Comparative Study of Three Phacotrabeculectomy Procedures through a Single Incision

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The objective of this study is to evaluate and compare the effects of three combined phacoemulsification and trabeculectomy procedures (phacotrabeculectomy) involving intraocular lens implantation through a single incision. Twenty-eight eyes of 28 patients suffering from chronic open angle glaucoma and chronic angle closure glaucoma were enrolled in this study. No-stitch phacotrabeculectomy (Group A), modified T-flap phacotrabeculectomy (Group B) and phacotrabeculectomy with sutures (Group C) were performed in 11, eight, and nine patients respectively, who were followed up for 6 months. At the end of that period, the mean reduction of intraocular pressure was 6.39 mm Hg; in group A, B and C, the reduction was 3.27, 4.87 and 11.55 mm Hg, respectively. The procedure followed in group C was therefore most effective, and there was a statistically significant difference between the groups (p < 0.05). The survival rate of blebs was also marked in group C. There were no apparent differences in terms of visual improvement, complications and number of medications between the groups. This study suggests that the choice of procedure should be determined by the desired degree of pressure reduction.

Key words: intraocular pressure, modified T-flap, no-stitch phacotrabeculectomy with sutures, single incision

INTRODUCTION

The surgical management of coexisting cataract and glaucoma has been greatly improved by the introduction of phacoemulsification with implantation of a posterior chamber intraocular lens. As phacoemulsification through a small scleral tunnel incision became popularized, trabeculectomy has combined with the phacoemulsification technique of cataract extraction.

Preliminary evidence suggests that small cataract incisions during combined surgery are associated with more effective control of intraocular pressure (IOP). Conventional combined surgery using the extracapsular cataract extraction technique has less effect on long-term IOP control than trabeculectomy alone, but when combined with phacoemulsification the results are promising.

After the combined phacoemulsification and trabeculectomy technique became popular, several surgical variations were introduced. In this study, the effects of three variations of combined phacoemulsification and trabeculectomy through a single scleral tunnel incision were evaluated and compared.

MATERIALS AND METHODS

Included in the study were patients with chronic
open-angle and chronic angle-closure glaucoma who had a visually significant cataract. Patients with neovascular, congenital or other secondary glaucoma were excluded, as were those who had previously undergone ocular surgery. Surgery was indicated when a glaucoma patient complained of visual disturbance, lens opacity was clinically detectable, and there was no previous evidence that the patient's visual acuity could not be improved by cataract surgery. We randomly assigned and performed combined phacoemulsification and trabeculectomy by means of a single incision; according the procedure used, patients were assigned to one of three groups: no-stitch technique (Group A), modified T-flap (Group B), and trabeculectomy with sutures (Group C).

Preoperative data included IOP measured by Goldmann appplanation tonometry, the number of glaucoma medications, Snellen visual acuity, gonioscopic findings, visual field and optic disc findings if available, age and gender.

Trabeulectomy combined with phacoemulsification is illustrated in Figure 1, and was performed as follows: A fornix-based flap was created by incising the conjunctiva and Tenon's capsule at the limbus at the 12 o'clock position over 2 to 3 clock hours. A 4-mm scleral tunnel was created 2 mm posterior to the limbus, permitting phacoemulsification. Using the no-stitch procedure, deep limbal tissue was removed with a Descemet punch at least 0.5 mm anterior to the scleral incision and no scleral stitching was performed. Using a modified T-flap procedure, a central relaxing T incision was made. Using a standard trabeculectomy with suture procedure, scleral flap was created by bilateral incisions anterior to the limbus. Punch sclerectomy was performed and a foldable intraocular lens was implanted in the bag. After peripheral iridectomy, the scleral flap was tied with one horizontal mattress 10-0 nylon suture, following the modified T-flap procedure, and four 10-0 nylon sutures, following the standard trabeculectomy with suture procedure. After checking for mild leakage of aqueous humor, the conjunctiva was secured to the limbus with a 10-0 nylon suture and the anterior chamber was reformed, conjunctival bleb being elevated by the injection of balanced salt solution through a preplaced side-port incision. No wound leakage was noted. One surgeon performed all surgery and in no case was antimetabolite used.

Postoperative data were collected at 1, 3, and 6 months, and included IOP, visible formation of bleb, number of glaucoma medications, Snellen visual acuity and any postoperative complications. Bleb formation was defined as clinically detectable elevation of conjunctiva around the area of scleral flap.

Statistical analysis was performed using the paired t-test within a group, and one-way analysis of variance (ANOVA) between the groups was used for IOP and number of medications. The Kaplan-Meier product-limit method was used for cumulative survival rate of blebs, and the chi-square test was used for differences in visual improvement and complications between the groups. A p-value of <0.05 was considered statistically significant.

**RESULTS**

Twenty-eight eyes of 28 primary glaucoma patients were followed up for 6 months and were enrolled in this study. The number of eyes in each group was 11, eight and nine, respectively. Demographic data for the three groups are shown in Table 1, and preoperative data in Table 2. There

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**Fig. 1.** Three phacotrabeculectomy procedures varied by modification of the scleral flap. Left: No-stitch phacotrabeculectomy with scleral tunnel incision; Middle: Modified T-flap with central relaxing incision; Right: Phacotrabeculectomy with sutures. (Site of trabeculectomy under the scleral flap is not seen in these figures.)
Table 1. Demographic data

<table>
<thead>
<tr>
<th>Group</th>
<th>No.(Eyes)</th>
<th>Age (±SD)</th>
<th>Sex (M : F)</th>
<th>Eye (R : L)</th>
<th>Diagnosis (COAG : CACG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>11</td>
<td>65.7 (±4.8)</td>
<td>5 : 6</td>
<td>5 : 6</td>
<td>3 : 8</td>
</tr>
<tr>
<td>B</td>
<td>8</td>
<td>68.1 (±9.6)</td>
<td>2 : 6</td>
<td>4 : 4</td>
<td>3 : 5</td>
</tr>
<tr>
<td>C</td>
<td>9</td>
<td>68.3 (±8.1)</td>
<td>4 : 5</td>
<td>6 : 3</td>
<td>3 : 6</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
<td>67.6 (±7.4)</td>
<td>11 : 17</td>
<td>15 : 13</td>
<td>9 : 19</td>
</tr>
</tbody>
</table>

M: male, F: female, COAG: chronic open-angle glaucoma, CACG: chronic angle-closure glaucoma

Table 2. Preoperative data

<table>
<thead>
<tr>
<th>Group</th>
<th>Visual acuity (range)</th>
<th>No. of medications (mean)</th>
<th>Cup/disc ratio (mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.02-0.5</td>
<td>1.09±0.94</td>
<td>0.64±0.21</td>
</tr>
<tr>
<td>B</td>
<td>0.02-0.3</td>
<td>1.22±0.99</td>
<td>0.70±0.19</td>
</tr>
<tr>
<td>C</td>
<td>HM-0.2</td>
<td>1.22±0.97</td>
<td>0.70±0.17</td>
</tr>
</tbody>
</table>

HM: Hand motion

Table 3. Mean IOP and postoperative IOP reduction (mm Hg)

<table>
<thead>
<tr>
<th>Group</th>
<th>Preop</th>
<th>1 month</th>
<th>3 months</th>
<th>6 months</th>
<th>1 month</th>
<th>3 months</th>
<th>6 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>17.18(±4.72)</td>
<td>13.27(±2.37)</td>
<td>12.81(±2.78)</td>
<td>13.81(±3.70)</td>
<td>3.90(±3.93)</td>
<td>4.36(±3.90)</td>
<td>3.27(±1.90)</td>
</tr>
<tr>
<td>B</td>
<td>17.50(±2.32)</td>
<td>12.62(±1.99)</td>
<td>13.37(±1.18)</td>
<td>12.62(±1.92)</td>
<td>4.87(±2.16)</td>
<td>4.12(±1.72)</td>
<td>4.87(±1.95)</td>
</tr>
<tr>
<td>C</td>
<td>24.44(±7.50)</td>
<td>12.11(±3.21)</td>
<td>12.44(±2.01)</td>
<td>13.00(±3.24)</td>
<td>12.33(±6.90)</td>
<td>12.11(±7.13)</td>
<td>11.55(±6.67)</td>
</tr>
<tr>
<td>Total</td>
<td>19.60(±6.15)</td>
<td>12.71(±2.53)</td>
<td>12.85(±2.13)</td>
<td>13.21(±3.07)</td>
<td>6.89(±5.98)</td>
<td>6.78(±5.95)</td>
<td>6.39(±5.39)</td>
</tr>
</tbody>
</table>

Fig. 2. Comparison of IOP reduction between the three groups.

were no significant differences between groups in terms of age, gender, or operated eye.

In each group, postoperative mean IOP was significantly lower than preoperative IOP; data are given in Table 3 and illustrated in Figure 2. As there was considerable difference in mean preoperative IOP between the groups, statistical analysis of mean IOP reduction, defined as the difference between IOP at a given time and preoperative baseline pres-

Fig. 3. Comparison of bleb survival between the groups (Kaplan-Meier method). Mean survival times up to 6 months follow up were 4.09 (±0.70), 4.25 (±0.84) and 4.78 (±0.77) months in group A, B and C, respectively.
Table 4. Summary of postoperative results at six months

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual acuity&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6/11 (54.5%)</td>
<td>5/8 (62.5%)</td>
<td>5/9 (55.5%)</td>
<td>16/28 (57.1%)</td>
</tr>
<tr>
<td>No. of medications</td>
<td>-0.64 (0.80)</td>
<td>-0.87 (0.83)</td>
<td>-1.22 (0.97)</td>
<td>-0.89 (0.87)</td>
</tr>
<tr>
<td>Bleb formation</td>
<td>6/11 (54.5%)</td>
<td>5/8 (62.5%)</td>
<td>7/9 (77.7%)</td>
<td>18/28 (64.3%)</td>
</tr>
<tr>
<td>Complications&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1/11 (9.1%)</td>
<td>2/8 (25.0%)</td>
<td>2/9 (22.2%)</td>
<td>4/28 (14.3%)</td>
</tr>
</tbody>
</table>

<sup>a</sup>: improved 0.5 or better in Snellen visual acuity. <sup>b</sup>: posterior capsule rupture, hyphema and wound leak

sure, was also performed. During the follow-up there was no statistically relevant difference in mean IOP between the three groups though mean IOP reductions were statistically different. Six months postoperatively these were 3.27 ± 1.90 mm Hg, 4.87 ± 1.95 mm Hg and 11.55 ± 6.67 mm Hg in group A, B and C, respectively. Reduction was most effective in group C, in which it was Group C statistically significant when measured at 1, 3 and 6 months (p = 0.0014, 0.0019 and 0.0004 respectively).

Other postoperative results at six months are shown in Table 4. Between the groups, there were no statistical differences in terms of visual improvement over 0.5 in Snellen acuity, reduced number of glaucoma medications or complications. The cumulative survival rate of the bleb formation was, however, higher in group C, in which the extent and height of bleb were also more prominent. Complications such as partial posterior capsule rupture, hyphema and wound leakage occurred in the three groups and the prevalence of such complications was similar between the groups. During the follow-up period, argon laser suture lysis was performed in one eye of group B and two of group C and digital massages were performed if needed.

**DISCUSSION**

The traditional aim of glaucoma surgery has been to preserve, not restore of vision. The prognosis of combined cataract and glaucoma surgery has, though, been significantly improved by the introduction of phacoemulsification with a small incision,<sup>1</sup> Phacoemulsification has many advantages over extracapsular cataract extraction; these include early visual rehabilitation, fewer complications, less frequent early increase in IOP,<sup>15</sup> and reduced postoperative IOP.<sup>16</sup> By using the same scleral incision, combined surgery can, furthermore, be performed more safely and effectively in patients with elevated preoperative IOP,<sup>17</sup> and the outcome of treatment of patients with both cataract and glaucoma is excellent.<sup>18</sup> The principle advantages of combined phacoemulsification and trabeculectomy through the same scleral tunnel incision are low induced astigmatism, early refractive stabilization, and rapid visual rehabilitation. In addition, the small incision minimizes the extent of tissue dissection and may thus reduce the stimulus to wound healing and early filtration failure. The conjunctiva is less disturbed, and an increase in the incidence of bleb formation has been also noted.<sup>11,19-20</sup>

Both fornix- and limbus-based conjunctival flaps may be used safely and effectively when performing combined phacoemulsification and trabeculectomy<sup>21</sup>; the former is technically easy but tends to induce greater anterior leakage. With regard to IOP control and visual acuity, scleral tunnel incision size is not significant.<sup>3</sup>

In combined phacoemulsification and trabeculectomy several scleral flap variations are possible. No-stitch or sutureless phacotrabeculectomy was previously introduced<sup>12</sup>; a sutureless wound has several unique advantages.<sup>13</sup> The absence of suture material and less tissue dissection should lessen local irritation and foreign-body reaction, leading to less fibrosis and scarring of the conjunctival and scleral flaps. Less induced astigmatism can, in addition, lead to earlier visual recovery. Average reported IOP reduction varies, ranging from 7 to 16 mm Hg.<sup>12-13</sup> One possible explanation of less IOP reduction in this study compared with previous results is inclusion criteria; we included only primary chronic glaucoma. Although the no-stitch procedure is known to be simple, safe and effective, its potential disadvantage is the lack of postoperative manipulation of bleb
function; the long-term effect of IOP control is still uncertain.

Modified T-flap procedure, using a central T relaxing incision and single horizontal suture, provides the possibility of postoperative manipulation of bleb function by laser suture lysis but has limited access time compared to combined phacoemulsification and trabeculectomy with sutures. Shingleton and Kalina\textsuperscript{14} used a single preplaced horizontal suture before creating a central T incision, but in this study a horizontal suture was placed after creating a central T incision and performing a sclerectomy; we believe that such a procedure was technically more simple.

Among the three procedures, standard phacotrabeculectomy with sutures achieved the greatest IOP reduction. It provides better IOP control and visual outcome than conventional combined extracapsular cataract extraction and trabeculectomy.\textsuperscript{4,5} The IOP reduction resulting from this combined procedure is less than that which follows trabeculectomy alone,\textsuperscript{22} but combined phacoemulsification and trabeculectomy is as effective as trabeculectomy alone.\textsuperscript{5} The advantages of visual outcome after phacoemulsification and IOP control after trabeculectomy can be obtained simultaneously. Postoperative bleb function can be manipulated with laser suture lysis as well as trabeculectomy alone. The use of adjunctive mitomycin C appears to be safe and effective.\textsuperscript{23-24}

In this era of small incision cataract surgery, surgical techniques and indications of coexisting cataract and glaucoma have changed considerably and are constantly evolving.\textsuperscript{25-26} The ophthalmic surgeon must answer two basic questions: when and how should combined surgery be performed? Based on the results of this study, the following recommendations may be suggested. All glaucoma patients with a visually significant cataract can be candidates for these safe, simple and effective procedures.

The choice of surgery should be determined according to the present status of glaucoma, especially by the desired reduction of IOP. When IOP has been substantially reduced preoperatively, the no-stitch procedure may be considered; it appeared technically easy and relatively simple, and these were its principle advantages. On the other hand, it achieved less IOP reduction than other procedures, it should be considered only in suspected glaucoma patients or those in whom the disease is well under control. Because the bleb disappeared more rapidly than after other procedures, it may also be considered as preventive measure in early IOP spike. If more IOP control is required, the modified T-flap procedure can be considered; this provides more IOP reduction than the no-stitch procedure or postoperative manipulation of bleb function by laser suture lysis and may be considered in borderline cases. In a poorly controlled or advanced glaucoma patient, maximum IOP reduction is required, and combined phacoemulsification and trabeculectomy with sutures may therefore be considered. The probable effects on IOP are similar to those of trabeculectomy alone. Furthermore, bleb function can be adjusted with adjunctive antimetabolite, or postoperatively.

There are certain limitations to our study. First, the study population makes it difficult to compare surgical results precisely; second, due to the short follow up period, long-term bleb survival is still questionable, especially in no-stitch phacotrabeculectomy; third, in chronic angle closure glaucoma, cataract removal per se to some extent reduces IOP. Although our results may not reflect the separate surgical effects of individual procedures, phacotrabeculectomy with suture appeared to control glaucoma more effectively than other procedures.

As the technology for the management of coexisting cataract and glaucoma improves, so the expectations of both patients and surgeons are changing. The opportunity to restore vision in addition to the traditional visual preservation approach to glaucoma surgery has been a wonderful addition to the glaucoma surgeon's repertoire. In this study three different combined phacoemulsification and trabeculectomy techniques, involving a single incision, were simple, safe and effective. The visual outcome and final IOP were similar but the degree of IOP reduction and bleb survival rate differed. Although more patient data and further follow-up study needed, we suggest that, on the basis of our results, the choice of procedure should depend on the desired postoperative IOP reduction, the target pressure.
REFERENCES


