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ORIGINAL ARTICLE

Effect of temperature-controlled cooling on light-based skin treatments

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Key words:

Introduction

A consideration of skin cooling requires an evaluation of both body and skin temperatures. Normal internal body temperature is 36.6°C. Normal skin epidermal temperature is 27–32°C. Brief contact with very cold temperatures will not cause any skin injury. Because electrolytes and solutes reduce the freezing temperature, freezing of the skin only begins at tissue temperatures between 0°C and −15°C. Ideally, the epidermal temperature should be significantly but harmlessly decreased by the cooling procedure, while the target (i.e. blood vessels or hair follicles) temperature should remain minimally affected. There are four commonly used forms of cooling. These include: (i) contact cooling such as ice or chilled gels; (ii) spray coolants; (iii) chilled contact cooling; and (iv) air cooling. What is intuitive, but not proved, is that the actual temperature of epidermal cooling is as important as the actual process of cooling.

Materials and methods

A human arm was treated with a broad base light source (Profile BBL; Sciton Lasers, Palo Alto, CA, USA) using a 515 nm filter, 12 J/cm^2 and a 20 ms pulse. Three distinct zones were treated with identical parameters. The only variable was the temperature at the contact cooling chill plate. One zone was treated at 20°C; a second zone at 24°C; a third zone at 28°C. A fourth untreated zone served as a control.

Results

Extensive crusting was noted after light-based treatment when contact chill plate temperatures of 24°C and 28°C were used; minimal crusting was noted, using identical treatment parameters, when the skin was further cooled to 20°C (Figure 1).

Discussion

It is now well recognized that no matter what cooling method is used, the anatomic depth of cooling is related to contact time. The epidermis is cooled in tens of milliseconds; epidermis and dermis are cooled in hundreds of milliseconds; bulk skin cooling requires seconds of contact cooling.

The benefits of cooling are as follows: (i) epidermal cooling minimizes epidermal damage and allows for higher delivered fluences; and (ii) cooling of the upper dermis is protective and also tends to relieve pain without decreasing efficacy (1,2).

The desired depth of cooling is related to different laser applications. With superficial port-wine stains, only epidermal cooling is required. For deeper lesions, such as hair follicles or leg veins, epidermal and upper papillary dermal cooling is desired. Bulk cooling is desired when targets are closely spaced together to decrease the risk of dermal injury. Such bulk cooling is best applied to dense areas such as the male beard or hairy male backs. In such situations, gross thermal injury of the dermis is a risk.

The simplest method of bulk cooling is through application of ice or a cold gel to the skin immediately prior to the procedure. Unfortunately, such procedures are not only limited in their degree of protection but also are not very elegant in their use.

More effective cooling is achieved with contact, cryogen or air cooling. However, this study

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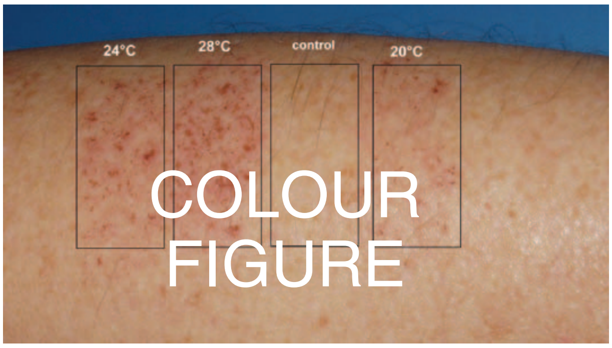

Figure 1.

documents that it is not only the duration of cooling that matters. It is also important to note the actual temperature of cooling. We have shown that, at least with broad based light technologies, varying levels of contact based cooling can have a profound effect on epidermal crusting. Extensive epidermal changes were noted when cooling plate temperatures of 24°C and 28°C were used. With identical treatment parameters, but a greater degree of cooling (20°C), minimal epidermal changes were noted. Such temperature control may also impact not only on the risk of epidermal crusting, but also on the risk of pigmentary changes and scarring after broad based light treatments.

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