Pars Plana Ahmed Valve Implant and Vitrectomy in the Management of Neovascular Glaucoma

Houshang Faghihi, MD1, Fedra HajiZadeh, MD2, Seyed-Farzad Mohammadi, MD3 Arezoo KadKhoda, MD4, Gholam-Ali Peyman, MD5, Mohammad Riazi-Esfahani, MD1

Abstract

Purpose: To evaluate the efficacy and safety of pars plana Ahmed valve implant combined with pars plana vitrectomy and endolaser photocoagulation for the treatment of neovascular glaucoma in patients with vitreous hemorrhage.

Methods: Retrospectively, we evaluated the records of 18 eyes of 17 consecutive neovascular glaucoma patients who had undergone pars plana vitrectomy and pars plana Ahmed valve implant. The patients were followed for a mean time of 14.2 months (range 6 to 28 months).

Results: Mean preoperative intraocular pressure with oral and two or three topical antiglaucoma medications was 53.3±10 mm Hg, and mean postoperative intraocular pressure without oral antiglaucoma medication was 16.3±7.1 mm Hg (P<0.0001) at the final visit. Overall success rate was 72.2%, defined as an intraocular pressure of higher than 5 mm Hg and less than 21 mm Hg with or without antiglaucoma medication. A postoperative hypertensive phase occurred in 7 patients (38.8%) of which all but one responded to medical therapy. Visual acuity was stabilized or improved in 77.7% of the eyes. There was one case of each of the following adverse events: mild vitreous cavity hemorrhage, hypotony, choroidal effusion, epiretinal membrane, corneal edema, and corneal ulcer. Two cases developed phthisis bulbi and lost light perception.

Conclusion: Pars plana vitrectomy and Ahmed valve implantation seems to be a viable surgical modality in the management of neovascular glaucoma and coexistent posterior segment pathology with a relative low rate of serious permanent postoperative complications.

Key words: Neovascular Glaucoma, Glaucoma Drainage Implant, Ahmed Glaucoma Valve, Pars Plana Vitrectomy, Laser Photocoagulation.

Introduction

Neovascular glaucoma (NVG) is a devastating ocular disease with a poor long-term visual prognosis. It usually presents as the end stage of retinal vascular diseases such as proliferative diabetic retinopathy and central retinal vein occlusion.\(^1\)

Despite advances in the surgical management of glaucoma, treatment of NVG is still a significant challenge. A variety of treatment modalities have been investigated in the management of NVG including panretinal photocoagulation, cyclocryotherapy, conventional filtering surgery, transscleral Neodymium: YAG laser cyclophotocoagulation\(^2\) and implantation of drainage tube devices.\(^3,4\)

Recently, pars plana vitrectomy and implantation of a drainage tube in the vitreous cavity has been reported with a success rate comparable to those of the conventional surgical modalities.\(^1,3,5\) The Ahmed glaucoma valve is the only valved drainage devices in common use. Previous studies have shown that valved drainage shunts decrease the rate of hypotony, flat anterior chamber, and associated complications\(^6,7\) with appropriate intraocular pressure (IOP) control in the early postoperative period.

The purpose of the current study is to evaluate the role of pars plana Ahmed valve implantation combined with vitrectomy and panretinal photocoagulation in the management of patients with medically uncontrolled NVG, who also have vitreous hemorrhage and need vitrectomy.

Methods

Participants

Records of 18 eyes of 17 patients with NVG who had undergone Ahmed valve implantation combined with vitrectomy and panretinal photocoagulation between January 2002 and December 2003 were reviewed retrospectively. Inclusion criteria were as follows:

- NVG patients with IOP > 30 mm Hg despite maximum tolerated (oral and topical) anti glaucoma medical therapy
- Dense vitreous haziness
- Underlying retinal pathology (diabetic retinopathy, central retinal vein occlusion, Eale’s disease)
- Visual acuity of light perception or better

IOP was measured with the Goldmann applanation tonometer

Surgical technique and postoperative care

The surgeries were all performed by a single vitreoretinal surgeon (HF). Following general anesthesia, a fornix-based conjunctival peritomy with relaxing incisions was made either in superotemporal or superonasal quadrants and the adjacent extraocular rectus muscles were isolated with a muscle hook. Models S2 and S3 of the single plate Ahmed glaucoma valve (New world medical Inc., Rancho Cucamonga CA) were used for all of the patients.

Patency of the implant tube was verified by irrigation with balanced salt solution. The implant was then anchored 10 mm posterior to the limbus between the rectus muscles with interrupted 5.0 Mersilene sutures. Pars plana vitrectomy was performed. The sclerotomies were placed 3 mm posterior to the limbus in aphakic and pseudophakic cases and 4 mm posterior to the limbus in phakic cases. Following evaluation of intraocular pathology, full panretinal endophotocoagulation was applied. The implant tube was trimmed to a length of 3-4 mm past the neighboring sclerotomy site. Next, the tube was inserted through the sclerotomy and anchored to episclera with a mattress suture. Indirect ophthalmoscopy was performed to verify correct positioning and unobstructed status of the implant tube by the vitreous. The implant entry site was covered by a heterologous scleral patch graft almost to the limbus. Following closure of the remaining sclerotomy sites with 7.0 Vicryl sutures, the overlying Tenon’s capsule was closed separately. Finally, 20 mg of gentamicin and 4 mg of betamethasone were injected subconjunctivally away from the implant position.

The patients were examined at the first and third postoperative days, one week later, and almost monthly thereafter. Topical antibiotics (gentamicin four times a day), steroids (prednisolone acetate every two hours that tapered during one month), and cycloplegics (cyclopentolate four times a day) were prescribed and tapered for the four postoperative weeks.
Outcomes and analysis

Data about underlying ocular diseases, prior ocular surgeries, baseline and final best corrected visual acuity (VA), lens status, pre- and postoperative IOP and antiglaucoma medications, and intra- and postoperative complications were retrieved.

Three outcomes were defined; complete success: a final IOP \( \leq 21 \) mm Hg or \( \geq 5 \) mm Hg without medications; qualified success: a final IOP \( \leq 21 \) mm Hg or \( \geq 5 \) mm Hg aided by topical antiglaucoma medications; failure: an IOP greater than \( 21 \) mm Hg with medications, phthisis, loss of light perception, or a need for further glaucoma surgery. Success rates were evaluated for the time periods of 3-6, 8-12, and 16-24 weeks and 6-12 months and more than 12 months of follow-up. Hypertensive phase (HP) was defined as IOP \( > 21 \) mm Hg during the first 3 months after surgery.

Paired t test was used to compare pre- with postoperative IOP. Pearson correlation was used to assess the relationship between baseline IOP and postoperative IOP. We used Wilcoxon test to compare the number of antiglaucoma medications before and after surgery. Student t test was used to evaluate the association of age and outcome. Chi square test was used to test the effect of previous surgery on the outcome (in the subset with diabetes mellitus as the underlying pathology).

Results

The mean age was 49 (14-80) years. Eight were female. The underlying pathologies were proliferative diabetic retinopathy (11 cases), central retinal vein occlusion (5 cases), and Eale’s disease (1 case). In 8 patients incomplete retinal photocoagulation had been performed prior to surgery. In the remaining, no laser therapy had been possible due to vitreous hemorrhage. In all 15 eyes in which the angle was visible preoperatively, the angle was closed. Table 1 shows the characteristics of the study group.

The mean follow-up time was 14.2 months (range 6 to 28 months). Complete success was achieved in 8 cases (44%) with an overall (complete and qualified) success rate of 72%. There were 5 cases (28%) of failure (Table 1). Mean preoperative IOP was 53.3±10 mm Hg and mean postoperative IOP was 16.3±7.1 mm Hg at the last visit (P<0.0001). Mean preoperative IOP was significantly higher than all of the mean postoperative IOPs of all follow-up visits (P<0.0004 for all) (Table 2 and Figure 1). The mean of the minimum and maximum postoperative IOPs were 11 and 22 mm Hg respectively. The average number of anti-glaucoma medications used preoperatively was 2.7±0.79 and postoperatively was 0.94±0.98 (P=0.001).

VA was stabilized or improved in 14 eyes (77.7%) and worsened in 4 eyes (22.2%). 2 patients lost light perception postoperatively. In 3 patients VA improved more than 3 Snellen lines.

No intraoperative complication was noted. The most common postoperative complication was mild anterior chamber hyphema that occurred in 5 cases (28%). All resolved uneventfully. Mild vitreous hemorrhage, choroidal effusion, and corneal edema, each occurred in one case and resolved uneventfully. We observed cataract in 3 eyes (16.6%), hypotony, and epiretinal membrane formations each in one eye. Corneal ulcer occurred in one eye which was controlled medically. Two cases developed phthisis bulbi [Optic atrophy that was an associated sign was noticed in 8 cases (44.5%) in the follow-ups. HP occurred in 7 patients (38.8%) at mean 6.7 weeks postoperation; all of them but 1 responded to medical therapy (Table 1)].

Age was marginally associated with the outcome, with those who failed were on average 17.5 years younger (P=0.08). In cases with the diabetes mellitus as the underlying disease, there was a significant association between the history of previous surgery and the outcome, and actually all who succeeded had had previous surgery (mostly cataract extraction) but all who failed had not (P=0.005).
<table>
<thead>
<tr>
<th>No</th>
<th>Sex/Age/Eye</th>
<th>Underlying disease</th>
<th>PRP</th>
<th>VA</th>
<th>Baseline previous surgery and/or lens status</th>
<th>IOP</th>
<th>Follow up in months</th>
<th>Final IOP</th>
<th>Number of postoperative medications</th>
<th>Postoperative minimum and maximum</th>
<th>Final VA</th>
<th>complications</th>
<th>outcome</th>
<th>Optic atrophy</th>
<th>HP/TIME (WEEK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F/43/R</td>
<td>DR</td>
<td>+</td>
<td>5/200</td>
<td>Vitrectomy, Aphakic</td>
<td>58</td>
<td>6</td>
<td>14</td>
<td>1</td>
<td>14-22</td>
<td>20/100</td>
<td>Postoperative hyphema</td>
<td>CS -</td>
<td>+/8</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>M/53/L</td>
<td>DR</td>
<td>+</td>
<td>5/200</td>
<td>Cataract extraction</td>
<td>60</td>
<td>28</td>
<td>14</td>
<td>0</td>
<td>15</td>
<td>20/800</td>
<td>None</td>
<td>CS +</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>M/57/R</td>
<td>CRVO</td>
<td>-</td>
<td>20/800</td>
<td>Cataract extraction</td>
<td>50</td>
<td>16</td>
<td>16</td>
<td>0</td>
<td>14-16</td>
<td>6/200</td>
<td>None</td>
<td>CS +</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>M/65/R</td>
<td>DR</td>
<td>+</td>
<td>20/800</td>
<td>Cataract extraction</td>
<td>48</td>
<td>14</td>
<td>15</td>
<td>2</td>
<td>6-34</td>
<td>1/200</td>
<td>None</td>
<td>CS +</td>
<td>+/2</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>F/80/R</td>
<td>CRVO</td>
<td>-</td>
<td>20/800</td>
<td>Cataract extraction</td>
<td>50</td>
<td>15</td>
<td>13</td>
<td>0</td>
<td>10-14</td>
<td>3/200</td>
<td>Cataract</td>
<td>CS +</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>M/73/R</td>
<td>DR</td>
<td>-</td>
<td>3/200</td>
<td>Cataract extraction</td>
<td>55</td>
<td>15</td>
<td>13</td>
<td>0</td>
<td>13</td>
<td>20/100</td>
<td>Hyphema and epiretinal membrane formation</td>
<td>CS -</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>M/67/R</td>
<td>DR</td>
<td>-</td>
<td>20/400</td>
<td>Cataract extraction</td>
<td>60</td>
<td>10</td>
<td>13</td>
<td>0</td>
<td>13-14</td>
<td>20/400</td>
<td>None</td>
<td>CS +</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>M/67/L</td>
<td>DR</td>
<td>-</td>
<td>20/200</td>
<td>Cataract extraction</td>
<td>65</td>
<td>10</td>
<td>12</td>
<td>0</td>
<td>12-14</td>
<td>20/200</td>
<td>Postoperative hyphema</td>
<td>CS -</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>M/15/R</td>
<td>CRVO</td>
<td>-</td>
<td>20/800</td>
<td>Vitrectomy, Aphakic</td>
<td>45</td>
<td>28</td>
<td>30</td>
<td>3</td>
<td>30</td>
<td>20/100</td>
<td>Corneal ulcer</td>
<td>F + +/10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>F/59/L</td>
<td>DR</td>
<td>+</td>
<td>20/1600</td>
<td>Cataract extraction</td>
<td>40</td>
<td>16</td>
<td>14</td>
<td>0</td>
<td>6-20</td>
<td>20/1600</td>
<td>None</td>
<td>CS +</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>F/34/L</td>
<td>CRVO</td>
<td>-</td>
<td>20/1600</td>
<td>Vitrectomy, Phakic Cataract</td>
<td>56</td>
<td>14</td>
<td>15</td>
<td>2</td>
<td>6-24</td>
<td>1/200</td>
<td>Choroidal effusion</td>
<td>CS -</td>
<td>+/10</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>F/14/L</td>
<td>Eale’s Disease</td>
<td>-</td>
<td>20/800</td>
<td>Vitrectomy, Cataract</td>
<td>40</td>
<td>6</td>
<td>18</td>
<td>1</td>
<td>8-20</td>
<td>20/400</td>
<td>None</td>
<td>QS -</td>
<td>+/13</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>M/44/L</td>
<td>DR</td>
<td>+</td>
<td>6/200</td>
<td>Cataract extraction</td>
<td>40</td>
<td>15</td>
<td>30</td>
<td>3</td>
<td>20-34</td>
<td>10/200</td>
<td>Vitreous cavity hemorrhage, Cataract and phthisis bulbi</td>
<td>F -</td>
<td>+/5</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>F/61/L</td>
<td>DR</td>
<td>-</td>
<td>2/200</td>
<td>Cataract extraction</td>
<td>38</td>
<td>6</td>
<td>6</td>
<td>1</td>
<td>Max: 20</td>
<td>NLP</td>
<td>None</td>
<td>F -</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>M/45/R</td>
<td>DR</td>
<td>-</td>
<td>20/800</td>
<td>Cataract extraction</td>
<td>70</td>
<td>15</td>
<td>14</td>
<td>0</td>
<td>14-24</td>
<td>20/100</td>
<td>Hypotony, hyphema, cataract, exudative retinal detachment, and phthisis bulbi</td>
<td>CS +</td>
<td>+/5</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>F/22/L</td>
<td>CRVO</td>
<td>-</td>
<td>20/800</td>
<td>Cataract extraction</td>
<td>65</td>
<td>23</td>
<td>8</td>
<td>0</td>
<td>4-8</td>
<td>NLP</td>
<td>None</td>
<td>F -</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>F/45/R</td>
<td>DR</td>
<td>+</td>
<td>20/1600</td>
<td>Cataract extraction</td>
<td>58</td>
<td>11</td>
<td>38</td>
<td>3</td>
<td>38</td>
<td>LP</td>
<td>None</td>
<td>F -</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>M/58/L</td>
<td>DR</td>
<td>+</td>
<td>20/800</td>
<td>Cataract extraction</td>
<td>62</td>
<td>9</td>
<td>16</td>
<td>1</td>
<td>16-26</td>
<td>20/100</td>
<td>Hyphema</td>
<td>CS +</td>
<td>+/4</td>
<td></td>
</tr>
</tbody>
</table>

F: female
DR: diabetic retinopathy
IOP: intraocular ocular pressure
CS: complete success
By vitrectomy we refer to pars plana deep vitrectomy

Table 2. Success rates and mean postoperative IOPs of the cases at different follow up times

<table>
<thead>
<tr>
<th>Follow up time</th>
<th>3-6 weeks</th>
<th>8-12 weeks</th>
<th>16-24 weeks</th>
<th>6-12 months</th>
<th>&gt;12 month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean IOP (mm Hg)**</td>
<td>15.4</td>
<td>15.2</td>
<td>16.7</td>
<td>16.7</td>
<td>16.3</td>
</tr>
<tr>
<td>No. of cases at the follow up</td>
<td>12</td>
<td>15</td>
<td>9</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td>Success rate (Qualified and complete)</td>
<td>75%</td>
<td>93%</td>
<td>100%</td>
<td>92%</td>
<td>72.7%</td>
</tr>
</tbody>
</table>

** Comparing to the baseline IOP, all P values of paired t tests were less than 0.0004.
Discussion

Despite recent advances in the surgical management of glaucoma, there is no consensus about the management of NVG.

There are two clear issues to be addressed: firstly management of the underlying disease and secondly reduction of IOP.

Panretinal photocoagulation and cryotherapy are helpful in inducing regression of iris neovascularization, but when synechial formation is advanced, these techniques are generally ineffective in controlling IOP.\(^8-10\) Additionally, response to panretinal photocoagulation—in terms of regression of neovascularization and reduction in IOP—is delayed (a period of up to 60 days is required for the benefits to become evident\(^9\)). There are several potential benefits of early IOP reduction on the natural course of NVG; retinal and choroidal perfusion in eyes with underlying pathologies like diabetic retinopathy and retinal vein occlusion can be restored faster\(^2\), ongoing optic nerve damage will stop\(^2\), or slow down and the drive for iris neovascularization will be inhibited. Severely elevated IOP results in breakdown of the blood-aqueous barrier and iris neovascularization is exacerbated as the breakdown increases the level of proteins and alters proportions of growth factors such as vascular endothelial growth factor in the ocular media.\(^1\)

Cyclodestructive procedures are effective at reducing IOP but they cannot be titrated and, as the term implies, they cause irreversible damage to intraocular tissues.\(^11\) They also have a relatively high incidence of complications, including hypotony and visual loss with a reported loss of light perception in 25 to 58% of the patients\(^12-15\) or failure to maintain adequate pressure control.\(^11\)

There are four main approaches to the management of NVG, each of these approaches has its own advantages and disadvantages:

1. Trabeculectomy
2. Drainage devices
3. Pars plana vitrectomy
4. Combination of above methods

The success rate of conventional trabeculectomy in active NVG has been reported to be between11-67%.\(^1,16\) This relatively low success rate is probably due to a state of generalized ocular ischemia and enhanced fibroproliferative response. With the use of adjuncts such as 5-fluorouracil and mitomycin-C, trabeculectomy has achieved success rates as high as 75%.\(^3,17\)

Drainage devices have improved the management of NVG. Variable success rates for IOP control have been reported ranging 47 to 96% for Schocket\(^1,19\), Molteno\(^20\), Baerveldt\(^2\), and Ahmed implants (without pars plana vitrectomy)\(^4,21,22\) in patients with NVG. Ahmed shunt implants have reported better in IOP control in the immediate postoperative period (days 1 to 7).\(^21\) Previous studies have also shown that the use of valved drainage shunts (Ahmed) decreases the rate of hypotony and flat anterior chamber and their associated complications.\(^23\)

A combined pars plana vitrectomy and filtering procedure has been effective in lowering the IOP in 50%-90.5%\(^24\) of cases but has been reported to be associated with severe fibrinous exudation in 76% of the cases.\(^5\) Loss of vision may occur in 11%-24% of the eyes and 50% of patients needed further surgery to control IOP.\(^24\)

Pars plana vitrectomy (with or without pars plana tube implantation) is now performed in selected cases of glaucoma associated with shallow and/or extensively closed anterior chamber angle, aphakia, and pseudophakia, in NVG, and in complicated and intractable glaucoma.\(^3,5,11,25-28\) Placement of an implant through the pars plana and away from anterior chamber eliminates some of the complications associated with anterior chamber tube insertion such as endothelial touch, and hyphema.\(^1\) But posterior segment complications associated with this technique such as retinal detachment (6%), obstruction of the tube’s tip by vitreous (9%), epiretinal membrane (9%), and cystoid macular edema (3%) mean this surgical procedure should be used selectively. The technique is most appropriate for glaucomatous eyes with very shallow or no peripheral anterior chamber associated with a retinal pathology for which vitrectomy is being performed primarily such as NVG with vitreous hemorrhage.\(^29\) Although recent studies\(^1,3\) suggest that pars plana vitrectomy combined with placement of an
implant tube is equally effective whether the tube is implanted into the anterior chamber or through the pars plana.

In 1991, Lloyd et al. reported 10 patients who underwent combined Molteno implantation and pars plana vitrectomy for NVG with an overall success rate of 60%.5 Lluttrull et al. reported 22 patients with NVG in 1995 for whom pars plana implants were used; their overall success rate in controlling IOP was 91%. VA was preserved in all but three cases and none of the eyes became hypotonus. The most common postoperative complication was mild choroidal effusion in 36% of the cases.3 But following to this report in 2000 he reported larger series of patients (31 persons) with NVG who underwent pneumatically stented Baerveldt implantation with overall success rate 78% (This is comparable to our success rate of 72%), within average 18 months following. Rate of complete success in this study was 52% (44% in our study) and qualified success rate was 26% (28% in our study). 13% of patients in this report lost their light perception (in our study this rate is 11%).5 The complications rate in last report, that included patients with complicated glaucoma, were 36% choroidal effusion, 4% cataract formation, 8% retinal detachment, 4% massive choroidal hemorrhage. Visual acuity was improved by two or more Snellen lines in 22% of patients.26 More recently Chalam et al.1 compared pars plana modified Baerveldt implant with Neodymium: YAG laser cyclophotocoagulation in NVG. The cumulative proportion of failure in the latter group was 23% compared to 5.6% in the former. 23% of the eyes in the laser group lost light perception in comparison with 5.6% in the implant group. The incidence of postoperative choroidal effusion in the implant group was 36% which is comparable to reports obtained by Luttrull et al. study.3,26

There are reports of anterior chamber implantation of the Ahmed valve without vitrectomy in patients with NVG and other types of glaucoma.4,21-23 but in our study we have combined pars plana implantation of an Ahmed device with vitrectomy and endolaser photocoagulation in NVG patients with vitreous hemorrhage.

Our overall success rate of 72% is relatively lower than the 78-94% success rates reported by similar studies of pars plana implantation using Molteno and Baerveldt devices respectively.1,3,26 But due to the small sample sizes of these studies (and possible incomparability of cases), it is difficult to infer which method (Molteno, Baerveldt, or Ahmed drainage devices implanted in to the pars plana following pars plana vitrectomy) is definitely superior. However, stabilization or improvement of VA in 77.7% of the cases seems comparable to the 72-86% reported by Luttrull et al.3 Beyond VA stabilization, some of the cases actually experienced VA improvement (in 3 patients VA improved more than 3 Snellen lines).

Serious postoperative complications were relatively low in our patients. The 5% risk of choroidal effusion is considerably less than previous reports (Table 3). Cataract progressed in 3 out of 9 phakic patients. Lower choroidal effusion may be attributable to the type of the implant used (Ahmed) and its superiority in effecting more immediate IOP control, although Luttrull et al.26 has also reported immediate IOP control and avoidance of hypotony with gas tamponade technique.

In 8 (44%) patients we find optic atrophy, we suppose it’s related to prior glaucomatous damage. However previous reports suggest that the plate will be within 2 mm of the optic nerve when placed 8-10 mm from the limbus in the superonasal quadrant in the human eye and may damage optic nerve.30,31 We had only one patient with superonasal implant, then we couldn’t discussed that this may lead to optic atrophy.

We had a low percentage of HP (38.8%) in comparison to Ayyala’s reported rate of 82%.30 However, they defined HP as IOP above 21 mm Hg during the first 6 postoperative months in comparison to the first 3 months in our study. The mean time of occurrence was 6.7 weeks postoperatively. 85% of these patients resolved with or without medication. The HP rate in our study is similar to 40% and 56% reported by Susanna et al.4 and Nouri-Mahdavi et al respectively.23 During follow-up, 85% of the hypertensive patients achieved a satisfactory IOP with or without medication. In our study, HP was not the main reason for failure.
Table 3. Comparison of success and complication rates for different surgical methods for neovascular glaucoma reported in the literature

| Methods and the study | Filtration surgery | Cyclocryotherapy | Anterior chamber tube shunt | Anterior retinal cryoablation | Pars plana vitrectomy and silicone endotamponade | Neodymium-YAG laser cyclophotocoagulation | Pars plana vitrectomy and Baerveldt | Our study: pars plana vitrectomy and Ahmed Valve |
|-----------------------|--------------------|------------------|-----------------------------|-----------------------------|-----------------------------------------------|------------------------------------------|--------------------------------|--------------------------------|--------------------------------|
| Success rate          | 67                 | 34               | 56-80                       | 82                          | 72                                           | 77                                        | 83-95                       | 72.5                         |                                |
| Average follow up     | 23                 | 25               | 12-23                       | 12                          | 12-36                                       | 6                                         | 6-18                         | 14.5                         |                                |
| Complications         |                    |                  |                             |                             |                                              |                                           |                              |                               |                                |
| Flat anterior chamber | 0.5                | 10-60            |                              |                              | 0                                            | 0                                        | 0                           | 0                            |                                |
| Severe hyphema        | 8                  | 6-8              | 23.5                        | 5-30                        | 0                                            | 5-16                                     | 17                          |                               |                                |
| Cataract              | 20                 | 3-30             |                              |                             | 31                                           | 5-16                                     | 17                          |                               |                                |
| Corneal problems      | 3-6                | 6.5              | 12.5                        | 27                          | 11                                           | 11                                      |                             |                               |                                |
| Choroidal effusion    | 9-11               | 0                |                              | 0                           | 36-39                                       | 5.5                                     |                              |                               |                                |
| Hyptotony             | 32-33              | 8-13             | 15                          | 23.5                        | 5.5                                         | 5.5                                     |                              |                               |                                |
| Phtisis bulbi         | 8                  | 13-34            | 1-8                         | 6                           | 23.5                                        | 5.5                                     | 11                          |                               |                                |
| Vitreous hemorrhage   | 3-6                | 13.5             | 5-30                        | 5.5                         |                                              |                                         |                              |                               |                                |
| Retinal detachment    | 1-8                | 0                | 9-30                        | 5.5                         |                                              |                                         |                              |                               |                                |
| Anterior segment necrosis | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lost light perception | 17                 | 25.4-58.5        | 7.5-31                      | 87                          | 31                                          | 23.5                                    | 5-6                         | 11                           |                                |

In patients No. 9 and 17 with qualified and complete failure, the IOP rise occurred after 19 and 5 months of surgery respectively. Cataract progressed in patient No. 14, and the cataract surgery was complicated by severe hyphema. This patient lost light perception.

We identified several possible factors associated with poor outcomes:

First, age was found to be a risk factor for the success of the procedure in our study. Second, previous surgery in people with diabetes mellitus as the underlying disease, there was a highly significant association between the history of previous cataract surgery and the surgical success. Only pseudophakic/aphakic eyes had a successful outcome, which may be due to the accessibility and effective removal of peripheral vitreous strands. Checking the tip of the tube status in the vitreous cavity or a more anterior placement of the tube in the vitreous cavity has also reduced the likelihood of tube obstruction. Luttrull and Chalam did not report this as a significant problem, may be intraocular gas bubble that injected in the vitreous cavity in final step in their patients, reduces the risk of tube obstruction by displacing peripheral vitreous away from the tube head. This raises a question in mind, "Should an intraocular air or gas bubble be placed in eyes undergoing pars plana vitrectomy with pars plana insertion of drainage device to reduce the risk of tube obstruction?"

Encapsulation of the filtration blebs is known to be a late complication,21,33,34 so our study is limited by the length of follow up and our inability to comment on the long-term efficacy of the procedure described.

Conclusion

In conclusion, the combination of pars plana vitrectomy and Ahmed valve implantation seems to be a viable surgical approach in eyes with NVG and coexistent posterior segment pathology. Older and also diabetic patients who had already undergone cataract extraction tended to have a better outcome. Our study is limited due to its retrospective nature, lack of having controls, smallness of sample size, and limited follow up. Modification in the surgical procedure, the
variety of glaucoma devices used, and the heterogeneity of the cases would make the generalizibility of our study as well as similar previous reports hampered. Further prospective randomized trials with a longer duration of follow-up are warranted to evaluate the efficacy and safety of this procedure compared to other established techniques.

References