CRYOSURGERY OF RETINAL DETACHMENT*† WITH SOLID CARBON DIOXIDE

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SOLID carbon dioxide was used successfully by Schoeler as early as 1918; Bietti (1934) and Deutschmann (1935) later confirmed its therapeutic value.

For further evaluation of the usefulness of solid carbon dioxide in retinal detachment surgery we have studied the ophthalmoscopic and histological aspects of 75 scleral applications of solid carbon dioxide in rabbits for periods varying from 3 to 60 seconds in comparison with 34 diathermy coagulations (Oosterhuis, Brihaye, and De Haan, 1968). Microscopic study revealed that the application of solid carbon dioxide (-79°C.) for 5 to 40 seconds resulted in good chorio-retinal scar formation, which developed from 3 days after freezing. The intensity and rate of development of the cold-induced lesions in general varied with application time, but both ophthalmoscopically and histologically the ultimate scars were very similar, irrespective of duration of freezing. Adverse effects in the treated area or changes in the vitreous due to overdosage were not observed, even after 60-second applications.

In view of the promising results obtained with rabbit eyes, and since the lesions produced in such eyes were comparable with those obtained in two human eyes treated with solid carbon dioxide before enucleation (*cf.* Rubinstein, 1965), we decided to use it in retinal detachment surgery. Extensive bacteriological investigation of the solid carbon dioxide in both aerobic and anaerobic culture media revealed that bacterial contamination was absent; therefore the solid carbon dioxide was applied directly to the sclera.

Method

The primitive but efficient method of making solid carbon dioxide cones by compressing the dry ice in an ear speculum was discontinued after the development of a carbon dioxide solidifier‡ producing cylindrical rods of solid carbon dioxide. After sterilization, this apparatus is screwed

FIG. 1.—Sterilized carbon dioxide solidifier screwed on to a carbon dioxide cylinder with a syphon covered with a sterile towel. After the cylinder is opened the evaporated gas escapes through a number of small holes.

* Received for publication October 20, 1967.

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‡ Designed and constructed by the Medical Workshop, Groningen, Holland.

on to a carbon dioxide cylinder provided with a syphon through which the liquid carbon dioxide flows into the solidifier, where it exerts its cooling effect by evaporation. The gas thus formed escapes from the solidifier through a number of small holes. After the carbon dioxide cylinder has been opened the solidifier is filled with carbon dioxide snow in about 30 seconds (Fig. 1). The solid carbon dioxide is then compressed and a cylindrical rod of 7 mm. diameter is expelled from the solidifier ready for use (Fig. 2).

In all patients cold treatment was combined with either scleral resection or filling of a scleral pocket with human donor sclera. The scleral surface was treated by adjacent 10-second applications of solid carbon dioxide. Subsequent fundus inspection revealed a slight, greyish discolouration of the retina in exceptional cases, but generally no signs of treatment were visible, indicating that the cold had not penetrated so deep into the eye as to damage the retina. In these cases we continued with another two series of 10-second applications in the area concerned. When retinal oedema was present, however, the application time was shortened to 5 seconds.

This method was preferred to continuous 30-second application because rabbit experiments had revealed that six cold treatments of 10 seconds and, to a lesser degree, three treatments of 20 seconds invariably caused more intense lesions than a single 60-second application. This suggests that the lesions were brought about by the process of freezing and thawing rather than by continuous freezing (Oosterhuis and others, 1968). Thus this method of repeated relatively short applications prevents the development of unwanted intra-ocular lesions by cold penetrating too far into the eye and yet permits the dosage to be controlled by the number of applications.

FIG. 2.—The solid carbon dioxide formed in the solidifier is compressed and subsequently expelled as a cylindrical rod of 7 mm. diameter.

FIG. 3.—The solid carbon dioxide rod is pointed after pushing it into a metal cone.

Direct scleral application of solid carbon dioxide is simple, reliable (because the temperature is invariably $-79^{\circ}\text{C}.$), and inexpensive, because no complicated apparatus is required which may break down. Moreover, unlike metal cryoprobes, the tip of the carbon dioxide rod does not stick to the scleral surface and can be shaped according to requirements during surgery. The area of scleral contact can be enlarged by oblique application of the rod and can be reduced to 1 mm. diameter by pushing the rod into a metal cone (Fig. 3); the rod thus made pointed is also useful for treating the corneal surface. Also, by pressing opposite sides of one end of the rod against a flat metal surface, it can easily be flattened to a wedge shape, which is very convenient in scleral application far posteriorly. This shape is especially useful in the scleral-pocket technique, which can then be performed in most cases without dissecting the sides of the pocket. The wedge-shaped rod can easily be inserted to the bottom of the scleral pocket, visibility of the scleral area to be treated by cold being of minor importance.

Results

The results of cryopexy in the twenty patients with retinal detachment so far treated do not permit statistical evaluation of its value in comparison with diathermy, but so far the results appear to be equally good.

One may become anxious when no reaction becomes visible ophthalmoscopically during the first 2 weeks, but during the repeated short applications the cold does not usually penetrate far enough into the eye to cause oedema of the detached retina (Rubinstein, 1965). Pigmentation develops later than after diathermy applications, either in the course of the second week or even later (Lincoff and McLean, 1966). Also, in the final cryo scars, pigmentation is usually less intense and of a finer texture than in the diathermy lesions. The cryo scars are highly uniform in appearance all over the treated area; the large retinal and choroidal vessels, especially the vortex veins and their main branches, remain patent, even when solid carbon dioxide has been applied directly over them, while the smaller vessels become occluded. We saw no symptoms whatever of overdosage.

One patient showed flat subretinal haemorrhages but these resorbed completely. They probably originated from the congested choroid at the site where an incision had been made for the drainage of subretinal fluid (Lincoff and McLean, 1966; Norton, 1966). Therefore, we now prefer to make that incision outside the cold-treated area. There was no intravitreal bleeding or any indication of damage to the vitreous. In all patients the vitreous remained clear. In one patient a second operation revealed that the thickness and texture of the sclera in the area previously treated with carbon dioxide was normal, as in the cases of Lincoff and McLean (1966) and Fison (1965). No postoperative infections occurred.

Summary

This report deals with the technique of using solid carbon dioxide in the treatment of patients with retinal detachment and describes an instrument for making solid carbon dioxide rods. The results in 20 patients appear to be favourable.

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