COMPLICATIONS OF CRYOEXTRACTION OF CATARACTS*†

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WITH growing interest in cryosurgical techniques, cryoextraction of cataracts—a method introduced by Krwawicz (1961, 1963)—is being tried by many British surgeons (Davies, 1965; Conway, 1965).

It has the advantage of minimizing the occurrence of accidental capsule rupture—a feature of often capital importance. It requires, however, a new and very different instrumentation and extraction technique and it has its quite new set of operative complications. This paper sets out to discuss these complications and to give guidance to those starting cryosurgical work. It is based on the personal experience of 150 cryoextractions, done without the use of chymotrypsin. The instruments used were (1) Krwawicz cryoextractor, (2) the author's cryosurgical unit,‡ (3) the author's iris retractor.§

COMPLICATIONS RELATING TO FAILURE OF FREEZING

With any type of cryoextracting instrument, cases are encountered when the tip of the instrument is brought into contact with the lens capsule, but fails to freeze to it, or freezes so feebly that the grip is broken on an attempt to move the lens. The reasons for this may be several:

(a) With the original Krwawicz instrument and other types using direct immersion in the coolant, the time during which the instrument is effective is limited. Once out of the coolant the small mass of metal rapidly warms up. Delay in applying it to the lens—caused for instance by difficulties of the assistant with retracting the cornea and retracting the iris—may make the instrument less effective.

(b) With immersion transfer cooling (ethyl alcohol in Krwawicz method) the level of alcohol in the inner test tube must be high enough to cover about three-quarters of the exposed instrument shaft to create effective cooling. If the level is too low the instrument takes a long time to cool and may not be ready for use even after 10 to 15 minutes of immersion.

(c) Excess alcohol in the test tube may penetrate into the thread of the plastic cover. While it is essential in any case to wipe the alcohol clean before using the instrument, the alcohol in the nut thread will seep down the shaft on which it will not freeze, and trickling, even in minute quantities, towards the applied tip will make freezing impossible.

(d) Failure to dip the operating tip in water before applying it to the lens capsule will also prevent freezing. No bond takes place between the dry, cold metal and the lens capsule; a

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thin layer of ice on the tip is required to secure the bond. These remarks apply to all types of extractors.

(e) The aqueous collecting in many eyes in front of the upper pole of the lens—when exposed—has to be wiped out, preferably with a brush, immediately before applying the tip to the lens. A pool of aqueous will prevent freezing by warming the tip.

(f) Most intumescent and hypermature lenses freeze more slowly than common senile cataracts. The bond may break away on attempting to pull the lens even after the normal few seconds delay; these lenses require longer freezing (Fig. 1).

(g) It is wise to depress the lower pole of the lens, tilting the upper pole forward before applying the tip. This ensures a firm probe-lens contact and a good bond by a thin layer of ice. Otherwise the bond may be weak and break.

(h) In cases of subluxated and luxated lenses it may be difficult to make the contact firm enough to ensure a bond because of the unsteadiness of the lens and intervening vitreous.

COMPLICATIONS RELATING TO CAPSULE RUPTURE

Accidental capsule rupture converting the extraction into an extracapsular one is still possible even with cryomethods. This may occur in certain circumstances.

(a) Round pupil extraction is achieved by retraction of the pupil upwards to expose the upper part of the lens to cryoprobe contact. Various types of retractors are used, but all of them have to hook under the iris sphincter through the pupil and slide up—taking the iris with them—over the lens surface. Breaking of the lens capsule during this manoeuvre may occur when it is not done gently. A strip of anterior capsule is thus removed. The lens nucleus may then be frozen to the cryoprobe in the ordinary way and extracted, and the lens material may be washed out.

(b) Intumescent cataracts freeze slowly in depth. With rapidly warming probes there may not be enough time to cool the lens sufficiently to create penetration and bind the capsule to the lens matter. The same applies when too high a temperature is used—the cooling is then too prolonged. In these situations an attempt to remove the lens leads to capsule breakage at the inferior pole of the lens. The capsule is then removed frozen to the

FIG. 1.—Extraction of intumescent cataract. In spite of large superficial freezing, penetration in depth is slow and lens remains soft and tenting on extraction. (Krwawicz probe.)

instrument tip like a folded parachute—in one piece—and the lens material and nucleus have to be removed subsequently.

(c) In one isolated case, a lens capsule broke when touched with the cryo tip—this occurred in an intumescent cataract.

COMPLICATIONS RELATING TO VITREOUS LOSS

Apart from initial dipping on the lower limbal region with a squint hook to tilt the upper pole of the lens forward to make a firmer bond with the tip of the cryoprobe, there is no pressure or displacement of the vitreous with this type of extraction. The lens is delivered by the sliding method; the stiffening of the lens from cooling and the strength of the cryo-bond make breaking of the zonule easy and hardly noticeable. The vitreous may present, however, in two circumstances:

(a) The iris retractor may be inadvertently depressed and may damage the vitreous face above. After delivery of the lens, a bead may present through the 12 o'clock iridectomy or follow the lens through the pupil.

(b) In cases of vitreous–lens adhesion, especially in young patients, the vitreous may *tent* out from the posterior capsule when the lens is lifted up. In this situation the lens should be extracted slowly on a horizontal plane so as to use the scleral edge of the wound and the surface of the iris retractor for shaving the vitreous off the lens capsule.

COMPLICATIONS RELATING TO ACCIDENTAL FREEZING

(a) *Cornea*.—The cornea is folded back by a forceps hold on the limbus-based flap (Jayles's forceps are very useful here) or by a suture. If it comes into even momentary contact with the bare tip of the cryoprobe, the corneal endothelium freezes to it firmly. Unfreezing can be achieved in various ways, depending on the kind of instrument used:

(1) With the Krwawicz instrument, the best way is to put a jet of room-temperature saline through a thin cannula against the metal–endothelium bond. This unfreezes it in a few seconds. Dropping saline on to this bond is much less satisfactory and speedy.

(2) With gas-flow instruments, the gas flow should be stopped and, depending on the mass of the tip, thawing will occur in time.

(3) With heater-controlled instruments, the foot switch should be used and unfreezing occurs in a few seconds.

The endothelial chilblain vanishes rapidly leaving no trace. There is no visible permanent damage (scar, etc.) to the endothelium.

(b) *Scleral Edge*.—Discussion relating to the cornea applies here too.

(c) *Iris*.—The iris freezes rapidly to the operating tip. With a broad iridectomy extraction this complication is unlikely. With round pupil extraction it may occur in two ways:

(1) By direct contact, if the iris slips down from the retractor, or by direct contact if the tip touches either side of the upwards tented pupil. A proper iris retractor should have a head broad enough to make the sides of the pupil nearly parallel so as to avoid this side touching. An iris hook makes a triangular lens exposure with the narrowest angle above, where a good exposure is most needed. A retractor with a solid blade will protect the retracted iris while the "double hook" type will not prevent touching of the iris above. By the use of a standard retractor, one creates a standard exposure in all cases and the size of the pupil at the beginning of the operation does not matter.

(2) With too prolonged freezing of the lens before lifting it up, a plaque of ice spreads over its surface and when it reaches the edge of the retracted iris, it will freeze it to the lens (Fig. 2, opposite). It is wise to lift the upper pole of the lens up a little soon after the bond with the tip is felt to be taking place and to allow freezing in depth for the next few seconds in this position. This takes the freezing process out of the way, above the iris plane.

FIG. 2.—The iris slips from under the tip of the retractor which is inadvertently tilted. Enlarging ice plaque on the lens surface freezes the ice pillar. Unfreezing by the use of booster heater and re-application of probe tip. (Author's cryosurgical unit).

If freezing to the iris does take place, the methods of unfreezing—depending on the instruments used—are the same as those described in relation to the cornea. With slight short-duration freezing, there is no permanent damage to the iris and the pupil stays round. With prolonged iris freezing, a patch of atrophy and depigmentation develops within the following week, but the pupil stays round as a rule.

(d) *Vitreous*.—In the extraction of luxated lenses, it is inevitable that some vitreous will be frozen to the tip of the instrument and removed with the lens. The temperature gradient within the vitreous is very slow, and the bead removed in these cases is small, and is not followed by vitreous loss.

CONSEQUENCES OF ACCIDENTAL FREEZING

No instrument which cannot be rapidly defrosted by one or another method should be used for cryoextraction. When the probe is being defrozen from the cornea or iris it releases the lens bond at the same time and one has to start the extraction from the beginning. The lens can be bonded to the cryoprobe and thawed away several times without visible changes in the capsule or weakness of successive bonds. With the Krwawicz type of externally-cooled probe, one can sometimes re-apply the same probe in time (before it warms up) and complete the operation. It is safer to have a spare instrument in the coolant, available for this emergency. With controlled instruments, the probe is simply re-applied and extraction completed.

GENERAL REMARKS

All these complications of cryoextraction may be avoided by skilful technique. They will be encountered by the novice in this type of extraction and gradually diminish in frequency in his hands. This paper does not give statistical figures because the author encountered them, singly or in batches, in his early work only, and statistics including this early material would be unrealistic. In careful and skilful hands they may never happen, provided one is aware of the possibilities. They can nearly all be effectively surmounted without permanent damage to the eye.

Having experimented with various temperatures of the operating tip, the author feels that the success of the simple Krwawicz instrument stems from the fact that the temperature of about -60°C obtained with it is about the right temperature for cryoextraction. Lower temperatures—down to -80°C —are useful for intumescent lenses, where more prolonged freezing is advisable before final lens removal. The site of application of the tip should be as near to the upper pole of the lens as possible. This takes the freezing plaque away from the cornea and the upper pole of the lens can easily be lifted a little to prevent the accidental freezing of the ice plaque to the iris. Even touching the silver retractor blade by the probe does no damage to the iris as the cold dissipates widely.

Cryoextraction is a safe procedure. It allows one to reduce the size of corneal section (because of sliding) and it can be used to extract intracapsularly lenses which would otherwise be very risky to tackle. Its only disadvantage is that with round pupil extraction it is not a one-man procedure, and an assistant is needed to deal with the iris retractor and cornea. Broad iridectomy extraction can easily be done single-handed.

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