Combined Trabeculotomy and Trabeculectomy as an Initial Procedure in Uncomplicated Congenital Glaucoma

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Objective: To review the results of combined trabeculotomy and trabeculectomy as a primary procedure in congenital glaucoma.

Methods: A retrospective review of 100 consecutive eyes in 60 children undergoing surgery from December 30, 1991, to April 17, 1996. Features at initial examination, ie, corneal size and clarity, presence or absence of anterior segment structural abnormalities, and intraocular pressure (IOP), were noted. Data pertaining to perioperative use of mitomycin and the occurrence of complications were collected. After surgery, all patients had IOP, corneal integrity, and any postoperative complication recorded under chloral hydrate sedation.

Results: Mean preoperative IOP was 31 mm Hg. Average horizontal corneal diameter was 12.60 mm. Ninety-five eyes had corneal opacification. Twenty-nine eyes had additional anterior segment anomalies, with ectropion uveae (n = 11), Peters anomaly (n = 9), and partial aniridia (n = 7) being the most common. Mitomycin (0.2 or 0.4 mg/mL) was used in 87 eyes. Eleven eyes sustained hyphemas during or just after surgery. Total average follow-up was 304 days. Eyes in which no coexistent anterior segment anomalies were present had a 78% (49 eyes) operative success (IOP, ≤21 mm Hg); however, in eyes with associated anterior segment anomalies, the success rate was much lower (45% [18 eyes]). The difference in success rates between both groups was statistically significant (P = .03, χ² test).

Conclusions: Primary combined trabeculotomy and trabeculectomy was a useful initial procedure in uncomplicated congenital glaucoma. This was particularly true where corneal opacification, as in nearly all our eyes, precluded goniotomy; however, where other stigmata of anterior segment dysgenesis coexisted, results were significantly poorer.


IN SAUDI ARABIA, congenital glaucoma is more frequent and of greater severity than in other parts of the world. Clear corneas, which allow goniotomy, are rare. Both trabeculotomy ab externo and trabeculectomy have been reported to be successful in congenital glaucoma with corneal opacification.1,2 Recently, Elder3 reported good results in a procedure combining trabeculotomy and trabeculectomy. He found a 93.5% success rate for the combined procedure compared with 72.0% for primary trabeculectomy with a 24-month follow-up; however, the numbers were relatively small (n = 16). At the King Khaled Eye Specialist Hospital, Riyadh, Saudi Arabia, we have performed combined trabeculotomy and trabeculectomy (CTT), often with the application of mitomycin, for the past 4 years as the primary procedure of choice. The purpose of our study was to evaluate our results.

RESULTS

A total of 29 eyes had an abnormal anterior chamber, and 63 eyes had a normal anterior chamber consistent with primary congenital glaucoma. In 8 eyes, no documentation of anterior chamber status was available. Patient demographic data are summarized in Table 1. All patients underwent CTT; of these, 87 eyes received mitomycin. Forty of the 87 eyes received the 0.2-mg/mL dose placed for 2 to 5 minutes, and 47 received the 0.4-mg/mL dose placed for 2 to 5 minutes. Results of mitomycin use are shown in Table 2.

Perioperative or postoperative complications included hyphema (n = 11), corectopia (n = 3), mild anterior lens opacity (n = 1), mild posterior synechia (n = 1), vitreous loss on posterior extension of the trabeculotomy incision (n = 1), and a transiently flat chamber after surgery (n = 1). Clinical follow-up was at 3 weeks and 3 months after surgery. At 3 months, an examination was performed under chloral hydrate sedation, and further therapeutic options were based on the results, if necessary. An IOP of less than 21 mm Hg was deemed to be a successful outcome.

Total average follow-up was 304 days. Where surgery was successful, mean fol-
PATIENTS AND METHODS

A retrospective medical chart review was performed of all patients who underwent CTT as a primary procedure from December 30, 1991, through April 17, 1996. For most patients, the most reliable initial examination was under anesthesia, although a few were examined under chloral hydrate sedation before surgery. The following parameters were noted: intraocular pressure (IOP), corneal diameter, corneal opacification, the presence or absence of anterior chamber structural abnormalities such as Peters or Rieger anomalies, ectropion uveae, and partial aniridia. The dates of surgery, use of antimetabolites, and occurrence of complications were also documented. The Research Council of the King Khaled Eye Specialist Hospital approved the project.

The surgical approach, with minor variations for individual surgeons, consisted of fashioning a combined limbus-based conjunctival and Tenon flap that was then dissected off the sclera in an anterior direction until the limbus was bared. Pockets between Tenon flap and the sclera above, below, and behind the initial conjunctival incision were created. A partial-thickness scleral trapezoid of 4.0 × 4.0 mm was dissected in an anterior direction until the limbus was reached. Limbal dissection at this stage was conservative because inadvertent perforation precluded the use of antimetabolites. Into the pockets between the sclera and Tenon flap, discs containing mitomycin were placed. Discs were also placed above and below the scleral trapdoor and left in situ for 2 to 5 minutes. Following their removal, copious irrigation with balanced salt solution was undertaken. The concentration of mitomycin and the length of time it was applied depended on the surgeon’s preference for the following doses of mitomycin: 0.2 or 0.4 mg/mL, applied for 2 to 3 minutes. In general, when mitomycin was not used, it was because inadvertent ocular penetration or exposure of choroid or ciliary body was believed to preclude its use. A paracentesis was routinely performed, and viscoelastic material was instilled into the anterior chamber. Further dissection of the scleral trapdoor anteriorly into clear cornea followed. A Grieshaber 681.01 blade (Grieshaver, Kennesaw, Ga) was used to cut down onto the Schlemm canal, which was usually identified by a gush of aqueous, sometimes tinged with blood. In some instances, the Schlemm canal was deroofed for 1 to 2 mm on either side of the original radial incision. The canal was threaded with 6-0 nylon to ensure that no false passages had been created. Following this, the trabeculotomy was introduced into the Schlemm canal, and a trabeculotomy was performed with a clockwise and counterclockwise rotation of the instrument through 90° (Figure 1). In a site separate from the canalotomy (but under the scleral flap), a trabeculotomy and peripheral iridectomy were performed (Figure 2). The trabeculotomy incision was not closed. The scleral flap was closed with two 10-0 nylon sutures. Tenon space and conjunctiva in 2 layers were closed with running 10-0 polyglycolic acid (Dexon; Ethicon Limited, Edinburgh, United Kingdom) or 9-0 or 10-0 polyglactin 910 sutures (Vicryl; Ethicon Limited) on tapered needles. Following surgery, all patients received a combination of polymyxin B sulfate, neomycin sulfate, and dexamethasone (Maxitrol) drops 4 times a day and ointment at night. Depending on the patient’s age, 0.5% or 1.0% atropine sulfate was instilled at night.

Intraocular pressure, corneal integrity, and any postoperative complications were recorded at the first sedated examination 3 months after surgery and at subsequent clinic visits. Finally, the duration of IOP control with or without medications was assessed. All IOP measurements were performed using the pneumotonometer or tonometer (Tonometer O+O Inc, Norwell, Mass). Statistical analysis was performed using individual eyes rather than patients.

low-up was 372 days (range, 83-956 days; SD, 246 days); where surgery was unsuccessful, mean follow-up was 166 days (range, 22-634 days; SD, 141 days). The overall surgical success rate was 67.0%. In 49 eyes (78%) undergoing CTT without coexistent anterior segment anomalies, the IOP was successfully reduced. In eyes with coexistent anterior segment anomalies, the success rate was much lower, ie, 18 eyes (45%) had a reasonable IOP after CTT. The difference in success rates between both groups was statistically significant (P = .03, χ² test). In 8 eyes with completely opacified corneas, 5 had successful results. Five of the 11 eyes in which a surgically related hyphema developed had normal anterior chambers, another 3 eyes had anterior segment anomalies, and the status of the anterior chamber was not available in 1 eye. Of these 11 eyes, 6 had a successful operation, whereas surgery failed in 5. Of these latter 5 eyes, 3 eyes had anterior segment abnormalities, anterior chamber in 1 eye was normal, and status was undocumented in 1 eye.

COMMENT

Trabeculotomy is enjoying resurgence and is now being performed in chronic open-angle glaucoma, in primary angle-closure glaucoma in conjunction with phacoemul-
nous system. Similarly in congenital glaucoma, CTT theoretically provides the following 2 mechanisms for IOP reduction: trabeculotomy reduces increased trabecular meshwork resistance, and aqueous filtration is increased via trabeculectomy. Turut et al\textsuperscript{11} report an approximately 80% success rate in congenital glaucoma with CTT. This result is similar to our success rate in uncomplicated congenital glaucoma. Otherwise, only scattered reports exist in the literature.\textsuperscript{2} The benefit of adding a trabeculectomy to primary trabeculotomy has yet to be proven. It is not clear how long the trabeculotomy remains functional in this setting. Equally unclear is how the additional trabeculectomy influences aqueous filtration through the trabeculotomy.

Regeneration of trabecular meshwork has been shown to occur in monkeys.\textsuperscript{12,13} It is not known whether trabecular regeneration occurs in humans. In the series by Board and Shields,\textsuperscript{8} no gonioscopic evidence of trabecular meshwork separation was noted following trabeculotomy. However, many reports attest to the long-term ability of trabeculotomy to reduce IOP.\textsuperscript{5,14,15} In none of these studies was the incision that opened the outer wall of the Schlemm canal closed. It is possible that filtration occurs through this canalotomy. Indeed Gillies and Brooks\textsuperscript{6} report long-term results with fistulizing trabeculotomy that were as successful as trabeculectomy. In our study, we did not close the incision over the Schlemm canal, adding a possible third route for the egress of aqueous.

We used mitomycin in primary procedures because we believed that success in the initial procedure was a priority. Failure to control IOP initially usually increases the risk for persistent corneal opacification or anisometropic amblyopia due to increased axial length; however, long-term follow-up is required to elucidate concerns regarding the use of mitomycin in this age group. Consistent use of mitomycin may have maintained functional fistulas through the trabeculectomy site or through the outer wall of the Schlemm canal. The use of mitomycin may have improved our long-term results. In general, diffuse filtration blebs are noted. Thin cystic or leaking blebs were not seen in this age group. It is possible that the very active reparative process in young children retarded or delayed the occurrence of these mitomycin-associated complications. Follow-up of 1 year is too short to deduce any definitive conclusions on this issue. It is of interest that there were relatively more surgical failures with the higher dose of mitomycin (Table 2). It is not clear why.

In our series, CTT was associated with poorer results when undertaken in secondary or complicated childhood glaucoma. This probably related to the overall poorer prognosis associated with complicated glaucoma.\textsuperscript{16} In contrast to the isolated and incomplete trabecular development seen in primary congenital glaucoma, complicated glaucoma may have compromised angles resulting from several different mechanisms or inadequate scleral outflow.

### Table 1. Clinical Findings From 100 Patient Eyes in 60 Children With Congenital Glaucoma

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Finding</th>
<th>Range (SD)</th>
</tr>
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<tbody>
<tr>
<td>Mean age at initial examination, d</td>
<td>77</td>
<td>2-870 (129.2)</td>
</tr>
<tr>
<td>No. of patients</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>Mean preoperative IOP, mm Hg\textsuperscript*</td>
<td>31</td>
<td>16.5-50 (8.0)</td>
</tr>
<tr>
<td>Average horizontal corneal diameter, mm\textsuperscript†</td>
<td>12.80</td>
<td>4.00-15.50 (1.26)</td>
</tr>
<tr>
<td>Average vertical corneal diameter, mm\textsuperscript‡</td>
<td>13.10</td>
<td>10.00-15.00 (1.24)</td>
</tr>
<tr>
<td>Features at initial examination, No. of eyes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corneal opacification</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>Normal anterior chamber findings</td>
<td>63</td>
<td></td>
</tr>
<tr>
<td>Abnormal anterior chamber findings</td>
<td>29§</td>
<td></td>
</tr>
<tr>
<td>Ectropion uvea</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Peters anomaly</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Partial aniridia</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Anterior iris insertion</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Peripheral iris stromal atrophy</td>
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<td></td>
</tr>
<tr>
<td>Sclerocornea</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>No view of anterior chamber</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript*IOP indicates intraocular pressure; ellipses, not applicable.
\textsuperscript†Measured on 98 eyes.
\textsuperscript‡Measured on 53 eyes.
\textsuperscript§Some patients had more than 1 abnormality.
Vitreous loss resulting from a posterior extension of the radial sclerotomy over the Schlemm canal during trabeculotomy was the only serious complication. A relatively low incidence of hyphema was noted. All of the hyphemas were trivial and resolved quickly. In comparison with the greater than 50% incidence of hyphema after trabeculotomy reported by McPherson and McFarland, our numbers were small. Despite a high incidence of postoperative hyphema, they reported an 80% success rate for trabeculotomy in developmental glaucoma. Half of our patients in whom a hyphema developed experienced surgical failure. Hyphema developed more often in eyes with complicated glaucoma. Nonetheless, the presence of blood in the anterior chamber may predispose a trabeculotomy to failure.

Whether trabeculotomy or trabeculectomy alone is superior to the combination of both is unclear. Elder compared primary trabeculectomy with CTT and found CTT to be superior. Our study, although similar, differed from that of Elder in that we used mitomycin in most of our patients. Our success rates for CTT were similar to those of McPherson and McFarland with trabeculectomy alone; however, these studies have been performed on 2 different population groups. A success rate of 67% with trabeculectomy alone has been reported previously in Saudi Arabia. In the same study, primary trabeculectomy alone achieved a 54% success rate, with follow-up of 11.2 months. Our success rate of 78% for CTT in primary congenital glaucoma with a similar population and follow-up suggests that CTT is superior to trabeculotomy or trabeculectomy alone. We have no experience with the recently described 360° trabeculotomy for primary congenital glaucoma. Despite the use of a blue polypropylene suture, it is possible that the high incidence of often severe corneal opacification in our population may preclude its use.

We found CTT a useful procedure in most of our patients with primary uncomplicated glaucoma. This procedure was largely free from complications, and glaucoma in nearly 80% of these patients was controlled with 1 surgery; however, success rates were much lower in patients with complicated childhood glaucoma. We recommend the use of CTT in patients with primary uncomplicated glaucoma and corneal opacification.

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Table 2. Results of Combined Trabeculotomy and Trabeculectomy Compared With Amount and Duration of Mitomycin Use

<table>
<thead>
<tr>
<th>Mitomycin Dose, mg/mL</th>
<th>Overall</th>
<th>Eyes With Normal</th>
<th>Eyes With Abnormal</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Success</td>
<td>Failure</td>
<td>Success</td>
</tr>
<tr>
<td>0.2 (n = 40)</td>
<td>20</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>For 5 min</td>
<td>20</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>For 4 min</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>For 3 min</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<tr>
<td>For 2 min</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.4 (n = 47)</td>
<td>18</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>For 5 min</td>
<td>18</td>
<td>12</td>
<td>14</td>
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<tr>
<td>For 4 min</td>
<td>2</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>For 3 min</td>
<td>6</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>None (n = 13)</td>
<td>8</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Total (N = 100)</td>
<td>67</td>
<td>33</td>
<td>49</td>
</tr>
</tbody>
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Surgical Outcome, No. of Eyes

<table>
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<tr>
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<td>14</td>
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<td>For 3 min</td>
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<td>For 2 min</td>
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REFERENCES