HISTOLOGY AND PATHOLOGY OF THE
SUPERSTRUCTURES OF THE
LID IN TRACHOMA

AND TREATMENT*

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For thirteen years I have operated for the cure of trachoma in its various stages, with distinct advantage to the patient. I had observed for a long time that in the operations made for entropion, the corneal conditions were always made better; and it seemed to me that the modification of this proceeding might be useful in the correction of corneal irritation, even before entropion should appear as one of the end-results of trachoma. As there was little of a definite nature written regarding the pathology of trachoma beyond that which takes place in the conjunctiva, it offered a field for investigation and explanation, thus placing this operation on the lid on a sound scientific basis. The presentation of this subject has been delayed by me for many years, although I am on record¹ as having discussed the value of my repair operation.

I have operated in more than 500 cases, ranging from the most extreme type, that so-called melancholy condition, xerophthalmia, to those of the early second stage, in which pannus was just making itself manifest. I have reached the point at which I can say to the patient, "I will cure you in from three to six weeks," as the case may be; and in few instances has there been a return of symptoms. One of the patients, an Indian, whose right eye gave him further trouble, returned and I found a calcareous mass which, under local anesthesia, I removed and all his trouble was abated. The eyes of another young man who continued to have symptoms after my operation, did not clear up as they should, but he was cured when a canthotomy in each side was performed. There were a few cases in which the cornea would become irritated, the pannus would increase, and one or two superficial ulcerations would appear, accompanied by photophobia and lacrimation and, in truth, many of the symptoms that might be observed before operation. In such cases we shall find a soggy middle turbinal and a sagging membrane over the septum near the middle turbinal, with more or less contact between the two parts. While it is conceivable that this condition of the nose may be brought about through infection of a similar nature, it is more likely that the eye condition simply occurs in a person who has a pathologic condition of the nose, often without being conscious of any nasal symptoms. This nasal condition becomes exaggerated from the chronic inflammation of the eye, with its attendant lacrimation, etc. The removal of the middle turbinal and the cauterization of the mucous membrane which is sagging from the septum will immediately cure the eye symptoms without further eye treatment. The result may be obtained with the cautery alone, without a turbinectomy, but it is not likely to be obtained with the latter when cautery is not used to pin the mucous membrane of the septum. In other words, in the few cases in which the repair operation has been of limited value, there is a distinct reason traceable to a definite cause,

which, when removed, results in the abatement of all symptoms. Usually we shall find only one eye affected, but I have seen cases in which both eyes were involved, relieved by the same nasal procedure. The conjunctiva and cornea change completely after the cauterization. The explanation of this I have attempted in another paper.

The histologic condition of the lid will indicate the kind of disease necessary to bring about the crimping of the tarsus, as well as the other changes in and around the tarsus which cause all of the disagreeable trachoma symptoms.

A quick survey of the histologic conditions of the lid from within will show the conjunctiva attached to a fibrous tarsus, in contradistinction to a cartilaginous tarsus often mentioned in the literature. Embedded in the fibrous tarsus, we have meibomian glands, which are sometimes of much importance in the pathology. Lying on the tarsus, close to the hair follicles, and spreading backward from its marginal attachment, the orbitotarsal fascia, or the palpebral fascia, as it is sometimes called, may be traced into the levator muscle. This muscle, attached to the tarsus, is split into many fibrillae, with much aerolar tissue surrounding the muscular ends. Above the orbitotarsal fascia and between it and the skin, is the orbicularis muscle, which is composed of voluntary and involuntary portions. The involuntary part, which is near the margin of the lid, keeps the eye closed when the patient is asleep. Of course, there are numerous glands and other organs of interest in the conjunctiva, as well as numerous glands and hair follicles in the margin of the lid. It is not necessary for my purpose to go into such details as a description of these structures would require. The lid is adapted to the eyeball, naturally curved. What happens to make this lid crimp and bring about the pathologic condition which, if continued, finally destroys the function of sight, is the important point I desire to emphasize.

The operative procedure cannot be successfully carried out without a clear understanding of the pathologic changes which are in process of development. If the ophthalmologist can understand this phase of it, then his repair operation will be directed to the pathologic phenomena presented. My procedure contemplates looking in on the pathologic conditions. I will present the accepted pathologic view of the early changes that take place in the conjunctiva. There are three distinct features characterizing trachoma: granulation, papillary hypertrophy, and the formation of connective tissue. By a large number of authors the disease is divided into two classes, papillary and granular.

STAGES OF TRACHOMA

In the trachoma occurring in Egypt, Callan uses a classification of four stages, depending on the comparative prominence of one of the foregoing essential features. In any classification of this disease, it must be borne in mind that the pathologic changes are so varied that it is practically impossible to have any distinct and definite classification. I see no reason why Callan's classification cannot be used in connection with trachoma in any country, so I am going to adopt this classification to a certain extent. It seems essential that I should include the pathologic conditions familiar to physicians.

Trachoma is a condition of the conjunctiva or mucous membrane of the eyelids resulting in the for-

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1. Cary, E. H.: Proc. Texas State Med. Soc., 1907.

mation of so-called trachoma granules, with or without papillary hypertrophy. In favorable cases, these granules disappear and are replaced by fibrous connective tissue. The essential and primary change in trachoma occurs in the adenoid or lymphoid tissue present in the conjunctiva; the other changes are secondary to the change in the lymphoid tissue.

In the first stage of trachoma, one will find varying numbers of small grayish or grayish-yellow islands or granules on the conjunctiva of the tarsus and of the superior culdesac, especially at the two extremities of the tarsus. These islands or granules are semitransparent, almost avascular, with small blood vessels converging toward them. The granules have an appearance somewhat similar to sago grains. This comprises the first stage of trachoma, according to Callan's classification, and may pass into the second stage or, in favorable cases or cases that have been treated, into the third or fourth stage. In the second stage one of two conditions will prevail: predominance either of granules or of the papillae.

Probably more cases of trachoma come under the observation of the physician during the second stage than during any other; hence the usual division into the granular and the papillary forms. In the granular type of the second stage, the granules are found all over the tarsi and in the upper fornix. As usually seen, the granules are from 1 to 2 mm. in diameter. They are the result of an enlargement of the adenoid nodules or lymphoid follicles usually present in the conjunctiva. This enlargement is due to hyperplasia of the lymphoid elements, that is, the lymphoid cells. Such a granule shows a vascular capsule of connective tissue surrounding a mass of cells, the more central of which are large lymphoid cells with granular nuclei, frequently containing the "cell inclusions," which were at one time considered the probable cause of trachoma. In the peripheral portion of the granules are smaller lymphoid cells, and running through the granules are strands of connective tissue. Along with the formation of the granules there is more or less hyperplasia of the adenoid tissue between the granules, with more or less lymphocytic infiltration. In some cases this change may be so marked that large tumor-like masses are formed, or so diffuse a change may take place that the tissue may assume a peculiarly glossy, gelatinous appearance. That the granules may break down, leaving ulcerations, seems questionable in the minds of many. In the other, or papillary type, in the second stage, occurs the hypertrophy of pseudopapillae. These papillae appear as red raspberry-like elevations which mask, to a greater or less extent, the typical gelatinous granules. This papillary form is most marked on the upper tarsus.

In the third stage, the formation of fibrous tissue and cicatrization is very evident. The first appearance of such cicatrization is in the form of gray or white lines, or striae, running in all directions throughout the hypertrophied conjunctiva. As the condition persists, these lines or striae become broader and more numerous. The extent of the cicatrization will depend on the extent of the primary change in the lymphoid tissue. The first part of the conjunctiva involved in trachoma is just beneath the epithelium, but the lymphocytic infiltration with the later fibrosis may involve the tarsus. The fibrosis with cicatrization may be diffuse or may occur in patches, and in some cases may have stellate arrangement.

In the fourth stage, there is a smooth conjunctiva seamed by white lines of connective tissue. Practically complete cicatrization has taken place, or in other words, the trachoma is cured, and here ends the pathologic study.

TREATMENT OF TRACHOMA

As we all know, the expression operation is frequently of value, and cures many of the cases seen early, or in other words, whenever pathologic conditions are limited to the conjunctiva, and structural changes have not taken place above it. When we reach the stage at which the case presents a pannus along with any other corneal disturbance, we may be confident that we already have pathologic changes in the tarsus, that is, in the orbitotarsal fascia, orbicularis muscle, and other structures of the lid, which make it a source of mechanical irritation to the cornea.

It has been difficult for me to determine what is the most active cause of the crimping, which we see while operating and after taking away the orbicularis muscle. I have observed in all instances a more or less marked tendency on the part of the spreading tendon of the levator with its thickened aponeurosis to roll on itself, so to speak, and to lessen the amount of tarsus in evidence after the removal of the orbicularis muscle. This we see when the tarsus is not thickened, and the crimping of the tarsus disappears as we rid it of the fibrous bands, and push back the rolled-up and adherent portion of the levator muscle. When this is done, the tarsus flattens out. This is the pathologic condition we may demonstrate, and when it is corrected, the apparent crimping of the tarsus is removed. Evidently, fibrous bands produce this rolling-up of the fibrillae of the tendon of the levator, which shortens the normal distance between the margin of the lid and the tendon. That portion of the orbicularis muscle called the palpebral portion, which has remained in a state of spasmodic contraction, is probably due to an involuntary effort of the muscle of the lid to protect the cornea.

The action of this involuntary muscle in contracting is to keep the lid closed in sleep and possibly to lift some of the weight of the lid off the globe. No doubt, the early changes in the conjunctiva have a tendency to crimp the tarsus. Then as a result of the extension of the inflammation into the loose connective tissue between the tarsus and the palpebral portion of the orbicularis muscle, there is an increase of the fibrous connective tissue. In this portion of the lid there is closer union of the muscles with the tarsus. Also, the fibrosis extends in between the fibers of the muscle, causing a shortening of the muscle, which, together with a firmer union with the tarsus, accentuates the already present crimping of the tarsus. Thus a vicious circle is established, with reflex irritation producing spasmodic contraction of the muscle, this spasm being relieved when the corneal irritation is subdued and returning as so-called exacerbations whenever the cornea becomes involved, either through something that irritates the cornea from the outside, or through any lighting up of the pathologic condition that remains in the lid. By observing the picture of the lid, we may readily see how the pathologic condition of the lid will vary in different individuals. In some, the meibomian glands become blocked, increasing localized areas of the tarsal thickening. In some cases there are calcareous deposits and changes too numerous to mention, all of which are under the

observation of the surgeon when he follows the operative procedure to be outlined in the care of such cases. No doubt the ciliary part of the palpebral portion of the orbicularis muscle has more or less tendency to produce trichiasis. Splitting the margin of the lid is necessary in some cases to overcome in a more rational way the crimping and particularly the torsion of the cilia. It should be understood that tarsal resection of any degree is a kind of repair of the pathologic changes resulting more in one than in another, due to the fibrosis in the parts above, and to the changes in the tarsus and conjunctiva beneath. With a removal of a section of the tarsus, less tarsal surface is offered for muscular attachment, and this compensates for the loss of muscular tissue that is removed, and directly tends to overexaggerate in the opposite direction the previously crimped tarsus, which had forced a sulcus or sulci beneath the lid. In a broad sense, my repair operation is an adaptation of methods previously used for entropion, with the distinct difference that there is a pathologic condition to correct, which requires the removal of muscular and fibrous tissue, the breaking up of fibrous bands, and the pushing back of the levator tendon, with the probable flattening of the tarsus. All this is done with the understanding that conditions may or may not require splitting the margin of the lid. This is to be determined during the operation, and based on the operator's judgment of his control of the position of the cilia, the skin surface to be stitched. The upper portion of the skin may be removed or not, as he feels the need of pinning the skin surface to the upper portion of the tarsus. This constitutes the fundamental procedure in tarsal repair. Of course, the expression of all granules is the first thing to be done before the lid operation is begun, as heretofore described.

I must not close without impressing the reader with some points connected with the after-treatment of the lids. It is not unusual for the cornea to appear very much irritated, and the eye to look as if the inflammation were exaggerated within a few days of the operation. This sometimes is the result of the use of petrolatum ointment of mercuric chlorid, which seems to irritate some subjects; again the cause is not perfectly clear, except that the operation was performed in a dirty field, and the use of a bandage to control the swelling may tend to block drainage sufficiently to bring about superficial infection. This reaction should not discourage the surgeon; all that is necessary is to treat the lids in the way which would have been followed without the operation, and all the symptoms will rapidly clear up. In a week or ten days the eyelids will be in much better shape, to be followed later with perfect results, and the cure will be brought about in a period of time covering from two to three or four weeks. I naturally take it for granted that every man will be wise enough to treat the symptoms as presented, and if so, success will surely follow in all cases in which this operative procedure is used.

ABSTRACT OF DISCUSSION

CAPT. VARD H. HULEN, San Francisco: It seems to me that Dr. Cary's operation is for the cure of the after-effects of trachoma rather than for the cure of the trachoma itself. Evidently Dr. Cary does this operation when there is entropion, because he says that in certain cases he splits the margin of the lid, and that makes practically the old Snelling operation for entropion.

DR. E. H. DEWEY, Des Moines, Iowa: I was with the Indian Service for six years, doing trachoma work. When we get

an old case tarsal excision is one of the best operations to cure trachoma. I usually do it under local anesthesia, and rarely have to put in a stitch when I close the wound.

DR. ARTHUR E. PRINCE, Springfield, Ill.: I have on a number of occasions done this operation about as described. I have obtained good results, but I have reserved the operation as a sort of last resort. I do not advocate the operation as a regular procedure. I have been much interested during the past three years in the application of carbon dioxide ice. I evert the lid so as to expose the retrotarsal fold, and make a rather light application, about two or three seconds, until the lid turns white. I freeze both lids. There is some virtue in it; I cannot tell you yet how much. I would recommend that if you have a case of trachoma that is not getting along well, freeze the conjunctiva lightly, repeat in a month and again in another month. I habitually freeze these small tendinous pterygiums with carbon dioxide ice. In all probability it obliterates the old capillary circulation, because immediately after the freezing a better condition of the conjunctiva and very much better vision is noted.

DR. EDWARD H. CARY, Dallas, Texas: This operation is useful in all cases of trachoma after the first stage. It is good enough for all of the pathologic changes which take place from the time enough pathology is present to produce pannus and small ulcerations. In the first stage of trachoma you would not think of using this procedure. The question of resecting the tarsus is left for the last stage, and is not to be thought of in connection with these intervening conditions, which you can treat with a simpler or a better method of operation than this, leaving the lid absolutely normal, so that there is no evidence after a few weeks of having operated at all.

RELATIVE DIGESTIBILITY OF MAIZE OIL (CORN OIL), COTTONSEED OIL AND LARD*

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At a time when the value and necessity of fats in foods are recognized as never before, the determination of the digestibility of those from new or little used, although abundant, sources is both interesting and important. Of as great interest is the comparison of their utilization with that of the fats for which they can be substituted. In this country a potentially rich source of edible oil is the germ of maize or Indian corn, which is separated from the rest of the kernel in the starch-making process.

Maize oil, or corn oil, has within the last few years been put on the market in increasing quantities. It is sometimes sold under these names, sometimes under trade names¹ that do not clearly indicate its source. The results of experiments here reported show the digestibility by dogs of corn oil compared with that of lard and cottonseed oil, for which it is chiefly substituted. It is probable that the digestibility by man would not differ much from these figures.

The dogs represented three different types. One was normal in development and vigor, a second was in a subnormal condition, and the third was excessively fat. All were adult females. As their weight did not differ materially, the same ration was used for all. It consisted of 40 gm. of cracker meal, 10 gm. of bone ash and 155 gm. of chopped lean beef, freed from visible fat as much as possible. In a fore period, no fat was given and the ether-soluble material

* From the Laboratory of Physiological Chemistry, University of Iowa.

1. The chief one of these oils sold under trade names, in the Middle West, is Mazola.