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Glaucoma Filtration Surgery: A Personal Review

Saul Sugar, MD*

This is a review of 25 years of filtration surgery for phakic open-angle glaucoma. Trabeculectomy is used in patients up to 55 or 60 years of age; limbal trephination, in older patients.

Notwithstanding the present popularity of laser trabecuoplasty, the need for filtration surgery for open-angle glaucoma still exists. Although most ophthalmologists today are more or less limited to trabeculectomy for filtration, I wish to present my own old-fashioned approach to surgical filtration.

Filtration surgery may be defined as the formation of hopefully permanent, new external drainage channels for aqueous humor that lead from the anterior chamber to the subconjunctival space and often through the conjunctiva. To maintain this drainage the fistulas must be of such size as to permit unhindered outflow, though not so large a size as to produce hypotony. When filtration surgery is successful, a filtering bleb varies in appearance from a diffuse, hardly distinguishable succulent one to a bleb that is large and sometimes cystic. The thin-walled bleb is dangerous because it is more vulnerable to infection and leakage and may be accompanied by hypotony.

The goal of filtration surgery, which is the normalization of intraocular pressure, is achieved in a high percentage of cases, depending on the technique and experience of the surgeon and the age and ocular condition of the patient. Filtration operations, in spite of their various designated names, are identical in principle, with certain techniques having varying advantages and disadvantages with different surgeons. The chief causes of failure of filtration surgery are such complications as contracture of the subconjunctival connective tissue, failure of anterior chamber reformation, and incarceration of intraocular structures in the fistula. The occurrence of these complications are not entirely dependent on the skill of the surgeon.

Surgical Procedures

The filtering operations include iridencleisis, the limbosclerectomies, and seton operations. The limbosclerectomies include the Lagrange operation, anterior lip sclerectomy, posterior lip sclerectomy, the Preziosi operation, thermal sclerostomy (Scheie), the limbal trephination, the corneoscleral trephination, and the subscleral sclerectomy (trabeculectomy).

The two filtration procedures that I currently use are: 1) limbal trephination for patients beyond the 55 to 60 age group and for those with low-tension glaucoma and 2) subscleral trephination (one type of trabeculectomy) for patients under the 55 to 60 age group. The limbal trephination was first performed in 1959 and described in 1961 (1). The trabeculectomy was first performed in 1956 and described in the American Journal of Ophthalmology in April 1961 (2).

When I first performed the operation, the basis of its use was to remove a segment of the trabecular meshwork and overlying Schlemm's canal or to remove enough of the trabecular wall to expose the opened canal to aqueous humor. The operation I performed failed, I believe, largely because the scleral flap was tightly sutured so that the aqueous would be forced into the opened ends of Schlemm's canal. Gonioscopically, however, there was scar tissue in the resected area, which appeared to eliminate the possibility of patency at the canal openings, so I abandoned the operation for several years.

My interest in trabeculectomy began in 1939 when I performed seven trabecular curettage procedures on adults, using a Barkan knife. This was a modification of Barkan's goniotrabeculotomy. These operations were only temporarily successful, and gonioscopy did not show what could be interpreted as gross openings into Schlemm's canal. As a result, however, the idea of a lamellar trabeculectomy developed and was performed in 1956. Meanwhile, I continued toward a "higher success rate" filtering operation. I had been trained on the Elliot corneoscleral trephination, which was the favorite operation for glaucoma throughout the world for about a half century, so a modified trephination was the procedure of my choice.

The procedures that have more or less been abandoned will not be discussed, but let me briefly mention the Elliot trephination. This operation was introduced by Fergus (3) and later by Elliot (4) in 1909 and was named "corneoscleral trephination" by Elliot (5). In this operation, a corneal splitter is used to split the superficial lamellae of the cornea attached to the limbal conjunctival flap for a distance of 1 mm into

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*Consultant, Department of Ophthalmology, Henry Ford Hospital
Address reprint requests to Dr Sugar, 25230 Southfield Rd, #103, Southfield, MI 48075.
the cornea. A 2.0 mm trephine is applied so far forward as to include the split area. A button of corneolimbus is removed. This operation has largely become obsolete because of the relatively high incidence of late infection resulting from the thin bleb in the area of corneal splitting. The operation was used in 1931 in 60% of glaucoma procedures at the Illinois Eye and Ear Infirmary. However, by 1945 its use was down to 5%, while iridencleisis became the favorite until the Scheie thermal sclerotomy and posterior lip sclerectomy became very popular in 1958, which remained popular for 10 years until the trabeculectomy procedure was described by Cairns in 1968.

I went ahead with the limbal trephination, in which the fistula does not involve the cornea, and found it highly successful in primary glaucoma, particularly in the over 59 age group, with rare serious complications such as late infection occurring. In younger people the operation was less successful. Later, when I returned to using the trabeculectomy as a filtering operation, I found it more effective than the limbal trephination in younger individuals and began to use it in patients up to 55 or 60 years old and to use the simpler and easier operation of limbal trephination in those who were older. All short-acting miotics are stopped at least the day before surgery, and all long-acting miotics at least two to three days before the operation.

In all the filtering operations I performed, patients were placed under local anesthesia. I used a preliminary Wheeler knife paracentesis placed obliquely through the edge of the lower temporal corneal quadrant.

During surgery, the size of the fistula is important. It should be large enough to permit a patent filtering tract, yet not so excessive in area as to result in hypotony. With a 2 mm trephine, the area excised with a total button would be 3.14 mm². I believe this to be excessive, on the basis of clinical impressions from observing cases of hypotony after the Scheie procedure; therefore, I prefer to hinge the button posteriorly and transect it, removing only the anterior third of the button. The excised area is then about 1.0 mm².

After all filtering operations, atropine is instilled and used daily for about two weeks. Steroid drops twice daily are begun on the second or third postoperative day and continued for two weeks. The suture is removed on the tenth day after surgery. The patient is discharged on the first postoperative day.

Results

A total of 490 limbal trephinations were performed and patients followed for periods of six months to 25 years. Of the 490 operations, 417 were performed on adults from 35 to 75 years of age; 25 on adults between 20 and 35 years of age; and 48 on infants, children, and young people up to 20 years of age. All patients in the latter group were operated on during the first part of this study. Failure was considered to be inadequate filtration as manifested by any tonometric reading over 20 mm Hg or a need for medical therapy for elevated intraocular pressure.

The first group of 417 adults over age 35 was divided into primary chronic open-angle glaucoma and secondary glaucoma groups. Of the patients with primary glaucoma, 395 trephinations were done for chronic open-angle glaucoma, and 22 for chronic angle-closure glaucoma. The success rate for the chronic open-angle group was 84.1% (Table I). Success rates for the various subgroups are also shown in Table I. The best results (95%) were obtained in 22 trephinations on patients with chronic angle-closure glaucoma (12 primary and 10 secondary).

| Table I | Comparison of Successful Results in 490 Limbal Trephinations by Age Group |
|---------|---------|---------|---------|---------|---------|---------|
| Operations | % Success |
| Primary Glaucoma | | | | | | |
| Adults over 35 | 417 | 84.6 |
| Chronic open-angle | 395 | 84.1 |
| Chronic angle-closure | 22 | 95.0 |
| Adults 20 to 35 | 14 | 64.0 |
| Patients up to age 20 | 32 | 50.0 |
| Secondary Glaucoma | | | | | | |
| Adults over 35 | 14 | 28.5 |
| Adults 20 to 35 | 11 | 54.5 |
| Patients up to age 20 | 16 | 37.5 |

Results were poor in the secondary glaucoma groups. In the group over age 35 (mostly cases with uveitis and ruberosis), 28.5% were successful. In the group between 20 and 35 years of age, 54.5% of the mostly pigmentary glaucomas were successful. In the group up to age 20, those with mostly congenital anomalies, only 37.5% were successful.

Postoperative complications in the series of limbal trephinations included 47 instances (10.4%) of flat anterior chambers, two of which required anterior chamber reformation and 35 hyphemas (7.1%), none of which were significant. Shallow anterior chambers were present for varying lengths of time in 43% of the cases. Cataracts occurred within a year in a 20-year-old patient who had relative hypotony. Removal of cataracts did not interfere with the efficacy of filtration. The most significant complication, late infection, which is relatively frequent after trephinations of the Elliot type, occurred in two cases.

Discussion

Comparison of success rates between the age groups described indicates that success is directly proportional to increasing age in primary glaucoma. This is believed to be due to the thickness and, perhaps, the physicochemical nature of Tenon’s capsular tissue, which is thick in early life and atrophies in middle and old age.
The success of the operation as a secondary procedure emphasized the importance of carefully choosing the site of reoperation. The new site was most successful when located in an area of minimal conjunctival scarring and as close to the 12 o'clock position as possible. The site is determined by ballooning the subconjunctival tissue with local anesthetic solution and finding the site of least adherence to the limbusclosa.

**Trabeculectomy**

Trabeculectomy may be defined as the removal of a segment of trabecular meshwork and overlying Schlemm's canal or enough of the trabecular wall to expose the opened canal to aqueous humor. The term was first introduced by Barkan in describing the angle after goniotrabeculotomy. Some call it subscleral sclerectomy.

The trabeculectomy operation is proving to be the most popular filtering procedure today. It was started with the intention of producing a direct opening from the anterior chamber into two open ends of Schlemm's canal. The first procedure describing a scleral lamellar flap and trabeculectomy I reported in 1961 (2) as an “experimental trabeculectomy.” Another description of trabeculectomy was in Greek by Coryllos in 1963 (6). A paper by Cairns in 1968 (7) reported such good results that use of the procedure became widespread, but its effectiveness was then attributed to filtration which may be associated with scleral filtration and inhibition of scleral wound closure by the aqueous humor. The open ends of the canal are always scarred closed. I have found this procedure to work best in individuals below 55 to 60 years of age.

The various ways of making the fistula in the deep layer of the limbus and cornea depend on instrumentation. One may use a knife, scissors, punch, or trephine to produce the fistula. I prefer the latter, which is designated by some as sub scleral trephination.

To produce the fistula, the operation is the same as for limbal trephination up to completion of the conjunctival incision. A scleral flap is then outlined by cautery and next by incision through 1/3 to 1/2 of the scleral thickness. It may be rectangular in shape with two corners or triangular (like the procedure of Frominopoulos, Dellaporta, and Stilma), with the two incisions meeting at the apex of the triangle, which should be about 4 mm to 5 mm from the limbus, not reaching the conjunctival incision position, and thus avoiding possible erosion of the apical suture into the conjunctival incision wound. One may then make a fistula either with a knife, scissors, punch, or trephine. If a trephine is used, a 2 mm trephine is applied as far forward as possible at the center of the deep layer, tilted slightly forward so as to enter the anterior chamber first just as with the limbal trephination procedure. The anterior third or half of the button is excised and a peripheral iridectomy made. Balanced salt solution is introduced through the Wheeler knife paracentesis using a 30-gauge blunt needle. Postoperative treatment is the same as for limbal trephination.

The sub scleral trephination is used instead of the rectangular deep layer resection described in the early trabeculectomies because the trephining is actually much easier to do, especially since in the trabeculectomy the superficial scleral flap extends into the cornea for 1-1/2 mm so as to avoid injury to the ciliary body when doing the peripheral iridectomy. In younger individuals the scleral flap is safer and makes a peripheral bleb more likely so that often a contact lens may be worn. In limbal trephination, since older individuals are involved and since the Tenon's capsule is thin and atrophic, there usually is no need to remove Tenon's capsule, so the conjunctiva and Tenon's layers are usually brought down together as a flap.

In the trabeculectomy, especially in younger individuals with thick Tenon's, the conjunctiva is dissected down separately from most of Tenon's capsule, which is subsequently resected.

Many surgeons have accepted the myth that the anterior chamber is always formed after trabeculectomy. It is certainly less frequently shallow, but flat chambers do occur. If the flap is tightly closed, the chamber certainly is more full, but the pressure-lowering effect usually is much less (8). I believe that the through-and-through trephination produces better tonometric results; therefore, I prefer it in cases of low-tension glaucoma.

A most important detail in trabeculectomy, in my opinion, is collagen shortening of the scleral flap edges with heat cautery so that the edges do not touch. This also makes the area quite bloodless. I use a triangular flap, even in combined cataract and trabeculectomy, since it is easier to dissect than a rectangular one. Only one absorbable suture is used to loosely suture the apex of the triangle. There certainly is no objection to using a rectangular scleral flap.

Trabeculectomy is easiest in the 12 o'clock area and next easiest in the upper temporal area, but if previous surgery has scarred much of the upper conjunctiva, the lower temporal quadrant should be considered.

I compared 193 limbal trephinations, performed from January 1976 through 1984 in patients over 55 years old, with 178 subscleral trephinations (trabeculectomies) for open-angle glaucoma in patients from 42 to 79 years old (Table I). The limbal trephinations (85.5%) were slightly more successful than the trabeculectomies (73%). I have generally preferred trabeculectomies for younger patients up to about 55 to 60 years old and used limbal trephinations for older patients. However, this rule was varied according to feedback from experience with failure of one or the other operation on the same eye.
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Table II
Comparison of Limbal and Subscleral Trephinations
(Trabeculectomies) 1976 through 1984

<table>
<thead>
<tr>
<th>Number of Operations</th>
<th>Age</th>
<th>% Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>193 Limbal trephinations</td>
<td>Over 55</td>
<td>85.5</td>
</tr>
<tr>
<td>178 Subscleral trephinations</td>
<td>42 to 79</td>
<td>73.0</td>
</tr>
</tbody>
</table>

Summary

My personal preference in the selection of surgery in phakic open-angle glaucoma, based on my own experiences and prejudices, is to use trabeculectomy in younger patients and those up to 55 or 60 years of age and what I call limbal trephination in those above this age. One may do just as well by using trabeculectomy in all phakic open-angle glaucoma cases.

References