ble to account satisfactorily for the action of the sympathetic nerve on the iris. The view that these nerves change the size of the pupil, through their action upon the muscular walls of the blood-vessels of the iris, is not well supported by the facts.

Their course toward the eyeball is partly along the walls of the arteries, partly along anastomoses which join the fifth cranial nerve. Section or paralysis of the sympathetic nerve of the neck is followed by contraction of the pupil, while its irritation dilates that aperture. These fibres can be traced through the rami communicantes of the last two cervical and the first two dorsal nerves into the spinal cord (Budge and Waller). The reflex centre of these fibres is partly in the corresponding region of the spinal cord, and partly in the medulla oblongata. Reflex dilatation of the pupil through this nerve channel can be readily induced by any sensory impression through almost any sensory nerve, at least when the pupil is not contracted by strong light, especially during sleep and incomplete narcosis. The pupil, indeed, is very sensitive to irritations of sensory nerves. It is not known that this reflex dilatation is of any utility.

It has recently been asserted by Tuwim[1] that the superior cervical sympathetic ganglion maintains a slight tonus of the dilator nerves of the iris, independently of, and even after, its separation from the central nervous system. Although his experiments seem conclusive, the question should be further investigated, since this would be the first instance known of tonic activity of nerves maintained by a sympathetic ganglion.

The fifth cranial nerve is the sensory nerve of the iris, endowing it with very great sensibility. Irritation of this nerve contracts the pupil very energetically in some animals, for instance the rabbit. Section of the nerve has the same effect, temporarily, the fibres being evidently kept in a state of transitory irritation by the injury, as occurs as well in certain other nerves. This influence of the fifth nerve upon the pupil does not exist in carnivorous animals. The observations in disease of that nerve in man are too conflicting to be decisive. The study of eye diseases attended with irritation renders it very likely that in man the fifth nerve is the vaso-dilator nerve of the iris, and that its reflex excitation congests the iris and contracts the pupil mechanically by the engorgement of the vessels. This is also the most plausible explanation of the intense pupillary contraction obtained on puncturing the anterior chamber, which result does not occur on operating on the dead eye.

Bibliography.—The optic properties of the eye were not understood until Kepler, in 1602, evolved the theory of optical instruments in general. The importance of the various parts of the eye in refraction was further elucidated by the Jesuit Scheiner in 1619. Minor additions were successively brought out by the labor of different authors, but it was only after Gauss had published his mathematical investigation of the cardinal points ("Dioptrische Untersuchungen," Göttingen, 1841) that the complete theory of the refraction in the eye could be deduced. This was done successfully by Listing, in the article "Dioptrik des Auges" in Wagner's "Handwörterbuch der Physiologie" (1853), who, by a critical selection of the older measurements of the refractive indices of the eye by Chossat and by Brewster, of the anatomical measurements of dimensions and curvature by Kraus, Kohlrausch, and others, determined the position of the ocular cardinal points with considerable accuracy. The most marvellously accurate methods, however, for measurements of the living eye, were first introduced by Helmholtz, who, in his "Handbuch der physiologischen Optik" (1867; 2d edition, revised, 1896), has produced a masterly treatise of rare originality, which every student of the subject must consult in the original. Since the publication of his large work, the first part of which on refraction appeared in 1856, Helmholtz has pursued these studies with the aid of numerous students, most of whose articles have appeared in the running numbers of the *Archiv für Ophthalmologie*. In an article by Reich (*Arch. f. Ophth.*, 1874, vol. xx., 1), Helmholtz corrects some of his former measurements and figures, and accepts as more nearly representing the values of the cardinal points in the average eye the figures which we have reproduced in the text of this article. Extensive measurements, especially of the curvature of the cornea, have also been made by Donders ("Anomalies of Accommodation and Refraction," 1864) and by Mauthner ("Vorlesungen ueber d. optischen Fehler des Auges," 1872), and more recently by Reuss (*Arch. f Ophthalmologie*, xvii., 1, p. 27). The entire theory of the formation of images in the eye, including physiological optics in general, is most exhaustively treated in Aubert's "Grundzüge der phys. Optik," in vol. ii. of Graefe and Saemisch's "Handbuch der gesammten Augenheilkunde" (1876), while important recent additions are to be found in Nagel's "Anomalien der Refraction," in vol. vi. of the same work. Very complete is also the treatise of Fick in vol. iii. of Hermann's "Handbuch der Physiologie."* All of these works must be consulted for the complete literature of the subject. In the English language the most extensive but older treatise is the work by Donders on "Anomalies of Accommodation and Refraction" (1864), which book marked quite an era in our knowledge of the physics of the different refractive conditions of the eye. In connection with this latter subject the work of Jaeger ("Einstellungen d. dioptrischen Apparats," 1861) must also be mentioned.

The mechanism of accommodation has been extensively discussed by former authors, by whom, however, no facts were brought forth beyond those taught by every-day observation. By some the accommodative changes were referred to the variations in the size of the pupil, while others even denied the existence of any accommodation. The most complete mathematical discussion was furnished by Th. Young in the "Philosophical Transactions" of 1801, in which it was shown by experiments and by deductions that the accommodation cannot depend on any changes except those in the form of the lens. The experimental proof that such changes do occur was furnished simultaneously and independently of each other by Cramer (in various publications in the Dutch language, between 1851 and 1855) and by Helmholtz (*Monatsberichte d. Berliner Academie*, February, 1853). The mode of action of the ciliary muscle was first explained by Helmholtz theoretically, and has since been confirmed experimentally by Hensen and Voelkers, who have likewise studied the innervation of the accommodative apparatus ("Experimentaluntersuchung über den Mechanismus der Accommodation," 1868, and *Archiv f. Ophthalmologie*, 1873, vol. xix.). Important measurements of the changes in the curvature of the lens during accommodation, and a mathematical inquiry into their efficiency were published by Knapp (*Archiv f. Ophth.*, 1860, vols. vi. and vii.).† Our knowledge of the range of accommodation in health and disease is due mainly to the researches of Donders ("Anomalies of Accommodation and Refraction").

On the innervation of the iris there exists an extensive literature, scattered throughout numerous physiological and ophthalmic serials. The older literature is exhaustively compiled in Budge's "Bewegungen der Iris," 1855. The present writer presented likewise a full review of the physiology of the iris in the Chicago *Journal of Nervous and Mental Diseases* (April and July, 1874), in which the complete literature up to that date can be found. Whatever has been done since 1874 is explicitly referred to in the text.

H. Gradle.

[1] Nagel: Anomal. d. Refraction, in Graefe and Saemisch's Handb. d. ges. Augenheilkunde, p. 461.
[2] Ueber schiefen Durchgang von Strahlenbündeln durch Linsen, Gratulationschrift an C. Ludwig, 1874.
[3] Archives of Ophthalmology, vol. ix., p. 29.

* The most recent compilation with many original measurements is Tscherning's "Physiological Optics," trans. by C. Weiland.
† Various doubts raised concerning Helmholtz theory of accommodation have been satisfactorily answered by confirmatory researches published by C. Hess in von Graefe's Archiv f. Ophthalmologie in a series of articles from 1897 to 1901.

[4] Proceedings of the International Congress at Copenhagen, 1884, Ophthalmic Section.
[5] Report of the Heidelberg Ophth. Society in Deutsche med. Wochenschrift, October 9th, 1884.
[6] Archiv f. Ophthalmologie, 1866, xii., p. 95.
[7] Archiv f. d. gesammte Physiologie, Bd. xxiv., p. 115.

EYE DISEASES. See under *Cataract, Choroid, Conjunctiva, Cornea, Glaucoma, Hypermetropia, Myopia*, etc.

EYE, INJURIES OF.—It will be proper, in writing on injuries of the eye, to take for granted that the reader is well acquainted with the anatomy and physiology of that organ, and such of its appendages and surroundings as, on account of structure, function, or situation, are likely, in case of injury, to require treatment differing in any way from that which would be suggested by the principles of general medicine and surgery.

It is understood, too, that the reader has acquired the art of using easily and well all the instruments and methods needed by the oculist for the diagnosis and treatment of those affections which are not traumatic. One requires, in handling cases of injury, not only to have at command an ophthalmoscope and a full case of surgical instruments, but to be well drilled in their use, and to possess also a certain adaptability to the situation and independence of thought and action, which will allow him to depart occasionally from conventionalities, and in emergency to use instruments for what they are worth, not necessarily for what they are made. For, though the results of violence may be routined off and classified as to the kind of operative interference that they may require, it is oftener in this branch than in any other that the surgeon will discover new and unprecedented situations or conditions which occur so infrequently as to have existed in literature only as forgotten curiosities.

Physical Conditions.—A word or two relative to the physical conditions which exist in the healthy eye may be of service in helping to appreciate those which are likely to exist in the injured organ, or in one in which inflammatory changes following injury have not been met by the necessary surgical interference.

The eye is a globe; it is filled with fluid, semifluid, or gelatinous matter which is practically incompressible. Its walls, though elastic and flexible, cannot be stretched very much, and as the sphere is that form which will contain the largest amount of matter within a given area of covering, the result is, there being no outlet, that if pressure is put upon this globe it will not change its shape very much without rupture. The physical conditions are very much the same as those of a leather ball filled with water—not those that exist in a rubber ball filled with air. The walls of this globe are very flexible, and when the globe itself is emptied any part of the sclerotic or cornea can be bent on itself like cloth. Neither of these tissues, either with or without its lining membrane, is subject to fracture in the true sense of the word, and when there is any complete and violent solution of continuity in these parts it is due either to laceration, to puncture, to cutting from some sharp substance, or to tension, erosion, or chemical action. The particular part at which rupture takes place will be the part at which the enveloping material is the weakest, unless, perchance, that part, at the time of the stress, is better supported by the pressure of neighboring parts, or unless some other portion is made comparatively weak by the pressure of some foreign substance which bends or indents it, and so places on it a local strain that cannot be transmitted. Rupture by contre-coup is not possible in the eye, though it is sometimes spoken of as having taken place.

Before considering each separate tissue in order, it may be well to supplement what has already been said by calling attention to the fact that the enclosing tunics of the healthy eye are more than full, and once their integrity is broken a small part of the contents is likely to be forced out by the elasticity of the tissues; that the secretion of aqueous and vitreous, and the supply of blood to the interior of the organ, keep its elastic covering always in a state of tension, and when, by rupture, cut, or puncture, or by ulceration, or decay of injured tissue, there is any solution of continuity, a part of the contents will have a tendency to escape; and while the opening remains, the constant building up of material to supply the place of what has been lost often forms a serious obstacle to the rapid healing of the wound, or the successful return of any part of its contents, such as protruding iris or vitreous, to the eye.

Without having at hand any experiments which may be quoted as giving definite knowledge of the actual strength of the materials used in the structure of the eye, it is possible to state, from records kept in cases of injury, that the part which is least capable of resisting strain put upon it by external pressure is the sclerotic, 3 or 4 mm. from the sclero-corneal margin. This is by far the most frequent seat of rupture, which nearly always takes place in a direction parallel to the sclero-corneal margin. The fact that it is usually found to have broken through the meridional fibres in the upper and inner quadrant is probably explained by the position of the surrounding parts, which are such as to protect it from external pressure, and yet to give little or no support when the eye is pressed upon from some other direction. The cornea rarely ruptures, and when it does, it is from some ragged extension of an irregular sclerotic tear, and is not to be looked upon as primarily a corneal lesion. The thickness of the sclerotic and cornea in the accompanying cut is not to show the actual size, but to indicate diagrammatically the relative liability of different parts to give way whenever, from any cause, sufficient pressure is put upon the eye itself to make a rupture of its tunics inevitable. In the same figure the choroid is drawn as if it were attached to the inner side of the sclera only at the nerve, at the venæ vorticosæ, and at the ciliary processes (Nos. 1, 2, 3). This is not really the fact, but it is so much more loosely attached at the intermediate points that, whenever the choroid itself ruptures—as it sometimes does if pressure so distorts the eye as to pull this membrane away from the overlying sclera—the break

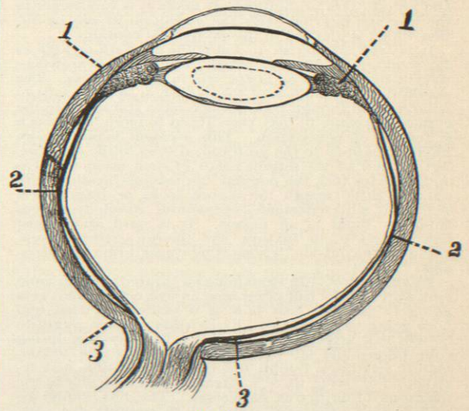

Fig. 2049.

does not ordinarily occur at any of the three points named above, but at some intermediate place. Such ruptures are most frequently seen, of course, in the posterior part of the eye, often nearer the nerve than the equator. They also do occur anteriorly to the venæ vorticosæ, and sometimes so far forward as to be unrecognizable during

life. The writer has seen one case in which history, symptoms, and ophthalmoscopic appearances warranted the diagnosis of rupture of choroid, with only this element of doubt in the case. The linear cicatrix which was in other respects so characteristic passed downward and inward about forty degrees from the vertical, directly across the head of the optic nerve, being visible up to the edge of the nerve above and reappearing at the edge of the choroid on the other side below.

The lens, in its capsule, and the suspensory ligament form rather an unsubstantial partition between the anterior and posterior chambers, and, while the outer tunics are intact, this structure is not very likely to be ruptured by any pressure which is uniformly distributed over the outside surface of that organ; but a distortion of the globe which tends to lengthen any diameter of the ciliary ring will do serious injury to this delicate structure, and a rupture of its walls in the immediate proximity of the lens or zonula so disturbs the equilibrium between the two chambers that dislocation is almost sure to follow. Quite often lens, iris, and zonula are all carried away by the pressure and expelled through the wound which has taken place in the stronger membranes.

The suspensory ligament is so delicate that it is said to have been ruptured by blows upon the head, which, not touching the eye at all, have caused the comparatively heavy lens to tear away its support by the rapid and violent vibrations thus imparted to it; though dislocations first discovered after such blows may be congenital.

It would be wrong to leave this subject without saying a word concerning the iris. The iris is one of the weakest muscles in the body, and the contractile tissue, which changes its size and shape so readily, is not able to do so against any appreciable resistance. In health it floats in the aqueous, attached only at the periphery in about the same manner that a delicate film of sea-weed exhibits its natural conformation in water, but collapses and loses its form when removed from that element. When the support of the lens is removed from behind it, it trembles with every movement. If there is a leak in the cornea in front of it, it is drawn into the opening, however slight, and unless extra precautions are taken it is sure to get in the way and interfere with the execution of any operation which is planned in the cavity that contains it.

It is well, of course, to know the strength as well as the weakness of different parts. The cornea is as deceptive in its strength as is the iris in its weakness. The reason that the amateur of the workshop so often fails to remove small foreign bodies which have stuck fast in the cornea is because he has been afraid to more than touch it for fear of penetration. This accident is much more likely to happen to the professional than to the amateur; but in view of the serious result of such accidents, it is well perhaps that the popular impressions be allowed to obtain. Still, though the cornea looks as fragile as a bubble, it will withstand considerable rough treatment from the hand of an expert. It is hard and almost ligamentous in its texture, and though extremely sensitive on the outside, is somewhere near 1 mm. in thickness.

Examination.—In examining an injured eye one must look at it as if he had never seen an eye before, and were going to find out just how it is made and what had been going on around it. Knowledge of what ought to be will call attention to what is. But injuries do not come tagged and labelled, and with hemorrhage, inflammatory swellings, lymph deposits, discoloration, and destruction of tissue, there is often as much difficulty in the diagnosis of injury as of disease. The lids should be pulled wide open and examined thoroughly for cuts, scars, perforations, and foreign bodies; neighboring cavities should be probed and foreign substances removed. One should look the cornea over at the window as he would examine any other lens for chips or scratches; he should also, by the aid of focal illumination at the gaslight, hunt for perforations, and should explore all depths of aqueous, lens, and vitreous by the lenses in the ophthalmoscope which will put them in and out of focus, being careful not to be so absorbed and interested in one injury that some other is overlooked and neglected.

Some readers of this Handbook, who do not make or do not wish to make a special study of ophthalmology, will doubtless be called on for advice, and will feel obliged to assume the care of diseased and injured organs of sight until such cases can be transferred to other hands. The first lesson to be learned by those who are thus feeling their way is what not to do.

Cases may be divided into those which need astringents and those which need anodynes. There is one astringent that must never be used—it is acetate of lead. Useful as it might be in some cases, it is so dangerous to many corneal affections that it should never be given except by an oculist so proficient as to be able to ignore rules and indulge in ophthalmological jugglery; but by him it is seldom needed. There is one anodyne that excels all others—it is atropine. The cases which are injured by atropine when they need astringents are so few as to be counted on the fingers of one hand. The cases which are injured by astringents when they need atropine are very many; so, when in doubt, if you use atropine you will benefit half the cases and injure none, whereas the astringents blindly used will benefit half the cases and injure many. The fact that atropine is poisonous to swallow, while most astringents are much less so; that atropine blurs the sight, while astringents do not; that atropine is nearly always used in serious cases, astringents in those comparatively simple, leads the novice to hope for the best and use astringents where he would much better, if he feels himself at all off his ground, believe in the worst and use atropine. The cases in which atropine must not be used are easy to diagnose, with the exception of glaucomatous trouble, with which this paper has nothing to do. Atropine may be used with caution where there is perforation or rupture of the globe near the sclero-corneal margin. Its use is said to predispose to prolapse in such cases. In the writer's belief neither the physical conditions nor the results of experience tend to corroborate this view. Atropine, generally speaking, should not be used when a foreign body is lodged on the iris or is loose in the anterior chamber, and likely from slight disturbance to fall down behind the iris or behind that part of the sclera which forms the opaque peripheral front wall of the chamber. In most other injuries atropine is the one remedy which the surgeon cannot well dispense with, while astringents, though sometimes useful, are seldom indispensable in the treatment of recent injuries.

Arlt found it convenient to divide injuries into:

1. Those produced by sudden compression or concussion.

2. Those produced by foreign bodies not acting chemically: (*a*) Those in which the foreign substance does not remain in the eye; (*b*) those in which the foreign body does remain in the eye.

3. Those produced by scalds, burns, and corroding substances.

This is a classification which must naturally run through any attempt to consider this subject, whether from a medical or a mechanical standpoint.

Hemorrhage.—A word or two may be said in a general way concerning hemorrhages, which are not connected with any lesion more definite than the breaking of a blood-vessel, the location of which is often unknown. Conjunctival extravasations of blood, such as come from slight blows, or from straining, coughing, stooping, or any violent disturbance of the circulation or increase of the heart's action, are of no particular importance, and require no treatment; apart from their gorgeous coloring they would scarcely attract the attention even of the patient. The parts should be examined carefully, to make sure that there is no solution of continuity. Then, if there has been no impairment of vision, either peripheral or central, the patient may be assured of certain recovery.

Hemorrhage into the anterior chamber is almost always

due to violence; it is rarely dependent upon scurvy or upon the presence of a neoplasm, and very rarely it has been reported due to other causes, such as menstrual or diathetic influence. The blood generally comes from the iris, and, unless the hemorrhage is caused by some dislocation or rupture other than that of the vessel's wall, is rapidly absorbed, sometimes disappearing within three days, sometimes remaining for as long a time as three weeks. When enough blood has been effused to conceal the inner structures of the eye, the diagnosis should be guarded, as they may have suffered serious injury.

Hemorrhage also takes place occasionally into the posterior chamber, leaving no trace of injury by which to account for the presence of blood. The ruptured vessels are supposed to be in the anterior extremity of the choroid. The depreciation of vision is often just as great as would attend choroidal rupture or other serious injury, so that it is impossible to tell at the time whether or not such injury has occurred. The treatment, of course, should be the same as that of the serious injuries which it sometimes accompanies and conceals, and it may not be possible, for six weeks or more, to say decidedly that no separation of retina or rupture of choroid has taken place near the posterior pole of the eye.

Commotio Retinæ.—After a blow on the eye, producing no other visible injury, vision may be reduced, the pupil becoming small and responding slowly to atropine while the retina is white and anæmic over the whole or a large part of its area. This condition reaches its height in about twenty-four hours and by the end of a week should be well on the way to recovery. The name, though given before the nature of the trouble was well understood, seems particularly well chosen, as the vitreous is violently forced into the region of the nerve fibres and other retinal layers are more or less affected. Such cases recover without treatment, but before allowing them to do so it is necessary to satisfy one's self that there is no rupture of the choroid or partial dislocation of the lens; that the amblyopia is not due to fracture of the skull at the optic foramen, to stretching of the zonula, or to paralysis of the accommodation.

Paralysis of Sphincter of Pupil and Ciliary Muscle.—Another injury which seems rather intangible, as far as its etiology is concerned, but which has actual existence, is the paralysis of accommodation, with partial or complete mydriasis, which sometimes follows a severe blow upon the eye. In mild cases recovery may be expected in a few days, but where the pupil is widely dilated and there is total loss of accommodative power, the patient does not recover. The indications, if any, are for the instillation of eserine.

Lids.—Passing now to those injuries in which actual damage has been done to the tissues themselves, I may simply remark, concerning the lids, that whatever may happen to them it is proper to treat the condition in accordance with the usual methods of general surgery, always remembering that they are much needed coverings for the eye itself, and when destroyed should be replaced at the expense of the surrounding tissue; care should also be taken to adjust the parts so that the contraction of the scars will not result in turning the lashes in upon the cornea or conjunctiva. Finally, it must not be forgotten that cuts across the edge of the lid margins are liable to gape and consequently they should be adjusted and supported during the healing process.

Conjunctiva.—Wounds—such as cuts, punctures, or tears—of the conjunctiva, unless they are inflicted by some instrument that causes contagion, and provided they do not involve other tissues, are not of a serious nature. They are amenable to the same treatment as is found effective in mild forms of conjunctivitis.

The extent of danger varies with the situation of the wound, the nature of the offending instrument, and the fitness of the system to undertake repair. In the first place, it is important to remember that even a slight cut in the conjunctiva of the lid may be the avenue through which some sharp instrument or foreign body has entered the orbit and has done serious injury to the optic nerve or the brain itself, a specially dangerous fracture of the orbital walls being produced by thrusts from sharp instruments which penetrate the upper part of the inner wall. Hence wounds near the peripheral part of the ocular conjunctiva should be closely examined, and evidence of foreign substances remaining in the wound or of serious injury to the orbit carefully weighed.

Small cuts or punctures limited to the conjunctiva are of little moment. The edges should be cleansed, sterilized, and freed from any particles of foreign matter that may still remain. Rest and cleanliness are the necessary conditions of recovery, and, though these wounds are not likely to be of an especially dangerous character, they demand some attention. The surgeon will often find it a difficult matter to decide just how far it is advisable to place restrictions upon the patient's usual manner of life. If wounds are comparatively large and the inflammation seems likely to affect the corneal tissues, or if there is any danger of serious results from the contraction of cicatricial tissue which may produce symblepharon, or ankyloblepharon, or entropion, or lachrymal obstruction, conjunctival wounds may be considered serious, and the patient should be made to consider recovery his first duty.

It may be necessary in some cases to put a stitch or two in the conjunctiva, to keep it in place until the healing process is established. Fine silk may be employed for this purpose, and usually it can be put in so lightly as to come out of its own accord when it is no longer needed. In putting in sutures about the eye it is very useful to have acquired sufficient dexterity to make the forceps take the place of one hand in tying the knot.

Should granulations spring up in or near the wound, they may be touched with nitrate of silver every other day. This and a one-per-cent. solution of alum for instillation will cause them to disappear.

If one of the recti muscles has been completely divided by a wound through the conjunctiva, the fact will be made manifest by an inability to move the eye toward the affected muscle, or by the occurrence of double vision, in which the image is displaced toward the injured side. The end of the muscle should be sought with a pair of fixation forceps and fixed in its proper place, as in the operation of bringing forward for strabismus.

The most serious wounds of the conjunctiva are, however, those which are made by burns from hot metals, acids, unslacked lime, and other irritating and corroding substances. The cornea is more than likely to be included, and upon the depth and extent of the corneal injury the final result is in great measure dependent. The principal danger, so far as the conjunctiva is concerned, is not so much the destruction of tissue as that, in healing, two surfaces which usually move freely over each other may become firmly united, causing symblepharon or ankyloblepharon, thus closing in part a cavity which should remain open. There is also the further danger that adhesions may take place between different parts of the conjunctival mucous surface of the lids, or between the lid and the cornea or some other part of the globe, and thus seriously lessen the mobility of the eye, or disfigure and inconvenience the patient by unsightly deformity or by the constant irritation of an organ so attached.

The first thing to be done in such cases is to remove the irritating substance, if it has not already been removed. Melted metal, which has cooled into place, must often be removed by the use of considerable force and with some mechanical injury to the parts. Lime and sand may be scraped carefully from the *cul-de-sac* with a Daviel's curette or spoon. It has been recommended that at the time of the accident alkalies should be washed from the eye with weak acids like vinegar, acids with weak alkalies like soda or salaratus; these remedies are usually at hand, and are chemically appropriate. But there is nothing so swift and appropriate as plenty of water, with which the eye may be flushed immediately. The fact that strong sulphuric acid and

lime evolve heat and are more injurious when small measures of water are added does not count for much when water can be supplied in large quantities and without any delay.

These injuries, when the cornea is not implicated, call for quiet antiphlogistic treatment, with the instillation of sterilized olive oil, linseed oil, or vaseline, and of atropine to allay any irritation or tendency of the cornea or iris to become inflamed.

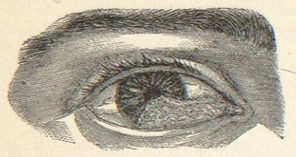

FIG. 2050.

If the injury is attended with much pain, cocaine should be used as often as necessary to secure the comfort of the patient. When the destruction of tissue extends so deeply in the *cul-de-sac* that there is no bridge, or only a narrow bridge of sound conjunctiva between the two injured parts, little or nothing can be done to prevent their growing together during the healing process. The opposed surfaces must be separated frequently, and in spite of this the contraction of cicatricial tissue will almost always bring them together as they heal, and will do this with persistency. Plates of wax, glass, silver, or gutta-percha may be worn for a while at some risk of irritating the eye, but in the course of time they will be crowded out, and are more likely to do harm than good. Attempts to improve the local conditions by resorting to surgical interference after the wound has entirely healed, are not likely to produce materially better results. Cutting the bridles and attachments affords only temporary relief, and it is only by the performance of a suitable plastic operation or by skin-grafting that we can hope occasionally to secure some measure of success.

If there is a free passage for a probe beneath the substance of the symblepharon, considerable improvement, or perhaps permanent relief, may be expected; but frequently the surgeon will exercise his ingenuity in vain. It may be put down as entirely improbable that any extensive symblepharon or ankyloblepharon which has grown up from the bottom of the *cul-de-sac*, will be greatly decreased in size by any of the measures mentioned.

The accompanying cuts are from Lawson, and represent very well the conditions indicated by the text. Fig. 2050 "represents the appearance produced by an injury to the eye from some fresh mortar, which was thrown into the eye the day before the boy was brought into the hospital." The coloring, of course, is not present, but the appearance of a burn caused by mortar is very characteristic. Fig. 2051 "is a good illustration of a case of partial ankyloblepharon, and shows very well the position of the fistula which is frequently met with when the inner portions of the lids are united." The particular case here pictured happens to have been the result of mechanical violence, but it may well have happened from either mechanical or chemical injury.

CORNEA.—Although the cornea is never ruptured by a blow or by pressure causing momentary increase of tension, and although it seldom suffers from any force transmitted to it through the closed lid (unless the lid itself is perforated), it often suffers severely from the impact of small bodies which have appreciable weight, and which so bruise without breaking its substance as to cause local death of the part struck. This results in the formation of what is known as corneal abscess. The abscess thus formed is, on account of the thinness of the membrane, not likely to exist as a sac filled with fluid of a purulent nature, but consists of tissue infiltrated with purulent matter which discharges itself either forward on the conjunctiva or backward into the anterior chamber, or more likely in both directions. This abscess may be of any extent, small or large; it may be superficial or it may involve the inner and deeper layers of the membrane. Its extent cannot be told at the time of the accident. The first sign of serious injury, apart from accompanying pain, is the conjunctival reddening and well-marked ciliary injection, which may extend entirely around the organ or may be confined to the immediate proximity of the part struck. Pain, photophobia, and lachrymation are naturally attendant on this condition, which may continue for two or three days before the grayish discoloration and opacity that follow the injury have marked out the seat and the limits of the destructive process. After this the disease follows the course of corneal abscess from any cause. Pus soon forms in the layers of the cornea and also in the anterior chamber, settling down to the lower part between the cornea and iris. By this time the inflammation will have advanced so far as to threaten the iris and ciliary region, and the pain is likely to be very severe. There is therefore danger that if the process is not checked by operative interference it may end in panophthalmitis. Pus at the bottom of the anterior chamber may be distinguished from that in the layers of the cornea by placing the patient on the side for a moment or two and witnessing the change of place caused by gravitation.

The treatment for corneal abscess of traumatic nature, either actual or threatened, is atropine, rest, and protection from the light. During the early stages, before the formation of pus has begun, cooling applications externally and iced compresses are likely to be of benefit. After suppuration is established, lukewarm or even hot water will be more gratefully borne and will probably hasten the progress of the disease toward recovery. Antiseptic precautions, of course, are necessary. They consist in frequent bathing with water of suitable temperature, to which four per cent. of boric acid has been added, or one-thirtieth of one per cent. of corrosive sublimate.

With pus in the anterior chamber and threatened or existing iritis or irido-cyclitis, it will often be necessary to administer morphine to relieve pain and to give the patient sufficient rest and comfort to insure the best recovery. Whatever the attitude of the patient is toward the use of this narcotic, it will be well to remember that pain is often worse than poison, and the surgeon should demand the right to choose.

If the pus at the bottom of the anterior chamber is more than 2 mm. in depth, or if the abscess takes on at its edge the halo of light gray, which indicates that the process at first due to traumatism is extending beyond the margin of the orlginal injury, it may be necessary to evacuate the anterior chamber, and, perhaps, to open the abscess according to Saemisch's method, by passing a Graefe knife, which is held with its back to the pupil and iris, into the anterior chamber on one side of the abscess and out on the other, thus cutting entirely through the abscess from within outward. After this, the wound must be kept freely open until recovery is well established. This operation is not always necessary, paracentesis of the lower part of the cornea, in such a position as to favor the evacuation of pus from the anterior chamber, being often attended with the best results. This opening should be renewed at least every second day, until no pus remains.

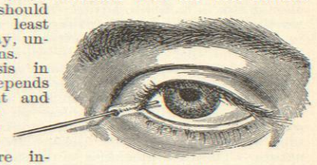

FIG. 2051.

The prognosis in these cases depends upon the extent and location of the abscess and the depth to which the tissues are involved. Wherever the abscess is, there will remain a white scar. This, of course, is of little importance if the scar is small and situated at the periphery; but if, on the other hand, it is situated in front of the pupil and is of such an extent as to obviate the possibility of making an artificial pupil, its presence will render the eye practically blind. If the abscess breaks externally, the lens or the iris is likely to rest against the wound and ultimately to become adherent to it, thus giving rise to unpleasant symptoms of irritation and inflammation, which may be well borne for many years, but which in some cases finally result in panophthalmitis and phthisis bulbi, or sometimes cause large and unsightly staphylomata. The usefulness of atropine and eserine in placing the iris in given positions should not be forgotten during the progress of the disease.

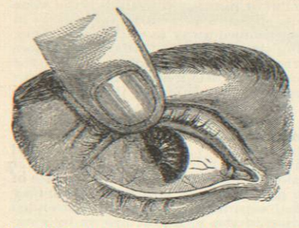

FIG. 2052.—Represents the Effects of a Burn from Molten Lead, that Splashed into the Eye from a Pot which the Patient was Carrying. (Lawson.)

Wounds of the cornea entailing solution of continuity may be mere superficial scratches, in which hardly more than epithelium has been removed, or they may penetrate the anterior chamber, injuring iris or lens, or extending to the deeper tissues of the eye. As the cornea is the principal lens in this physiological camera, the danger is twofold—that of its destruction as part of the firm enveloping membrane which holds the structures together, or that of distortion, deformity, or opacity, which destroys its usefulness as an optical instrument. If the wound is a mere superficial abrasion, complete recovery may be expected, though such injuries are often attended with great pain, neuralgic in its nature, with photophobia, lachrymation, and ciliary injection. The use of cold compresses, or of a bandage which keeps the eye closed and prevents the lid from rubbing up and down over the abraded surface, will allow it to heal in a few days, and the instillation of atropine, thrice daily, will banish the pain and hasten recovery. Occasionally, a slight abrasion made by some rough instrument, perhaps by the nail of an infant, on the cornea of its mother or nurse, will apparently heal within a few days, giving rise to no trouble at the time; but two or three weeks afterward, when the incident may have been entirely forgotten, severe and persistent neuralgic pains will call the surgeon's attention to a slight irregularity on the surface of the cornea, and with the instillation of atropine and a light bandage worn for a few days, the patient will entirely recover.

The prognosis for these wounds is favorable for the most part. Unless the loss of substance extends as deeply as the membrane of Descemet, there will be no visible scar, the transparency of the tissue remaining; but if the wound is at or near the centre of the organ, and not of a rather superficial nature, so much irregularity of surface will remain as materially to affect the eye as an organ of sight. Very slight injuries, such as those just considered, are often fraught with considerable danger to old people who are poorly nourished, or to those suffering from debilitating disease, such injuries taking the form of persistent and progressive ulceration, which is checked with difficulty. After the character of such trouble is established, it is no longer traumatic in its nature, and should be treated like any other similar ulceration.

When the cornea is penetrated by a clean, sharp instrument, which does not at the same time injure iris or lens, the wound, if not of large dimensions, may be expected to heal up quietly without any very great disturbance. The aqueous humor will, of course, be evacuated, except in very minute punctures; then, afterward, if the lips of the wound are adjusted by gentle pressure (preferably through the lid with a Daviel's curette), they will often unite by first intention, and allow the chamber to be re-established by the secretion of aqueous, which takes place very rapidly. Quite often, furthermore, the iris will not become attached to the wound against which at first it was pressing. Punctured wounds made by rough or blunt instruments often give rise to much more trouble. There is a larger vent for the escape of aqueous. The iris or the lens is likely to be pressed against the wound, or perhaps pushed through it. The healing process does not take place without some destruction of tissue and the formation of a white scar, to which either iris or lens or both may be permanently attached.

If the wound is seen at the outset, effort should be made to get the eye into something approaching its normal condition. Ragged edges of the wound or of the protruding iris, which cannot live, should be snipped off with the scissors. Gentle manipulations with Daviel's curette scoop or with the rubber spatula may cause the iris to return into the chamber. If it does not return, it should be excised, unless it has become adherent or seems to occupy a useful position in preventing the further escape of the contents of the anterior chamber. Should it be necessary to allow the iris to heal into the wound, or if later it becomes irritable, an iridectomy can be done to set the matter right.

Any wound which so opens the walls of the globe as to allow the escape of any appreciable part of its contents is a serious affair, and demands perfect quiet on the part of the patient—usually, indeed, the recumbent posture, especially during the early part of recovery. Next to rest, the most important thing, in corneal injuries, is to give frequent irrigations with normal salt solution or with some mild antiseptic solution (boric acid, for example). Avoid all depleting measures; allay pain with atropine or cocaine instillations, or with morphine subcutaneously if necessary to give the patient needed rest. If, after the healing process is well under way, there remains a fistula through which aqueous continually escapes, touch it with nitrate of silver, or burn it very slightly with the electro-cautery. It may be, and often is necessary, after recovery, to perform an iridectomy, for the purpose of affording relief from the irritating effects of iris attachments, or for that of making an artificial pupil.

Burns, scalds, and injuries of the cornea from irritating and corroding substances are of a more serious nature than similar accidents which affect only the conjunctiva; any deep destruction of tissue brought about in this way is followed by serious reactionary inflammation and resulting opacity. The danger of symblepharon is great in some cases, and should be guarded against as in conjunctival injuries. If the wound is seen immediately after the injury, it will in most cases give very little evidence of the amount of damage which has resulted or will result, but after the lapse of two or three days one can judge more accurately of the extent of this damage. Another word of warning should be given here against all collyria containing preparations of lead. Many cases, in which the eyes have been burned by acid or other corroding substance, have been made hopelessly blind by the use of acetate of lead collyria prescribed by some well-meaning apothecary who must needs do something in the emergency. The harmfulness of the lead preparations lies in the fact that they render all scars in the corneal tissue thoroughly opaque, and so interfere with the transmission of light to the retina.

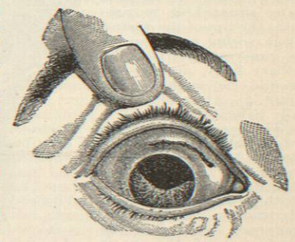

FIG. 2053.—Rupture of Sclerotic, in which Lens and Upper Half of Iris were Lost at the Time of the Injury. (Lawson.)