The Journal of the American Medical Association

Vol. XXXV

CHICAGO, ILLINOIS, AUGUST 18, 1900.

No. 7.

Original Articles.

THE SURGICAL TREATMENT OF CONICAL CORNEA.*

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Surgery in the treatment of conical cornea has a limited application. The various surgical measures which have from time to time been advised and practiced are justifiable only in certain progressive or confirmed expressions of this congenital deformity of the eye.

In the main, the purpose of surgical intervention concerns itself with attempts: 1. To arrest an inexorable advance of a deformed central area of the cornea by converting this region—in part or altogether—into an opaque scar or a series of cicatricial lines, thereby affording a more or less effectual check to an otherwise hopeless progression. 2. To effect a betterment of vision in confirmed cases which have been rendered helpless in consequence of hopelessly reduced sight, after all other methods of treatment, including every kind and combination of lenses, stenopaic appliances, etc., have been discarded as useless.

ARREST OF ADVANCING DEFORMITY.

In taking up the first proposition, it must at once be stated that this tendency to progression again, declares itself only in a limited number of cases of this class. For the latter alone it is justifiable to attempt through the aid of surgery to bring about an arrest of this progressive advance of a conical deformity of the cornea, which, since birth, or for many years, has been known to be present, but which throughout a longer antecedent period has remained stationary. What starts it, or whether it is due to inherent local or general causes, remains a mystery. Furthermore, it must be added that the deformed region of the cornea is not in the exact center, but rather involves the paracentral regions, and of these again, that just below the mathematical center. It is also observed that this progressive advance commonly begins between the twelfth and twenty-fourth year. It is so slow in some cases, and the aid which corrective lenses afford is not infrequently so satisfactory—particularly if successive changes are made as the needs for failing vision demand—that, for a longer or shorter period, this progression is either not recognized at all or is assigned to a not unnatural increase of the complicated error of refraction which is present. The fact that the refraction in most cases is myopic makes this oversight during the earlier stages of advance not only a possible, but a common one.

It is also not infrequently observed that, whilst this increase of conicity affects both eyes, it is almost invariably more rapid and destructive in one eye, and leads in

this eye to complete suspension of function, whereas, in the fellow eye, progress is retarded, or may even be entirely arrested.

It is, indeed, then, an important, as well as a difficult, question to decide whether in cases in which the progression has unmistakably begun, but is not rapidly destructive to vision and the comfortable use of the eyes is not too seriously interfered with—whether in such cases it is at all justifiable to interfere during the early stages of advance, or whether surgical interference should be deferred until vision falls below a standard of less than 0, and a person so affected is rendered helpless in consequence of his reduced sight.

The indications which may suggest whatever surgery is considered justifiable or necessary are not clearly defined. This congenital lesion is a rare one, and for this reason both common and individual experience are necessarily limited. Among the accepted disclosures recognized as clinical facts, it is not infrequently observed that in certain cases which have remained stationary for years, and in which suddenly and mysteriously a marked and progressive advance of this congenital deformity shows itself, this is again, after a variable period of time, lasting in most cases, months, and often even years—spontaneously arrested, leaving the patient a fraction of available vision for the most necessary practical needs. Another equally established clinical fact is that this progressive increase of the deformity is more rapid and more pronounced in one eye, and in this hopeless reduction of sight takes place, but in the fellow eye, the same process either does not advance so rapidly or terminates more fortunately in spontaneous arrest, leaving the patient a fraction of available sight. It is not easy to decide whether in such cases it is justifiable to practice interference, which, even in the most favorable instances, is beset with dangers and is extremely tedious, so long as a fraction of useful vision belongs to the fellow eye.

We must not lose sight of the fact that a spontaneous arrest may take place in any case at any stage of progression. By keeping this in mind, too great haste of surgical interference in cases belonging to this class is avoided. This is to be the more remembered in those cases in which the fellow eye is either defective or altogether blind from the same or some other cause.

For these and other reasons to be referred to, the indications for interference can only be settled along lines which apply to the cases in question, and which only the judgment and experience of the surgeon can determine.¹

¹ The first purpose of surgical intervention also bears directly upon that which was long a mooted question: whether the conical protrusion of the central region was solid and due to an actual increase or thickening, or, rather it was rarefied and due to an excessive or abnormal thinning of the layers of the cornea at this point. Clinical and anatomical studies of typical cases of conical cornea since then have established certain facts which were misinterpreted by the older German and English ophthalmologists. For instance, Himly—*Handbuch der Augenheilkunde*—regarded this excessive conicity as a solid growth or a morbid thickening, and selected for it the name of hyperkeratosis. Sir William Adams—*Journal of the Sciences and Arts*—shared this view and

*Presented to the Section on Ophthalmology, at the Fifty-first Annual Meeting of the American Medical Association, held at Atlantic City, N. J., June 5-8, 1900.

This brings up questions of practical importance in every case in which operative treatment may be not only justifiable, but indicated. Foremost among these are: Can the surgical methods which have been practiced, singly or combined, in those cases which show an inexorable advance of an existing congenital deformity of the cornea, really affect an arrest of such progression? Are those methods successful which are directed to the cornea alone? Do they involve serious risks? Are they attended by a fair share of success? How explain the good they accomplish, granting that they really bring about a cicatricial flattening with increased resistance of the ectatic region?

The last is perhaps the most important question. It would indeed be an achievement worth striving for, if, in these cases we could verify, in part and in a certain proportion of cases only, the cherished theoretic conclusion that if we substitute opaque scar-tissue, the result of a carefully guarded traumatism, cauterization—galvanocaustic, especially—excision or abscission of the prominent cone for the relaxed and thinned tissues of the ectatic region—we would fulfill the most essential requisite toward bringing about a check to an otherwise hopeless and uninterrupted progression. If this could be brought about with reasonable safety, a supplementary iridectomy would add greatly to the betterment of sight and the purpose of surgical interferences be accomplished.

Unfortunately, however, this is not easy of attainment. It will not be denied that, in some instances, brilliant returns attend operative treatment on the cornea alone, undertaken with the specific purpose to reduce through cicatricial contraction the central deformity and its progressive activity so mysteriously and insidiously aroused. Experience with these cases will soon demonstrate conclusively that such attempts are fraught with exceptional risks. Either reaction out of proportion to the traumatism inflicted is excited, which may even terminate in loss of the eye, or, subsequently the scar-region undergoes repeated necrotic changes,

held "that the lesion was the effect of a morbid growth and that the short sight of the patient was to be attributed to the increased refractive power of the part which together with that of the crystalline lens brought the rays of light to a point far short of the retina, etc." For this reason he advised and practiced the removal of the lens, and in the case which he reports, and which Mackenzie—*Text-Book of the Diseases of the Eye*, p. 659—considered of sufficient importance to quote extensively, a brilliant success was achieved.

Wardrop—*Anatomy of the Human Eye*, p. 819—however, held to the opposite view, which since then has been generally accepted, that an abnormal thickening of the protruded region was not present, but that, on the contrary, the ectatic region was rarefied. In support of this view, he mentioned a case in which a slight blow upon the eye caused rupture of the cornea at this point.

For more modern conclusions and investigations, see:

Fuchs: *Text-Book of Diseases of the Eye*.

Bowman: *Cornée Conique*; Congress de Londres; *Compte rendu*, 1873, p. 204.

Silcock: *Conical Cornea*; *Trans. Ophth. S. U. K.*, vol. xiii, p. 56.

Tweedy: *The Physical Factor in Conical Cornea*; *Ophth. R.*, p. 127.

Schless: *Basel*, 1891: *Drei Fälle von Doppelseitigem Keratoconus*.

Critchett: *A Case of Conical Cornea treated by galvano-cautery without perforation of the cornea and subsequent small iridectomy*. *Trans. Ophth. S. U. K.*, Vol. xv, p. 73.

Gibson: *Treatment of Keratoconus by means of the galvano-cautery and iridectomy*; *THE JOURNAL* xix, p. 3.

Gullstrand: *Ein Fall von Keratoconus mit deutlicher Pulsation der Hornhaut*; *Nord. Ophth. Tidsskrift*, iv, p. 3.

Knapp: *Five Cases of Keratoconus Treated with Galvano-Cautery*. *Arch. Ophth.*, p. 540.

Snellen: *Die Behandlung des Kerato-Konus*; *Graefe Arch. f. Ophth.*, July, 1897.

Bullard, J. W.: *Keratoconus*; *Am. Jour. of Ophth.*, July and August, 1897.

Sattler, Robert: *The Surgical Treatment of Keratoconus*. Reprinted from the *Am. Ophth. S. Trans.*, 1898.

and instead of offering greater resistance, the opposite takes place and the ectasia is more pronounced.

It can only be claimed for the surgical methods which are concerned with the cornea alone, that they are uncertain in their results in affecting an arrest of progression, and that they involve exceptional risks. This brings up another question: Is the central region of the normal cornea more vulnerable to traumatism, and, if so, is this tendency increased in a congenital deformity such as is present in these cases, with thinning, and doubtless also more precarious nutrition of the central lamellæ of the cornea? That this is the fact is the conclusion which has come to me from a limited experience with these cases.

They recall to mind other surgical experiences, such as the sudden starting up—after a long period of inactivity—of a violent and destructive endocapsulitis, in old and confirmed cases of partial or anterior phthisis of the globe with ectatic leucoma of the cornea. In such cases, a slight traumatism—a blow or abrasion of the central region of the cornea—sets up a lesion which in rapidity of progress and destructive tendency is exceptional, and can be averted only by prompt enucleation.

Occasionally also we see, especially in strumous children of African parentage, a fatal expression of pustular keratitis if it happens to localize itself in the very center of the cornea. In spite of every method of treatment, a hopeless infective lesion of the globe results, with loss of the eye.

So also in cases of common traumatism, such as the lodgment of a foreign body. If this is imbedded in or near the center of the cornea, it may, in exceptional cases, be followed—even if promptly removed, and with every caution—by violent and sometimes fatal reaction, taking on the expression of endocapsulitis. If meddling or careless interference is practiced, as is done by some mechanics, who, in certain shops, gain a reputation for dexterity in removing particles of emery or steel from the eyes of their fellow workmen—if the foreign body is imbedded in the center, the attempts at removal, which, in other parts, cause little or, at least, no serious reaction, sometimes result in a violent disturbance.

Several years ago a mechanic came to me with the history that on the preceding day a fellow workman had removed a piece of steel from the cornea with a pen-knife. I found a small infiltration in the very center of the cornea and a dusky, or rust-like, discoloration. It was assumed that an infection had occurred, and an unfavorable prognosis was given. The epithelial layer of the cornea was rough; chemosis of the ocular conjunctiva and proptosis were just beginning. In spite of heroic measures, in a few hours the cornea became hazy and an extraocular infection—endocapsulitis—developed amidst symptoms of intense severity. To anticipate prolonged suffering, as the eye was lost, on the third day it was enucleated. It may be said that the mechanic used a dirty knife, or that its point was rough and conveyed infectious material, or that infection was subsequently conducted along other channels. The most careful inquiry, however, failed to develop more than that the same service had been rendered to others on the same day. Since then I have had several opportunities to confirm this conclusion—that the central region of the cornea is more vulnerable to traumatism and is followed by reaction out of proportion to the injury inflicted. Another and more common experience is that if a violent reaction follows in these cases, it

takes on a fatal expression of endocapsulitis, or extra-ocular suppuration, conclusively showing that pyogenic infection traveled along the lymph-spaces—capsule of Tenon—and here has excited, first, an extraocular suppuration, to which is added later on an intraocular infection. Or, perhaps, it is only that the symptoms of the extraocular complication—capsule of Tenon—overshadow those of the intraocular for reasons which are well known. A recent experience again confirmed this statement. An eye with adherent leucoma and phthisis anterior had been blind for twelve years but absolutely free from all irritation or pain. As the result of a slight traumatism, the central ectatic region of the scar was abraded eighteen hours before I saw the patient. At the time of his visit the lids were edematous; the ocular conjunctiva chemotic; the globe dislocated forward and rigidly fixed; excessive pain; no discharge. The cicatricial area was abraded in the center but with no deep pitting; the remaining portion appeared dry and the entire region of the scar showed a peculiar leaden discoloration.

Vomiting had occurred several times and nausea was constant. The eye was at once removed. The capsule of Tenon and the tendons of the muscles showed advanced plastic inflammation, and when the globe was removed the internal surface of the entire capsule was covered with a distinct, pyogenic membrane. The globe was opened, and under the choroid, intraocular plastic inflammation was only in its inception.

To this may be added a case of conical cornea published in the Transactions of the Ophthalmological Society. In this case, for the relief of rapidly increasing keratoconus in a young woman apparently in the best of health, I proposed as a first surgical or exploratory interference, the excision of a narrow, wedge-shaped piece of tissue from a little below the center of the cornea. This simple excision of a narrow strip was followed by paracentesis, amidst the strictest aseptic precautions. Forty-eight hours subsequently endocapsulitis developed with such rapid and violent symptoms that enucleation was the only remedy.

Similar cases have been reported. One mentioned by Mackenzie as occurring in the practice of Adams, bears evidence that this complication was known even to the earlier English surgeons.

It must be admitted that disastrous complications may attend the most carefully planned and executed surgical measures, directed in the main with a specific purpose to the cornea. Experience also sufficiently upholds the fact that repeated paracentesis, cauterization, excision or abscission of the deformed region—in cases in which serious complications do not follow—effect in exceptional cases only an arrest and reduction of the central ectasia. It is a question even with these successful ones, whether the good which is accomplished is not brought about through the central opacity of the cornea, for it is this which aids the supplementary measures on the iris and lens, which almost without exception are necessary to improve or raise vision to a higher standard. For this reason those operative measures which involve a major amount of surgical traumatism to the deformed cornea should be avoided. Surgical treatment must be undertaken with no other prospect than to render opaque the central regions, but with no reliable hope that it will bring about greater resistance of the ectatic region. For this reason the simplest surgical measures should be chosen, and these, as is well known, consist of cautious cauterization and tattooage.

SECURING BETTER VISION.

The second proposition concerns itself with attempts to bring about a betterment of sight in confirmed cases of this ocular deformity, in which vision has been hopelessly reduced: either, as the result of extreme conicity of the central regions of the cornea following a mysteriously started progression, but which was spontaneously arrested or was favorably influenced by the treatment practiced—adjustment of lenses, etc.; or 2, because of an excessive congenital deformity, but in which there can be discovered no evidence that the progressive tendency referred to has ever taken place. In the largest number of cases of this class it will be found that an excessive congenital deformity is present without tendency to fatal progression.

The cases which belong to this class are often greatly and permanently benefited through the selection and faithful use of proper corrective lenses. Sometimes stenopaic appliances are of great aid, but as often not. Strong crossed cylinders, or any combination of lenses which after repeated empirical tests has been found to aid vision, may prove of great service, and such lenses decentered placed or held by the patient in certain positions in front of the eye may even afford an increase of vision over the same lens in exact position directly in front of the eye in the test-frames.

For this certainly smaller class of cases of an excessive deformity, but in which lenses afford a fair amount of vision, should surgery be advised? If vision falls below a standard which implies helplessness, this must be considered a measure of justifiable expediency. If progression has not taken place, such cases offer far better returns from surgical treatment than those already referred to. With these, however, the same statements hold good, though they apply with less force to these cases: to avoid all unnecessary surgery with the cornea, limiting it rather to cauterization, followed by tattooage of the ectatic regions, relying for the restoration of better vision mainly on the supplementary measures—iridectomy and removal of the lens, or both.

Surgical experience and clinical observations uphold two expressions of conical cornea.

The first is more frequent. It is more amenable to the measures ordinarily employed as well as to surgery. The second is less frequent and also less amenable to non-surgical treatment and fraught with more danger if surgery is resorted to.

In the first expression of conical cornea, the entire structure participates in the deformity, but the conicity of the central region is without exception more pronounced. If progression starts, it again finds its chief declaration in the central regions.

The apex of the central cone is generally sharp. Neither involuntary pressure of the lids nor that which is voluntarily exerted, affects, disturbs or alters the conical shape. The apex of the cone is not easily indented with the blunt end of a probe. Surgical experience, furthermore, discloses that the apex region of the central cone, in most instances, is abnormally thin. It may happen, however, that the affected region in this more common expression, may even be increased in thickness. Vision is generally correspondingly reduced, but can, in most cases, be benefited, even with advanced progress or excessive deformity.

The second expression of conical cornea is less frequently observed. The conicity of the central region comprises a larger area. Implication of the peripheric regions of the cornea, though pronounced, is not so marked as in the preceding form. In other words, the

entire cornea is less conical, but a larger portion of the central area is more ectatic. In this form, abnormal thinning of this ectatic region, and, in particular, of the apex of the cone, is met with without exception. The normal pressure of the upper lid, in marked or advanced cases, is sufficient to distort the shape and outline of the conical protuberance. Forceful contraction of the palpebral fissure produces flattening of this region. Pressure against this ectatic central region with a blunt probe readily confirms that this region has a lesser resistance and is easily indented. Surgical experience also fully corroborates the rarefaction of texture at this point. Clinical experience also confirms other points, and that is that visible pulsation of the thinned area is noticed.

The surgical methods for the relief of conical cornea are many and have long been practiced.

The obliteration of the conical protuberance by repeated cauterization with nitrate of silver and other escharotics, led eventually to surgical measures which accomplished this same object of cicatricial contraction and opacity with a lesser amount of painful reaction and danger and in a shorter period of time. For this reason, the use of the thermocautery, and in particular, galvanocautery, has superseded the older methods, and this procedure is justly entitled to preference. More than this, cauterization carefully practiced in selected cases is at present considered one of the safest and most useful surgical methods. Even if undertaken for no other purpose than to transform the deformed but clear central region into an opaque one without any definite hope that a reduction of the conical deformity may be brought about, a very desirable aim is accomplished.

The observation that after an accidental rupture of the thinned central region, the scar which followed reduced the deformity, led, especially on the part of French surgeons, of which Desmarres was a prominent advocate, to repeated paracenteses, followed by compress bandage and rest.

Early in the history of the surgical treatment of conical cornea, supplementary interference on the part of the iris and lens was found necessary even in cases in which the primary object was realized. On account of the large opaque area which followed, and not infrequently anterior synechiæ, it was found almost without exception, necessary to perform a small iridectomy.

The view current for a long time that the central ectasia was a thickening of this portion of the cornea, led to the suggestion, and also to the practical surgical experiment of abscission of the prominent cone, excision of wedge-shaped pieces of tissue from or near the apex region, splitting of the cone by crucial incision, with or without paracentesis, cauterization, tattooage, etc. All these methods, however, were found to have a limited application only. They were all fraught with great dangers, and the returns from such treatment, always tedious and painful, were so unsatisfactory that such surgical procedures were only practiced infrequently and with the greatest hesitation.

In the early history of the surgical treatment of conical cornea, the suggestion was made that removal of the lens was a practical venture and accomplished a most desirable benefit for the patient. This suggestion was made and acted upon by Sir William Adams² as early as 1817. He had, in a case of successful cataract extraction, in a woman with high myopia, observed that she could see better without any, or required much weaker convex lenses than are ordinarily worn by per-

sons who had undergone an operation for cataract. He recognized the high myopia so uniformly present in conical cornea and suggested and successfully practiced the removal of the lens in a typical case. Useful vision was restored in this case.

During a long interval of time, little or no progress was made either in the perfection of old or the discovery of new methods. Some surgeons condemned operative interference entirely and others practiced it only in extreme cases. For iridectomy, iridotomy and iridenkleisis were substituted by some surgeons.

The knowledge gained from surgical experience and careful clinical studies of conical cornea enables us to summarize briefly: That the surgical treatment of this uncommon deformity of the cornea is attended by uncertainty and danger even in the most favorable cases. Also, that it is without exception tedious. If it is undertaken with the hope of improving vision by reducing the central ectasia through cicatricial contraction alone, it will prove in most cases an unsatisfactory venture.

The simplest and least risky surgical method consists of the discriminate and cautious use of the galvanocautery, supplemented, if necessary by an iridectomy, iridotomy, or iridenkleisis.

Abscission or excision of the central ectatic region, repeated paracenteses, are one and all most uncertain in their final results. The most vicious resentment may follow the most cautious attempts of such surgical interferences and for this reason they should not be too hastily resorted to.

Experience with the more desperate cases suggests as the most rational plan of surgical interference: 1, the removal of the lens by discission or extraction; this is followed by superficial cauterization with the galvanocautery and tattooage—simply to render the ectatic region opaque, but not with the hope or object of bringing about greater resistance on the part of this locality, or, what is less likely to occur, a better restoration of shape and curvature of other parts of the cornea. This accomplished, it may be expedient to perform a small iridectomy, placed in the locality in which it may furnish the greatest possible good.

It must be remembered as an inviolable fact of surgical experience that the most carefully guarded traumatism to the deformed or central region of the cornea may be followed by fierce, and at times by fatal, reaction. In conclusion, it may be stated that surgical treatment is justifiable in a certain number of cases, and while not often one of imperative necessity, may be one of practical expediency, which, however, only the judgment and experience of a surgeon must determine in every case.

THE TREATMENT OF KERATOCONUS WITH GALVANOCAUTERY.*

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In 1892, I published five cases of keratoconus¹ which I had treated with galvanocautery.

CASE 1.—Operation was performed on both eyes. On the left eye the apex was cauterized with a fine loop in an area of 2x3 mm. and then pierced, so that the aqueous spurted out. Healing was free from dangerous reaction, but slow. The chamber closed and opened seven times. Before the operation patient read J. 1 at 1" and with -7D. 20/200; eighteen months after the operation he read J. 1 fluently at 10", and with -4D.

*Presented to the Section on Ophthalmology, at the Fifty-first Annual Meeting of the American Medical Association, held at Atlantic City, N. J., June 5-8, 1900.

1. Arch. of Ophthalmology, Vol. xxi, p. 540.

2. Adams, Sir Wm.: *Journal of the Sciences and the Arts*, vol. 11, p. 403, London, 1817.