

fresh air and a fair amount of outdoor exercise are indispensable. There can be no greater mistake than the common practice of keeping a child suffering from phlyctenular ophthalmia shut up in a darkened room on account of intolerance of light. When out in the open air the eyes can be sufficiently protected by wearing a large shade. Further protection can, if deemed necessary, be secured by means of a bandage. A firm compression bandage may be of great service if there is ulceration of the cornea. The ulceration may indeed be so considerable as to require the same treatment as suppuration keratitis. The condition in which a circle of exceedingly minute phlyctenulae surrounds the extreme margin of the cornea is perhaps, strictly speaking, an affection of the conjunctiva. It is apt to be attended with severe irritation and great pericorneal injection, only yielding slowly to treatment, which in the main need not differ materially from the measures just recommended for the purely corneal affection.

A modified form of phlyctenular keratitis, known as *fascicular keratitis*, must also here receive mention, as it is not of infrequent occurrence, tends to run a protracted course, and is often very troublesome. In this form a rather large phlyctenula appears at the corneal margin and slowly advances across its surface, and a leash of blood-vessels follows in the wake of the advancing infiltration, which often has a yellowish color at its most prominent part. Should the band thus formed extend as far as the centre of the cornea, it there curves upon itself and assumes a sort of horseshoe figure. Severe irritation is characteristic of this form of strumous keratitis. A rapid cure of this affection can nearly always be obtained by destroying the infiltration with a fine point of solid nitrate of silver or with pure carbolic acid applied with a pointed piece of wood; such application must be carefully limited to the advancing infiltration. For a few days afterward, mild soothing and cleansing treatment is required. A streak of opacity always persists for a long time after the inflammation has passed away, and is sometimes permanent.

*Herpes cornea* is not to be confounded with phlyctenular keratitis, from which it differs widely in symptoms, causation, and pathology, true corneal herpes being undoubtedly identical in character with herpetic eruptions elsewhere.

In this affection one or more small vesicles, containing a transparent fluid, form on the surface of the cornea, and leave superficial excoriations when ruptured. Severe neuralgic pains accompany vesication, but may cease when the vesicles give way; they return, however, as often as fresh ones are formed. During the attack, which is almost always unilateral, there is pericorneal injection, and the eye is often extremely irritable. Three forms of corneal herpes are recognized (De Wecker, "Thér. oculaire," p. 169, 1879):—

1. *Herpes catarrhalis*, which occurs in conjunction with catarrhal affections of the air passages.
2. *Herpes zoster cornea*, which probably depends upon an inflammatory affection of the fifth nerve, and is very often associated with the cutaneous eruption known as zoster ophthalmicus. Intense pain, both preceding and following the corneal eruption, together with local anaesthesia of the parts affected, is characteristic of this affection. Superficial ulceration and infiltration of the cornea, which is slow in healing, is more conspicuous than in the catarrhal form. In zoster ophthalmicus corneal lesions are likely to occur only when the nasal branch of the first division of the fifth is involved, as evidenced by the cutaneous eruption at the corresponding side of the nose.
3. *Herpes idiopathica cornea* differs from the second variety mainly in its tendency to recur, sometimes periodically, and in not being associated with an eruption of cutaneous zoster.

*Treatment.* The first variety requires no other treatment than such as may be necessary for other co-existing catarrhal affections. In the second and third varieties hot applications of belladonna or chamomile in the form of fomentations are beneficial, atropine instillations and a

compression bandage are also to be employed; large doses of quinine have been found beneficial, and, later on, applications of electricity (the constant current). Arsenic given for a short time in full doses seems to relieve the neuralgic symptoms.

*Keratitis bullosa* is a rare affection which might readily be mistaken for herpes cornea, as it is characterized by the rapid formation of transparent vesicles on the corneal surface, which come and go with sudden attacks of severe pain in the eye. In this disease the vesicles are much larger than in corneal herpes; there may be only one large flaccid bleb, 4 to 5 mm. in diameter, or several of these of various sizes. When these burst or are removed, the subjacent cloudy cornea is laid bare, but in the course of a few days the epithelium is restored again, only to undergo a repetition of the process. Again, eyes affected in this way are usually otherwise in an unsound condition. For example, there may be absolute glaucoma or old irido-choroiditis, and under these circumstances the formation of vesicles probably depends upon a disturbance in the lymph channels of the cornea, which is always the seat of chronic interstitial changes—keratitis parenchymatosa (Gräfe-Saemisch, *Ges. Augenheilk.*, vol. iv., p. 272). The treatment of this condition is not very satisfactory in its results; removal of the blebs is only palliative; shaving off a layer of subjacent cornea has been known to prevent their recurrence. The operations of iridectomy and sclerotomy have proved curative in some instances. Enucleation of the eyeball is justifiable as a last resort, and will prove a welcome relief after months or years of suffering.

*Vascular Keratitis.* Superficial infiltrations of the cornea, with roughness of the epithelial layer, caused by erosions and hypertrophic irregularities of its cellular elements, may occur without obvious reason, or in consequence of repeated attacks of phlyctenular keratitis, or as the result of trachomatous conjunctivitis (Fig. 1, Plate XXIV.). With these changes blood-vessels develop more or less abundantly between the epithelial layer and Bowman's membrane, as well as in the corneal substance immediately beneath,—a combination of lesions that constitute, when the vessels are numerous, the condition known as pannus. Of this two varieties are recognized: *pannus tenuis*, when the new-formed blood-vessels are comparatively few and scattered; *pannus crassus*, when they are so numerous as to give the cornea a distinctly red appearance.

When this process encroaches upon the pupillary area of the cornea, vision becomes correspondingly impaired, being reduced in some instances to qualitative perception of light. In the presence of pannus the eye becomes liable to attacks of an inflammatory character, attended with pericorneal injection, pain, lachrymation, and photophobia. At such times the cloudiness and vascularity are notably increased. The cornea may undergo further changes in the way of ulceration, partial thinning, and permanent alterations of curvature. In any case, after recovery more or less permanent cloudiness remains, as may readily be seen by focal illumination, which also reveals minute permanent blood-vessels too small to be seen by the naked eye.

*Treatment.* So long as any acute symptoms are present every form of stimulating treatment is to be avoided, but may be resorted to when these have subsided of their own accord or under the use of atropine, warm fomentations, and the frequent introduction of vaseline into the conjunctival sac. The red oxide of mercury ointment is often very efficacious in all forms of the disease, especially in phlyctenular pannus. Tannin and glycerin, or a spray of cupric sulphate, gr. v. ad ℥ i. (Schweigger), are often of service in the pannus of granular ophthalmia. In these cases the conjunctiva will, of course, require suitable treatment, and the pannus as well as the recurring attacks of irritation may disappear with the cure of the granulations. The operation of peritomy may be required for high degrees of pannus, and often yields excellent results. Formerly, inoculation with the pus of ophthalmia neonatorum was much in vogue, and in selected cases



of dense pannus was found very satisfactory, but it was always open to the objection that the inflammation once set up could not be controlled, and might prove, as it sometimes did, destructive. Since the introduction of jequirity brilliant results have been obtained by its use, in just such cases as would have been deemed suitable for inoculation. By varying the strength of the solution used and the number of applications the surgeon will experience no difficulty in regulating the intensity of its action. Operations for relieving undue pressure of the eyelids (cantholysis or canthoplasty), or for obviating inversion of the eyelashes (entropion and trichiasis), are sometimes required.

*Traumatic Keratitis.* See the section that treats of Wounds of the Cornea.

*Parenchymatous Keratitis* (Interstitial Keratitis) is a form of inflammation characterized by infiltration of the cornea in its entire thickness, without tendency to ulceration or abscess; the whole cornea is more or less involved. The epithelium has a stippled appearance, which, with the subjacent opacity, gives to the cornea, in some cases, a resemblance to ground glass (Plate XXIV., Fig. 6). The onset of the disease is preceded for some days by symptoms of irritability, lachrymation, and slight pericorneal injection. Corneal opacity, either peripheral or central, now soon makes its appearance; the former being attended with the formation of fine, closely set blood-vessels grouped together as a vascular patch, which slowly advances from the corneal margin toward its centre. In this way the entire cornea may become densely opaque and highly vascularized, although in the worst cases a yellowish infiltration occupies its central portions. In another class of cases a central cloudiness of the cornea appears, and, while gradually extending toward the periphery, becomes more and more opaque, but not vascular. Between these two types there are mixed forms; there are others in which the opacity has a patchy appearance, some of the patches being vascularized, while others are not.

The disease runs a slow course and relapses are not infrequent. As a rule, six or eight weeks elapse before it reaches its acme; then, after remaining stationary for some weeks longer, it slowly subsides. Irritative phenomena may last for from three months to a year, while the clearing process is proportionately protracted and rarely terminates in complete restoration of transparency. Symptoms of irritation, with deep ciliary injection, may be very slight or intense according to the severity of the case and the degree of vascularization. Vision is always greatly reduced for the time being; both eyes are likely to suffer, though rarely attacked simultaneously; the interval may be weeks or many months; relapses after partial recovery are not unknown. When the disease is of syphilitic origin the iris nearly always participates in the inflammation, and if a further extension of the disease occurs, there may be iritis or irido-choroiditis.

The disease is always of constitutional origin, and hereditary syphilis is clearly the predisposing cause far more frequently than any other known dyscrasia. Acquired syphilis will account for a few cases. The strumous diathesis is assigned an important place by some observers (von Arlt). The subjects of inherited gout are also said to be liable to this form of keratitis (Noyes).

When parenchymatous keratitis occurs in hereditary syphilis, other well-known signs of this taint are commonly present, especially the so-called syphilitic teeth ("Syphilitic Diseases of the Eye and Ear," by Jonathan Hutchinson). There is then usually a history of one or more abortions or still-born children prior to the birth of the affected individual. The tendency may occur in two or three consecutive children of the same parents whilst those coming later escape. The affection occurs, as a rule, in young persons of from five to twenty years of age, rarely at an earlier or later period of life.

*Treatment.*—If the disease can be traced to hereditary syphilis, mercury in some form should be administered, preferably a mild course of inunction, which may be continued for a long period if care be taken not to push

it so far as to cause or increase debility. It should be omitted for a time the moment the gums begin to show redness and swelling. Iodide of potassium in moderate doses may be resorted to later on. Throughout the course of treatment roborant measures are indicated; existing anæmia is best combated with the syrup of the iodide of iron, though iron with quinine or strychnine may sometimes be found better adapted to the requirements of the case. Cod-liver oil is also a valuable remedy in these cases if the patient is of strumous habit; under these circumstances mercury must be employed with great caution, if used at all. In lieu thereof various preparations of the iodides may be used. Errors of digestion must be corrected with suitable remedies. Good plain food and abundance of fresh air are of course essential means in keeping up the general health. A large shade and tinted glasses may be worn when the patient is in the open air or exposed to strong light. In the local treatment one leading principle is to be steadily kept in view: *No astringent or irritating remedy is to be employed until all signs of active irritation have subsided.* The moderate use of atropine is always indicated during the active stages of the disease. A two- or four-grain solution may be instilled once or several times daily, according to the degree of irritation; in other words, *the pupil must be kept moderately dilated* so long as the eye remains inflamed. Fomentations with hot water or chamomile infusion may be employed for twenty minutes at a time, frequently during the day, until the disease is well on the decline. Used in this way they are said to shorten the course of the disease and mitigate its severity. The presence of conjunctivitis of slight degree does not call for astringent treatment, though solutions of borax and boric acid may be used under these circumstances with benefit. Solution of atropine sometimes sets up a characteristic conjunctivitis, in which case it must be abandoned, and, if necessary, some other mydriatic chosen (duboisine, homatropine, hyoscyamine). Recently the subconjunctival injection, every few days, of mercuric perchloride (1 to 2,000) has been highly extolled by several writers.

Some protracted cases may require an iridectomy (or sclerotomy, De Wecker) before they begin to improve, particularly if there be undue tension of the eyeball. After all irritation has subsided, the careful use of stimulating applications, such as the oxide of mercury ointment, or insufflations of calomel once or twice daily, may assist in removing the residual corneal opacities of parenchymatous keratitis. When this disease occurs in gouty subjects (usually adults), pain and photophobia are prominent symptoms (Noyes). Constitutional remedies suitable to the diathesis are to be administered. Muriate of pilocarpine (gr.  $\frac{1}{4}$  to  $\frac{1}{2}$  by hypodermic injections, once daily) is also recommended, particularly if atropine instillations are not well borne. The local treatment must be of the soothing character already mentioned. Paracentesis of the cornea is also useful in relieving pain if there is obviously increased tension of the globe.

*Suppurative Keratitis* is a term applicable to all inflammatory affections of the cornea which are attended with purulent infiltration, and it includes abscess of the cornea as well as several forms of corneal ulceration. Either abscess or ulcer may originate spontaneously, or as the result of some, perhaps, trivial injury; either may commence as a simple infiltration, or the formation of pus may take place from the outset. Every case of suppurative keratitis is probably the result of infection of some wound or lesion which has permitted the entrance of disease germs beneath the normal protective barrier which the strong corneal epithelium furnishes. Debility and malnutrition diminish the patient's power of resistance and so favor the suppurative process. Pneumococci, staphylococci, and streptococci are the common forms of disease germs met with in suppuration of the cornea, and it must be borne in mind that these are also commonly present in the normal conjunctival sac; hence the necessity for strict asepsis in all corneal wounds.

Deposits of pus in the anterior chamber (Plate XXIV.,

Fig. 3), called *hypopyon*, are of common occurrence in suppurative keratitis. The occurrence of this phenomenon has been accounted for in several ways: (1) The pus cells may travel through the posterior corneal layers and Descemet's membrane (Horner); (2) or they may pass between the layers of the cornea on to its lower periphery, reaching the anterior chamber through the interstices of the ligamentum pectinatum (Stromyer); (3) by direct rupture of a corneal abscess, the pus may escape into the anterior chamber; (4) the epithelial cells of Descemet's membrane may undergo purulent proliferation; (5) as already stated, an associated purulent iritis or iridocyclitis induced by the transudation of irritant ptomaines from the suppurating cornea to the interior of the eye may contribute to the formation of pus in the anterior chamber, or it may perhaps wholly account for the phenomenon.

Whatever its origin, the purulent mass in the anterior chamber may be of a semi-solid or gelatinous consistence, and so cohesive as to admit of being withdrawn bodily from the chamber after an incision sufficiently large for an iridectomy has been made.

Suppurative affections of the cornea attended with hypopyon are either sthenic, with great pain and inflammatory symptoms of an active character, or asthenic and sluggish, with little or no pain, etc. The latter are indicative of a very low state of nutrition, or of torpor of the fifth nerve. A circumscribed purulent infiltration of the cornea without superficial loss of substance constitutes an abscess and may be attended with hypopyon, etc., so long as the disease does not advance beyond this stage; but sooner or later the surface is likely to give way, and the abscess then becomes an ulcer. Whenever hypopyon results from suppurative keratitis the corneal lesion always presents more or less of a dull yellow color, caused by infiltration of the part with pus cells. In the sthenic form there are pain, often intense, deep-seated injection of the eyeball, photophobia, and lachrymation. The appearance of the cornea varies according to the extent of the disease and its mode of progress. The sthenic abscess or ulcer is surrounded with a zone of gray infiltration, sometimes of a streaky appearance; the ulcerated surface may be excavated or nearly on a level with the surrounding cornea; its surface is always more or less covered with a layer of grayish or yellowish-gray broken-down material. Pus in the anterior chamber may appear at its lower edge as a narrow yellow streak, a wide space of clear cornea intervening between this and the lower edge of the ulcer or abscess; or a streak of purulent deposit behind the cornea or between its lamellæ may extend from the ulcer to the hypopyon. A large accumulation in the anterior chamber may extend to the level of the ulceration, so that they appear to blend with each other. Perforation of the cornea, with or without prolapse of the iris, may occur before the ulceration has extended very widely; or the ulceration may involve so much of the cornea that it becomes transformed into a dull yellow necrotic mass. The term *serpiginous corneal ulcer* has been applied by Saemisch to those "forms of suppurative keratitis which are distinguished by the tendency to penetrate into the parenchyma and extend superficially, especially in one direction." Such ulcers are apt to progress, sometimes rapidly, and may prove very destructive.

Eyes subject to chronic conjunctivitis, with blennorrhœa of the lachrymal sac, seem particularly prone to destructive suppurative keratitis, probably owing to the continued presence of septic material in the conjunctival sac. Purely asthenic suppurative keratitis commences as a rule about the centre of the cornea. In this affection all signs of active inflammation are wanting; the absence of a gray zone of infiltration around the suppurating area is also to be noted; and the surrounding cornea may even appear unusually pellucid, only becoming infiltrated and cloudy when healing has commenced. The changes which take place during the healing of corneal ulcers have already been briefly described; we may here add that with this, in asthenic cases, a certain degree of

irritation develops, whilst in the sthenic forms the existing sthenic irritation tends to subside.

*Treatment.*—Rest and protection of the eye are of primary importance; both these indications are best secured by the judicious use of a compression bandage. The eye must also be kept free from unhealthy secretions, by washing several times daily with a warm two-per-cent. solution of boric acid, or with a solution of formalin, 1 to 3,000. In addition to this, the moderate use of warm-water fomentations, or warm carbolic lotion, 1 to 1,000, followed by instillations of solution of atropine (gr. iv. ad  $\xi$ i.) will be necessary. This measure will often arrest the suppurative process in its early stages, the ulcer taking on a healing action, and the hypopyon rapidly disappearing. Should a fair trial of this treatment fail to arrest the disease, and especially if the ulceration, etc., continue to increase, a more energetic interference will be necessary. Scraping the ulcerated surface with a small sharp scoop and then carefully applying the actual cautery is the most efficient means of local disinfection. Division of the ulcer according to the method of Saemisch is preferred by some to the cautery, and it is quite true that if the corneal destruction has not progressed too far, say not beyond one-third of the extent of the cornea, this operation will often suffice to stay the destructive process. Opening the anterior chamber allows the escape of its purulent contents, and, by relaxing the tension of the cornea, promotes its nutrition. The performance of this operation is now greatly facilitated by placing the eye under the local anæsthetic influence of cocaine. The Saemisch operation is performed as follows: The narrow cataract knife of von Graefe is made to penetrate the sound cornea, close to one margin of the ulcer, behind which it passes to emerge in a similar position at the opposite side of the ulcer, care being taken to avoid the iris and lens; the contents of the anterior chamber escape through the opening. If the exudation be partially tenacious, the use of the iridectomy forceps may be required to remove the tenacious coagulum from the anterior chamber after the incision has been made.

Borated lint, to be retained on the eye with a compression bandage, may be kept applied until the next day; after this, repeated fomentations with a warm solution of boric acid (1 to 30) or formalin (1 to 3,000) will be required. Under this treatment, the plan recommended by Saemisch, of reopening the wound daily with a small probe until the ulcer becomes clean, will be found unnecessary (Noyes). Or the operation may be followed by instillations of eserine (one-half-per-cent. solution) several times daily (De Wecker), instead of by further instrumental interference.

If the necrotic process is arrested, the ulcer will become clean and will slowly heal, perhaps with adhesion between iris and cornea if the ulcer has been large, in which case also a staphylomatous bulging may occur and require appropriate treatment. In many cases more or less of a permanent scar will remain, often a dense leucoma, with impairment or complete loss of vision. Total destruction of the vision will sometimes occur despite all treatment, especially if panophthalmitis develops; the ruined eye, under such circumstances, may be eviscerated in order to save the patient from the long period of suffering which would attend suppurative inflammation of the eyeball. Enucleation of a hopelessly suppurating eyeball involves some risk of being followed by septic meningitis and for this reason simple evisceration is to be preferred. In suppurative keratitis a tonic treatment is always indicated, and in the asthenic forms stimulants can be used with benefit, and the hygienic conditions must be made as favorable as possible.

*Ulcers of the cornea*, not associated with hypopyon, are of frequent occurrence. They vary much as to appearance, situation, course, duration, and importance; they originate from abrasions or injuries of various kinds, from the injurious effects of certain morbid conditions of the conjunctiva or other diseases of the eye, and from defective states of nutrition generally. They may be superficial or deep, clean and smooth, with rounded