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THE CLINICAL COURSE AND THE DIAGNOSIS OF TRACHOMA

M. H. FOSTER, A.M., M.D.

Surgeon, U. S. Publ. Health Service

BOSTON

Trachoma may be described as a specific, transmissible, destructive inflammation of the conjunctiva, characterized by the formation of the so-called trachoma granulations, which may be either papillary or follicular; the ultimate formation of scar tissue; marked chronicity, and intractability to all forms of local treatment.

Various inflammations of the conjunctiva give rise to the formation of follicles that cannot be distinguished by inspection from those caused by trachoma; hence the formation of scar tissue is the one all important diagnostic feature of the disease. If trachoma had been called "scar producing conjunctivitis" much of the confusion of ideas and differences of opinion that now exist concerning the diagnosis of the disorder would never have arisen.

Clinically trachoma presents itself in two forms: (1) fulminating trachoma, and (2) slow trachoma.

The first is a very acute inflammation which comes on suddenly and is accompanied by the usual symptoms of a severe infection of the conjunctiva, that is, redness, swelling, lachrimation, photophobia, pain and marked thickening of the lids. This type of the disease is rare, and will be described more fully later on.

"Slow trachoma" seems to be the best term to apply to the ordinary forms of the disease. At first blush it would appear that "chronic" would be the proper adjective to use. But the condition referred to under the second heading may be either acute or chronic; hence the name "slow trachoma" will be used in this article to refer to all forms of trachoma except the fulminating type.

Slow trachoma is essentially a chronic and long drawn out disease, generally extending over a number of years. It may begin acutely, or the onset may be so insidious that the patient is not aware that there is anything wrong with the eyes. In a short time the granulations appear. These may be considered under two general headings, the papillary and the follicular.

The papillary granulations are minute structures somewhat difficult to describe. They are closely packed together, and so small that the naked eye does not ordinarily recognize them as discrete bodies, but gets the impression that the areas involved are swollen, uneven and "raw" looking on the surface. An area of papillary granulations somewhat resembles in appearance the surface of the tip of the normal tongue.

The follicular granulations are more or less rounded bodies ranging in size from the head of a pin to a small pea, and presenting considerable variation in appearance and structure. Some stand well above the surface, with a more or less pedunculated base; others are buried in the conjunctiva. They may be bright red, pinkish gray, pinkish yellow, or almost white; the latter are deeply buried. The red are quite firm; the yellowish are generally soft and gelatinous, and may be translucent. The last are known as the "sago grain" or "frog spawn" granulations.

The largest follicles are found in the culdesac, and often bleed slightly when the lid is everted. The entire conjunctiva may be studded or infiltrated with these bodies, or only a few isolated ones observed.

In a varying time, depending on the severity of the case, scar tissue begins to appear as fine white lines or irregular areas between the granulations. The production of scar tissue goes on slowly, and ultimately replaces the normal conjunctiva on practically the entire surface of the upper lid and the culdesac.

Slow trachoma occurs in various grades of acuity. A small percentage of the cases are benign, running their course with slight discomfort to the patient. Others are severe, with much inflammatory reaction and marked symptoms. All possible gradations between these two extremes are seen in the clinics.

A striking characteristic of the disease is the tendency to alternating periods of quiescence and exacerbations of the inflammatory process. The diagnostic lesions are always present, however, and can easily be detected by a careful examination of the inverted upper lid and culdesac.

In the late stages, cicatrization becomes an important feature. If the tarsal plate is involved, the shrinkage and resulting deformities of this structure cause entropion. When this is marked, the eyelashes rub against the cornea, producing ulceration and opacity. In this manner sight is involved, and ultimately vision may be lost.

"Trachoma is a veritable curse to the countries where the disease is endemic, its victims suffer for years and are usually incapacitated for years; many of them become blind."¹

METHOD OF EXAMINING THE EYE

Before attempting to diagnose trachoma, it is imperative that the observer should become thoroughly familiar with the appearance of the conjunctiva in both health and disease, and especially the conjunctiva of the upper lid and culdesac. To explore this part of the eye it is necessary to evert the lid and also to expose the culdesac by special manipulation. The best instrument for this purpose is the ordinary wire loop

1. Haab: External Diseases of the Eye.

glove buttoner obtainable in most clothing stores. The loop should be bent slightly so that it is curved on the flat, somewhat resembling in miniature the blade of an obstetric forceps. With practice it is possible to turn the lids very quickly and to bring down and examine various parts of the culdesac with but little discom-

Fig. 1.—An old case of slow trachoma. This shows the proper method of using the glove buttoner as an eye turner in everting the upper lid and of exposing the culdesac. It is noted that about half of the culdesac is shown in this picture.

fort to the patient, provided one has a reasonable degree of aptitude.

The eye turner is held in the right hand, and the lashes of the upper lid are caught between the thumb and the forefinger of the left. The patient's head is pushed well backward by extension at the neck, and at the same time he is told to look down (Fig. 1). The lid is easily everted over the wire loop, and the different parts of the culdesac brought into view by the proper manipulation of the point.

A normal lid when examined in this manner presents an appearance as shown in Fig. 2. The conjunctiva exposed is sharply separated into two divisions, the lower part—the culdesac—and that reflected over the tarsal plate. For brevity of description, this part of the conjunctiva will sometimes be referred to as the "tarsal plate," by which term is meant the conjunctival surface of the upper lid proper, and the other part as the culdesac.

The real relations of the lid as concerns direction are of course reversed when it is everted; but in all descriptions reference will be made to the everted lid, giving the relation of the structures as they appear when the lid is in this position. The appearance and distribution of the blood supply is an important feature in the diagnosis of trachoma, and will be described in detail.

The culdesac is normally bluish pink, and contains numerous blood vessels. The conjunctiva here is thin, so that in health the arteries stand out very distinctly like cords. These vessels (in the upturned lid) run upward toward the tarsal plate, and at the bottom of the plate they anastomose by horizontal branches which form pointed arches. From these arches numerous fine vessels arise which run directly upward

over the tarsal plate. It is unusual to find such a regular and symmetrical distribution of the arteries as is shown in the illustration, which is however, a true copy of a selected eye; but this may be taken as the ideal type, and all normal eyes follow it more or less closely.

The conjunctiva over the tarsal plate in health is always redder and more granular than that of the culdesac, and in its lower part thicker and less transparent. In the upper part of the plate the meibomian glands can usually be seen under the conjunctiva as vertical yellowish lines likened to strings of very minute yellow beads.

By pressing the tip of the glove buttoner toward the examiner and putting the structures over it on the stretch, the conjunctiva can be made more or less anemic; and as this maneuver is extremely useful in diagnosing trachoma, it is very important that the physician become familiar with the appearance of the normal and the inflamed lids when subjected to this procedure.

When a normal lid is made tense by pressure with the point of the eye turner from below, the blood is forced out of the tissues and a white area appears. This spot is pure white or pink, and shades out evenly in all directions. If there are any irregularities of color present, they are faint vertical streaks running up and down, the meibomian glands. The same condition holds true of all simple inflammatory conditions of the lid. When they are pressed forward by the turner, the white area is even in color, and fades out uniformly in all directions. In trachoma, however, when the conjunctiva is made anemic in this way, it does so in a blotchy and uneven manner. The bloodless area does not fade out evenly to the pink and red of the unaltered tissue, but patches of red and white alternate in a more or less haphazard and irregular fashion. The white streaks run not only up and down, but transversely and in all directions. To get this effect it is necessary to use just the right amount of pressure, because if the force is too great the red

Fig. 2.—A normal eyelid. Note the lower one fifth, which is the culdesac. The conjunctiva in this region is thin and bluish pink, and the blood vessels stand out prominently like cords. The conjunctiva in the upper four fifths, covering the tarsal plate, is thicker, yellowish red, and supplied with blood vessels which run vertically upward across the plate from the anastomotic arches formed from the transverse branches of the arteries of the culdesac. The three small, whitish spots on the nasal side are areas of calcareous degeneration, and should not be mistaken for follicles.

areas will also disappear and the contrast will be lost. The pressure, therefore, is varied until we are satisfied that the conjunctiva presents a uniform appearance under all conditions of anemia. The explanation of this phenomenon is extremely simple. In health or in

the ordinary inflammations, the structure of the conjunctiva in any given area is practically uniform, that is, it is a homogeneous tissue; but in trachoma the structures are permanently changed. Scar tissue is formed, and it is deposited in irregular and more or

Fig. 3.—Upper lid of right eye. This illustration shows the appearance of a case of slow trachoma before proper pressure has been made with the eye turner. The lid is roughened and the adventitious blood vessels can be noticed running across the outer third of the tarsal plate. It is impossible, however, to make out any scar tissue when the lid is manipulated in this fashion. This should be contrasted with the same lid after the proper pressure has been applied, as shown in Figure 4.

less sharply defined patches. Between these patches are areas of highly vascular inflammatory tissue or normal conjunctiva (Figs. 3 and 4).

When pressure is made from beneath this ordinarily invisible scar tissue, it becomes white much more easily than the other elements of the conjunctiva; hence this maneuver enables us to detect it when it is present in very small amounts, that is, in the early stages of the disease. In well marked cases of long standing (Figs. 5 and 6), the scar tissue is at once apparent even to the most casual observer on simply everting the lid; but in recent or very mild cases, the scar tissue may be present in so slight an amount as not to be apparent unless the lid is manipulated as described above. The whole conjunctiva in such patients is more or less inflamed and swollen, and the small areas of scar tissue are deep down and obscured by the inflammatory changes (Fig. 3).

The lower lids are inspected by pulling them down with the index finger and having the patient look up, meantime moving the finger slightly from side to side to roll out all parts of the lower fornix.

It cannot be positively determined that any suspected individual is free from this disease until both lids of each eye have been carefully examined in the manner just described. Certain changes on the tarsal plate are always present in trachoma; but they may be so slight that only an expert can detect them, and the upper culdesac should invariably be examined by all ordinary observers.

The specific causative agent of trachoma has not as yet been discovered, although a tremendous amount of research work along this line has been carried out.

Prowazek has described certain cell inclusions that are frequently found in smears from trachomatous eyes that have been stained by Giemsa's method. Similar inclusions are found, however, in the pus from inclusion blennorrhoea and sometimes in the genital discharges of men and women suffering from acute inflammation of these parts. Reference must also be made to Lindner's "initial bodies." These are cocci-like bodies seen in the cavities of the protoplasm of the epithelial cells. They apparently multiply, and are believed by some investigators to be living organisms. Whatever the ultimate decision may be regarding the true nature of these cell inclusions, the subject may be dismissed for the present with the statement that the finding of these bodies is so inconstant as to render the making of smears and their microscopic examination of but little practical assistance in the clinical diagnosis.

Despite occasional assertions to the contrary, there is no doubt that trachoma is transmissible from one person to another. Fulminating trachoma spreads rapidly among the crowded occupants of a vessel's steerage, as has been amply demonstrated several times on vessels arriving at Ellis Island.

The virus of slow trachoma is not as virulent as the other variety, and some individuals undoubtedly possess a high degree of resistance to it. This explains the fact that several members of a family may escape although all the rest have the disease. Deliberate and accidental inoculations in human eyes have not always resulted in producing the disease. Cases are also occasionally encountered in which but one eye is involved.

The results of the attempts to inoculate apes and

Fig. 4.—This is the same lid shown in Figure 3, but the glove buttoner has been manipulated so as to make the lid more or less anemic and bring out the scar tissue. Note the areas of papillary granulations surrounded by the bands of white scar tissue. This method of using the turner to make the lid anemic requires some practice, but is of extreme importance in detecting scar tissue in its early stages.

other animals with trachoma are inconclusive. Certain workers claim to have done so; but as the condi-

tion produced disappeared spontaneously in a few months without the formation of scar tissue, the identity of the disease produced in these animals with human trachoma has not been satisfactorily proved. The fact that inclusion bodies were found in the scrapings from the ape's eyes cannot be considered as confirmatory until the nature of these inclusions is definitely settled.

Surgeon C. H. Lavinder and I made numerous attempts to inoculate *Rhesus* monkeys and baboons with material obtained in cases of slow trachoma of the acute type. The experiments were carried on for several months, but the results were uniformly negative.

THE GRANULATIONS

Papillary Granulations.—The gross appearance of these granulations has already been described. According to MacCallan:

The papillary growths are caused by an increase in the surface area of the hypertrophic conjunctiva. The latter is thrown into folds between which correspondingly deep clefts are formed; then on cross section the folds appear as papillary ridges. The connective tissue forming the papillae is covered with a very much thickened epithelium which of course is continued on into the depressions. These depressions have thus in microscopic cross section the appearance of narrow canals lined with epithelium and were accordingly regarded at one time as tubular glands; and hence the formation of new glands was alleged to occur in trachoma.

Papillary hypertrophy as above described is not pathognomonic of trachoma; it is found in any condition of long continued irritation of the conjunctiva such as results from ectropion, spring catarrh and chronic conjunctivitis.

Follicular Granulations.—These are the larger granulations ranging in size from a pinhead to a small pea. The largest ones are found in the culdesac. There are three quite distinct types, the red follicles which are the ordinary kind, the yellow gelatinous follicles, and the buried white follicles. All three varieties may be found in the same eye.

The firm red follicle is a very common lesion in all forms of trachoma (Fig. 9). These follicles may be simply poorly defined eminences in the conjunctiva, or well marked rounded bodies. The whole upper lid may be a mass of these new formations (Fig. 11), but it is more usual to find them along the lower border of the tarsal plate (Fig. 9).

The gelatinous granulations are grayish yellow bodies, soft in consistency, and frequently translucent. Large predunculated gelatinous follicles are often

found in the culdesac. They may bleed slightly when the lid is everted. These are the so-called "sago grain" or "frog spawn" granulations (Figs. 5 and 10).

Sometimes they fuse together, forming an area of intermingled gelatinous and scar tissue. This condition is known as Stellwag's brawny edema, or the gelatinous trachoma of Stellwag. It is especially common in the culdesac, the conjunctiva in this region being very much thickened, light bluish gray, and composed of fairly smooth scar tissue infiltrated with gelatinous material (Fig. 6).

The pure white follicle is found in the tarsal region, deeply buried in the conjunctiva, showing through as a small whitish spot or point (Fig. 9). Granulations of this description are not very common; when present they are generally found in the acute type of slow trachoma. As they are very rare in the ordinary inflammations of the conjunctiva, they may be rated as having some diagnostic importance. Care must be taken, however, not to mistake the small yellow bodies, often seen in normal eyes and due to a deposit of calcareous matter, for real follicles.

The follicular granulations are extremely sluggish in slow trachoma, and may exist for months without apparent change. Similar structures are seen in various forms of inflammation of the conjunctiva, especially in follicular catarrh, and vernal conjunctivitis. They are apparently not an essential lesion of the disease, but merely the reaction of the lymphoid elements of the conjunctiva to certain types of prolonged irritation.

The microscopic pathology of trachoma is in a somewhat chaotic state, considerable difference of opinion existing on many important points. It has been commonly taught that the follicles either ruptured and became organized, or became organized without rupture, and that in this way the scar tissue was produced. The objection to this view is the fact that the follicles produced by other forms of inflammation, especially follicular conjunctivitis, histologically resemble very closely the follicles in trachoma, and that these structures disappear without the formation of scar tissue, or at least without producing enough scar tissue to be detected clinically. The organization of the follicles either with or without rupture does not seem sufficient to explain the amount of cicatrization found in trachoma.

From a clinical standpoint there is good reason to believe that when the virus of trachoma attacks an eye, it ultimately invades the deeper structures of the conjunctiva and frequently in old cases the tarsal plate. The organism proliferates in these deeper structures, and gives rise to products that cause a rapid hyper-

Fig. 5.—Upper lid of right eye. A typical case of slow trachoma of several years' standing. The islands of papillary granulations separated by vertical narrow lines of scar tissue are well marked. There are five large gelatinous follicles at the lower border of the tarsal plate. Note that the culdesac has been replaced almost entirely by scar tissue. The normal vertical vessels in the culdesac have disappeared, and a few adventitious vessels running in an oblique direction can be seen in the nasal side of the culdesac. There still remains some normal conjunctiva in the upper part of the lid.

plasia not only of the lymphoid elements but also of the connective tissue cells. The proliferation and organization of the fibrous elements of the conjunctiva produce the scar tissue which ultimately crowds out and entirely replaces the normal elements of the conjunctiva. The process of cicatrization, then, as pointed out by Fuchs,² is somewhat analogous to interstitial hepatitis, and *not* at all similar to the healing of an ulcer by scar tissue. As long as there is any lymphoid tissue left, the infection remains in it indefinitely. The virus does not exist in the scar tissue after the latter becomes fully organized.

Mayou asserts that by the use of certain plasma stains it is possible to distinguish histologically between many of the follicles of trachoma and those found in follicular conjunctivitis. He believes that:

The granules found in trachoma are follicular formation plus trachomatous infection, the follicles being simply an effort on the part of the tissue to produce mononuclear cells, and becoming secondarily infected with trachoma. Although, indeed, as a general rule a considerable number of them seem to be infected even in the early states, . . . yet follicles can be found in trachomatous conjunctivitis which are evidently not infected with trachoma.

This view coincides closely with the clinical course of the disease, and is probably correct. The student should clearly understand that the follicular granulations are not an essential or diagnostic feature of trachoma, but should be considered as a complication. They do, however, afford a lurking place for the virus where it proliferates or may remain latent for months.

In trachomatous eyes there is first the formation of ordinary follicles which are due to the irritation; and later on the virus invades these structures so that at first they are ordinary follicles and later on specific.

Rupture of the follicle may take place either from a thinning of the epithelium overlying it, owing to pressure from beneath, or from an interference with the blood supply by the scar tissue, causing necrosis.

The follicles are semisolid; hence, when rupture occurs, a part of the contents may escape, but not all. Septic infection of the ruptured follicle, however, is likely to occur, and the secondary inflammatory process ensuing may cause a temporary increase in size. Ultimately the follicle is destroyed by the combined action of the pyogenic organisms and the trachoma virus.

Undoubtedly some of the follicles, especially the smaller ones and those deeply buried in the conjunctiva, disappear by some process of absorption or atrophy.

Cases under treatment have been examined daily for a period of a year and a half without the rupture of any of the follicles being observed, and hence it will be apparent that the formation and rupture of the follicle is not a progressive pathologic process occurring in a more or less definite period of time.

It was formerly the custom to attempt to destroy these bodies by expression. In nontrachomatous cases, mechanical destruction of the follicles is followed by a disappearance of the condition in a comparatively short length of time. Some of the popularity of this method of treatment was probably due to cures produced in cases in which a mistake had been made in the diagnosis. Expression in true trachoma may hasten the disappearance of the larger follicular granulations, but it has no effect on the papillary granulations which are always present. A striking characteristic of trachomatous tissue is its ability to regenerate after partial destruction. The granulations may be curetted, excised, expressed or cauterized, and yet they return

with disheartening persistence. It is impossible to remove all the lymphoid tissue by these means, and any trace that is left will promptly proliferate again. Grattage, that is, scrubbing the surface of the lid and culdesac with a tooth brush, is much more satisfactory because this operation removes the granulation tissue quite thoroughly;

and the mercuric chlorid solution used on the brush is likely to sterilize what little remains. Grattage, however, cannot produce a cure when the tarsal plate is invaded by the trachomatous process, the infected tissue here being buried deep in the cartilage where the bristles of the brush cannot possibly reach it. Grattage followed some weeks afterward by removal of the tarsal plate is the procedure advocated by certain specialists for cases of this description.

The visible granulations in trachoma are generally limited to the under surfaces of the lids and culdesac, similar formations being very rarely seen on the bulbar conjunctiva. However, Mayou³ determined that on section the bulbar conjunctiva does show changes, and at the corneal limbus certain inflammatory and degenerative areas may be noted. When properly stained and sectioned, on microscopic examination these areas are found to contain typical trachomatous follicles. Occasionally small pits or sunken scars may be observed just outside the limbus due to the cicatrization of these areas.⁴

SCAR TISSUE

In severe cases the scar tissue begins in the culdesac and spreads most rapidly in that region. In mild cases it may first of all be detected in the inner canthus at

Fig. 6.—Upper lid of left eye. An old case of slow trachoma. Cicatrization is well marked. There remain, however, a few areas of papillary granulations near the center of the lid. The culdesac is completely filled up with a mass of poorly defined gelatinous granulations representing a typical case of Stellwag's brawny edema. The disease has existed for about six years.

2. Fuchs, H. E.: Text Book of Ophthalmology, Ed. 5.

3. Mayou, H. S.: The Changes Produced by Inflammation in the Conjunctiva, Hunterian Lecture, 1906.

4. MacCallan, A. F.: Trachoma and Its Complications in Egypt, Cambridge, 1913.

the junction of the tarsal plate with the culdesac, and careful search should always be made in this locality in doubtful cases. On the tarsal plate it generally extends upward in narrow bands toward the edge of the lid, with islands of exuberant lymphoid tissue in between (Fig. 5). A large stellate area in the middle of the tarsus is not unusual.

In the majority of patients the extreme outer and inner borders of the plate are the last to become cicatrized. The culdesac always becomes completely

Fig. 7.—Follicular conjunctivitis, upper lid of right eye. The culdesac and the lower portion of the tarsal plate are studded with a large number of follicles. These follicles are fairly uniform in size, almost perfect hemispheres, and they appear to spring from the surface of the conjunctiva and are not buried in that structure. This form of follicular conjunctivitis is not so common as that shown in Figure 8. The diagnosis from trachoma in cases of this type is made by the fact that the conjunctiva is not thickened, that the normal blood supply is maintained, the vessels of which can plainly be seen running vertically upward in the culdesac; also by the size, appearance and superficial position of the follicles. It should be observed that there is no thickening in the conjunctiva of the culdesac, that structure being normal in the spaces between the granulations.

converted into scar tissue long before the process is completed on the upper lid. When completely organized, the scar tissue is pure white, smooth, and somewhat glistening. Usually it forms in islands which slowly spread; but very rarely the formation takes place simultaneously and at a uniform rate over the entire tarsal conjunctiva. In mild cases the process goes on very slowly, and it may be years before the lids are completely cicatrized.

Patients are occasionally encountered with a narrow band of scar tissue running horizontally across the culdesac. The strip is so even in width and sharply demarked as to appear as if made by a surgical operation. The tarsal conjunctiva is somewhat thickened, but not characteristic of trachoma. MacCallan⁴ believes that scars of this description are produced by a former attack of gonorrheal conjunctivitis, and this opinion is probably correct.

The lower lids for some reason recover much more promptly than the upper, and it is not always easy to decide whether scar tissue is present. For this reason an examination of the lower lid alone often affords but little information in slow trachoma. Many well marked and severe cases will be found in which the lower lids present absolutely no pathologic changes to the naked eye.

In fulminating trachoma, however, the lower lid is diagnostic in the early stages.

PANNUS

In all cases of trachoma, pannus is generally present. This statement is not to be construed as meaning that a leash of large blood vessels will be found running across the cornea; but that on close inspection, with

a hand lens if necessary, a fringe of very fine, almost invisible vessels invading the cornea from the conjunctiva can be detected. They are generally most marked in the upper and lower segments, but may extend completely around the corneal limbus. A more or less opaque gelatinous membrane is apt to follow the vessels onto the cornea.

Pannus is now considered as trachoma of the cornea and to be due to an invasion of that structure by the specific inflammation.

A temporary invasion of the cornea by fine vessels as described above may be encountered in a number of acute inflammations of both the cornea and the conjunctiva. According to MacCallan,⁴ the permanent pannus of trachoma may be distinguished from that due to ulcers of the cornea and a secondary variety produced by interstitial keratitis, by the following points: When due to an ulcer, the vessels are larger and are localized to one part of the cornea. The pannus produced by interstitial keratitis arises from the deeper blood vessels of the sclera, and the vessels seen on the cornea cannot be followed up and proved to be continuous with those of the conjunctiva; while in trachoma it can be determined that the fine vessels seen on the cornea are branches from the conjunctival blood supply.

Pannus of a moderate degree frequently clears up, leaving but slight evidence. When present it is merely an evidence of irritation of the cornea and the response of that tissue to inflammation, and should be considered as a corroborative and not a positive sign of trachoma.

CORNEA

In old neglected cases or those that have been very severe, it is common to find corneal opacities with extensive pannus. Many such eyes are seen among the Egyptians, Syrians, Indians and some of the mountaineers of our own country.

Fig. 8.—Typical case of follicular conjunctivitis, upper lid of left eye. In this patient the culdesac is filled up with a number of irregularly shaped, light colored follicles. The conjunctiva over the tarsal plate is somewhat roughened and thickened, and contains a few scattered small lymphoid follicles. Here there is a hypertrophy of the lymphoid elements of the conjunctiva with chronic conjunctivitis. The diagnosis between cases of this type and trachoma is sometimes extremely difficult. Lids of this description are very frequently found in schoolchildren, and often cause the examiner much embarrassment in making a diagnosis. Careful observation will show, however, that the normal blood vessels can still be seen here and there in the culdesac; also, that there are areas of more or less normal conjunctiva between the large follicles in that region. In such cases no scar tissue can be detected; neither is there any true trachoma pannus. The examination of the throat and nose in these patients will almost always show that there is hypertrophy of the adenoid tissue in these localities, such as enlarged tonsils or adenoids.

Ulceration of the cornea in trachoma results from two causes:

1. The trachomatous inflammation attacks the tissue of the cornea itself, or some other form of infection gains lodgment in a trachomatous eye, causing the ulcer by the usual pathologic changes.

2. The contraction of the eyelid, especially the deformity of the tarsal plate, produces trichiasis, and the inverted lashes rub on and irritate the cornea. The last seems to be the commonest cause of opacity of the cornea.

The older teaching, that the roughness of the upper lid due to the follicles was responsible for the damaged cornea, cannot be true. Hundreds of cases with eyelids fairly studded with follicles are seen in which the cornea is clear and uninjured; hence some other cause for the corneal lesions must be sought.

The invasion of the cornea by the disease itself and the trichiasis are the more likely causes. Some weight must also be given to the interference with the circulation of this structure due to the constant pressure of a deformed lid.

DEFORMITIES OF THE LIDS

Some degree of ptosis is present in almost all cases of slow trachoma of long standing, and it is especially marked in the fulminating type of the disease, the lids being greatly swollen.

In old cases the shrinkage of the scar tissue produces various deformities, and the lower edge of the lid is apt to present a wavy line instead of the normal curve with the convexity downward (Fig. 12). Such eyes have a "droopy" look, very significant to the trained observer.

In severe cases the inflammatory process does not stop at the conjunctiva, but also invades the tarsal cartilages where no ordinary applications can reach it. Scar tissue is produced here as elsewhere, and the plate may be twisted and pulled entirely out of shape by the resulting cicatrization. Entropion with trichiasis, as mentioned above, is the usual result and the most serious. In slow trachoma the disease may exist for many years before these changes become evident, and in some mild cases they never appear at all.

The conditions which have just been described are the usual lesions of trachoma. Among the rarer sequelae of severe cases of the disease should be mentioned exerosis conjunctivae, posterior symblepharon and ectropion of the lower lid.

DISCHARGE

In all trachoma there is more or less secretion; but the disease is so often complicated with other conjunctivitis that the nature of the discharge is of little importance and of no help in making the diagnosis.

CLASSIFICATION OF TRACHOMA

Various classifications based on clinical characteristics have been proposed by the different writers on trachoma. Some of them are rather complicated, and none altogether satisfactory. A common plan has been to describe the papillary, follicular and mixed forms, according to the type of granulations which predominated. As papillary granulations are always present as long as the trachoma is active, there can be no such condition as a simple "follicular" form in contradistinction to a "mixed" type, and either the "follicular" or the "mixed" subdivision should be omitted, for the terms in this instance are synonymous.

If some clinical classification of slow trachoma is desired to secure brevity of description, the term

"papillary" might be properly applied to those cases of trachoma in which no follicles can be detected by the naked eye, and "follicular" to those in which, in addition to the papillary granulations, definite follicles are present. It must be clearly understood, however, that this is a clinical classification only; because if the papillary cases are examined microscopically, true trachoma follicles will be found in the conjunctiva, but they are too small or too deeply buried to be seen on inspection.

The gelatinous trachoma of Stellwag has already been mentioned. In it there is a fusing together and gelatinous infiltration of the follicles which is more commonly found in the culdesac.

STAGES OF TRACHOMA

When the formation of scar tissue has advanced sufficiently so that it is easily observed in the conjunctiva, the eye is described as being in the beginning stage of cicatrization.

As the process proceeds and the areas of scar tissue

Fig. 9.—Recent case of slow trachoma, upper lid of right eye. The lower part of the culdesac of this eye is completely converted into scar tissue. On the lower part of the tarsal plate there is an area of poorly defined, deep red, partially buried granulations. Higher up still are a number of deeply buried small white granulations. Careful examination with the eye turner showed beginning scar tissue between the granulations over the tarsal plate. The deep buried white granulations are strongly significant of trachoma. Note the thickening of the culdesac and the absence of any visible blood vessels in that locality. This case should be studied in conjunction with Figure 8. The diagnosis of trachoma is made on the scar tissue and deeply buried white granulations, and the absence of the normal blood supply. There was also marked pannus in this case.

equal or exceed the other parts, the case is referred to as being in the advanced stage of cicatrization.

"Cicatricial lids" is the term applied to the eyes when the trachomatous tissue has been completely replaced by firm, smooth, white scar tissue. This is nature's only method of effecting a cure.

RELATION TO SURROUNDINGS, RACE AND AGE

Trachoma flourishes chiefly among the overcrowded, underfed, overworked, and those living in bad hygienic surroundings generally. No locality or race is exempt, however, and occasionally cases are found among the well-to-do and those whose method of life is above reproach from a sanitary standpoint. The age inci-

dence is extensive. I have seen a well marked case in a child under 2, and I have a patient under treatment now who contracted the disease after 63.

FULMINATING TRACHOMA

Fulminating trachoma is an acute and severe inflammation of the conjunctiva. The onset is abrupt, the upper and lower lids becoming affected practically simultaneously.

The palpebral conjunctiva is intensely red, very edematous, and much thickened. It has not the velvety appearance of a severe case of acute conjunctivitis, but is more coarsely granular; and while it may not present typical discrete follicles, its surface is markedly irregular and uneven like a piece of broken granite (Fig. 11). The ocular conjunctiva is always more or less involved, sometimes very severely; but it does not usually present any diagnostic symptoms other than those of a very intense reaction. The conjunctiva of the lower lid presents the same appearance of broken granite and appears to be superabundant, being thrown up into folds or ridges. Discrete and definite follicles may also be present in this locality.

While the lids are always very much thickened from the start in this type of the disease, the time for the appearance of the characteristic unevenness or follicles varies considerably. It may be delayed for seven or eight days, generally, however, appearing early or about the fourth day.

There is photophobia, blepharospasm, and a profuse watery discharge sometimes mucopurulent. The cornea often becomes involved either from an interference of its blood supply by the edematous and inflamed ocular conjunctiva, or by being attacked directly by the infection itself. Ulceration and infiltration may follow with widespread destruction to the corneal substance and subsequent opacities.

Fulminating trachoma is much more easily transmitted from one person to another than slow trachoma. Generally both eyes are affected, but in rare instances only one eye is involved. The period of incubation has not been definitely determined, but appears to be within eight days.

Fulminating trachoma is a rare disease; in fact, its existence has been denied by some authorities; but on a number of occasions, cases of this type of the disorder have appeared among the crowded occupants of the same steerage compartment of vessels arriving at Ellis Island.

Differential Diagnosis.—Fulminating trachoma must be diagnosed in the early stages from severe phlyctenular conjunctivitis and from acute infections of that membrane by various micro-organisms, especially the gonococcus and the diplobacillus of Morax-Axenfeld. Unless one of these specific organisms is demonstrable in a properly stained smear made from the discharge,

the diagnosis may be impossible for a few days. As soon, however, as the characteristic lymphoid enlargement has appeared, the true nature of the disease may be determined. The upper lids in severe simple conjunctivitis and phlyctenular conjunctivitis may present a roughened granular appearance which is apt to be confusing; but in these conditions the lower lids never present the same exuberance of the conjunctiva with the lymphoid follicles so well marked or so prominent as they are in fulminating trachoma. The characteristic phlyctenules in phlyctenular conjunctivitis will also assist in separating that disease. It must also be remembered that there may be an attack of phlyctenular conjunctivitis in an eye already infected with trachoma or a severe attack of acute conjunctivitis in conjunction with follicular catarrh, in which case the diagnosis is practically impossible until the acute complication has subsided. The shortest period in which scar tissue has been demonstrable in these cases by me was six weeks after the beginning of the attack. This, however, is probably unusual, scar tissue not appearing in the ordinary case of the fulminating type until several months have elapsed.

In fulminating trachoma the ocular conjunctiva is always intensely inflamed.

This symptom is of material assistance in separating the disease from slow trachoma which is undergoing an acute exacerbation.

COMPLICATIONS OF TRACHOMA

An eye that is already the seat of a trachomatous inflammation may have added thereto any of the other infections to which the conjunctiva and cornea are liable. These conditions are known as "complicated trachoma," and are quite common. The trachomatous process does not protect the eye, as far as is known, from any other kind of inflammation; but, on the other hand, it appears to predispose it to certain forms. A gonorrheal infection is

Fig. 10.—Slow trachoma of some months' standing, upper lid of right eye. The culdesac here is filled with a mass of poorly defined, semi-gelatinous granulations of a pinkish salmon color. Deep cracks can be observed between the granulations which are arranged more or less roughly in rows. The conjunctiva of the tarsal plate is much thickened, very rough, and shows numerous small granulations which can be best detected at the nasal and temporal extremities. No blood vessels are visible anywhere in the eye. No scar tissue could be detected by the most careful search. It is difficult to make a positive diagnosis of trachoma in eyes of this type at the first examination, although the appearance is strongly suggestive of that disease. Patients presenting this appearance should be given treatment for several weeks before a definite and positive opinion is given as to the nature of the disease.

very common with trachoma among the Egyptians, and spring catarrh is frequently complicated by trachoma in localities on which both diseases are common.

The addition of any other infection to a trachomatous eye causes a swelling, redness and discharge which may make the diagnosis for the time being extremely difficult or impossible. Most of these complications, however, can be subdued or overcome by appropriate treatment, maintained for a sufficient length of time, and then the true condition can be definitely determined. The clinical appearance of complicated trachoma, therefore, is that of the original disease plus the symptoms of the added infection. The rule in all such cases is appropriate treatment until the complication has subsided.

DIFFERENTIAL DIAGNOSIS OF SLOW TRACHOMA

The important diagnostic symptoms of trachoma are scar tissue, papillary granulations and trachoma fol-

licles. The most important of these is the scar tissue. It may not be present in the early stage, but sooner or later it is bound to appear. The method of searching for and demonstrating the presence of scar tissue has already been fully explained. It must be remembered in this connection, however, that scars are formed in the conjunctiva by burns from lime or other escharotics, and also by certain infections that cause sufficient inflammatory reaction to produce sloughing or ulceration of that membrane. The narrow strip running horizontally across the culdesac caused by gonorrhea has already been described. Considerable scarring also is the result occasionally of severe cases of smallpox. The scars formed by burns or ulcers, however, differ materially in appearance from those of trachoma, as they are sharply demarked and the conjunctiva is not infiltrated in the irregular manner that is found in that disease.

FOLLICULAR CONJUNCTIVITIS

There are two types of follicular conjunctivitis. The variety illustrated in Figure 7 is unusual. This form may be described as a true folliculosis without an accompanying conjunctivitis. The follicles are small, in color match that part of the conjunctiva in which they are found, glassy in appearance, very uniform in size, sharply demarked from the surrounding tissues, and appear to spring from the surface of the conjunctiva rather than to be embedded in that structure. In these cases the conjunctiva is not inflamed or thickened, but maintains its normal appearance between the follicles; and, what is of the utmost importance, the blood vessels show the same arrangement and stand out as clearly as they do in the normal eye.

The other type of follicular conjunctivitis is that shown in Figure 8. Here there are numerous follicles in addition to a low grade chronic conjunctivitis. The follicles are irregular in shape and size. The largest are found chiefly in the culdesac or on the lower border of the tarsal plate. They are not so sharply demarked as in the preceding type, and there is more or less thickening and roughening of the conjunctiva between the follicles, although not nearly so much as is found in a true trachoma. The blood supply, while somewhat obscured by the slight inflammatory reaction present, is nevertheless normal, and can be made out on proper examination.

It is this form of follicular conjunctivitis that has caused the greatest confusion in the diagnosis of trachoma, especially among schoolchildren. The process appears to be merely a part of a general hyperplasia of the lymphoid tissue throughout the entire body, for in such cases there are often found adenoids and enlarged tonsils; and the period of life in which this disease occurs corresponds to that in which there seems to be a marked tendency for all the lymphoid

tissue to proliferate on slight stimulation. The local irritation in this instance may be due to dust, foul air, gases, and even possibly eye strain.

When the characteristic scar tissue can be made out by the proper manipulation of the eye turner, it is easy to rule out follicular conjunctivitis. In recent cases the diagnosis must be made on two things: (1) the condition of the conjunctiva of the culdesac and lower one third of the tarsal plate (everted lid), and (2) the blood supply of the culdesac.

In the early stages of trachoma, the fornical conjunctiva of the upper lid is always more swollen, inflamed and rough than in follicular conjunctivitis, and no areas of normal tissue can be seen in this region or over the lower third of the tarsal plate.

No visible blood vessels can be detected in the culdesac in the beginning stages of trachoma, as the inflammatory changes obscure them. In follicular conjunctivitis the vessels may be almost hidden or considerably distorted by the follicles; but if any vessels are observed running in a *vertical or approximately vertical direction* across the culdesac, it is safe to exclude trachoma (Fig. 8).

Occasionally it may be necessary to treat the eyes for a few days with sedative and slightly astringent remedies in order to overcome a temporary inflammation before giving a positive opinion as to the nature of the case.

VERNAL CATARRH AND OTHER DISEASES

In this disease the conjunctiva of the tarsus is the seat of a number of papillae which are broader and flatter than those in trachoma. The new growths are crowded closely together, resembling somewhat a cobblestone pavement, and are frequently covered by a bluish white film. In addition to the palpebral lesions, there also may be new formations around the limbus of the cornea in the shape of uneven,

hard, gelatinous masses. The symptoms of vernal catarrh are much worse in the spring and summer than in the winter, and the history of the case often will assist in the diagnosis. The characteristic lesions are present throughout the year, but the signs of acute inflammation, that is, the redness, photophobia and lacrimation, are much ameliorated during the winter.

Some cases show involvement only of the tarsal plate, with no symptoms around the limbus of the cornea. In others the cornea is the only part affected. The secretion is generally scant, but when properly stained shows a large number of eosinophil cells.

The diagnosis from trachoma is made on the history; the appearance of the granulations, which are larger, flatter, paler and more closely packed together than in trachoma; the bluish white membrane when present, and the large number of eosinophil cells found in the discharge.

Fig. 11.—Fulminating trachoma of several months' standing. The upper lid is everted and fastened in position on the rubber eye plate by means of two sutures. The patient is under ether preparatory to the grattage operation. A good part of the culdesac can be seen, especially in the nasal half of the eye. Note the numerous granulations, which have been described under the section on fulminating trachoma as having a characteristic appearance something similar to broken granite.

The commoner inflammatory conditions of the conjunctiva likely to be mistaken for trachoma have been described in detail. Other diseases that present clinically somewhat similar lesions to trachoma and may on rare occasions have to be diagnosed from that disorder are tuberculosis of the conjunctiva, syphilis of the conjunctiva, nodules around foreign bodies and Parinaud's conjunctivitis.

Tuberculosis of the conjunctiva appears as small grayish nodules on the tarsal surface with occasional ulcers. There is apt to be swelling of the glands in front of the ear. The bacillus may be found in sections of the involved tissue or by inoculation of the material into guinea-pigs. As a general thing, the disease attacks but one eye, and is not very painful.

Parinaud's conjunctivitis is a rare disease involving in most instances but one eye. It is characterized by the formation of follicles and sometimes ulcers in the conjunctiva. A marked feature is the systemic condition, the patient at the onset having fever, chills and enlargement of the preauricular gland, which frequently goes on to abscess formation. The entire parotid region may be swollen and tender. Sometimes the retromaxillary and cervical glands are also involved. In addition to the follicles, the eyelids are swollen and hard, and the culdesac is often very red and edematous. The chills, fever and involvement of the glands differentiate this form of conjunctivitis from trachoma.

WHEN IS TRACHOMA CURED?

On this point there is a great diversity of opinion. Patients attending clinics are often discharged as cured when acute inflammatory symptoms have subsided and there is no discharge. Such cases, however, almost invariably relapse sooner or later, and the mere cessation of secretion and the acute subjective symptoms should not be taken as proof of recovery from the disease. When an eye has become infected with the trachoma virus, it is liable to a recurrence as long as any normal conjunctiva, or any lymphoid tissue in the conjunctiva remains. The infection lingers in the granulations apparently indefinitely, and some trifling local irritation or constitutional disorder may cause it to spring into renewed activity at any time, and thus produce an acute exacerbation of the disease.

A case can never be said to be certainly cured until all the conjunctiva of the upper lids has become completely replaced by smooth, white, avascular, fibrous scar tissue, and the lower lids are free from any evidences of the disease. A vascular scar tissue cannot be infected by the virus of trachoma. In treating trachoma with silver nitrate, copper sulphate, grating, expression, etc., the cicatricial process is simply hastened by chemical and mechanical destruction of the normal and abnormal tissue of the lids and the irritation resulting from these various measures.

THE ILLUSTRATIONS

It is extremely difficult to get good illustrations of trachoma, as there are several things which interfere with accurate reproductions of the conjunctiva. In order to show the diseased area to the artist it is necessary to evert the upper lid. This procedure is more or less uncomfortable to the patient, and the lid cannot be maintained in this position for a very long period of time. The appearance and color of the conjunctiva itself changes from moment to moment on account of the varying blood supply and the irritation produced by the eversion.

Long training is essential in order that the observer should be able to grasp and appreciate quickly the very minute pathologic changes by which the different inflammatory diseases of the conjunctiva are diagnosed. It is extremely important that in all cases the culdesac should be carefully brought into view by proper manipulation of the tip of the glove buttoner. In most of the illustrations the entire culdesac is shown, but it should be remembered that in the actual work the examiner can see only one part of the culdesac at a time. Hence, in actual practice, it is impossible to get as complete a view of the diseased structures as is shown in the pictures.

The black and white drawings were made by Artist Leonard H. Wilder of the United States Hygienic Laboratory, after paintings made by S. Shimatori of actual cases occurring in immigrants at the United States Immigrant Hospital at Ellis Island, New York. They are as correct reproductions of the conditions seen as the artists could portray.

The illustrations were made three times the original size in

Fig. 12.—Thickening and deformity of the lids produced by a long standing case of trachoma. Note that the outer two thirds of the right upper lid presents a curve which is concave downward, while the normal eye has its concavity upward.

order that the finer details on which so much depends in the diagnosis of trachoma might not be lost in the process of reproduction. It is advised that they be studied, first of all with a minus lens of sufficient strength to bring them down to the size of a normal eyelid, in order to get the general effect, and afterward with the naked eye for the purpose of observing the finer details.

U. S. Immigration Station.

City Celebrates New Water Supply.—October 12, New York began its celebration of the completion of the Catskill aqueduct. This aqueduct is approximately 120 miles long and its construction has covered a period of ten years. It has been completed, however, within contract time, without a labor strike, and its cost has been kept within the original estimate. The opportunity offered by the completion of this great work for teaching important civic lessons is not being neglected. The great influence of water supply on the public health is being impressed in the school celebrations and public meetings. For this purpose a pamphlet has been prepared by the department of health at the request of the Mayor's Catskill Aqueduct Celebration Committee which is being used as a text for compositions on this subject.