Autotrichograft sutures in cataract surgery

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Suturing in cataract surgery is now practised almost universally. Advances in materials and techniques are enabling us to achieve more satisfactory wound healing with a shorter duration of postoperative inflammation. The suture material needs to be of fine calibre, non-irritant, absorbable, non-antigenic, strong enough to withstand the intraocular pressure, and able to maintain a knot without slipping.

The sutures in general use are of proteinaceous material derived from other species of the animal kingdom, and synthetic materials, such as Orlon, Perlon, and Monofilament Nylon (Aquavella and Sheehey, 1969), are also used. The latter, being non-absorbable may lead to physical irritation.

Aichmair (1963), comparing 6-0 catgut (Ethicon) and 6-0 silk (Ethicon), investigated the incidence of wound dehiscence and flat anterior chamber, with resultant secondary glaucoma or other complications. Wound leakage through suture sites was studied by Sugar and Deen (1963), who stressed the importance of coaptation of the wound edges determined by the even penetration of the needle at the two edges.

Epithelial downgrowth, a very discouraging complication of cataract surgery, has been found to occur less frequently with catgut than with silk sutures (Dunnington and Regan, 1953). This is perhaps because the catgut is absorbed more quickly. Limbus-based conjunctival flaps with buried sutures eliminate the involvement of the epithelial layers in the track of the suture.

Histological studies have shown that the reaction provoked by catgut has a preponderance of polymorphonuclear leucocytes (O'Donoghue, Clarke, and Pokhrell, 1969). To reduce the antigenic property of sutures, Vörösmarthy and Scheid (1963), working on rat-tail tendon fibres, treated them with iodine and alcohol. Zauberman and Nathan (1967) compared the reaction to commonly-used suture materials in the corneae of laboratory animals with that evoked by autograft fibres obtained from tendons. They found that, with silk and catgut, infiltration with polymorphonuclears occurred and was followed by necrotic changes and proliferation of highly vascular fibroblastic tissue, whereas with the autograft tendon fibres there was vascular invasion followed by regression.

The common ectodermal origin of corneal tissue and hair suggested the use of the patients' own hair as sutures.

Present investigation

This paper reports the results with autotrichograft sutures in a series of 189 cataract extractions over a period of 2 years. The patients' ages ranged from 33 to 81 years (Table I). The first 65 operations were performed on unselected cases alternating with cases in which conventional suture materials were used (Ethicon 6-0 chromic catgut or 7-0 virgin silk) on a G1 cutting needle. The other 124 cases were not taken in strict rotation.

Table I Age and sex distribution of 189 eyes

Age (yrs)	Over 60		Under 60	
Sex	Male	Female	Male	Female
No. of eyes	31	64	35	59

SUTURES

Three or four strands of hair were obtained from the patient before the administration of local anaesthesia for cataract surgery, labelled appropriately, immersed in pure Lysol for 10 minutes, rinsed in sterile water, boiled for 10 minutes, and placed in readiness on the instrument trolley.

CASES

All except 28 of the 189 eyes (see Table II) underwent straightforward cataract extractions. Among the 161 eyes in the uncomplicated group were four belonging to patients whose fellow eyes had previously been sutured with conventional sutures after cataract surgery, so that it was possible to compare their convalescence (Figs 1 and 2).

Table II Cataracts with unusual features

Pseudoexfoliation of lens capsule	3
Lens-induced uveitis with secondary glaucoma	6
Complicated cataract	1
Diabetes mellitus	15
Subluxation of cataractous lens	1
High myopia	2
Total	28

FIG. 1 Left eye sutured with patient's own hair **FIG. 2** Right eye sutured with patient's own hair (a), left eye with chromic catgut (b)

OPERATION (Fig. 3, overleaf)

The classical von Graefe section, with an adequate limbus-based conjunctival flap and post-placed sutures, was used in almost every case. The *ab externo* approach with keratome and scissors and a limbus-based conjunctival flap was used in four cases.

FIG. 3 Operative technique

Three autotrichograft sutures were inserted at 45° of arc to each other. Each was tied in a double knot and the ends were cut short. In two cases four sutures and in two others five sutures were used. Intracapsular extractions were performed in 133 cases and planned extracapsular extractions in sixteen. The intracapsular extractions were aided by enzymatic zonulolysis in 86 cases. The lens was delivered by Castroviejo's cross-action forceps (38), the erysophake (111), or the cryoprobe (24) (Table III).

POSTOPERATIVE COURSE

There was very little inflammation and the eyes were quiet at the end of 72 or, at the most, 96 hrs. Only three cases remained inflamed for 18, 15, and 21 days respectively, and all three of these patients were diabetic. It is noteworthy that twelve other diabetics progressed well without undue reaction. Two patients had hyphaema which cleared up without complications. The three patients in whom pseudoexfoliation of the lens capsule occurred despite preoperative therapy with acetazolamide all had shallow anterior chambers postoperatively, and required further surgery in the form of aspiration of loculated aqueous from within the vitreous body. Wound ectasia occurred in only one case, but this resulted in a draining bleb. Epithelialization of the anterior chamber occurred in only two patients, both of whom were long-standing diabetics (Table IV). The absence of iris prolapse is noteworthy.

Follow-up studies were carried out at intervals and the wound site was inspected by slit-lamp biomicroscopy for the presence of suture material (Table V).

In two cases the sutures persisted for 40 weeks, but in the great majority of cases—176—there was no trace of them at the end of 10 weeks; in 52 they had already disappeared after 5 weeks. There were no signs of irritation or inflammation; no swelling of the autotrichograft sutures was observed during convalescence and this is very relevant to the absence of mechanical irritation. In the

Table III *Steps of operation*

<i>Steps of operation</i>		<i>No. of eyes</i>
von Graefe section with limbus-based conjunctival flap		185
Keratome and scissors section with limbus-based conjunctival flap		4
		189
Enzymatic zonulolysis		86
Number of autotrichograft sutures	Three	185
	Four	3
	Five	2
		189
Single peripheral iridectomy		189
Mode of extraction	Castroviejo's cross-action forceps	38
	Phakoeresis	111
	Cryoprobe	24
	Extracapsular	16
		189
Re-formation of anterior chamber with sterile air		173
Chamber not re-formed		16
		189

Table IV *Postoperative complications*

<i>Postoperative complications</i>	
Hyphaema	2
Prolapse of iris	0
Epithelialization of anterior chamber	2
Draining bleb	1
Flat anterior chamber with loculated aqueous in vitreous	3

Table V *Suture absorbability*

<i>No trace of Sutures at end of</i>	<i>5 wks</i>	<i>10 wks</i>	<i>20 wks</i>
<i>No. of eyes</i>	52	176	187

six cases of lens-induced uveitis, the intensity of postoperative inflammation was no greater than in the uncomplicated cases. So long as there is no irritation, the slow absorption of the sutures is desirable as it maintains a good apposition until firm healing has been achieved.

FINAL ASSESSMENT (Table VI)

The two cases of epithelialization of the anterior chamber developed occlusio pupillae and the fundus could not be seen. Of the remaining 187, all but seven had normal fundi. Two of the seven were high myopes, one had retinal venous occlusion (diabetic), one circinate retinopathy, one retinal detachment, and two glaucomatous cupping of the optic disc.

Table VI *Final assessment*

<i>Final assessment</i>			<i>No. of eyes</i>
Fundus	Good view	Normal	182
		Central retinal vein occlusion (diabetic)	1
		Circinate retinopathy	1
		Retinal detachment	1
		Glaucomatous cupping of disc	2
	Not seen	Epithelialization of anterior chamber	2
Pupil		Central	179
		Slightly eccentric	6
		Occlusio pupillae	2
		Persistent sedimentation	2
Astigmatism		Within 2 D cyl.	178

Discussion

Having conceived the idea of the suitability of an individual's own proteins—scalp hair—for the purpose, of suturing, by virtue of the common ectodermal origin of cornea and hair, studies of the comparative calibre size of human hair and other suture material (Fig. 4) and estimations of tensile strength were carried out (Tables VII and VIII).

FIG. 4 Calibre of sutures compared $\times 100$

Table VII Calibre of suture material (μ)

Calibre of suture material	(μ)
6-0 plain catgut	130
6-0 chromic catgut	122
Virgin silk	60
Human hair male	65
female	61
female	62

Table VIII Tensile strength of suture material (g.)

Tensile strength of suture material			(g.)
Virgin silk			64
6-0 Chromic catgut			350
6-0 Plain catgut			392
Human hair in eight typical cases	Sex	Age (yrs)	(g.)
	F	22	84
	F	60	122
	F	35	130
	F	45	110
	F	55	135
	F	70	125
	M	68	98
	M	55	120

The necessary tensile strength is as follows:

Upper limit of normal intraocular pressure 22 mm. Hg.

Pressure of 1 mm. Hg = Force of 1.36 g./sq. cm. of surface.

Total upward force on semicircular flap of 10 mm. diameter with intraocular pressure of 22 mm. Hg = $22 \times 1.36 \times \frac{1}{2}\pi (\frac{1}{2})^2$ g.

$$= 11.75 \text{ g.}$$

If the above force is withstood by three sutures, each suture would bear $\frac{1}{3}$ of the total force.

Hence the force on each tied suture at 22 mm. Hg intraocular pressure = 3.92 g.

At 50 mm. Hg intraocular pressure the force on each tied suture = $3.92 \times \frac{50 \text{ g.}}{22} = 8.90 \text{ g.}$

As each tied suture consists of a double strand of suture material, the tensile strength required of the material = $\frac{8.90 \text{ g.}}{2} = 4.45 \text{ g.}$

From the values of tensile strength obtained, it is therefore quite apparent that the tensile strength of human hair is amply adequate. Human hair does not imbibe water and swell as does catgut. In addition, the frictional property of human hair is admirably suited for the maintenance of a secure knot—a factor lacking in catgut. The remarkably mild degree of postoperative inflammation is the result of these desirable physical features and the lack of antigenicity. The fine calibre, and hence the small size, of the knot does not cause irritation, and this, together with the early absorption, reduces the incidence of epithelial downgrowth, and permits better coaptation of the wound edges with almost complete elimination of wound dehiscence (except one case in this series) even in the presence of increased intraocular pressure.

Conclusions

The absorbability, lack of antigenicity, fine calibre of preformed strands, ready availability, and almost complete elimination of most of the dreaded complications of cataract surgery all favour the use of autotrichograft sutures.

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