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Thirty Years After the Creation of Cryoophthalmology

Po 30 latach od powstania krioofthalmologii

Low temperatures in ophthalmology were first applied in the end of the previous century. However, those experiments were not sufficiently documented and were not widely used. So the report concerning the Krwawicz (6) method of the cataract cryoextraction published in 1960 is commonly treated as the beginning of the modern cryoophthalmology. This extremely effective and simple method very quickly met with approbation and became commonly applied. After the surgical exposure of the opacified lens the copper cryoextractor frozen to about -72°C was applied to it. The deep lens freezing to the apparatus occurred enclosing the subcapsular masses. Then the fibres of Zinn ligament were broken and the cataract was gently removed. Due to its safety and the lack of complications the above technique led the real revolution in the cataract surgery. Its was compared to the epochal contribution of Daviel who was the first to remove the lens in 1774. Its importance however, was not just limited to the improvement of the surgical technique. Thanks to the cryoextraction the possibilities of the low temperature application in medicine were noticed. In a short period of time low temperatures began to be used in some other specialities: laryngology, neurosurgery, oncology, etc. It was found out that great number of the eye diseases could be treated in that way, including viral keratitis, haemorrhages to the vitreous, glaucoma, etc. The gradually gained experience gave rise to the new branch of ophthalmology called cryoophthalmology.

The method of lens cryoextraction was published in Poland in 1960, and as quickly as in 1961 was popularized in the world-wide literature (6). Thus 30 years have passed since, as it was defined in the memoirs of our Academy edited in 1974 "the modern eye cryosurgery has been created in the Medical Academy in Lublin by professor Tadeusz Krwawicz". The questions can be asked concerning the present condition of this science, its role in ophthalmology, its development and the future.

During the last few years the technique of the cataract surgery underwent some significant changes. Due to the implantation of the intraocular lenses the modern method of the extracapsular cataract surgery is just being used. The cryoextrac-

tion remained to be applied in some types of the complicated cataract, especially in the removal of the subluxated lenses, as well as in the cataract complicated by the iris adhesions resulting from uveitis. However, one should remember that the extracapsular cataract surgery is technically more difficult than cryoextraction. The training of the surgeons is longer. The operation is more expensive and requires more complicated equipment; it lasts longer in comparison with cryoextraction. Because of all these things the cryoextraction is still of great importance. In poor countries, especially in the Third World cataract is operated on mainly by using the low temperature. This is a mass operation. Christian Hospital in Taxilla in Pakistan performs over 100 cataract operations daily using the cryoextraction method (5). There are more than 3.8 million of people who are blind due to cataract in Africa (3). The surgical treatment in all these cases will be possible thanks to the simple and cheap low temperature method. Thus cryoextraction maintained its high position. Most probably it is still the most common operation performed all over the world thanks to which millions of people regain their priceless sense of sight.

It happened so during the cataract low temperature operation that the frozen apparatus touched the cornea which became frozen, whitish in colour and lost its transparency. A moment later, however, the macroscopic picture of the tissue became normal again and no negative consequences were observed. The above findings suggested the use of the cornea freezing for the therapeutical purposes. The first reports concerning this problem were published by K r w a w i c z (7) in 1964. They described the cryoapplication of the viral keratitis. The placement of the cryoapplicator with the spherical end frozen to -72°C over the viral cornea ulceration for 7 sec. led to the healing of the defect in 2—4 days' time. The corneal degeneration was another disease in which the low temperature gave the successful results. After the cryotherapy the clouded cornea became partly transparent and the visual acuity improved by 2—3 lines on the Snellen's chart (8). Moreover, the positive results and the shorter healing process were also observed in such diseases as Mooren's ulcer, kraetomycosis cornea, base burns and wounds. In a short time cryotherapy became the recognized method of treating those diseases. Efforts were made to explain the way the low temperature caused the improvement in the diseases of so different etiology. The hypotheses put forward suggested the direct action of low temperature on the corneal herpes virus. It believed that this can be a factor effecting the interferon activity. Moreover, the cryoapplication was said to cause the gentle removal of the surface infected corneal layers. In 1979 K r w a w i c z (9) proved that the low temperature application resulted in the inactivation of collagenase, the enzyme causing the lytic destruction of the cornea collagen fibres. Recently the way in which the enzyme activity is inhibited has been demonstrated (14). The low temperature application leads to dehydration, crystallization, cell membrane rupturing and the decline of the inflammatory cell infiltration in the cornea, which is the

source of collagenase. One can assume that this process is the cause of the positive low temperature effects in so many different corneal diseases.

The cryotherapy of glaucoma was first performed by Bietti et al. (2) in 1950. Its wider use, however, began only in the 60s together with the development of the cryoophthalmology (1). The ciliary body freezing leads to the ciliary epithelium injury which in turn, results in the vascular bed atrophy and the decrease of the aqueous humor secretion. This method of treatment is far more sparing than cyclodiathermy or the fistulous operations. There were significant differences in the techniques of that operation at the start. They concerned the temperatures used, and the end diameters as well as points of the cryoapplicator's placement. The experiments performed in the recent years have proved that the ice crystals in the ciliary body area occur when the cryoapplicator of 2.5 mm diameter frozen to -70 — -80° C was placed for 60 sec., the best results are obtained with the ciliary processes frozen from their bases to their tops so the apparatus should be applied 1.5 mm from the limbus in the upper part and 1 mm in the lower part of the eye ball (13). The cryotherapy performed in that way results in almost twice as frequent normalization of the intraocular pressure in comparison with the results obtained in the initial period.

The low temperatures can also be used directly on the sclera. The sclera cryopexy in the retinal detachment is an approved method of treatment and aims at creating the synechia between the retina and the choroid. The method is far more sparing than diathermocoagulation, it does not destroy the sclera architecture so the tissue presents the proper structure already 9 days after the surgery. The cryotherapy appeared to be effective also in the treatment of the retinopathy of prematurity. At present it is the main method performed in the active phase of this disease. After the low temperature application the cryocoagulation of the non-vascularized retina takes place and its vaso-creative activity decreases thus, in consequence, the development of fibrovascular proliferation is inhibited (12).

As early as in 1969 the positive effects of low temperature on the haemorrhage absorption and the vitreous opacities regression were noticed. The first reports concerning this problem were presented by the French authors (4). The haemorrhage absorption from the vitreous was sometimes observed directly after the surgery. The physicians believed that the results were surprisingly positive. Haut (4) wrote: "the way in which the cryotherapy causes the vitreous clearing up cannot be satisfactorily explained yet, nor can the proper hypothesis be put forward". Today we know that the low temperature application leads to the vessel permeability increase and the quicker macrophage penetration from the peripheral blood to the vitreous. Moreover, the numerous cells of the retinal pigment epithelium migrate to its internal coats and to the vitreous. Those cells are said to play an important role in retinal pathology. In some cases they can act as fibroblasts, have the phagocyte properties, and can be converted into

macrophages (11). Furthermore, due to the cryotherapy the vitreous fibrinolytic activity increases.

In 1988 Krwawicz (10) wrote: "the low temperature accompanied us through all the centuries, and we did not understand it or need it. However, it is the power which releases adhesion, causes the changes in the cell and results in the tissue inflammation or even necrosis if need be". Only the cataract extraction using the adhesion caused by the low temperature made the development of this new branch of ophthalmology possible. Thirty years later we can say that cryoophthalmology is of a great importance. During these years the theoretical bases for the low temperature applications in many eye diseases were created using various tissue changes resulting from cooling. This branch is still in progress showing the liveliness and many research centres all over the world are strongly interested in it.

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STRESZCZENIE

Mija obecnie 30 lat od czasu, gdy profesor Tadeusz Krwawicz z Akademii Medycznej w Lublinie przedstawił nowy sposób operowania zaćmy z użyciem niskiej temperatury. Metoda ta nie tylko bardzo szybko zyskała powszechne uznanie, ale zwróciła także uwagę na możliwości kryjące się w zastosowaniu zimna w medycynie. Wkrótce okazało się, że cały szereg chorób ocznych można wyleczyć stosując niskie temperatury. Dało to podstawy do stworzenia nowej gałęzi okulistyki tzw. krioftalmologii. Omówiono rozwój tej nauki, obecne jej miejsce w okulistyce i nowe osiągnięcia. Po 30 latach krioftalmologia, której początki powstały w Akademii Medycznej w Lublinie, zachowała swoje znaczenie, wykazuje dalszy rozwój i żywotność oraz jest przedmiotem zainteresowania wielu ośrodków naukowych w świecie.

