

## THE USE OF COLD IN THE SURGERY OF THE LENS

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### *Introduction*

The use of extremely low temperatures in certain kinds of treatments, either surgical or clinical, is a resource widely employed in Ophthalmology.

The first experiments with low temperatures in this field dates back to 1910, when Schollar reported a number of cases of cicatrization of chorioretinitis through the freezing of the sclerotic of rabbits with carbonic snow. In 1933, Bietti published the results of his researches on the comparative effects of episcleral diathermo-coagulation, thermo-cuagulation and cryocaustication, having tried to determine the intraocular temperatures after these different kinds of techniques. In 1935, Deutschmann experimented with the application of dry ice to obtain adhesive chorioretinitis in cases of detachment of the retina, and reported satisfactory results.

In 1963, Kelman and Cooper surveyed the immediate and delayed effects of the freezing of tissues, with the purpose of better assessing its possibilities in cryo-ophthalmic surgery. They found that the solidification of the tissues could be promptly obtained, and could also be maintained as long as the temperature was kept below their freezing point, this depending on several factors among which stood out their water content. Such freezing usually occurred at a few degrees below 0° C. The fluids contained in the blood or lymph vessels were frozen, and the blood started flowing again after ceasing the freezing. In other

words, the blood had been hemolysed. This process took place, however, only in the vessels of broader caliber for the capillaries underwent definitive obstruction. In tissues not vascularized, such as those of the lens, a homogeneous ball was promptly formed, the tip of the surgical tool employed firmly adhering to the lens tissues.

The delayed effects of freezing, especially when it lasted too long or was too intense, generally meant the aseptic necrosis of the cells, ice crystals being formed inside them, this being due either to the rupture of their membranes or to changes in the electrolytic equilibrium of the cytoplasm. Capillar obstruction played a major role in the cryogenic necrosis of vascularized tissues. Yet such delayed effects compared favourably with those of diathermo-coagulation. The cryogenic chorioretinitis is today employed in the surgery of the retina since a uniform degree of pigmentation is obtained, and the vessels of broader caliber are not impaired. The cryo-termic transcleral of the chorioretina is gradually replacing the techniques of diathermic and photo-coagulation. The shortcomings of heat (temperatures may be as high as 100° C) are obvious: its transmission to the vitreous body is liable to provoke the retraction of the latter, besides being apt to cause the formation of vitreous retinian bridles which, according to some authors, would account for a large number of relapses. The fact that cryo-surgery spares the broader vessels in both the choroid and the retina, thus preventing the impairing of remote tissues, also represents an asset of such technique.

The procedure is likely to be extended to other types of surgery. In glaucoma, for instance, it may be indicated with measurable cryogenic necrosis of the sclerotic. Pterygium would be another field for the application of cryo-surgery according to the specialists who have an experience in its possibilities. As regards herpetic keratitis Krwawicz reports good results in a substantial number of cases. We have thus far dealt with only a few cases of that sort (twenty-five), although we can report fairly satisfactory results.

#### *Intracapsular extraction of cataract*

The arguments against intracapsular extraction of the lens belong to the past since modern Ophthalmology no more takes them into consideration. However, in spite of every technical and tactical development, the intracapsular extraction of cataract in adults and/or aged patients still has to face certain hindrances which prevent total extraction of the capsule in a hundred per cent of cases. There are some cases in which an extreme fragility of the crystalloid (for example, in hypermature cataracts with degeneration of the capsule) when it is impossible an effective grip, and the capsule is sometimes torn when tweezers are

applied, no matter how developed their model is, or how carefully they might be handled. Furthermore, such capsules are not strong enough to permit the employment of a cupping-glass. The extreme distension of the lens may sometimes render difficult or impossible its being gripped with tweezers, and the puncture of the capsule with the tip of a very thin needle must be undertaken, a resource not always crowned with success. Subluxated cataracts often present problems which are hard to cope with by means of tweezers or cupping-glasses; in either case it is necessary to exert a pressure upon the lens, which is expected to yield to it. This may make the gripping of the lens rather precarious, besides involving the risk for cataract to be sunk into the vitreous body, and the added risk of loss of substance of the latter.

The fact that the cryo-extractor requires but the contact of its tip against the anterior crystalloid, without exerting the slightest pressure upon it, when are present the risks of tearing a distended or degenerated capsule and/or total subluxation of the lens, would suffice to rank the cryo-extractor far above the utilization of tweezers and cupping-glasses. With the cryo-extractor it is possible to increase the percentage of intracapsular extractions. It also has in its favour the circumstance that no pressure at all against the eyeball is exerted in order to promote the rupture of the zonula. Nor is it necessary to use alphachimotripsine to facilitate such purpose. The freezing of the small area in which the tip of the cryo-extractor becomes in contact with the lens is followed by a uniform and progressive retraction of the capsule, which is freed from its zonular adherences without application of any other resources. Within a few seconds (ten in average), it is possible to pull the lens, which is extracted with a sliding motion. Once removed, the grooves of the capsular retraction can be seen by the naked eye, and they converge towards the point where the ice ball has been formed. Through such ice ball the lens will remain firmly adhered to the tip of the cryo-extractor. The firmness of this cryo-capsular adherence is in fact remarkable, and it increases with prolonged contact.

We have used since 1963 the model of cryo-extractor devised by Krwawicz, the specialist to whom, in our opinion, should be credited the present-day development of Cryo-Ophthalmology. We have introduced some modifications in the original cryo-extractor of this Polish surgeon, altering its format and changing the procedures for its sterilization and freezing. It must be emphasized, however, that nothing has been changed as regards Krwawicz's original conception.

We sterilize the cryo-extractor by maintaining it in a formalized recipient, its freezing is obtaining by plunging it directly into dry ice (carbonic snow). Five

minutes are enough for utilization of the cryo-extractor after its having been put in contact with the dry ice.

More modern tools are now available, which can do without dry ice. The units devised by Kelman for the surgery of detachment of the retina and for the surgery of the lens are most up-to-date. We favour Keeler's model, which provides the required low temperature by means of the use of CO<sub>2</sub>. Such instrument can be utilized in cases of detachment of the retina and those of cataract extraction as well.

#### *How we undertake the cryo- extraction of cataracts*

A) The essential steps of the anesthesia (sedation) and of the surgical act will be described below.

The success of ophthalmological surgery, especially intra-ocular, requires the following conditions:

- 1) An absolute immobility of the patient, during and after the operation;
- 2) Intraocular hypotension during the operation;
- 3) A quiet post-surgical period with sedation and absence of vomiting.

We favour general anaesthesia, and the technique we employ consists of induction with barbiturics, relaxing with curarization, intubation and ventilation with a Takaoka respirator, and, finally, vaporization with anesthetic Ether for the sake of analgesia.

With the employment of curarization, muscular tonicity is abolished; and through perfect ventilation, namely normo-ventilation, CO<sub>2</sub> is lowered to a normal level, which secures the non-emergence of the hipercapnia syndrom whose symptoms (increase of intraocular pression, vomiting, psycho-motor agitation) are absolutely counter-indicated in ophthalmological surgery.

Such technique provides immobility during and after the operation, as well as a quiet post-surgical period. Vomiting is reducing to a minimum, and the patient recovers consciousness fifteen to thirty minutes after the anaesthesia is over.

For cryo-extraction with the Krawicz-stool, or with some other model such as Keeler's any technique for the opening of the anterior chamber proves satisfactory, being only required the keratotomy of half-circumference in order that the cornea might be easily lifted before the contact of the cryo-extractor tip with

the crystalloid is attempted. We always make the initial incision with a spear, and enlarge it with a pair of scissors. The previous corneo-sclero-conjunctival should be at 12 o'clock. Total, peripheral or no iridectomy is practised. The cryo-extractor tip must contact the crystalloid at a point as possible to the upper limit of its circumference.

When the cryo-extractor touches the capsule and the proper tissues, freezing takes place within a few seconds, and this is felt and seen by the surgeon: a whitish area is formed around the point of contact, and a firm adherence immediately occurs. In order to make possible the extraction of the lens by sliding, it will be necessary only to maintain such contact for about ten seconds, not being required the use of alphachimotripsine. With the retraction of the capsule as a result of its freezing, its zonular adhesences are loosened. Lateral and/or rotating movements with the cryo-extractor, as recommended by Krwawicz, are unnecessary. We never attempt them. We think that, in case of particularly weak capsules, such movements are liable to provoke their rupture. Once established the adhesion, it will not give way, as we have mentioned. It may happen that the whole capsule is extracted while the lens tissue remains *in situ*. It will then be removed with the cryo-extractor itself, or with a hook, by exerting pressure and counter-pressure.

After the extraction, the iris is replaced and the incision is sutured, usually with seven corneo-sclero-conjunctival stitches. Air is injected into the anterior chamber.

### *Our Statistics*

We began to employ Krwawicz's cryo-extractor in March 1963, and have thus far undertaken 970 operations with such procedure. We have succeeded in obtaining intracapsular extractions in 941 cases (97%).

427 cases were of senile cortico and cortico-nuclear cataracts, comprising incipient, hypermature and mature forms. 425 intracapsular extraction were obtained (99,5%). 234 cases were of senile hypomature cataracts, being obtained 224 intracapsular extractions (95,77%). 108 cases were of Morganian cataracts, and 104 intracapsular extractions were obtained (96,3%).

60 cases were of senile tumescent cataracts, being obtained 58 total extractions (96,7%).

110 cases were of cataracts with attending complications (this group comprised 31 cases of post-uveitis, 8 cases of postdetachment of the retina, 26 cases of irido-

cyclitis with ulterior synechias, 24 congenital cases of late development —the patients being over 30 years of age— 13 cases of post-glaucoma, and 8 cases of high myopia). For this whole group, 99 intracapsular extractions were obtained (90%).

In 15 cases of subluxated cataracts, with absence of vitreous body in the anterior chamber, total extraction was obtained in every instance, without any further complications.

In 16 cases of traumatic cataracts (patients with ages ranging from 22 to 39) total extraction was obtained in all of them.

Concerning complications which occurred during the surgical act, we report 38 losses of the vitreous body, and 7 instances of massive hemorrhage in the anterior chamber.

As regards complications verified during the post-surgical period, obviously not inherent with the procedure, we report the following ones: 11 instances of iris hernia; 34 of pupil discentration; 13 of glaucoma; 24 of retardation in the forming of the anterior chamber; 35 of ulterior hyphema. Not a single occurrence of infection ever took place.

718 cases out of the 970 were operated on with total iridectomy (74%); 194 without iridectomy (20%); and the remainder 58 with peripheral iridectomy. We favour, in general, total iridectomy because of the safety it provides to the post-surgical period, as well as for the rather small occurrence of post-cataract glaucoma.

### *Conclusions*

1. Cryo-surgery has opened up new and interesting possibilities for eye surgery.
2. With respect to detachment of the retina, the prospects are promising. As regards glaucoma and pterygium, the procedure remains still inconclusive.
3. Cryo-extraction of cataract is a brilliant achievement. It has definitely imposed itself as the the best procedure to those wishing to improve their statistics of total extraction.
4. Tumescant cataracts, those with degenerated or extramely thin capsules, as well as subluxated cataracts, either hypermature or not, find in the cryo-extractor technique a procedure apt to secure nearly cent per cent of intracapsular extractions.

5. Cryo-therapy of Herpetic keratitis is another great field opened to the new technique. Our experience with 25 cases (87% of good results) have convinced us of its effectiveness.

## SUMMARY

### *The Cold in the Surgery of the Lens*

The Author analyses the advantages of the use of low temperature in surgery, especially in Ophthalmology. Based on his personal experience, already wide enough (970 cases), he acknowledges to be an enthusiast of the intracapsular extraction of the cataract through the Freezing method. He uses the Krwawicz's cryo-extractor with personal modifications, and underlines the advantages of such a method over those requiring tweezers and cupping-glasses, in case of hypermature, Morgagnian, and subluxated cataracts, as well as those with degenerated capsules. His statistics record, up to now, 97% of intracapsular extractions, which include the cases that permitted him to get acquainted with the method.

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