

Visualization Issues in Ocular Trauma Surgery

BY FERENC KUHN, MD

Open globe trauma remains a major preventable source of blindness throughout the world. Once the injury occurs, it is up to the individual surgeon to ensure that the case ends up with the best possible outcome. There are several aspects essential to ensure a successful surgical intervention in ocular trauma, and each of these topics deserves a discussion of its own. This article reviews the most important points regarding how these injuries can be better managed to obtain superior surgical results.

PREPARATION AND PREOPERATIVE CONSIDERATIONS

To provide optimal care for patients with ocular trauma, a facility must be properly prepared to handle any kind of injury at any time of day, any day of the week. This is unfortunately becoming an increasingly difficult proposition in the developed world. The necessary items include a properly equipped microscope, appropriate instrumentation and operating systems, and readily available adjuncts (eg, silicone oil). Not least important is well-trained personnel to assist in surgery.

The surgeon must have undergone specific training in ocular traumatology. This, sadly, is another issue of major concern. Currently even a simple maneuver, such as suturing a corneal wound, often poses a major difficulty for young residents, who are increasingly responsible for treating patients after “normal-business-hours.” The difficulty is due to a lack of training, which is why the International Society of Ocular Trauma (ISOT) and the American Society of Ocular Trauma (ASOT) have been fighting to make trauma training part of the residency curriculum worldwide.

The surgeon must properly evaluate the injured person. A meaningful history should be taken, with a concentration on facts that are relevant to the injury.

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A brief physical examination should then be undertaken to determine whether any systemic injuries have been sustained. Finally, it must be established whether the eye injury is open-globe. If it is, the examination should be limited to answering the major questions such as the risk (or presence) of endophthalmitis; whether the posterior segment is involved; or whether an intraocular foreign body (IOFB) is present. Fine details of the injury, such as the exact location of the scleral wound or its length, are left to be determined during surgery to avoid the risk of an expulsive choroidal hemorrhage during the examination, *horribile dictu*, caused by the forceful opening of the lids.

The ophthalmologist must then design his surgical plan regarding timing and staging of the treatment, including how soon the wound should be closed (as a general rule, the sooner the better) and whether any additional procedures (from hyphema removal to complete pars plana vitrectomy) should be performed during the primary surgery or later (and the timing of subsequent procedures).

Based on the needs of the injured eye (and person), the ophthalmologist must then make a self-evaluation: Is he able to actually perform the treatment that is now considered ideal for the case, rather than performing a procedure that he is most familiar with? A worst-case

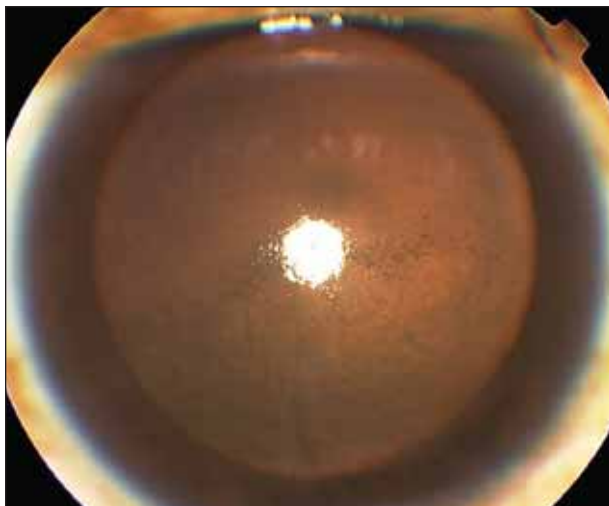


Figure 1. Severe stromal edema.

scenario of a surgeon's failure to self-evaluate: This author recently was made aware of a case in which a patient with an intravitreal IOFB and early endophthalmitis was referred to a cataract surgeon. According to this cataract surgeon's own notes, he irrigated the anterior chamber (AC) through a 2.75-mm limbal incision and then used a cannula to inject vancomycin into the "vitreous" (the eye was phakic). No vitrectomy or IOFB extraction was performed. The end result was that the eye had to be eviscerated the next day. The bottom line is that if the attending ophthalmologist is not able to perform the procedure that is the best for the eye, the patient must be referred to the closest facility where all the elements of successful treatment are available.

THE SURGICAL PROCEDURE: VISIBILITY IS CRUCIAL

The initial requirement in surgery is to understand that a methodical antero-posterior approach is necessary. No step should be skipped because this often results in a suboptimal outcome. The following constitute the important steps in surgery.

Cornea. If the wound is corneal, it should be closed with sutures that are of full thickness (100% deep: the thread lies inside the anterior chamber). Such a suture instantly and permanently closes the "door" to aqueous access into the stroma. With the traditional two-thirds or 90%-deep suture, the wound is still be open posteriorly for a while, and the resulting corneal edema prevents the surgeon from performing vitrectomy when it's ideal (immediate or early).

The corneal epithelium is often edematous in the early postinjury period. Although the use of a wide-angle viewing system such as the Binocular Indirect



Figure 2. Blood-stained cornea: the intracameral blood actually penetrated the stroma.

Ophthalmo-Microscope (BIOM; Oculus GmbH, Wetzlar, Germany; see below) can overcome some of the haziness caused by the edema, it is much preferable to scrape the epithelium. The only exception is in a patient with diabetes or a history of recurrent erosion.

If there is severe corneal stromal edema (Figure 1), a piece of cotton saturated with 40% glucose can be placed on the cornea; this sometimes is able to substantially reduce the water content of the cornea.

If the cornea is blood-stained (imbibition is better term: the intracameral blood actually penetrates the stroma, not just stains the endothelial surface; Figure 2), the surgeon has only unfavorable choices.

- The surgeon can delay surgery until the blood spontaneously clears, which is an unacceptable option because this can take many months.
- The surgeon can perform limited surgery on the deeper structures to the extent visibility through the compromised cornea allows; however, this approach is limited and so is also a suboptimal option.
- The surgeon can use an endoscope to perform vitrectomy. The limitations of this option are many, including lack of stereopsis, loss of orientation, and loss of view in case of a fresh hemorrhage. Only surgeons who are very experienced in endoscopy may be able to make good use of endoscopy as an early option. (For further details, see: Boscher C, Kuhn F. Endoscopy. In: Kuhn, F, ed. *Ocular Traumatology*. Berlin: Springer; 2008:473-484.)
- A final option is to use a temporary keratoprosthesis, which provides a clear, unhindered view throughout surgery; however, this requires corneal transplantation, with its own implications regarding postoperative care. Because the donor cornea survives in more than 90% the cases, this seems the best of the options listed here,

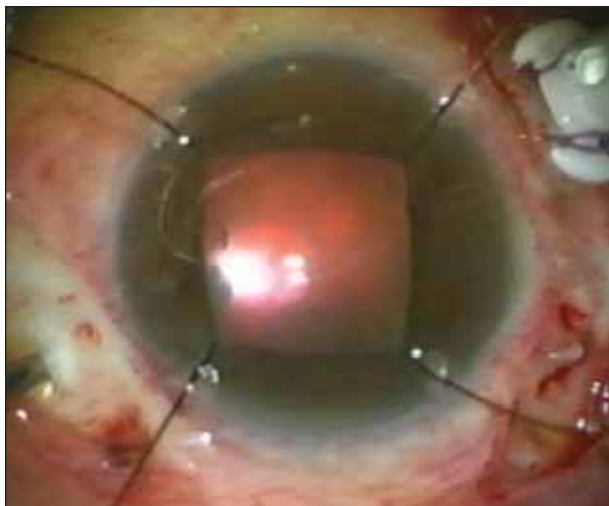


Figure 3. Iris retractors used on an inadequately dilated pupil.

but obviously makes the surgery much more complex. The best option therefore is to prevent corneal blood imbibition by strict control of the intraocular pressure (IOP) and early evacuation of the blood as necessary.

Hyphema. In most cases, the blood spontaneously absorbs without additional sequelae. If the IOP is elevated, however, observation is a poor choice; even a small amount of pressure elevation can in a short period of time lead to corneal blood imbibition (see above).

Removal of the hyphema is always recommended when surgery for deeper pathologies is performed. In addition to improving visualization (more than half of eyes with injury-related hyphema have posterior segment pathologies, according to ASOT), it also prevents late complications such as glaucoma and synechia-formation. There are several techniques for the removal of the blood; what is common in all is the need for an infusion, typically an AC maintainer.

- **Monomanual.** In this approach, the surgeon creates a paracentesis and then irrigates the AC with a cannula-equipped syringe, typically 5 mL. The lower lip of the wound is pressed down so as to provide room for the evacuation of the bloody fluid. Alternatively, an aspiration-and-irrigation device can be used.

- **Bimanual:** Two paracenteses are created, one for irrigation and one for fluid exit.

These options are equally applicable if the blood is not yet clotted. A clot, however, requires the careful use of the vitrectomy probe. The probe's port must be in constant contact with the blood during aspiration to avoid collapse of the AC; this procedure is best done by an experienced posterior segment surgeon.

Pupil. An inadequately dilated pupil not only restricts



Figure 4. Perfluorocarbon-silicone oil exchange.

the view of the retina, but it may also interfere with imaging the retina, especially at higher magnification. Although by using BIOM the surgeon is able to overcome some of the problems associated with the anterior segment abnormalities listed here, it is preferred to use intracameral epinephrine or iris retractors (Figure 3).

Lens. If a lens opacity is real (preoperative determination of whether a traumatic cataract is present can be difficult) and it interferes with the visualization of the retina, it is best to remove the lens. Caveat: A surgeon should not simply apply his or her favorite technique (typically phacoemulsification) of removing an elective cataract for the removal of a traumatic one. The instrumentation and technique must be adapted to the requirements of the individual case. (For further information, see: Kuhn F, Mester V. Lens. In: Kuhn, F, ed. *Ocular Traumatology*. Berlin: Springer; 2008:245-268.)

VISUALIZATION WITH THE BIOM

The BIOM is a wide-angle viewing system that provides excellent, high-resolution imaging of the vitreous and retina for the surgeon. Although there are other panoramic viewing systems with their own distinctive features, the BIOM is the most widely used because of the following:

- it is non-contact, which is particularly useful in trauma surgery because it inflicts no (additional) damage on the corneal epithelium or a freshly sutured wound;
- it is not bulky, providing unhindered physical access to the eyeball, which is important for instance when scleral depression is necessary;
- it is fixed to the microscope so that no assistant is needed to hold it and continually monitor its position during surgery;

- it provides a decent view even when media opacity (anywhere from the cornea up to the vitreous) is present and/or the pupil is small;
- the availability of different lenses allows the surgeon to choose the viewing field, from a small area such as the macula with a high-resolution image, to a wide field (up to 120°), or to combine high central resolution with a relatively large field;
- it provides excellent depth perception;
- it provides an excellent view during all possible exchanges during vitreoretinal surgery including fluid-air, air-silicone oil, fluid-perfluorocarbon, and perfluorocarbon-silicone oil (Figure 4); and
- the learning curve is short.

However, surgeons must also understand the limitations of wide-angle viewing systems such as the BIOM. First, it is not intended to be used for viewing tissues in front of the vitreous. Even when vitrectomy is performed immediately behind the clear crystalline lens, it is better to use the microscope without the BIOM so that the risk of bumping the lens is reduced. Second, for fine macular work, such as removal of an unstained internal limiting membrane, a contact lens is preferred for its higher resolution.

SUMMARY

Surgery on a traumatized eye remains a challenge. Good visualization of all structures, but especially that of the retina, is crucial to success. The surgeon must follow a consciously designed plan to optimize the intra-operative view, and proceed in a methodical antero-posterior fashion, making the most of the advantages optimized visualization offers in vitreoretinal surgery. Such a methodical approach allows the surgeon to limit the damage beyond that which has occurred at the time of injury. ■

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