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ON

CONICAL CORNEA.

BY

JAMES H. PICKFORD, M.D., M.R.I.A.

LICENTIATE OF THE KING AND QUEEN'S COLLEGE OF PHYSICIANS IN IRELAND;
CORRESPONDING MEMBER OF THE ASSOCIATION OF THE KING AND
QUEEN'S COLLEGE OF PHYSICIANS.

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ON

CONICAL CORNEA.

THERE is probably no disease to which the eye is subject, hitherto so rebellious to medicine, so intractable in its nature, and, at the same time, so fatal to vision, as conical cornea; and not one, the pathology and treatment of which are so little understood.*

In the following pages, after enumerating a few of the more prominent symptoms of the disease, I shall request the attention of the Association,

1st. To the generally received opinions of the nature of the malady.

2ndly. To the treatment recommended by writers on the subject.

3rdly. To a more successful mode of treatment.

4thly. To an attempt to explain the rationale of such treatment, by a reference to the anatomical structure of the part affected, and to the probable pathology of the disease.

The attention of the Profession was first directed to conical cornea by Levéillé, the French translator of Scarpa on the Diseases of the Eye, in a note under the head of Staphyloma. His description of the disease is so exceedingly accurate that I am induced to quote his own words:

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* "We must, I believe, confess at last, that we do not understand the pathology of conical cornea, that its causes are totally obscure, and that we know no treatment capable of remedying it." "I cannot say that I have seen any plan productive of benefit."—*A Treatise on the Diseases of the Eye*, by W. Lawrence, F. R. S.; page 379. London, 1833.

"From the result of my practice, I much fear, that *conical formed cornea* may be ranked with the incurable maladies."—An Essay on *Staphyloma pellucidum conicum*, by Robert Lyall, *Edinburgh Med. and Surg. Journal*, vol. vii. p. 11, 1811.

"Il m'est arrivé naguère, d'observer une singulière maladie de la cornée; je ne saurais trop dans quelle classe de maladie des yeux la ranger, si l'on ne peut la rapporter au staphylôme. Chez une dame de trente cinq ans, ayant les deux yeux naturellement saillans, saine d'ailleurs, le centre de la cornée des deux yeux se souleva graduellement, au point que cette membrane ne formait plus, comme à l'ordinaire, un segment regulier de sphère, mais un cône notablement saillant, et terminé en pointe dans son milieu. La cornée de chaque œil, regardée de côté, semblait un petit entonnoir transparent, dont la pointe était tournée en déhors. Dans certaines positions de l'œil, il semblait que la pointe du cône fût un peu moins transparente que le reste de la cornée; dans d'autres, ce qui était nébuleux, l'était si peu, qu'il ne pouvait faire un obstacle notable à la vision. En plaçant l'œil directement contre une fenêtre, ce point saillant du centre de la cornée, plutôt que de transmettre la lumière, la réflechissait avec une telle force, qu'elle semblait étincelante; et comme ce phénomène avait lieu précisément contre la pupille, il en resultait, qu'étant rétrécie dans un grand jour, elle ne permettait à la malade que de distinguer confusément les objets."*

Neither sex nor age is exempt from this disease; females, however, appear to be for the most part its subjects. Mr. Wardrop† has seen it in a boy 6 years old, and Sir William Adams‡ met with it in a person upwards of 70 years of age, though the middle period of life is that in which it chiefly makes its invasion. It is sometimes congenital.§

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* *Traité Pratique des Maladies des Yeux, traduit de l'Italien de Scarpa,* par J. B. F. Levéillé, tom. ii. p. 179. Paris, 1802.

† *Essays on the Morbid Anatomy of the Human Eye,* by James Wardrop, vol. i. p. 117. Edinburgh, 1808.

‡ *Journal of Science and the Arts,* vol. ii. p. 402. London, 1817.

§ *Manuel Pratique d'Ophthalmologie,* par Prof. Stœber, Strasbourg, 1834.

Professor von Ammon says, congenital *Hyperkeratosis,* or *Ochlodes,* a term which he prefers, is accompanied by a peculiar conformation of the cranium, and that he has met with this in several children of one family.

"Beachtungswerth ist es, dass auch bei dieser Hyperkeratosis congenita eine

Conical cornea, "*staphyloma pellucidum*," is a somewhat rare disease, though Demours states that he and his father, who had observed it as far back as 1747, have notes in their case-books (journaux) of upwards of a hundred cases.* Beer, however, is silent on the subject, as are most of the German writers.

Mr. Wardrop,† in his Essays on Morbid Anatomy, gives an elaborate account of the disease, which he names *conical formed cornea.*

Mr. Lyall‡ enters into a lengthened description of the malady in an essay in the Edinburgh Medical and Surgical Journal, and in his inaugural thesis published at Petersburg in 1816. He calls the disease *staphyloma conicum pellucidum.*

Dr. G. E. Wimmer, in his *Thesis de Hyperceratosi*, printed at Leipzig, 1831, enters most fully into the history of the disease and the published statements respecting it.

Professor Himly of Göttingen has collected every thing known on the subject, and transferred it to the pages of his Bibliothek für Ophthalmologie.§

In the disease under consideration the normal convexity of the cornea is lost; a transparent conical structure, apparently differing in no particular from the natural texture of the cornea, unpreceded and unattended by pain or inflammation, supplies its place; the cornea is prolonged forwards, and presents to the observer a peculiar dazzling, sparkling point of brilliancy, a dew-drop, or gem-like radiance, as though a piece of solid crystal were embedded in its centre.

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eigenthümliche Form des Schädels, nämlich ein sogenannter Spitzkopf sich vorfindet. Ich habe dieses schon Einmal bei mehrern Geschwistern beobachtet, die sämmtlich eine angeborne Hyperkeratosis tragen."—Dr. Friedrich August v. Ammon's *Zeitschrift für die Ophthalmologie*, vol. i. p. 123. Dresden, 1830.

* *Traité des Maladies des Yeux*, par A. P. Demours, tom. i. p. 316. Paris, 1818.

† Op. cit. ‡ Op. cit.

§ *Bibliothek für Ophthalmologie, Kenntniss und Behandlung der Sinneüberhaupt in ihren gesunden und kranken Zustande.* Vol. i. Hannov. 1816.

This appearance is occasioned by the excessive refraction, by the corneal cone, of such rays of light as pass through it, together with the reflexion, in due relation to the incident angle, of a certain portion of all rays impinging upon its surface.

In extreme cases it is not unusual to find the apex of the cone opaque. This may arise from inflammatory action, occasioned by the friction of the lids upon the corneal projection, or by other causes, to which an eye of this peculiar form must be subjected.

Should this inflammatory condition be excessive, ulceration and staphyloma may be the consequence. Demours says, "La protubérance augmente dans quelques cas rares, se montre accompagnée d'ophthalmie, et sort de cette classe particulière, pour entrer dans le nombre immense des staphylômes de la cornée."*

Patients, when first attacked, become myopic, but, as the disease increases, are unable to distinguish small objects, even in the direction of the axis of the eye, unless held within an inch or so of the cornea. All direct and useful vision is now, nearly, if not totally, intercepted, though, on the temporal side of the eye, even minute objects are easily discerned. This will hereafter be rendered apparent, by the projection of an eye of a patient now under my care at the Sussex and Brighton Infirmary for Diseases of the Eye.

When the disease is far advanced, patients most frequently complain of observing a circle, or circle of annuli, around a lighted candle or lamp, as in the annexed engraving, greater or less, according to the more or less perfect development of the disease.

I have seldom, however, met with any one so affected (and my experience in this somewhat uncommon disease is not very limited), who complained of the candle or other luminous body appearing to be multiplied four, five, or more times, though this

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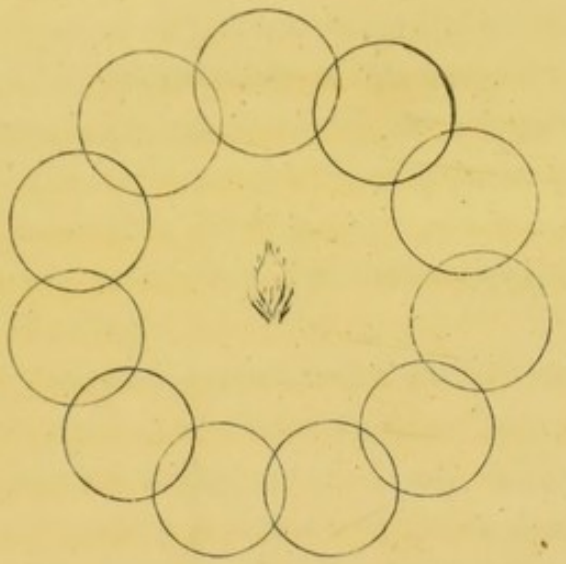
* Op. cit. p. 316.



is mentioned by authors, and attributed by Sir David Brewster to the irregularities of the corneal cone, the surface of which he has invariably found to present numerous small "spherical elevations and depressions, sufficiently accounting (in his opinion) for the broken and multiplied images of luminous objects."*

These irregularities, or small spherical elevations, will, however, equally well explain the chain-like appearance of the circle above-mentioned; each elevation being, in fact, a small cone, so that the vertex of the obtuse corneal cone may be said to consist of a series or congregation of minute cones, irregularly clustered together, appreciable only by aid of a powerful lens, or by observation of the changes produced upon the image of a lighted taper made to traverse its surface.

I.—*With regard to the generally received opinions of the nature of the malady.*

Some writers are of opinion that the conical appearance assumed by the cornea consists in a deposit, upon its external surface, of translucent matter, of the same character as the cornea itself.† This opinion is shown to be erroneous by Professor Jäeger‡ and Mr. Middlemore, the former of whom found, upon examining after death the cornea of a person who had been the subject of this disease, a central depression, the size of a mode-

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* *Essays on the Morbid Anatomy of the Human Eye*, by James Wardrop, vol. i. p. 121. Edinburgh, 1808.

† Sir William Adams—*Journal of Science and the Arts*, vol. ii. p. 403. London, 1817.

‡ "Als man die Cornea zwischen die Finger nahm, bemerkte man deutlich eine Vertiefung in der Mitte, die von einem dicken Wulst umgeben war. Man schnitt nun die Cornea in der Mitte durch, und fand das mittlere Dritttheil derselben, 3mal dünner als gewöhnlich, ähnlich einem Postpapiere und die zwei äussern Dritttheil bedeutend verdickt und zwar deutlich in den mittleren Lamellen, die äusserste und innerste nicht, die mittlere Substanz ist homogen. Die Verdickung des äussern Theiles verliert sich allmählig in die Verdünnung, so dass der Durchmesser der letztern die Grösse einer mässig erweiterten Pupille hat."—*Resultate der anatomischen Untersuchung zweier mit Hyperkeratosis behafteter Augen*, von Herrn Prof. Dr. Jäeger in Erlangen, in *Ammon's Zeitschrift*, vol. i. p. 548. Dresden, 1830.

rately dilated pupil, about the substance of writing paper, with a marginal thickening, which gradually increased towards the sclerotic.

Mr. Middlemore says, "I have had one opportunity of examining, after death, the state of the cornea in a person who was affected with conical cornea in an extreme degree, and in that instance its laminæ were less moveable upon each other, its circumference was of a natural and ordinary degree of thickness, but its apex was much thinner than usual, and rendered opaque on its exterior only, for its neural surface, even at the apex, was perfectly transparent; in other respects it did not appear to have undergone any change, unless I mention that alteration in the evenness and equality of its surface discovered by Dr. Brewster, but which was not visible to the naked eye."*

In corroboration of these statements I may adduce the case of a gentleman, the subject of this disease, mentioned by Mr. Wardrop,† in whom the cornea burst from a blow received upon the eye.

Some believe that the aqueous humour, being secreted in greater quantity than usual, distending the chambers, has the power of thrusting forward, as it were, the centre of the cornea, by a slow degree of stretching.‡

I would ask, were this last hypothesis correct, why should the cornea assume a conical form? It is easy to understand how increase of the aqueous humour may distend, attenuate, and inflame the cornea, and enlarge its diameter, dilate the pupil, and impair the mobility of the iris; occasion a sense of fullness and tension in the eye, and give rise to headach or circumorbital pain, none of which symptoms, however, attend conical cornea; but it is not so easy to comprehend why it should tend to the

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* *Treatise on the Diseases of the Eye and its Appendages*, by Richard Middlemore, M. R. C. S., vol. i. p. 532, *note*. London, 1835.

† Op. cit.

‡ Mr. Lyall, Op. cit. pp. 10, 11.

formation of a cone. Mr. Lyall, on the contrary, "thinks the question may be easily answered, since Mr. Everard Home, in the Philosophical Transactions, informs us, that 'in stretching the cornea, the central part yields most readily to the power applied.'—Cæteris paribus, then it follows, that the cornea must assume a conical form, when it yields in consequence of distention internally."*

Mr. Travers† considers the disease to consist in "a process of thinning, or an absorption of the interlamellar texture of the cornea," "in consequence of which it loses its natural tonic resistance to the pressure of the contents of the globe."‡ "The disease," says Mr. Travers, "is sometimes slow, occupying months, and even years; and, on the contrary, I have seen it produced in its greatest extent in the short space of eight weeks." "If left to itself," however, "the cornea does not give way, but remains in the condition described." Were Mr. Travers' pathology correct, I contend that it *ought* to and *would* give way. He adds, that "no remedy yet proposed has been followed by a beneficial result." Mr. Travers is the only writer with whom I am acquainted who ascribes the disease to a constitutional origin, and who recommends constitutional treatment. He "has found steel and arsenic decidedly serviceable." To these he conjoins "cold bathing, and the practice of often opening the eyes in cold spring water."§

Others attribute the disease "to some faulty action of the nutrient vessels."‖ Possibly with much more of reason and probability might we say, as I shall endeavour hereafter to show,

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* Mr. Lyall, op. cit. p. 11.

† *Synopsis of Diseases of the Eye*, by Benj. Travers, F. R. S. Second edition. p. 124. London, 1821.

‡ Dr. Littell, of Philadelphia, entertains similar opinions—*A Manual of the Diseases of the Eye*, by S. Littell, M. D., revised and enlarged by Hugh Houston, p. 149. London, 1840.

§ Op. cit. p. 292.

‖ *A practical Treatise on Diseases of the Eye*, by William Mackenzie, M. D. Second edition, p. 625. London, 1835.

that it depends upon some faulty action of the absorbent vessels and nutrient capillaries of the cornea itself, induced by the debility of the nerves of the part. Indeed, if Jäeger's and Middlemore's accounts prove, on further investigation, to be uniformly correct, this is the only explanation which can be given with our present limited knowledge of the pathology of this singular disease.

On the other hand, if the disease be found to depend on increased deposit merely, we must admit the supposition of "a faulty action of the nutrient vessels."

II.—*With regard to the treatment recommended by writers on the subject.*

What has been said of the pathology applies with equal justice to the treatment of this disease. All writers are agreed that nothing is known either of the one or the other. Various remedies, both general and local, have been prescribed for its cure or relief; all have failed, even in arresting its progress.*

Some practitioners recommend the application, once a week, of a leech or two, to the lower eyelid or temple. Others advise bleeding, frequent cupping, issues to the temples, perpetual blisters and astringent collyria; some one thing, some another.

Some writers, believing it to depend upon an excess of aqueous humour, the consequence of a dropsical tendency, have administered "calomel, &c., internally, with a view to excite the action of the absorbent system, and thus remove the increased quantity of aqueous humour from the anterior chamber, but without the least success."†

Others have evacuated this fluid, unmindful of its exceedingly rapid renewal: for, so soon as the puncture is sufficiently

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* The late Mr. Tyrrell, however, says, "that in the early stage of the alteration," he "believes that it may be retarded, if not prevented from further increase, by the local use of stimuli; but" he has "never known any diminution occur."—*A practical Work on the Diseases of the Eye, and their Treatment*, By Frederick Tyrrell, vol. i. p. 276. London, 1840.

† Mr. Lyall, op. cit. pp. 12, 13.

healed to bear its pressure, so soon will the chambers be filled with the fluid as before the operation.* No permanent relief of any ind , neither benefit to vision, nor mitigation of the disease, can therefore arise from so inconsiderate a mode of treatment.

There are others who recommend constant and well directed pressure on the apex of the corneal cone. The futility, not to say mischief, of this unscientific plan is self apparent. It is replete with objections, exclusive of the utter hopelessness of its effecting a cure. Its advocates expect to occasion, by these means, absorption of the apex of the cone, and, ultimately, of the whole of the transformed cornea. If Jäeger's account be proved to be correct, and if the apex of the cone be, as he states, not thicker than "writing paper," what must be the state of the patient's eye after it had been subjected to pressure, sufficiently long to answer the proposed end? Would not the remedy here be infinitely worse than the disease?

Some writers, satisfied, after the most ample experience, of the insufficiency of remedies, content themselves with doing nothing: "Lorsque je suis consulté," says Demours, "pour cette lésion, je conseille de n'y rien faire de particulier."†

Sir William Adams broke up the crystalline lens, in order, as he states, that the rays of light might fall upon the retina, and not be brought, by the increased refractive power of the cornea and lens, to a point far short of the sentient apparatus of the organ of vision.

Sir John F. W. Herschel, speaking of "short-sighted persons," says, "they have their eyes too convex, and this defect is remediable by the use of proper lenses;" and he then refers to the operation under consideration in the following terms:— "There are cases, however, though rare, in which the cornea becomes so very prominent as to render it impossible to apply conveniently a lens sufficiently concave to counteract its action. Such cases would be accompanied with irremediable blindness,

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* Mr. Lyall and Mr. Gibson, op. cit. pp. 10, 11. Mr. Lawrence, op. cit.

† Op. cit. tom. i. p. 316.

but for that happy boldness justifiable only by the certainty of our knowledge of the true nature and laws of vision, which, in such a case, has suggested the opening of the eye and removal of the crystalline lens, though in a perfectly sound state."*

Sir John proposes to remedy the defective vision arising from malconformations of the cornea, "by adapting a lens to the eye, of nearly the same refractive power, and having its surface next the eye an exact *intaglio* fac-simile of the irregular cornea."† "Should," says he, "any very bad cases of irregular cornea be found, it is worthy of consideration, whether at least a temporary distinct vision could not be procured, by applying in contact with the surface of the eye some transparent animal jelly contained in a spherical capsule of glass; or, whether an actual mould of the cornea might not be taken, and impressed on some transparent medium. The operation would of course be delicate, but certainly less so than that of cutting open a living eye, and taking out its contents."‡

Entertaining the highest possible respect for the opinion of so eminent an authority as Sir John Herschel, and for the talent and labours of Sir William Adams, I must be permitted to question the "happiness" of that "boldness" which has suggested the removal of the crystalline lens as a remedy for the depraved vision of those afflicted with the disease under consideration.

The circumstance, alone, of the operation having fallen into disuse is, in itself, sufficiently condemnatory of its supposed utility.§ Could but the rays of light, with accustomed regularity of convergence, reach the lens, all would be well; a deep double concave glass, by occasioning a prior divergence, would remedy the defect of vision; but, could they do this, one of the

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* Article "Light," *Encyclopædia Metropolitana*, p. 398, § 358.

† *Ibid.* p. 398, § 359. ‡ *Ibid.* p. 398, *note.*

§ "I should not think of proposing any such operation, unless the affection had gone so far as to make the eye useless, and I should then expect no good from it. The proceeding has not been employed with advantage in any instance."—Mr. W. Lawrence, op. cit. p. 379.

very peculiarities of the disease itself would vanish, and cease to exist; for, were the refractive powers of the cornea merely "increased," and not in excess, all rays entering it would pass onwards to the lens and retina, without producing that peculiar sparkling, luminous appearance, that diamond-like radiance before mentioned; one of the essential characteristics of the disease.

The removal of the lens from the axis of vision cannot, I contend, produce any effect upon the corneal cone; for this it is which refracts unduly, and in excess, the rays of light falling upon the upper portion of its surface, and offers a permanent barrier to their reaching the lens with their ordinary convergence and regularity.

How far I am justified in arriving at this conclusion will be seen by a reference to the annexed diagram of the eye of Alfred Adams, æt. 17, a patient under my care at the Sussex and Brighton Infirmary for Diseases of the Eye.*

The left eye, of the profile of which I made an accurate outline, and of which the following is a magnified view, has been affected with the disease for the last two years. I found, upon admeasurement, that the sides of the cone subtended an angle of 92°. The patient, on being desired to look steadily in his

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* This individual is already so much improved, though he has been under treatment but a comparatively short time, that, with some little difficulty, he can read even small print. Upon looking at his brother's nose, at a distance of five feet, he can now see the whole of his face, and objects on either side. The circle of annuli is no longer present, its place being supplied by two concentric circles of minute but innumerable flames (incomplete, however, at their upper parts), having a diameter of twelve inches only. The moon appears surrounded by two concentric circles of satellites, also incomplete at their upper parts. The image of the flame now appears perfect when the rays of light are incident to the sides of the corneal cone at an angle exceeding 25°. The apex of the cone has been perceptibly rounded off.

It is exceedingly interesting to mark from time to time, during the treatment, the slow but progressive changes which the diseased cornea undergoes towards a restoration to its normal figure. From repeated observations which I have made,

brother's face, at a distance of about eighteen inches, and to fix his eye upon the point of his nose, said, he could only see this and the mouth. Whilst, on the temporal side, the field of vision being evidently much increased, he saw my hand distinctly, at a right angle with the axis of his own eye. Over the nose, and inferiorly, vision was, of course, more limited, but equally distinct. Through a hole, made with a needle in a card, he was enabled to read very small print. Upon looking at the flame of a candle in a darkened room, he saw, at the distance of about twelve feet, a circle of rings, as described before, and which he figured on paper, having a diameter of about eighteen inches. This circle disappeared altogether when the candle was so placed that the rays of light fell upon the temporal side of the cone at an angle with its axis exceeding 30°. Upon approaching to within two feet of the candle it appeared to be "a ball of fire, about the size of a cricket ball."

It must be borne in mind that the figure of the healthy cor-

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it would appear that this change consists more especially in the rounding off of the apex of the cone.

Fig. I. of the following diagrams is an accurate profile of the eye of Alfred Adams, on his admission into the Infirmary. Fig. II. is the same eye after thirteen weeks' treatment, in which this rounding off is very apparent.

Fig. I.

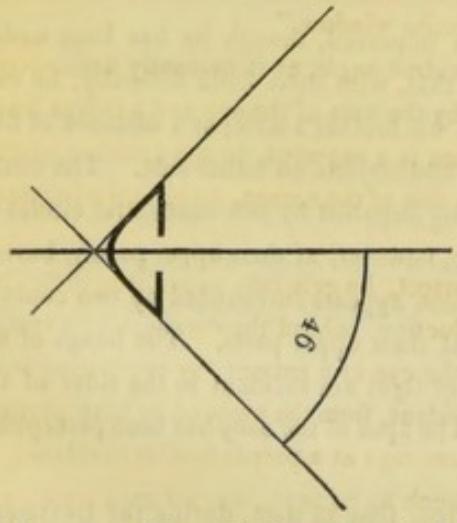
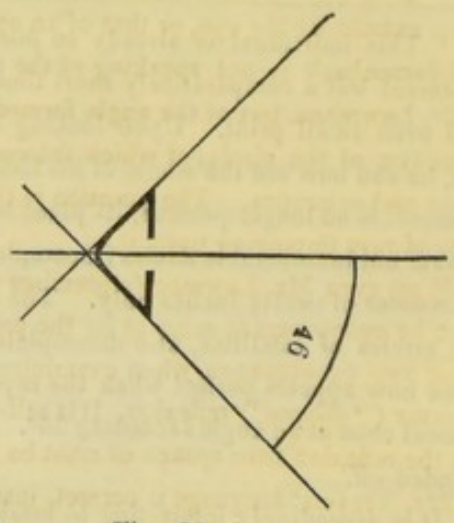


Fig. II.



nea is an ellipsoid of revolution about the major axis,* through which the curvature of all its sections is equal; that it presents, in every direction, an arc of 96° 55′ 20″; that "rays of light, falling upon it at an angle more acute than 48°, pass through it;"† and that it is essential to perfect vision that all rays im-

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* *Sur la Courbure des Milieux Réfringens de l'Œil chez le Bœuf*, par M. Chossat. Annales de Chim. tom. x. p. 337.

† *Institutions of Physiology*, by J. Fred. Blumenbach, M. D. Translated by John Elliotson, M. D. 3rd edition, p. 173. London, 1820.

Some very strange and unaccountable misconception appears to have arisen with regard to this passage of Blumenbach, which has been contorted and twisted into an infinite variety of shapes by each successive writer, according to his own peculiar views of the subject.

Mr. Travers says (*Sketch of the Physiology of the Eye and its Appendages*, p. 49), "the rays which fall within an angle of 48°, or thereabouts, measured on the surface of the cornea, pass through it, and are refracted in their passage. Those which are not included within this angle are reflected by the verge of the cornea and the sclerotic coat."

Mr. Lawrence (op. cit. p. 49,) says, "All the rays falling upon the cornea do not pass through it; in order to permeate it they must strike upon the part within a certain given angle (of about forty-eight degrees). Those which fall upon it more obliquely, are reflected from it, and produce that sparkling appearance which characterizes the living eye, and which it is necessary to introduce into portraits, in order to give them a character of life. The same reflection produces the image which we see behind the cornea, as that of our own countenance, when we are examining the eye, or that of an opposite window."

Blumenbach is not speaking of the *incident angle*, as is evidently understood by Mr. Lawrence, but of the angle formed by the axis of the eye and a radius from the centre of the circle, of which the cornea is a segment, to the junction of the cornea and sclerotica. The question is the size of the cornea, and not the incident angle of rays impinging upon it.

Were even Mr. Lawrence's premises correct, he gets into some little difficulty when he endeavours to account for the production, behind the cornea, of the image of our own countenance, when examining the eye of a patient, by attributing it to the same ("*oblique*") reflexion. It is self-evident, from the position of both parties, that the reflexion here spoken of must be from rays at a perpendicular incidence.

Mr. Travers' language is correct, insomuch as he says, that all rays which are incident to the cornea will enter, whilst all those which do not impinge upon it cannot pass through it. He is not quite so clear when he says that those rays

pinging upon it, which enter the pupil, except that coincident with the axis of the eye, be refracted, and made to converge and unite in a focus upon the retina; and, that, for the perfection of the images there formed, the accurate convergence of all these rays to their respective foci is imperative; and, consequently, that if rays parallel to the axis of the eye, or bundles of peripheral rays of any given cone or cones converge and unite in a focus at a point anterior to, or beyond the surface of the retina, vision is indistinct: and that, in the former case, the rays, not meeting the retina, will decussate and pass onwards, forming, when they do impinge upon its surface, circles of light, exclusive of the bright focus of the central rays, corresponding to the diameter of the base of such cone or cones at the point of contact with it. Hence it follows, that if, from undue refraction by the corneal cone, one or more of such cones be formed, so will a corresponding number of such circles, each within the other, be pictured upon the retina at the point of contact of such peripheral rays. This will be rendered apparent by the annexed diagram, Fig. I.

As, however, I am dealing with the cornea, and not with

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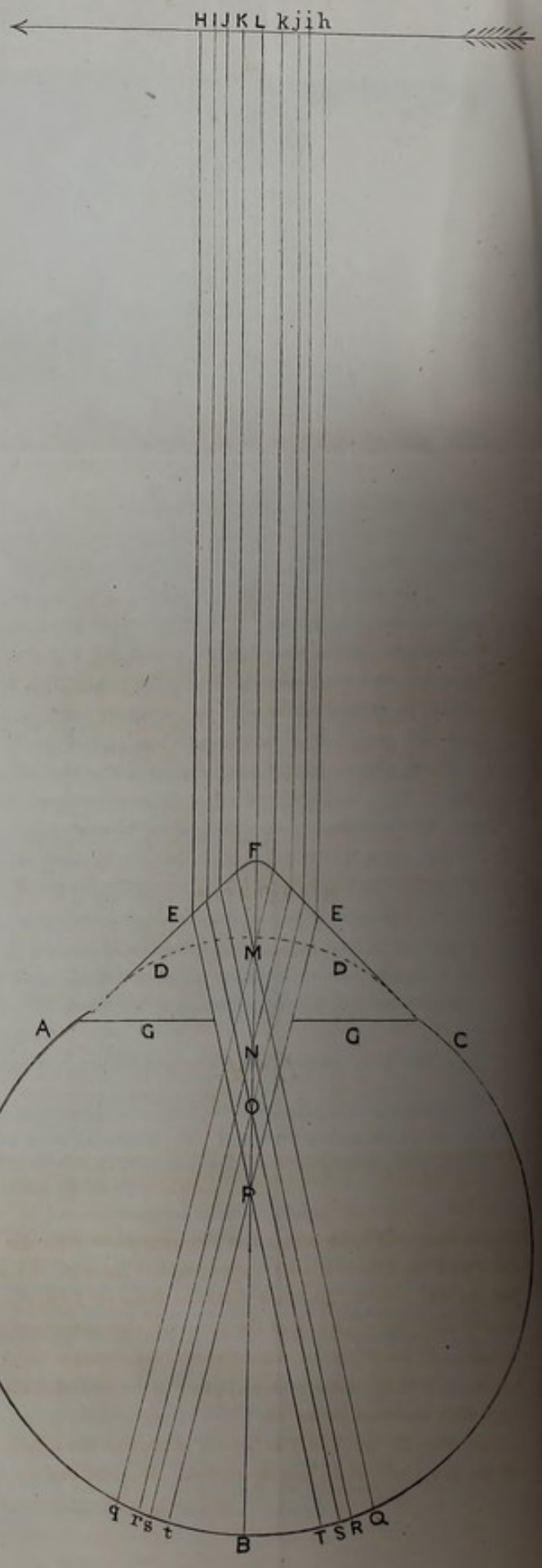
which are not included within an angle of 48°, or thereabouts, are reflected by the verge of the cornea and the sclerotic coat. This would have the effect of making the cornea appear to be encircled, at its junction with the sclerotica, by a ring of dazzling light of intense brilliancy:

——— lætos oculis afflârat honores.

Sir John F. W. Herschel, however, sets the question at rest. He says (Article "Light," *Encyclopædia Metropolitana*, p. 367, § 171), "When a ray of light is incident on the surface of any transparent uncrystallized medium, a portion of it is reflected; another portion is *dispersed* in all directions, and serves to render the surface visible; and the remainder enters the medium and pursues its course within it."

And at page 369, § 184, we find, "When the ray is incident on the exterior surface of the medium, a portion is reflected and the remainder refracted. The ratio of reflexion to refraction is smallest at a perpendicular incidence, and increases regularly till the incidence becomes 90°; but even at *extreme obliquities*, and when the incident ray *just grazes* the surface, *the reflexion is never total, or nearly total, a very considerable portion being always intromitted.*"

Fig. 1



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the lens, I have supposed in Fig. I. and Fig. II., the latter to have been removed, and the eye, therefore, to be in the condition in which it would have been, had the patient submitted to its extraction or solution for the cure of that defect of vision occasioned by the "increased refractive powers" of the conical cornea. In the case before us its presence would only have the effect of augmenting the undue convergence of the rays. I have not taken into calculation the refraction of the rays by the vitreous humour, as this is foreign to my object, but have allowed them to pass on in straight lines. It may be well, notwithstanding, to keep in view that the index of refraction of the cornea and aqueous humour, taken together, is 1·337, or, the sine of incidence and refraction as four to three; that the mean refractive index of the crystalline lens is 1·384; and the refractive index of the vitreous humour, 1·339.

Neither must it be forgotten, that, in the disease under consideration, the sphericity of the cornea, so to speak, is totally lost, saving so much of its obtuse apex as approximates to the form of the healthy cornea, and that we have no longer to treat an ellipsoid of revolution, but a plane surface, the slant sides of the cone.

In the annexed diagram, Fig. I., let ABC represent the sclerotic coat of the eye, magnified four diameters. DD the healthy cornea. EE the sides of the corneal cone, subtending with the apex F an angle of ninety-two degrees. FB the axis of the eye. GG the iris. L a ray coincident with the axis of the eye FB. HIJK k j i h are rays parallel thereto. Kk traverse the corneal cone at the same distance from its apex F, and intersect the line of its axis at the point M, decussate and pass on to Qq. Jj intersect the same line at N, decussate and pass on to Rr. Ii at O, decussate and pass on to Ss; and Hh at P, decussate and pass on to Tt.

In Fig. II. let ABC, as before, represent the sclerotic coat of the eye, magnified four diameters. DD the healthy cornea.

EE the sides of the corneal cone, subtending with the apex F, an angle of ninety-two degrees. FB the axis of the eye. GG the iris. Let H be a ray from the object viewed coincident with the axis of the eye, and let II, two rays parallel thereto, traverse the corneal cone at the same short distance from H, the refraction being there inconsiderable, they intersect the axis at the point χ. JKLM, four converging rays falling on the sides of the cone at no pq, and refracted, J to a—K to β—L to γ—M to δ. N, a cone of five rays, $\varepsilon\zeta\eta\theta\iota$, falling upon the side of the corneal cone near its base, the peripheral rays $\varepsilon\iota$ at $\kappa\lambda$, and refracted, ε to a—ζ to b—η a ray perpendicular to E, the side of the corneal cone, passing on unrefracted to c—θ refracted to d—and ι to e. OPQRSTU, seven converging rays falling upon the opposite side of the cone below I, and refracted, O to f—P to g—Q to h—R to i—S to k—T to l—U to m. V, a cone of six rays, $\mu\nu\xi o\pi\varrho$, falling upon the side of the corneal cone near its base, the peripheral rays $\mu\varrho$ at $\sigma\tau$, and refracted, μ to n—ν to o—ξ to p—o to q—π to r—and ϱ to s.

It will be seen that in Fig. II. the ray coincident with the axis of the eye, and those parallel thereto, falling upon the obtuse summit of the cone, which, at this spot, bears some resemblance to the natural cornea, pass through it, the latter being duly refracted by it and the aqueous (and crystalline, if not removed) and vitreous humours, depicting on the retina the image of the object viewed; as, for instance, in the case before us, the patient was able to distinguish the point of his brother's nose and his mouth, and, by converging the rays through the pinhole aperture of the card, even to read small print. JK, from excess of refraction, decussate in the anterior chamber, and pass through the pupil; L and M likewise decussate, and are then lost on the anterior surface of the iris; whilst OPQ, though they do not decussate each other, are yet crossed by JKLM; but RSTU decussate each other, and intersect all the rest. Confusion of vision is consequently produced, and the patient is unable to distinguish objects in these different directions. The

Fig. II

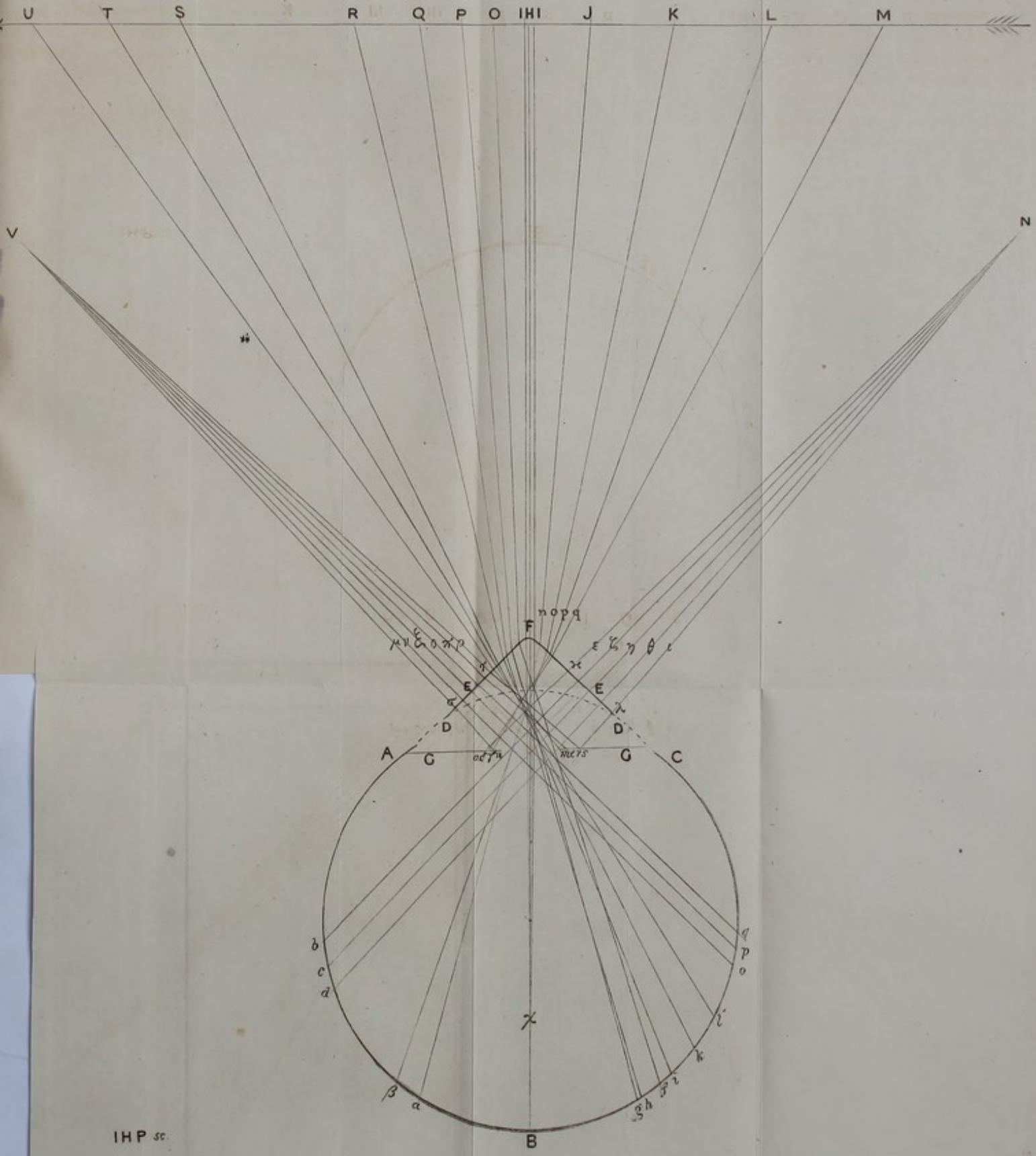
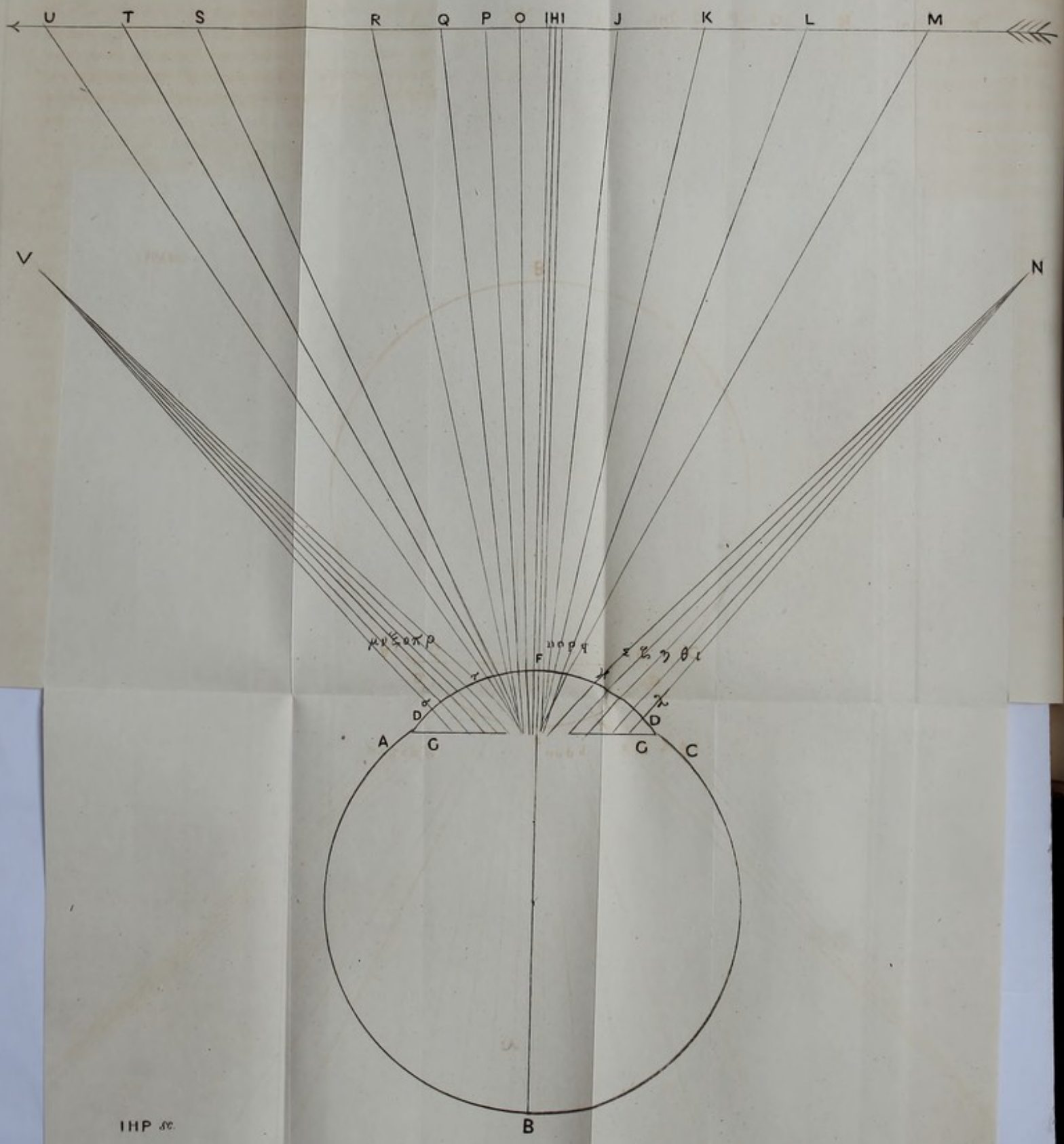


Fig. III



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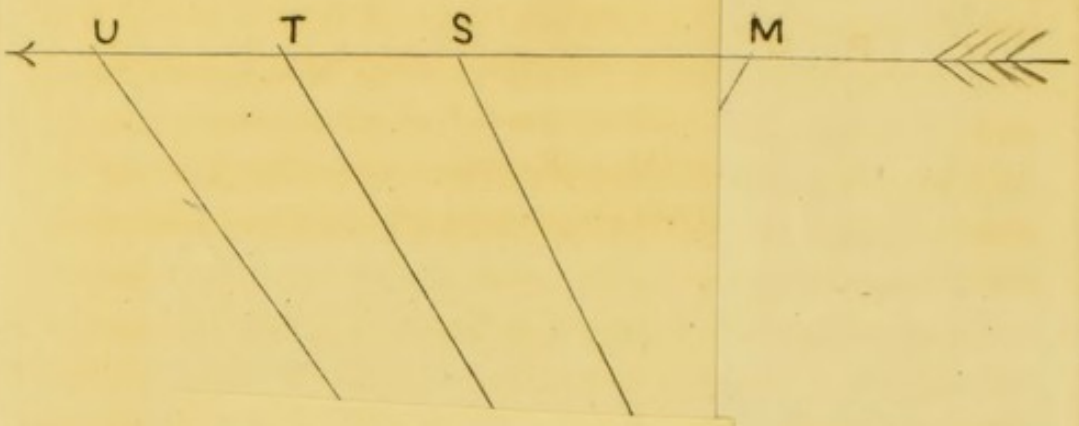
U
T
S
M


V
N

cone of rays N, on the other hand, striking almost perpendicularly on the side of the cone E, suffer but little refraction, and proceed onward nearly in straight lines, except such as are reflected from the iris: this applies equally to the cone of rays V. Hence, the patient sees on the nasal, superior, inferior, and temporal sides of the cone near its base, as instanced above.

The numerous crossings and decussations of the rays in Fig. II., which take place in the anterior chamber, and before the rays can have reached the lens, plainly shew that the removal of the lens can neither compensate for this intricacy of distorted rays, nor rectify the irregularities of their course; much less unravel the labyrinth of confusion created by the excess of refraction by the corneal cone. How then, let me ask, can we be justified in recommending the removal of a sound part of the organ of vision, in order to cure an error of function occasioned by disease of another part? The lens is not at fault, and its removal is not only uncalled for, but ought, on every principle, to be strongly deprecated.

Fig. III. shows the course which the same rays, falling upon a healthy cornea, would take in their passage through the anterior chamber.

If it be contended, that the solution of the lens would admit of a sinking or flattening of the corneal cone, it must be replied, that no such sinking or flattening could ensue. Let us suppose, for the sake of argument, the disease to consist in a superposed solid cone of diaphanous matter, a morbid growth of the centre of the cornea, it could not sink, neither could it flatten, nor become more obtuse; and if, on the other hand, we are to consider it as consisting in an altered form of the anterior chamber, an increase in the antero-posterior diameter, a hollow corneal cone, with vertex of extreme tenuity, the sides increasing in substance towards the base, as described by Jäeger, an increased secretion of the aqueous humour, consequent upon solution of the lens,

would, in either case, fill the space previously occupied by this body, and thus perpetuate the deformity and the disease.

Until, therefore, the external form of the cornea be changed,—until this conical projection, be it a solid cone, be it, on the contrary, a hollow cone, with vertex of extreme tenuity, increasing in substance towards the base, be got rid of, all, or nearly all, the pencils of light incident to the upper portion of its surface must be unduly refracted, producing excessive and irregular convergence, and consequent confusion in the direction of the rays of light, for which nothing can compensate, which nothing can rectify, neither the abstraction of the natural lens nor the superaddition of an artificial one. Hence, I repeat, the removal of the lens is uncalled for, injudicious, and indefensible.

The late Mr. Tyrrell hit upon a very ingenious, though very inefficient expedient for remedying the defective vision. "It consists in altering the position of the pupil, and removing it from beneath the centre of the cornea, or that part which has its figure most changed, to near the margin, where the least change has occurred; the error in refraction is consequently much lessened, and the vision becomes more perfect, and the focus lengthened."* This he effected by puncturing the outer and lower part of the cornea with a broad needle, and then dragging into the wound and strangulating it there, the pupillary margin and so much of the temporal portion of the iris "as is requisite to cause the pupillary opening of the iris to change its position, from the centre to the outer and lower part of the cornea."†

By this "simple plan," he says, he has "benefited the vision, and in two cases very considerably."‡ It is evident, however, that the beneficial effects of the operation upon vision must have been of an exceedingly limited and one-sided character,

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* Op. cit. vol. i. p. 277. † Ibidem, p. 278.

‡ Ibidem, p. 279.

insomuch as, supposing the new pupil to be at that part of the iris between G and Dλ, Fig. II., the sole advantage gained would be, that rays parallel with the axis of the eye, from objects viewed between J and K, incident to the corneal cone with $\theta\iota$, would enter the pupil, as would also rays from LM. Objects from N and V were before visible, and remain nearly unaffected by the operation. On the other hand it does not obviate the confusion occasioned by the excessive refraction by the corneal cone.

Whilst, then, means have been proposed as curative, and experimental measures have been multiplied, the results have been uniformly unsatisfactory and abortive. Writers, how much soever they may have differed in their pathology and indications of cure, are unanimous on this point.

III.—*With reference to a more successful mode of treatment.*

I now proceed to detail three, out of several cases which I have treated during the last ten or eleven years, both in public and private practice, under a full conviction of the truth of the observation so frequently made by one of my most gifted teachers, the late Mr. Abernethy, "that a case is worth all the reasoning in the world, and one fact better than a hatfull of theory."

Case I.—Hannah Hudson, æt. 28, was admitted under my care, May 1, 1832, a patient of the Brighthelmstone General Dispensary, with conical cornea of the left eye. I directed a blister for the temple, to be dressed with cerat. cantharidis; five grains of blue pill to be taken every night, and a mixture with quinine and Epsom salts, twice during the day.

May 5th. Iodine was exhibited internally, used externally as a collyrium, and rubbed into the eyelids every night, in the form of ointment.

June 7th. I directed, in addition to the iodine, an emetic, consisting of zinci. sulph. gr. xxv., to be taken early in the morning twice a week.

July 12th. A disposition to the same disease in the right eye much lessened. There is still a circle round objects viewed with this eye, yet she can see to read with it better, and at a greater distance.

July 23rd. A slight attack of fever suspended the treatment until the

26th. The emetics were now exhibited every morning; the iodine was continued externally and internally; occasionally, leeches were applied to the eye, and unguentum hydrargyri fortius was substituted for the unguentum iodinii. Under this combined treatment she remained, with trifling and unimportant variations, until

Oct. 25th, a period of nearly six months, when she was discharged "*much relieved.*"

The success attendant on this mode of treatment was exceedingly gratifying and encouraging.

About this time, in consequence of a suggestion of Mr. Guthrie,* I determined to make use of emetics and purgatives only, without iodine, combining the aperient with the emetic, as prescribed by him. In the above case, my object in administering iodine was to endeavour to promote absorption, through its agency, of that which I then believed to be superposed deposit of corneal matter. It was not long before an opportunity presented itself for putting this modified plan of treatment into operation.

Case II.—Anna Hollands, æt. 21, said to be subject to "epileptic fits," but which were, more probably, of an hysterical character, was admitted, under my care, 12th March, 1833, a patient of the Sussex and Brighton Infirmary for Diseases of the Eye, with conical cornea.

On her admission the left eye only was affected. She was ordered to take

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* *London Medical and Surgical Journal*, vol. i. p. 361; Lectures delivered at the Royal College of Surgeons in London, 1832.

Zinci sulph. ℈ i.
Magnesiæ sulph. ʒ iv.
Primo mane quotidie.

She persevered with the emeto-purgative plan for upwards of twelve months, when she was discharged "*perfectly cured.*"

About eighteen months after her discharge she was re-admitted, the disease having returned. The same treatment was steadily pursued for several months, *with like good results.*

I copy a few observations made from time to time in my note-book.

March 19th, 1833. Says she sees better. Upon looking at a candle, sees a circle nearly twelve inches in diameter.

26th. Says the circle round the candle is not more than four inches in diameter. Sees every thing very much better.

April 9th. Circle diminishing. Now about the size of a tea-cup.

23rd. Size of a wine-glass.

In this way the improvement progressed gradually towards "*perfect recovery.*"

I frequently inquired of her, during the treatment, whether she found the emetics and purgatives debilitate her, or interfere with her general health, to which she invariably replied—"no, but that, on the contrary, *her health had improved.*"

It appears that in 1836 this patient's right eye became affected with the same disease, but though she accompanied to the Eye Infirmary, in September, 1839, her friend Mary Boys, who lives in the same village, and whose case is detailed below, she was not desirous of submitting to that treatment which had cured the left eye, "*because she was able to see as well as ever with that eye.*"

May 22nd, 1843. I saw Anna Hollands this day. The left eye continues perfectly free from disease. She can see with it to read the smallest print with ease, and without any assistance

from glasses. The right eye is in much the same condition as it was in 1836—very conical.

Case III.—Mary Boys, æt. 27, a dressmaker, admitted, under my care, a patient of the Sussex and Brighton Infirmary for Diseases of the Eye, 10th Sept. 1839, the subject of conical cornea of the left eye to an extreme degree.

Was ordered to take

Antimonii potassio-tartratis gr. i.
Magnesiæ sulph. ʒ iv.
Primo mane quotidie.

Dec. 13. Decidedly better. Cornea flatter.

Feb. 4th, 1840. Cornea flatter. Says she can see better.

March 17th. Cornea very much flatter. Says she can see better. From this time she absented herself from the Institution, with the exception of occasional visits.

Aug. 21st. I saw her again; says she "sees much the same." The right eye has a slight conical appearance, which, she thinks, begun about three months since. Left cornea flatter.

Nov. 24th. Can see much better; and, at her own request, was discharged.

May 10th, 1842. She was readmitted with conical corneæ. The emeto-purgative plan was again had recourse to. She took the remedies more or less regularly, at first every day, and then once or twice a week only, from this date to

May 2nd, 1843, when the corneæ being nearly flat, she was discharged, sufficiently recovered to resume her business, *improved in health*, having gained flesh during the treatment.

The detail of similar cases could not add anything to that which has been already stated.

It is worthy of observation, that, in Case I., despite the full and free employment of the iodine for five weeks, no diminution of the disease took place until after the emetics were combined with it and the aperient. How much soever I might then have been disposed to attribute a portion of the benefit to the absorbent power of the iodine, subsequent experience has shown

me that the sole merit is due to the emeto-purgative plan of treatment.

I am now in the habit of prescribing zinci sulphas, which I much prefer to antimonii potassio-tartras, having found that its good effects are fully equal to those of tartar emetic, whilst its operation is certainly much less distressing to the patient. Repeated experience has confirmed this preference.

The Association will not have failed to have remarked the fact of the return of the disease in Case II. after the discontinuance of the emetics, and of its subsequent removal by their re-employment. Neither will the circumstance of the second eye becoming affected after this period, and the continuance of the disease up to the present time, *without treatment*, have escaped attention.

In Case III. it will be seen that the interruption to the plan of treatment from 4th February to 21st August, afforded the other eye an opportunity of developing the disease.

IV.—*An attempt to explain the rationale of such treatment, by a reference to the anatomical structure of the part affected, and to the probable pathology of the disease.*

It would be matter of absolute impossibility to attempt to account for disease, or to explain either its pathological condition, or the action of remedies, without due reference to the anatomical structure of the part under consideration; but, on the present occasion, on the very threshold of our investigation, we are beset with difficulties and obstructions.

I am yet not without hope of being able to approximate somewhat towards the rationale of the treatment, and modus operandi of the medicine.

Mr. Guthrie professes to know nothing about it. He appears to have prescribed tartar emetic and epsom salts, as I prescribed sulphate of zinc and sulphate of magnesia, with iodine, "empirically."

We are told by some anatomists, that the cornea, that membrane which fills so important an office in the animal economy,

has not any blood-vessels, absorbents, or nerves.* Better to have said, "doubtless it has not only blood-vessels, but nerves and absorbents, though inappreciable to our senses." For why deny to the living cornea the existence of that, of which, under disease, we have daily evidence.

Transparency of the most perfect kind is essential to the cornea, but do we not see healthy and diseased actions take place in this membrane as rapidly as in any other part of the body, and can we for a moment suppose that it is unorganized? Are we to be left to infer that Infinite Wisdom has not the power to create transparent vessels and nerves? Because our visual organs cannot detect their delicate and diaphanous texture, though our reasoning faculties must admit their presence, are we therefore to deny their existence? We ought rather to be struck with increased wonder and admiration at this further proof of beauteous and harmonious design in the works of Omnipotence, and of his admirable adaptation of means to the end. Need we be reminded that we are "fearfully and wonderfully made."

The cornea, in common with other structures, is liable to inflammation, ulceration, suppuration, mortification, &c. In ulceration of this membrane, for instance, do we not see vessels carrying red blood to the ulcerated portion? Are we to suppose these vessels had no existence previously, and that they were just formed for the express purpose of repairing the disease? If so, it would imply an innate power of creating vessels for the repair of mischief, when that mischief arose; with another more extraordinary power still, that of getting rid of them, most effectually, when no longer necessary! What, I would ask, becomes of these vessels when the injury is repaired? They are no longer visible. Do they merely cease to carry red blood? Do they then circulate only serous matter, or are they altoge-

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* Elle ne parait pas contenir de nerfs ni de vaisseux sanguins.—*Anatomie de l'homme*, par Jules Cloquet, tom. iii. p. 345; Paris, 1828.

ther obliterated? We must admit, inferentially at least, that there are vessels, diaphanous vessels, but that they carry only the thinner and serous parts of the blood, serous vessels. How, otherwise, could disease be removed or could wounds heal? After an operation for extraction, for instance, whence comes the plastic matter which glues together the lips of the wound? Blood-vessels, then, must and do exist in the cornea.

But are there also absorbent vessels and nerves? That there is an *absorbent function* no one will pretend to dispute, though the existence of lymphatics, until lately, was denied.

It is an acknowledged truth, that nerves always accompany blood-vessels. If, then, we admit the presence of the latter, though of so translucent and admirably delicate a texture that they elude our search, our microscopic investigations, our most powerful lenses, may we not infer that the usual accompaniments of blood-vessels exist here, as elsewhere.*

Touch but the cornea, or, rather, its external covering, with the finger nail, are not excruciating pain and lachrymation induced? Does it not feel most acutely? But, it may be said, the covering of the cornea is not the cornea. I admit it; but it is, nevertheless, endowed with the most exquisite sensibility, the product, be it remembered, of nervous presence; yet, this investing membrane is also diaphanous. No nervous fibrils are seen threading their way over its surface; yet, there they are, and in a most refined and exalted state of sensibility.

But what direct proof, if any, have we that blood-vessels, nerves, and absorbents exist in the cornea? What say anatomists, of the cornea, and of its organization?

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* Sir John W. F. Herschel, when speaking of the probable muscular structure of the crystalline lens, says, "in it we have satisfactory evidence of a muscular structure; and, were it not so, the analogy of pellucid animals, in which no muscular fibres can be discovered, and which yet possess the power of motion and obedience to the nervous stimulus, though nerves, no more than muscles, can be seen in them, would render the idea of a muscular power resident in the crystalline easily admissible, though nerves have as yet not been traced into it."—Article "Light," in *Encyclopædia Metropolitana*, p. 397, § 356.

"The cornea consists of three layers besides the delicate layer of epithelium which invests its free surface. The most superficial layer is rendered, by hot water, immediately of a snowy-white colour; the most internal lamina is the aqueous membrane, which is attached to the lamina fusca of the sclerotica; the middle layer, which constitutes the chief substance of the cornea, is formed of an interlacement of bundles of bright fibres without any intermixture of corpuscules. This is, according to my observation, reduced wholly to chondrin by boiling."*

The same writer says, "the existence of vessels in the substance of the cornea is doubtful; they have never been injected.† Nevertheless, penetrating ulcers and granulations are formed in the cornea, which can scarcely be conceived to occur without the agency of vessels. In calves, of nearly the full time, I have repeatedly seen vessels containing red blood in the corneal conjunctiva, and could trace them with a lens more than a line over the margin of the cornea. Henle has injected and made drawings of these vessels; they measured from $\frac{1}{1319}$th to $\frac{1}{694}$th of an inch, and the finest twigs were not then injected; their trunks, which arose from a circular vessel that ran around the cornea, were somewhat larger. I have the preparations of these parts in my possession. Professor Wutzer has seen them. Professor Retzius has injected similar vessels in adult animals. It is well known that, in inflammation, the cornea contains vessels carrying red blood. I saw at Utrecht, in the possession of Schroeder van der Kolk, a most beautiful injected preparation of a slightly inflamed eye, in which the conjunctiva as well as the aqueous membrane were injected."‡

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* *Elements of Physiology*, by J. Müller, M. D.; translated from the German, by William Baly, M. D., 2nd edition, vol. i. p. 390; London, 1840.

† Professor Römer of Vienna has succeeded in injecting them.—*Bemerkungen über die arteriellen Gefässe der Bindehaut des Augapfels;* vom Professor Dr. Roemer, in Wien; in Professor Dr. Friedrich August von Ammon's *Zeitschrift für die Ophthalmologie*, vol. v. p. 21. Heidelberg und Leipzig, 1837.

‡ Op. cit. vol. i. pp. 227–8.

" All these facts, however, render it very probable that even the cornea and capsule of the lens, to which vasa serosa have been hitherto ascribed, are really provided with vessels carrying red blood.*

" While, however, we maintain that blood vessels exist even in transparent membranes, we by no means prove that all the vessels of these parts are of such size as to admit the red particles of the blood. On the contrary, it is probable that the greater part of the more delicate vessels of these parts transmit only the fluid part of the blood, the liquor sanguinis."†

Mr. Travers says, " Numerous lines have been observed to form figures of many sides between the plates of the cornea in the eye of the negro, and supposed, from a reddish tinge, to be blood-vessels."‡

Mr. Charles Bell says, " In an eye in which the tunica conjunctiva was most minutely injected, as well as the internal vessels of the eye, I had resolved carefully to examine the structure of the cornea; and after a long maceration, in which it had greatly swelled, I observed a set of vessels totally distinct from the extremities of the minute blood-vessels. The minute blood-vessels which were injected, stopped abruptly on the margin of the cornea. But these I now mention are particular; they are in great profusion, large, and perfectly pellucid; they are large towards the middle of the cornea, and diminish towards the margin. Their free communication formed a net work, deep in the thickened substance of the cornea. The size, perfect pellucidness, and intimate connexion of these vessels, might, perhaps, incline one to call this a cellular structure."§

Lymphatics abound in the cornea; they have been injected with mercury by Fohmann, who has shown that they exist in the greatest profusion throughout its substance. Arnold has

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* Op. cit. vol. i. p. 228. † *Ibidem*, vol. i. p. 229.

‡ Op. cit. p. 20.

§ *The Anatomy of the Human Body.* By Charles Bell, vol. iii. pp. 250, 251. London, 1803.

given a figure of them in his *Tabulæ Anatomicæ*, fascic. II. tab. 2, fig. 7 and 10.

With regard to the nerves of the cornea; the only direct evidence we have of their existence, is on the authority of Dr. Schlemm of Berlin,* who states, that "he has traced branches of the ciliary nerves into the cornea." This, however, has been most positively disputed by Arnold,† after a very patient and minute dissection and microscopic examination of the eyes of man and the larger animals.

If, however, the actual existence of nerves in the cornea is to be disputed because we cannot detect their presence, their influence upon the blood-vessels and absorbents, which have been recognized, cannot, under any circumstances, be denied.

The ciliary nerves, it will be remembered, are derived from the lenticular ganglion, and nasal branch of the first division of the fifth pair.

The lenticular ganglion derives its long root from the nasal branch of the first division of the fifth pair, which branch, before it enters the orbit, receives a filament from the superior cervical ganglion; and its short root from the third pair of nerves; and receives, also, a distinct filament from the cavernous plexus of the sympathetic, connecting it with the rest of the sympathetic system.

The ciliary nerves, therefore, communicate with, and derive their influence from, the cerebro-spinal and sympathetic systems.

The general sensibility of the eye is derived from the ophthalmic nerve and its nasal branch, whilst the *nutrition* of the organ is *under the influence of the sympathetic*. This nerve, by virtue of its connexion with the lenticular ganglion, exercises

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* *Encyclopädisches Wörterbuch der Medicinischen Wissenschaften*, vol. iv. pp. 22, 23. Berlin, 1830. Quoted by the editor of Ammon's Zeitschrift, vol. i. p. 113, under the section devoted to *Ophthalmologische Miscellën vom Herausgeber*. Dresden, 1830.

† *Anatomische und Physiologische Untersuchungen ueber das Auge des Menschen*, von Dr. Friedrich Arnold, pp. 20-23, pl. I. fig. 2. Heidelberg und Leipzig, 1832.

immense influence over the nutrition of the eye. If the superior cervical ganglion be removed, inflammation of the eye, with effusion of lymph, ensues; the same occurrence has been remarked by Mayer after tying the sympathetic nerve.*

In a deteriorated condition of the general health, the cornea frequently ulcerates. Of this we have daily examples in squalid, half-starved, atrophied and strumous children. As often do we see this state kept up or aggravated by leeches, blisters, low diet and darkened rooms, and as often rapidly get well under the opposite mode of treatment.

Dr. Mackenzie says, that "in emaciated infants particularly, he has repeatedly seen the cornea of one or both eyes become thin and prominent, and give way without much, and even without any apparent inflammation." "In 1832," he "saw several instances of the same destructive ulceration of the cornea, occurring after malignant cholera."† He aptly compares the state of such eyes to that of those wretched dogs, which Majendie, in the wanton performance of some of his miscalled scientific experiments, doomed to be fed, or rather starved, on purified sugar and distilled water, until they died from inanition, their death being preceded by perforating ulcer of the cornea, and evacuation of the humours.‡ These revolting immolations of brute creation at the shrine of science and philosophy, are a disgrace to humanity and the nineteenth century.

If it be ceded that blood-vessels, absorbents, and nerves exist in the cornea, there will be no difficulty in understanding how debility of the nerves may induce faulty action of its absorbent and nutrient vessels. For there is no local disease which has not its origin in the nerves of the part affected.

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* *Gräfe und Walther's Journal der Chirurgie und Augen-Heilkunde*, vol. x. p. 3. Berlin, 1828.

† Op. cit. p. 577. See also, *A Case of Ulcerated Cornea from Inanition*, by Joseph Brown, M.D., in *Edinburgh Journal of Medical Science*, vol. iii., p. 218. Edinburgh, 1827.

‡ *Memoire sur les Propriétés Nutritives des Substances qui ne contiennent pas l'Azote*, p. 7. Paris, 1816.

On this point my highly talented and valued friend Dr. Billing says, "all *diseases*, in fact, commence, as I have already repeatedly said, by disturbance of the function of the solid parts of the machine; and, first of all, of the nervous system. This is solidism or neuro-pathology. The nervous system, it is superfluous to repeat, regulates and supplies all with energy. There is no organic sensibility, or organic contractility, independent of the nerves. Every natural impression is received by the nerves; every morbid agent is first felt by, and operates upon the nerves. Inflammation of cellular tissue, bone, conjunctiva, &c., through mechanical or other violence, result, as we have shewn, in consequence of injury to the peripheral nerves and to the capillaries."*

Diseased action having been once set up, whether in the absorbent or nutrient vessels matters not, either removal of, or additions to parts existing must ensue. Hence, if the absorbents be over active, thinning of the cornea would result, whilst nature, ever anxious to repair an evil, would be busied in depositing new matter, *externally*, to counteract the ill effects of the increased action of the absorbents going on *within*. This will explain the *growth* of the disease, and also the irregularities of the external surface of the corneal cone, described by Sir David Brewster; the central and internal depression, with circumferential thickening, found by Jäeger; the hollow cone with vertex of extreme tenuity, gradually increasing in substance towards the base; and will, at the same time, account for "the laminæ being less moveable upon each other," as described by Mr. Middlemore, and, also, for the cornea not "giving way," upon the principle of its elongated form being *the product of growth*, and not, as Mr. Travers states, "the consequence of its having lost its natural resistance to the pressure of the contents of the globe."

Hence, I feel I am justified in stating that I believe conical

* *First Principles of Medicine*, by Archibald Billing, M.D., 4th Edit. p. 225. London, 1841.

cornea, *ceratoconus*, to depend upon faulty action, induced by debility of the nerves of the cornea, of its absorbent vessels, calling for an increased deposit from the nutrient capillaries, to repair the mischief arising from such faulty action.*

The disease is analogous to hypertrophy, with dilatation, of the ventricles of the heart, and to aneurism.

I would merely glance at the possible similarity of arrangement which the vessels and nerves of the cornea may bear to those of the membrana pupillaris. Converging, as they must, more or less, like rays to a centre, it would result, that the central part of the cornea must be the point where all meet. If, then, by impaired nervous energy, faulty action be communicated to the nutrient and absorbent vessels, we should have undue absorption and deposit at this identical point.

It may be replied that, admitting the reasoning to be just, I am here making general what ought to be considered the exception, and that, with this notion, every one ought to have conical cornea. Not so; the exception is the faulty action of the vessels, the consequence of some particular constitutional tendency. I merely speak of their probable arrangements, terminations, and commencements. In a state of diseased action, with such an arrangement, I think it more than probable that such a result might be foreseen and calculated upon.†

I shall now, therefore, submit the probability, in the disease under consideration, of gastric or intestinal disturbance or irritation, inducing, through the medium of the par vagum, sympathetic, and ciliary nerves, faulty action of the absorbent and nutrient vessels of the cornea, the combined effect of which would be conical cornea.

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* This increased deposit would observe the same laws as do parts which are undergoing hypertrophy, where, though the nutritive matter effused assumes first the form of nucleated cells, yet each tissue exerts a different assimilating influence on it, and causes the transformation of the cells into tissue of its own kind, and not into mere fibrous or cellular tissue, as is seen in inflammation.

† Professor Römer has lately shewn, by injection, that such is the actual distribution of the blood-vessels of the cornea. Op. cit.

Had the time permittted, it was my intention to have discussed, more fully, the rationale of the treatment before detailed.

I must now content myself with remarking, that whatever would restore the healthy functions of the nerves, or increase the energy of the nervous system, so as to communicate to the capillaries of the part a tone or power to resume their healthy action, would give a check to the disease, and that a continuance of healthy action would allow time for the cornea to reacquire its normal form and refractive powers.

We have not a sufficient number of recorded experiments to determine directly the influence of the nerves on the action of the capillaries.

I cannot, however, on this point, do better than quote the words of my friend Dr. Billing. "Let us see," says he, "how far we can go in proving that the *capillaries depend* upon *nervous influence* for their contractile *action*. Blushing is, perhaps, the most unequivocal proof that an alteration in the nerves is the cause of sudden dilatation of the capillaries. It is not the action of the heart alone which causes the partial flush, for, first, the heart often acts stronger without causing blushing, and next, the blush is partial; whereas, when the mere action of the heart causes increased redness of the skin, as from exercise, it is not partial, as it is in blushing from mental emotion. And this, which is sudden weakness of the capillaries, has been commonly attributed to the 'increased arterial action,' and 'determination to the face.' I attribute this giving way of the capillaries to derivation of the nervous influence, which, being directed to or expended in the brain more freely by mental emotion, robs, for the moment, the capillaries of the face of their energy."*

The same writer has shewn that "emetics and purgatives possess a sedative and constringent power,"† and that "antimony

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* Op. cit. pp. 27, 28. † Ibidem, p. 171.

exerts a locally tonic or astringent effect on the capillaries of inflamed or congested parts, as well as on those of all the secreting structures."*

It is worthy of consideration how far small and constantly-repeated doses of antimony, or of any other metal, such as mercury, zinc, or copper, may produce the same beneficial effect upon the disease as emetics with purgatives. Formerly, fever was treated by the daily exhibition of emetics. We now obtain equally good results from small and oft-repeated doses of antimony.

The disease in question consists, essentially, in debility and elongation of the capillaries of the part, with morbid deposits. The cure, in their retraction by means of tonics.

It would occupy too much of our time to enter as fully as the interesting nature of the subject demands, into the different forms of sympathy, and their application in the treatment of disease. On these points the ably written chapter on "Sympathies," in Baly's translation of "*Müller's Physiology*,"† will amply repay an attentive perusal.

In conclusion, I may repeat, that I believe conical cornea to depend upon some disturbance in the functions of the great sympathetic, spinal nerves, and par vagum; producing, through the medium of the lenticular ganglion and fifth pair of nerves, faulty action of the nutrient capillaries and absorbent vessels of the cornea itself: that emetics and purgatives, by the powerful influence they induce upon the gastric, associate, and consensual nerves, restore the healthy functions of the weakened nutrient and absorbent vessels, the result of which is a slow but progressive retraction of the diseased corneal growth, and a consequent restoration of vision.

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* Op. cit. p. 99.

† 2nd Edit. vol. i. p. 804.

THE END.

Doctor Craigie,
with the sincere regards of his
friend the Author —

November, 1837. —