

CRYOEXTRACTION OF CATARACT AND ITS INFLUENCE ON THE DEVELOPMENT OF CRYO-OPHTHALMOLOGY*

By
TADEUSZ KRWAWICZ

The operative treatment of cataract is not always a simple task. Everyone who is practicing such operations is also familiar with their difficulties, which are often considerable. There are, of course, some universally accepted principles and more recent technical improvements which have created conditions for an easier and safer extraction of the cataractous lens. In spite of this, however, the risk of failure was still considerable, because the favourable result of the operations of total removal of cataract often depended on which was broken first: the delicate zonule fibres, or the sometimes even more delicate capsule of the opaque lens.

This commonly practiced, but difficult, and at the same time one of the most fascinating ophthalmological operations suffered from the great part that chance played in its performance. It must be said that this role of chance has been greatly diminished thanks to the most interesting variation of the technique of total extraction consisting in grasping the lens with a suction cup, instead with a forceps. This method has been spread by the work of Professor Ignacio Barraquer, who devoted a whole life of study and investigation to the problems of cataract surgery, and to whose memory I have the great honour to dedicate this lecture.

The endeavour to perfect the art of ocular surgery by all possible and available means has resulted during recent years in the utilization of cold as the basic physical principle of a surgical instrument. Based on the technology of extremely low temperatures, a new branch of surgery, and especially of ocular surgery, the so-called cryosurgery, has come into being¹.

* Ignacio Barraquer y Barraquer Memorial Lecture.

TADEUSZ KRZAWICZ

The idea to apply low temperature for cataract extraction presented itself during experimental investigations on the possibility of storing tissues by freezing. Some experiments with frozen-died animal lenses made it necessary to find a method of removing the lens undamaged from the eye. This proved rather difficult, as the lens was usually damaged. On that occasion a copper wire, soldered to a piece of metal refrigerated in a mixture of dry ice and alcohol, was used for the first time.

It was noticed that when the lens capsule was touched with the tip of the refrigerated instrument, for which we later suggested the name "cryoextractor", there occurred immediate, circumscribed freezing of the capsule, which attached itself to the instrument. In the course of further experimentation, a method of cataract extraction was developed.

The first reports^{2,3,4} on the possibility of applying low temperature for cataract extraction acted, to quote Bellows⁵, as a catalyst which stimulated a number of authors to undertake experimental and clinical investigations or further possibilities of the cryogenic technique, on new instruments and apparatus, and on the effects of cold on the ocular tissues. The ophthalmological world quickly realized the potentialities inherent in ocular cryogenics.

The history of cryoextraction is not so old as of most other ophthalmological operations. Only ten years elapsed since the moment when it was practiced for the first time¹. Nevertheless, this operation has found an almost universal acceptance and is regarded as the safest method of cataract extraction⁶.

In the first line, the application of low temperature established a basis for progress in the art of restoring sight to people affected with cataract. The uncertainty inherent in the traditional methods of cataract extraction can be removed by making use of low temperature. It can be said that the risk of capsular complications now belongs to the past and that we are not so far from ultimate stabilization in this field. In consequence, the operator's nervous tension is reduced⁷, and consistently good results can be assured. More and more ophthalmologists adopt the cryogenic technique because of its advantages over the application of the forceps or erisiphake⁸.

The tensile strength of the capsule grasped with the forceps is about 15 grams; for the erisiphake it is 17 or 18 grams, but it rises to 250 grams and more when the cryoextractor is used^{9,10}. The traction force is applied

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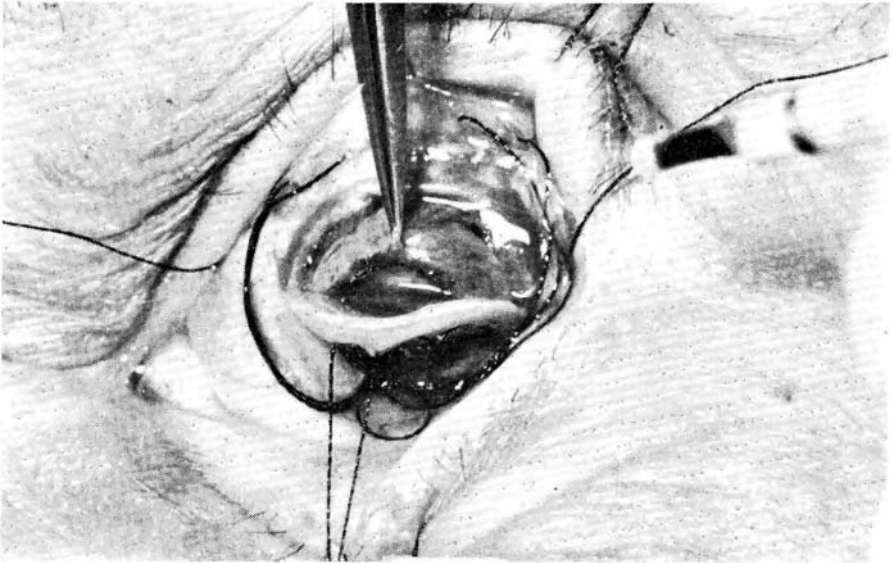


Fig. N° 1

The corneal flap is lifted and is held in this position by the auxiliary suture. The forceps grasps the iris, and the cryoextractor is ready for use.



Fig. N° 2

The iris is lifted with the forceps in the form of a tent.

to the capsule over a large area; thanks to this circumstance there is no need to use counterpressure, so that the risk of vitreous loss is reduced¹¹.

The result of the operation does not depend on the type of the cryoextractor, but on the condition of the cataract and on the operator's experience¹². Cryoextractor does not require any changes in the operative technique; every operator may safely go on using his preferred technique.

Cryoextraction has brought about a real progress, evidenced by better operative results and by a decreased incidence of complications¹³. In comparison with other methods, it assures the best results as far as visual acuity is concerned^{14,15,16,17,18}. The occurrence of complications depends on the experience of the operator, and those who apply cryoextraction¹⁹ agree in the opinion that all types of cataract can be removed intracapsularly and with greater security than by any other method.

In the original method of cryoextraction of cataract^{2,3,4}, the initial stages of the operation do not differ much from those of the conventional methods, up to the moment when the cataract is exposed. It is then that the ball-shaped end of the cryoextractor is applied to the lens. Immediately upon application, the refrigerated part of the capsule adheres firmly to the instrument, so that the lens can be manipulated freely.

We are now convinced that cryoextraction is a method that spares the ocular tissues by enabling the surgeon to operate more delicately. We have also arrived at the conclusion that this operative procedure can be simplified even more than it could be initially expected. No winder section is now necessary, or counterpressure, or retraction of the iris with a special instrument; there is also no need of the operative assistance being engaged more than with the traditional methods¹.

The classical method of cryoextraction, which we employed for several years, required a very active co-operation of the operative assistance. The assistant lifted the corneal flap and retracted the iris with a retractor or another instrument, and thus bore a great part of the responsibility for the outcome of the operation. This circumstance sometimes gave rise to complaints that a well-trained and highly qualified assistance is not always available. Besides, there are operators who prefer to be independent of extraneous help¹. The need of a competent assistant was considered as a drawback of cryoextraction²⁰, and our personal opinion was not much different.

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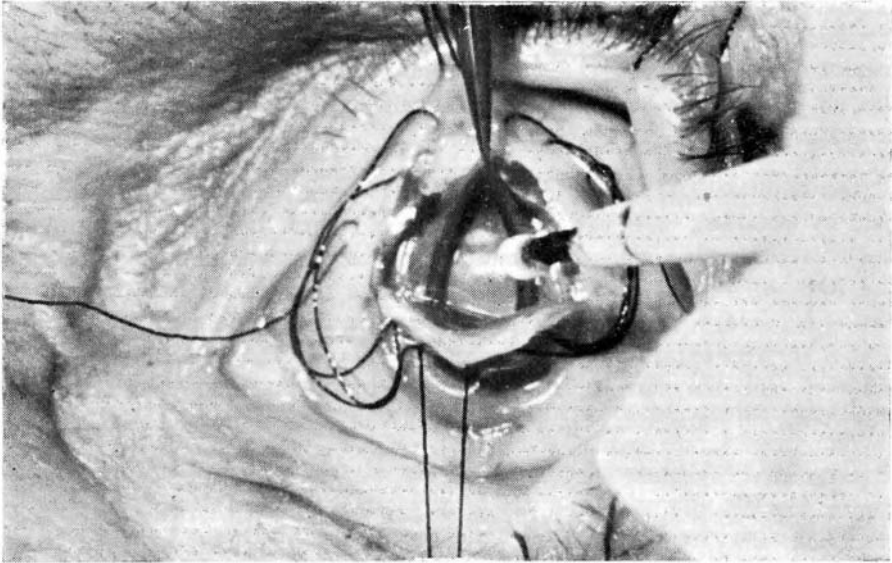


Fig. N° 3

A sufficiently large part of the surface of the lens is exposed so that the instrument can be safely applied to it.

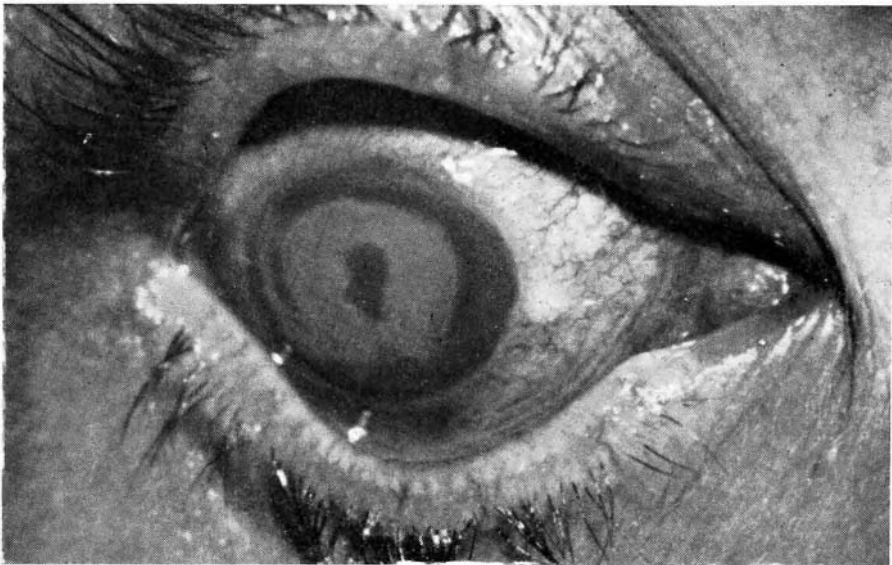


Fig. N° 4

Herpes simplex keratitis treated by a traditional method, 60 days before cryogenic treatment.

Recently it has been found that, thanks to the constant advances of cryosurgery of cataract, this inconvenience can be obviated by reducing the role of the assistance if the whole burden of the operation is laid on the surgeon²¹. This can be achieved by introducing the following modification of the original cryoextraction technique.

An additional suture is used to lift the corneal flap; this suture can be held by assistant, or it can be fixed with a clamp. The iris is grasped by the operator with a smooth or mosquito forceps, and is pulled upwards in the form of a tent. Now a sufficiently large part of the surface of the lens is exposed, so that the instrument can be safely applied to it (Figs. 1, 2 and 3). The cataract is delivered with rotating movements, the iris is adjusted, and the corneal flap is allowed to fall back into position. The additional suture is removed before tying the corneo-scleral suture.

In this way the assistance can be freed from the responsible task of pulling the iris upwards by means of a retractor. When this pulling was too strong the iris could be injured, and when it was insufficient there was an increased risk of touching the iris with the refrigerated instrument. We do not feel now any need of hooks or retractors, and we have discontinued their use.

Our experience with this modified technique has demonstrated that it represents an essential advance in comparison with the classical form of cryoextraction. It does away with the doubts expressed by numerous authors, and especially with the objection²² that cryoextraction with round pupil cannot be carried out by one man only, and that in this case a very active assistance is needed. We have found that the present modification contributes to a more smooth and delicate extraction of the cataract, and that the intraoperative complications, both capsular and others, become less frequent. When the lens is exposed in accordance with the technique just described, there is little probability that the iris or the cornea will be touched with the cold cryoextractor.

The decision to apply enzymatic zonulolysis can be taken during the operation, when a considerable resistance of the zonule is observed. In such cases the operation can be interrupted at any moment, zonulolysis can be performed, and cryoextraction can be resumed¹.

The original cryoextractor is still willingly used by many operators in its classical form. When refrigerated to -79°C in a mixture of dry ice and alcohol, it warms up slowly and reaches -20°C after 5 minutes' exposure

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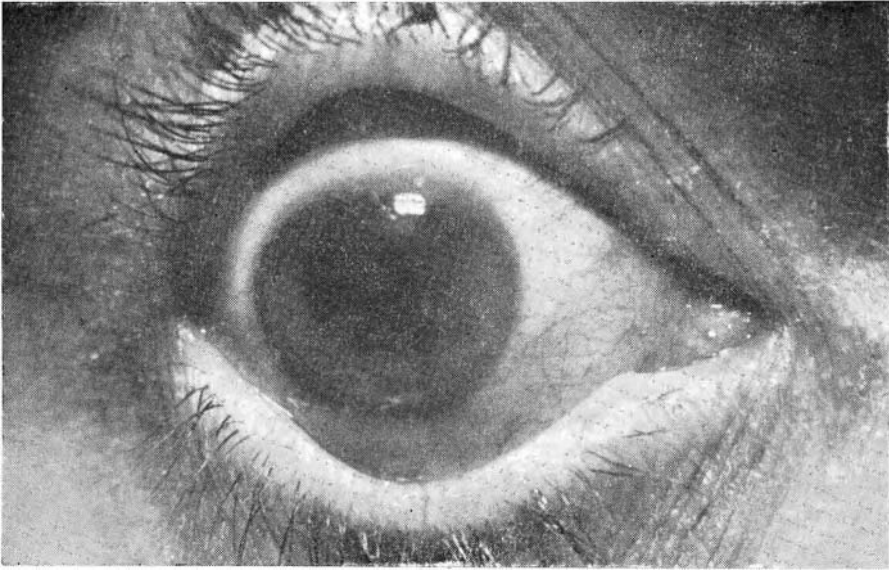


Fig. N° 5

The same case, 30 days after cryotherapy.



Fig. N° 6

Herpes simplex keratitis treated by a traditional method, 14 days before cryogenic treatment.

to room temperature. This short span of time is fully sufficient to perform cryoextraction without haste. The performance of the cryoextractor refrigerated to -79°C is the same as at -20°C , the higher temperature being balanced by a longer time of the application of the instrument to the lens^{1,23}. Good results of cryoextraction with the use of the original model of the cryoextractor have been reported by a number of authors^{17,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39}.

The growing popularity of cryoextraction brought with it numerous modifications of the instrument itself and of the method of obtaining its refrigeration^{40,41,42,43}. The number of excellent, modern devices which are now available is so great that it is practically impossible to get acquainted with all of them. All the instruments can be useful in the hand of operators who employ them habitually because the basic idea is always the same. It should be remembered, however, that even the most ingenious technical device cannot replace the delicacy of the surgeon's hand, and that cryoextraction of cataract is not a method which would decrease the importance of the human factor¹.

The great diversity of instruments for cryogenic cataract extraction indicates that ultimate stabilization in this field is still to come. But even those which are available now make it possible to avoid in many thousands of patients every year the highly undesirable capsular and other complications and to assure better operative results.

The indications of cryoextraction comprise now all kinds of cataract, including complicated cataract. Virtually, no contraindications are known, which means that in all cases in which the intracapsular technique was formerly used cryosurgery always gives better results. Bellows⁴⁴ has rightly remarked that a surgeon who has not adopted the cryogenic method exclusively should certainly consider its application in those cases in which capsular rupture is particularly undesirable.

The essential danger of cryoextraction might lie, as it was initially feared, in the transmission of low temperature to the other parts of the eye, and, in consequence, in the damage of the surrounding tissues. However, when cryoextraction is carried out correctly no complications connected with the cryogenic technique will arise because the only part of the eye which is refrigerated, the lens, is instantaneously removed⁴⁵. The temperature of the tissues surrounding the lens, measured during experimental cryoextraction, has proved to be virtually the same as when the traditional methods of cataract extraction are used^{23,46}.

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Fig. N° 7

The same case, 5 days after cryotherapy.

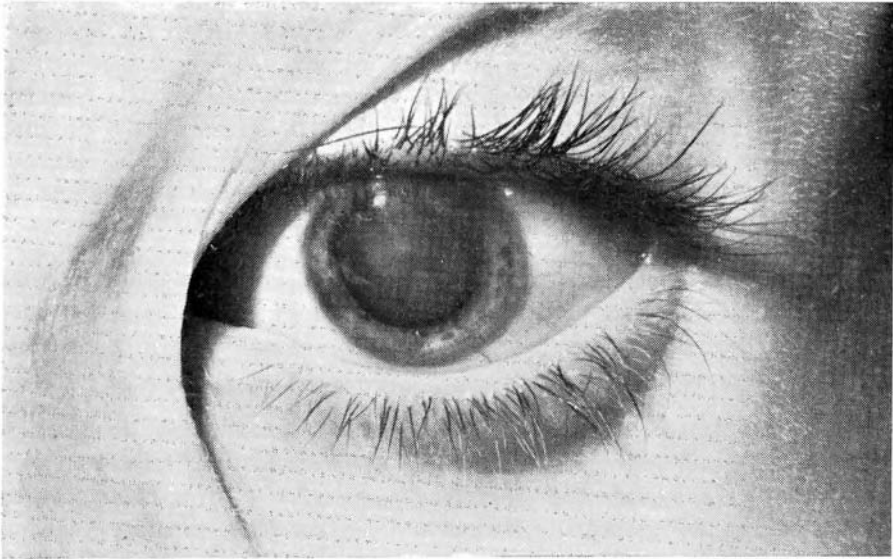


Fig. N° 8

Corneal scar produced by keratitis, prior to cryotherapy. Visual acuity: 0.1.

Accidental touching of the adjacent tissues, and especially of the iris, with the cold cryoextractor is an infrequent and rather harmless complication, as the adhesion can be instantaneously abolished. Such freezing of the iris or cornea is usually of no consequence for the visual acuity.

We have also observed the complication of accidental damaging the lens capsule; this usually happens when a less experienced operator notices that the cryoextractor has been applied too far from the equator or too near the margin of the iris. To correct the position of the instrument, he lifts it involuntarily and breaks the capsule. Sometimes damage to the capsule is done by a retractor or hook, or even by the cryoextractor itself. It is possible, however, to remedy this complication by renewed application of the cryoextractor to the margin of the capsular tear. The cataract can then be removed as a whole^{45,47}.

It also happens sometimes that the operator begins extracting the lens too early after the application of the cryoextractor; the bond between the instrument and the lens is still too weak, and the cryoextractor detaches itself from the capsule, but without injuring it.

The average percentage of intracapsular cataract extractions, as it can be deduced from the world literature, is about 98 per cent³⁶. In our clinical material, which comprises now 5,210 cryogenic cataract extractions, capsular rupture occurred in one per cent, vitreous loss in 0.8 per cent, selective zonulolysis was applied since its introduction in 4.2 per cent of operations. Other intra— and postoperative complications are less frequent than when the traditional techniques are used. It is also worthy noticing that about 60 per cent of these operations concerned intumescent cataract, which means that so many patients could be operated upon earlier, without waiting until their cataracts would become mature.

Our present experience, as well as the data given by other authors, justify the opinion that cryoextraction of cataract can be regarded as a method rendering good services. This is the reason of the growing popularity of this method.

The experience with the application of low temperature for cataract extraction, as well as the observation of some complications connected with this operation, suggested the idea of using cold for treating virus diseases of the cornea, and especially herpes simplex keratitis. In early years of cryoextraction we sometimes met with the complication which consisted in accidental touching the cornea with the cold instrument. If, however,

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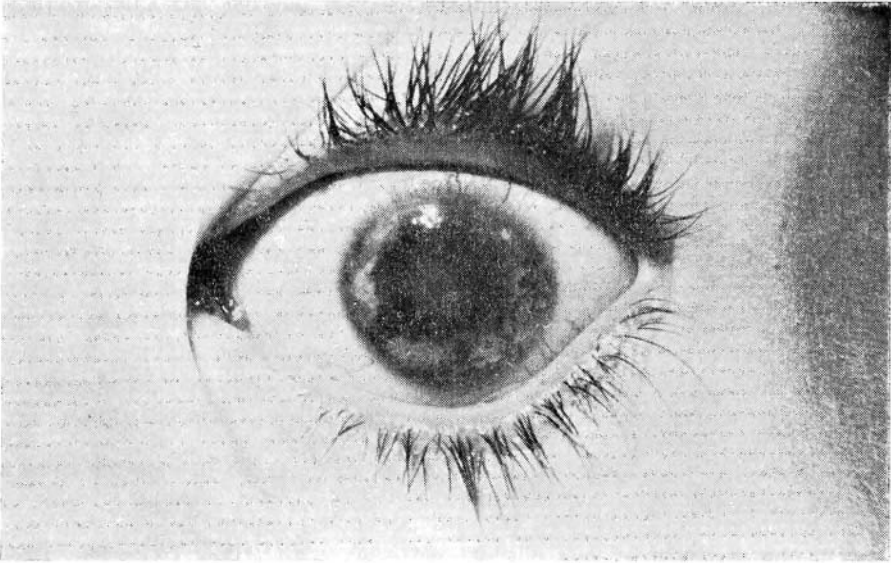


Fig. N° 9

The same eye, 2 months after cryotherapy. Visual acuity: 0.2.

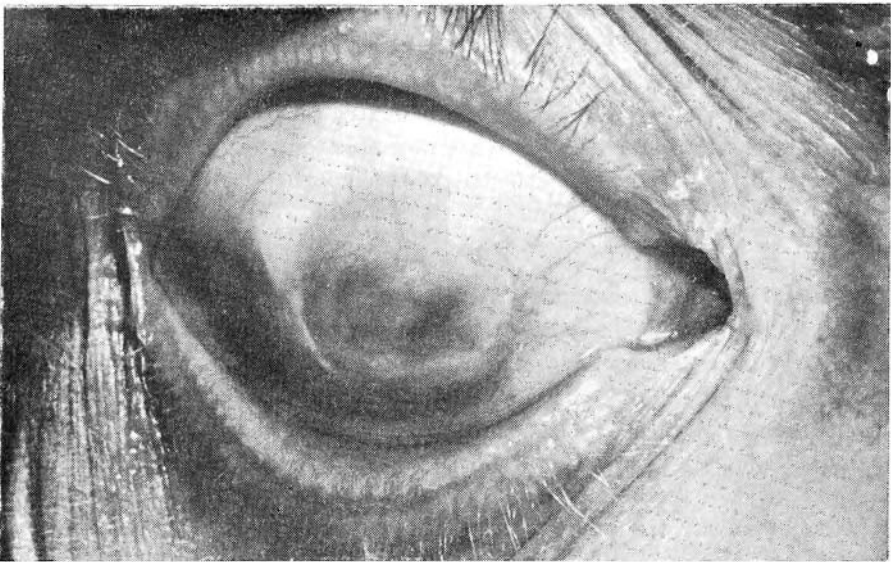


Fig. N° 10

A case of Salzmann's nodular dystrophy of the cornea in a one-eyed patient, prior to cryotherapy. Visual acuity: 0.02.

the cryoextractor was quickly detached from the cornea, this accident never had any negative effect on its transparency. This return of the partially frozen cornea to its normal condition seemed not only to prove the safety of such procedure, but to indicate some further possibility of applying low temperature directly to the cornea in cases of its disease.

Experimental data were obtained on the effect of low temperature of about -60°C applied to the healthy cornea, and later to corneas with artificially produced ulceration, and it was verified that momentary, repeated, superficial and circumscribed refrigeration of the cornea produces a reversible effect and does not harm the transparency of the tissue. Thus conditions have been created for initiating cryotherapy of virus diseases of the cornea, and in consequence, as we know it now, a radical change in the treatment of herpes simplex keratitis has occurred,^{48,49,50,51,52,53,54.}

Figures 4, 5, 6 and 7 show the results of this method of treating herpes simplex keratitis.

On the strength of our clinical material, which now comprises 1,200 cases, as well as of the data published by other authors, we can state that almost all cases of herpes simplex keratitis can be cured in this way, without recurring to other methods; maximum visual acuity can be preserved because cryotherapy spares the corneal tissue.

Our assurance that low temperature, when applied under strictly defined conditions, is safe to the ocular tissues incited us to use it for the treatment of other corneal diseases. We are now able to obtain partial restoration of transparency in corneas affected with superficial scars or with degenerative processes^{55,56.} Figures 8, 9, 10 and 11 illustrate the results obtained by means of cryotherapy in the conditions just mentioned.

Cryotherapy is also becoming of importance in the treatment of iridocyclitis^{57,58,59.} In such cases cold is applied transconjunctivally to the sclera, in the area of the ciliary body, and is supplemented with basic and causative treatment, if the etiology of the disease is known. Under the influence of low temperature, precipitates recede more quickly, vitreous dust clears up, and the inflammatory condition of the eye subsides. This effect of cryotherapy could be verified by observing cases of bilateral chronic iridocyclitis, in which systemic treatment was combined with cyclocryoapplication performed on one eye only. While the symptoms of inflammation and precipitates receded quickly and very distinctly in the eye under cryogenic treatment, the condition of the other eye improved much more slowly.

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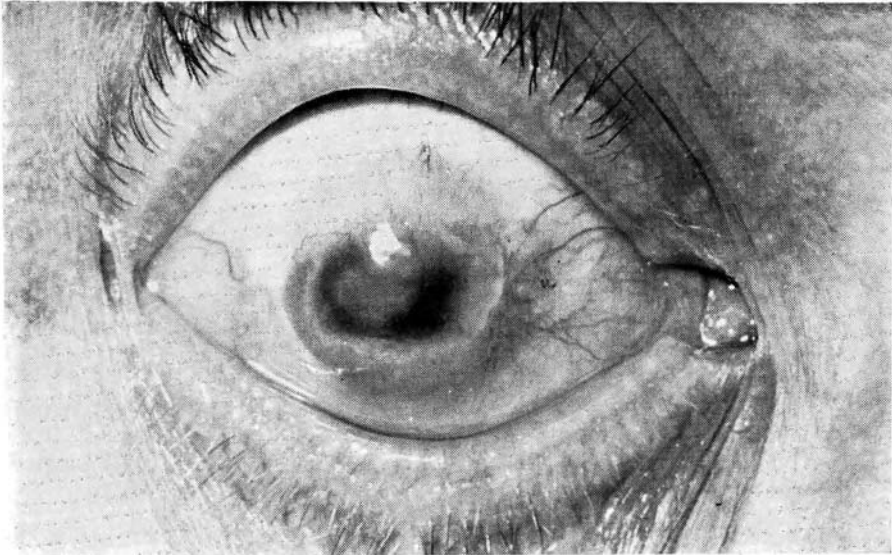


Fig. N° 11

The same cornea after cryotherapy. Visual acuity: 0.2

Bietti's idea⁶⁰ of using low temperature for the treatment of retinal detachment could also be revived. The cryogenic method, which spares the ocular tissues, is becoming increasingly popular, at the expense of diathermo-coagulation of the sclera.

Finally, the use of cold for the treatment of glaucoma should also be mentioned^{61,62}.

The facts that I had the honour to put forth in this lecture pertain to the present scope of cryosurgery and cryotherapy. With regard to further possibilities which may be expected from cryo-ophthalmology, we may await new developments in the treatment of intraocular neoplasms, pterygium, conjunctival hypertrophy, angiomatosis retinae, conjunctivitis vernalis, episcleritis, sympathetic ophthalmia, trachoma, and in many other pathological conditions.

Long-standing clinical experience and prolonged follow-up of the therapeutic results will decide on the value of cryosurgery and cryotherapy in these diverse fields of ocular pathology.

A great number of facts now speak in favour of cryo-ophthalmology. We do not regard it as an exaggeration to say that it paves the way for new developments and for progress in ophthalmology.

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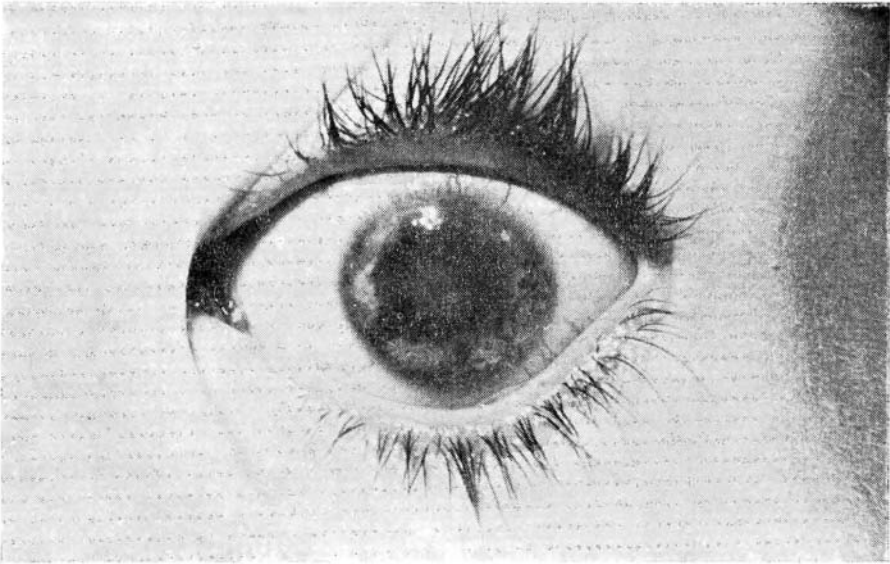


Fig. N° 9

The same eye, 2 months after cryotherapy. Visual acuity: 0.2.

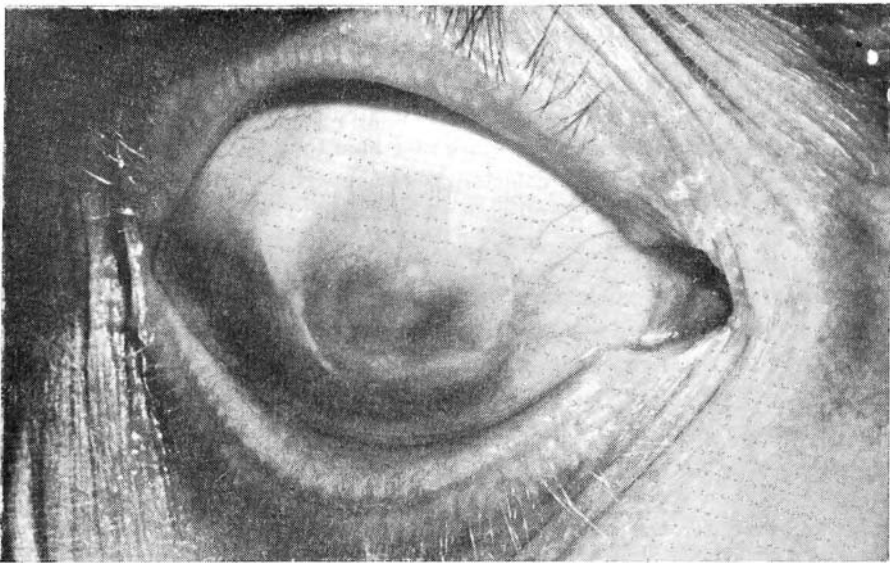


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A case of Salzmann's nodular dystrophy of the cornea in a one-eyed patient, prior to cryotherapy. Visual acuity: 0.02.

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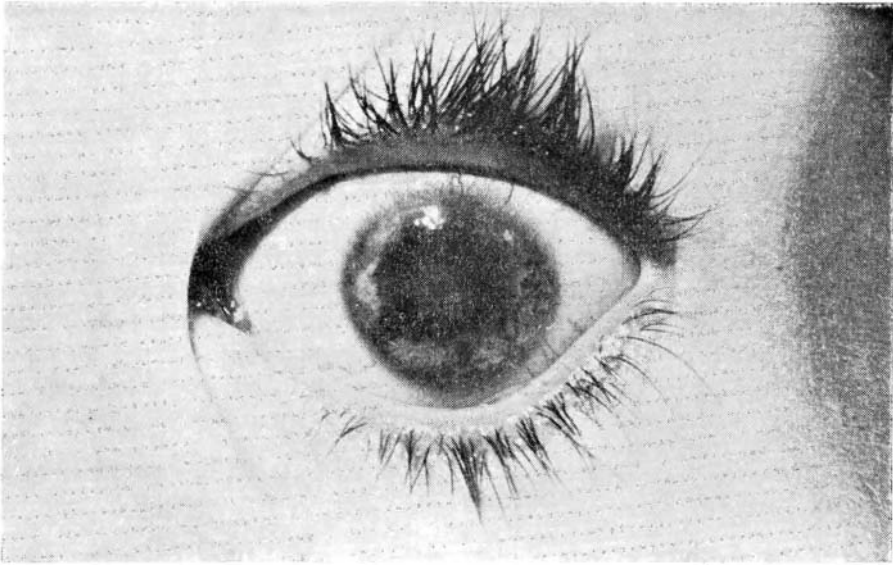


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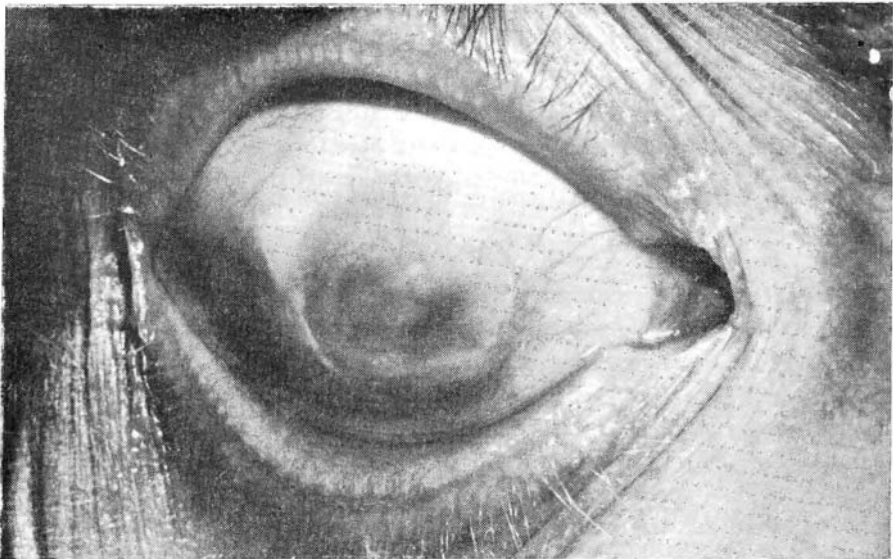


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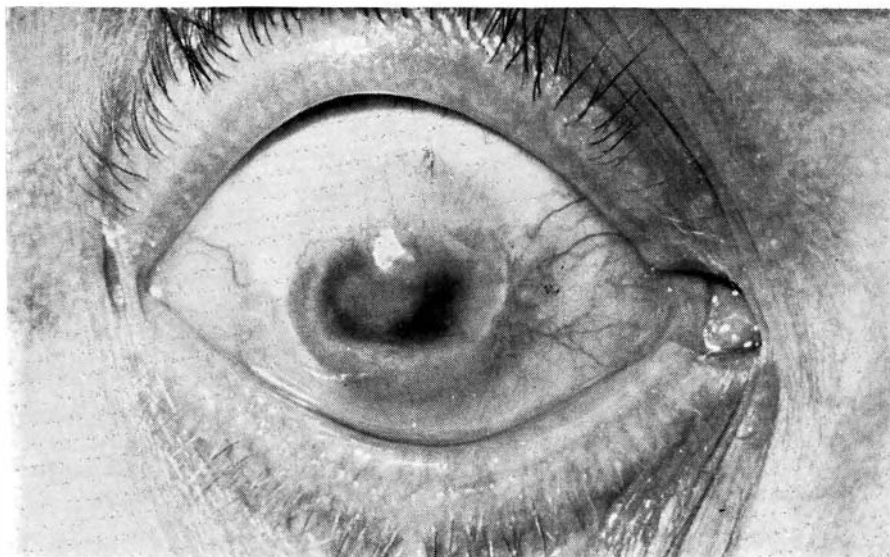


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