Society of Chiropodists and Podiatrists

Continuing Professional Development

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Cryosurgery in podiatric practice

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Cryosurgery is the deliberate destruction, in a controlled manner, of diseased tissue by cold. The benefits and hazards of tissue injury from cold have been recognised for many years. Successful cryosurgery requires an understanding of the effects of freezing living tissue in order to optimise the therapeutic benefit. Failure to appreciate the destructive power of very cold liquids will result in harm to patients whereas prudent use of this treatment modality will bring significant benefit.

Key Point

For all the simplicity of its use it is important not to underestimate the destructive power of cryosurgery

HISTORY OF CRYOSURGERY

Cold has a numbing effect on the skin and for centuries this fact has been used beneficially to reduce pain. Over 4000 years ago the Egyptians were aware that cold minimised the painful effects of trauma and reduced inflammation. Hippocrates advocated hypothermia to reduce swelling, haemorrhage and pain. James Arnott, in London, investigated the local anaesthetic properties of cold to palliate the pain of cancers in the terminally ill. He managed to achieve temperatures as low as minus 25ºC with a solution of ice and saline. At the end of the 19th century oxygen was liquefied experimentally and a little later a small commercial preparation of liquid nitrogen was made by Linde. Dewar liquefied hydrogen in 1898 and soon developed the Dewar vacuum flask for the storage and transport of these fluids. This had the immediate benefit of allowing therapeutic use of cold liquids away from the laboratory.

Cold has been used specifically to damage nerves in malignant conditions for pain relief. The ability to destroy tumours is now employed across many specialities from thoracic surgery and liver surgery, to ear nose and throat, as well as dermatology and podiatry (see Table 1).

Table 1. Cryosurgery in various specialities

Speciality	Therapeutic use
Thoracic surgery	Destruction of lung tumours
Pain relief	Sensory nerve paresis
Ophthalmology	Lens extraction
Proctology	Haemorrhoid therapy
Cardiac surgery	Conduction defect therapy

BIOLOGY

Cellular injury following freezing may be brought about by both intra- and extracellular ice formation, disruption of cell membranes and changes in cutaneous circulation during freezing. Within 30 minutes of freezing, the capillary endothelial cells swell and microthrombi form. Hypoxia develops as the circulation is impaired. Much cellular injury occurs during thawing. The critical determinants of the extent of this injury are the rate of freezing, the lowest temperature reached, the duration of the freeze and the rate of thawing. Repetition of the freeze-thaw cycle produces greater tissue destruction than a single freeze-thaw cycle. Temperatures necessary to produce cell death in skin vary according to cell morphology, but most cells are killed at –25ºC to –30ºC. This temperature can be readily achieved at 3–4 mm depth from the skin surface using appropriate liquid nitrogen spray techniques. In contrast, the cotton wool bud method tends to be less effective.

Melanocytes are most sensitive to cold temperatures and clinically this is seen as hypopigmentation after cryosurgery – sometimes after very short freezes. Fibroblasts, in contrast, are resistant to cold and may survive deep freezes. Collagen is itself even more hardy and remains structurally intact after cellular death. This explains why cryosurgery scars are usually flat, the anatomical configuration is undisturbed even after a profound freeze, and why hypertrophic scars and keloids are remarkably resistant to treatment.

REFRIGERANTS

Within podiatry, the most commonly used refrigerants are liquid nitrogen (as a direct spray method or through a probe) and nitrous oxide (through a probe). It should be remembered that with the latter, although the techniques of application are similar to that of a liquid nitrogen probe, the temperatures attained are not as low. Other refrigerants that are available include fluorocarbon liquids in aerosol spray preparations.

Currently, there is little evidence to demonstrate that the temperatures attained by these are as effective as those from liquid nitrogen or nitrous oxide.

SHAPE OF CRYOINJURY

When a liquid nitrogen spray or probe is applied to the skin surface the temperature drops quickly. Warm air temperature reduces the effect directly and produces vasodilatation. The temperature drop is less in the deeper tissues and laterally. Accurate temperature mapping shows the isotherms and the shape of the iceball. The effect can be visualised *in vitro* by freezing a transparent disc of suitable material. Initially the shape is nearly that of a hemisphere but when the freeze is more protracted the deeper part of the iceball becomes more pointed. The importance of these shapes is critical to planning therapeutic procedures. It is easy to assume that beneath the surface ice field there is a destructive cylinder of ice but in fact, under the lateral part of the surface ice there is little effect at all (see Figure 1).

ORGANISATIONAL ASPECTS OF CRYOSURGERY

There are several components needed to ensure the safe use of cryosurgery in the clinic. This is a useful checklist:

- Competency – proper training
- Patient selection
- Equipment purchase and supply of cryogen
- Room – comfortable with couch
- Consent
- Keep good records
- Use information handouts
- Follow-up policy.

COMPETENCY

Different professional bodies set their own standards for knowledge and practical skills. In some the model of learning still includes an apprenticeship or training component. The overriding factor in any case is that the practitioner must be able to demonstrate competence in this technique.

Key point

Cryosurgery is a practical skill that needs background knowledge and supervised practice. These should be part of a learning package

PATIENT SELECTION

Cryotherapy is well tolerated in adults. It is not usually suitable for children under 10 years of age, although some young children over five years of age may tolerate single freeze times of 5–10 seconds to a few lesions only. Patients should be warned, before treatment, about post-operative effects and individual susceptibilities should be taken into account, *eg* anyone with dark skin may develop marked hypopigmentation.

EQUIPMENT AND TECHNIQUE

A supply of liquid nitrogen or other cryogen must be secured. This may be *ad hoc* from the local hospital either by agreeing to delivery or collecting it personally. Ownership of a storage tank makes life easier and this can be refilled, two or three times per annum, by an industrial supplier.

The cotton wool bud is the simplest method of application. Ideally an amount of liquid nitrogen should be decanted into a metal galipot for each patient. This will prevent contamination

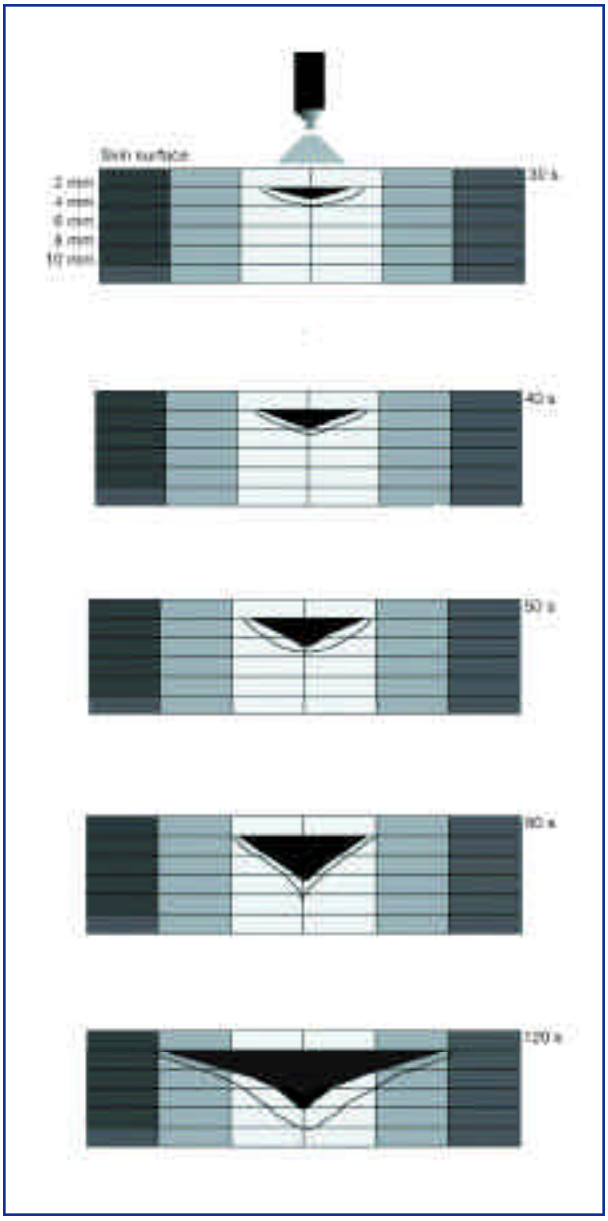

Figure 1. Shape of the icefield
(Reproduced with permission from Dawber RPR, Colver GB, Jackson A. *Cutaneous Cryosurgery. Principles and Clinical Practice*. London: Martin Dunitz, 1997.)

of the main supply with human papilloma virus, which could occur if buds are repeatedly dipped into it. A bud, not too tightly packed, is dipped into the nitrogen and applied firmly to the lesion. Larger lesions may require several applications. Cotton wool buds vary in their volume, compactness and the pressure exerted by them. These variables lead to a lack of precision and less reproducible results except in very small lesions, *eg* warts.

The base unit of the cryospray is a vacuum flask. The treatment arm will receive either screw-on spray nozzles or probes of varying dimensions (see Figure 2). The rate of delivery of cryogen depends on the nozzle size – in the Cry-Ac unit (Brymill UK®) these range from A to D but B and C are most used in clinical practice. The tip is held about 1 cm from

Figure 2. Cryospray base unit with treatment arm and spray nozzle

the skin for treatment. Spray tips bent at right angles can be very helpful to reach certain sites. The nitrogen can be concentrated onto a small area by delivery down neoprene cones or a plastic shield with apertures of different sizes (see Figure 3). It is important to remember that this method increases the destructive power of the treatment and shorter application times will be needed.

Cryoprobes (see Figure 4) allow the nitrogen to circulate around the treatment tip but it is then vented through a plastic tube and it is only the metal tip that contacts the skin. Probes have their advocates and they allow the operator to apply pressure during the procedure. This gives a deeper freeze and some authors feel this is the treatment of choice for verrucae. When used in this way it is common to apply lubricant jelly first to obtain good contact. Not only does this ensure even freezing of the tissues but allows the frozen skin to be lifted off deeper structures by elevating the probe once ice has formed. This is not necessary on the plantar surface but is helpful on the dorsal surface to avoid cold injury to tendons, nerves and blood vessels.

Figure 3. Plastic shield with holes of varying diameter

Figure 4. Cryoprobe being used to treat a verruca

For any of the techniques described a second treatment cycle following complete thawing can be used for a greater therapeutic effect. The quantity of interstitial fluid increases following the initial freeze and allows a more rapid iceball formation on subsequent freezing. Double freezes are more useful for malignant disease but some specialists find them helpful for benign lesions. It is absolutely vital to gain experience using more conservative treatment schedules before progressing to more aggressive ones. Each piece of equipment, nozzle size, air temperature, *etc*, has an impact on the clinical effect and the goal should be to provide a predictable response.

Key points

Cotton bud, cryospray and cryoprobe are all reasonable ways to apply liquid nitrogen

The most important aspect is to become familiar with one or more techniques to ensure safe practice

A second treatment cycle following complete thawing can be used for a greater therapeutic effect

It is absolutely vital to gain experience using more conservative treatment schedules before progressing to more aggressive ones

THE ROOM

The normal clinical setting for podiatry is well suited to the practice of cryosurgery. When treating the feet the patient must be comfortable in a recumbent position. The lighting should be good, ideally with a ceiling-fixed cold-tip light on a rotating arm. It is best not to work in a very small room without ventilation because of the risks, however slight, of a significant nitrogen spillage.

CONSENT

There is general agreement that patients must be properly informed about the treatment options for their condition, the relative merits of each and the side-effects and complications of the treatment chosen. There is not a consensus on whether or how the consent to treatment should be documented. Some organisations are satisfied with a written summary of the discussion while others require the patient's signature at the end of a detailed document. There is a legal argument that valid consent cannot be taken on the same day as a non-urgent procedure – arguing that everyone should have an opportunity to reflect on the discussion. However there is almost universal agreement that in the case of simple procedures such as cryosurgery it is reasonable, and usually expected by the patient, to proceed immediately with treatment.

RECORDS

There should be notes to record the choice of treatment, the method used, *ie* probe or spray, nozzle diameter, application time and number of cycles. It is good practice to record discussion about complications, chance of a successful outcome and whether a handout was given.

HANDOUTS

Details of frequently occurring side-effects should be included in a handout so that the patient knows what to expect. It should include details on wound care and offer a contact number should a problem develop. An example of a handout is given in Figure 5.

Key point

Documentation should reflect a discussion about complications and the chance of a successful outcome

FOLLOW-UP POLICY

This is fairly straightforward but depends on reaching agreement with the patient about the goals and end point of treatment. If therapy succeeds in alleviating symptoms after one visit there may be no need to return even if the lesion has not fully resolved. Equally you may agree that if there has been no improvement after three visits that nothing further can be done.

REPRODUCIBLE TREATMENT SCHEDULES (FTC – FREEZE THAW CYCLE)

Many practitioners simply apply the bud or spray to the lesion until the ice field extends 1 mm beyond the lateral margin of the lesion, and maintain it for a few seconds. If the patient has a huge reaction or conversely there is no benefit, the operator will have no accurate way of determining how to proceed at the next visit. It is useful therefore to record the treatment in the notes. One method of doing this is the spot freeze method and this is suitable for lesions up to approximately 1 cm. The spray or probe is applied to the centre until ice has developed within the desired field. This field is then maintained for a given number of seconds (usually 5–30 depending on the pathology of the lesion). Counting begins only when the desired field has been achieved, not at the commencement of spraying. When the ice ball has been established it should not be allowed to continue growing to an ever-increasing diameter because this would cause unnecessary damage collaterally. It is best to then intermittently spray to merely maintain or "top-up" the ice ball to the chosen size. It is also desirable to have a constant approach to the other variables. *eg* spray nozzle or probe diameter, distance spray is held from the skin (best at 1.0–1.5 cm).

The terminology for accurate documentation and reproducibility of treatment is called the freeze-thaw cycle. If a lesion is frozen until the ice ball reaches the predetermined diameter and the spraying then continues for a further 5 seconds the treatment is called a 5 second freeze-thaw cycle or '5 sec FTC'. The freeze time used should be recorded in the notes for future reference.

Cryosurgery Information Leaflet

You have been treated with cryosurgery for your warts/verrucae. The initial pain usually settles within 10 minutes. However after a few hours it may begin again and you may need to take paracetamol or aspirin to relieve it. Putting your foot up may also reduce the pain.

It is common to get swelling and weeping from the treated area and this may persist for a few days. If a blister forms you should only prick it with a sterile pin but do not cut off the blister roof.

If you do not think that it is progressing as you expected then please contact the office on this telephone number.

Tel: ……

Figure 5. Information leaflet for patients

Key point

Learning a reproducible treatment schedule is beneficial to the patient and allows a standard nomenclature for the clinical notes

BENIGN LESIONS

Verrucae and warts

These are synonymous and are lesions produced by infection with human papilloma virus (HPV). Verruca often refers to lesions on the sole of the foot or plantar warts (see Figure 6). There are more than 50 subtypes of HPV and the subtype usually determines the anatomical distribution and morphology of the lesion. In other words it would be unlikely that the same subtype would produce both a filiform wart and a mosaic verruca. There are varying host responses that

Figure 6. Verruca

Table 2. Cryosurgery for benign lesions using Cry-Ac® system (C nozzle)		
Disease	**Spray time (seconds) after formation of ice field**	**Lateral freeze**
Wart, dorsum of foot	5–10	1 mm
Mosaic/plantar wart	5–30	1 mm
Molluscum contagiosum	Ice formation only	None
Seborrhoeic keratoses	5–20	1 mm
Myxoid cyst of digit	30	2 mm
Granulation tissue with ingrown toenail	30	1 mm

determine the degree of hyperkeratosis and inflammatory response.

It is helpful to explain to the patient that the virus has been shown (by the polymerase chain reaction) to reside in epidermal cells up to 1 cm distant from the clinical lesion. This explains why occasionally, after the inflammation has settled down, there will be growth of several new warts at the periphery of the treated area. Discussing realistic expectations will go a long way to reducing the disappointment of failed treatment.

See Table 2 for treatment details. Paring a hyperkeratotic lesion before therapy is usually helpful. Local anaesthesia can be utilised prior to freezing and some practitioners believe it enables a more effective dose of nitrogen to be delivered than would be possible without it. Adrenaline is not necessary.

Molluscum contagiosum

These are single and multiple and often have an umbilicated centre. This pox virus infection is uncommon on the foot. However the lesions are particularly responsive to cryotherapy. Spraying the surface for a few seconds is usually sufficient to ensure resolution.

Granulation tissue

The mainstay of relieving the symptoms of ingrown toenails rests with removal of the offending nail spike by conservative resection or matricectomy. However, granulation tissue is highly vascular and responds very well to freezing. The spray method is the easiest to apply and generally a single 30 second FTC is sufficient (see Figure 7).

CONTRAINDICATIONS

There are no absolute contraindications, but it is best avoided in patients who may react to cold temperatures, ie those patients with cold urticaria or a history of cryoglobulinaemia. Cryoglobulinaemia is a rare condition characterised by the presence of abnormal proteins called cryoglobulins in the bloodstream. These become insoluble at reduced temperatures and precipitate into the microvasculature on exposure to cold causing restricted blood flow in exposed areas.

POST-OPERATIVE CARE

A dressing is advisable for those lesions treated with longer freeze times. Some degree of exudation may be expected during the first few days and an antiseptic dressing such as

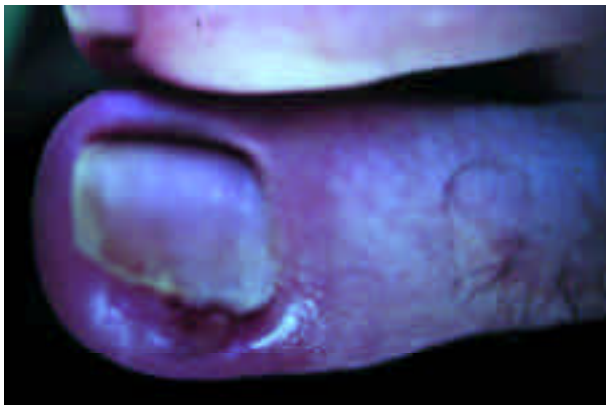

Figure 7a. Granulation tissue with ingrown nail

Figure 7b. Immediately after freezing

Povidone-Iodine helps prevent secondary infection. Wounds can be washed and it is important that crust and exudate is removed regularly. Adequate analgesics should be prescribed. Patients should be told to expect some pain, discomfort and swelling initially. Feet will feel sore for several days after treatment of multiple viral warts.

COMPLICATIONS OF CRYOSURGERY

Pain, swelling and blistering frequently occur when longer freeze times are used. Hypopigmentation of the treated area is seen in people with dark skin, but this may improve in time. Paraesthesia occurs but is usually temporary. Prolonged sensory abnormality is rare. Cryosurgery around the nails can lead to nail dystrophy and to extensor tendon injury.

Milia are small keratin filled epidermal cysts and formation may be seen months post-operatively but resolve spontaneously. A thin hypertrophic scar is also possible but will settle spontaneously in the following months. Patients on anticoagulants and corticosteroids tend to tolerate cryosurgery well.

Key point

Pain following cryosurgery can be considerable and should not be underestimated. An information leaflet is an additional benefit for the patient to take home

FURTHER READING

Dawber RPR, Colver GB, Jackson A. *Cutaneous Cryosurgery. Principles and Clinical Practice.* Martin Dunitz, London 1997.

Post-reading activity

Short Answer Questions

1. What are the principles behind cryosurgery?

2. What can bring about the cellular injury following freezing?

3. What are the critical determinants of the extent of this injury?

4. At what temperature are most cells killed?

5. What are the contraindications to use of cryosurgery?

6. What are the potential complications of cryosurgery?

7. Why are reproducible treatment schedules important?

8. If a 5 second freeze-thaw cycle was recorded in a patient's notes, how would you reproduce this treatment?

9. Which aspects of treatment need to be recorded in a patient's notes?

10. Why can several new warts grow on the periphery of a previously treated verruca?

Reflection

After reading this CPD article, take a few minutes to reflect on cryosurgery and how it is used. Areas for reflection may include:

- **How often do I, or would I, use cryosurgery?**
- **Am I using cryosurgery effectively and giving the patient the best care possible?**
- **How do I assess my treatment outcomes?**
- **How does this article change my practice, if at all?**

Notes

Notes

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