Cryotherapy in Retinal Vascular Disease

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Core Messages

- Cryotherapy is applied to generate chorioretinal scars, to reduce retinal ischemia or to occlude abnormal retinal vessels
- Repetitive treatments are necessary to achieve permanent obliteration of vascular abnormalities
- Cryotherapy is superior to laser coagulation in the case of media opacity and in shallow (exudative or tractional) retinal detachments
- The freeze zone of cryoburns has a better depth than the zone of destruction after laser treatment. Therefore cryotherapy is especially useful for smaller tumors
- The freeze zone of cryoburns is wider, about 3–8 mm, than laser burns. Transition and demarcation of the intact retina are less abrupt. Therefore cryotherapy is especially useful when a strong vitreoretinal adhesion is attempted. The shallow transition to the intact retina weakens the retina less than laser burns and thereby largely avoids tears at the edge of the chorioretinal adhesions

Cryotherapy has a long history in the treatment of retinal vascular disease. Freezing the retina to create inflammation in the area of application began as early as 1918, when Schöler applied solid carbon dioxide to the sclera and described choroidal inflammation [9]. In the treatment of proliferative retinopathy, cryotherapy today has largely been replaced by laser photocoagulation. However, the transscleral mode of application renders cryotherapy particularly useful in the case of hazy media or cataracts. It is also useful in treating more peripheral lesions that cannot be easily visualized at a slit lamp.

Cryotherapy induces a greater breakdown of the blood-ocular barrier, which has been implicated in the risk of cystoid macular edema, choroidal detachment and exudative retinal detachment. Laser flare photometry showed a greater increase in aqueous flare and a slower recovery of visual acuity after limited external retinal cryotherapy compared to laser coagulation. However, this difference did not affect visual acuity 10 weeks after treatment [13].

Cryotherapy in retinal detachment surgery has long been associated with a number of postoperative events, including macular pucker and proliferative vitreoretinopathy (PVR) due to dispersion of viable pigment epithelial cells and breakdown of the blood-ocular barrier. However, blood-ocular barrier breakdown is clinically irrelevant if excessive cryoapplication is avoided, and if applied to eyes with uncomplicated retinal detachment, and without significant preoperative PVR. In comparison, transscleral diode laser did not show better results in retinal detachment surgery [12].

In the treatment of ischemic retinal diseases, mobilization of retinal pigment epithelium (RPE) cells and risk of PVR does not apply as for the lack of retinal holes. Blood-retinal barrier breakdown, however, will be temporarily aggravated.

The pathology of cryotherapy lesions has been well investigated. The formation of retinal scars includes desmosomal connection between the Müller cells and the basement membrane of RPE. Processes of Müller cells infiltrate the collagen lamellae of Bruch’s membrane [3–5]. Laboratory studies have shown that there is little difference in the strength of the chorioretinal scar created by laser photocoagulation and by cryotherapy [1, 15].

It usually takes about 5–7 days for a chorioretinal scar to complete. The repair and remodeling after cryotherapy vary depending on the intensity of the application. For treatment of vascular abnormalities repetitive freezing of the choroid and the outer retinal layers (3 times) is mandatory.

Although laser photocoagulation in many indications has replaced cryocoagulation, cryotherapy is still used as adjunctive treatment in the therapy of vascular disease.
15.1 Technique of Cryotherapy and Equipment

Essentials

Equipment needed:
- Cryoprobe
- Indirect ophthalmoscope
- Condensing 20- and 28-dpt lenses for indirect ophthalmoscopy
- Lid speculum
- Topical anesthetic
- Local anesthetic for injection (e.g., 4% Xylocaine without epinephrine)
- Mydriatic eye drops

A variety of probe tips and cryotherapy machines are available; most are gas operated. Most cryosurgical units use either carbon dioxide or nitrous oxide gas and are based on the Joule-Thompson principle that a sudden drop in temperature occurs when pressurized gas is allowed to expand through a narrow aperture. The tube is defrosted by a passage of another warm gas, or the same gas under low pressure. A silicone sleeve limits the cooling effect to the tip of the probe. When nitrous oxide gas is used, a pressure of 600 psi is sufficient to produce cooling up to –89°C.

The surgeon should be certain that the shaft of the probe is insulated, and test the freezing before usage. Treatment should be controlled via indirect ophthalmoscopy. The freezing should be terminated soon after a distinct whitening of the neurosensory retina is observed.

In general subconjunctival anesthesia is sufficient for cryotherapy.

A quantity of 0.2 – 0.3 ml of 4% Xylocaine is injected subconjunctivally in the quadrant requiring therapy. After 10 – 15 min, sufficient anesthesia is achieved and treatment may be started. For treatment of children general anesthesia should be given priority.

For applications close to the posterior pole it is necessary to open the conjunctiva. Usually a few seconds are sufficient to achieve a sustained freezing until the retina first turns white. After thawing, a faint gray area representing intra-retinal edema is all that remains of the cryoapplication. Prolonged freezing is necessary when subretinal exudation increases the distance between the retina and cryoprobe. The probe should not be removed until thawing is completed to avoid retinal breaks.

Postoperative medications are rarely necessary, but antibiotic ointment can be applied.

Complications of treatment itself, such as corneal abrasion, subconjunctival hemorrhage and intraocular hemorrhage, are rare. If an intraocular hemorrhage under treatment should occur, pressure on the eye helps to stop the bleeding. It is possible to perforate the sclera (thin sclera in myopia or reoperation) with the cryoprobe when using as a scleral depressor. In that case the wound needs to be treated like a rupture or penetration of other origin.

Depending on the duration of freezing, chorioretinal scars develop that vary in scleral penetration. Cryogenic necrosis reaches the outer limiting membrane after light application (L); to the nerve fiber layer after a medium application (M); and to the internal limiting membrane after heavy application (H). (With permission from Ingrid Kreissig (ed): Minimal surgery for retinal detachment. Thieme, Stuttgart, 2000, p. 104)

Endocryocoagulation is indicated during vitrectomy when endophotocoagulation is insufficient to completely obliterate pathologic retinal vessels, e.g., in Coats’ disease or familial exudative vitreoretinopathy (FEVR). The endocryoprobe is inserted through the sclerotomy and the tip held without pressure in close apposition to the retina. While freezing, the tip is tightly connected to the retinal tissue. While the frozen part of the retina is rigid, the surrounding tissue can easily tear. Thus the tip of the endoprobe must not be moved while freezing. Complete thawing should be awaited before removing the probe from the retina. Unlike laser burns, cryotherapy does not show an immediate treatment effect on the retina.