Applications of Endoscopy in Vitreoretinal Surgery

The first prototype of an ocular endoscope was reported in 1934 for removing nonmagnetic intravitreal foreign bodies. This initial prototype needed further technological improvements in miniature optics, charge coupled device (CCD), video cameras, and advances in flexible optical fiber to make the ocular endoscope a useful adjunct in ophthalmic surgery. The presence of corneal opacity, small pupil, hyphema, opacified or contracted anterior, and posterior capsule obscure or prevent the view of the retina during vitreoretinal surgery through conventional viewing systems; and therefore, in such cases, the ophthalmic microendoscope has been claimed to be useful. It can also be useful in the removal of membranes from the peripheral retina and ciliary body areas which are otherwise difficult to visualize by conventional viewing systems during vitrectomy.

Other uses of ocular endoscopes include photocoagulation of ciliary processes, subretinal surgery, visualization of intravitreal ganciclovir implants, removal of dislocated nuclear fragments situated in the periphery of the retina, surgery for sulcus fixation of posterior chamber intraocular lens (PCIOL), removal of intraocular foreign bodies, and for the surgical management of complex retinal detachment (RD).

The objective of this study is to present our experience in the use of endoscopic vitreoretinal surgery (EndoVRS) in Kuwait. To the best of our knowledge, this is the first report regarding the use of endoscope in vitreoretinal surgery from the Middle East.

Subjects and Methods

This was a prospective, noncomparative, and interventional study of consecutive cases that underwent endoscopic procedure at a tertiary care eye hospital (Al-Bahar Eye Center) in Kuwait after the equipment was introduced to the hospital in January 2004. The local ethics committee cleared the study.

Cases in which conventional vitreoretinal procedures were not possible due to media opacities were included in the study. Decision to use the endoscope was taken during preoperative assessment of the patient. Informed consent was taken from the patients undergoing EndoVRS. To be included in the study, the patient needed to have a minimum follow-up of 2 months after the procedure. The data collected included age, sex, ocular history, medical history, eye affected, preoperative best-corrected visual acuity, anterior segment examination findings on the slit lamp biomicroscopy, posterior segment examination findings by B-scan ultrasound, and indirect ophthalmoscopy if possible. We noted the details of the endoscopic surgery and operative complications. Postoperative findings of visual acuity, intraocular pressure, posterior segment status, and ultrasound findings were noted. The major outcomes of the study were 1) anatomic outcome, e.g., status of retina at the end of stipulated period of follow-up, recurrence of vitreous hemorrhages, stability of scleral fixed IOL, and 2) functional outcome like improvement of vision, decrease in pain due to decrease in intraocular pressure, prevention of eye going into phthisis or neovascular glaucoma, and control of intraocular inflammation in cases of endophthalmitis.

The endoscopic system used in our hospital is E-4 Microprobe (Endo-Optiks Inc., Little Silver, NJ). This E-4 endoscopic system can be used with both fiber optic endoscope as well as gradient index (GRIN) lens endoscope. The compact endoscopy cabinet houses a xenon light source and a CCD camera. The CCD
camera is used to process the image obtained by the fiber optic. The video display can be any compatible high-resolution monitor that is placed near the surgeon to view the procedure. This compact unit also creates an opportunity to simultaneously image and to use endolaser (when used in combination with a laser). We used a fused fiber-optic type of endoscope. The advantage of fused fiber optic technology is that it is more flexible and has larger field of view and is focused only once before starting the surgery. Moreover it can be used while being away from the retina hence making it easier to work with and decreasing complications like inadvertent retinal damage. Another type of endoscope is the GRIN lens endoscope, which is also being used in ophthalmic surgery. GRIN lens endoscope consists of a series of miniaturized lenses and has better resolution but small observational field. The surgeon can control the focus here by using foot pedal making it more useful for closer working distances like in subretinal surgery.

The first step is to ascertain the orientation of the optics of the endoscopic image on the monitor. This is done by focusing the endoscope 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 a standard 20 gauge sclerotomy incision or may be inserted through a limbal incision in aphakic eyes. First, the intravitreal position of the tip of the irrigation cannula was verified in cases where vitrectomy was needed under endoscopic view. Vitrectomy cutter was inserted through another sclerotomy site as in the conventional pars plana vitrectomy. 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.

Cases in which only endo-cyclophotocoagulation (ECP) was needed, only one sclerotomy with preplaced sutures was made to insert the endoscope without placing the irrigation cannula. Both our cases for ECP were previously vitrectomized. Photocoagulation of ciliary processes was done through an endolaser probe, which couples an illumination and laser in one probe. After the procedure, the preplaced suture is tightened by the assistant and the endoscopic probe is slowly removed from the eye thus preventing the occurrence of hypotony.

**Results**

Fourteen consecutive cases in which endoscope was used are reported in this study. Their demographic characteristics, primary diagnosis, and main procedure done are given in Table 1. Clinical characteristics such as preoperative and postoperative vision and intraocular pressures, reason for the use of endoscope, and final outcome are given in Table 2.

The first two cases underwent endoscopic cyclophotocoagulation for intractable glaucoma.

The diagnosis in Case 1 was neovascular glaucoma with florid iris and angle neovascularization. On examination her vision was counting fingers close to face in right eye and 20/400 in left eye. The preoperative IOP was 38 mmHg in right eye. The intraocular pressure remained high in spite of maximal antiglaucoma treatment; hence endoscopic cyclophotocoagulation was planned in this patient. The patient had undergone pars plana vitrectomy earlier for non re-

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**Table 1. Demographic Characteristics, Primary Diagnosis, and Main Procedure Done**

<table>
<thead>
<tr>
<th>Case</th>
<th>Age, yr/Sex</th>
<th>Eye</th>
<th>Diagnosis</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>62/M</td>
<td>R</td>
<td>NVG</td>
<td>PHC of ciliary processes</td>
</tr>
<tr>
<td>2</td>
<td>62/F</td>
<td>R</td>
<td>Pseudophakic glaucoma</td>
<td>PHC of ciliary processes</td>
</tr>
<tr>
<td>3</td>
<td>52/F</td>
<td>R</td>
<td>Recurrent vit hem</td>
<td>Exam of sclerotomies &amp; shaving of vit plug</td>
</tr>
<tr>
<td>4</td>
<td>47/M</td>
<td>L</td>
<td>Recurrent vit hem</td>
<td>Removal of fibrovascular complex under the sclerotomy</td>
</tr>
<tr>
<td>5</td>
<td>35/M</td>
<td>R</td>
<td>Subluxated lens</td>
<td>Scleral fixation of IOL</td>
</tr>
<tr>
<td>6</td>
<td>50/M</td>
<td>R</td>
<td>Subluxated IOL</td>
<td>Scleral fixation of IOL</td>
</tr>
<tr>
<td>7</td>
<td>87/M</td>
<td>R</td>
<td>OCP, RD</td>
<td>EndoVRS</td>
</tr>
<tr>
<td>8</td>
<td>65/M</td>
<td>R</td>
<td>BSK, corneal edema, vit hem, TRD</td>
<td>EndoVRS</td>
</tr>
<tr>
<td>9</td>
<td>75/F</td>
<td>L</td>
<td>RD</td>
<td>EndoVRS</td>
</tr>
<tr>
<td>10</td>
<td>55/M</td>
<td>R</td>
<td>Chronic endophthalmitis</td>
<td>EndoVRS, IOL explant</td>
</tr>
<tr>
<td>11</td>
<td>5/F</td>
<td>R</td>
<td>Trauma, RD</td>
<td>EndoVRS</td>
</tr>
<tr>
<td>12</td>
<td>12/M</td>
<td>L</td>
<td>Trauma, lacerated corneal wound, RD</td>
<td>EndoVRS</td>
</tr>
<tr>
<td>13</td>
<td>43/F</td>
<td>R</td>
<td>Trauma, lacerated corneal wound, RD</td>
<td>EndoVRS</td>
</tr>
<tr>
<td>14</td>
<td>26/M</td>
<td>R</td>
<td>Trauma, RD</td>
<td>EndoVRS</td>
</tr>
</tbody>
</table>

NVG = neovascular glaucoma; PHC = photocoagulation; IOL = intraocular lens; OCP = ocular cicatricial pemphigoid; RD = retinal detachment; BSK = bullous striate keratopathy.
solving vitreous hemorrhage. For ECP pars plana route was used and since the patient was phakic, curved endoscope probe was used to avoid lens touch. During endoscopy, it was noted that retinal photoagulation was incomplete peripherally; therefore, laser was done to peripheral retina using the endoscope. In the same sitting, photoagulation of ciliary processes was done assisted by the endoscope. When last seen 6 months post ECP her vision was counting fingers and the IOP decreased to 6 mmHg. Slit lamp examination showed regression of the anterior chamber neovascularization.

Case 2 was diagnosed with pseudophakic glaucoma in the right eye. The patient underwent eventful phacoemulsification, complicated with posterior capsular rent and limited anterior vitrectomy in same eye 3 years ago. On examination, vision in right eye was 20/400 and IOP was 36 mmHg that was refractory to maximal antiglaucoma medications. ECP through pars plana approach was done. Post ECP her IOP decreased to 16 mmHg in the right eye and no significant postoperative complications were noted. When last follow-up examination was done 9 months later her vision was 20/300 in right eye and IOP stabilized at 16 mmHg.

The next two cases were recurrent vitreous hemorrhage. The endoscope was used in these cases to inspect the sclerotomies from inside for the presence of fibrovascular complex that might be a source of recurrent vitreous hemorrhage.

Case 3 was a female patient with proliferative diabetic retinopathy in both eyes. She had undergone panretinal photocoagulation, complicated with posterior capsular rent and limited anterior vitrectomy in same eye 3 years ago. On examination, vision in right eye was 20/400 and IOP was 36 mmHg that was refractory to maximal antiglaucoma medications. ECP through pars plana approach was done. Post ECP her IOP decreased to 16 mmHg in the right eye and no significant postoperative complications were noted. When last follow-up examination was done 9 months later her vision was 20/300 in right eye and IOP stabilized at 16 mmHg.

In Cases 5 and 6, the endoscope was used for scleral fixation of IOL. Case 5 was a male patient with traumatic subluxated cataractous lens in the right eye for which he underwent lensectomy. His preoperative visual acuity in the right eye was 20/400 and IOP was 16 mmHg. The endoscope was used to place sutures for SROL. The endoscope helped to locate the sulcus correctly and find a suitable place for fixation sutures. A standard three-port vitrectomy was planned with both superonasal and superotemporal sclerotomies made closer to horizontal meridian. The endoscope was introduced through the superotemporal sclerotomy to identify the sulcus in 6 and 12 o’clock positions. The 10-0 Prolene suture needles were inserted through the sclera and visualized from the inner side with the endoscope. After placing the sutures, a clear corneal incision were made through which 10-0 Prolene sutures were pulled out using Sinskey hook. The two ends of 10-0 Prolene were tied to the haptics. A foldable three-piece IOL was inserted through 3 mm corneal incision and sutures were secured. The position of both haptics was examined with the endoscope at the end of the procedure. At the last visit, 13 months after the procedure, the SF1OL was stable. The patient had 20/30 vision with correction and IOP was 16 mmHg.

Case 6 was a 50-year-old man with trauma in his right eye in 1992 who underwent cataract extraction with PCIOL insertion elsewhere in 1998. He developed RD after cataract surgery for which scleral buckling was done in 1998. His retina redetached in 2001 and conventional pars plana vitrectomy with sulfur hexafluoride (SF₆) gas injection was done. Postoperatively PCIOL was decentered. Through conventional pars plana route the PCIOL was sutured to the sclera. He had another trauma in 2005, which caused the IOL to subluxate due to separation of temporal scleral fixation Prolene suture. At this juncture, his vision was 20160 in the right eye with IOP 16 mmHg. The endo-
Table 2. Clinical Characteristics

<table>
<thead>
<tr>
<th>Case</th>
<th>Reason for the Use of Endoscope</th>
<th>Preop VA</th>
<th>Postop VA</th>
<th>Preop IOP, mmHg</th>
<th>Postop IOP, mmHg</th>
<th>Follow-Up (mo)</th>
<th>End Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ECP</td>
<td>CF</td>
<td>CF</td>
<td>38</td>
<td>6</td>
<td>6</td>
<td>IOP stable &amp; controlled</td>
</tr>
<tr>
<td>2</td>
<td>ECP</td>
<td>20/400</td>
<td>20/300</td>
<td>36</td>
<td>16</td>
<td>9</td>
<td>IOP stable &amp; controlled</td>
</tr>
<tr>
<td>3</td>
<td>Recurrent vit hem</td>
<td>HM</td>
<td>20/400</td>
<td>18</td>
<td>18</td>
<td>9</td>
<td>No vit hem Retina attached</td>
</tr>
<tr>
<td>4</td>
<td>Recurrent vit hem</td>
<td>HM</td>
<td>20/60</td>
<td>18</td>
<td>18</td>
<td>6</td>
<td>No vit hem, retina attached</td>
</tr>
<tr>
<td>5</td>
<td>To place suture in sulcus in SFIOL</td>
<td>201400</td>
<td>20/30</td>
<td>16</td>
<td>16</td>
<td>13</td>
<td>SFIOL in place</td>
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<tr>
<td>6</td>
<td>To place suture in sulcus in SFIOL</td>
<td>20160</td>
<td>20140</td>
<td>16</td>
<td>16</td>
<td>3</td>
<td>SFIOL in place</td>
</tr>
<tr>
<td>7</td>
<td>OCP &amp; RD</td>
<td>LP</td>
<td>CF</td>
<td>—</td>
<td>13</td>
<td></td>
<td>Endophthalmitis resolved &amp; retina attached</td>
</tr>
<tr>
<td>8</td>
<td>Buphous keratopathy &amp; RD</td>
<td>LP</td>
<td>CF</td>
<td>18</td>
<td>16</td>
<td>8</td>
<td>Retina attached</td>
</tr>
<tr>
<td>9</td>
<td>Corneal opacity &amp; RD</td>
<td>LP</td>
<td>CF</td>
<td>28</td>
<td>12</td>
<td>6</td>
<td>Endophthalmitis resolved &amp; retina attached</td>
</tr>
<tr>
<td>10</td>
<td>Hazy cornea, thick fibrin memb, chr endophthalmitis</td>
<td>LP</td>
<td>201100</td>
<td>20</td>
<td>16</td>
<td>2</td>
<td>Retina attached</td>
</tr>
<tr>
<td>11</td>
<td>Posttraumatic corneal opacity &amp; RD</td>
<td>LP</td>
<td>CF</td>
<td>—</td>
<td>12</td>
<td>2</td>
<td>Retina attached</td>
</tr>
<tr>
<td>12</td>
<td>Posttraumatic corneal opacity &amp; RD</td>
<td>H.M.</td>
<td>CF</td>
<td>10</td>
<td>8</td>
<td>6</td>
<td>Retina attached and no phthisis</td>
</tr>
<tr>
<td>13</td>
<td>Posttraumatic corneal opacity &amp; RD</td>
<td>NLP</td>
<td>NLP</td>
<td>8</td>
<td>4</td>
<td></td>
<td>Retina attached</td>
</tr>
<tr>
<td>14</td>
<td>Posttraumatic corneal opacity &amp; RD</td>
<td>201400</td>
<td>—</td>
<td>12</td>
<td></td>
<td></td>
<td>Retina attached</td>
</tr>
</tbody>
</table>

VA = visual acuity; IOP = intraocular pressure; ECP = endoscopic cyclophotocoagulation; CF = counting fingers; HM = perception of hand motion; SFIOL = scleral fixated intraocular lens; OCP = Ocular cicatricial pemphigoid; RD = retinal detachment; LP = light perception; NLP = no light perception.

scope was used to assist in resuturing the IOL to the sulcus. When last seen, 3 months after the procedure, the IOL was centered with vision stable at 20/40 and IOP was 16 mmHg.

In Cases 7 to 9, the endoscope was used to perform EndoVRS. In all these cases media was hazy, and conventional vitrectomy was not possible.

Case 7 was an 87-year-old man with ocular cicatricial pemphigoid. He was one-eyed, the left eye being phthisic. His right eye showed severe entropion, symblepharon, opaque vascularized cornea, and no view of the fundus. Type I keratoprosthesis was implanted in the right eye a year ago. The patient developed late onset endophthalmitis. The endophthalmitis was treated successfully with intraocular injections of antibiotics. However, he later developed total RD. Fundus view was significantly compromised due to retro-keratoprosthesis thick membrane. B-scan ultrasound showed a total RD with multiple membranes. His preoperative assessment revealed visual acuity of light perception in right eye. Endoscope assisted vitrectomy, membrane peeling, 360° retinotomy with endoscopic laser delivery, and silicone oil injection was done. Postoperatively, his vision improved to 20/300. The retina remained flat during the follow-up period. When examined last, 13 months following endoscopic procedure, the vision in his right eye was counting fingers at 1 meter. Slit lamp examination showed retro keratoprosthesis membrane. B-scan ultrasound showed a flat retina.

Case 8 was a 65-year-old diabetic man who underwent cataract extraction 12 years ago. On examination the patient had vision of light perception in the right eye. Slit lamp examination showed corneal edema in the right eye with updrawn pupil, neovascularization of iris, and thick posterior capsular membrane. IOP was 18 mmHg. There was no view of the fundus due to vitreous hemorrhage. B-scan ultrasound showed RD with multiple membranes. He underwent endoscopic vitrectomy with endolaser and silicone oil injection. Photocoagulation of the ciliary processes was also done prophylactically due to high risk of IOP rise because of neovascularization of iris. On follow-up
examination after 8 months, vision was counting fingers at 2 m. Retina was flat under silicone oil and IOP was well controlled at 16 mmHg.

Case 9 was a 75-year-old diabetic woman with proliferative diabetic retinopathy. Extracapsular cataract extraction in both eyes had been done 15 years ago. She presented to us with decrease in vision in both eyes and pain in left eye. On examination, her vision was counting fingers right eye and light perception in left eye. Slit lamp examination showed aphakia, decompensated cornea, and neovascularization of iris in both eyes. Intraocular pressure was 20 and 28 mmHg, respectively, in right and left eye. Right eye retina was well lased and stable. Left eye had vitreous hemorrhage and B-scan showed tractional RD for which she underwent EndoVRS with membrane removal, fluid air exchange, endolaser, and gas (C2F6) injection. Photocoagulation of the ciliary processes was done at the same time. Six months postoperatively the retina was flat, IOP was 12 mmHg, and vision recorded was counting fingers at 2 m in left eye.

Case 10 was a 55-year-old man with chronic endophthalmitis. He had undergone phacoemulsification with IOL implantation complicated by posterior capsular rupture and vitreous loss in right eye 11 months ago. He had recurrent episodes of inflammation and was treated conservatively. He was referred to the retina clinic with history of severe pain and decrease in vision. On examination, his vision was light perception in the right eye. IOP was 20 mmHg. Slit lamp examination showed hazy cornea, vitreo-corneal touch, exudative membrane over lens and iris, and whitish plaque behind lens. When examined with endoscope during EndoVRS, a thick exudative membrane was seen on the under surface of iris extending to the ciliary body. It was peeled off using an intraocular forceps. Endoscopy also revealed whitish plaque sequestered between the IOL and the capsule. The IOL was explanted and intravitreal antibiotics were injected at the end of the surgery. When examined last, 2 months after the procedure, the patient was comfortable with decrease in pain. The vision was 20/100 with aphakic correction and the retina was flat.

Cases 11 to 14 had history of severe eye trauma resulting in opaque cornea and rhegmatogenous RD with proliferative vitreoretinopathy (PVR).

Case 11 was a 5-year-old girl admitted through the casualty unit with history of trauma to right eye with a sharp object. Primary repair of the full thickness corneal wound was done on the same day. Since the corneal tear was ragged, even after good closure of wound, cornea was markedly distorted and there was very hazy view of the fundus. On follow-up visit 3 weeks later, vision recorded was light perception in the right eye. B-scan ultrasound showed a total RD in the right eye. She underwent conventional vitrectomy, lensectomy, and endolaser with silicone oil injection. Postoperatively she developed epithelial downgrowth. A compromised fundus examination showed residual traction over the retina. She needed another surgery, which was not possible with conventional viewing system due to very hazy view of the retina because of epithelial downgrowth. She under went endoscopic vitrectomy with membrane peeling and reinjection of silicone oil after endolaser. On last recorded follow-up visit at 2 months postoperatively, her vision was counting fingers at 2 m and retina looked flat under oil.

Case 12 was a 12-year-old boy admitted with severe sclerocorneal laceration in his left eye. Primary repair of the full thickness sclerocorneal wound was done on the same day. Postoperatively RD was detected by B-scan ultrasound. Vision recorded at this point was hand motion close to face. Since the cornea was grossly distorted and the fundus view was very hazy, endoscopic vitrectomy was done. On examination with the endoscope, total RD with retinal incarceration was seen at the site of scleral wound. He underwent vitrectomy with relaxing retinotomy, endolaser, and silicone oil injection. Postoperative period was uneventful. On follow-up visit 2 months after EndoVRS, vision recorded was counting fingers at 0.5 m and retina was flat under silicone oil.

Case 13 was a 43-year-old woman who presented to the retina service after repair of traumatic corneoscleral laceration 10 days before presentation. Her vision was no light perception and there was no view of retina due to corneal scarring and cataract. B-scan ultrasound examination showed detached retina. When she was informed that no surgery could help her to improve vision but she was likely to develop phthisis bulb she agreed to undergo endoscopic surgery to repair RD to preserve the globe. She underwent endoscopic pars plana lensectomy, vitrectomy, relaxing retinotomy, endolaser, and silicone injection. At 6 months of follow-up her vision was no perception of light in the right eye. The retina was flat under oil and the IOP was 8 mmHg with no signs of phthisis bulb.

Case 14 was a 26-year-old man who underwent penetrating keratoplasty (PKP) in his right eye for keratoconus. He had a trauma to the same eye and presented with dehiscence of the wound at the graft host junction. After repair of the gaping wound, the patient was referred to retina clinic because B-scan showed total RD with shallow choroidal. The graft became hazy following trauma and showed signs of decompensation. The view of the fundus was significantly compromised due to graft failure. His preoper-
ative visual acuity was light perception in the right eye. After resolution of choroidal, EndoVRS was done successfully with silicone oil injection. When last seen 4 months after the procedure, vision was 20/1400 with flat retina. The corneal graft remained the same. He was scheduled for another graft.

Discussion

Cases 1 and 2 were having intractable glaucoma that responded well to endoscopic cyclophotocoagulation (ECP). A sclerotomy was made and preplaced suture put before inserting the endoscope. We did only one sclerotomy and avoided another sclerotomy (for Infusion) to minimize the pull on vitreous and to decrease chances of hemorrhage and RD due to multiple scleral entries. The lowering of IOP was not due to hypotony as both the cases showed sustained lowering of IOP over a period of more than 6 months. No postoperative complications were observed in our cases though in a series of similar cases Valmaggia and De Smet\(^8\) observed inflammation as an immediate postoperative complication. They used endoscope to photoagulate the ciliary processes in six eyes and reported good result in cases of glaucoma related to panuveitis, iris dystrophy, and post-RD surgery. Two cases of neovascular glaucoma did not show significant decrease in IOP in their series. In another study, however, Kawai\(^10\) reported satisfactory outcomes after ECP in six cases of neovascular glaucoma.

Cases 3 and 4 were of recurrent vitreous hemorrhage. It has been reported that vitreous incarceration, anterior hyaloidal fibrovascular proliferation, and fibrovascular ingrowth can be a cause of recurrent vitreous hemorrhage after primary vitrectomy is done for complications of diabetic retinopathy.\(^1,19\) Clinical signs of fibrous ingrowth are dilated episcleral vessels that terminate at the sclerotomy site, hemorrhage in Berger space, and fibrovascular proliferation along the meridian of the sclerotomy site. Bhende et al\(^18\) reported vitreous incarceration detected by ultrasound biomicroscopy in 18% cases of recurrent vitreous hemorrhage. Hershberger et al\(^19\) reported fibrovascular ingrowth seen by ultrasound biomicroscopy in 58% of their cases. Repeated conventional pars plana vitrectomy with extensive clearing under the vitrectomy sites is done in these cases to stop recurrent vitreous hemorrhage. Endoscope can play a pivotal role intraoperatively in these cases as it allows the surgeon to examine the sclerotomy site from inside and remove fibrovascular complex completely under direct visualization.

In Cases 5 and 6, scleral fixation of IOL was done under endoscopic view. Ab externo scleral fixation of PC IOL is a blind procedure in most cases and ultrasound biomicroscopy showed the difficulty in reliably placing the haptics in the ciliary sulcus using this technique.\(^20\) Placement of the haptic and sutures in the ciliary sulcus to promote attachment of scar tissue may enhance the long-term stability of scleral-fixated PC IOL.\(^21\) Endoscopic visualization of the iridociliary angle during surgery greatly helps in placing the sutures correctly. We also observed that the security of the knot on the IOL haptic as well as the correct position of the IOL could be seen by the surgeon using an endoscope at the end of the surgery.

In Cases 7 to 9 EndoVRS was used to deal with complex RD with hazy media. In Case 7, endoscope was used because there was no view of fundus due to retro-keratoprosthesisthick membrane. Moreover, endoscope is useful for safer intraocular instrument placement especially in these eyes with cicatricial changes, which may have disrupted anatomy (elastic rigid circumferential organization of zonular and anterior vitreous bundles). Secondly, retina is friable in post endophthalmitis cases. EndoVRS helps in control of traction on retina during insertion of instruments by complete removal of anterior vitreous base and of debris on the ciliary body. Another important aspect is clear sclerotomy sites at the end of the surgery.

Cases 8 and 9 were proliferative diabetic retinopathy cases with hazy media. Endoscopic vitrectomy has been used in proliferative diabetic retinopathy by Ciardella et al\(^7\) in eight cases. The endoscopic vitrectomy was chosen over the conventional one due to hazy media and the need to approach retro-iridial space in presence of neovascularization in that area. The authors reported good results with no significant complications except for a retinal tear while peeling fibrovascular membranes. However, this is not due to specific application of the endoscopic vitrectomy, as retinal tears during peeling of fibrovascular membranes is known to occur during vitrectomy using conventional microscopic visualization. Uram\(^22\) reported a series of 10 consecutive patients with grade D3 anterior PVR. Endoscopy assisted vitrectomy, lensectomy, membraneectomy, fluid gas exchange, and endophotocoagulation was done. Six out of 10 patients had attached retina after a follow-up period of 3 to 12 months (mean 9.2 months). Because endoscopy allows meticulous exploration of intraocular contents and an earlier surgery even in presence of hazy media, it may be useful in decreasing a number of PVR related complications.\(^22\) We could have waited for the availability of cornea and would have done vitrectomy along with penetrating keratoplasty, but that would
have led to unnecessary delay and more proliferative vitreoretinopathy (PVR) changes.

Case 10 was a case of chronic endophthalmitis. This type of case provides an opportunity for a fascinating new use of endoscope especially in dealing with the sequelae of endophthalmitis. The majority of these cases are with hazy media, fibrin, or exudative membranes over the iris, lens, and under surface of iris. Inflammatory membranes over the iris and ciliary body can be detected and removed under direct visualization using an endoscope. De Smet et al. demonstrated the value of ophthalmic endoscopy in treating patients with severe vision-threatening endophthalmitis in whom visualization through the anterior ocular structures was compromised. In their series of 15 cases, they concluded that the ophthalmic endoscope aids in performing safe, diagnostic, and therapeutic vitrectomy in endophthalmitis.

Cases 11 to 14 were trauma cases. Not much has been reported in the literature regarding the use of endoscope in posttraumatic complications in the posterior segment of the eye, though one of the initial uses of endoscope was reported in removal of nonmagnetic intraocular foreign body. De Smet et al. used endoscope to do vitrectomy in two cases of posttraumatic endophthalmitis. The concept of EndoVRS for trauma cases is relevant for several reasons: first, because of lack of transparency of anterior segment, mainly due to corneal edema, traumatic perforations of cornea, irregular suturing of ragged wounds, corneal scarring, hyphema, and disorganized anterior chamber of eye; secondly, after ocular injury, ciliary or choroidal hemorrhage, and/or detachments can occur. Moreover, anterior displacement of the vitreous base and retina are frequent. In these cases, location of the sclerotomies and correct insertion of instruments is crucial because of wrong tracks resulting in subbiliary, suprachoroidal, subretinal infusion, and in retinal perforations. It can be argued at this point that pars plana vitrectomy combined with keratoplasty using a temporary keratoprosthesis can be used in patients with vitreoretinal disorders complicated by severe corneal opacification. Examples of temporary keratoprosthesis are the Landers type and Eckardt type. According to Ikeda the use of the Eckardt temporary keratoprosthesis is superior because of a wider optical diameter and easier visualization of the peripheral fundus. However, one problem with this procedure is that many patients develop postoperative rejection and loss of transparency of the corneal graft. To maintain good transparency of the corneal graft after surgery, vitrectomy must be minimally invasive to reduce postoperative inflammation.

Secondly, there is a problem of availability of donor cornea. An endoscope-assisted vitrectomy can bypass the above mentioned problems and a penetrating keratoplasty can be done at a later stage when the postoperative inflammatory process is under control and a donor cornea is available. When the cornea or lens is opaque or fibrin is present in the vitreous, it precludes a clear view of the posterior segment. In this situation, even a wide angle system would appear to be less useful than the endoscope. Care has to be taken because endoscope itself has to be introduced into the eye first without damage to retina, and secondly the tip of the endoscope can be blocked with hemorrhage or fibrin.

Endoscopic vitrectomy has a potential advantage in trauma cases with vitreoretinal complications, especially in pediatric cases where delay in surgery due to hazy media or delay due to non availability of cornea for simultaneous penetrating keratoplasty can lead to severe PVR changes and amblyopia.

Conclusion

At present, most preoperative conditions which hamper visualization can be tackled by conventional procedures like penetrating keratoplasty or temporary keratoprosthesis for opaque cornea, cataract surgery for opaque crystalline lens, and sphincterotomy or use of iris hooks for non-dilating pupils. The use of endoscope is an alternative modality that allows the surgeon to complete the surgical procedure without the above mentioned procedures. Since endoscope allows earlier surgery in case of hazy media and better exploration of intracocular structures, it might reduce inflammatory processes and thereby suppress evolving anatomic changes before they lead to PVR and related complications. Also, previously inaccessible structures like ciliary body, hack surface of iris, and subretinal space can be explored for hidden foreign bodies and new blood vessels. Endoscopes can also be used to examine the sclerotomy site from inside in cases of recurrent vitreous hemorrhage. Photocoagulation of ciliary processes under direct visualization using an endoscope is another exciting proposition.

Certainly, there is a learning curve and the surgeon needs to get more experience before attempting to operate on complex cases. It is an acquired skill and remains a challenge. We initially started diagnostic endoscopy to assess the posterior segment in cases scheduled for PKP where there was no view of the fundus due to hazy cornea. Another method we used to get oriented to the image was to use the endoscope in routine pars plana vitrecto-
mies, just to get the feel of the instrument and to get used to the pseudo stereopsis. This can be learned by getting used to the shadow of c共同 trimmed caused by the light from the fiber optic. When we got used to the view and the orientation of image we attempted to use endoscope in surgical situations.

The aim of this article is not to propose a substitute to the presently available surgical techniques. The aim is to suggest an alternate modality of surgical intervention, which can be a useful addition to any vitreoretinal operating room.

In due course, the ophthalmic endoscope will prove to be a safe adjunct to vitreoretinal surgery for both diagnosis and treatment, whenever standard microscopic visualisation is limited.

Key words: ophthalmic endoscope, viewing systems, retina and vitreous surgery, traumatic retinal detachment, endoscopic cyclophotocoagulation, sclerotomy.

References


