Cryoprobe traction-extraction of glomus jugulare tumor with cryosurgery.

From Cahan, W. G., Five Years of Cryosurgery Experience: Benign and Malignant Tumors with Hemorrhagic Conditions. In: Rand, R. W., Rinrent, A. P., and von Leden, H. (Eds.), Cryosurgery. Springfield, Illinois, C. C. Thomas, 1968. 428 pp. P. 396.
Cryosurgery for Cancer

The Editor interviews William G. Cahan, M.D., Attending Surgeon, Thoracic Service, Memorial Sloan-Kettering Cancer Center and Clinical Associate Professor of Surgery, Cornell University Medical College, New York, New York.

Dr. Holleb: Why is there so much interest in cryosurgery today?

Dr. Cahan: Because of its many unique properties, cryosurgery has been found to be a remarkably versatile surgical tool.

Dr. Holleb: What are some of these unique properties?

Dr. Cahan: Cryosurgery’s most outstanding characteristic is its ability to cause local tissue necrosis by producing rapidly achieved, profoundly low temperatures in the specified area. Since the source of freezing has its origin at the tip of precise instruments or cryoprobes, even minute areas can be necrotized. Healing is kindlier and scar formation healthier. Also, because the neuroreceptors are especially cryosensitive, the procedure is relatively pain-free and has even been used to desensitize. In addition, we have found that cryosurgery produces intracapillary thrombosis and, therefore, curtails bleeding of capillary type. Happily, large arteries are usually resistant to damage by this technique. There is also extreme adherence between the cold metal tip of the probe and warm tissue. This makes cryosurgery a useful method for traction-extraction when indicated.
Fig. 1. Contact and penetration techniques. A (left) shows contact freezing with thermocouple needles in place. B (right) shows penetration freezing with multiple, overlapping zones and thermocouple needles.

Cahan, W. G., and von Leden, H. Cryogenics in Surgery. Flushing, New York, Medical Examination Publishing Co., 1971. 539 pp. Pp 207 and 212.

Dr. Holleb: What is the difference between the effects produced by cryosurgery and those of electrocautery?

Dr. Cahan: Cryosurgery has a delayed reaction and is associated with little pain while electrocautery produces an immediately observable response but is usually painful. Unlike cryosurgery, electrocautery is potentially hemorrhagic. Another important difference between the two methods is that cryosurgery produces a finer scar and one that is likely to heal more rapidly than that following cautery.

Dr. Holleb: Because of its many properties, cryosurgery must have broad applicability?

Dr. Cahan: Virtually every surgical specialty now uses cryosurgery and there is a long list of its applications to date for both benign and malignant conditions. It has, for instance, been applied in dermatology for the treatment of such conditions as verrucae, kerasotes, angiomata, etc.; in neurology, for Parkinson's disease, arteriovenous aneurysms and hemangiomas of the brain; in ophthalmology, for the traction removal of cataracts and detached retinas; in otology, for glomus jugulare tumors and Meniere's disease; in head and neck surgery, for the removal of polyps, the reduction of bleeding in Weber-Osler-Remu disease and even for tonsillectomies; in gynecology, for chronic cervicitis and menometrorrhagia; in urology, for the management of intractable bladder hemorrhage and benign prostatic hypertrophy; and in bone surgery, for the treatment of benign giant cell tumors, hemangiomas, fibrous dysplasia and aneurysmal bone cysts.

Dr. Holleb: Where is cryosurgery effective in the management of cancer?
Dr. Cahan: It is particularly useful for surface or skin cancers. It is also used for palliation of locally recurrent cancers resistant to all other methods of treatment. Unlike radiation therapy, cryosurgery can be applied repeatedly at the same site. The bulk, pain, bleeding and odor often associated with large recurrent cancers can be effectively reduced. We have also frozen more internally placed recurrent cancers; for example, in the cervix, prostate, bladder, larynx and perineum. Metastases in bone are treated and pain relief unobtainable by radiation therapy has been achieved. Pancreatic cancer and deposits in the liver have also been congelated and well tolerated.

Dr. Holleb: Has there been any evidence of an immune reaction affecting distant metastases?

Dr. Cahan: I have never seen this happen in any of my many cancer patients. However, recent laboratory evidence suggests that the distant metastases from cancers of the prostate may diminish in size following cryosurgery.

Dr. Holleb: When was cryosurgery first used in the management of cancer?

Dr. Cahan: The use of cold in the treatment of disease, including cancer, is an ancient concept. Thirty to forty years ago, "cryotherapy," as distinguished from cryosurgery, was used in an attempt to control cancer by dropping the patient’s systemic temperature. Many unsubstantiated claims were made and the technique fell into disrepute. Interest in extreme cold for the treatment of disease was reawakened when liquid nitrogen (−196°C.) became available. Dr. Irving Cooper performed a cryothalamectomy to reduce the palsy and tremors associated with Parkinson’s disease. About a decade ago, Dr. Cooper used one of his tiny brain probes to freeze a small area of advanced rectal cancer and produced cellular necrosis. When this was reported, it occurred to me that with certain modifications in equipment, cryosurgery might be a unique method of treating different types and stages of cancer.

Dr. Holleb: What modifications in equipment have occurred during the last 10 years?

Dr. Cahan: The neurological cryoprobes were designed for freezing very small areas—up to one cm.—and were inadequate for cancers that were usually many times that size. In other words, it was like using a fly swatter to kill an elephant. Therefore, it was necessary for me to devise instruments of varying shapes and sizes to accomplish specific tasks. We now have probes that
can be applied not only to surface problems but also to those within the uterus, prostate, larynx and other areas.

**Dr. Holleb:** Is liquid nitrogen the only refrigerant used?

**Dr. Cahan:** No. Although it is still widely used, other agents such as freon, gaseous nitrogen (N₂), carbon dioxide snow, carbon dioxide gas and nitrous oxide are now also employed.

**Dr. Holleb:** What is the minimum effective temperature for tissue destruction?

**Dr. Cahan:** Tissues, as do cancers, probably vary in their cryosensitivity. Arbitrarily, temperatures of −40°C. or lower will almost always produce necrosis. However, we over-freeze by usually having the probe tip temperature at least −120°C. It must be remembered that the temperature gradient changes rapidly the further one goes from the freezing source. Consequently, the important factor is the temperature of the tissues being treated. This can be monitored with thermocouple needles introduced into the periphery of the tumor.

**Dr. Holleb:** How is the probe brought in contact with the tissue?

**Dr. Cahan:** This can be done in several ways. One method, contact freezing, places the probe on the surface of the cancer and freezing occurs centrifugally. (Fig. 1.) The second method, penetration freezing, introduces the probe into the cancer so that the deeper reaches can be treated. (Fig. 1.) In another technique, freezing is accomplished by pouring liquid nitrogen through a funnel into an enclosed space. This has been used for bone and bladder cancers. Liquid nitrogen can also be sprayed directly on the involved area and this is valuable for large, diffuse surface conditions.

**Dr. Holleb:** Once the desired freezing is accomplished, what happens next?

**Dr. Cahan:** Because of the adherence of the probe to tissue, a special rewarmer was devised which heats the tip of the probe and permits its early removal. However, the tissue is allowed to thaw slowly and spontaneously, as slow thawing also destroys cells.

**Dr. Holleb:** Does only one freeze-thaw cycle produce sufficient necrosis?

**Dr. Cahan:** Usually not. We have shown that two or more freeze-thaw cycles augment the probability of necrosis.
Dr. Holleb: Cryosurgery sounds relatively simple. Can it be employed by physicians not specifically trained in this specialized technique?

Dr. Cahan: Cryosurgery is not as simple as it may seem. It requires not only a knowledge of the instruments and machines but also of the diseases being treated. There are definite hazards to its use.

Dr. Holleb: What are these hazards?

Dr. Cahan: The most oft-repeated hazard is to under-freeze. That is, to assume that all the tissue that has become white and hard will eventually necrotize. This can be guarded against by thermocouple needles and experience. Another danger can arise if neighboring organs are inadvertently congelated and consequently damaged. These organs can be shielded with insulating material and monitored by palpation or by thermocouple needles placed in their vicinity. Also, hasty withdrawal of the probe before it is detachable, lack of a sufficient number of freeze-thaw cycles and hastening of the thawing process can interfere with effective results.

Dr. Holleb: Realizing that all the potential applications of cryosurgery have not yet been fully explored, what are some of the major areas of future study?

Dr. Cahan: Some of the goals include: developing more probes of varying shapes and sizes for a variety of needs; finding methods of accelerating freezing either by local physical means or multiple simultaneous sources; gaining more information on the biologic effects of freezing tumors and calculating their cryosensitivities as well as performing more extensive studies of autoimmunization; learning more about the hemostatic properties of cryosurgery and its value in difficult problems of hemorrhage; studying methods which would make cryosurgery more effective for local pain relief and developing ways to destroy areas of the brain to help reduce inaccessible, intractable pain; and determining whether cancers treated by cryosurgery become more sensitive to subsequent chemotherapy or radiotherapy. There is much work still to be done. Yet, cryosurgery has already demonstrated its success not only as a new surgical technique but also as a simplification and refinement of older ones.

Dr. Holleb: Thank you, Dr. Cahan.
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