



SHORT COMMUNICATION

The story behind cryosurgery

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Introduction

Cryosurgery is used to describe the controlled destruction of tissue by freezing. Today, cryosurgery is widely practiced in medicine, so it would be interesting to know how the story of cryosurgery began. Here are some short stories behind the discovery and evolution of cryosurgery.

The earliest therapeutic uses of cold

The first use of cold as a means of physical treatment dates back to the age of the ancient Egyptians, as described by an Egyptian papyrus document. As early as 2500 B.C., the ancient Egyptians identified the analgesic and anti-inflammatory effects of cold. They noted that cold application soothes sites of trauma, minimizes pain and reduces inflammation.

Later, Hippocrates (460–370 B.C.), an ancient Greek physician commonly referred to as the father of medicine, found that local cold exposure has the ability to reduce swelling, bleeding and pain.

Also, tissue cooling by surface application of snow and ice was used to produce anesthesia before the amputation of soldiers in Napoleon's Grand Army^[1].

Modern cryosurgery begins

The "modern" cryosurgery is relatively of young age and its birth is closely intertwined with developments in low temperature physics, engineering, and instrumentation.

It is only during the last few centuries that cold treatment has evolved from generalized application to specific, focal destruction of tissue in today's cryosurgery.

English physician James Arnott, "the father of modern cryosurgery", was the first person to use extreme cold locally for the destruction of tissue. He used a mixture of salt and crushed ice for the palliation of tumors, with resultant reduction of pain and local hemorrhage. Arnott won the prize medal at the Great Exhibition of London of

1851 for his cold equipment that allowed reducing tissue temperature to $-20\text{ }^{\circ}\text{C}$ ^[2,3].

End of the 19th century: The race for liquefied gases begins

In the late 1800s, along with tremendous scientific advances, there was an interest in liquefying gases. Oxygen was first liquefied in small quantities in 1877. Over the next few years, all of the so-called "permanent gases" (oxygen, nitrogen and hydrogen) were liquefied. In 1895–1896, commercial liquefaction of air was established by Carl Von Linde. The term "cryogen" came into use during those years^[4].

The day liquid air became available to physicians

Campbell White in 1899 was the first one to use liquefied gas in medicine. He used liquid air ($-195\text{ }^{\circ}\text{C}$) for the treatment of diverse skin diseases. White used a glass flask that acted as a liquid air sprayer, which became the first handheld cryosurgery device. In 1907, Whitehouse used sprayed liquid air to treat a wide variety of skin conditions that ranged from epitheliomas to lupus erythematosus to vascular nevi^[5].

Liquid oxygen quits the race

Because of its similar properties to liquid air, liquid oxygen ($-182.9\text{ }^{\circ}\text{C}$) was used as a cryogenic agent in a similar way as liquid air, particularly during the 1920s and 1930s. However, liquid oxygen soon became obsolete as a cryogenic agent because of safety considerations related to fire^[6].

Carbon dioxide snow gains interest

In parallel to the investigation on the medical use of liquid air (1907), the use of carbon dioxide snow ($-78.5\text{ }^{\circ}\text{C}$) was

favored by William A. Pusey^[7]. After 1910, liquid air was seldom used, and solid CO₂ became the most popular cryogenic agent because it was cheaper and more readily available than liquid air. The carbon dioxide was held in liquefied state by pressure (about 800 psi). When released into air, the decrease in pressure causes freezing and formation of a white snow that was then compressed into various shapes suitable for different treatments. John F. Hall-Edwards first described his carbon dioxide collector and compressor in 1911^[4].

Liquid nitrogen comes ahead

Liquid nitrogen (-196 °C) became commercially available and was introduced into clinical practice in 1950 by Herman V. Allington, who described the technique of using cotton swabs dipped in liquid nitrogen for the treatment of a variety of non-neoplastic skin diseases^[8].

Application and storage of refrigerants

Generally, refrigerants were applied either by direct painting onto the skin or by means of a dipped cotton wool applicator into liquid air. However, the depth of freezing achieved was inadequate for the treatment of tumors. In 1907, Whitehouse designed a spray bottle of liquid air which provided much lower minimum temperatures^[5].

The physical chemist James Dewar solved the problems of transportation and storage of liquid gas. He invented a flask with two silvered walls separated by an evacuated air chamber, thus insulating the inside from the outside of the flask. Even today the containers used to keep liquid nitrogen have much of the same design and are still called “Dewar flasks”.

Through the collaboration between a physician, Irving Cooper, and an engineer, Arnold Lee, the first cryosurgical probe was built in 1961, which became the prototype for the subsequent liquid nitrogen cryosurgical probe. In 1963, Cooper described the use of liquid nitrogen probe for brain surgery. This new piece of equipment opened up the way for many new inventions in the area of cryosurgery^[9].

Handheld cryosurgical apparatus

A more widespread use of cryosurgery in medical practice came with the design of handheld devices that can be easily used in the physician’s office. Various cryosurgical apparatuses were developed using liquid nitrogen, nitrous oxide, carbon dioxide and other cryogens. In 1965, Dr. Douglas Torre developed a liquid nitrogen spray device that could also be equipped with cryoprobe tips of different sizes and shapes^[10,11]. Finally, in 1967, Dr. Setrag Zacarian designed a handheld cryosurgical device using liquid nitrogen. Zacarian brought the term “cryosurgery” into use for the first time. A series of different designs followed, which gave rise to several models of handheld cryosurgical units^[12,13].

Cryosurgical equipment and techniques nowadays

Liquid nitrogen (-196 °C) is the most popular cryogen

in current use; it is the coldest and can destroy a large volume of tissue required for treatment of malignant lesions. Handheld devices using liquid nitrogen are the most commonly used units nowadays. Basically, they are small containers with storage capacity of 250–500 mL, most commonly used as a spray, and less often as a closed system with cryoprobes of different sizes and shapes (contact therapy)^[13,14]. A unique technique, “intralesional cryosurgery”, was later introduced in 1993 by Egyptian dermatologist Dr. Ahmed Hani Weshahy, who used needles called “Weshahy cryoneedles” to deeply freeze lesion irrespective of lesion volume, while cells at the surface, particularly melanocytes, are much less affected, hence minimizing surface reactions^[15].

The story of cryosurgery has never reached an end

After nearly two centuries, cryosurgery is gaining more interest in several fields of medicine, including dermatology. Over the years, cryosurgery has become a well-established treatment modality for a wide variety of benign skin lesions and is also highly effective treatment for premalignant lesions as well as for selected cases of malignant skin lesions. Dermatologic Cryosurgery has become widely applicable and has now reached a unique status, with new indications and novel uses still being described.

Conflict of interest

The author declares no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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