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# MANAGEMENT OF SEVERE CORNEOSCLERAL LACERATIONS

OSKRBA HUDIH KORNEO-SKLERALNIH POŠKODB

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**Key words:** *cornea; sclera; traumatology; penetrating injuries; wound repair*

**Abstract** – Background. *Ocular injuries, such as caused by windscreen glass particles or metallic foreign bodies, are very common. In most cases, the corneal laceration is found to be horizontal, and very often it crosses the limbus. Thereby, different tissues of the eyeball are involved simultaneously, e.g. iris root, sclera, outer muscles, trabecular meshwork, ciliary body, pars plana, lens, vitreous etc. For reconstruction and repair, a strong order of procedures is important. After exclusion or location of intraocular foreign bodies by x-ray or ultrasonic methods, the first aim has to be the stabilisation of the globe. First step should be a limbus reconstructing suture, to be followed by Tenon tent, Flieringa ring, scleral exploration (until the very end of the laceration is found, even by muscle surgery), and prefixing of a scleral buckle and/or cerclage if necessary. Not before all these tasks have been fulfilled, the anterior chamber should be entered, and repair of the lens, iris and cornea can be started. The globe being now stabilised in his whole entity, sometimes a primary vitrectomy can be necessary, and also this is the best point of time for the removal of an intraocular foreign body. Post-op treatment should be on in-patient base.*

## Background

Ocular injuries with penetrating corneal lacerations crossing the limbus are very common. They need special treatment that differs widely from a mere suturing and local wound repair. Thus, certain rules of the reconstruction have been improved, and shall be given in this paper.

## Questions and clinical evidence

Why are limbus crossing lacerations so dangerous?

We know that they can lead to hypotony on the one side or glaucoma on the other one. They can also cause a severe vascularization of the cornea, or retinal detachment, and may even lead to the loss of the entire eye. Moreover, even also the other eye might be lost later, by sympathetic ophthalmia.

Why is the danger so dramatically increasing if not only the cornea is lacerated, but the laceration crosses the limbus?

This depends on the fact that suddenly in only some millimetres space a number of important tissues of the eye are invol-

**Gljučne besede:** *roženica; beločnica; travmatologija; penetrantne poškodbe; oskrba ran*

**Izvleček** – Izhodišča. *Očesne poškodbe, kot npr. povzročene z drobci vetrobranskega stekla ali s kovinskimi tujki, so zelo pogoste. V večini primerov so poškodbe horizontalne in zelo pogosto prečkajo limbus. Pri tem je lahko naenkrat poškodovanih več očesnih tkiv, npr. baza šarenice, beločnica, zunanje očesne mišice, trabekulum, ciliarnik, pars plana, leča, steklovina ipd. Pri rekonstrukciji je potreben natančen vrstni red. Po potrditvi in lokalizaciji tujka v očesu z radiološkimi ali ultrazvočnimi metodami je prvi cilj rekonstrukcije stabilizacija očesa. Prvi korak pri tem je šiv, ki rekonstruira limbus, nato pa sledi »šotor« Tenonove ovojnice, Flieringa obroč, eksploracija in pregled tesnosti beločnice in prednastavitev skleralne plombe in/ali serklaže, če je le-ta potrebna. V sprednji prekat naj ne bi vstopili, dokler ne izpolnimo teh pogojev, ki omogočajo začetek rekonstrukcije drugih delov očesa, kot so leča, šarenica in roženica. V očesu, ki je tako stabilizirano, je včasih potrebna tudi primarna vitrektomija, ob kateri je možno na najboljši način odstraniti intraokularni tujek. Pooperativno zdravljenje je potrebno izvajati v bolnišnici.*

ved at one time. Not only the cornea and the conjunctiva, but also the sclera, the trabeculum, Tenon's capsule, the ciliary body, the choroid, the vitreous base, the retina, and very often even an external muscle.

These conditions cause a great challenge to the surgeon, from the very beginning. He has to decide in which order the single steps of repair have to be applied to the injured eye.

The priorities seem to be obvious: the eye is severely damaged (Fig. 1a and 1b). That means:

- It needs corneal suture!
- It needs also a cleavage of anterior chamber!
- Could one save the prolapsed iris and begin with that?
- Is there any foreign body to be extracted first?
- Should one coagulate the bleedings?
- Or perform a primary vitrectomy?
- Should one first admit a cerclage to save the most important part of the eye, the retina?

Again – what to begin with? The answer is given by the eye itself according to its anatomy.



Fig. 1a and 1b. Typical aspect of a limbus crossing laceration (real and schematic). Note the approximately horizontal wound, prolaps of the iris, deformed pupil, and hyphema. Underneath the scleral part, we must assume that also the ciliary body, retina and vitreous body is involved.

Sl. 1a in 1b. Značilno stanje ob raztrganini očesa, ki prečka limbus (resnična in shematska slika). Vidna je horizontalna rana, prolaps šarenice, razokrožena zenica in krvavitev v sprednji prekat. Pri taki poškodbi moramo pomisliti, da so lahko prizadeti tudi ciliarnik, steklovina in mrežnica.



Fig. 2. Varying thickness of the eye wall in the limbus region (see oblique frame). This configuration is stiffening the form though the material itself is rather weak. This advantage is used technically in numerous constructions (see Figs. 3–6). From Eisner (1), slightly modified.

Sl. 2. Variacija debeline stene očesa v predelu limbusa (glej poševni okvir). Taka struktura omogoča čvrstost, čeprav je tkivo relativno šibko. To prednost se tehnično uporablja v številnih konstrukcijah. Rahlo modificirano po Eisnerju (1).

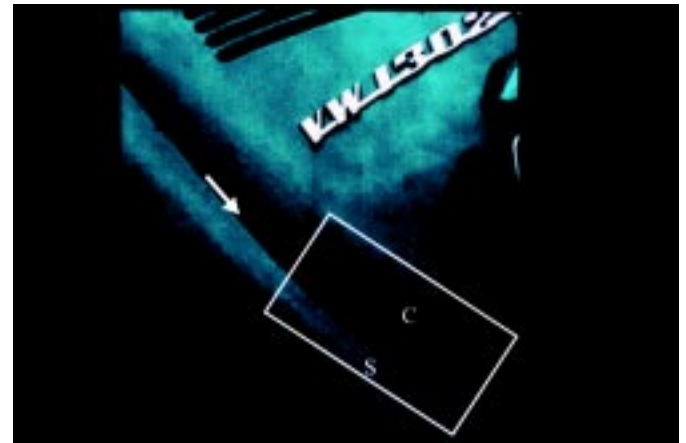


Fig. 3. »Limbus like region« in car building: rear of a VW beetle (arrow = »limbus«, S = sclera, C = cornea, compare frames with that in Fig. 2). What seems only to be a question of designers proves as an important contribution to stability.

Sl. 3. Primer »limbusa« npr. pri gradnji avtomobilov: zadek VW hrošča (puščica = limbus, S = sklera, C = kornea, primerjajte okvirje s tistim v sl. 2. Kar izgleda le poseg oblikovalca, ima pomemben smisel v stabilnosti in čvrstosti.

## The architecture of the limbus region

In a schematic drawing, taken from Eisner's famous book (1), one can easily recognise that the wall of the eyeball is of different thickness at different locations (Fig. 2). The limbus area is characterised by the fact that both cornea and sclera are thickening before they meet. Moreover, both structures meet with two differently curved shapes. Thus, they are forming a figure that is very well known e. g. in architecture, car building and furniture designing. There, it is used in order to guarantee a stable form even in thin and – seen alone – rather weak materials.

If one looks around, one will see hundreds of artificial »limbus« of that kind in our surroundings (Fig. 3).

If elements of this configuration are hit by a blunt trauma, they never develop a »limbus crossing laceration«. The defect is

always running »limbus parallel«, like we are used to observe it in blunt eye injuries (Fig. 4). This shows that this special »anatomic« form is crucial for the mechanical stability of the concerned artificial structures, and for the eyeball, too. Therefore, in case of limbus crossing lacerations we are able to gain an early re-stabilisation of the injured globe, if we begin with the reconstruction of its limbus.

Thus, we have to conclude that *any limbus crossing laceration needs limbus securing management*.

## The initial method of repair: 3 steps of stabilisation

In most cases, three different techniques should be applied: Flieringa's ring, Tenon tent, and limbus securing suture. They



Fig. 4. In plastic chairs (as very common in Denmark) the configuration of the legs and their connection with the seat are formed after the stabilising »limbus« principle. Blunt traumas never lead to a »limbus crossing laceration«, but – comparable to blunt ocular traumas – to »limbus parallel« cracks. This documents the high stability of this form in respect to the 90 degree crossing direction (arrow = »limbus«, S = sclera, C = cornea).

Sl. 4. Plastični stoli, kakršni so zelo pogosti na Danskem, imajo konfiguracijo nog in njihovo povezavo s sedalom urejeno na principu stabilizacije, podobno kot je zgrajen limbus. Tope poškodbe skoraj nikdar ne povzročijo limbus-prečkajoče rane, ampak vodijo običajno do limbus-paralelnih ruptur. To dokazuje visoko stabilnost te oblike.

may be combined, but have to be used in a strong temporal order. I may first give an overview:

1) The metal support ring of Flieringa can be helpful, as also well known from the keratoplasty operation, to stabilise the globe as an entity (2). Unfortunately, it is insufficient to stabilise the limbus itself, especially when a wound is crossing the limbus twice (which is not a rare finding).

2) Tenon's tent appears to be not more than a microsurgical trick. (To my knowledge, it was invented by the author.)

The procedure: After a careful preparation of the whole (not injured) conjunctiva of at least the upper two quadrants, and exactly at its border to the corneal epithelium, the Tenon capsule can be identified separately and dissected at its margin. Both tissue sheets are then grasped together, lifted, bound backwards over the lid margin with the inner side up, and fixed with the aid of some silk sutures, approximately to the region of the eye brow. Further on, it must be carefully covered with some viscoelastic material throughout the whole operation in order to prevent desiccation of this sensitive structure.

By this means, the entire globe is lifted up a little bit, like sitting on a strengthened fisherman's net. All tractions (as resulting e. g. from ocular muscle actions or from the surgical management itself) are now transmitted to Tenon's capsule and the entire connective tissue system of the orbit. Thus, any wound loses its tendency to open wider throughout and by surgery. The procedure is easy, quick, and extremely useful.

3) The limbus-securing suture is the most important, and earliest step of the management (see Fig. 5).

Exactly where the laceration crosses the limbus, both edges of the conjunctiva are identified. Then, the conjunctiva is removed carefully from the underlying sclera always being aware that the corneoscleral wound should not be opened wider by this procedure. For this purpose, the conjunctiva is also dissected from the limbus on either side for about 2 - 3 mm length. In a ca. 0.5 mm distance from the corneoscleral transition, a suture with 9 × 0 Nylon (or, less recommended, 8 × 0 Vicryl) is



Fig. 5. In limbus securing management, the limbus securing suture should be made first in order to adjust the wound in this very place with the highest precision. Further stabilisation may be achieved by the fixation of a Flieringa ring and/or constructing a Tenon tent (see text).

Sl. 5. Pri zavarovanju limbusa mora biti šiv, ki stabilizira limbus, napravljen najprej, da s tem naravna rano na tem mestu s kar največjo natančnostjo. Nadaljnji koraki stabilizacije se lahko dosežejo s fiksacijo Flieringa obročka in/ali s konstrukcijo Tenonovega šotora (glej tekst).

placed. It has to run exactly tangentially to the curvature of the limbus, and must also be equal on both sides in depth and distances from the wound margin. If there is any prolapsed intraocular tissue in the wound gap, this should be redressed gently with a spatula while forming the knot and drawing the suture together. Sufficiently performed, the suture reconstructs the limbus shape so exactly now that one can recognise neither any transposition of the wound margins nor any discontinuity. The whole limbus line around the eye looks as if no laceration had taken place. As mentioned above, this is not a mere cosmetic result but improves to stabilise the entire globe.

The correct order of these 3 steps should not follow the above description, but the other way round. The first step must be the limbus-securing suture, followed by completing the conjunctival and Tenon preparation, the adjustment and fixation of a Flieringa ring, and at last the construction of the Tenon tent.

Now, all necessary and useful steps can follow (also in a strong order; see Fig. 5 and 6):

- Coagulation of episcleral bleedings.
- Suturing of the continuing scleral wound, sometimes requiring muscle surgery when running far centrally.
- Cleavage and reformation of the anterior chamber, regularly using viscoelastics.
- Removal of long lasting extraocular iris tissue.
- Re-fixation of a disrupted iris root.
- Reformation of the pupil.
- Suturing of the corneal part of the wound.
- Lens removal / repair with fibrinogen glue / IOL implantation.
- Primary vitrectomy (in rare cases). Extraction of a foreign body.
- Retinal detachment preventing surgery if the wound exceeds 3 mm of limbus distance (coagulation, cerclage).

At last, both corners of the preformed triangular flaps of the conjunctiva are used to generate a Z-plastic, in order to cover the sutured deep (scleral) wound by a superficial (conjunctival) layer with minimal contact between each other (to prevent immobilisation by scarring).



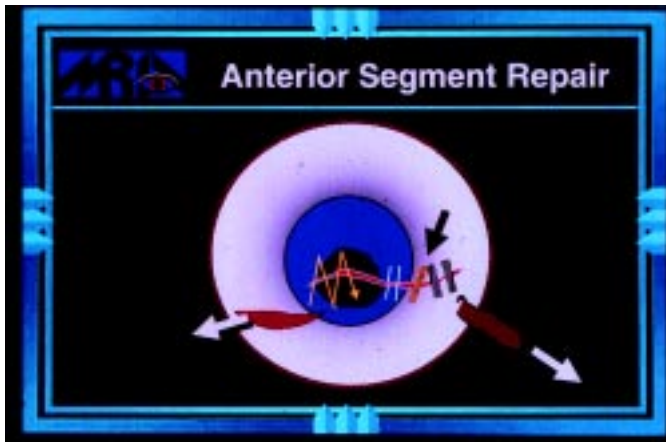


Fig. 6. Anterior segment repair is most secure, effective and precise, if its necessary steps obey to a strict order: the limbus securing suture (arrow) is followed by removal of damaged iris tissue, scleral adaptation sutures, cleavage of the anterior chamber, reconstruction of the pupil, and at last (!) by the corneal closure (single stitches with buried knots or running suture).

Sl. 6. Rekonstrukcija sprednjega segmenta je najvarnejša, učinkovita in natančna, če se spoštuje naslednji vrstni red: šivu, ki rekonstruira limbus (puščica), sledi odstranitev poškodovane tkiva šarenice, skleralni adaptacijski šivi, sprostitvev sprednjega prekata, rekonstrukcija zenice in na koncu zapiranje roženične rane (s posameznimi šivi z zakopanimi vozli ali s tekočim šivom).

## Discussion

Doubtless, the exact reformation of the limbus is of great importance for the further fate of the injured eye.

### 1) Traumatic limbus deficiency

In my fathers slide collection (3), gathered some 40 years ago in his private praxis, I found some typical examples. At that time, where ophthalmologic microscopes were used in a few centres only, and neither nylon sutures, nor vitrectoms, neither ophthalmic lasers nor viscoelastics had been invented, the outcome of corneoscleral lacerations where often rather poor. Lacking an exact limbus restoration, these eyes developed high astigmatism, distorted and uncentered pupil, and the upper edge of the former scleral wound was resorbed irreversibly. An example may be seen in Fig. 7 where an accidental filtering bleb has formed on the site of posttraumatic limbus deficiency: the eye suffers from chronic hypotony, and may be lost by phthisis.

### 2) Limbus securing suture

Why should a procedure that simple, consisting in a single stitch only, prevent those terrible dangers we have listed above? The answer is easy, like the management itself: it stabilises the entire globe.

From this reason, one can hardly understand why the method is not described anywhere before, even not in the giant work of Mackensen (one of the fathers of ocular microsurgery) and Neubauer (the famous ocular traumatologist) (4).

An only slightly similar procedure is shown in a schematic drawing by Foster and Mark (2), but there the conjunctiva is not removed, the suture probably too far apart from the limbus, and made of a too thin nylon material. Nevertheless, the authors recommend their suture also as a first step, thus demonstrating that they got the same clinical experience (though at least not mentioning the anatomical cause for their management).

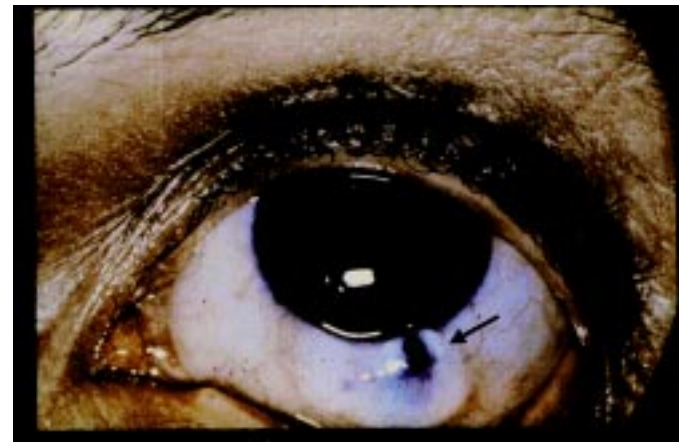


Fig. 7. Posttraumatic limbus deficiency: an accidental filtering bleb has formed, the eye suffers from chronic hypotony, and may be lost by phthisis.

Sl. 7. Potravmatska fistula v predelu limbusa. Zaradi nezadostne rekonstrukcije limbusa se je razvila nezaželjena filtracijska blazinica in zaradi kronične hipotonije očesu grozi ftiza.

In contrary, in Eisner's famous book (1) we find a scheme that is obviously wrong. If one sutures a limbus crossing laceration only by corneal single stitches, and meets with the last, proximal one, also the scleral part – obviously rather by chance –, one will never get an eye with low posttraumatic astigmatism. Also, the globe will remain unstable (if the suture is too thin). Or the cornea will be entered by vessels due to hypoxia, if the whole globe reforming power has to be made up by a too strengthening suture. Deposited in the cornea only, a rather thick (e. g. 9 × 0 Nylon) suture would be necessary which has also another disadvantage: It cannot be overgrown by the corneal epithelium (whereas the limbus securing suture is buried totally underneath the conjunctiva), the knot can hardly be buried, and the whole suture has to be strengthened so much that it causes hypoxia in the captured corneal tissue, followed by deep vascular ingrowth.

### 3) Priorities

What has to be done first? What to begin with in case of a severe accident? This initial question can now be answered easily as seen from the ophthalmological point of view: The very first task consists in the stabilisation of the globe.

## Conclusions

More than 30 years of clinical experience in the management of penetrating injuries give rise to the understanding that an eye with a limbus crossing corneoscleral laceration should be treated initially in a 3 step procedure: limbus securing suture, Tenon tent, Flieringa ring. Thereby, one reaches an early stabilisation of the entire globe. This is the only certain condition for the success of all the necessary following steps of eye repair management.

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