Necrosis of the Cornea

Synonyms

Vorschädigung der Cornea bei der infantilen Encephalitis

Heratomalacie
Necrosis Cornea
Necrosis Corneae
Keratitis Keratitica
Marantischer Epithelgeschwür
Infantile Hornhautvorschädigung

by

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In discussing the subject of this thesis no attempt will be made to go into its history, or into that of the condition of tarsus conjunctivae which has become associated with it, since practically all that could be said under this head would merely be a repetition of portions of the articles by Leber and de Bouveit in the Archiv für Ophthalmologie, Band xxi., and by Sämisch in the Handbuch under tarsus conjunctivae; and further the list of the literature appended contains almost every thing written in this connection.

But I will at once proceed to describe two cases which occurred at the Augenklinik at Heidelberg, of which the material was placed at my disposal by Professor Otto Becker with the greatest kindness; and it may be added that only one of them belongs to the subject in question.

The first is that of a woman, Elizabeth West, aged 35, who was admitted to the Augenklinik on Oct. 27, 1883.

On admission patient was in so depressed
and weakly a condition that it was impossible to obtain any account from her at the time.

On examining the left eye, the lids were found to be somewhat thickened, but only slightly reddened. The palpebral conjunctiva exhibited marked papillary projections, especially on the upper lid, and in the oculopalpebral folds they were very abundant. The ocular conjunctiva was only slightly injected, as also were the ciliary vessels.

The globe itself was diminished in size and possessed a quadrangular form.

On the conjunctiva was seen a conglomerate whitish yellow mass partly granular and partly scalby, the attempt to remove some of which for microscopic examination failed at the time.

Only a very narrow ring of corneal tissue still remained; and projecting from the interior of the eye in the place of the destroyed cornea was a sensitive homogeneous mass, which obstructed any view of a possibly present iris or of
The anterior media.

The globe was quite soft, and there was no pain on pressure.

Vision was totally lost.

The right eye was quite normal, both conjunctiva, and globes; vision was also perfect.

On October 20th, the left eye was enucleated; the afteroperation was most satisfactory, the stump being quite healed by November 14th. Patient's general condition was also much improved, and she was able to get about as usual. Three days later she was discharged.

The microscopical examination of the whitish yellow mass detects numerous Nereis bacilli, and also micrococci.

The eyeball was hardened in chrome acid and in Müller's fluid. It was divided somewhat peripherally in a horizontal plane.

The naked eye description is from the other half of the globe to that used for microscopic examination.
The globe is flattened from before backwards, (see Figure 1), the antero-posterior diameter measuring 19 mm., and the greatest transverse 22 mm. This is principally due to a localised protrusion of the sclerotic coat externally, which measures 7 mm. in its antero-posterior diameter. Behind the equator, on the same side, there is also another protrusion; and on the opposite side two more. The choroid does not follow the sclera in these protrusions but there is a space between the two coats which is filled by a dense tissue. The sclera is much thickest behind the equator, measuring here 2.25 mm.; but anteriorly it gradually becomes thinner, measuring just behind the ciliary body 1.8 mm., and opposite them 0.75 - 0.66 mm. The cornea is greatly increased in thickness, except towards the centre where the lens lay in contact with it; in this position it is very thin.

The choroid is most markedly thickened. The retina is detached, and separated from the choroid by a soft mass, which
looks like evagination. Within the space enclosed by the utricle lies a mass which is probably the much diminished vitreous. Anteriorly the two surfaces of the utricle come into contact forming an isthmus-like process, which is united in front to a transverse band stretching from side to side between the ciliary processes.

In front of this boundary lie, united in an almost indistinguishable manner, ciliary processes, iris, and corneal tissue surrounding the lens, the upper portion of which here lies in contact with the posterior surface of the cornea, the anterior chamber being altogether obliterated.

In the other half of the globe the lens protruded through the ulcerated cornea, and as it had undergone calcification it was necessary to remove it.

Microscopical examination

In the centre of the cornea is a large aperture, measuring from 3.3 to 4.5 mm.
in transverse diameter, which opens into
a space where the calcified lens lay.
Into this the epithelium dips down on
both sides for a considerable distance,
while in the rest of its extent it is bounded
by the lens capsule. This latter lies in contact
with somewhat condensed inflammatory
tissue in which are seen several portions
of calcified material; while another large
irregularly shaped piece, which is probably
a part of the lens, projects through the
epithelium and helps to form the internal
boundary of the space.
The cornea has undergone the most
marked alterations, and exhibits from before
backwards the following changes:—
the epithelium is much thickened consisting
of several layers of peculiarly shaped cells,
the upart of which are arranged vertically,
and contain very large nuclei, while the
more superficial are large and irregularly
polygonal, only the most superficial tending
to become at all flattened.
On the surface of the epithelium there are
masses consisting of a clear homogeneous
material which is closely adapted to the irregularities of the surface. It acquires a yellow tint with the various dyes used (logwood, picric-carmine, ammonia-carmine, alaun-carmine), and is surmounted by granular and fibrillar material with some blood and small round cells. Between the epithelial cells, especially in the neighbourhood of the limbus are small round, finely granular masses which probably consist of calcific material. Beneath the epithelium lies a very cellular tissue consisting mostly of round cells, and also of a small amount of wavy tissue; it is penetrated in all directions by blood vessels, some of which are of considerable size, and which are seen cut in all directions, vertically and obliquely. Posteriorly this cellular tissue decreases more and more, while the fibrous increases; but islands of cellular tissue are still to be seen, and also spaces containing probably coagulated vitreous. Still deeper lies the true corneal tissue.
which is broken up into irregular masses, which sometimes present an opaque and pearly appearance. In the intervening spaces are seen small islands of round cells, small blood-vessels and granular and finely fibrillar material.

This cellular tissue also extends outward into the sclera, separating the fibres of that coat, so that it is impossible to recognise distinctly the position of the corneosclerotic junction.

The sclera exhibits no great difference of structure except that the fibres have a very wavy appearance which is due to the folding of this coat.

Between the sclera and choroid there lies in the protrusions already mentioned an almost transparent tissue, consisting of very fine mat-like glistening fibres, forming a network and enclosing round and branched cells and some pigment granules. This tissue is intimately adherent to the sclera, and is continuous with the lamina fusca. Towards the lamina vasae, however, the meshes are distended and contain granular material.

Of the iris there is not much to be seen, and it is hardly to be distinguished from the cornea to which it is adherent except at places where portions of the
posterior elastic lamina still remain. Externally in the position of the iris is a mass of much cleaner tissue which consists of very fine hyaline fibres, between which are round and branched cells; some of these are large and contain granular precipitate, while others are also vacuolated; these latter are probably to be regarded as degenerated epithelial cells of the iris (da Gama Pinto). There are also many pigment granules scattered about. This is probably degenerated iris tissue united to the cornea, and assisting in the formation of the staphylomatous tissue.

In places this tissue is bordered posteriorly by a layer of pigment which is to be regarded as the remains of the degenerated pigment layer of the iris and it undoubtedly indicates that that structure lies anterior to it.

The ciliary body is changed in form; it no longer possesses the usual cylindrical shape, but is flattened from before backwards. This is caused mechanically by
the choroid being drawn inwards behind it. It is extremely cellular, but slightly pigmented, and is mostly degenerated into a mass of connective tissue. The pigment epithelium covering it appears to be peculiarly thickened, and the cells are apparently a little oedematous and in places also proliferated; and they are probably undergoing similar changes to those of the iris already described. The ciliary processes are much atrophied and have undergone similar changes to those of the iris. The cells on the spines appear proliferated and form masses of partly pigmented and partly unpigmented cells, such as one not seldom sees in eyes with cataracts.

When one passes from the ciliary bodies to the region where the lens ought to be, one comes to the space from which that structure was removed. Posteriorly this is bounded by a thick transverse band measuring about 0.75 mm. from before backwards in the centre. It consists of a connective tissue with
distinct fibers and numerous cells, which are often degenerated; there are also frequent pigment granules, which are in places collected in clusters, as well as many blood vessels.

Following this posteriorly one comes immediately to the utricle, with which it is directly united. When followed laterally and anteriorly it is found to extend somewhat forward so as to include the space occupied by the lens, approaching and then becoming continuous with the cornea, and the remains of the iris and ciliary body; so that it can be confidently asserted that the ciliary processes and the degenerated iris have had a considerable share in building up this tissue. In this position it is much less cellular than elsewhere.

Following laterally and posteriorly it comes into contact with ora serata exactly where the utricle ceases and the pars ciliaris utriculi begins; and a more careful examination of this portion discloses some remains of the normal
Structure of the Uvula.

At this point (i.e. opposite the ora serrata) the choroid presents a great protrusion on each side, being drawn upwards and separated from the sclerotic by the contraction of the newly formed tissue, the space between the two coats being filled in the manner already described.

This mass of tissue behind the lens therefore consists of the degenerated vitreous and uvea and of the products of inflammation of the ciliary body and iris.

The options is much degenerated and consists mostly of fibrous tissue, especially from the lamina cribrosa forwards. But sections of well preserved ciliary nerves are to be seen.

Of the uvea almost absolutely no distinction into layers can be made out. The rods and cones have entirely disappeared, and only one incomplete layer of cells can be at all distinguished, and this from its position is probably the internal nuclear. Externally to the optic nerve it is entirely detached from the choroid, but internally for a very
short distance the two coats were adherent and
where the one begins and the other ends can
only be distinguished by the presence of distinct
individual vessels and of pigmented tissue.
The outer coats of the choroid are much thicker
the individual layers appearing to be affected,
whereas also been a great infiltration of
lymphocytes. The walls of the bloodvessels, which
are enormously congested, are also increased in
thickness, and the perivascular sheaths are very
distinct. On its inner aspect are seen and then
run small projections covered by the retinal
epithelium, and containing colloid material which
has in some instances undergone calcification.
Many sections were doubly stained and examin-
ed for microorganisms. Numerous microtodi
were found in the tissue around the lens
and in the interior of the eye especially
between the choroid and retina; and between
the fibrils of the newly formed tissue
immediately behind the lens there were
seen at one spot some bacilli resembling
the morbilli bacilli in appearance, but
this was the only locality in which any
rod-shaped microorganisms were found.
The second case is that of Marie Josephine Baron, 3½ years of age, who was admitted to the Augenklinike on Nov 25, 1883.

The child had always been weakly and had been ailing for some time. The father, who was a labourer, stated that the child's eyes had only been noticed to have been affected during the five or six days immediately before admission.

On examination the lids of the left eye were found to be normal, but the conjunctiva bulbi as far as the oculopalpebral fold was pale and covered with dry, fatty, looking scales, such as one only sees in Xeraxis.

The cornea was transparent except in two positions, one the size of a hemisected inferiorly and internally near the limbus, where there was an ulcer extending down to Descemet's membrane, the edges of which were somewhat infiltrated. Superiorly and internally from this, was the other, an old and indistinctly defined macula, the surface of which was rough.

The anterior chamber was deeper than
normal, and was filled with pus of a dirty grey colour for a height of about 1.5 mm. The pupil was somewhat dilated.
The lids of the right eye were also normal and the condition of the conjunctiva was exactly similar to that of the left.
The cornea presented a remarkable appearance somewhat less than a half in the outer part being quite clear and smooth, while the remaining portion at the first glance looks like an infiltrated staphyloplomatous scar. This protrusion was of a dirty grey colour and measured 2.5 mm. in height. It was further examined under narcosis, and was found to be of almost cartilaginous hardness; towards the interior and inferior aspect of the cornea it gradually faded away, appearing to pass into the normal tissue. Superficially a small portion of this protrusion, which measured about 1 mm., could be raised with a fine probe, and it was removed close to the corneal surface.
The patient, who was extremely debilitated, rapidly sank, and died eight hours after
admission.

Twelve hours later the eyes were removed, in doing which the left was ruptured at the seat of the ulcer. Both globes were immersed in chromic acid and Müller's fluid.

A sagittal vertical section was made of the left eye, which measured 23.5 mm. in the anteroposterior diameter, and in the vertical 22 mm.

In the lower portion of the cornea about 1.5 mm. from the corneoscleral junction there has been a loss of substance, leaving a somewhat fundiform excavation with greyish yellow edges. The posterior elastic lamina has been ruptured and a knuckle of iris protrudes through the perforation (see Figure 2); but the cornea otherwise has a normal appearance.

The lens is much altered in shape and position, but this is probably due to pressure from iris during removal of the eye. It no longer possesses the usual curvatures but is concave anteriorly and very convex posteriorly; and it is also dislocated down.
wards and towards the ulcer, being separated from the prolapsed portion of iris only by a small collection of exudation, of which some also lies on the anterior capsule.
The eye presents no other macroscopic pathological appearance.

Microscopically the edges of the ulcer are seen to be rough and irregular, and sloping gradually downwards to the floor. On both sides they are separated from the normal corneal tissue by most distinct lines of demarcation which are somewhat concave towards the ulcer. This portion of tissue included between these lines stains very slightly and has a somewhat opaque appearance, while the rest of the cornea acquires a much deeper colour. The tissue thus differentiated is very richly infiltrated with pus cells, and towards the free edges is broken up and disintegrated; a few lamellae are also seen lying on the prolapsed iris.
Below the lower line of demarcation (i.e.
nearer the limbus there is also a purulent infiltration of the corneal tissue, but this is however confined chiefly to the deeper layers immediately adjacent to Descemet's membrane. This exudation of round cells also extends more peripherally around the canal of Schlemm, and into the spaces of the ligamentum posticum when it is so great that it becomes continuous with that lying in front of the iris. The rest of the cornea is rather more cellular than normal.

Towards the upper margin of the ulcer the epithelium gradually diminishes in height, until it is finally represented by a single layer of elongated and flattened cells, which cease together with Bowman's membrane where the corneal tissue begins to be much infiltrated. At the inferior margin however the epithelium on the contrary is thickened and consists of several layers, the middle zone of which is composed of large and almost round cells.

Descemet's membrane extends slightly below the margin of the pupil in a normal
condition: below this it is detached and thrown into folds. The endothelial cells covering it as they approach the ulcer at first become
singular, and finally cease at some distance from it.
The iris is congested and infiltrated with round cells, and inferiorly is prolapsed into the base of the ulcer.
On both sides the tissue round the canal of Schlemm is richly infiltrated with round cells, which extend through the ligamentum
pectinatum and lie in great quantity peripherally between the iris and cornea, flattening the former structure inferiorly near its origin.
The ciliary body and processes, and the choroid are much flattened, the first having lost its usual spindle-shape; but otherwise the appearance presented is normal; and it would appear as if some pressure had been applied from behind, but this may have occurred during the removal of the eye.
The optic nerve, and the sclera appear to be quite normal, and no evidence
could be seen of any obstruction of the bloodvessels at the limbus.

Of the right eye a section was made horizontally through the centre. The globe measures 22.5 mm. in both the antero-posterior and transverse diameters.

The inner half of the cornea has been the seat of a process leading to disintegration of its tissue. The area so affected begins at a distance of about 1 mm. from the corneosclerotic junction and extends outward for about 5 mm. It may be divided into three parts (see Figure 3) — an inner, of light greyish colour situated over a piece of the cornea near the limbus which still remains transparent; a central darker portion, which is fairly well defined and which projects considerably beyond the normal curvature of the surface; and an outer, extending like a wedge into the more healthy tissue external to it.

Internally, the iris is in contact with the cornea in the whole of its extent, and immediately behind the affected tissue projects
into a small gap which seems to have been caused by the central portion having been pushed outwards. Covering it posteriorly is a thin greyish-white membrane which extends across the pupil on to the anterior surface of the iris externally; this is adherent to the third part of the iris tissue, thus almost obliterating the anterior chamber.

In other respects the eye is apparently normal.

Microscopical examination.
Through the prominence on the inner aspect of the cornea a section had been made and the surface here is in consequence markedly irregular. A small process is still seen to project over the epithelium inferiorly.
The central part of the affected corneal tissue consists of much broken up and disorganised Lamellae together with numerous small round cells and partly granular and partly fibrillar material, which is in places collected into islands, while on the
deeper parts there are also clusters of the former. Towards the surface there are great quantities of vis blood corpuscles entangled among the lamellae and fibrils.structurally this disintegration is confined to the more superficial layers so that a crater is formed, and this is bounded by lines of demarcation, the external of which is the more marked, here there is a distinct cleavage of the corneal tissue extending from the anterior chamber outwards almost to the epithelium, the edge being partly occupied by fibrils of exudation, leucocytes and some pigment, but neither of these lines is so distinct as those in the other eye.

The surface of this partion does not present a trace of epithelium, while posteriorly Descemet's membrane has been ruptured and a fan-ribble of iris protrudes into the substance of the cornea.

Following the cornea laterally from the lines of demarcation it is seen that the lamellae become arranged in a more parallel manner, but they are nevertheless separated by elongated and mostly spindle-shaped spaces which are
filled with leucocytes and granular material. Towards the centre this infiltration is di-
tributed at first pretty evenly throughout the whole breadth of the cornea, but
ggradually it becomes confined to the more
central layers and finally ceases in a
conical form. Internally, the infiltration
lies principally in the superficial layers
near the epithelium, and between them
in the neighbourhood of the ligamentum
pectinatum.
Although the whole of the cornea is more
cellular than normal, yet nowhere is
this keeping up of cells more striking
than round the canal of Schlemm where
it is as great as even in the immediate
vicinity of the disintegrated tissue.
The epithelium on Bowman's membrane
behaves in the same way as that of
the left eye, but it ceases a little sooner
than the membrane itself. Descemet's
membrane is ruptured opposite the central
part of the affected tissue as already
described, and in some sections also almost
opposite the termination of the edge of
purulent infiltration which, at this point, becomes continuous with the pupillary membrane to be mentioned below, the anterior chamber being thus reduced to very narrow limits. The endothelium is very irregular and in many places is altogether absent. As has already been described the iris internally is adherent to the bottom of the crater, but only the anterior surface is thus affected, the pigment layer remaining uninfluenced. The whole iris as well as this paramitary exhibits an enormous cell infiltration and distension of vessels, which diminish only towards the periphery. The anterior surface of the iris is covered with a layer of pus cells which are held together by a network of fine fibrils. This extends across the pupil forming a pupillary membrane of great thickness which passes insensibly into the disintegrated corneal tissue near the prolapsed portion of iris, and also extends along the posterior surface of the iris externally.

On the anterior capsule and on the
suspensory ligament both anteriorly and
generally lie fair cells and red blood
corpuscles.
There is an immense increase of nuclei in
the ciliary muscle, otherwise the ciliary
body and processes and the choroid appear
unchanged or only slightly congested.
The urine appears to be normal, but lying
in the vitreous are round cells containing
several nuclei which are particularly
abundant anteriorly.
The optic nerve at its entrance appears to
be slightly more cellular than normal.
The lens exhibits several spaces in its
substance, but these have been caused by
the hardening process.
The sclera is intensely cellular and ves-
cular. As in the other eye there was
no evidence of thrombosis in any of the
vessels at the corneosclerotic junction.

On examining specially stained sections from
both eyes for microorganisms, bacilli were
seen on the surface of the conjunctival
epithelium, and between the cells of the
most superficial layer, and scattered sparsely in the more superficial portion of the disintegrated tissue, but not in those parts where the cornea was only infiltrated with pus. There were also a few micrococci, both forms being more numerous in the right eye. In the anterior of both eyes there was a total absence of any bacilli, but micrococci were found in great abundance in the network forming the tisuepia in the anterior chamber.

The following is the report of the post-mortem examination, which was made by Prof. Julius Arnold of Heidelberg, twelve hours after death.

Rigor mortis was very slight. The skin in general was pallid, and somewhat dry; it could be raised in folds especially over the thorax and abdomen, and to a less extent on the extremities. The nails were very pale. The mucous membrane of the lips pale and somewhat livid, and the skin of the upper lip and of the alae nasi was peculiarly dry and thick.
The eye of the history.
The skeleton was fairly powerful; the thorax flattened, but otherwise the measurements were average.
The subcutaneous tissue was destitute of fat; and the muscles badly developed, pale and friable. On opening the chest the lungs collapsed but very slightly, still covering the heart so that the apex only was exposed.
The pericardium contained an average quantity of fluid; the membrane itself was clear and transparent. The heart was of average size and contained in its cavities a considerable quantity of firm, firm coagula, and some thin fluid blood. The left valves were clear and transparent; the wall of the left ventricle of average thickness and pale, but of normal consistence.
The left lung was adherent to the diaphragm but the pleura was otherwise unchanged. The bronchi contained a frothy secretion, and their mucous membrane was somewhat redened. The upper lobe was elastic and filled with air, but was somewhat congested and moist; the lower lobe on its upper
two-thirds was of the same consistence, but in the lower part there was, in an area 2 cm. in breadth, and 1.5 cm. in height, a whole series of smooth walled cavities, the tissue surrounding these being tough and infiltrated, and containing no air. These cavities are connected with bronchi and are in part merely tranverse sections of them.

The right lung is quite free; the pleura normal, the bronchi as in the other lung, the tissue of all its lobes congested, moist and containing somewhat less air. In the lowest lobe, corresponding to the sharp free margin, were single dark patches, which consisted of a bronchus filled with pus, the surrounding tissue being infiltrated with blood.

The position of the abdominal viscera was normal. The mesenteric glands were enlarged, and on section grey, and somewhat moist. The mucous membrane of the duodenum in its lower portion is considerably injected and exhibits several invaginations. The small intestine was in a condition of medium contusion; it contained a very small quantity of fecal mucus; the mucous membrane was cov.
...ew with a thick layer of mucus, and was markedly injected. That of the large intestine was in general thickened and thrown into folds, the crests of which were congested. The solitary glands and Peyer's patches were not particularly altered; but the former especially in the small intestine were somewhat congested, and there on the tips of the ridges of a yellowish colour; the latter too were in places more prominent being congested and in places filled with haemorrhage. The stomach was of average size, and contained very small smelling remains of food in small quantity; the mucous mem- brane was covered with mucus, and was markedly injected.

The spleen was 6.75 cm. long, and 6.25 cm. broad, and 2 cm. thick. It was fairly vascular and consistient; the meduphymen capsulae were numerous and easily seen, and the trabeculae were also distinct.

Both kidneys were of average size; the capsule easily removed without any loss of substance. The cortex exhibited spots of unequal injection; but the substance was more evenly injected, and some white lines were seen in it. The
pelvis were somewhat distended, and the mucous
membrane opaque.
The gall-bladder contained light yellow thin mucous
gall. The liver was large, the acini distinct
with light yellow periphery, one pale in centre;
and the whole surface has a fatty aspect.
The cervical glands were somewhat swollen.
The intima of the corona, thin and shining.

On the posterior wall of the pharynx, as well
as in the oesophagus there was a whitish yellow
deposit which can easily be washed away.
The entrance to the glottis was somewhat irregular:
by congested, as also was the epiglottis, which
was rather thickly covered with mucous.

Corresponding to the posterior half of the squamous
bone, there was between the dura mater and
the bone a circumcised haemorrhage. The
dura was lightly attached to the skull
especially along the longitudinal sinus.
The pia mater of the hemispheres exhibited
a marked congestion of the capillaries and
veins, but at the base it is paler, everywhere
it is clear and transparent. The large
vessels have thin and transparent walls.
The cerebellum is much congested and edematous.
and somewhat soft. The meninges presented an
exactly similar appearance. The lateral
ventricles were distended and contained a clear
serous fluid.

Anatomical Diagnosis

Gastric and intestinal catarrh.
Hyperaemia and oedema of the brain.
Necrosis of both eyes.
Bronchietasis.

In reading these two cases it is at once
evident that we have to do with two forms
of disease widely differing from one another
in their pathology, but at the same time
possessing one feature in common, name-
ly, the presence of necrosis conjunctivae.
And it is this fact which gives them a
special value as affording a comparison
from the study of which it is hoped that
some further evidence may be obtained as
to the real pathological significance of the
necrosis bacilli, and to the disputed patho-
logy of that form of corneal ulceration
occurring most commonly in infants, and
of which Case 2 is a good example.
The first case is without doubt one of Panophthalmitis, presenting the usual serious aspects of that condition, and having terminated in sloughing of the cornea, followed by perforation of the lens and general disorganisation of the eye, together with those subsequent changes brought about principally by the contraction of the newly formed inflammatory tissue, as has been well described by Prof. Gayet in his Essai sur l'Atrophie du globe oculaire. Of the marked alterations, which have taken place, one only seems to call for special notice, and that is the tissue which lies between the choroid and sclera in the protrusions of the latter. This appears to be, as Gayet specially remarks, composed solely of the lamina lesea which is folded upon itself in consequence of its adhesion to the sclera; and it is to be noted that congestive lymph was seen only in the meshes situated more internally, as one would have expected.

I regret that there is nothing stated in the history as to the manner in which this
condition arose, but it was probably due to traumatic agency for that is the most common cause, and this view is supported by the subsequent events.

On the conjunctive whose vitality was so greatly lowered a necrotic condition had become established, and the Kneuss bacilli were found to be present in great numbers.

But on examining the various structures and the interior of the eye for the presence of microorganisms while numerous micrococci were found, as I have shown in similar cases, the only evidence that the Kneuss bacilli had penetrated more deeply than the surface consists in the presence of some bacilli between the fibers of the tectum immediately behind the lens.

This undoubtedly resembles the Kneuss bacilli in appearance very strongly, but it is an entirely different condition from that described by Leber, who found numerous bacilli in the interior of the eye resembling those on the ocular surface, while it practically agrees with the observations made by Stöerner. And if these bacilli did
the capabilities ascribed to them of causing such serious general and local disturbance one would have expected to have found them in large numbers in that organ in which they are said to produce their most apparent and disastrous results. Nor does Schultz in his article, which exhibits the marked influence exerted on his mind by Leben, make any definite mention of having observed them in the interior of the eye. And it should be expressly noted that after the removal of the diseased eye the patient began to recover rapidly without any special treatment, thus excluding the possibility that she was suffering from some general infection, and proving that on the contrary the general state was dependent on the local cause.

The other case, that of Marie Baron, will be regarded as a typical example of that rapid destruction of the cornea described by von Grafe, Arlt, Forster, Stomer, and Leben under various titles.

As in other similar cases we have here a weakly illnourished child subjected to the unfavourable influence of poverty, who
exhibits traces of previous disease of the eye, and whose whole general condition is one of great debility associated with pulmonary disease of some standing which would of itself cause considerable exhaustion. That this may have been of a tubercular nature is suggested by the occurrence of strikingly similar cavities in the lungs of guinea pigs affected with tuberculous, as mentioned by myself who regarded them as formed by the softening of the caseous centre of tuberculous nodules and by dilatation of minute bronchi. The child was also suffering from gastro- 
enteritis, which would naturally be accom-
panied by diarrhoea.

In both eyes Keratitis of the conjunctiva was present, and as in Case 1, the bacilli were found presenting an almost pure cultivation. But further microscopical examination shows that they were confined to the more superi-
official layers of the epithelium covering the ocular conjunctiva, and to a slight extent penetrating into the disintegrated corneal stroma. In the vitreous of neither eye were any bacilli found although among
the pus cells causing the hypopyon in the anterior chamber numerous monocytes were to be seen, and they are probably to be regarded as an essential factor of this condition, as of others of a similar nature.

Before proceeding further with the discussion of this case I will here give an account of a third which is of very great interest as affording some definite evidence of the pathological value of the Torosíbacillus.

Adeline Holstein aged 16 was admitted on May 2nd, 1887 into the Augenklinik at Steidsberg. She was tall for her age and previous to the present attack had suffered with her eyes. For the last seven months she had complained of her left eye for the condition of which she could assign no cause. She has been treated with various remedies, but ineffectually.

On examination the eye presented the following appearance:—The lids were normal and there was no injection of either the conjunctival or pericorneal vessels. The whole cornea was superficially opaque, the opacity being more dense in the lower third, while
the upper two-thirds presented the appearance one is accustomed to see in phlyctenular keratitis.
The lower third was separated from the rest of the cornea by a sharply defined horizontal line. Covering this area was a layer of somewhat glistening white fatty looking deposit, which also extended outwards over the limbus slightly on to the conjunctiva. This surface on the cornea and conjunctiva was quite dry, not being covered with the lacrimal secretion, the tears rolling over it as over a fatty surface.
It was impossible to determine if she was also affected with hemeralopia in this eye, but it is not probable since in the other eye, which was quite normal, vision was perfect.
The microscopic examination of a scraping removed from the fatty looking surface shows that it consisted of an almost pure cultivation of the Xerococcus bacillus.
The treatment at first consisted in the repeated application of arsenic, but this produced no satisfactory result, the condition
remaining as before, and the bacilli still as abundant, which differs from the results obtained by Thalberg, but the case differs considerably from those reported by him.

It was fortuitous that a similar vessel, then in addition colonel was placed in, but as this also proved ineffective, the cutaneous surface was lightly scraped and afterwards painted with a one per cent solution, a proceeding which, it is worthy of notice, caused some pain and considerable lachrymation. This was repeated daily with the striking result that although the rough uneven condition of the corneal surface persisted, though to a less degree, the bacilli rapidly diminished in number in the scrapings daily removed till on the fourth day not one was observed, while here and there in the field a few micrococci were seen.

In spite of this the cutaneous condition still continued and after staying in the hospital for two months the patient was discharged, the state of the eye being practically unimproved.
The evidence of this case excludes the idea that the bacilli are the primary cause of the appearance presented by the conjunctiva, and it would seem that if their presence is in any way an element of the disease, it is that in this particular condition of the conjunctival surface they find a soil peculiarly well adapted for their growth; and it seems to me that it is in the highest degree probable that they aid in the production of the characteristic fatty surface, since when cultivated on serum they produce a similar fatty, glancing appearance on the surface. This contention appears to me to be supported by the experiments of Schlecht and of Freneh and Fränkel, although it is quite contrary to the results obtained by Debié and by Reissi; but those of the former cannot by any means be regarded as absolutely free from error since the culture used for experiment is acknowledged not to have been absolutely pure. Nor does it seem at all astonishing that when the conjunctival sac had been packed

6 23. p. 246
with masses of agar-agar together with bacilli and micrococci, and then tightly closed, the cornea should become opaque, or even ulcerated, and that some bacilli should have been found in the most superficial layers of the ulcerated surface. For to the experiments made by Hecquet and Prier offer much support to Leber's view, for while they failed to obtain any positive results with dogs and rabbits, on the human eye the bacillus is said to have produced merely a xerotic condition, and no ulceration even when disease already existed.

Both Sattler\(^7\) and Franke\(^2\) have demonstrated that the Bacillus oculis when transfused directly from the eye will grow only on serum and not on agar-agar or other nutrient material; a fact which throws serious doubt on the identity of the bacilli obtained by Leber from the secretions of the kidney, in his case. Schleicher\(^4\) failed to obtain any results from inoculating eyes with the bacilli; and Franke\(^1\) and Franke\(^2\) found that when pure cultures were introduced into the conjunctival sac or into the anterior chamber.

\(^7\) 44. p. 148  
\(^2\) 61. p. 178  
\(^3\) 23. p. 147  
\(^4\) 50. p. 149
a were injected into the veins and peritoneal cavity of rabbits, mice and guineapigs that no harmful results followed, or also when rubbed on the human conjunctiva, no were any xerotic products.

Another proof the innocence of the xerotic bacillus is afforded by a case of Kuehbi's: bosses in which the bacilli were present in both eyes but only one came was ulcerated, and in this eye only was another microorganism present. 2

And further thin bacillus is by no means found only when the conjunctiva presents a xerotic appearance. Sattler found it in the eyes of individual who had nothing the matter with them generally or locally. Schleir detected it under the same conditions, and also in cases of slight chronic conjunctivitis and in others even there was a hypersecretion of the Meibomian glands. And other observers have noticed it in a peculiar frothy exudate which collects between the lid in some forms of conjunctivitis. This bacillus presents microscopically the same appearance as that of the untroubled xerotic bacilli, and its identity may be regarded as established since when cultivated it pro:

1 2  3  4  5  6  7  8  9  10
it is acknowledged that it has no harmful
effect on serpiginous corneal affections, nor
does it disturb the healing of wounds in
glaucoma or cataract. So that one may
conclude that the Herpes bacilli do not
possess the destructive powers that have been
accrued to them, and that they take no
part in the production of the corneal
ulceration. This conclusion is in agreement
with the view held by Jenner, who regarded
the myxomatous infiltration as not being in the
least the cause of the disease. But he
thought that it had an influence in two
directions, namely that it led to a rapid
separation of the layers of the cornea, and
secondly that it acted as an irritant of
its greater importance probably than that
of a corona.²
Passing then from the local action of the
bacillus to its alleged effect on the
general constitution the evidence for this is found
to be very scanty, and is rest entirely upon
one case of Leber's³, whose facts by no
means sufficiently support his conclusions.
Bacilli similar in appearance have been

⁷ J. B. 194, 31, J. 196 ⁸ 16, p. 183 ³ 23
found in the lungs and in pleuritis effusion by Reckart, and by Schultze; and the latter found similar organisms in the epithelium lining the pelvis of the kidneys; but the former infrequency states in one of his cases that the kidneys were unaffected while in the other their condition is not mentioned. And in the report of the post mortem examination in Case 2, made by the same pathologist as Prof. Arnold, it is only mentioned that the mucous membrane of the pelvis of the kidney was opaque. Therefore one is compelled to say at present that there is not sufficient evidence to demonstrate any general action of the bacilli. This theory, then, having to be put on one side there remain several others to be considered. The suggestion made by von Gröf that this affection of the cornea is of neurosyphilitic origin and is to be regarded as a symptom of a form of encephalitis is hardly now regarded as tenable. Since the observations made by Fastovetz on the brains of infants, and particularly since the discussion on Janet's case before the
Medical Society of Berlin.

The idea that the necrosis of the cornea might be due to thrombosis of the vessels at the limbus is also negatived by the fact that there is no evidence of this occurrence during life, nor under the microscope subsequently. And further if such were the cause the ulcer should be seen extending round the periphery of the cornea, and not on that portion exposed between the lids.

So that one is compelled to regard the process as one of necrosis due to the depressed condition of vitality and nutrition of the patient, a view which is supported not only by the consideration of the conditions under which the disease occurs and by the greater number of authorities, but it is one also which agrees with the facts observed.

The conditions under which it most commonly occurs in those countries where it is more often seen have been vivisely described by Blessing, Thalberg, Tzanchev, Canna Lobo and de Gouveia. In Russia the greatest number of cases, and these are not confined to infants only, occur towards the end of the fests,
more especially of the great fast kept during March and April, and it is striking that these cases are limited to those who belong to the orthodox Greek Church, while the children of Jews and others do not suffer from it; nor do it occur in Finland where the fasts are not observed. And there is yet another point, that it occurs mostly in those towns where the poor are usually poorer than elsewhere and are unable to obtain a proper food supply; and it is to be noted that the disease is more observed in the East where, although the fast is rigorously kept, the supply of fish is poor and abun- 
dant.² In Brazil it occurs under similar conditions which are thus described by Gama Lobo:³ There are plantations on which the 
daily food of the slaves consists of bean 
mush cooked with water, and to this is 
added at most once or twice a week a small 
quantity of dried fish. This is the condition 
of things under the bitter owners. On this the 
slaves are compelled to rise to their arduous 
duties at 3 a.m., and to continue at work till 
e p.m. In addition to this one must take
into consideration the influence of their un:
: happy mental and social condition.
These remarks apply as well to cases of the
: conjunctivitis as to the corneal ulceration.
The latter also occurs as a result of diseases
: causing great exhaustion, such as marco:
: mus., intestinal catarrh, summer cholera,
: dysentery, pneumonia, purulent peri.
: cavititis, carbuncles, syphilis, scarlet fever,
: measles, typhus, cholera, small pox and
: purpuric fever, and it is unquestionably
: identical in these cases with sloughing of
: other tissues occurring under similar conditions,
: such as one sees on the vulva occasionally
: after measles, or prominent bums in rickets,
: and in cachexia. And the reaction,
: manifested by keratitis, iritis, and cyclitis,
: which sets in when recovery begins to take
: place, suggests a comparison with the
: third stage of cholera.
But I am convinced that the loss of
: fluid from the general system and the
: surroundings of the patient have a most
: important bearing upon the production
: of this disease, for I have had many
opportunities of watching children, very frequently of strumous constitution, much debilitated by purely surgical disease, by marasmus, and by acute diseases, such as pneumonia, who slept with the eyelids apart. But they were well supplied with suitable nourishment and with stimulants and in none of them have I detected any signs of keratitis or of corneal ulceration. During the past six months I have only seen one case of the latter disease at this hospital. This was a neglected child of 3, who had been suffering from hip joint disease for 12 years. On admission the right eye was observed to be closed: on examining it a small yellowish-white spot was seen a little below and internal to the centre of the cornea, but there was no injection of the conjunctival or perilimbal vessels, nor was there any keratitis. Next day a small ulcer superficial ulcer has formed which healed very slowly under the influence of atropine and the constant application of moist warmth, combined with a generous diet in which was included two ounces of port wine daily. There has been no diarrhea, nor any history of the child.
being apart during sleep, but the mother was an unobservant woman.

Similar views were held by Storrie, who says: "if one watch such a miserable woe-like child in its sleep, one sees that the lids are not closed but are distinctly separated leaving exposed in really deep sleep the lower half of the cornea sometimes more peripherally, sometimes more centrally, the last being more frequent; so that this portion of the cornea and the triangular space of conjunctiva on each side of it are exposed to the air and to external factors." (To this statement Léber objects saying that the eyelids are always closed, but as Thalberg remarks they are at first open but when the ocular conjunctiva becomes dry and xerotic the irritation caused is so great that the child now keeps them constantly shut.) "This condition," continues Storrie, "being associ-ated with a simultaneous loss of water from the general system due to protracted disease, or incapacity to take nourishment, a superficial keratitis occurs, a drying and cracking of the epithelium, and a splitting of its layers becomes easily perceptible. There
can be no doubt that the simultaneous loss of water plays a most important part in the production of this disease."

Hirschberg describes the condition in words almost identical with those just quoted. He found that he hardly ever saw cases of this nature in better class private practice, and he further remarks that it is noteworthy that its outbreak is in summer at a time when the rate of mortality is accustomed to be immensely increased by cases of vomiting and diarrhea occurring in children; an explanation of its apparently epidemic nature more natural and more consonant with facts than to ascribe it to parasitic influence."

And one is irresistibly reminded of Magendie's experiments on dogs, which he fed on sugar and distilled water only, one of the results being central perforating ulcers of the cornea. Schaden's cases cannot be quoted in this connection for they have, I think, but a very slight relation to the subject in question.

The clinical history and the anatomical condition of the cases described are also in accordance with this view, in particular those presented by the cornea when the necrotic process is seen to be bounded by time indicating the extent to which the tissues were already affected at the time of death. And this is
divided into two portions, a central where the process has begun, where the tissue is disintegrated and no longer possesses a definite structure, and a surrounding part which was probably already dead but not yet disorganised; while beyond this is tissue exhibiting in common with the iris slight signs of reaction in the presence of the necrosed tissue.

Attention might here be drawn to the keeping up of leucocytes in the neighbourhood of the canal of Schlemm, bearing out the view that hypopyon is produced, in the absence of irritio by exudation and immigration of leucocytes from the small deeply situated ciliary veins (cantump). 7

That a parasitic origin is improbable is supported by the almost total absence of bacilli among the necrosed tissue, although they existed in such quantities on the surface and from the results of experiments already quoted.

But the process is probably brought about by a great diminution of the flow of the lymph stream through the canal tissue, that a slight external agency is capable of upset.
ring the balance, and causing death and disintegration of the tissue. With this the other symptoms observed in this and similar cases agree; namely the low temperature in spirit of the serious changes that are taking place, the absence of almost all signs of inflammation and irritation, and the presence of sores of undoubtedly necrotic origin on other parts of the body.

The condition of the brain is merely a sequence of the severe disturbance of nutrition, seen best in children prematurely born but also in others who have suffered severely from the scarlatina or from cinchoba. And consequently the encephalitis is to be regarded only as a coordinate symptom of the disease. And it is conceivable that the hemorrhage between the Dura mater and the bone, referred to, may have occurred during the administration of chloroform.

From these considerations I believe that the following conclusions may be drawn; namely that the kerotic process is primarily a local affection of the cornea, which in its altered condition affords a peculiarly
favorable. For the so-called Hirsch bacilli, and that while they help to produce the characteristic appearance they have no
no saline local or general influence. But
that the origin of the corneal ulceration
is to be found in the lowered condition
of vitality due to defective or improper
nourishment, often associated with diarreha
and vomiting; or to either of these alone;
or to other serious diseases causing distress:
absence of the general trophic functions.
And that this condition almost always be:
minated fatally in infants, while wounds
in older children and adults are much
more frequent.
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