Endoscope-assisted pars plana vitrectomy in severe ocular trauma

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ABSTRACT
Purpose To report the results of pars plana vitrectomy (PPV) assisted by ophthalmic endoscope (OE) in severe ocular trauma cases which are unsuitable for PPV using conventional viewing systems. Since Kuwait does not have any significant cornea banking facility, donor corneas are not readily available for PKP, hence, TKP could not be used. Another inclusion criterion was to include eyes which presented with post-traumatic endophthalmitis, where anterior segment fibrin/corneal haziness prevented adequate view for pars plana core vitrectomy. An endoscope was used in the above mentioned situations to provide a view of the posterior segment of the eye to perform pars plana vitrectomy (PPV). Main outcome measured was anatomic status of the retina, secondary outcomes measured were: functional status regarding vision, intraocular pressure and control of inflammation in cases of endophthalmitis.

Results Fifty trauma cases were included in the study. Out of these, 43 eyes had open globe injuries (32 eyes without intraocular foreign body (IOFB), and 11 eyes with retained IOFB), and seven eyes had post-traumatic endophthalmitis. In the open globe injury group, 36 (83.7%) eyes reported improvement in vision. In endophthalmitis group, five eyes showed improvement in vision.

Conclusions OE provided a clear view to conduct PPV in select trauma cases where delay in surgery due to hazy media or due to non-availability of donor cornea for simultaneous penetrating keratoplasty can lead to severe proliferative vitreoretinopathy changes.

INTRODUCTION
Ocular trauma is a major cause of visual morbidity and is the foremost reason of unilateral blindness. The pathophysiology of closed and open globe injuries result in vitreoretinal complications that often necessitates surgical intervention. Large traumatic perforations with iris, lens and vitreous loss along with haemorrhage and retinal or choroidal detachment set the stage for proliferative vitreoretinopathy (PVR). If not operated early, PVR may lead to complicated or inoperable pathologies.

In the immediate period after the injury, the rapidity with which treatment is instituted may have an important effect on the final result. However, if severe trauma results in corneal opacification, disorganised anterior segment, small pupil, hyphema, opacified or contracted anterior and posterior capsule, the view from conventional viewing systems (eg, operating microscope, wide-angle viewing systems) may not allow early vitreoretinal surgery. In cases with dense corneal opacification for vitreoretinal intervention, alternative means of visualising the posterior segment of the eye is needed—for example, temporary keratoprosthesis (TKP) and ophthalmic endoscope (OE). Using TKP might solve the visibility problems, but it raises many intraoperative complications and surgical limitations, including a need for penetrating keratoplasty (PKP) at the end of the vitreoretinal surgery. Although the first reported use of an endoscope in the human eye was in a case of ocular trauma to remove intraocular foreign body (IOFB), not much has been reported regarding use of an endoscope in severe trauma cases. We have been using an ocular endoscope in our institute for the last 7 years, and have published our experience with ocular endoscope-assisted surgeries for both anterior segment as well as posterior segment interventions. In the present study, we report the use of an endoscope in severe trauma cases where vitreoretinal surgical intervention was not possible through conventional viewing systems.

MATERIAL AND METHODS
This was a prospective, non-comparative, interventional case series consisting of 50 consecutive trauma cases. All the patients were explained the procedure in detail and an informed consent was taken from them. This study was approved by the institutional review board and the Kuwait Ophthalmic Council. The main inclusion criteria was severe ocular trauma which caused posterior segment pathology (either retinal detachment or IOFB), but the damage to the cornea/anterior segment did not allow use of conventional viewing systems, like operating microscope and wide-angle viewing systems. Since Kuwait does not have any significant cornea banking facility, donor corneas are not readily available for PKP, hence, TKP could not be used. Another inclusion criterion was to include eyes which presented with post-traumatic endophthalmitis, where anterior segment fibrin/corneal haziness prevented adequate view for pars plana core vitrectomy. An endoscope was used in the above mentioned situations to provide a view of the posterior segment of the eye to perform pars plana vitrectomy (PPV). Main outcome measured was anatomic status of the retina, secondary outcomes measured were: functional status regarding vision, intraocular pressure and control of inflammation in cases of endophthalmitis.

The endoscopic system used was E-4 Microprobe (Endo-Optiks Inc, Little Silver, New Jersey, USA). This E-4 endoscopic system can be used with both a fibre-optic endoscope as well as a gradient-index-lens endoscope. We used a fused fibre-optic type of endoscope. The advantages of fused fibre-optic technology is that it is more flexible, has a larger field of view, and the working distance between fused fibre-optic endoscope and the retina is more, hence, easier to work and with less chance of complications, like inadvertent retinal damage. It is a 0.85 mm/20 G probe. The compact endoscopy cabinet houses a 175-W xenon light source and a 10 k-pixel charge-coupled device.
(CCD) camera. This compact unit also creates the opportunity to simultaneously image and to do endolaser. A high-resolution monitor (Sony PVM-14M2MDU) is placed near the surgeon for video display.

The decision to use an endoscope was taken based on pre-operative clinical picture and slit lamp examination. The operating microscope was kept on standby at all the times and was used wherever possible, especially for anterior segment procedures and cleaning/debridement. The first step in using an ocular endoscope is to ascertain the orientation of the optics of the endoscopic image on the monitor by focusing on any object (we used a 2 ml syringe) and to see the orientation of Number 2 which should be upright. The endoscope probe (straight or curved) is inserted in the eye through the pars plana by making a standard 20-gauge sclerotomy incision. First, the intravitreal position of the tip of the irrigation cannula was verified. A vitrectomy cutter was inserted through another sclerotomy site as in the conventional PPV. The vitreoretinal procedures are performed as usual with the sole difference being that the retina is being viewed on the monitor near the surgeon instead of through the microscope.

The cases were grouped into three groups. Group I consisted of 32 eyes with open globe injuries without IOFB. Group II consisted of 11 eyes with open globe injuries and retained IOFB. Group III consisted of seven eyes with post-traumatic endophthalmitis. Out of these 43 open globe injury eyes, 32 (74.4%) eyes had corneal laceration involving the central visual axis obscuring the view needed for PPV. Eleven (25.6%) eyes had corneoscleral laceration, predominantly involving the sclera, out of which nine eyes had large posterior extension up to and beyond muscle insertions. Retinal detachment was observed in 36 (72%) eyes. According to the intraoperative observations, multiple tears were seen in 23 (63.8%) eyes. Single retinal tear with associated retinal detachment was seen in 13 (35.2%) eyes. In seven eyes, there was retinal tear without retinal detachment. Vitreous was removed adjacent to the tear in all the cases. Vitreous base excision was not done in all the cases, it was attempted in 17 (34%) cases where concomitant lensectomy was done. In the majority of cases, the superior sclerotomies for the endoscope and cutter insertions were planned nearer the 9 and 3 o’clock meridian for broader reach. Lensectomy was done using the endoscope view aided with a microscope whenever possible. In the endophthalmitis group, primary repair had been done earlier. In three (42.8%) eyes, the surgeon who performed primary repair reported vitreous haemorrhage. No case with retinal detachment or IOFB was reported. All patients received intravitreal antibiotic before and after surgery in accordance with the hospital protocol, that is, intravitreal injection of Vancomycin (Vancolon-Julphar Pharmaceuticals, UAE) and Ceftazidine (Fortum-Glaxo Wellcome Italy S.p.A.).

**RESULTS**

The demographic profiles with salient clinical features of the cases are tabulated in Table 1.

Fifty trauma cases were enrolled in the study. The mean age of the patients (45 males and five females) was 34.54 years.
(range 7–56 years). The mean period of follow up was 13.54 months (range 3–52 months).

Group I: (open globe injuries with retinal detachment without IOFB). Thirty-two eyes were enrolled in this group. The causes of injury included, road traffic accident—23 eyes (71.8%); stab injuries with sharp objects like metal, knife, pen/pencil—nine eyes (28.1%). Vitreous haemorrhage and retinal detachment was seen in all these 32 eyes. The mean time interval of secondary intervention (endoscope-assisted PPV) was 9.8 days (range 2–20 days). Silicone oil tamponade was used in all these 32 eyes. Peripheral retinal support by placing a sclera buckle was used in nine eyes. Out of 32 eyes, six eyes showed redetachment, which were operated upon again using an endoscope for the posterior segment view. Twenty-nine eyes (90.6%) reported attached retina at the last follow-up (mean 8 months) (figure 1). Two eyes showed shallow inferior peripheral detachment, and one eye showed macula off retinal detachment. Out of 32 eyes operated in this group, 26 (81.2%) eyes showed better vision postoperatively. Five eyes did not show any improvement in postoperative vision, and one eye showed decrease in vision.

Group II: (open globe injuries with retained IOFB). The origin of IOFB in 10 cases was work-related projectile metallic object, and in one case, a glass IOFB. The mean time interval time between trauma and surgical intervention was 1.7 days. Retinal tear with vitreous haemorrhage was seen in all 11 cases. Associated retinal detachment was seen in four eyes. Retinal detachment occurred in another four eyes during IOFB removal and/or inducing posterior hyaloids detachment. Added procedure like lensectomy was done in six eyes. Silicone oil tamponade was used in three eyes, and long-acting gas tamponade (C3F8- perfluoropropane) was used in five eyes. The retina was attached in all cases. Ten out of 11 eyes in this group showed improvement in visual status postoperatively (figure 2).

Table 2 enumerates the result of the cases in Groups I and II. The table also shows the visual results when the cases were grouped according to the time of intervention (PPV) after the trauma. Simultaneous use of an endoscope along with primary closure of wound should be avoided. It is best to do a primary repair and wait for a few days for the eye to settle down. In our series, in only three cases with IOFB, we used an endoscope simultaneously with the primary closure of the injured globe. As is seen in Table 2, vision improvement is best in the patients operated within 3 days of trauma with statistically significant p value.

Group III: (post-traumatic endophthalmitis). Seven patients underwent an endoscope-assisted core vitrectomy for post-traumatic endophthalmitis. The mean time interval between trauma and surgical intervention was 5.71 days (range 4–7 days). Cornea was edematous/hazy, and the anterior chamber showed hypopyon and/or fibrin in all the seven eyes, causing poor visualisation of the posterior segment. Postoperative vision was no light perception in two eyes (progressed to phthisis bulbi), perception of hand motion in one eye, counting fingers close to the eye in three cases, and 20/100 in one eye.

DISCUSSION

PPV in a severely traumatised eye poses many technical challenges. Clear view of posterior segment during PPV in severe ocular trauma can be achieved through either an endoscope or TKP. There are certain advantages with TKP—for example, good view of the posterior segment, ease of surgery, binocularity and stereopsis. But TKP has several disadvantages also, the foremost being the need of a donor cornea for PKP at...
the end of retinal surgery. Though there are some reports in literature about Aachen keratoprosthesis, which can be used as an intraoperative viewing device during PPV, and then left in place for up to 8–10 weeks, pending PKP. Second, placing and removing the keratoprosthesis increases the duration of surgery. It involves an ‘open-sky’ stage. If hypotony occurs during the open-sky situation, this may result in suprachoroidal haemorrhage. The fixation sutures and the keratoprosthesis itself also damage the fine edge of the recipient cornea. The keratoprosthesis also limits the trephination size to a fairly limited diameter because the interface between cornea and prosthesis must not leak during the operation. Moreover, it is difficult to achieve a watertight junction between the traumatised cornea and the TKP, which may be technically challenging, especially in large and irregular corneal lacerations. Another problem with simultaneous PKP and vitrectomy is the corneal graft rejection. Long-term follow-up of combined PKP with vitreoretinal surgery is important, as many patients develop postoperative loss of transparency of the corneal graft. To maintain good transparency of the corneal graft after surgery, vitrectomy must be minimally invasive, and postoperative anti-inflammatory treatment must be ensured. In one case report series, 101 eyes with coexisting corneal and vitreoretinal pathology were analysed following PPV and PKP using TKP. It was a large series with a fairly long follow-up (mean—25 months). Overall success rate for retinal reattachment reported was 95.8% when PPV was done early, but the reattachment rate decreased to 83.1% when PPV was done when PVR was present. It reiterated the fact that early surgery in trauma cases leads to better results. In this series, corneal graft rejection was seen in 31.8% eyes. The authors opined that complexity of surgery, intraoperative manipulations, postoperative inflammation and silicone oil use may be the incriminating factors for the compromised graft clarity. These problems can be circumvented if an endoscope is used for the primary vitrectomy, and PKP is done at a later stage when the eye is stable, ocular inflammation has subsided, and silicone oil is removed. In another study, the corneal graft survival rate was analysed when it was done at the time of PPV, compared with when the graft was done at a later stage. It was observed that corneal transplant failure was less in eyes when (a) the retina was attached before PKP, (b) in eyes that did not need silicone oil tamponade and (c) in eyes that underwent corneal graft later when any further surgery was not required. In this series, 21 eyes (62%) showed silicone oil corneal endothelium contact, and all these eyes showed graft failure. The presence of a large silicone oil bubble in the anterior chamber can result in severe damage to the corneal endothelium caused by the mechanical effect of the silicone oil or hypoxia, and insufficient nourishment of the endothelium because of inadequate aqueous flow. Better results were reported in eyes in which silicone oil removal preceded PKP, or if it was performed at the time of silicone oil removal. We used silicone oil tamponade in 35 eyes in our series (all 32 eyes in Group I, and in three eyes from Group II). Out of these, 11 eyes underwent PKP after the silicone oil was removed, and showed attached retina, with no signs of corneal graft failure at last follow-up (mean 7 months, range 4–21 months). Twelve eyes underwent silicone oil removal only and reported attached retina, eight eyes are still silicone oil filled and four patients were lost in follow-up. In a study similar to ours, feasibility of an endoscope-assisted PPV was analysed in cases where corneal haziness was obscuring posterior segment view through conventional viewing systems. Seven cases with retinal pathology associated with corneal haze were enrolled in this study. The cause of corneal haze was: in five eyes corneal oedema after cataract surgery, in one eye due to penetrating intraocular trauma by a ferrous foreign body, and in one eye due to endophthalmitis. The authors concluded that an endoscope-assisted PPV not only helped in repairing retinal pathology, but it also decreased the duration of surgery by avoiding the need for keratoprosthesis.

In Group III, an endoscope was used to do core vitrectomy in endophthalmitis cases where corneal haze due to trauma or due to hypopyon, fibrin or exudative membranes over the lens and iris made PPV difficult using conventional viewing systems. In patients with endophthalmitis, the risk of primary graft failure is high, and later regrafting also carries a higher risk of graft rejection. An endoscope-assisted PPV not only allowed core vitrectomy, but it also enabled in debulking the inflammatory load by detecting and removing inflammatory membranes under the iris and over the ciliary body under direct visualisation. There are published reports that demonstrate the value of ophthalmic endoscopy in treating patients with severe vision-threatening endophthalmitis, in whom visualisation through the anterior ocular structures is compromised. In one series of 15 cases, the authors concluded that the OE aids in performing safe, diagnostic and therapeutic vitrectomy in endophthalmitis. In one study reporting incidence of endophthalmitis after IOLB, 17 (38.7%) eyes recorded deterioration in vision after surgery. In another study regarding endophthalmitis following open globe injury, the authors observed that 16.8% eyes underwent enucleation/evisceration following endophthalmitis. In our series in the endophthalmitis group, two eyes (28.5%) ended up with no light perception.

**Limitations of the endoscope**

The limitations of an endoscope include cost of the instrument, steep learning curve, limited field of view, lack of stereopsis and inability to perform bimanual procedures. The 2-dimensional view and resolution of the image acquired through the endoscope cannot be compared with the 3-dimensional (stereoscopic) view attained by contact/non-contact wide-field viewing lenses or TKP. To get used to the above mentioned technical problems, to start with, an endoscope should be used in routine PPV cases just to get used to the view, for endolaser, and as a diagnostic tool to view peripheral retina. Complex surgical procedures should be attempted when the surgeon becomes more dexterous. We do not advocate the use of an endoscope as the primary mode of surgery in ocular trauma but do feel that an endoscope can be a useful adjunct for vitreoretinal surgeons in tackling difficult and severe ocular trauma cases, especially in a scenario where donor corneas are not available for PKP following TKP use. A word of caution here: care has to be taken because the endoscope itself has to be introduced into the eye first without damage to the retina. Sometimes a false track may be formed, and the endoscope may go behind the retina/choroid. Always make sure that the endoscope is in the vitreous cavity before starting vitrectomy. When the endoscope is focused initially, it should be a little away from the focusing object (to provide some working distance between the endoscope and the retina) to avoid inadvertent retina touch during the surgery. Crystalline lens touch is another complication which can be avoided by using a curved endoscope probe. Sometimes the tip of the endoscope can be blocked with haemorrhage or fibrin which needs to be cleaned.
CONCLUSION

An endoscope is useful in certain situations where TKP cannot be used due to non-availability of cornea for subsequent PKP at the end of the procedure. An endoscope allows earlier surgery in case of hazy media, and better exploration of intraocular structures; it might reduce inflammatory processes and thereby suppress evolving anatomic changes before they lead to PVR and related complications.

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