TRABECULECTOMY: EFFECT OF VARYING SURGICAL SITE

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SUMMARY

Trabeculectomy reduces intraocular pressure by fistula formation into a subconjunctival bleb. The operation site traditionally has been at the superior corneo-scleral junction with a failure rate of 10–30%. The causes of trabeculectomy failure can be broadly classified into intraocular, scleral and extraocular. Extraocular factors account for the majority of failures, the main cause being increased subconjunctival fibrosis. Hitherto the effect of varying the site of filtration surgery on intraocular pressure control has not been studied. We therefore carried out a prospective study to evaluate the optimum site for trabeculectomy. Sixty patients were randomised to undergo a superior, nasal or temporal trabeculectomy. Patients who underwent a nasal trabeculectomy had significantly lower intraocular pressures 18 months after surgery ($p<0.05$), with 30% having an intraocular pressure of $\leq$10 mmHg.

Trabeculectomy was first described by Cairns in 1968. He described the operation at the 12 o'clock position but added that it may be performed anywhere in the corneo-scleral circumference.[1] Since then the operation has traditionally been performed and described most frequently at the 12 o'clock position.[2] The reason for this is probably that surgical access is easiest superiorly. The peripheral iridectomy is unlikely to cause diplopia or a cosmetic defect at the 12 o'clock position and the resultant bleb is well covered by the upper eye lid.

Trabeculectomy lowers intraocular pressure by fistula formation into a subconjunctival bleb.[3,4] The success rate of trabeculectomy in primary glaucoma is reported to be between 67% and 94%.[5] Surgical failure is usually apparent in the first 6 post-operative months, and is generally due to increased subconjunctival fibrosis.[6]

Several studies have investigated the reasons for success and failure of trabeculectomy. The type of conjunctival flap (fornix-based versus limbus-based) has been shown to influence bleb morphology and vascularity but to have no influence on control of intraocular pressure.[7] Other studies have reported that an avascular area in the bleb correlates with better intraocular pressure control.[8] Trabeculectomies have been performed with partial and total tenectomy. Total tenectomy was more likely to result in a cystic bleb. No difference in intraocular pressure control, however, was found between the two groups.[9] More recently studies have shown that subconjunctival 5-fluorouracil decreases fibroblast proliferation and so reduces the risk of drainage failure.[10] The success rate of trabeculectomy has been shown to be significantly higher when it is carried out as a primary procedure without prior topical antiglaucoma medication.[11] Topical medication is associated with increased numbers of inflammatory cells and fibroblasts in the conjunctival and episcleral tissue leading to a greater risk of filtration failure.[12,13]

Hitherto, the effect of varying the site of filtration surgery on intraocular pressure control has never been investigated. We therefore carried out a prospective study to evaluate the effect of performing trabeculectomy surgery at different sites on the corneo-scleral limbus.

PATIENTS AND METHODS

A prospective study was conducted on 60 patients. The subjects were randomised using random tables to undergo a nasal, superior or temporal trabeculectomy, forming three groups of 20 patients each (Fig. 1). All patients had

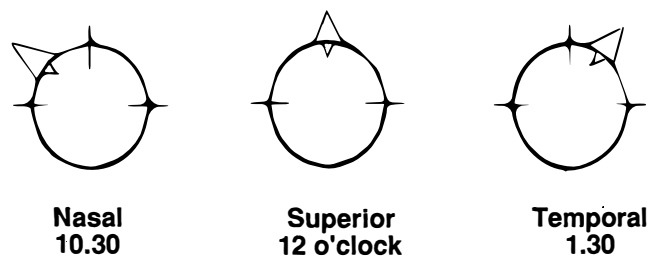

Fig. 1. *The nasal, superior and temporal sites at the corneo-scleral limbus in the left eye, where trabeculectomy was performed.*

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Table I. Age and sex distribution of the study subjects in each trabeculectomy group

	Nasal	Superior	Temporal
Male	9	8	10
Female	11	12	10
Age range (yr)	54–86	66–82	54–90
Av. age (yr)	67	73	70
Age <60 (yr)	1	0	2

chronic open angle glaucoma. None of the subjects had suffered from previous eye disease or undergone ocular surgery or laser therapy.

The study group consisted of 27 males and 33 females. Patients' ages ranged from 54 to 90 years with an average age of 70 years. Three patients were less than 60 years of age. Table I shows the age and sex distribution of the study subjects in each trabeculectomy group.

The duration of chronic open angle glaucoma in the study group ranged from 4 months to 12 years with an average of 2.53 years (Table II). The pre-operative intraocular pressure ranged from 18 to 40 mmHg with an average of 28 mmHg (Table III). Thirty-three patients were on two types of topical antiglaucoma medication pre-operatively, 18 on three types and 9 on one type of topical medication. Three patients were also on oral Diamox (Lederle) tablets (Table IV). No significant difference was found between the three trabeculectomy groups as regards age, sex, duration of glaucoma, pre-operative intraocular pressure and numbers of anti-glaucoma medications.

Pre-operatively all patients had guttae (gtt.) chloramphenicol q.i.d. to both eyes for 24 hours. Surgery was performed by ophthalmic staff at registrar grade or higher. All surgeons were right-handed. Surgery was performed on 28 right and 32 left eyes. Analysis of variance of these factors showed no significant differences between the three groups. Squint calipers were used to mark the 12, 3 and 9 o'clock positions on the corneo-scleral limbus and the trabeculectomy was performed at 10.30 (nasal), 12.00 (superior) or 1.30 (temporal) clock hours.

Surgery was standardised and all patients had a fornix-based conjunctival flap without a radial cut. The conjunctiva and Tenon's tissue were cut together with dissection down to sclera. Wet cautery was applied to the sclera and a one-third superficial sceral flap (5 mm × 3 mm) was fashioned. An inner sclero-trabecular block of 2 mm × 3 mm was resected and peripheral iridectomy performed. The triangular scleral flap was sutured with a single Virgin silk 8.0 suture at the apex and the conjunctiva with two Virgin silk 8.0 sutures at the limbus. A drop of betnesol N was administered at the end of surgery.

Post-operative medication consisted of gtt. betnesol N q.i.d. and gtt. cyclopentolate 1% b.d. in the first 2 post-operative weeks and then b.d. and o.d. respectively in the third to sixth post-operative weeks. Patients were examined and intraocular pressures documented at the third post-operative day and the second, eighth and eighteenth post-operative months.

Table II. Duration of chronic open angle glaucoma among subjects in each trabeculectomy group

	Nasal	Superior	Temporal
Range of duration	4 months–10 years	4 months–12 years	8 months–10 years
Av duration (yr)	2.6	2.7	2.3

Table III. Pre-operative intraocular pressure (IOP) range in each trabeculectomy group

	Nasal	Superior	Temporal
Pre-op IOP range (mmHg)	18–34	20–40	18–34
Average IOP (mmHg)	29	27	28

RESULTS

No intra-operative complications occurred. In the early post-operative period 4 patients in the nasal trabeculectomy group had bleb leakage and 2 required re-suture of the bleb. Bleb leakage was seen in 1 patient in the superior group and in 2 patients in the temporal group. The overall incidence of bleb leakage was 11.7% (7 patients) and re-suture of bleb 5% (3 patients). Hyphaema was encountered in 10% (6 patients) and shallowing of the anterior chamber in 13.3% (8 patients) (Table V).

In the late post-operative period topical antiglaucoma medication was required for 2 patients in the nasal group, for 3 patients in the superior group and for 1 patient in the temporal group. All treatment was instituted in the first 6 post-operative months. None of the patients required revision or repeat filtration surgery. Corneal dellen adjacent to the trabeculectomy bleb occurred in 4 (20%) patients in the nasal group, with 5 (25%) patients complaining of discomfort. Corneal dellen occurred in 1 (5%) patient in the temporal group and discomfort in 2 (10%) patients. These complications were not seen in the superior group (Table VI).

Average intraocular pressure in each group at each of the four post-operative visits ranged from 8.1 to 14.5 mmHg in the nasal trabeculectomy group, 11.05 to 17.45 mmHg in the superior group and 10.75 to 18.15 mmHg in the temporal group (Table VII). At each visit the average intraocular pressure in the nasal group was lower than in either the superior or temporal group.

All absolute intraocular pressures in each of the three groups at each post-operative visit were analysed. One-way analysis of variance showed significant differences ($p = 0.023$) between the three groups at the 18-month post-operative visit. The differences between the average intraocular pressures in each group at 18 months were then

Table IV. Pre-operative topical and oral antiglaucoma medication in subjects in each trabeculectomy group

Antiglaucoma medication	Nasal	Superior	Temporal
No. of topical treatments			
1	2	4	3
2	13	9	11
3	5	7	6
Diamox tablets	1	0	1

Table V. Complications seen in the early post-operative period following trabeculectomy at the nasal, superior and temporal sites

	Nasal	Superior	Temporal	Overall %
Leakage	4	1	2	11.7
Re-suture	2	0	1	5
Hyphaema	2	3	1	10
Shallowing of AC	3	2	3	13.3

AC, anterior chamber.

analysed using unpaired *t*-tests. This showed a significantly lower average intraocular pressure in the nasal trabeculectomy group ($p.= 0.0135$) compared with the temporal group at 18 months. Although intraocular pressures in the nasal group were consistently lower than those in the superior group, this result was not statistically significant (Table VIII).

The average intraocular pressure in each group at each visit is plotted in graph form in Fig. 2. All three trabeculectomy groups undergo a rise in intraocular pressure in the first few months after surgery. After the eighth post-operative month, however, nasal trabeculectomies undergo only a 0.3 mmHg rise in pressure compared with 1.45 mmHg in the superior group and 2.2 mmHg in the temporal group.

Fig. 3 shows a scatter diagram of absolute intraocular pressures 18 months post-operatively in all 60 subjects in the three trabeculectomy groups. The number of patients with an intraocular pressure of <10 mmHg is 6 (30%) in the nasal trabeculectomy group, 2 (10%) in the superior group and none in the temporal group.

DISCUSSION

Since its first description trabeculectomy has been very successful in lowering intraocular pressure in glaucoma. This lowering of intraocular pressure has been shown to both improve and preserve visual field.[14,15]

To our knowledge this is the first study to examine the site of trabeculectomy as a factor which may influence the results of filtration surgery. Our report suggests that nasally sited trabeculectomies achieve consistently lower average intraocular pressures post-operatively than do superior or temporal trabeculectomies. This was statistically significant ($p<0.05$) when the average intraocular pressure in the nasal trabeculectomy group was compared with that in the temporal group at 18 months post-operatively.

Thirty per cent (6 patients) of the nasal trabeculectomy group achieved intraocular pressures of <10 mmHg 18 months after surgery, compared with 5% (1 patient) in the superior group and none in the temporal group. It has been shown that in certain conditions such as advanced glaucomatous atrophy, severe visual field loss and low-tension glaucoma, it is desirable to achieve single-figure intraocular pressures after filtration surgery.[16] All three groups demonstrated a slow but similar rise in intraocular pressure during the first 8 months after surgery. However, after this period the intraocular pressures in the nasal trabeculectomy group reach a plateau, with minimal long-term rise compared with the superior and temporal groups.

Table VI. Complications seen in the late post-operative period following trabeculectomy at the nasal, superior and temporal sites

	Nasal	Superior	Temporal
Dellen	4 (20%)	0	1
Discomfort	5 (25%)	0	2
Antiglaucoma medication	2	3	1

Table VII. Average intraocular pressures at the post-operative visits in each of the three trabeculectomy groups

	Intraocular pressure (mmHg)		
Post-operative period	Nasal	Superior	Temporal
3 days	8.1	11.05	10.75
2 months	11.7	12.95	12.2
8 months	14.2	16.0	15.95
18 months	14.5	17.45	18.15

The causes of trabeculectomy failure may be broadly classified into intraocular, scleral and extraocular.[17] Extraocular causes account for the majority of filtration failures.[18] The main reason for this is scarring at the conjunctival–Tenon's capsule–episcleral interface, external to the scleral flap. Other observed factors are synthesis of extracellular matrix such as collagen and glycosaminoglycans,[5] and an increased inflammatory reaction in subconjunctival tissue with the presence of macrophages and lymphocytes.[18]

Lavin suggests that administration of topical antiglaucoma medication for even a few months before trabeculectomy has an effect on subsequent bleb fibrosis and intraocular pressure control.[11] To substantiate our findings on nasal trabeculectomies the ideal study would, of course, be to perform trabeculectomy at different sites on virgin conjunctiva that has not undergone any previous medical or surgical treatment.

Nasal trabeculectomies do have disadvantages, the first being that surgical access is less favourable. In our study bleb leakage and re-suture occurred more frequently in the nasal trabeculectomy group. This may be due to poor conjunctival suturing techniques as a result of difficult access or to local differences in nasal conjunctiva. Thirty per cent (6 patients) of nasal trabeculectomies developed corneal dellen compared with 10% (2 patients) in the temporal group and none in the superior group. Soon and Quigley studied 97 consecutive trabeculectomies and noted a 10% rate of corneal dellen formation. They reasoned that an elevation at the limbus led to localised disruption of the tear film which in turn led to corneal dehydration and del-

Table VIII. Analysis of intraocular pressure (IOP) between trabeculectomy groups 18 months post-operatively

	Nasal vs. temporal	Nasal vs. superior
Mean IOP difference (mmHg)	3.5	2.8
Standard error	1.35	1.46
p value	0.0135	0.062
95% confidence limits	0.76–6.27	–0.15–5.75

Averages were compared using an unpaired *t*-test.

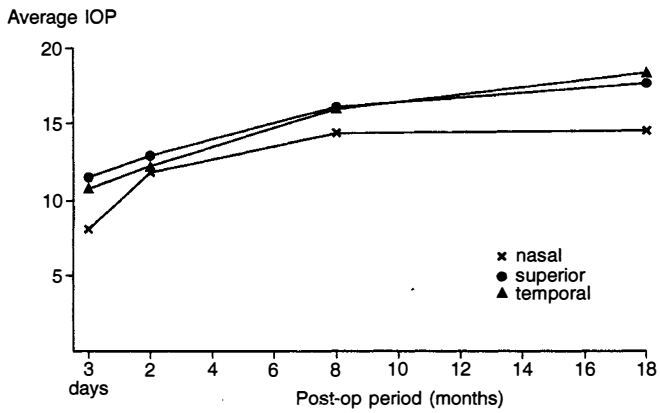

Fig. 2. *The average intraocular pressures in each trabeculectomy group at each of the four post-operative visits.*

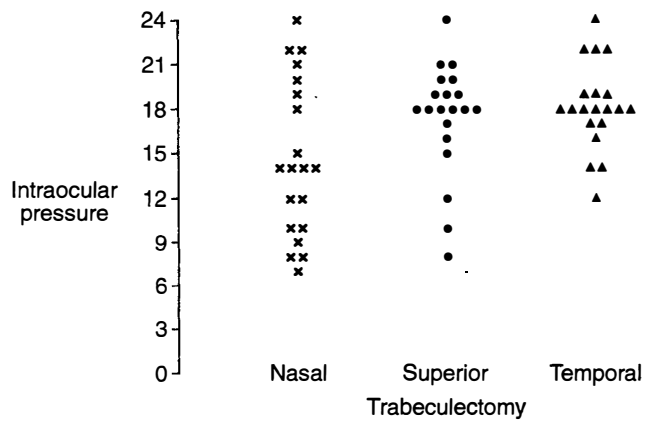

Fig. 3. *Scatter diagram showing the absolute intraocular pressures 18 months post-operatively in all 60 subjects in the three trabeculectomy groups.*

len formation. In their study as in ours the corneal dellen were all short lasting and resolved completely. They felt that this related to the eventual flattening out process in the drainage bleb.[19] Twenty-five per cent (5 patients) in the nasal trabeculectomy group also complained of discomfort due to exuberant bleb formation. One female patient in particular was concerned as the nasal drainage bleb had extended inferiorly and was quite visible externally, resulting in poor cosmesis. This complication is undesirable as little can be done to reverse the effects of surgery. It is notable that corneal dellen and bleb discomfort were not seen in the superior trabeculectomy group.

The reasons for the differences in outcome seen in the three trabeculectomy groups may be the result of variation in cellular and morphological characteristics of conjunctiva and its underlying tissue in various regions of the eye. While these differences are quoted in other texts,[13] there has been little anatomical work into the regional variation in bulbar and limbal conjunctival and subconjunctival tissue. Regional variation in tissue planes may lead to differences in dissection and the degree of cautery used. These factors may also play a role in the type of drainage bleb formed, its local effect and its ability to control intraocular pressure in the long term.

In conclusion, nasal trabeculectomies achieve better intraocular pressure control in the long term. However, they may also suffer from disadvantages such as bleb leakage, corneal dellen and patient discomfort. Overall the success rate of trabeculectomy is high;[20,21] therefore a nasal trabeculectomy should perhaps be considered, particularly in situations where low intraocular pressures are desirable as in low tension glaucoma and advanced glaucomas.

Key words: Filtration bleb, Intraocular pressure, Surgical site, Trabeculectomy.

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