Clinical Study

The importance of temperature control while using a wide-spectrum light source (IPL)

Sharona Levi-Friedman CRA, E. Krieger MD,
Formatk Systems Ltd. Tirat- Carmel, Israel.

1. Introduction

The use of intense pulsed light technologies for the treatment of dermo-aesthetic conditions such as pigmentary and vascular lesions, has become an elective therapeutic choice in the last 3 decades, improving ever more various technological aspects.

The mechanism of action contemplated in the theory of Selective Photothermolysis, introduced by R. Anderson and J. Parrish in 1983, presupposes a selective absorption of specific wavelengths by different chromophores (melanin, hemoglobin and water) so that the thermal damage occurs only to the target tissue and does not propagate in the surrounding area. However, except for epidermal pigmented lesions, melanin in the epidermis is an unwanted site for absorption of light. Thus, darkly pigmented skin is at high risk for epidermal injury during any laser treatment using visible or near infrared wavelengths less than 1,000nm. The authors differentiated absorption curves within these various chromophores according to specific wavelengths and recognized the criticality of heat accumulated in a given point, defining a value called TRT (Thermal Relaxation Time) referred to the capacity of a specific tissue to disperse this thermal energy without damaging non-lesioned tissue. This value is in direct relation with the exposure time - thermal excursion (pulse duration) and to the amount of energy emitted (fluence). The pulse should therefore carry enough energy to make the target damaged but at the same time should be short so as not to cause thermal damage to the surrounding areas. It is conceivable therefore that cooling the epidermis during the use of a light-based technologies (laser & IPL) assumes a primary importance in reducing the risk of side effects occurrence.

Normal skin epidermal temperature is 28–33˚C. A short contact with very cold temperatures will not cause any skin injury. 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 4 commonly used forms of cooling: contact cooling such as ice or chilled gels; spray coolants; chilled contact cooling; and air cooling. The actual temperature of epidermal cooling is as important as the actual process of cooling. (D.J. Goldberg, Effect of temperature-controlled cooling on light-based skin treatments, Journal of

Cosmetic and Laser Therapy. 2006; 8: 155–156)

2. Materials and methods

A human calf was treated with a broad band Intense Pulsed Light (Magma Spark Pro; Formatk Systems, Tirat Carmel, Israel) using a 530 nm filter, 20J/cm² at 20ms pulse. Five distinct zones were treated with identical parameters. The only variable was the temperature at the contact cooling chill plate. One zone was treated at 25˚C (no cooling – room temperature); a second zone at 20˚C; a third zone at 15˚C; a forth zone at 10°C and the fifth zone at 5°C.

3. Results

A significant adverse reaction was observed after treatment of the uncooled zone at 25°C. following diffused crust formations. A rather aggressive but minor reaction with crust formation was observed in the area cooled to 20°C. The cooling to 15°C in the third zone has further reduced the superficial thermal damage that becomes more moderate, giving rise to a slight reaction with minimal sporadic formation of crusts. The forth and the fifth zone, respectively cooled at 10°C and 5°C, were completely saved from any adverse reaction and the corresponding areas of the epidermis did not suffer any visible or perceptible thermal damage. (Fig. 1)

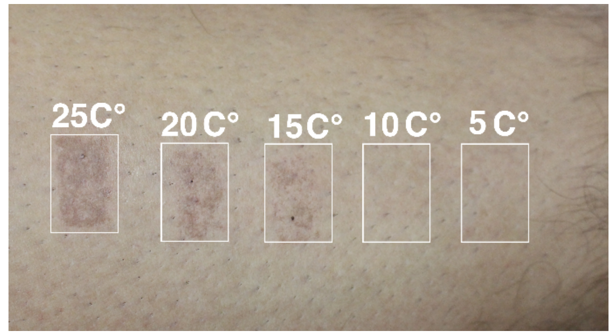

Figure 1: the reactions observed following the treatment with IPL at 5 different cooling temperatures

4. Discussion

The two variables that regulate the cooling quality of the skin consist in the exposure time of the contact cooling surface on the skin, this in particular, determines the depth of penetration, 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 desired depth of cooling is related to different laser applications. The other variable concerns the intensity of the cooling, therefore the temperature of the cooling surface. In this study we isolated the first variable, i.e. the exposure time, by establishing the same exposure time range (T) in all different spots within the treated area. This time range was in the order of hundreds of milliseconds and in any case less than one second (T<1sec). Thus, the depth of penetration concerned mainly the epidermis & dermis layers. Consequently, the only examined remained variable was related to the temperature that varied by 5°C steps between the spots performed in 5 different points within the treated area. It is evident that skin cooling provides a protective element of primary importance both to the epidermis and to the papillary dermis, minimising the risk of burns, reducing discomfort and allowing to use high fluences without compromising the results. However, since these minimum temperature changes, as can be clearly seen in the photo (Fig.1), have generated skin reactions of different entities; this can be exploited for clinical purposes where a drastic reduction of the skin temperature can compromise the results such as in the case of vascular lesions where an immediate vasoconstriction may occur, resulting from excessive cooling. At the same time, being able to adequately cool the cutaneous area of the lesion in a controlled manner is an important safety measure for the patient that should be applied.

5. Conclusions

Cooling the skin during the application of light-based technologies is of fundamental importance in preventing side effects, the temperature of the contact surface and therefore the skin temperature is significantly important in determining the efficacy of protecting the epidermis. Furthermore, the anatomic depth of cooling is directly related to contact time. Temperature regulation and cooling application time allow the operator to fine-tune clinical performance by adapting these parameters to treatment needs and patient conditions. For example, in the case of superficial vascular lesions (PWS, Telangiectasia), by setting to moderate cooling, a vasoconstriction phenomenon is avoided, improving the clinical results. In the case of superficial pigmented lesions, intensive cooling is desirable to protect the epidermis. The possibility of adapting the parameters relating to cooling therefore represents a strong advantage for the operator who can refine the treatment according to specific needs and to the patient who is guaranteed greater safety, efficacy and comfort.

6. References

1. *D.J. Goldberg, Effect of temperature-controlled cooling on light-based skin treatments, Journal of Cosmetic and Laser Therapy. 2006; 8: 155–156*
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3. Zenzie HH, Altshuler GB, Smirnov MZ, Anderson RR. Evaluation of cooling methods for laser dermatology. Lasers Surg Med. 2000;26:130–44.