Dr. S. Foutsizoglou discusses the use of selective transcutaneous delivery of energy using intense ultrasound short pulses for facial rejuvenation.

Introduction

In recent years there has been a big buzz surrounding non-ablative energy delivery systems to treat superficial rhytids and skin sagging accompanying the aging face. Laser, light, radiofrequency, heating, just to name a few forms of energy, have been utilized for the sake of looking younger. Non-ablative skin tightening is associated with minimal downtime and reduced risk of adverse events allowing patients to resume their normal activities much quicker compared with rhytidectomy. However energy-based devices used in the cosmetic arena for facial rejuvenation have failed to replace ablative skin tightening and lifting due to their lack of efficacy, long-term satisfactory results, consistency and reliability. Whereas it is easier to volumize the face in a non-surgical manner (e.g. dermal fillers, sculptra) when it comes to skin tightening and lifting things start becoming pretty difficult as potentially effective treatments should simultaneously deal with loss of facial volume, gravity, reduction of collagen, elastin and glycosaminoglycans and underlying soft tissue and skeleton changes secondary to the aging process. Numerous broadband light devices, monopolar and bipolar radiofrequency devices and various other energy-based devices are on the market promising reduction of wrinkles and skin sagging or, in bolder statements, results similar to the superficial musculoaponeurotic system (SMAS) lift. However it has been impossible, so far, to address all the above issues with the use of a single non-surgical device or modality.

On September 30th, 2010 Dr Diane Duncan, an American plastic surgeon, gave a talk to BACD members along with a demonstration on a newly introduced therapeutic ultrasound device, Ulthera, which combines visualization beneath the skin’s surface with the delivery of focused acoustic energy, which is selectively absorbed, causing rapid heating inflammation of the discreet thermal coagulation points on an order of 1mm. The company and the presenting surgeon claimed that the ‘high amounts of delivered energy convert into remodeling of the dermis and deeper tissues’ leading to significant and almost instant skin tightening and lifting without any serious adverse reactions except for mild to moderate discomfort. Too good to be true or is it actually the beginning of the application of ultrasound focused energy in dermatology and plastic surgery?

Ultherapy

Ultherapy takes advantage of the intense focused ultrasound technology which can be used as an noninvasive modality for sharply confined heating and controlled thermal injury within the skin, subcutaneous tissue, or fibromuscular layer. The technology used by Ulthera was originally explored for the treatment of solid benign and malignant whole-organ tumours as high-intensity focused ultrasound has been shown to cause precise coagulative necrosis to targeted tissue leaving nearby regions intact. Ultrasound-based imaging systems have always been considered the safest diagnostic modalities and have been routinely used in the whole spectrum of Medicine.
However, by using a highly directive source geometry with the source energy settings increased significantly, ultrasound energy can be focused spatially in a tightly confined region (on the order of 1 mm³) to cause selective tissue thermal coagulation. This Intense Ultrasound (IUS) approach enables the creation of well-defined thermal injury zones (TIZs) at depths within soft tissue while leaving the surrounding regions unaffected.

The ultrasound waves induce a vibration in the composite molecules of a given tissue during propagation. The friction developed between the molecules is the source of the generated heat. Studies using intense ultrasound generated energy directed to porcine soft tissues have shown that most of the delivered energy was deposited in the form of heat causing sharply focused coagulation changes around the focal zone of the beam, leaving the adjacent tissues unaffected. Thermal coagulation is thought to induce a “wound healing” response stimulating fibroblasts to synthesize and lay down new collagen. In addition, when tissue is heated to 65°C, there is a disruption of the intermolecular peptide bonds of the collagen triple helix (denaturation). As these bonds dissociate, the 3-dimensional structure unwinds, and immediate collagen contraction ensues. This principle is not new to Cosmetic Medicine as it has been used in various nonsurgical treatments for facial rejuvenation and skin resurfacing including Thermage and CO2 or erbium Laser. What makes Ulthera different is the fact that there is no epidermal disruption, the thermal lesions can be of variable geometry and are precisely placed deep-dermally or subcutaneous-ly targeting the SMAS causing selective collagen denaturation, imaging and focused energy can be generated by using the same handpiece and the absorption of US energy is colour-blind making it suitable for all phototypes.

Figure 1: The Ulthera System
Pre-treatment

210 Days Post Treatment 1, single plane
90 Days Post Treatment 2, double plane

Improved Jawline Definition
Submental Lifting

Pre

90 days post treatment

Brow elevation, decreased lid laxity, softened periorbital lines
For the demonstration two lady models of about 50 years of age volunteered to have the treatment. Topical anaesthesia in the form of EMLA cream was used prior to Ultherapy for the first model who had her neck and lower face treated whereas the second model had in total 15ml of 2% lignocaine injected periorbitally for her periorbital lines and brow elevation. For both models Ulthera’s patented DeepSee Transducers with integrated See and Treat buttons were used to deliver geometrically focused energy at two depths, i.e. 3mm and 4.5mm, at 7MHz and 7MHz & 4MHz respectively. Lower frequencies tend to penetrate deeper in tissues. On-screen visualization of the underlying tissue ensured thermal coagulation took place in the right plane. The handpiece is designed to mechanically slide in a straight line to deliver a series of ultrasound pulses along a linear path. Therapeutic delivery of acoustic energy create discrete thermal coagulation points (TCPs) approximately 1mm3 in size. A single application of the transducer is equivalent to 25mm line of evenly spaced TCPs.

The whole procedure in both cases took approximately 40 minutes and both models reported pain as 6 out of 10. There was mild erythema in both cases without any other immediate side effects or adverse reactions. Both ladies rated their post-Ultherapy results satisfactory noticing an immediate improvement in the neck and jowl and softening of periorbital lines and slight brow elevation respectively.

**References**


