DIAMOND KNIFE IN CATARACT SURGERY*†

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SURGEONS have always searched for sharper cutting instruments whether it be needles, scissors, or knives. The stainless steel blade has until recently been the sharpest knife-edge, but diamond knives‡ are much sharper. The diamonds are of gem quality and the blades were developed originally for sectioning biological materials especially for electron microscopy. This paper presents their use in making the cataract incision, their first known use in human surgery.

The cutting edge of a stainless steel knife blade magnified $1000\times$ is shown at the left of Fig. 1, while the perfect diamond knife-edge at the same magnification is on the right.

FIG. 1.—Diamond knife, right, is perfectly smooth with no defects detectable at the $1000\times$ magnification shown here. Sharpest conventional stainless steel blade used in surgery is shown at the same magnification on the left.

* Received for publication January 23, 1967.

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‡ Manufactured by the Instrument Products Division of the E. I. du Pont de Nemours & Company, Incorporated.

The edge of the ultrasharp diamond knife blade is less than 100 Å. By contrast, a red blood cell is 80,000 Å wide. The diamond knife makes a perfect, bevelled incision, and the life of the edge is almost indefinite if it is handled with care. Autoclaving or other means of sterilization in no way affects the cutting edge. Should resharpenering ever be necessary, it is feasible, but is a factory procedure.

Before use in human surgery, the knives were tested on cadavers, rabbits, and eyes to be enucleated (Durham, 1966a). The perfect bevelled incision gives perfect apposition of the wound edges, securing faster healing and normal restoration of the shape of the eye.

For use in cataract surgery (Durham, 1966b), the diamond edge is mounted in a metal shank at an angle of 35° to give a bevelled incision. The knife rotates on a "Teflon" bearing and provides up to a 360° incision, the depth being controlled by a guard set at 0.8 mm. The diameter is adjustable so that a cornea-scleral or completely corneal incision is possible.

Fig. 2 shows the device holding the eye and positioned ready for the incision, Fig. 3 shows the two-piece construction of the instrument, and Fig. 4 the vacuum side and the "Teflon" bearing.

FIG. 2.—Vacuum fixation device holds eye in position while diamond surgical knife rotates on outer ring to make a perfect bevelled incision for cataract surgery. Continuous inspection is permitted as the incision is made.

FIG. 3.—The knife holder, right, fits on to the vacuum fixation device, left.

FIG. 4.—Vacuum surface and "Teflon" bearing.

Surgical Procedure

Upper and lower lid sutures as well as a superior rectus suture are inserted, although a speculum can also be used. The eye is fixed by vacuum while the knife is applied to the cornea-scleral margin. The vacuum can be supplied by a separate pump, an anaesthesia suction machine, or a house supply. The usual incision is at the cornea-scleral margin, but a completely corneal incision may be made by adjusting the blade to a shorter radius. A flap, either fornix-based or limbal-based, is feasible, but many of our operations were

performed without a flap. Without a flap the conjunctiva retracts spontaneously for several mm. or can be retracted further by blunt dissection. A partial-thickness 180° incision approximately 3/4 mm. in depth is made, since a penetrating incision has been shown to cause prolapse of the iris and often of the vitreous, because of the vacuum (Fig. 5). The vacuum and knife are removed after the incision, the preplaced sutures are inserted and the incision is completed with knife and scissors. The cataract is removed as the surgeon wishes. The sutures are tied and additional reinforcing sutures are placed. Acetylcholine is instilled into the anterior chamber for miosis and restoration of the chamber.

FIG. 5.—Non-penetrating corneo-scleral incision without preparation of conjunctival flap.

Results in Use

Over 57 cataract operations have been performed with the diamond knife (Table I).

TABLE I
PARTICULARS OF 57 LENS EXTRACTIONS

Age (yrs)	Range Mean	42-70 65
Sex	Male Female	26 31 } 57
Anaesthesia	General Local	36 21 } 57
Visual Result	20/20 20/30 20/40 20/60 20/200 or less	19 13 5 9 2 } 48
Complications due to Incision		6

The complications attributable to the section and to wound healing are summarized in Table II, and compared with those encountered by one of us (M.H.L.) in 277 cataract operations using a similar technique but making the limbal section with a von Graefe knife. The two series do not show a significant statistical difference, but with the diamond knife there was a higher incidence of hyphaema and one case of post-operative glaucoma following collapse of the anterior chamber.

TABLE II
COMPLICATIONS

Complication	Diamond Knife (57)		von Graefe Knife (277)	
	No.	Per cent.	No.	Per cent.
Vitreous haemorrhage	1	1.7		
Hyphaema	3	5.0	2	0.75
Shallow anterior chamber (1-7 days postoperatively)	2*	3.5	3	1.0
Late prolapse of iris (after 3 weeks)			2	0.75
Total	6	10.2	7	2.5

* 1 developed angle-closure glaucoma following collapse of anterior chamber

Summary

The diamond knife can safely be used for cataract surgery, and permits a perfectly placed bevelled incision not possible with a steel knife. It was hoped to make a penetrating incision with the knife and its vacuum fixation, but we found (as did Barraquer Moner, 1945), that the vacuum tended to produce prolapse of the iris and vitreous, and we now use a partial thickness incision, completed by a steel knife incision into the anterior chamber and scissors.

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