Endophthalmitis associated with the Ahmed glaucoma valve implant

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G laucoma drainage implants (GDIs) have become an important method of controlling intraocular pressure (IOP) in patients with refractory glaucoma. Surgery with GDIs is associated with similar operative and post-operative complications that may occur after filtering surgery such as hypotony, hyphaema, cataract, corneal decompensation, and failure to control IOP. In addition, several unique complications may develop with GDIs related to the presence of an implanted foreign body such as diplopia and transcorneal tube erosion.

Although endophthalmitis is a rare complication after GDI surgery, the exact rate is not known. Several retrospective studies of GDIs have included a single case or a few cases of endophthalmitis resulting in rates ranging from 0.8% to 6.3%.

We report the rate, clinical course, risk factors, and treatment outcomes of endophthalmitis associated with Ahmed glaucoma valve implant (New World Medical, Rancho Cucamonga, CA, USA) at one institution.

METHODS

This study was reviewed and approved by the institutional review board of the King Khaled Eye Specialist Hospital (KKESH). A computerised relational database search was conducted to identify all patients who were implanted with Ahmed glaucoma valve (AGV) and developed endophthalmitis following surgery at the King Khaled Eye Specialist Hospital in Riyadh, Saudi Arabia, between 1 January 1994 and 30 November 2003. Only medical records of the patients who developed endophthalmitis were retrospectively reviewed. Endophthalmitis developed in nine (1.7%) eyes; the rate was five times higher in children than in adults. Delayed endophthalmitis (developed 6 weeks after surgery) occurred in eight of nine eyes. Conjunctival erosion overlying the AGV tube was present in six of nine eyes. Common organisms isolated in the vitreous included *Haemophilus influenzae* and *Streptococcus* species. Multiple regression analysis revealed that younger age and conjunctival erosion over the tube were significant risk factors associated with endophthalmitis.

CONCLUSION: Endophthalmitis is a rare complication of GDI surgery that appears to be more common in children. Conjunctival disheuscence over the GDI tube seems to represent a major risk factor for endophthalmitis. Prompt surgical revision of an exposed GDI tube is highly recommended.

Multiple surgeons performed the AGV implant procedures. In the majority of cases a limbal based conjunctival flap was created between superior and lateral recti muscles. The valve plate was secured 8–10 mm posterior to the limbus using an 8–0 non-absorbable suture. The tube was cut to an appropriate length and inserted into the anterior chamber through a 23 gauge needle track and covered by either donor sclera, dura, or pericardial patch graft. Autologous scleral patch graft was not used in any of the procedures. Patients younger than 6 months with an axial length less than 22 mm received the paediatric model (AGV; model S1). Otherwise the adult model (AGV; model S2) was used. The AGV was the only glaucoma valve implant used at KKESH during the period of the study and other glaucoma drainage implants were not available for comparison.

Based on the chart review, data of patients who developed endophthalmitis following AGV implant surgery were collected and reviewed. This included demographic information, clinical settings, pertinent operative and preoperative data, culture sites, and type of organisms. In addition, treatments and treatment outcomes were also noted. Diagnosis of endophthalmitis was based on clinical findings and ultrasonography.

A multiple regression analysis was performed to determine how the variables of age (above and below 18 years of age) and the presence or absence of conjunctival erosion related to endophthalmitis. Statistical analyses were conducted using GB STAT 10.0 (Dynamic Microsystems, Inc, Silver Spring, MD, USA).

RESULTS

The relational database search identified 102 patients (113 eyes) under age 18 years (paediatric), and 403 patients (429 eyes) over age 18 years (adult) who underwent AGV surgery.

Abbreviations: AGV, Ahmed glaucoma valve; GDI, glaucoma drainage implant; IOP, intraocular pressure
### Table 1: Demographics, clinical settings, culture sites, and type of organism

<table>
<thead>
<tr>
<th>Patient No</th>
<th>Age (years)</th>
<th>Sex</th>
<th>Glaucoma diagnosis</th>
<th>Mitomycin C use</th>
<th>Implant location</th>
<th>Type of patch graft</th>
<th>Interval (days)</th>
<th>Duration (days)</th>
<th>Presenting visual acuity</th>
<th>Tube erosion</th>
<th>Culture site</th>
<th>Organism(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.8</td>
<td>F</td>
<td>Congenital glaucoma</td>
<td>Yes</td>
<td>IT</td>
<td>Sclera</td>
<td>63</td>
<td>7</td>
<td>NR</td>
<td>No</td>
<td>AC, VIT</td>
<td>Haemophilus influenzae, Streptococcus pneumoniae</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>F</td>
<td>Congenital glaucoma</td>
<td>Yes</td>
<td>ST</td>
<td>Pericardium</td>
<td>30</td>
<td>5</td>
<td>NR</td>
<td>Yes</td>
<td>AC, VIT</td>
<td>Streptococcus pneumoniae</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>F</td>
<td>Congenital glaucoma</td>
<td>Yes</td>
<td>IT</td>
<td>Dura</td>
<td>104</td>
<td>2</td>
<td>NR</td>
<td>Yes</td>
<td>AC, VIT</td>
<td>No growth</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>M</td>
<td>Congenital glaucoma</td>
<td>Yes</td>
<td>ST</td>
<td>Dura</td>
<td>270</td>
<td>5</td>
<td>LP</td>
<td>No</td>
<td>VIT</td>
<td>Streptococcus pneumoniae</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>F</td>
<td>Congenital glaucoma</td>
<td>Yes</td>
<td>ST</td>
<td>Dura</td>
<td>210</td>
<td>2</td>
<td>CF</td>
<td>Yes</td>
<td>AC, VIT</td>
<td>Haemophilus influenzae</td>
</tr>
<tr>
<td>6</td>
<td>43</td>
<td>M</td>
<td>Secondary glaucoma</td>
<td>Yes</td>
<td>ST</td>
<td>Sclera</td>
<td>180</td>
<td>4</td>
<td>CF</td>
<td>Yes</td>
<td>AC, VIT</td>
<td>Streptococcus agalactiae</td>
</tr>
<tr>
<td>7</td>
<td>60</td>
<td>F</td>
<td>Secondary glaucoma</td>
<td>Yes</td>
<td>SN</td>
<td>Sclera</td>
<td>300</td>
<td>1</td>
<td>HM</td>
<td>Yes</td>
<td>VIT</td>
<td>Streptococcus agalactiae</td>
</tr>
<tr>
<td>8</td>
<td>78</td>
<td>M</td>
<td>Secondary glaucoma</td>
<td>No</td>
<td>ST</td>
<td>Dura</td>
<td>306</td>
<td>2</td>
<td>CF</td>
<td>No</td>
<td>VIT</td>
<td>Streptococcus mitis</td>
</tr>
<tr>
<td>9</td>
<td>63</td>
<td>M</td>
<td>Primary glaucoma</td>
<td></td>
<td></td>
<td>Sclera</td>
<td>330</td>
<td>5</td>
<td>Poor LP</td>
<td>No</td>
<td>VIT</td>
<td>Pseudomonas aeruginosa</td>
</tr>
</tbody>
</table>

**Notes:**
- AC, anterior chamber; CF, counting fingers; F, female; HM, hand movements; LP, light perception; IT, inferotemporal; M, male; NR, not recorded since patient was sedated; SN, superonasal; ST, superotemporal; VIT, vitreous.
- Interval between AGV implant surgery and endophthalmitis diagnosis: duration of symptoms before diagnosis of endophthalmitis.

**Results:**
- Visual acuity was presented for each patient.
- Organisms identified included Haemophilus influenzae, Streptococcus pneumoniae, and Pseudomonas aeruginosa.
- The mean age of patients at the time of endophthalmitis was 28.3 years (range 0.8–78 years; 2.2 years for pediatric age group and four (0.05%) in the adult age group.
- The mean number of previous glaucoma surgeries was 1.1 for the pediatric group and 0.8–78 years for the adult group.
- Endophthalmitis was detected in nine (1.7%) of these eyes (Table 1; five (4.4%) in the pediatric age group and four (0.05%) in the adult age group.

**Discussion:**
- The infection developed in one of nine eyes within the first few weeks of surgery.
- The mean interval between AGV implant surgery and endophthalmitis was 206 days (range 63–630 days) delayed onset endophthalmitis (developed more than 20/100). One child had history of conjunctivitis 10 days before development of endophthalmitis.

**Conclusion:**
- The most common previous glaucoma surgery was trabeculectomy with antimetabolite (mitomycin C was used as an adjunct in eight of nine eyes). Three eyes received the paediatric model and six eyes received the adult model of the AGV respectively. No patient had more than one implant in any eye.

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*Note: The table content is a summary of the data presented in the text.*
Three of nine patients had a final visual acuity outcome of no light perception and six of nine patients attained a final visual acuity of better than 20/200.

**DISCUSSION**

Glaucoma drainage implants (GDIs) have become increasingly useful in surgical management of glaucoma that is refractory to standard filtering surgery. Although intraocular pressure may be successfully controlled, postoperative complications do occur. This large series from a single institution highlights the clinical features, risk factors, and outcomes that have been previously only presented in small case series.

In our series the overall rate of endophthalmitis was 1.7%. We compared this rate with an analysis of endophthalmitis presentations were not seen in our series. The rate of endophthalmitis in this series was fairly consistent with that reported in the literature (mean 2.0%; range 0.8%–6.3%); however, the rate of endophthalmitis following AGV implant surgery in the paediatric age group was five times higher than the rate reported for glaucoma implants in adults (0–2%).

Our series suggest that most cases (eight of nine) of endophthalmitis secondary to AGV implant surgery were delayed in onset (6 weeks after surgery). This concurs with isolated cases in series or individual case reports which also suggested most endophthalmitis following GDIs were delayed in onset. However, isolated cases of early endophthalmitis associated with GDIs have also been reported. Perkins reported early postoperative endophthalmitis following placement of a Molteno implant in an adult patient. In our series the patient with early endophthalmitis was a child. Moreover, endophthalmitis has also been described after tube repositioning and needling. Such presentations were not seen in our series.

Tube exposure following conjunctival erosion in AGV implant appeared to be a major risk factor for the development of endophthalmitis as shown by regression analysis in our series. Other series have also reported conjunctival tube erosion without risk analysis. Gedde et al reported four cases of endophthalmitis associated with GDIs. In their series all cases were associated with conjunctival erosion overlying the tube. Recently, Morad et al reported three cases of endophthalmitis following AGV. Two of these cases were noted to have tube exposure at the time of presentation. In our series, six of nine eyes were found to have conjunctival erosion over the tube at the time of presentation. The conjunctival erosion was at the limbus in three of six eyes.

**Table 2** Treatment performed and clinical outcomes

<table>
<thead>
<tr>
<th>Patient</th>
<th>Top/injection</th>
<th>V pars plana vitrectomy/injection</th>
<th>Pre-infection</th>
<th>Post-infection</th>
</tr>
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<tbody>
<tr>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>PPV</td>
<td>V, A</td>
<td>No</td>
<td>V</td>
</tr>
<tr>
<td>2</td>
<td>Top</td>
<td>V, C</td>
<td>Yes</td>
<td>V, B</td>
</tr>
<tr>
<td>3</td>
<td>Top</td>
<td>V, A</td>
<td>Yes</td>
<td>_</td>
</tr>
<tr>
<td>4</td>
<td>Top</td>
<td>V, A</td>
<td>No</td>
<td>V, E</td>
</tr>
<tr>
<td>5</td>
<td>PPV</td>
<td>V, C, D</td>
<td>No</td>
<td>C, CE</td>
</tr>
<tr>
<td>6</td>
<td>Top</td>
<td>V, A</td>
<td>No</td>
<td>_</td>
</tr>
<tr>
<td>7</td>
<td>Top</td>
<td>V, A, D</td>
<td>Yes</td>
<td>V, P</td>
</tr>
<tr>
<td>8</td>
<td>PPV</td>
<td>V, C, D</td>
<td>No</td>
<td>V, B</td>
</tr>
<tr>
<td>9</td>
<td>Primary evisceration</td>
<td>NA</td>
<td>Yes</td>
<td>_</td>
</tr>
</tbody>
</table>

A, amikacin; AM, ampicillin; B, bacitracin; C, ceftazidime; CE, cefaclor; CF, counting fingers; D, dexamethasone; E, erythromycin; FL, follow light; FO, follow objects; HM, hand movements; LP, light perception; NA, not applicable; NLP, no light perception; P, penicillin; T, tobramycin; V, vancomycin.

**Table 3** Endophthalmitis associated with GDIs reported in various studies

<table>
<thead>
<tr>
<th>Source</th>
<th>Study date</th>
<th>Number of cases</th>
<th>Number of endophthalmitis cases</th>
<th>% of endophthalmitis</th>
<th>Type of implant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Munoz et al</td>
<td>1991</td>
<td>53</td>
<td>1</td>
<td>1.9</td>
<td>Molteno</td>
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<tr>
<td>Hill et al</td>
<td>1991</td>
<td>70</td>
<td>1</td>
<td>1.4</td>
<td>Molteno</td>
</tr>
<tr>
<td>Chishara et al</td>
<td>1992</td>
<td>16</td>
<td>1</td>
<td>6.3</td>
<td>White pump</td>
</tr>
<tr>
<td>The Krupin Eye Valve Filtering Surgery Study Group</td>
<td>1994</td>
<td>50</td>
<td>1</td>
<td>2</td>
<td>Krupin valve with disc</td>
</tr>
<tr>
<td>Lloyd et al</td>
<td>1994</td>
<td>73</td>
<td>1</td>
<td>1.4</td>
<td>Baerveldt</td>
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<tr>
<td>Perkins et al</td>
<td>1995</td>
<td>21</td>
<td>1</td>
<td>4.8</td>
<td>Molteno</td>
</tr>
<tr>
<td>Price and Wellemeyer</td>
<td>1995</td>
<td>76</td>
<td>1</td>
<td>1.3</td>
<td>Molteno</td>
</tr>
<tr>
<td>Law et al</td>
<td>1996</td>
<td>38</td>
<td>1</td>
<td>2.6</td>
<td>Molteno</td>
</tr>
<tr>
<td>Nguyen et al</td>
<td>1997</td>
<td>107</td>
<td>1</td>
<td>0.9</td>
<td>Baerveldt</td>
</tr>
<tr>
<td>Diodeyere et al</td>
<td>2001</td>
<td>35</td>
<td>1</td>
<td>2.6</td>
<td>Ahmed</td>
</tr>
<tr>
<td>Krishna et al</td>
<td>2001</td>
<td>65</td>
<td>2</td>
<td>3.1</td>
<td>Baerveldt</td>
</tr>
<tr>
<td>Taglia et al</td>
<td>2002</td>
<td>27</td>
<td>1</td>
<td>3.7</td>
<td>Molteno</td>
</tr>
<tr>
<td>Morad et al</td>
<td>2003</td>
<td>60</td>
<td>3</td>
<td>5</td>
<td>Ahmed</td>
</tr>
<tr>
<td>Sash et al</td>
<td>2003</td>
<td>124</td>
<td>1</td>
<td>0.8</td>
<td>Baerveldt</td>
</tr>
<tr>
<td>Tsai et al</td>
<td>2003</td>
<td>70</td>
<td>1</td>
<td>1.4</td>
<td>Ahmed</td>
</tr>
<tr>
<td>Present study</td>
<td>2004</td>
<td>542</td>
<td>9</td>
<td>1.7</td>
<td>Ahmed</td>
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</tbody>
</table>

Total 1427 27 1.9
and at other locations in others. It did not appear to be related to the conjunctival incision line which was a few millimetres away from the limbus in the majority of the cases. Reasons for conjunctival erosion over patch grafts and tube are not totally clear and are possibly multifactorial. Most patients had multiple previous conjunctival surgeries with exposure to antimetabolites; in addition seven of nine eyes had received mitomycin C during implant surgery and this may have played a part in the erosion of the conjunctiva. The rate of tube erosion through the conjunctiva can be reduced by covering the anterior portion of the tube by a patch graft. Different tissues have been utilised as a patch graft and these include sclera,29 dura mater,30 fascia lata,31 pericardium,32 and autologous sclera.33 Conjunctival erosion overlying the tube in our series occurred despite the use of a dura mater patch graft in five eyes, a donor sclera patch graft in three eyes, and a pericardial patch graft in one eye. The eroded conjunctiva surrounding the tube probably serves as a conduit by which normal flora may pass from the ocular surface into the eye. Given the increased risk of endophthalmitis, we recommend prompt surgical revision in all cases in which there is an exposed tube of a GDI.

Organisms causing endophthalmitis following GDIs in children are Haemophilus influenzae, Streptococcus pneumoniae or both. In our series, cultures revealed Streptococcus pneumoniae in two eyes and H influenzae in one eye. Both organisms were cultured from one eye (patient 4). Gedde et al.,4 and Al-Torbaq and Edward20 reported H influenzae caused endophthalmitis following GDIs in two separate paediatric patients. This is not surprising as H influenzae and Streptococcus pneumoniae are part of the normal bacterial flora of the conjunctiva and upper respiratory tract, and a common cause of infection in both tissues.24 25 In adults, organisms causing GDI related endophthalmitis include coagulase negative and coagulase positive Staphylococcus species, Streptococcus pneumoniae, and Pseudomonas aeruginosa.12 26 In our series other Gram positive organisms including Streptococcus agalactiae and Streptococcus mitis were isolated from the vitreous sample in two separate eyes. Pseudomonas aeruginosa was a cause of severe endophthalmitis in one eye that was initially treated by evisceration. It appears that in general, bacterial flora causing GDI related endophthalmitis in Saudi Arabia are similar to those reported in patients from the Western hemisphere. Recommendations for the removal of the glaucoma shunt device at the time of treatment in an eye with endophthalmitis remain unclear. Gedde and Perkins recommended shunt removal at the time of treatment because of concerns the shunt might serve as a reservoir for the infectious organism.4 26 In contrast, others have reported successful outcomes with intravitreal antibiotics without removing the shunt device.25 30 In our series, there appeared to be no difference in final visual acuity relating to whether the implant was or was not removed at the time of treatment. However, it must be noted our sample size is too small to make any definite recommendations.

It is unclear whether pars plana vitrectomy with intravitreal antibiotics injection or vitreous tap with intravitreal antibiotics injection alone is the treatment of choice for GDI related endophthalmitis. Morad et al.10 reported three cases of endophthalmitis following AGV implant surgery. All cases were treated with implant removal, vitrectomy and intravitreal antibiotics; two eyes progressed to phthisis. Francis et al.25 reported poor outcome with vitreous tap and intravitreal antibiotics injection in a patient who developed endophthalmitis following a Baerveldt drainage implant despite rapid treatment. In our series it appeared that either initial approach to treatment (pars plana vitrectomy with intravitreal antibiotics or intravitreal antibiotic injection alone) did not have a significant impact on the final visual outcome. These findings may have been influenced by the relatively long interval between onset of symptoms and presentation.

In our series the visual outcome is poor. Of note is that most patients had poor visual acuity before the onset of infection because of either advanced glaucoma or corneal opacities.

In conclusion, endophthalmitis is a rare complication following AGV implant surgery and is usually delayed in onset. The rate of endophthalmitis following AGV implant surgery in the paediatric age group was five times higher than in adults. Conjunctival erosions over the AGV tube were present in most cases and seem to represent a major risk factor for endophthalmitis. Prompt surgical revision of such erosions is highly recommended.

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