Thermage Radiofrequency

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Rhoda S. Narins, Kenneth Beer, David J. Narins

18.1 Introduction

The ideal device for skin tightening would be able to accomplish a nonsurgical facelift with minimal downtime, risk and discomfort. Various devices have been introduced with the promise of delivering this miracle, but perhaps none has so captivated the attention of consumers (and physicians driven by their patients) as ThermaCool TC™ by Thermage®. This device employs a radiofrequency energy source to heat and subsequently tighten dermal connective tissue.

Rather than using light to heat the skin, ThermaCool TC™ utilizes an elegant application of electrical engineering to deliver uniform heating to an area of dermis without burning the intervening epidermis. A 6-MHz current is generated by the radiofrequency generator within the main part of the device [1]. This current is delivered to the skin via a disposable tip. The disposable tip and software that govern it are the truly novel aspects of the system. The tip contains a contact surface of a known area and software constantly measures skin temperature, resistance and other key parameters. This information is evaluated in real time by a computer and if any monitored data fall out of predetermined parameters, energy delivery is aborted to avoid tissue injury. For instance, with the newer treatment tips if all four corners of the tip are not in contact with the patient's skin, the device will not deliver a pulse since doing so would most likely result in the delivery of current to a smaller area of skin than was intended and likely result in a burn. Cryogen spray is delivered by the hand piece to cool the inner surface of the treatment tip membrane. Unlike lasers and light sources, which produce heating in tissue depending on the differential absorption of optical energy by the target (selective photothermolysis), the ThermaCool TC™ uses radiofrequency energy to deliver a uniform volumetric heating effect into the deep dermis and underlying tissue. Heat is generated by the tissue's natural resistance to the flow of current within an electric field, rather than from photon absorption. The ThermaCool TC™ has a unique capacitive coupled electrode design that disperses energy uniformly across the surface area of the treatment tip membrane. This creates a uniform electric field (zone of heating) in tissue at controlled depths. The electric field changes polarity six million times per second. Charged particles within the electric field change orientation at that same frequency, and the tissue's natural resistance to this electron movement generates heat (resistive heating). Utilization of a unique method of contact cooling prior to, during and after application of the energy produces a reverse thermal gradient with the greatest heating in the deep dermis while protecting the epidermis from thermal injury. It tightens deep tissue while sparing the epidermis. The depth of heating is treatment tip dependent not wavelength-dependent. Depths of heating and cooling are controlled by treatment tip geometry and/or cooling parameter adjustments within the tip. In the future new treatment tips may enable different levels of the dermis and subcutaneous tissue to be targeted. The complete mechanism of action of the tissue tightening is unclear. It has been hypothesized that the ThermaCool TC™ delivers enough heat into a large volume of tissue to cause immediate collagen contraction followed by a significant wound-healing response, resulting in gradual tissue tightening over time. The heat produced by the radiofrequency energy changes the molecular structure of the triple-helix collagen molecule by heating it to a point where it breaks the hydrogen bonds, resulting in collagen contraction. Unpublished transmission electron microscopy research performed immediately after treatment reinforces this hypothesis. This research demonstrated an immediate morphological change in individual collagen fibrils and confirmed the presence of partial denatured (contracted) collagen in the mid and deep dermis.

The elegance and efficacy of the ThermaCool TC™ system lies in what is referred to as volumetric heating. To picture this, it is useful to first banish traditional perceptions of heating in which a continuous front of heat is delivered to a surface and subsequently penetrates whatever lies beneath. Traditional heating implies that heat diminishes as the radiation travels through a target as energy is absorbed by the material it interacts with. Radiofrequency waves, as utilized by ThermaCool TC™, are more akin to microwaves, which heat deeply rather than superficially. A homogenous wave of heat is pro-