Local anæsthesia in general medicine and surgery : being the practical application of the author's recent discoveries / By J. Leonard Corning.

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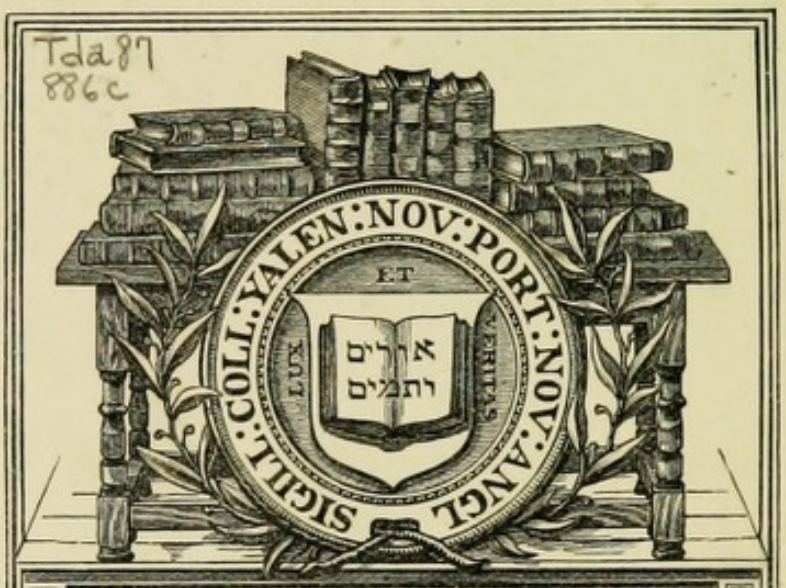

"I give these Books
for the founding of a College in this Colony"

President Franklin Carter
with the sincere regards of
the author J. Howard Comings

Jan. 14th. 1889.

LOCAL ANÆSTHESIA

IN

GENERAL MEDICINE AND SURGERY,

BEING THE PRACTICAL APPLICATION OF THE AUTHOR'S RECENT DISCOVERIES.

BY

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1886.

TO

FRANK P. FOSTER, M. D.,

THESE PAGES ARE INSCRIBED

AS A SLIGHT TOKEN OF

ESTEEM AND PERSONAL REGARD.

PREFACE.

NEXT to averting death, the most royal prerogative of the modern physician is the annihilation of pain.

Be he physician or surgeon, the medical man of to-day will find that his reputation as a man of parts hinges in great measure upon his ability to avert or relieve suffering. Just in so far as he is able to accomplish this without danger or inconvenience to his client will he meet with success in the practice of his profession. Let this fact serve, then, as an excuse for the present contribution to practical neurology.

The spontaneous and practically universal notice accorded my discovery, upon which this *brochure* is based, has been a source of some surprise to the author. I should indeed be guilty of affectation did I not confess that this testimony of approval on the part of my colleagues in the profession has caused me satisfaction. As time rolls on, I shall hope to prove not unworthy of this confidence.

26 WEST FORTY-SEVENTH STREET,
NEW YORK, *November*, 1885.

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PART I.

HISTORICAL AND PRELIMINARY.

I.

CEREBRAL ANÆSTHESIA.

Although the pursuit of pleasure has constituted such an important element in human history, it is none the less true that the quest of real or imaginary enjoyment has brought in its train a thousand aches of mind and body alike. With all our vaunted progress in the arts—with all our philosophy—with all our sociological complications—we yet stand on the brink of an abyss of misery. It is but natural that, failing to eliminate the causes of suffering, man should have attempted to exorcise pain by occult spells or more cunning devices. Anæsthesia is the outgrowth of this idea.

From the remotest ages humanity has sought exemption from the bodily pain resulting from wounds, disease, or surgical operations. Thus, we are told that the ancient Assyrians alleviated and even entirely prevented the pain incident to circumcision by compressing the veins in the neck. It is probable,

however, that the unconsciousness thus induced was owing to concomitant compression of the carotids. In recent times compression of the carotids has been revived by myself in the form of mechanical and electro-mechanical compression.*

In India the soporific properties of opium and Indian hemp have been well known for countless ages, and it is also probable that the ancient Egyptians were conversant with the sleep-giving virtues of various substances. Of the exact nature of the soporifics employed by the Egyptians we are unfortunately not in a position to judge at the present day. About the commencement of the Christian era the surgeons were accustomed to employ a drug which possessed the power of producing unconsciousness for several hours. This was undoubtedly the potent mandragora which maintained a lofty position among the priests, soothsayers, and medical charlatans of the ancient world. When employed as an anæsthetic, mandragora was prepared with wine; the draught prepared in this manner was known as *morion* among the Grecian physicians.

* "Prolonged Instrumental Compression of the Primitive Carotid Artery as a Therapeutic Agent," by J. Leonard Corning, M. D., New York. "Medical Record" for February 18, 1882. Also article in "Philadelphia Medical News" of June 17, 1882; likewise published in the "American Journal of Neurology and Psychiatry," 1882. See, also, "Brain-Rest: A Disquisition on the Curative Properties of Prolonged Sleep," Second Edition, by J. Leonard Corning, M. D. G. P. Putnam's Sons, New York, 1885. For paper on the combined application of compression and electricity, see "Electrization of the Sympathetic and Pneumogastric Nerves, with Simultaneous Bilateral Compression of the Carotids," by J. Leonard Corning, M. D. "The New York Medical Journal" for February 23, 1884.

Probably the earliest reference to anæsthesia by inhalation is contained in the works of Herodotus. According to this authority, the Scythians were in the habit of producing intoxication by the inhalation of the vapors of a peculiar kind of hemp. As Lyman observes, this was probably a drug resembling *hasheesh.*

It is said that Theodoric, a famous surgeon of the school of Bologna, was in the habit of preparing a soporific inhalant for the benefit of persons about to submit to severe operations. The fluid in question contained hyoscyamus, hemlock, lettuce, ivy, mandragora, deadly nightshade, and opium; it was administered upon a sponge previously saturated with hot water, and is said to have possessed great potency.

With the decline of surgery and other superstitions of mediævalism, the employment of these powerful agents progressively diminished, until, at the close of the eighteenth century, physicians of good repute were content to cause intoxication with spirits or to employ opiates moderately.

About this time what may perhaps be considered as the first attempt at local anæsthesia was made. James Moore, a surgeon of England, published, in 1784, a monograph entitled "A Method of preventing or diminishing Pain in Several Operations of Surgery." The principal feature of this method consisted in the employment of clamp-like devices, by means of which it was possible to apply pressure of any degree of severity to the nerve-stems of the extremities upon which the operation was to be under-

taken. Although the method of Moore was put to a practical test by several medical men of eminence, it did not accomplish what he had been led to anticipate, and was eventually completely forgotten.

In 1799 Sir Humphry Davy, then a young man, discovered the intoxicating effects of nitrous-oxide gas. Owing, however, to a variety of causes, one of the principal of which being certain technical difficulties connected with the manufacture of the gas, this important discovery did not receive an extensive practical application till many years afterward.

Most of the following facts connected with the discovery of the anæsthetic properties of ether are taken from Dr. Lyman's well-known book on anæsthesia, to which I am indebted for the principal facts contained in this historical *résumé:* "In the year 1839 a party of boys, in Anderson, South Carolina, were thus amusing themselves (with the inhalation of ether), when in their excited mood they seized a negro boy who was watching the antics of his betters, and by main force compelled him to inhale the ether from a handkerchief which was held over his mouth and nose. At first his struggles only added to the amusement of his captors; but soon they ceased; the boy was unconscious, motionless, stertorous—evidently dying. But, after an hour of consternation on the part of the spectators, he revived and was no worse for his alarming experience. Three years after this occurrence one of the actors in this affair, a young man named Wilhite, entered the office of Dr. W. C. Long, a physician who was then practicing in the town of Jefferson, Jackson County, Georgia. The worthy

doctor and his pupils were in the habit of diversifying more serious occupations by the inhalation of ether, and during the course of this amusement he often observed that while thus excited he was quite insensible to the effects of the blows and bruises which were sustained in this condition. Young Wilhite's account of his experience with the negro boy, who had been unconscious for an hour without injury, added courage to his meditations, and, in March, 1842, he persuaded a patient, from whose neck he was about to remove a tumor, to inhale ether, of which he had previously become very fond, until quite insensible. The operation was then performed without pain, and recovery followed without accident. This great event was thus simply recorded by Dr. Long in his ledger: 'James Venable, 1842. Ether and excising tumor, $2.00.'

"Three months later another tumor was removed by the doctor, under similar circumstances, from the same patient. Three other patients were operated upon, with equal success, during the years 1842 and 1843; but, as the region of country in which he lived was then, before the days of railways and telegraphs, so far removed from contact with the great world, the wonderful discovery remained unknown beyond the circle of the immediate neighborhood until long after the properties of ether had been fully investigated elsewhere.

"In like manner, during the year 1839, a young student of chemistry, in the city of Rochester, New York, William E. Clarke by name, now a veteran physician in Chicago, was in the habit of enter-

taining his companions with inhalations of ether. Among the participants in these frolics was another young man named William T. G. Morton, who afterward became a dentist. At the Berkshire Medical College, during the winter of 1841–1842, Clarke diligently propagated this convivial method among his fellow-students. Emboldened by these experiences, in January, 1842, having returned to Rochester, he administered ether, from a towel, to a young woman named Hobbie, and one of her teeth was then extracted without pain by a dentist named Elijah Pope."

In 1844 Dr. Colton administered nitrous-oxide gas to a dentist, Horace Wells by name, from whom a large molar was extracted without pain.

. . . . . .

"In the year 1846 William T. G. Morton was occupying his brain with the idea of painless dentistry. The memory of his experience in the year 1839, and his conversation with apothecaries and chemists —notably with Dr. Charles Jackson, an expert chemist—led him to experiment with ether by inhalation. On the evening of September 30, 1846, he put himself to sleep with ether, and when he recovered consciousness he found that he had been insensible for eight minutes. This was the result for which he had hoped, and the first patient who entered his office—a boy named Eben Frost—was persuaded to undertake a repetition of the experiment. Unconsciousness was again produced, a tooth was extracted without pain, and the original object of his desires had been attained. But the more important ques-

tion of the applicability of ether to the production of anæsthesia during the capital operations of surgery remained without answer until Morton, like his predecessor Wells, proposed to administer the anæsthetic to a patient selected by the surgeon, Dr. Warren, at the Massachusetts General Hospital. Consent was readily obtained, and on October 17, 1846, the attempt was made in the old surgical theatre of the hospital; a patient with a venous tumor of the jaw was etherized by Dr. Morton. The tumor was removed by Dr. Warren without causing pain, though the patient did not become completely insensible. Next day a woman with a fatty tumor on her arm was subjected to operation while under the influence of ether. This time the anæsthesia was perfect, and after one or two other similar experiments an amputation of the thigh was performed by Dr. Hayward, one of the surgeons of the hospital, upon a woman named Alice Mohan, who was etherized by Dr. Morton in the presence of a large number of spectators. From this date the success of anæsthesia in surgery was placed beyond all doubt." *

As is well known, the question of priority of discovery has given rise to an acrimonious controversy. For my own part, I must confess that Morton's right to the honor of the discovery of the anæsthetic properties of ether is incontestable. It is true that others, as we have seen, are said to have made note of the

* "Artificial Anæsthesia," by Henry M. Lyman, M. D., New York, 1881. I am indebted to this book for most of the historical notes contained in this chapter.

physiological action of ether, and now and then engaged in sporadic attempts to utilize the properties of the drug; and, as in the case of Long, previously referred to, they may (?) even have made notes of their endeavors in private diaries and "ledgers." It must not be forgotten, however, that the medical faculties of both hemispheres remained ignorant of these closet philosophers, and their deeds as well. If we are to consider the claims of these hermits, we are much more obliged to respect the priority of opium-eaters, "mesmerists," and the consumers of Indian hemp. We must draw the line somewhere, and I, in company with the Congressional Committee, which reported on the matter in 1863, would therefore ascribe the honor of the discovery to the man who first published in print his immortal achievement to the world, and demonstrated practically its transcendent advantages before his colleagues in the profession in open Senate assembled. That man was undoubtedly Dr. William T. G. Morton. Let those who doubt examine the report * above referred to, which is one of the most eloquent documents which it has ever

* Report Com. No. 89, 37th Congress, 3d session, Senate, February 14, 1863. Submitted by Mr. Wilson, from the Committee on Military Affairs and the Militia. See, also, "The Invention of Anæsthetic Inhalation; or, Discovery of Anæsthesia." By William J. Morton, M. D. Reprinted, with additions and alterations, from "The Virginia Medical Monthly," March, 1880. Besides the report just referred to, numerous others were made to Congress from time to time, all favorable to Dr. Morton. Among these I will only mention the following: Reports of Select Committee, H. R., 30th Congress, 2d session; Naval Committee, H. R., 32d Congress; Military Committee, Senate, 32d Congress; Naval Committee, 32d Congress; Select Committee, H. R., 32d Congress, 1st session; Military Committee, Senate, 37th Congress, 3d session.

fallen to my lot to peruse; and I am sure that the most cold-hearted will feel that this great man is at least entitled to the honor of those achievements which cost him both health and fortune.

During the year 1847 the physiologist Flourens presented to the Academy of Sciences a paper in which he narrated sundry experiments which went to show that animals exposed to the vapor of chloroform became profoundly insensible—so much so, in fact, that the most painful experiments could be performed upon them without the slightest token of suffering. During the same year Michael Cadmore Furnell, a medical student, announced to certain of the surgeons of St. Bartholomew's Hospital that he had discovered a milder anæsthetic than ether, and he requested Mr. Coote to practically test the virtues of chloroform. The peculiar physiological properties of chloroform Furnell had learned by chance while a student under the tutelage of Dr. John Bell. Sir William Lawrence and Mr. Holmes Coote yielded to the request of Furnell, and during the summer of 1847 a number of trials were made, which were so satisfactory that the gentlemen in question were about to experiment further, when Dr. Simpson published the famous paper which added chloroform to the previously discovered resources of anæsthesia. As is well known, chloroform is still preferred in Europe, and during my student days, while sojourning abroad, I had occasion to witness its administration in many hundreds of cases in the various clinics of Germany. In the United States, however, we still give preference to ether, and it must be ad-

mitted that our predilections in this respect are well founded.

Since the introduction of ether and chloroform the anæsthetic properties of various other substances have been investigated with more or less successful results. It would be entirely foreign to the purpose of this monograph to enumerate all these compounds. I would therefore merely remark that most of the volatile anæsthetics are either alcoholic or of alcoholic derivation.

To trace out the entire physiological picture of chloroform or ether anæsthetization would be, in so far as our future argument is concerned, a task of supererogation. It would, however, be well to remember that the chief potency of these agents lies in their ability to curtail the cerebral functions; sensation, perception, and volition being profoundly affected or abolished by their administration. In the present state of physiological chemistry it is quite impossible to point out the nature of the ultimate process by which chloroform and other anæsthetics act upon the tissues. The most that we can say is, that it retards metamorphosis in the cellular elements of the nervous tissues, and particularly in those of the brain. This ultimate effect of volatile anæsthetics may, therefore, be characterized as paralyzing.

The form of anæsthesia which is induced by the substances previously considered is based upon the quality possessed by them of abolishing conscious perception. We may, therefore, properly speak of this ultimate quality as *cerebral anæsthesia.* It is true that when chloroform is injected under the skin

a circumscribed insensible spot may sometimes be produced. But this is not anæsthesia in the proper sense of the word, since the anæsthetic spot persists for many days, and is therefore owing to permanent destructive tissue-changes inaugurated by the drug. The severe pain often felt on making such injections is also corroborative of these destructive effects. Recently I have taken the opportunity of testing the effects of alcohol and chloroform when injected subcutaneously; but, as far as any pronounced local anæsthesia was concerned, my experiments were wholly negative.*

It is not surprising that, having succeeded in producing a condition of anæsthesia dependent upon unconsciousness—upon an irreceptive condition of the sensorium to peripheral impressions—the thought of producing anæsthesia by abolishing conduction in the sensory nerves, by suitable means, should have been rife in the minds of progressive physicians. Accordingly, we find Nunnely, of Leeds, endeavoring to produce local anæsthesia by the aid of chloroform. Indeed, he even went so far as to claim that he had succeeded in rendering a finger and an eye sufficiently anæsthetic for the execution of a surgical operation. Simpson, on the contrary, was not encouraged by certain endeavors in the same direction; and as for myself, I am entirely satisfied of the inevitable futility of all such attempts, for the reasons already given.

The discovery, then, of some substance which,

* See letter from the author contained in the "New York Medical Journal" for September 26, 1885.

while speedily abolishing conduction, should at the same time result in no permanent impairment of the physiological integrity of the sensory-nerves, was a desideratum of the first importance to the success of local anæsthesia. Such a substance we have unconsciously had in our possession for a number of years, but it is not till within a comparatively recent period that we have been made fully aware of its invaluable physiological qualities.

II.

COCA.

When the Spanish conquerors landed on the Peruvian coast, they found that the coca-leaf was held in high esteem by the natives, who regarded it with superstitious awe and ascribed to it supernatural powers. The vulgar were, however, debarred from the privileges of the wonderful plant, and only those high in station—the priests and the hereditary nobility—were allowed to chew the sacred leaf. Among the highest privileges which the sovereign could bestow upon a subject was the right to chew the coca-leaves, which was esteemed far above the richest presents of gold or silver.

With the disappearance of the empire of the Incas the restrictions upon the use of the coca-leaf became things of the past; and soon the employment of the leaves grew to be practically univer-

sal among the Indians. Instead of throwing obstacles in the way, the conquerors of the country encouraged the consumption of the leaf among the natives. This they did for a twofold reason. In the first place, they perceived that they were able to increase the effectiveness of the native laborers by allowing the latter to use the leaf; and, secondly, they saw in this increased consumption a profitable source of revenue. We are informed, indeed, that a portion of the taxes paid by the natives to the Spanish conquerors were in the form of coca-leaves—a commodity which the government had no difficulty in disposing of at an exorbitant profit.

This practically universal consumption of the leaf on the part of the natives has been continued till the present day with undiminished vigor. What is the motive for this extraordinary infatuation?

Physiological Effects.—The answer to the above question is not difficult to find for those who have had the opportunity to practically study the effects of the coca-leaf upon the human organism. All trustworthy travelers agree that the most immediate and palpable effect produced by the absorption of the principles of the coca-leaf into the system consists in a marvelous invigoration of the strength, both mental and physical. Provided with a small quantity of coca-leaves, the native is enabled to undertake the most difficult and prolonged marches with little other sustenance than a few grains of unbolted cereals and a minimum of water. Given a good preparation of the drug—such, for instance, as the Mariani wine—and the European or American man of letters

is able to compass an amount of mental work which, without such aid, would cause irritability, sleeplessness, or even protracted exhaustion of brain-resources.

The absorption of large doses of coca produces a species of intoxication, accompanied by sensations of lively satisfaction as well as hallucinations of various kinds. Mantegazza, who has experienced this intoxication, refers to it in the following somewhat extravagant language: "Porté sur les ailes de deux feuilles de coca, je volais dans les espaces de 77,438 mondes, les uns plus splendides que les autres. Je préfère une vie de dix ans avec la coca, à une de cent mille sans la coca. . . . Il me semblait être isolé du monde entier et je voyais les images les plus bizarres et les plus splendides de coloris et de forme qu'on puisse imaginer."

The digestive functions are also considerably modified by the use of coca; the mouth becomes dry, and to a certain extent anæsthetic, and soon afterward the desire for food diminishes or disappears altogether.

The circulation and respiration are also stimulated by considerable doses of coca. Thus, in doses of from fifteen to twenty grammes it causes an increase in the pulsations of the heart, greater strength of the pulse, and, finally, an elevation of the general temperature. As a consequence of these physiological conditions, coca causes an increase in oxidation, and at the same time the quantity of urea secreted by the kidneys is augmented (Gazeau). As Mariani candidly observes, in his able brochure, like all good things, coca may be abused; and when the drug is

absorbed in immoderate quantities for a long time, a species of cocaism may be engendered analogous to alcoholism or morphiamania. A case of this kind came under my own observation recently in which there were icterus, dyspeptic symptoms, and obstinate insomnia. The loss of flesh was also considerable. By a little care on the part of the physician, however, such accidents are easily avoided.

The extraordinarily stimulating influence of coca upon the cerebral centers induced me to recommend it some time since in the treatment of brain-exhaustion, mental depression, worry, and irritability;* and I can truly say that, as my experience with the drug in this direction has multiplied, I have become more and more impressed with its wonderful potency in the treatment of functional nervous affections. The best preparation of the drug with which I am acquainted is Mariani's wine.

III.

COCAINE.

It is natural that, having observed the remarkable effects exercised by extracts made from the crude leaves, chemists should have made quest for the alkaloid or alkaloids upon which these phenom-

* "Brain-Exhaustion, with some Preliminary Considerations on Cerebral Dynamics," by J. Leonard Corning, M. D. D. Appleton & Co., New York.

ena might reasonably, in a measure, be supposed to depend. Accordingly, we find Woekenroder, Johnston, Goedker, and Maclagan making attempts in this direction, but without success. These failures did not, however, deter other chemists from persevering, and accordingly we find Niemann, a pupil of Woehler, pursuing the same line of research. Finally, in 1859, his efforts were rewarded with success, and in that year he gave *cocaine* to the chemical world.

For over ten years the medical world remained ignorant of the most remarkable physiological property of this substance. But in 1862 Prof. Schraff announced that he had discovered that when this alkaloid is applied to the tip of the tongue the locality in question becomes anæsthetized. This was certainly a significant observation, and it is absolutely surprising that further researches touching the local action of the drug on nerve-filaments were not immediately undertaken. True it is, however, that this remarkable phenomenon remained practically unheeded for a series of years, till, in 1884, a talented young physician of Vienna, Dr. Karl Koller, again took up the matter and published the results of a series of experiments, which will ever remain a lasting source of honor to himself and medicine alike. As this discovery of Koller has been treated in some quarters as though it were a matter of pure accident, I propose to quote enough from his original paper to prove that this remarkable acquisition to medicine and surgery is the direct outgrowth of a train of theoretic considerations of no mean order. "Starting," he says, "from the supposition that a substance paralyz-

ing the sensitive terminations of the mucous membrane of the tongue could not greatly differ in its action on the cornea and conjunctiva, I have made, in the laboratory of Prof. Stricker, a number of experiments on animals, of which, in brief, the following were the results obtained:*

"A few drops of a watery solution of muriate of cocaine dropped on the cornea of a guinea-pig, rabbit, or dog, or instilled into the conjunctival sac in the ordinary way, cause for a short time winking of the eyelids, evidently in consequence of a slight irritation. After one half to one minute the animal again opens its eyes, which gradually assume a staring look. If now the cornea is touched with a pinhead (in which experiment we have carefully to avoid touching the eyelashes), the lids are not closed by reflex and the eyeball does not move, the head is not drawn back as usual, the animal remains perfectly quiet, and, on application of stronger irritation, we can convince ourselves of the complete anæsthesia of the cornea. In this way I have scratched and transfixed the corneæ of my animals used for experiment with needles, and have excited them with electric currents so strong as to cause pain in my fingers, and become quite intolerable in the tongue; I have cauterized the cornea with the nitrate of silver stick until it became milky white; during all this the animals did not move. The last experiment convinced me that the anæsthesia involved the whole

* "On the Use of Cocaine to anæsthetize the Eye," by Dr. Karl Koller. "Wiener med. Wochenschrift," Oct. 25th and Nov. 1, 1884. Translated by Dr. H. Knapp.

thickness of the cornea, and did not affect the surface only. But if I incised the cornea, the animals manifested intense pain, when the aqueous humor escaped and the iris prolapsed. I have been unable hitherto to decide, by experiments on animals, whether or not the iris could be anæsthetized by dropping the solution into the corneal wound, or by prolonged instillations into the conjunctival sac; for experiments to test the sensibility of non-narcotized animals are very complicated and difficult, and do not yield unambiguous results. The last question which I subjected to experimentation on animals—viz., whether or not the inflamed cornea could be anæsthetized by cocaine —was answered in the affirmative. The cornea in which I had incited a foreign-body keratitis became as insensible as a healthy one.

"Complete anæsthesia of the cornea from the use of a two-per-cent solution lasts ten minutes on an average. After such successful experiments on animals I did not hesitate to apply cocaine also to the human eye, trying it first on myself and some of my friends, then on a great number of other persons, obtaining, without exception, the result of a perfect anæsthesia of the cornea and conjunctiva."

By repeated instillations Koller found that the period of anæsthesia may be considerably prolonged. He also tested the efficacy of the anæsthetic effects of the alkaloid on diseased eyes with good results; several surgical operations were undertaken with success, and there was no irritation. For further details concerning these ophthalmological undertakings, I would refer the reader to the original paper,

previously indicated in a foot-note, or to Dr. H. Knapp's* excellent translation, from which the above extracts are taken.

Some interesting observations on the physiological effects of the alkaloid of coca were made by Dr. Isaac Ott, of Easton, Pa., several years ago. Since then the number of contributions to the literature of the subject has increased to a notable degree.

One of the most recent and admirable experimental contributions to the physiological literature of the subject is the exhaustive paper of Dr. Herman M. Biggs.† The following facts are taken from Dr. Biggs's article, the experiments in question being conducted on frogs:

"In conclusion, then, the action of cocaine on the frog may be summed up as follows:

"1. It has a powerful local anæsthetic action on the skin, mucous membrane, and the eye. It usually produces mydriasis.

"2. It has a depressant action on the heart, reduces the force and frequency of its pulsations and finally paralyzes it (first the ventricles and then the auricles) in diastole.

"3. In small doses it at first slightly increases the number of the respirations, then decreases them, and in large doses diminishes them rapidly from the first, finally causing death from a paralysis of respiration.

"4. It at first slightly heightens, and then greatly

* "Cocaine and its Uses in Ophthalmic and General Surgery," by H. Knapp, M. D. G. P. Putnam's Sons, New York, 1885.

† "Journal of the American Med. Association" for January 17, 1885. See, also, "The New York Medical Journal" for February 7, 1885, page 176.

depresses, the reflex action of the spinal cord in small doses. Large doses depress from the first.

"5. Small doses at first slightly increase the irritability of the sensory nerves, then depress their irritability, and large doses depress from the first.

"6. Both large and small (not very small) doses have a depressant action on the motor nerves.

"7. It paralyzes the pneumogastric nerves.

"8. Doses of moderate size diminish the excitability of the striated muscles.

"9. The local application of cocaine to any of the more highly constituted organs or tissues causes a temporary cessation of their functional activity.

"10. From the local and constitutional action on the different organs and tissues, it is rendered probable that its general action is wholly a local one exercised on all parts for which it has a chemical affinity, through its presence in the blood."

To Dr. Henry D. Noyes, of New York, is due the credit of having first directed the attention of American practitioners to the remarkable facts observed by Koller. This he did in a letter entitled "A Few Cursory Notes on the Proceedings of the Meeting of the German Ophthalmological Society, held at Heidelberg in the middle of September of this Year," contained in the "Medical Record" for October 11, 1884. The facts contained in these notes were sufficiently significant to attract the general attention of American physicians, and especially that of the ophthalmologists of New York.

In a few days Dr. Cornelius R. Agnew reported two squint operations that had been performed with-

out pain by the use of cocaine; and a case of injury to the eye, in which irritability and blepharospasm had been greatly relieved by the instillation of the alkaloid. Subsequently Dr. Agnew operated in numerous other cases of eye disease requiring surgical interference, with the most brilliant results.

At the same time Drs. William Oliver Moore and J. L. Minor were also using the anæsthetic in ophthalmic surgery, and notes giving an account of the cases operated upon by these gentlemen appeared in the "Medical Record" of October 18th.

Dr. D. B. St. John Roosa ("Medical Record" for October 25th) employed it in four operations for strabismus, and Dr. David Webster has made use of it in canthoplasty and other plastic operations about the eye with complete success. Dr. H. Knapp also published a paper on cocaine in the same journal. Dr. C. S. Bull was probably the first physician to use cocaine in this country.* Soon after these earlier reports cocaine was tried in almost all departments of surgery. It was used in otology by Drs. Knapp, Kinnicutt, Roosa, C. S. Bull, and others; in rhino-pharyngo-laryngology by Drs. W. C. Jarvis, G. M. Lefferts, F. H. Bosworth, and many other gentlemen; in gynæcology and obstetrics by Drs. W. M. Polk, Le Fevre, and numerous other physicians; and in genito-urinary surgery by Drs. Keyes, Otis, and a large number of other physicians in various parts of the country. It would be quite foreign to the objects of the present publication were I to enter upon

* See a paper by Dr. E. R. Squibb, contained in the "New York Medical Journal" for November 22, 1884.

even a cursory criticism of these various applications of the alkaloid. This is all the more unnecessary from the fact that Dr. H. Knapp, in the little work already referred to, has worked up the historical side of the question in a very satisfactory manner. I will merely add, therefore, that, for the purposes of local anæsthesia, it is of the first importance to employ the very best alkaloid obtainable in the market. It is, moreover, but justice to state, in this connection, that I have found the hydrochlorate of cocaine manufactured by Mr. Angelo Mariani unsurpassed, both for medicinal and anæsthetic purposes. Before definitely concluding the historical portion of the subject, however, there remain to be noticed three recent communications, which have a more or less direct bearing upon the specific objects of the present publication. I refer to the papers of Dr. N. J. Hepburn ("Medical Record," November 15, 1884), Dr. R. J. Hall, and Dr. Halsted ("New York Medical Journal," December 6, 1884), in which an account is given of the experience of these gentlemen in the hypodermic use of the drug.

In the communication above indicated Dr. Hepburn remarks:

"In the course of some experimental inquiries into the anæsthetic action of hydrochlorate of cocaine I observed some facts which may be of interest at this time.

"A two-per-cent solution of the salt (Merck's) was used in each instance, injected under the skin of the arm by means of a hard-rubber hypodermic syringe with gilded steel needle.

"On October 16, 1884, I injected six minims of the solution at 7.30 A. M. In one minute and a half there was partial anæsthesia of the skin, and subcutaneous cellular tissue for a space of eight lines in every direction from the center of the injection. In four minutes the anæsthesia was complete over the same area, which was bounded by a hyperæsthetic line separating the anæsthetic portion from that of normal sensation. The injection was repeated every five minutes in adjacent spots, with precisely similar results, until forty-eight minims had been used.

"By this time the general physiological effects of the drug began to manifest themselves so plainly that it was deemed unadvisable to continue the experiment. These effects were increased frequency of the pulse, increase of one fourth in the number of respirations per minute, an agreeable feeling of warmth, moderate mydriasis, slightly crossed diplopia, and agreeable hallucinations with closed eyes, which fancies disappeared when the eyes were opened. The power of locomotion was very slightly interfered with. These symptoms gradually disappeared until, two hours after the last injection, nothing abnormal was noticed."

On a subsequent trial Dr. Hepburn observed "a general impairment of cutaneous sensibility, a feeling as if walking on cushions, a tendency to walk on the heels, and a sensation on grasping an object as if something spongy were interposed."

In his communication to the "New York Medical Journal" Dr. Hall observes:

"Wishing to use the hydrochlorate of cocaine in

some small operations at the Roosevelt Hospital Outdoor Department, I made some experiments on myself, to determine the best mode of using it. The preparation was a four-per-cent solution made by Parke, Davis & Co. Injecting subcutaneously six minims on the dorsal surface of the forearm, at the junction of the middle and upper thirds, near the ulnar border, caused complete loss of sensation over an area extending *downward* as far as the lower end of the ulna, from three quarters of an inch to an inch wide above, and half an inch wide below, obviously following the distribution of a cutaneous branch of the ulnar nerve. There was no diminution of sensibility above the point at which the needle was introduced. A number of subsequent experiments showed that the anæsthesia extended over the region supplied by the cutaneous nerves near or into which the injection was made. Thus, in a number of experiments made by Dr. Halsted and myself, we have found that, injected subcutaneously into the leg or forearm, not in the neighborhood of any large nerve-trunk, it will cause anæsthesia for a distance of two or three inches below the point of injection."

Dr. Hall also noted the occurrence of constitutional symptoms. On this point he observes:

"With the anæsthesia, marked constitutional symptoms appeared; about six minutes after the injection there was giddiness, at first slight, then well marked, so that I could not walk without staggering; and, finally, there was quite severe nausea, which would have been much worse, I think, had not the stomach been empty. At the same time the skin

was covered with cold perspiration, and the pupils were dilated."

Dr. Hall also conducted some interesting experiments on himself touching the applicability of cocaine in dentistry. For an account of these observations, which were made with the assistance of Dr. Nash, of New York, I must refer to Dr. Hall's original paper. This, in brief, was about the condition of affairs in the realms of local anæsthesia, when I instituted a series of experiments, the outcome of which has been a discovery which I confidently trust will prove of benefit to medicine and surgery alike. I merely desire to state emphatically, in this connection, that *the discovery in question was in no respect the result of chance, but was, on the contrary, the direct outgrowth of a chain of deductive reasoning*, the principal impulse to which was given by a series of experimental studies on the cerebral circulation undertaken and published by me several years since.

For the sake of making myself thoroughly understood on this point, and likewise with the purpose of giving as thorough an exposition as possible of the physiological questions involved, I shall take the liberty of quoting the essay in which I first gave publicity to my discovery.

PART II.

THE AUTHOR'S METHOD OF LOCAL ANÆSTHETIZATION BY INCARCERATION OF THE ANÆSTHETIC IN THE FIELD OF OPERATION.

IV.

As the succeeding portions of this monograph are devoted to an exposition of my own theories and methods, I shall take the liberty of prefacing the purely technical maxims which follow with the essay wherein I first embodied the considerations that led to the experiments and subsequent discovery of the relation existing between local anæmia and local anæsthesia:

ON THE PROLONGATION OF THE ANÆSTHETIC EFFECTS OF THE HYDROCHLORATE OF COCAINE WHEN SUBCUTANEOUSLY INJECTED. AN EXPERIMENTAL STUDY.*

The uses to which the various preparations of cocaine have been put since Koller first discovered the local anæsthetic properties of the alkaloid are legion.

* Contained in the "New York Medical Journal" for September 19, 1885.

To recapitulate these manifold applications of the drug would be manifestly a work of supererogation. Enough that they are such as would naturally suggest themselves to an imagination of average capacity familiar with the fundamental experiment of the talented young physician of Vienna. So far as I am aware, there has been no departure in principle involved in the various uses to which this truly remarkable substance has been put. And yet I believe that improvements in this direction are not only desirable, but readily attainable. For instance, it would be a matter of practical moment if, by some device, we could prolong the local anæsthetic effects of the alkaloid when used hypodermically for surgical and other purposes. How can this object be attained? To answer this question, we must for a moment consider the manner in which cocaine, when subcutaneously injected, is capable of acting upon the filaments of the sensory nerves.

In the first place, it is reasonable to infer that, after the introduction of cocaine beneath the skin, a certain period of time elapses during which the anæsthetic agent is diffused throughout the surrounding tissue. That the blood-stream in the capillaries renders efficient service in this process of distribution may be accepted as proved, since, when the amount of cocaine injected is considerable, characteristic constitutional symptoms are developed.

Secondly, when the terminal filaments of the sensory nerves which ramify in the saturated tissue are exposed for a sufficient length of time to the influence of the cocaine, changes are set up in the nerve-

substance of sufficient magnitude to cause interference with conduction, and we have all the symptoms of local anæsthesia. The more extended and important the nerve-stems affected, the wider will be, of necessity, the expanse of the anæsthetic zone.

But, if this is the true logic of local anæsthesia, if we are to look upon the capillary blood-stream as the means by which the anæsthetic substance is distributed, how does it happen that the effects of cocaine, when subcutaneously injected, are evanescent, except where large doses, frequently repeated, are employed? To this question I would reply that we are to look upon the capillary circulation in a twofold manner: first as a distributor, it is true, but afterward as a *diluter* and *remover* of the anæsthetic substance. The rapid decline in the local anæsthetic effects of the hydrochlorate of cocaine, then, is, according to this theory, owing to the subsequent diluting or *removing* attributes of the blood-stream. The constitutional symptoms developed when cocaine has been extensively injected for local anæsthetic purposes constitute evidence in favor of this view.

Is it possible to adduce inductive evidence in favor of this *a priori* reasoning? I believe so; but not only do I believe that such evidence may be had for the seeking, but I feel assured that the data thus gained may be turned to practical account in the exigencies arising in practice.

Guided by a train of reflections in keeping with those detailed above, I have had recourse to a series of experiments which I will first summarize as briefly as possible, and then offer a word or two of comment,

trusting that by so doing I may not incur the criticism of being too prolix.

Experiment I.—This and the following were performed upon Mr. A. M. Guerin, who kindly placed himself at my disposal.

I injected five minims of a four-per-cent solution of the hydrochlorate of cocaine in the neighborhood of the external cutaneous nerve of the forearm, a short distance below and to the right of the biceps tendon. In a short time the effects of the agent became apparent. The skin for some distance around, and particularly below the puncture, was anæsthetic. After the lapse of a few minutes, judging that the anæsthesia had reached its maximum extent and intensity, I applied an Esmarch's tourniquet around the arm a short distance above the elbow. On examining the radial artery, I found that the pulse was entirely obliterated.

From time to time I examined the condition of sensibility in the forearm, and particularly about the region of the puncture. After the lapse of fifteen minutes the anæsthesia had extended, contrary to my expectations, down the right anterior aspect of the forearm several inches, and was of sufficient intensity to admit of pinching and pricking *ad libitum.* One of the amusements of the gentleman experimented upon, at this and subsequent stages of the investigation, was to thrust needles into the anæsthetic portions of the skin, which was all the more remarkable in him inasmuch as he is a person of rather susceptible and nervous temperament. When I attempted to do the like on other portions of the in-

tegument, energetic reflex contractions were evoked, and lively sensations of pain. After the tourniquet had remained in place for over half an hour the anæsthesia was decidedly more profound than during the first twelve or fifteen minutes of the experiment, this profundity of insensibility being without doubt attributable to the long saturation of the nervous filaments in the anæsthetic. Such saturation was evidently only rendered possible by the use of the tourniquet, which, arresting the circulation, prevented the elimination and dissipation of the anæsthetic by the blood. After the lapse of nearly forty minutes I removed the tourniquet, not, however, because the anæsthesia showed the slightest diminution, for the latter, on investigation, proved to be as profound as ever, but on account of the unnecessary tightness of the tourniquet, which caused the gentleman experimented upon considerable inconvenience. In a few minutes after the access of the blood to the forearm the anæsthesia began to decline, and was soon entirely lost.

Experiment II.—I exsanguinated the left forearm by means of the elastic bandage of Esmarch. I then applied the tourniquet above the condyles as before. Ten minims of a four-per-cent solution of cocaine were then injected at short intervals, the injections forming a line which extended from the radial to the ulnar side of the upper portion of the arm. After the lapse of ten minutes I noticed that the inflated, blister-like elevations which marked the points of injection were quite prominent, and showed no tendency to diminish. I also ascertained, by examina-

tions with a needle from time to time, that the zone of anæsthesia was exceedingly circumscribed, being mostly restricted to the immediate neighborhood of the elevations at the points of injection. Five minutes later, as there was no appreciable diminution in the size of the elevations, and as there was no sign pointing to the slightest diffusion of the anæsthetic, I massaged the parts immediately above the line of injections, and, having thus succeeded in causing some diffusion of the cocaine, I was not surprised to find that shortly afterward the zone of anæsthesia had increased in width and extended in a band about an inch and a half broad across the entire breadth of the forearm. Into this region needles could be thrust without causing the slightest pain or reflex action of any kind. The extension of the anæsthesia along the districts supplied by the cutaneous nerves of the forearm was, however, not sufficiently pronounced to merit notice. This was perhaps owing to the extremely superficial nature of the injections.

The tourniquet remained in place for over forty minutes, during which time the zone above described was quite insensible to the prick of a sharp needle.

Experiment III.—I first injected five minims in the neighborhood of the external cutaneous nerve of the forearm, as in the first experiment. Five or six minutes afterward, however, instead of applying the tourniquet immediately, as in the first experiment, I first exsanguinated the forearm by means of Esmarch's bandage, taking care *not to compress the tissue immediately above the point of injection.* I then applied the tourniquet. The anæsthetic zone in this

case was proportionately much larger than in the previous experiment, following the general direction of the external cutaneous nerve, so far as I was able to judge, in a downward direction, for some three inches or more. The maximum breadth of the anæsthetic zone was perhaps a little less than an inch.

The tourniquet was allowed to remain in place for about an hour, during which time I was unable to note the slightest diminution in the anæsthesia.

Summary.—Experiment I goes to show that simple arrest of the circulation in the part, shortly after injection of the anæsthetic, is sufficient to prolong and intensify the anæsthesia.

Experiment II shows that, if the injection is made *after* exsanguination and compression, there is little diffusion of the anæsthetic, and, consequently, a commensurate diminution in the number of nerve-filaments exposed to the influence of the solution. It is true, however, as we have seen, that by the aid of massage some purely mechanical diffusion may be produced.

Experiment III seems to prove that, if the injection is made a few moments before exsanguination and the application of the tourniquet, a sufficient amount of saturation of the tissue is obtained to expose a large number of nerve-filaments to the influence of the anæsthetic; and yet, unless we wait too long, there is no danger of diluting or dissipating the solution (by the access of too much blood) to such a degree as to weaken or nullify the anæsthetic influence.

The essential advantages of this method of local

anæsthetization consist in our ability to expose the nerve-filaments for any length of time to the influence of the anæsthetic. We are thus practically able to prolong the anæsthesia to an indefinite degree. We are furthermore enabled to do this by the use of comparatively small quantities of cocaine, repeated injections being unnecessary to prolong the anæsthesia, as is necessary when the circulation is not arrested. There is, consequently, no danger of constitutional disturbances from overdosing.

It is clear that this method may be applied in the surgery of all the extremities; and in the treatment of neuralgias and other disorders of the peripheral nervous system it is, I believe, destined to render good service.

I would merely add that, as my experience has become more extended, I have felt constrained, all things duly considered, to give preference to the method detailed in Experiment III. Instead, however, of applying the Esmarch bandage for exsanguination after injection, I apply it before introducing the anæsthetic into the part—that is to say, I wind the bandage, beginning with the distal extremity of the limb, and continuing until the point which I wish to anæsthetize is reached. The bandage is then held firmly while I make the necessary number of injections. Then, making a long fold with the bandage, so as to skip the injected zone, I continue winding until the point is reached where I wish to apply the tourniquet. The object in leaving the injected zone free from the bandage is to avoid pressing away the anæsthetic.

V.

HAVING in the previous chapter stated, in a general and I hope comprehensible manner, my theory and its resultant discovery, I shall now endeavor to give a more detailed description of my method of cutaneous and subcutaneous anæsthesia, which is the direct outgrowth of the investigations referred to. And here let me remark that what I mean by subcutaneous anæsthesia is not only the anæsthetization of the tissue immediately below the skin, but of all parts between the bone and the integument. Nay, more, I should like much to see the bone itself anæsthetized; and, indeed, Dr. M. J. Roberts, of New York, is at present at work on this portion of the problem, and I am sure that, if it is within the realm of practical feasibility, he will accomplish his object.

1. *On mapping out the Veins.*

As the injection of the anæsthetic solution into the lumina of the larger veins is not desirable, I am in the habit of adopting a simple precautionary measure with a view to avoiding the occurrence of such an accident. The procedure in question consists in what I have termed mapping out the veins (Fig. 1). It is performed in the following manner: A piece of ordinary elastic webbing is passed around the limb, above the point to be operated upon, and drawn sufficiently tight to interrupt the circulation in the superficial veins, but not sufficiently so to cause interference with the arterial blood-flow. While the elastic

is securely held in place by the hand of an assistant or by a simple buckle, I am in the habit of tracing out the course of the distended veins by means of an ordinary blue crayon-pencil, which latter should be soft, in order to avoid scratching or other injury to the integument. The whole process occupies but a few minutes, and may be performed by the veriest tyro in pictorial art.

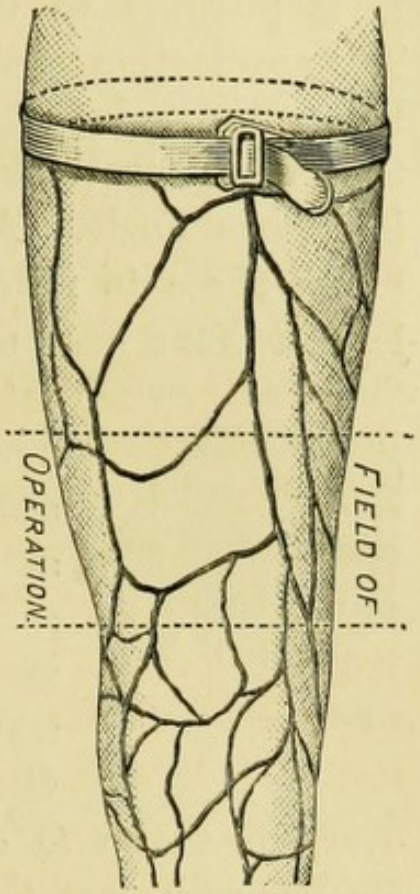

FIG. 1.—Author's method of mapping out the veins.

The practical advantage of this geography of the veins will at once appear after the application of the Esmarch bandage and tourniquet; for after such exsanguination the veins often become imperceptible, and, were it not for the tracings, we should frequently puncture a vein, in spite of our anatomical erudition.

2. *On the Exsanguination of the Limb.*

This is best performed by the aid of the Esmarch elastic bandage (Fig. 2). Beginning with the toes or fingers, as the case may be, the bandage is wound around the limb in the form of a spiral, each fold overlapping the one which preceded it (Fig. 3). In this way, if the bandage be held continuously on the stretch, while the manipulation is in progress,

it is possible to deprive the extremity of blood. The application of the bandage should cease slightly below the point where the operation is to be performed and the injections made. A few minutes (from three to four) after the injections have been made, the application of the bandage may, if desirable, be continued a short distance above the upper margin of the anæsthetic zone. Care must, however, be taken *to avoid applying the bandage over the points of injection*, as by so doing the anæsthetic solution might be pressed out of the tissues and carried away by the general circulation. Such deportation of the anæsthetic is best avoided by making a long fold *behind* the points of injection (on the other side of the limb), and, after a subsequent turn or two of the bandage, applying the tourniquet. Let me add, however, that in most cases the application of the bandage should cease when the lower boundary of the prospective anæsthetic zone (field of operation) has been attained.

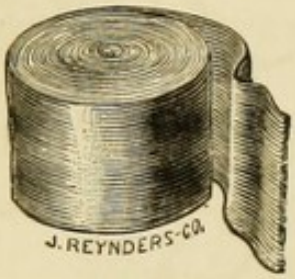

FIG. 2.—Esmarch bandage.

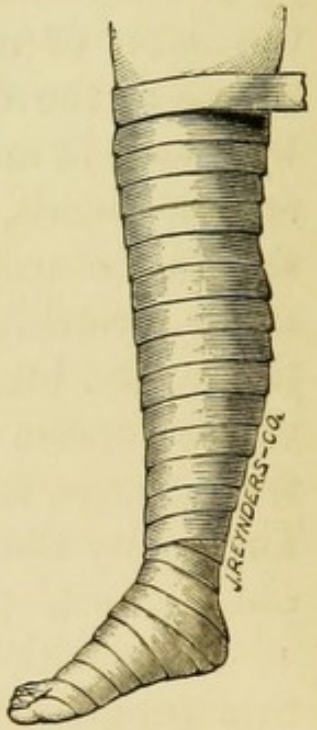

FIG. 3.—Showing the application of the Esmarch bandage.

3. *On making Injections of the Anæsthetic.*

This should be done immediately after the application of the Esmarch bandage, and should take place

a short distance above the margin of the latter. The superficial injections should be made first. For this purpose I usually employ a one- or two-per-cent solution, injecting the anæsthetic into the skin just below the epidermis, in doses of from two to five minims, as circumstances may indicate. These superficial injections should be made as rapidly as possible, and, as soon as the anæsthesia of the skin is in a measure accomplished, the operator should proceed to anæsthetize the deeper strata of the limb. This is accomplished by the aid of long, fine needles attached to a syringe of a capacity of one hundred minims (Fig. 4). The solutions which I employ for these deep injections are from one to two per cent in strength; and I have even used those of one half per cent. If, as the needle descends into the tissue, the solution be injected before the point at the rate of a drop or two at a time, no pain will be caused by the whole procedure. And here I would observe that the greater the extent of the operation, the weaker should be the solution, if we are to avoid the occurrence of constitutional symptoms. It must be remembered that the use of weak solutions is quite possible, in my method, since the tourniquet causes the anæsthetic to remain in contact with the nerve-filaments for as long a time as may be desired. Of course, where no tourniquet is used, as in the old methods, the employment of these weak solutions is quite out of the ques-

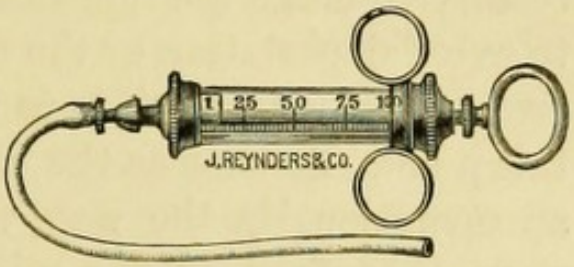

FIG. 4.—Author's syringe.

tion, as the anæsthetic fluid, instead of being incarcerated in the field of operation, is washed out of the tissues by the blood-stream with such rapidity that the nerve-filaments remain but little or not at all affected. The immense advantage of a method by which it is possible to inject one hundred minims of a potent anæsthetic fluid without danger of constitutional symptoms requires no insistence. How easily such constitutional symptoms may be produced where solutions of a high percentage are employed is graphically illustrated by the experience of Drs. Hepburn and Hall, already referred to. Finally, it is necessary to make the injections as rapidly as possible to avoid deportation of the anæsthetic by the blood-stream. It is impossible to insist too earnestly upon this point. As soon as the injections are completed—an operation, by the way, which should not occupy more than four or five minutes at the utmost—the tourniquet should be applied a short distance above the *upper* border of the anæsthetic zone.

4. *On the Incarceration of the Anæsthetic in the Field of Operation. Application of the Tourniquet.*

There are various forms of tourniquets to be had in the shops. The best-known instruments are those of Petit, Skey, Signoroni, and Esmarch. In my original experiments I used the tourniquet of Esmarch; but I soon found that for the purposes of local anæsthesia it left much to be desired. In the first place, it was painful to wear for protracted periods; and, secondly, it left deep marks upon the skin, which

remained a long time after removal of the instrument. I have therefore had constructed an India-rubber band two inches broad and three feet long, the edges of which are nicely rounded (Fig. 5, *a*). This tourniquet is applied around the limb above the anæsthetic zone in two or more folds, and secured in place by means of a powerful clamp of my own designing (Fig. 5, *b*). The construction of the latter is quite simple. It consists, in the first place, of two wings or blades, provided with round, ridge-like elevations on their inner surfaces. The two wings are joined at one end by means of a stout hinge, and at the other there is a powerful screw, which, being actuated by a milled wheel grasped by the hand of the operator, causes the jaws of the blades to close upon the folds of the India-rubber strap and hold the tourniquet securely in place.

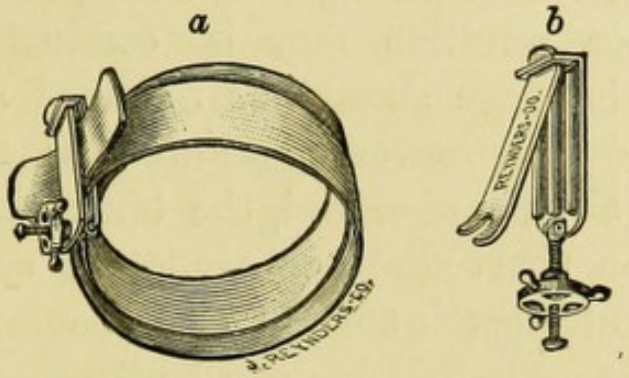

FIG. 5.—Author's tourniquet and clamp.

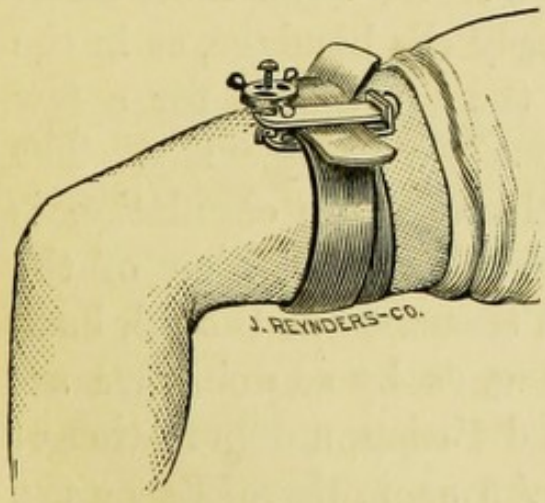

FIG. 6.—Showing application of the author's tourniquet.

As soon as the tourniquet has been properly adjusted, the extent, in a lateral and vertical direction, of the anæsthetic zone

should be carefully ascertained by means of the æsthesiometric probe (Fig. 9). Should the depth and lateral expanse of the anæsthetic zone be sufficient to justify the anticipation that the operation in question may be conducted without pain, the bandage should be removed at once, the tourniquet being, however, allowed to remain in place. As already observed, the tourniquet should be applied a short distance *above* the *upper* boundary of the anæsthetic zone (Fig. 6).

5. *On the Method of making Supplementary Injections.*

Although it is usually possible to determine beforehand approximately the necessary number of injections, it sometimes happens that after the commencement of the operation, especially where the latter involves deep-seated tissues, a supplementary injection or two is required. To make these latter it is only necessary to reapply the bandage, as in the beginning, and to release the tourniquet for a few seconds, while the injections are being made. The object in this temporary release of the circulation is to promote a *local* diffusion or absorption of the anæsthetic by the adjacent tissue. We should, however, avoid waiting too long, as by so doing we are sure to promote a general diffusion, a deportation of the anæsthetic solution. As soon, therefore, as the injections have been made, we should make haste to reapply the tourniquet, subsequently removing the bandage as before.

If the rules previously laid down are scrupulously

and intelligently followed, no great difficulty will be experienced in executing operations, be their magnitude great or small.

6. *The Exploratory Anæsthetic Trocar.*

If a few minims of a two-per-cent solution (from two to three) are injected *into the skin*, an anæsthetic spot will be formed in about a minute. The anæsthesia is, however, not profound in extent, but is confined to the skin, as we can readily prove by the aid of a sharp needle, which can only be thrust into the integument for about a quarter of an inch without pain. But if now, instead of the needle, we take a hypodermic syringe provided with a fine trocar, and thrust it into the tissues, taking care before advancing to inject a small quantity of the fluid before the point of the instrument, we shall find it possible to penetrate to any degree without pain. The exploratory trocar depicted in Fig. 7 is founded upon

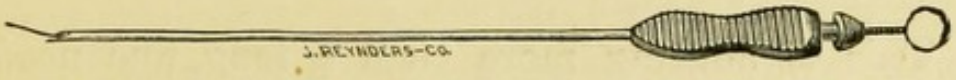

FIG. 7.—Author's anæsthetic trocar.

this observation. It consists of a long, slender, hollow needle, like those used in ordinary aspiration, and is provided with a flat metal handle. The latter is tubular, and is connected with the syringe, previously described, containing one hundred minims of a one-per-cent solution of the hydrochlorate of cocaine.

This instrument was originally designed by me for the local medication of nerves in neuralgia and the like. It is clear that, after we have penetrated

as far as desirable, we can disconnect the syringe from the trocar, and, filling the former with some form of medicated solution, inject the same at will through the trocar.

7. *The Exploratory Anæsthetic Knife*

is founded upon the principle just indicated. It is nothing more than a narrow scalpel, provided with a canal, which, debouching near the point, leads up

Fig. 8.—Author's anæsthetic bistoury.

through the handle, and is connected thence with the syringe already referred to (Fig. 8). In cutting down upon nerves, or for the purpose of opening abscesses, an instrument of this kind is of service.

8. *The Æsthesiometric Probe.*

This is nothing more than a long, fine needle, provided with a flat handle, and designed with a

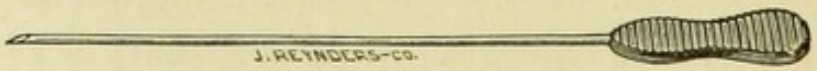

Fig. 9.—Author's æsthesiometric probe.

view to ascertaining the intensity and profundity of the anæsthesia (Fig. 9). It will be found to render good service in practice.

VI.

INCARCERATION OF THE ANÆSTHETIC BY MEANS OF RINGS, OR PROLONGING THE DURATION OF CUTANEOUS ANÆSTHESIA BY INTERRUPTING THE CIRCULATION IN THE SUPERFICIAL VEINS.

When four or five minims of a two-per-cent solution of the hydrochlorate of cocaine are injected into the skin, an anæsthetic zone will be induced, circular in shape and varying in extent from half an inch to an inch and a half, or even more, according to the diffusion of the anæsthetic throughout the neighboring tissue. The depth of the anæsthesia will not, however, be great unless the point of the needle has actually pierced the skin. If the tourniquet is not placed around the limb at a point situated above the anæsthetic zone, the latter subsides with comparative rapidity; and I have noticed that this decline in the intensity and extent of the anæsthetic zone takes place *from the periphery, and advances toward the center of the latter.* This observation led me to suspect that the deportation of the anæsthetic took place, to a considerable extent, through the instrumentality of the cutaneous veins. I at once saw in this fact the possibility of a further extension of my method to regions of the body where the application of the tourniquet was difficult or practically impossible.

Following to its sequence this train of reasoning, I had constructed a number of rings composed of thick wire and covered with India-rubber (Fig. 10). For the latter purpose I employed ordinary India-

rubber tubing, which may be passed over the wire without difficulty. These rings are of various sizes, and may be placed over almost any region of the body. They are especially useful about the head, face, neck, breast, and certain regions of the back. For the purpose of pressing them down upon the integument, I employ handles or strong elastic bands, which are passed around the part to be operated upon.

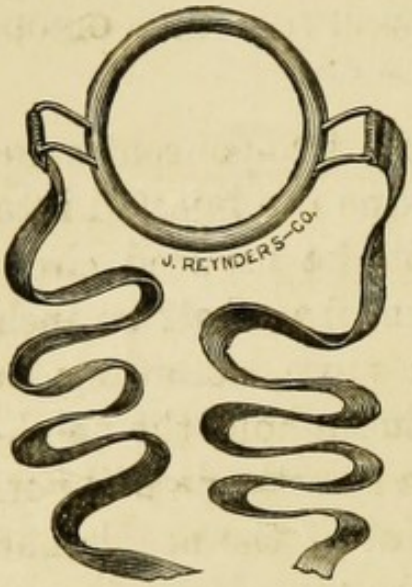

Fig. 10.—Showing rings for incarcerating the anæsthetic in the scalp and other regions.

Although these appliances are by no means as effective as the tourniquet, for obvious reasons they do serve to sensibly prolong the anæsthesia; at least this is true of cutaneous anæsthesia. For purposes of deep anæsthetization, however, their utility is of course not as pronounced. In using these contrivances, I first make the injection and then apply the ring firmly around the latter.

Incarceration of the Anæsthetic by means of Hæmostatic Clamps.

This principle admits of application in operations about the eyelids, mouth, cheeks, and, to a limited extent, about the nose. For operations about the eyelids, the simple and ingenious entropium-forceps of Dr. Henry D. Noyes is well adapted (Fig. 11).

For protracted plastic operations about the lips

and cheeks, I have designed a simple appliance which seems to fulfill all theoretic and practical indications. It consists, in the first instance, of a light forceps about four inches long. At the extremity

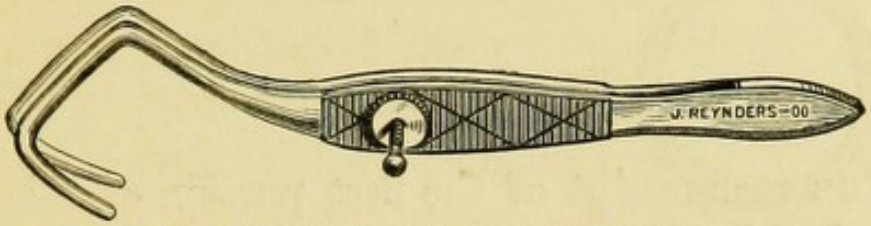

Fig. 11.—Dr. Noyes's entropium-forceps.

of one of the branches is a metal disk, at the end of the other is a large ring. In employing the instrument in operations about the cheeks, the disk is passed into the mouth and pressed against the side of the latter. By rotating the screw (seen in the cut) the branches of the instrument are approximated, the ring being thus firmly pressed against the external aspect of the cheek. All the space inclosed within the ring is of course available for operative purposes. When it is desired to increase the field of operation, either a larger ring may be screwed to the branch of the instrument, or the smaller ring may be moved about from time to time, and fresh injections made. It is thus possible to dissect out flaps of considerable magnitude (Fig. 12). As a matter of course, some little skill is required to execute extensive plastic operations by this method; but I am confident that the surgeon will be amply

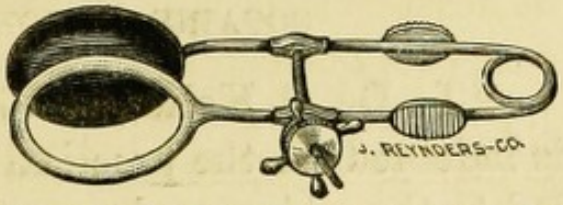

Fig. 12.—Author's hæmostatic clamp, for plastic operations about the mouth and cheeks.

repaid for his trouble, since he is able to spare his patient the inconvenience and possible danger of etherization.

VII.

THE manuscript of the first portion of this brochure had hardly gone to press when a paper on the anæsthetization of bones, by Dr. Milton Josiah Roberts, of New York, appeared in the "Medical Record" for October 17, 1885. I have already had occasion to allude to Dr. Roberts's studies in this direction. It now remains to notice more in detail his remarkable achievements in this department of surgery. To this end I shall quote in full from his paper referred to above.

COCAINE IN BONE SURGERY.*

"To Dr. C. Koller, of Vienna, the civilized world is indebted for the practical suggestions which have led to the widespread use of cocaine as a local anæsthetic. The results already obtained by numerous clinicians and scientific observers, along the line of research originally pointed out by Koller, form a phenomenal chapter in the progress of knowledge regarding relief from pain. But it has been in the application of the drug to mucous membranes that

* With one or two immaterial omissions, this is a literal quotation of Dr. Roberts's paper. (*Vide* the "Medical Record" for October 17, 1885.)

its most brilliant and beneficial effects have been obtained. The results of its hypodermatic use in other localities, though exceedingly gratifying, did not give promise of all that was desired in the way of a local anæsthetic. Thus used, its effects were so transient and limited in extent as to require the administration of an excessive amount of the drug, which in turn gave rise to unpleasant constitutional disturbances.

"It remained for Dr. J. Leonard Corning,* of New York, to point out and experimentally demonstrate the value of a fundamental departure in the method of its administration, which is to yield by far the most extraordinary practical results yet obtained in its local use as an anæsthetic.

"In brief, Dr. Corning's experiments showed 'that simple arrest of the circulation in the part, shortly after injecting the anæsthetic, is sufficient to prolong and intensify the anæsthesia.' It is clear, therefore, that circulating blood is the active agent in washing the drug out of the tissues into which it has been injected, and thereby shortening the period of anæsthesia.

"September 30, 1885, I performed a minor surgical operation in soft tissues, upon a delicate young lady patient in my office, Dr. Corning kindly administering the local anæsthetic according to his method. The profound anæsthesia produced, the small amount

* "On the Prolongation of the Anæsthetic Effects of the Hydrochlorate of Cocaine when Subcutaneously Injected. An Experimental Study." By J. Leonard Corning, M. D. (*Vide* "New York Medical Journal," September 19, 1885.)

of cocaine used, and the great duration of its effects, were gratifying surprises to me. For the first time it now seemed probable to me that in the use of cocaine according to this method I was shortly to realize the practical execution of an idea which I have long cherished—viz., the local anæsthetization of bone and overlying soft tissues.

"On the following day (October 1, 1885), having pondered over the subject, I ventured to predict, at my clinic at the New York Post-Graduate Medical School and Hospital, the successful application of this method in bone surgery; I proceeded to detail on that occasion the plan which I would try when the first opportunity presented itself. I called attention to the great convenience of the local anæsthetization of bone in the elaboration of the line of work proposed by me in February last.*

"Assisted by Drs. George R. Elliott and Charles E. Bruce, on Wednesday, October 14, 1885, at the New York Post-Graduate Medical School and Hospital, I proceeded as follows with a young lady brought to me by Dr. Martin Burke, of this city: She was twenty-seven years of age, and suffered from chronic disease of her elbow-joint of several years' standing. Pus was being discharged from three openings about the joint. The tissues round about were infiltrated with inflammatory products and œdematous. The patient came into the operating-

* "The Exploration, Excavation, and Illumination of the Interior of Bones in any Part of the Body." Being remarks addressed to the Clinical Society of the New York Post-Graduate Medical School and Hospital, February 21, 1885.

room fully expecting to have ether administered, and, when told that a local anæsthetic was to be used, was so apprehensive of pain from the proposed operation that it was with great difficulty that she could be persuaded to get upon the operating-table. She was weak from hunger and anxiety regarding the operation. An ounce of brandy, in water, was given her.

"Having provided myself with a hypodermic syringe, loaded with a five-per-cent solution of Merck's cocaine, I began puncturing the skin, injecting at each point about one minim of the solution as near the surface as possible. The area over which these injections were made was an extensive one, covering a segment of the limb from about three and a half inches above the joint to an equal distance below the joint, and involving its entire circumference. It was observed that the diffusion of the anæsthetic drug was very slow, on account of the infiltration of the tissues with inflammatory products, thus interfering with the local circulation, and consequently with the distribution of the drug. About twenty punctures were made, and a like number of minims of the solution, representing a grain of the drug, injected. At the expiration of about fifteen minutes an Esmarch's bandage was applied to the limb, extending from the tips of the fingers to within three and a half inches of the elbow-joint. The object of this was, in the first place, to get as much blood as possible out of the limb prior to beginning the operation, and, in the second place, to relieve the patient of the sensation of engorgement of the limb

when subsequently girdled with an elastic band above the joint.

"Superficial anæsthesia having been secured, the deeper tissues were penetrated by the needle, and about two minims of the solution injected at each point. The patient no longer winced under the repeated introductions of the needle. The evidences of profound anæsthesia were now manifest to all present, though the patient was still exceedingly apprehensive of pain. The arm was next encircled with a strong elastic band, at a point about four inches above the elbow-joint. With a scalpel a five-and-a-half-inch longitudinal incision over the external condyle of the humerus and to the outside of the olecranon process was made, in order to connect two openings from which pus was being discharged. The patient's head being turned, she did not realize that the knife had been used.

"Having reached the bone in the neighborhood of the external condyle, the needle of the syringe was introduced under the periosteum in several places and minim injections of the cocaine solution made.

"For the purpose of locating the bone lesion and determining its extent, I introduced a drill one sixteenth of an inch in diameter into the head-piece of my electro-osteotome, closed the circuit, and rapidly penetrated the condyles of the humerus. No pain whatever was experienced by the patient. As the drill passed transversely through the lower end of the bone, I could easily appreciate that it had entered a cavity. Upon withdrawing the drill, the *débris* lying in its groove was, at my request, imme-

diately submitted to microscopical examination by Dr. George R. Elliott. He reported that the specimen removed was composed of bone spiculæ, fat-droplets, a few red blood-corpuscles, and numerous pus-cells. The lacunæ in the particles of bone removed were variously arranged in comparison with each other, and presented an abnormal appearance. In many of the minute spiculæ of bone the lacunæ were absent and replaced by fat-droplets. In small areas also the intervening substance was entirely composed of fat-droplets. Fat-droplets were also to be seen in the corpuscles occupying the lacunæ. These findings were regarded as indicating beyond all doubt the existence of a carious process.

"In order to explore the site of disease more thoroughly, I introduced a quarter-inch drill into the electro-osteotome and followed the path made by the smaller one through the bone. Absolutely no pain was experienced by the patient in the passage of this large drill. Upon its withdrawal and examination of the cavity by means of a probe, it was found that the dissolution of the internal condyle of the humerus was nearly complete. The cavity was cleaned out, the soft tissues on the inner aspect of the arm punctured, and a drainage-tube introduced.

"It was still uncertain, however, whether the other bones entering into the formation of the joint were involved in the carious process. To determine this, I again made use of a small drill, transversely penetrating the ulna on a level with the coronoid process. Again my patient manifested no discom-

fort. The *débris* lodged in the groove of the drill was at once kindly examined microscopically by Dr. Elliott. He found it to be composed of small bone spiculæ which presented a perfectly healthy appearance. No further exploratory punctures of bone were deemed necessary. A second drainage-tube was introduced through an opening which existed on the lower posterior aspect of the arm and was passed through a counter-opening on the upper and inner aspect of the forearm. The longitudinal incision in the soft parts was closed by interrupted sutures, antiseptic dressings applied, and the patient permitted to go home."

In the face of such facts as these, comment is, to say the least, supererogatory. It will, indeed, be admitted without question, I think, that the case just cited illustrates one of the most signal triumphs of scientific surgery. Dr. Roberts is certainly to be congratulated upon an operation which is evidently destined to inaugurate a new epoch in the surgery of the bones.

One week after the publication of the operations just described, Dr. Roberts announced to the profession two additional cases in which he had undertaken bone operations of magnitude, making use, as before, of my method of local anæsthetization.

As these operations are in the highest degree instructive from a scientific and practical point of view, I shall take the liberty of quoting in full from Dr. Roberts's remarkable paper:

COCAINE ANÆSTHESIA IN FEMORAL SUPRA-CONDYLOID OSTEOTOMY AND EXCISION OF THE HIP-JOINT.*

"The temporary character of the local anæsthetic effect of cocaine, thanks to the brilliant suggestion of Dr. Corning,† is a thing of the past. It is now possible to prolong this effect of the drug to any desired extent by simply obstructing the circulation of the blood through the tissues into which it is injected, thus effectually preventing its escape from the area desired to be rendered anæsthetic.

"In the 'Medical Record' of this date, October 17th, will be found a communication from me on cocaine in bone surgery, with a description of my first operation. I now desire to report two additional operations performed, under cocaine anæsthesia, this afternoon. These operations were both performed in one of the Randall's Island hospitals, and one or both of them witnessed by Dr. James R. Healey, Dr. E. L. Cocks, Dr. G. H. Cocks, Dr. C. C. Bradley, Dr. Stephen Vittum, Dr. O. C. Tarbox, Dr. M. J. Rockwell, Dr. G. D. Wheat, and Dr. R. Lewis, the six last-named gentlemen composing the house staff and assisting in the operations.

"Before describing the operations in detail, however, I may remark that they were undertaken with the idea of making a crucial test of the

* Reported to the Clinical Society of the New York Post-Graduate Medical School and Hospital, October 17, 1885. (Published in the "New York Medical Journal" for October 24, 1885.)

† "On the Prolongation of the Anæsthetic Effects of the Hydrochlorate of Cocaine when Subcutaneously Injected. An Experimental Study." By J. Leonard Corning, M. D. "New York Medical Journal," September 19, 1885.

efficacy of the method of local anæsthetization employed. Just what advantages this particular method possesses, and the determination of the range of its practicable applicability, are questions which can not be satisfactorily answered by the results obtained in a few experimental operations. It is possible, nevertheless, by the elimination of obvious sources of error, to determine the probable extent, profundity, durability, and regularity in the production of the local anæsthetic effects of the drug.

"My first operation, above referred to, was for elbow-joint disease. It involved, in addition to the extensive division of soft tissues, the excavation of the entire inner condyle of the humerus and part of its outer condyle. Though a small drill-hole was made transversely through the upper end of the ulna, which bone, upon microscopical examination of the *débris* thus removed, was ascertained to be in a healthy condition, the main part of the operation was confined to the removal of diseased bone, and therefore the parts divided might not have been possessed of their normal degree of sensitiveness. This source of error, as will appear, does not require to be considered in the operations now to be reported upon. Again, my first patient, though a delicate female in an exceedingly apprehensive frame of mind, was an adult. The question arose, Was the method also applicable to operations on children? Then, too, there was the question of fear and mental excitement, which forced itself into recognition, when considering the possible causes of the manifest absence of pain during the operation.

"*Femoral Supra-condyloid Osteotomy for Genu Valgum.*—The first operation which I have to report was performed upon a boy about four years of age. Some months ago, the patient being etherized, I did four cuneiform osteotomies upon the bones of his legs in their lower third for the correction of anterior curvatures. There remained marked genu valgum of the left limb. When placed upon the operating-table on this occasion, the little fellow showed some signs of fear. Applying a fine needle, half an inch in length, to a hypodermic syringe containing a freshly made five-per-cent solution of cocaine (Merck's), I made superficial injections over the inner anterior aspect of the thigh just above the knee. The successive injections, for the most part, were made into the periphery of the area of redness (ischæmia) resulting from previous injections. Whenever this rule was deviated from, the child would wince and complain of pain, though he did not cry out. For the purpose of anæsthetizing the deeper tissues, the short needle was replaced by one an inch long and the injections were continued. Having secured anæsthesia along the line of Macewen's incision, an Esmarch's bandage was applied from the toes up to the knee-joint, where it was fastened. A second Esmarch's bandage was continued from this point up the limb to about five inches above the joint. Here the thigh was encircled by a strong elastic band, and the Esmarch's bandage last applied removed, exposing that segment of the limb to be operated upon. The bandage first applied was left in position throughout the operation. Three or

four injections down to the bone were made along the proposed line of incision. The knife was now carried down to the bone along the same line, making an incision two inches and a half long. The child made no complaint whatever. Introducing the needle of the syringe through the wound thus made, I injected six or eight minims under the periosteum and into the tissues above (in front) and below (behind) the bone in order that the passage of my retractors between the bone and soft parts, as well as the subsequent section of bone, might be rendered painless. Upon my attempting to introduce the retractor, the child evinced discomfort when I reached the outer aspect of the bone. I immediately withdrew the retractor and injected about four minims down to the bone and under the periosteum, on the outer aspect of the thigh. This enabled me to proceed with the introduction of the retractors without complaint on the part of my little patient. The retractors being introduced and the soft tissues drawn back, freely exposing the bone, I quickly removed a cuneiform segment from the femur just above the epiphysis, by means of my electro-osteotome. Again no pain was manifested by the child. The Esmarch's bandage and elastic girdle about the thigh were removed, the wound was closed and covered with antiseptic dressing, and the limb brought into line and secured in position by means of a gutta-percha splint. During this latter procedure and the first punctures of the hypodermic needle the child complained slightly of pain. At all other times during the operation he manifested no discomfort. He

was laid upon a cot near by, and watched the subsequent operation with apparent delight, for whenever I looked at him he smiled pleasantly, and, when questioned, answered cheerfully. In this operation three grains of cocaine were injected.

"*Excision of the Hip-Joint.*—Encouraged by the results thus obtained in the cocainization of bone and overlying soft tissues, I proceeded at once to try the efficacy of local anæsthesia in excision of the hip-joint, there being a patient in the ward awaiting this operation. The subject of the second experimental operation was a girl about six years old who had suffered from hip-disease for many months. An abscess, the result of the morbid process going on in the bone, had opened spontaneously and was discharging its pus through a fistulous opening.

"The superficial and deep structures were cocainized in the same manner as before, a two-and-a-half inch needle being used for the deepest injections. I had not proceeded far when I was informed that my supply of cocaine was exhausted. A messenger was immediately sent for more cocaine solution, but could only procure a four-per-cent solution which had been made up several days. With this I continued the injection until I had apparently secured profound anæsthesia along the intended line of incision. A strong elastic band was tied about the proximal end of the thigh. With his fingers placed under it on the outer aspect of the limb, an assistant stretched this band and drew it upward over the crest of the ilium. The pressure thus produced was sufficient to interfere with the superficial circulation. No means were

at hand for compressing the abdominal aorta. The usual incision for exsection of the joint was made down to the bone. The patient complained considerably of pain, but did not cry out. Cocaine was injected through the wound into the tissues about the upper end of the bone. Injections were also made into or under the periosteum. The venous hæmorrhage was considerable, and seemed to wash the cocaine out of the tissues into which it had been injected. On this account, or in consequence of being obliged to use a weaker solution, and one not freshly made, the anæsthesia was not so profound or so enduring as in the previous operation. A longitudinal incision through the periosteum did not cause the patient any pain, but, when the periosteum was peeled off from the bone, the pain experienced was considerable. Section of the bone below the great trochanter with the electro-osteotome was without pain. Upon removal of the bone, the head and most of the neck of the femur were found to have been destroyed by disease. The acetabulum did not appear to be involved. The wound was closed with strong catgut sutures, drainage-tubes having been previously introduced, antiseptic dressings were placed over the line of suture, and a gutta-percha splint was molded to the contour of the limb and body, and allowed to harden."

VIII.

LOCAL ANÆSTHESIA IN FRACTURES.*

By J. R. Conway, Jr., M. D.

Case I.—"Adam Freiting, aged thirty-seven, German, painter, residence 153 Attorney Street, admitted to Gouverneur Hospital, October 26, 1885. While painting the cornice of a house, the scaffolding on which he was standing gave way and he fell to the ground, striking upon his right buttock and the palmar surface of the right hand.

"The right radius was found to be fractured about three fourths of an inch from the lower extremity of the bone, and the lower fragment was displaced backward upon the upper one and firmly held in that position. He also received severe contusions of the right buttock and hip, but no other fracture or serious injury.

"I attempted to examine the injured limb, but caused him so much pain in doing so that I resolved to try if deep injections of cocaine at the point of fracture would sufficiently anæsthetize the parts to allow of a thorough examination and reduction of the deformity without causing him pain.

"I pushed the needle perpendicularly down into the tissues upon the posterior surface of the forearm, directly over the seat of fracture, until it could be felt touching the rough fractured bone; then three

* A notice of Dr. Conway's interesting cases appeared in "The Medical Record" for November 14, 1885. The more extended account of the same herein contained was kindly communicated to me in a letter which I recently received from Dr. Conway.—J. L. C.

minims of the four-per-cent solution of the hydrochlorate of cocaine were slowly injected between the fragments. After withdrawing the needle slightly, so that its point rested in the soft tissues just over the fracture, two minims more were discharged in this situation.

"On the outer side of the fracture I adopted the same procedure, endeavoring in the deepest injection to get the point of the needle far enough anteriorly to leave a couple of minims of the solution in the tissues anterior to the fracture, as well as between the fragments in this situation, and in the deeper soft parts on the external aspect of the forearm. The third injection was made between the ulna and radius posteriorly, and as deep as the bone, so that the solution would reach the inner aspect of the fragments and the tissues immediately surrounding them. Altogether, seventeen minims of the four-per-cent solution were used—seven minims in the external injection, and five minims in each of the other two.

"I think it is very important that the solution should not only reach fractured surfaces of the bone, but should also be injected into the deeper tissues surrounding the fracture, for, although the bone may be thoroughly anæsthetized, the manipulation necessary for examination and reduction will cause pain in the injured soft parts about the fracture unless they also are rendered insensitive.

"After completing my last injection I immediately applied an Esmarch's tourniquet to the arm just above the elbow, in order that I might check the circulation and so lengthen the anæsthesia for any

desired length of time—a method of anæsthetization first suggested and practiced by Dr. J. Leonard Corning, of this city.

"In five minutes from the time of the first injection I found that firm pressure over the seat of fracture caused no uncomfortable sensation. Flexion, extension, and lateral motion of the wrist were then made without any complaint from the patient, and, when questioned, he said that he experienced no pain. This was all in marked contrast to his sensations before the cocaine was administered. Then he could not bear the least pressure over the fracture, and any motion of the joint caused great agony.

"After I had satisfied myself by a very thorough examination that there was no doubt as to the fact that absolute anæsthesia was produced, I proceeded to reduce the deformity by extreme extension of the wrist-joint, together with traction.

"This was successfully accomplished at the first trial, although considerable force had to be used.

"The patient bore the reduction very calmly, never uttering a single complaint, and afterward assured me that he really felt no actual pain from the procedure.

"The fragments were now in proper position, and could readily be moved one upon the other. Rubbing the broken surfaces of bone together was unattended by the slightest symptom of pain.

"I allowed the Esmarch tourniquet to remain on about a half-hour, and at the end of that time the anæsthesia was as profound as in the first ten minutes after injection. Removing the bandage, splints

were applied, and the patient was surprised to find that he had escaped so cheaply from what he expected would be a very painful operation. In about ten or fifteen minutes more sensation in the fracture returned, but the pain was not excessive or sufficient to give rise to any complaints. I noticed no bad after-effects from the use of the cocaine. The patient is doing well (November 14th), and has already some union in the fracture."

CASE II.—"John O'Brien, aged eight years, schoolboy. Residence, 700 Water Street. Admitted to Gouverneur Hospital, October 29, 1885. While at play in school he was thrown down and fell upon his hands and knees. Examination revealed a Colles fracture of the right radius, with displacement of the lower fragment backward.

"There was much sensitiveness about the fracture, and the boy cried piteously at any attempts I made to examine it. I injected fifteen minims of the four-per-cent solution in the same manner as in the preceding case, but trusted to digital compression of the brachial for stoppage of the circulation. In about five minutes complete anæsthesia was produced, and I was enabled to carefully examine the fracture and reduce the deformity without causing the little patient any pain. After reduction I could scrape the fragments together as much as I wished without eliciting symptoms of pain. The case is doing well, very little swelling having occurred."

CASE III.—"Morris Dalton, aged forty years, longshoreman. Residence, 66 Columbia Street. Admitted to Gouverneur Hospital, November 2, 1885.

He fell from the deck into the hold of a canal-boat and received a Colles fracture of the left radius.

"In this case there was no deformity present, but, as the diagnosis was a little obscure and there was so much pain about the wrist, I thought it better to use the cocaine and make a more thorough examination than I could without it. In this case only ten minims of the four-per-cent solution was used in two deep injections of five minims each into the inner and outer sides of the fracture, and between the fragments in these situations. None of the solution was introduced into the soft parts about the seat of fracture, and no stoppage of the circulation was thought necessary, as the examination could easily be made in a few minutes.

"I waited seven minutes from the time of the first injection, and then began my examination. He suffered no pain when the examination was confined to endeavoring to rub the bones together and get a false point of motion, but when I attempted forced extension or flexion of the wrist, he complained of pain. The anæsthesia disappeared in about twelve minutes from the time of injection." *

LOCAL ANÆSTHESIA IN DISLOCATIONS OF THE ELBOW.

By J. R. Conway, Jr., M. D.

"Jacob Schlicksuff, aged twenty-seven, varnisher. Residence, 88 Avenue A. Admitted to Gouverneur

* This case affords an excellent illustration of the rapid disappearance of the anæsthesia of the deeper tissues when the anæsthetic is *not* incarcerated in the field of operation by arrest of the circulation.—J. L. C.

Hospital, October 30, 1885. In attempting to jump from a car in motion he fell and dislocated both bones of the forearm (left), backward. Examination of the injured joint was attended by considerable pain. I thought it possible that, if the cocaine solution was injected into the ligaments and soft tissues about the joint, a painless examination and reduction could be effected.

"I used altogether twenty-five minims of the four-per-cent solution, making four injections into the two lateral, posterior, and partly into the anterior, ligaments, and the soft parts immediately above the ligaments. I then applied an Esmarch to the arm, and waited ten minutes.

"At the expiration of that time I began my examination. Motion in any direction caused no pain. There was absolutely no tenderness. Reduction was effected by means of forced flexion of the elbow, together with traction of the forearm, and counter-extension upon the arm. It did not take three seconds, and the patient merely exclaimed 'Oh'! and said it hurt him a little just as the bones were slipping into position, but nothing to speak of.* There was remarkably little inflammation following such a severe injury to the joint as this was.

"Forty-eight hours afterward I could detect no swelling about the joint, and passive motion was unattended with pain. It is possible that the cocaine prevented inflammatory reaction. The patient did

* Until the Esmarch bandage was removed the anæsthesia persisted in full force, but began to disappear fifteen minutes after its removal.

remarkably well, and was discharged from the hospital in less than a week, merely carrying the arm in a sling."*

VIII.

ON THE PROLONGED DURATION OF THE ANÆSTHESIA AFTER REMOVAL OF THE TOURNIQUET, CONSEQUENT UPON THE PROTRACTED CONTACT OF THE ANÆSTHETIC WITH THE FILAMENTS OF THE SENSORY NERVES.

When the tourniquet has been allowed to remain in place above an anæsthetic zone for from twenty-five to thirty-five minutes, or even less time, I have sometimes remarked that, after removal of the tourniquet, the anæsthesia persists for some time. This phenomenon is undoubtedly owing to the fact that the anæsthetic has remained so long in contact with the filaments of the sensory nerves as to give rise to profound chemical changes in the latter. A protracted interference with nervous conduction is the natural consequence of such changes; and not until the blood-stream has bathed the affected nerve-filaments for a protracted period is the chemical *status quo ante* of the latter sufficiently reestablished to again admit of the transmission of sensory impressions.

It is clear that, under certain circumstances, the surgeon can avail himself of this principle with great practical benefit.

* It will at once occur to the reader that these cases of Dr. Conway have a strong confirmatory bearing on those of Dr. Roberts, previously referred to.—J. L. C.

In the "Medical Record" for October 24, 1885, Dr. Charles E. Bruce, of New York, has made brief mention of a case in which the condition of anæsthesia remained for upward of five hours after removal of the tourniquet. The patient, a young man, twenty years of age, was a sufferer from congenital phimosis, and Dr. Bruce decided to operate according to the method pursued by me in Experiment II of my original paper, which has already been quoted in full at the beginning of Part II of this book.

Dr. Bruce's mode of procedure was briefly as follows: A strong piece of narrow elastic webbing was wound around the penis, beginning with the foreskin and continuing until the bandage had enveloped the organ as far as the abdomen. At this point a small tourniquet, improvised from elastic webbing of similar character, was secured about the organ, thus completely shutting off the blood-supply. The bandage was now removed from the pendant portion of the penis, and several minute injections of the hydrochlorate of cocaine were made into the foreskin. Anæsthesia was soon complete, and the necessary amount of foreskin was removed without pain. The subsequent steps in the operation were equally painless, and the little tourniquet remained in place for about forty minutes.

The interesting feature in this case is the fact that the anæsthesia persisted for over five hours after removal of the tourniquet.

In this connection I would merely add that a similar state of things is occasionally observed in anæsthetization of the extremities where the tourni-

quet has been allowed to remain in place for an unusual length of time. That the phenomenon is in no wise due to numbness is easily demonstrated by an examination with the electric brush. When the brush is passed over the anæsthetic zone there are no reflex phenomena whatever; whereas when the brush is brought in contact with other portions of the extremity, below the tourniquet, contractions and pain are evoked. The phenomenon seems to be more readily evoked in soft, spongy tissues than in those of firmer consistency.

IX.

OPERATIONS UPON SOFT TISSUES.

PERFORMED BY J. WILLISTON WRIGHT, M. D.,

PROFESSOR OF SURGERY IN THE MEDICAL DEPARTMENT OF THE UNIVERSITY OF THE CITY OF NEW YORK, ETC.

AFTER reading the original essay in which my preliminary experiments were embodied,* Dr. J. Williston Wright proceeded, on the afternoon of the same day (September 19th), to put the method to a practical test.

The patient selected for operation suffered from an ovoid tumor of the forearm, which was very adherent and necessitated some deliberation in the manipulations incident to its removal.

After injection of the anæsthetic into the tumor

* Quoted in full in the preliminary portion of this brochure. *Vide* also the "New York Medical Journal" for September 19, 1885.

and its immediate vicinity, the arm was exsanguinated, by means of the Esmarch bandage, and the tourniquet applied around the arm above the tumor.

With a view to submitting the method to a thorough test, Dr. Wright proceeded with as much deliberation as possible.

After an incision of sufficient length had been made, the adhesions were carefully divided and the tumor eventually removed without the slightest pain. The ligation of the vessels and the placing of the sutures was equally painless.

The duration of the anæsthesia in this case was nearly one hour; and at the conclusion of the operation there was no diminution in the degree of insensibility.

October 21, 1885, Dr. Wright again operated according to the principles laid down in my original paper. On this occasion it was a question of *extirpating a wen situated on the left temple.*

For the purpose of incarcerating the anæsthetic in the field of operation, Dr. Wright had recourse to a most ingenious device—the "horse-shoe tourniquet"—designed by himself some time since, with a view to the bloodless removal of tumors from the scalp.

As this instrument seems to me both practical and ingenious, and capable of many applications in operations about the scalp, I have had a cut made of the original model, which was kindly loaned me by Dr. Wright (Fig. 13).

The construction of the implement is exceedingly simple. It consists, in the first instance, of two

branches joined together like the arms of a horse-shoe. At the point of puncture there is an Archimedean screw. By rotating this screw, the arms may be expanded or approximated at will. At the end of one of the arms is a small metal ring covered with leather, which is placed around the tumor to be extirpated, while the extremity of the other branch is armed with a spoon-like enlargement, also covered

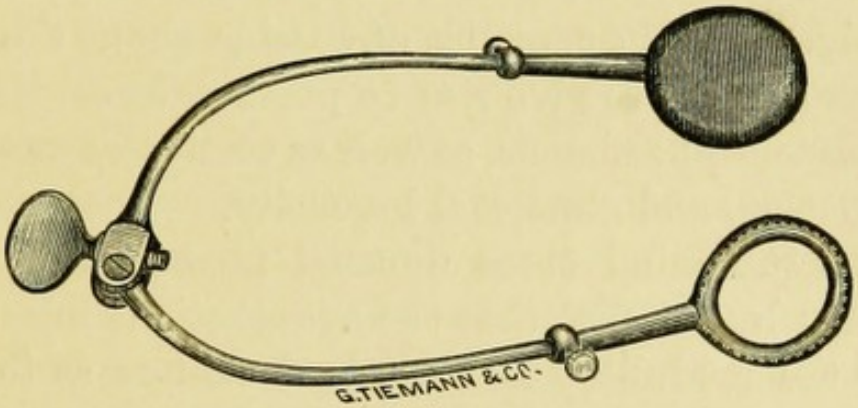

FIG. 13.—Dr. J. Williston Wright's horse-shoe tourniquet.

with leather. In removing the wen from the temple, Dr. Wright placed the ring around the tumor, while the spoon of the other arm rested against the opposite temple. The anæsthetic solution was then injected in and around the tumor, and the screw of the instrument turned, at once, until the pressure of the ring interrupted the circulation in and around the tumor. The incarceration of the anæsthetic within the field of operation being thus effectually performed, the tumor was removed without pain. On this occasion, as in the previous operation, Dr. Wright purposely protracted the various manipulations as much as possible, in order to submit the method to a further test. Anæsthesia was maintained in this

case for three quarters of an hour, when the tourniquet was removed.

Possible Danger incident to the Application of Cocaine about the Head.

It has frequently been observed that instillations of cocaine into the conjunctival sac give rise to dizziness and other constitutional symptoms. The same may be said with regard to hypodermic injections of relatively small quantities of cocaine about the head, which sometimes give rise to portentous cardiac and circulatory phenomena, as well as vertigo, mental incoordination, and abnormal loquacity.

To my mind these unusual phenomena are explained by the fact that the anæsthetic is injected so near the medullary and cerebral centers as to exert an inordinate—a concentrated effect, so to speak, upon the latter. It must also be remembered that most of the solutions heretofore employed have been of a relatively high percentage. The following case, occurring recently in the practice of Dr. J. Williston Wright, well illustrates the above fact. I am indebted to Dr. Wright for the following history of the case in question, kindly transmitted to me by letter.

"F. W., aged seventy-seven, a highly intelligent professional man, with no organic disease, so far as could be ascertained—a man of wonderful nerve and composure.

"For two or three years past has suffered from an epithelial cancer of lobe of right ear, during which time he has had several operations without an anæsthetic.

"*October* 24, 1885.—Another operation being necessary, it was decided to inject cocaine into the tissue to be removed, as being preferable to general anæsthesia in a person of his age.

"Operation, begun at 2.30 P. M., lasted one hour, during which time about sixty minims altogether of a five-per-cent solution were injected, a large portion of which, however, ran out through the spongy tissue and was lost. It was therefore estimated that, at most, not more than from one and a half to two and a half grains of the hydrochlorate were actually employed.

"No constitutional symptoms were encountered, until the operation had been completed for fifteen minutes, and the patient had left the operating-table and was sitting in a chair to have a bandage applied.

"At the first turn of the bandage he complained of its being too tight; and, on looking at his face, the latter was found to be intensely congested, even to extreme lividity, the lips being of a deep blue color, the eyelids livid and puffy, the conjunctivæ intensely injected, the ears swollen and purple, and, in a word, the face resembling that of a man in the middle of an apoplectic seizure. The patient also complained of a feeling of heat in the head ("flashes of heat"); there was also slight nausea, but no disturbance of intellect. Pulse 90 (usually 75), and gradually increasing in rapidity, but regular. The trunk, as far down as the penis and scrotum, was intensely red (not blue), the color of the skin resembling that observed after inhaling the nitrate of

amyl. Patient placed in recumbent posture and sinapisms applied to præcordial region, spine, and legs. Ice was applied to head. Ten minutes later pulse 108, nausea increased, excessive yawning, lividity of face continued.

"In half an hour lividity began to diminish; says he feels better and desires to urinate. Was placed on his feet and supported. While attempting to urinate had a slight convulsive tremor, and fell back into my arms. Was placed upon a lounge. His conversation at this time was very incoherent and confused, and the facial lividity still continued. Pulse intermits and is growing weaker. Examined hands and feet, but could detect no loss of sensation. Vomited a little mucus. Face suddenly blanched; pulse stopped, patient sighed deeply, yawned, and fell back exhausted after a slight tremor, followed by subsultus—apparently dead. Jaw dropped; respiration ceased. I injected ʒij sp. vini gallici hypodermically, and employed Sylvester's method. In one minute patient began to breathe, pulse returned, and in half an hour he was conversing with me about a matter which interested him several weeks ago. Pulse at this time was 96, regular. Color of face and trunk normal, temperature 99°, and he said he was all right.

"Left him at 6 P. M.; saw him at 9.30, and found him perfectly comfortable.

"October 25th, saw him and dressed wound. Patient slept well all night, and, after a cathartic of Rochelle salts this morning, said he felt as well as ever."

Dr. Wright pertinently inquires: "Was it cocaine? If not, what then?"

I should reply, on the strength of Dr. Wright's most graphic and scientific history, that the phenomena observed were undoubtedly due to the action of the cocaine upon the cardiac, vaso-motor, and respiratory centers in the medulla, the vehemence of the symptoms being due to the proximity of the point of injection to the cerebro-spinal axis. The plausibility of this hypothesis will, I think, sufficiently appear when we bear in mind the potent local action of the drug, which is such a distinguishing feature of cocaine.

By incarcerating the anæsthetic according to my method, it is possible, as already noted, to employ solutions of relatively small percentage. Consequently the amount of the alkaloid required is relatively small, and there is much less danger of constitutional disturbances, when the anæsthetic is injected about the head. Still, as Dr. Wright's case shows, disagreeable results may sometimes follow the use of even relatively moderate quantities of the drug. I am convinced, too, that constitutional idiosyncrasy has much to do with the matter. Moreover, I have remarked that where persons have become habituated to the use of extracts and other preparations of coca, they manifest far greater tolerance of even large hypodermic doses of cocaine than where the system has not been thus gradually accustomed to the drug.

Dr. Wright's case is certainly of the utmost interest to physiologists and physicians alike.

X.

THE INFLUENCE OF COCAINE UPON THE HEALING OF WOUNDS.

As cocaine is evidently destined to play an important part in the surgery of the future, it becomes pertinent to inquire as to how far the processes of healing are influenced by the presence of the alkaloid. Fortunately, the question is one which may be answered inductively; and the observations which I am about to cite go far toward affording a definite conclusion.

In some recent experiments, Dr. Lucien Howe,* of Buffalo, has sought to determine the influence of cocaine upon the healing of wounds by producing equal lesions in both eyes of an animal, and then comparing the one treated with cocaine with the other, either left to itself or treated with atropine. With regard to these researches Dr. Howe observes: †

"The anæsthetic effect of cocaine upon the eye, already so well known, suggests an inquiry as to the influence it may also have on the healing of wounds. A considerable time must necessarily elapse before clinical experience can furnish sufficient data to warrant conclusions which are entirely reliable. Different individuals and the circumstances accompanying the operations vary so greatly that, in spite of the many

* "The Effect of Cocaine upon the Healing of Wounds," by Lucien Howe, M. D. The "New York Medical Journal" for August 8, 1885.

† *Op. et loc. cit.*

cases already published in which cocaine has been used, only a series of those exactly similar would furnish an average for just comparison. In certain rather rare instances, it is true, the same operation is made on each eye of the same individual at the same time, and in these the effect of the drug can be tested. But such cases are by no means numerous. I have, therefore, endeavored to determine its influence upon the healing of wounds by producing equal lesions in both eyes of an animal, and then comparing the one treated with cocaine with the other, either left to itself or treated with atropine. The principal objects of this inquiry were to detect any unfavorable influence cocaine might exert upon such wounds by reason of the irritation produced, or of the effect upon the nerve-supply. On the contrary, if its action was advantageous, it was important to determine what parts of the eye it affected, and if for the iris or any other portion it was as reliable as atropine. It is well to settle such questions as soon as possible after the discovery of an agent like this, whose anæsthetic properties naturally excite unguarded enthusiasm or too great confidence in a really valuable drug. Accordingly, in October last, in the laboratory of Professor Zuntz, in Berlin, I noted the healing process in wounds as follows:

"Rupture of conjunctiva in one rabbit.

"Rupture of conjunctiva in two Guinea-pigs.

"Abrasion of corneal epithelium in two rabbits.

"Abrasion of corneal epithelium in one Guinea-pig.

"Abrasion of corneal epithelium in one cat.

"Burn of conjunctiva and cornea in two rabbits.

"Puncture of cornea in one cat.

"Iridectomy, simple, in one rabbit.

"Iridectomy, iris being left in wound, in two rabbits.

"Iridectomy, iris left in wound, in three Guinea-pigs.

"Traumatic cataract in three Guinea-pigs."

After citing several experiments illustrative of his methods of research, Dr. Howe concludes as follows:

"No attempt has been made in any systematic manner to verify these experiments by a similar series upon the human subject. One is not justified in subjecting an eye recently operated upon for iridectomy, for example, to the manipulation, or even violence, which such an exact examination often demands, but the great majority of clinical experience thus far seems to be in perfect accord with the results reached by experiments upon the animals mentioned.

"These conclusions may be briefly stated as follows:

"1. In lesions of the conjunctiva, perfect solutions of the hydrochlorate of cocaine have no appreciable effect, beneficial or otherwise, upon the healing process. When the solution is imperfect, a slight additional hyperæmia is produced, which persists longer than in the other eye, but this is ordinarily of no practical importance.

"2. In lesions of the cornea it has a beneficial effect, like other mydriatics, but inferior to that of

atropine. In imperfect solutions a perceptible abrasion of the epithelium is produced, and, though this is quickly renewed, the healing is thereby delayed by the cocaine.

"3. In wounds of the iris the mydriatic action of cocaine is evident; but here again it is inferior to atropine, and is of little value in detaching firm synechiæ. Imperfect solutions, however, do not appear to hinder the healing process any more than when applied to the conjunctiva or cornea. Indeed, as strong mixtures possess decided antiseptic properties, they would seem to exert a favorable effect in this respect."

As the use of cocaine in major surgical operations becomes more general we may expect to obtain further statistics on this interesting portion of the subject.

XI.

SPINAL ANÆSTHESIA AND LOCAL MEDICATION OF THE CORD.*

It is my desire on this occasion to draw attention to a procedure in therapy which, so far as I am aware, possesses the merit of novelty. The arguments which I shall advance in its favor are twofold in kind: First, I shall cite certain physiological facts with which the procedure in question stands in im-

* Published by the author in the "New York Medical Journal" for October 31, 1885.

mediate relationship; and, secondly, I shall endeavor to record conscientiously the actual phenomena evoked by the use of the method itself.

To take up the argument in this order, I would remark, then, that, when a certain quantity of a remedy, say strychnine, is thrown under the skin of a frog, certain phenomena make their appearance which show indubitably that the functions of the spinal cord are profoundly affected. The animal is thrown into violent convulsions, and assumes a rigid attitude, and we have presented the picture of an artificial tetanus. This is a spectacle of the physiological laboratory, and one with which we are all familiar.

If, now, we remove the posterior arches of three or four of the vertebræ of the animal, and, seizing the membranous coverings of the cord, insert the end of a hypodermic needle so that we are able to inject a small quantity of a solution of strychnine, we shall find, first, that not only are the convulsive phenomena immediately produced, but, secondly, that a smaller quantity of the fluid is required to evoke them than when the drug is placed under the skin at a point remote from the spinal cord.

It was formerly supposed that this phenomenon was due to the direct contact of the strychnine with the nervous elements of the cord; but Harley * has shown that the poison can act only through the intermediation of the blood-vessels, since, when the latter are separated from the cord, the solution re-

* "A Hand-book of Therapeutics," by Sidney Ringer, M. D., New York, 1870, p. 387.

mains entirely inert, the convulsions failing to appear.

From the foregoing considerations, it is clear that, in order to obtain the most immediate, direct, and powerful effects upon the cord with a minimum quantity of a medicinal substance, it is by no means necessary to bring the substance into direct contact with the cord; it is not necessary to inject the same beneath the membranes, as in the case of the frog, since the effects are entirely due to the absorption of the fluid by the minute vessels. On the other hand, in order to obtain these local effects, it is first necessary to inject the solution in the vicinity of the cord, and, secondly, to select such a spot as will insure the most direct possible entry of the fluid into the circulation about the cord. Is there in man a locality which fulfills these conditions? Instead of answering this question at once, I will rather detail some recent experiments performed by myself, by means of which, I trust, all doubts on the subject will be effectually set at rest.

Protocol of Experiments.—Some time since I began a series of experiments with a view to determining whether the local medication (anæsthetization) of the spinal cord was within the range of practical achievement. The drug made use of was the hydrochlorate of cocaine. As the introduction of a hypodermic needle beneath the membranes of the medulla spinalis is not practicable without removal of the arches of the vertebræ (on account of the danger of wounding the cord), I decided to inject the anæsthetic between the spinous processes of the lower dorsal ver-

tebræ. I was led to resort to this expedient from a knowledge of the fact that in the human subject numerous small veins (venæ spinosæ) run down between the spinous processes of the vertebræ, and, entering the spinal canal, join the more considerable vessels of the plexus spinalis interna. From these theoretical considerations I reasoned that it was highly probable that, if the anæsthetic was placed between the spinous processes of the vertebræ, it (the anæsthetic) would be rapidly absorbed by the minute ramifications of the veins referred to, and, being transported by the blood to the substance of the cord, would give rise to anæsthesia of the sensory and perhaps also of the motor tracts of the same. To be more explicit, I hoped to produce artificially a temporary condition of things analogous in its physiological consequences to the effects observed in transverse myelitis or after total section of the cord. I therefore anticipated a more or less local action of the drug upon the cord. My hopes in this regard were based somewhat upon the well-known lethargy of the circulation in the cord, particularly at its lower portion—a condition of things highly promotive of the local action of the drug.

Experiment I.—This was performed on a young dog. At ten o'clock, A. M., I injected twenty minims of a two-per-cent solution of the hydrochlorate of cocaine into the space situated between the spinous processes of two of the inferior dorsal vertebræ. Five minutes after the injection there were evidences of marked inco-ordination in the posterior extremities; the dog threw his hind-legs about aimlessly,

holding them far apart, much after the manner of some ataxic patients. A few minutes later there was marked evidence of weakness in the hind-legs, but there were no signs whatever of feebleness in the anterior extremities. I now tested the condition of sensibility by means of a powerful faradaic battery, one of the conducting cords of which was attached to a fine wire brush. When the wire brush was applied to the hind-legs, there was no reflex action whatever on the part of the latter, at least such was the case except when the most powerful currents were employed. But, on the other hand, when I applied the wire brush to either of the anterior extremities, the limb was drawn away violently, and the animal set up the most dismal howls. Similar effects were observed on pinching and pricking the limbs.

These phenomena persisted for a considerable length of time, and traces of inco-ordination were observed two hours after the injection had been made. After the lapse of about four hours, however, the dog seemed to have recovered his usual health, and walked about without difficulty.

During the progress of the experiment nothing of an abnormal nature was observed in the fore-legs. I infer from this fact that the action of the anæsthetic was practically local, being confined, for the most part, to that portion of the cord situated immediately beneath the point of injection. It is conceivable, however, that, had the quantity of anæsthetic fluid injected been greater, the anterior limbs might also have been affected. An *absolute* localization of the anæsthesia is indeed hardly within the range of pos-

sibilities, on account of the numerous blood-vessels. It is true, nevertheless, as we have seen, that the local action of the drug is greatly favored, at least so far as the inferior segment of the cord is concerned, by reason of the lethargy of the circulation at this point.

Experiment II.—This was performed on a man who had long been a sufferer from spinal weakness and seminal incontinence, and who for many years had been addicted to masturbation and other forms of sexual abuse. Without entering into the clinical details of the case, which are devoid of any special interest, I will proceed at once to give an account of the experimental observation which constitutes its only claim to attention.

As in the case of the dog previously referred to, I was bent upon abolishing reflex action and annulling sensory conduction in the cord. To this end I injected thirty minims of a three-per-cent solution of the hydrochlorate of cocaine into the space situated between the spinous processes of the eleventh and twelfth dorsal vertebræ. As there was no numbness, tingling, or other evidence of modified sensibility after the lapse of six or eight minutes, I again injected thirty minims of the solution at the same spot and in the same manner. About ten minutes later the patient complained that his legs "felt sleepy"; and, on making a careful examination with the wire brush, I found that sensibility was greatly impaired. Currents which caused lively sensations of pain and reflex contractions in the upper extremities were disregarded and barely perceived in the lower limbs.

The same was true of the prick of a needle. Fifteen or twenty minutes later the anæsthesia had increased in intensity, and, although there were some evidences of diffusion on the part of the anæsthetic, the impairment of sensibility was principally limited to the lower extremities, the lumbar regions, the penis, and the scrotum. About this time I applied the wire brush to the soles of the feet and to the toes, using about the maximum strength of a powerful faradaic battery, without causing either pain or reflex contractions, while a current of half the strength evoked intense pain and reflex contractions in the upper limbs. Some time later I fancied that I could discern some obtuseness of sensibility in the upper limbs; but on this point I feel compelled to speak with reserve. When the patient closed his eyes he experienced some dizziness while standing, but there was no inco-ordination or motor impairment discernible in the gait. The power of distinguishing differences in pressure seemed also to be preserved; but I regret to say that I did not test the sensibility to variations of temperature. The passage of a sound, though usually accompanied by considerable pain, remained almost unperceived, and an urethral electrode caused no inconvenience, even when strong currents were used. The sensibility of the scrotum and glans penis was also impaired to a marked degree, as proved by repeated tests with the electric brush. The pupils were but slightly dilated.

When the patient left my office, an hour or more after the injections, sensibility was still impaired to a marked degree, but otherwise he seemed none the

worse for his experience. The patellar tendon reflexes were, however, abolished.

The therapeutic advantages afforded by such local medication would seem to be great in a large number of morbid conditions of the cord. There is, indeed, no reason why strychnine and other remedies should not be employed in this local manner as well as cocaine. In strychnine poisoning, tetanus, and hydrophobia, it should also render good service. I will merely add that on the morning succeeding the injections the patient informed me that he had experienced tingling sensations and numbness in the lower limbs until nightfall. There was also dryness of the throat and mouth, accompanied by mental exhilaration. I could hear nothing of any cardiac disturbances.

On making an examination with the electric brush, sensibility was found to be normal in the lower limbs, scrotum, and glans penis. The passage of the sound was, as formerly, accompanied by some pain, and the urethral electrode provoked unpleasant sensations, even when mild currents were employed.

The only constitutional symptoms complained of were headache and slight vertigo, already referred to. At no time was there nausea.

Whether the method will ever find an application as a substitute for etherization in genito-urinary or other branches of surgery, further experience alone can show. Be the destiny of the observation what it may, it has seemed to me, on the whole, worth recording.

APPENDIX.

After the preceding portions of this brochure had gone to press, the following cases, in which my method of local anæsthetization had been successfully employed, were communicated to me by letter by Dr. Weir and Dr. Wright.

Operations of Dr. Robert F. Weir, Clinical Professor of Surgery at the College of Physicians and Surgeons, New York.

The first operation in which Dr. Weir made use of the method was undertaken for the resection of the middle metacarpal bone of the right hand, the lower portion of the same being in an advanced state of necrosis.

The solution, to the amount of two drachms (four per cent), was first carefully injected, and the tourniquet, in the shape of a strong rubber band, secured tightly around the wrist so as to effectually interrupt the circulation in the hand. The steps necessary to the removal of the bone were then undertaken, the whole course of the operation being without pain.

The second application of the method by Dr. Weir is ingenious, and, so far as I am aware, abso-

lutely unique. It was a question of undertaking Volkmann's operation for hydrocele. As in the previous operation, a four-per-cent solution was employed. The injection of the anæsthetic was made as carefully as possible, and the incarceration of the latter was attained by securing a strong India-rubber cord around the base of the scrotum. The duration of the operation was about twenty minutes, and there was "no pain whatever."

Dr. Weir informs me that the ingenious plan of operating for hydrocele under cocaine was first witnessed by himself at St. Luke's Hospital, the surgeon being Dr. Robert Abbe, of New York.

Additional Operations performed by Dr. J. Williston Wright, Professor of Surgery in the Medical Department of the University of the City of New York.

Adelaide F., aged twenty-five, October 1, 1885. Sebaceous tumor of the scalp, the size of a large almond, situated on right side of occiput, which was first noticed during the previous summer, and which was attributed to a blow from a stick of wood in the hands of a child. The tumor was incised, and its contents evacuated; but the cyst-wall, being very adherent from previous inflammation, was not removed, and an attempt was made to destroy its secreting surface by frequent applications of nitrate of silver to its interior. Failing in this, it was decided to remove the remains of the old cyst by incision. Operation, November 25th.

A piece of firm rubber tubing, five sixteenths of

an inch in diameter, was coiled upon itself in such a manner as to form a flat circular mat five and a half inches in diameter, having an opening in its center of about two and a half inches in diameter, while the different coils of tubing were held together by a few stitches of thread. This simple and ingenious appliance for operations of the scalp is depicted at Fig. 14. The central opening in the mat was then placed upon the tumor of the scalp, and its peripheral parts firmly bound down upon the adjacent portions of the scalp by applying over them several turns of an Esmarch elastic bandage, carried around the occipito-frontal circumference of the head, so as to partially interrupt the circulation. I then injected into the scalp, on each side of the old sinus leading into the cyst, five drops of a five-per-cent solution of hydrochlorate of cocaine. In four minutes the parts were thoroughly anæsthetic; and, after making an incision through the scalp two inches in length, I cut away the adherent remains of the old sac with scissors, the patient experiencing no pain whatever from the operation. Anæsthesia perfect at the end of thirty-five minutes, although the circulation had not been absolutely controlled.

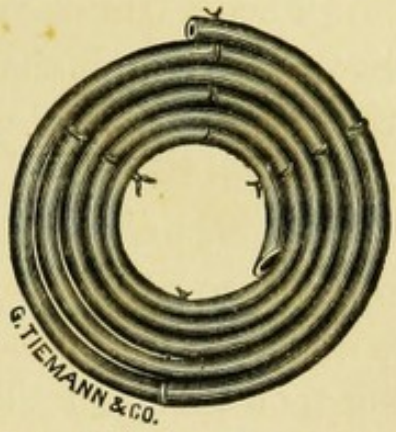

FIG. 14. — Dr. J. Williston Wright's appliance for incarceration of the anæsthetic in operations about the scalp.

The Esmarch was now removed; the wound cleansed and disinfected; a drainage-tube introduced, and, at the end of perhaps five minutes, an attempt

was made to close the wound by sutures. This part of the operation gave so much pain that it was found necessary to paint the edges of the incision with the cocaine solution before the needle could be passed.

[The subsidence of the anæsthesia after the removal of the Esmarch is an eloquent proof of the efficacy of the latter in perpetuating the condition of insensibility in the field of operation.—J. L. C.]

November 25, 1885, I. B., aged twenty-seven. Has an aggravated form of in-growing nail on the great toe of each foot. Injected five drops of a five-per-cent solution of cocaine into the soft parts on each side of the free border of the nail on the left foot, and in one minute thereafter applied a constricting rubber bandage to the root of the toe. The nail was then removed entire by the use of the blunt dissector, without the slightest pain on the part of the patient. In the mean time the right great toe had been exsanguinated by the Esmarch bandage, and, thus prepared, the same quantity of cocaine solution was injected in the same way. On pricking this toe five minutes later, the patient complained of great pain. The toe was now thoroughly massaged, but was still found to be sensitive. The Esmarch was then removed, the blood allowed to enter the toe for a moment, and then reapplied. Anæsthesia was now complete, and the nail was removed, as in the other foot, without pain.

[This is a graphic corroboration of what I said in my first paper on the best method of injecting the anæsthetic. See pages 34–41; also, in "New

York Medical Journal" for September 19, 1885.—J. L. C.]

M. J., aged fifteen, November, 1885. Large granulating sore at flexure of right elbow-joint, resulting from division of cicatrix of burn, which occurred at the age of two years. Injected ten drops of a four-per-cent solution of cocaine on inside of left arm. Five minutes later applied rubber bandage above site of puncture, and removed an elliptical piece of skin one and a half inches in length by three quarters of an inch in width at its widest part, to be transferred to sore on opposite arm, as a graft. No pain.

On the Prevention of Constitutional Symptoms.

As observed in a preceding chapter of the second part of this brochure, I am convinced that the strength of the solutions of the hydrochlorate heretofore employed in surgical operations has been far too great; at all events, since the introduction of my method such powerful solutions are no longer necessary, as I have had occasion to demonstrate to my entire satisfaction. The philosophy of all this is simple enough. When we inject the anæsthetic according to the old methods—that is to say, without resort to incarceration—the solution remains so short a time in contact with the filaments of the sensory nerves that the percentage of the hydrochlorate of cocaine must of necessity be great in order to give rise to a sufficient chemical change in the nervous ramifications to cause insensibility. On the other hand, when we employ the ligature, when we incarcerate the anæsthetic

fluid, we may greatly reduce the strength of the latter, since the solution, being maintained for any desired length of time in contact with the filaments of the sensory nerves, has abundant opportunity to act upon the latter. Here, then, we have a great principle, and, by laying hold upon the same, we have it in our power to diminish to a vast degree the possibility of the occurrence of constitutional symptoms. Let our first maxim be, then, to employ as weak solutions of the anæsthetic as possible. Our next maxim should be to protract the return of the anæsthetic into the general circulation. This may be accomplished by gradually releasing the ligature; the latter may even be removed for a few seconds at a time, and then, having been shifted, reapplied for several minutes. Where a large amount of the anæsthetic has been employed, as in extensive operations upon the soft tissues, this procedure may be repeated with profit every ten minutes or so for two or three hours. A nurse or an assistant can readily be taught to execute this simple manipulation in a few minutes. Where, however, the solution is of low percentage (one, or even one-half per cent), and the quantity injected relatively small, such precautions are usually hardly necessary. Sometimes, too, I remove the tourniquet altogether, and apply in its place a garter of ordinary elastic webbing, provided with a buckle. The elastic band is tightened just sufficiently to interfere with the venous circulation, and, being easily borne, may be allowed to remain in place for an hour or more. Finally, before proceeding to operate, it is well, especially in the case

of feeble, anæmic individuals, to administer a small quantity of alcohol, preferably, perhaps, in the form of brandy.

Should there be any pallor after removal of the ligature, the inhalation of a few drops of the nitrite of amyl will remedy the matter.

On Heating the Anæsthetic Solution before Injection.

Guided by the well-known fact that chemical reactions of various kinds are promoted by heat, I conceived that, by heating the anæsthetic fluid before injection of the same into the tissues, solutions of relatively small percentage might be employed. On putting this theory to the test, I found that by heating the anæsthetic fluid to from 99° to 102° Fahr., immediately before injecting, I was able to produce anæsthetic spots in the skin by the use of one-fifth-per-cent and even one-tenth-per-cent solutions (1 : 500 or 1 : 1,000). It is clear, therefore, that we have in this discovery an additional means of preventing the occurrence of constitutional symptoms in those who are peculiarly susceptible to the influence of cocaine.

The heating of the anæsthetic should not be undertaken over the gas-flame or fire, but should be attained by dipping a beaker-glass containing the anæsthetic into a vessel of hot water. The temperature of the anæsthetic should be accurately determined by means of the thermometer. The syringe should also be heated to the necessary temperature, which may be readily accomplished by allowing it to remain submerged in the anæsthetic solution. As

a rule, I believe that a temperature of about 99° will be found sufficient; and probably, too, in most instances, solutions of from one half to one per cent will be found most useful.

Future experience can of course alone determine the advantages or disadvantages of the method.

I would merely add, however, that, in a recent operation undertaken by Dr. M. Josiah Roberts, of New York, for the evacuation and radical cure of a large abscess in the neighborhood of the triceps muscle, local insensibility was maintained for an hour and a half by the use of a solution of the hydrochlorate of cocaine of only one third per cent. The solution was heated by me to 99° before injection, and the tourniquet applied just above the field of operation. The quantity of cocaine employed was only a little more than one third of a grain. The various devices recommended by me for carrying out my method of local anæsthetization in different regions of the body are manufactured by Messrs. J. Reynders & Co., of New York. They are put up in a neat box of exceedingly small dimensions, and in that form may be had at a moderate price.

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THE END.