knapp's roller forceps, 93

S

Saemisch's keratotomy, 132, 135
Sarcoma of ciliary body, enucleation of eyeball in, indications for, 420
of conjunctiva, 419
of choroid, enucleation of eyeball in, indications for, 420
exenteration of orbit for, indication for, 467
of iris, enucleation of eyeball in, indication for, 420
of lid, operation for, 371
Sattler-Blaskovics' operation for ectropion, 310
Scalpel, 65
Scar, cystoid, sclerectomy and, 195
filtrating, as result of posterior sclerotomy, 194
tissue, formation of, 53
Schiotz tonometer, 173
Schirmer's method opticociliary neurectomy, 434
Schlemm's canal, 125, 128
effect of iridectomy on, 190
Schulek's capsule forceps, 89
sphincterolysis, 208
sphincterotome, 79
sphincterotomy, 208
Schweigger's resection to strengthen ocular muscles, 453
Scissors, method of using, 82
Sclera, 123, 124
adherent scar of, enucleation of eyeball in, indications for, 421
Sclera, cauterization of, 157
De Wecker's anterior sclerotomy, 189
effect of iridectomy on, 188
Elliot's trephining of, 189
excision of, Lagrange, 196
foreign body in, removal of, 492
incision of, in cyclodialysis, 202
for glaucoma, 201
paracentesis of, 154
operative procedure in, 154
perforation of, during advancement, 457
removing foreign body from eyeball through, 480
resection of, Müller's method, 156
trephining of, for glaucoma, 177
wounds of, suturing of, 152
Sclerectomy, sclerectoiridectomy, after treatment of, 201
complications of, 200
postoperative, 201
incision in, 196
instruments for, 196
iridectomy in, 200
Lagrange, 189, 195
operative procedure in, 196
preparation for, 196
Sclerosis of lens, 212
Sclerotomy, anterior, after-treatment of, 193
complications during operation, 193
definition of, 190
De Wecker's, 189
Graefe's knife in, method of using, 66, 67, 68
indications for, 190
instruments for, 190
preparation for, 190
for glaucoma, 62
posterior, 193
after-treatment of, 195
definition of, 193
filtrating scar as result of, 194
Graefe's knife in, method of using, 69
indications for, 193
instruments for, 194
for luxation of lens, 187
McKenzie's, 189
operative procedure in, 194
preparation for, 194
Sideroscope, locating intra-ocular foreign body, use of, 475
Sinus venosus scleræ, 128
Skin graft for cicatricial ectropion, 327
Smith-Priestley photophore, 24
Smith's capsule forceps of, 90
Snellen's aluminum cup, 50

Snellen's ligature for non-cicatricial ectropion, 305
operation for entropion and trichiasis, 337
of lower lid contraindication for, 344
Snowden's lid retractor, 107, 113
Spastic, entropion, 329
Spencer-Watson operation, entropion and trichiasis of lower lid, contraindication for, 344
for partial trichiasis, 343
Sphincterolysis, Schulek's, 208
Sphincterotomy, Schulek's, 208
Squint, alternating, 439
examination to determine degree of, 438
periodic, 439
Staphyloma of cornea, ablation in, indications for, 142
Beer's operation for, 143
Czermak's operation for, 146
De Wecker's operation for, 146
enucleation in, indications for, 143
expulsive hemorrhage in, 143
iridectomy in, indications for, 142
Knapp's operation for, 145
operation for, 142
ectropion and, 303
enucleation of eyeball in, indications for, 422
keratoplasty for, 139, 140
scleral, 54
Staphylotomy, Abadie's, 209
Stereoscopic exercises for strabismus, 437
Sterilization of contaminated instruments, 41
for dressings, 30
effect of, on cocaine, 31
of eye drops, 31
general, for instruments, 31
Gerson's method of, 18
for hands, 30, 41
of silk, catgut needles, 32
of solutions, 31
for trays, bowls, etc., 30
Sterilizer, portable alcohol, 41
Stevens' tenotomy scissors, 82
Strabismus, alternating constant convergent, 439
concomitant, 437, 449
convergent, 437, 439
overcorrected, 445
undercorrected, 445
divergent, 439
examination for result of operation of, 448
Strabismus, divergent, postoperative, complicating tenotomy, 447
latent, 440
paralytic, 437, 449
stereoscopic exercises for, 437
Strabometer, use of, in determining strength of muscles, 438
Stricturotomy of nasal duct, 386
Subconjunctival injection, method of giving, 36
Subcutaneous injection, method of giving, 37
Subtarsal muscle of eyelid, 303
Suspensory ligament, 130
Suturing of cornea, 150
operative procedure in, 151
of sclera, operative procedure in, 153
of scleral wounds, 152
Symblepharon, 369
anterior, 406
Arlt's operation for, 407
Czermak's operation for, 408
Harlan's operation for, 411
Knapp's operation for, 409
May-Hotz's operation for, 412
operations for, 405
posterior, 406
Rogman's operation for, 411
Taylor's pedunculated skin flaps for, 410
Teale's operation for, 409
Weeks' operation for, 412
Wolf's operation for, 410
Synechia, anterior, complication after keratotomy, 136
iridolysis for, 209
iritomy for, 209
operations for, 207
prolapse of iris as cause of, 210
sphincterolysis for, 208
sphincterotome for liberation of, 79
sphincterotomy for, 208
staphylotomy for, 209
as cause of complicated cataract, 220
complication during iridectomy, 187
posterior, 129, 217
in discission of cataract, 282
contraindication for, 226
in extraction of lens, 237
postoperative complication, 58
Syphilitic affection of lacrimal sac, 382, 391
Szymanowski's operation for non-cicatricial ectropion, 307

T

TARSORRHAPHY for ectropion, 306
Fuchs', 355
permanent, indications for, 354
temporary, indications for, 353
operative procedure in, 353
Walther-Graefe's, 355
Tarsus of eyelids, 302
fornix and, combined excision of, 401
Kuhnt's tarsectomy for, 340
total anesthesia of, 38
Tattooing in albinism, 149
in aniridia, 149
in cataracts, 149
of cornea, 149
after-treatment of, 150
contraindications for, 149
indications for, 149
instruments for, 149
operative procedure in, 149
preparation for, 149
in iridocyclitis, 149
for keratoconus, 147, 149
in leukoma, 149
Taylor's pedunculated skin flaps for symblepharon, 410
Teale's operation for symblepharon, 409
Tearing of iris during iridectomy, 187
Tenotomy, 436
after-treatment of, 446
complications of, during operation, 446
postoperative, 446
for all muscles, technique of, 446
indications for, 441
of internal rectus, 441
detachment of muscle in, 443
examination of, immediate effect of operation, 444
incision in, conjunctiva, 442
Knapp's suture of conjunctiva in, 446
seeking for lateral insertions, 443
suturing of conjunctiva in, 445
Terrien on cataracts, 219
Terson on posterior sclerotomy, 194
Thiersch graft, operative procedure in, 328
Toti's operation on nasal duct, 386
Trachoma, 329
as cause of infection, 28
ectropion and, 304
excision of fornix for, 400
expression of follicles for, 396
Trachoma, expression of, forceps for, 93, 94
Flarer's operation for entropion of lower lid after, 344
fornix and tarsus combined excision of, 401
Knapp's expression with roller forceps, 397
Kuhnt's expression, 398
tarsectomy for, 340
of lacrimal sac, extirpation for, 391
operations for, 396
Transplantation of fat in Tenon's capsule, 430
Traumatism, paracentesis in, indications for, 132, 133
postoperative complication, 55, 58
Trephining of cornea, 137
of sclera, Elliot, 189
Trichiasis, 329
Anagnostakis-Hotz's operation for, 332
Celsus' operation for, 331
entropion and, 329
Gaillard-Arlt's ligature for, 330
Jaesche-Arlt's operation for, 333
Kuhnt's tarsectomy for, 340
of lower lid, Flarer's operation for, 344
Kuhnt's tarsectomy for, 345
operations for, 344
Machek-Blaskovics' operation for 335
Panas' operation for, 339
partial, electrolysis for, 342
epilation for, 342
Spencer-Watson's operation for, 343
Snellen's operation for, 337
Tuberculosis in blepharoplasty, 327
of ciliary body, enucleation of eyeball in, indication for, 421
of iris, enucleation of eyeball in, indication for, 421
of lacrimal gland, extirpation of, indication for, 374
sac, 382
Tumors of conjunctiva, 419
of cornea, cauterization of, indications for, 147
epibulbar, 420
of eyeball, ectropion and, 303
malignant, 420
of eyelid, operation for, 371
intra-ocular, enucleation of, indication for, 420
of iris, 179
of orbit, incision in, indication for, 462
Tyrrell's blunt hook, 101

U

Ulcer of cornea, infected, extirpation of lacrimal sac for, 391
perforated, cause of iris prolapse, 210
Urine, 25
Utensils, method of sterilization of, 30
Uveal tract, 126
iridectomy in, indications for, 158

V

Vascular coat of the eyeball, 126
Vitreous cause of postoperative complication, 63
chamber, 131
opening of, for glaucoma, 194
removal of foreign body from, 479
loss of, after removal of foreign body, 483
luxation of lens into, 222
opacities of, therapeutic injections for, 418
prolapse of, in combined flap extraction, 267, 268
complicating discission of lens capsule, 229
extraction of lens, 246
in discission, De Wecker's pince-ciseaux, 290
during iridectomy, 188
extraction of lens after, 269
postoperative complication, 56, 57
replacing of corneal flap in, 271
result of atrophy or rupture of zonule, 268
error in technique, 268
wedging of, after iridectomy, 188
Von Hippel's incomplete partial keratoplasty, 137, 139
trephine, 69

W

Waldhauer's modification of Jaesche-Arlt operation for entropion and trichiasis, 333
Walther-Graefe's tarsorrhaphy, 355
Warts on eyelids, operation for, 371
Weber's grooved foreign body gouge, 79
knife, 65
loop, 104
method of replacing lens, 187
Weeks' lid retractors, 107, 113
operation for symblepharon, 412
Wenzel-Wecker's extraction of cataract, 220
Wharton-Jones' operation for cicatricial ectropion, 313
Wicherkiewicz's plasty for coloboma of lid, 369
Wolf graft, after-treatment of, 328
operative procedure in, 327
Wolf's operation for symblepharon, 410
Worth's advancement, 452
Wound, infection of, 57
rupture of, 55
of sclera, suturing of, 152
operative procedure in, 153

X

Xanthelasma of lid, operation for, 371
X-rays, locating intra-ocular foreign body, use of, 475

Z

Ziegler's discission of lens with knife-needle, 293
galvanocautery puncture, 347
iridotomy, 285
knife-needle, 80
in discission of lens, 293
Zonule, atrophy of, cause of prolapse of vitreous, 268
rupture of, complicating discission of lens, 225
during iridectomy, 188
of Zinn, 130, 131
condition of, in luxation of lens, 221