EMTONE® TECHNOLOGY FOR CELLULITE REDUCTION: MECHANISM OF ACTION

There are many invasive and non-invasive approaches to the treatment of cellulite. These include lymphatic drainage, manual or mechanical massage, acoustic wave therapy, and application of laser or radiofrequency (RF) based treatments. These approaches are either used on a standalone principle or in combination with each other in order to enhance the results. The purpose of combined therapies is to achieve higher efficiency via the synergy of various physiological effects induced by the respective technologies. EMTONE combines monopolar RF and Targeted Pressure Energy. As such, it introduces a unique non-invasive solution combining two proven approaches to the treatment of cellulite. Due to the simultaneous effects, the therapy time is reduced and the results are significantly improved.

PATHOPHYSIOLOGY OF CELLULITE

Cellulite is considered to be a common topographical alternation of the human skin, which mostly occurs in the dermis and hypodermis. 80 – 90% of post-pubertal women are affected by some form of cellulite. The main causes of this skin condition are heredity, unhealthy lifestyle and hormonal changes.

Prevalence of cellulite in women is much higher than in men. Compared to men, women have a larger number of fat cells (adipocytes) in the subcutaneous tissue (hypodermis), which also has a greater propensity to deposit fat. Due to this predisposition, excessive calorie intake in women will cause an increase in adipocyte enlargement.

The fat cells are located in chambers (lobules) which are separated by vertical and horizontal connective tissue septae. Due to the increasing number (hyperplasia) and size (hypertrophy) of the adipocytes, the fat chambers become distended and are pushed up against the skin surface. Moreover, the collagen in female skin has different arrangements - fibers of connective tissue are oriented perpendicular to the skin surface, while male collagen bonds form approximately 45° angles. Shortening of these septae due to fibrosis and loss of their elasticity provokes retraction and causes depressions that are characteristic for cellulite.

Previously described anatomical alternations lead to a dimpled and uneven surface of the skin, generally known as the orange peel, mattress or cottage cheese skin appearance. As a consequence the capillary system is constrained by the enlarged adipose tissue, resulting in a reduction of blood and lymph flow, and an increased storage of waste products[1,2].

EFFECT OF EMTONE ON TARGET TISSUE

Collagen

Collagen, as the main component of connective tissue, is also an important structural part of the dermis and hypodermis. The hypodermis connective septae influenced by cellulite are characterized by rigid structure of fibrotic collagen fibrils.
The simultaneous emission of monopolar RF and Targeted Pressure Energy represented by thermal and mechanical energies activates the function of metalloproteinases (MMP's) in the extracellular matrix. MMP's are responsible for the degradation of the collagen protein structure[5,6]. The mechanical stress concurrently results in dissociation of fibrils, a reduction in their structural density thereby increasing conformational freedom and reducing their thermal stability. Due to this phenomenon the temperature required for collagen denaturation is decreased[3,4]. Thermal stimulation thus leads to a disruption of the intramolecular hydrogen bonds and a partial shrinkage of collagen triple helix can be observed at lower temperatures. As a direct consequence, the collagen remodeling and the neocollagenesis are initiated sooner. Micro-inflammatory stimulation of fibroblasts caused by heat accumulation results in their proliferation. This causes a significant increase in production of procollagen mRNA[7]. The heating

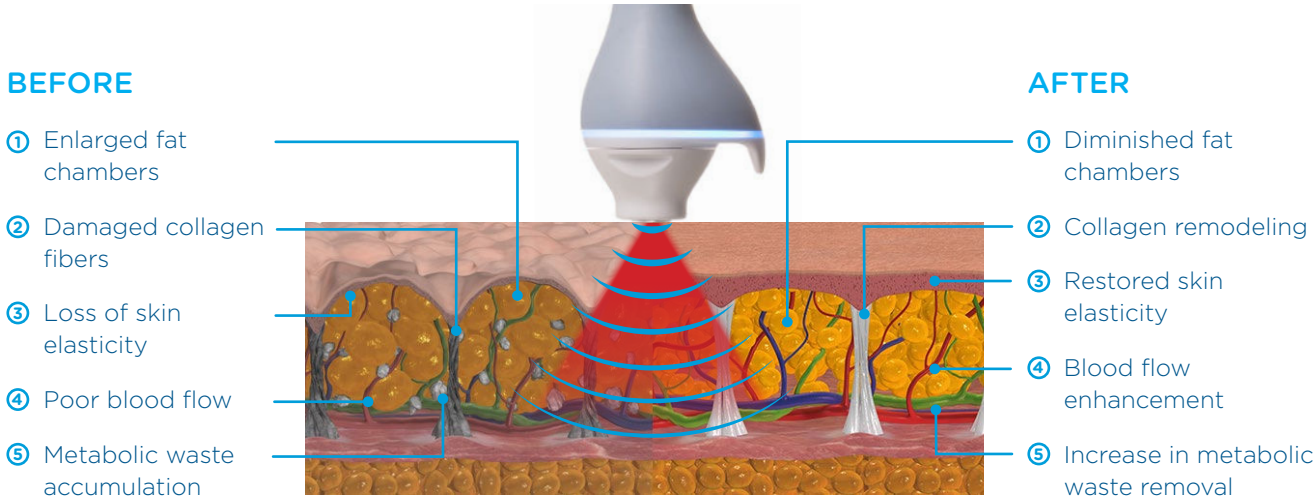

Figure 1: Illustration of skin structure changes after EMTONE treatment.

of collagen to the critical temperature of 42°C stimulates the production of HSP47 protein. This protein is involved in the formation of collagen at the endoplasmic reticulum, and ensures proper conformation of the collagen tertiary structure. This is necessary for collagen's correct function[8]. Exposure to the mechanical energy accelerates proliferative activity of fibroblasts and creates a suitable environment for the synthesis of new collagen and elastin by reducing oxidative stress in the tissue[9,10].
The simultaneous effect of mechanical and thermal energy results in the disruption of old damaged collagen fibers followed by the synthesis of new healthy ones. The fibroblasts concurrently produce new elastin fibers. These facts lead to a thickening of the dermis, relaxation of connective septae in the hypodermis and an increase in elasticity.

Adipocytes

Applied monopolar RF waves penetrate into the deeper layers of the skin, where the heat is absorbed by different cells. Different kinds of tissue absorb different amounts of heat depending on their electrical resistance (impedance). The electrical impedance is determined by tissue water content (water is a very good electrical conductor). Fat tissue has a much lower water content (10 – 20 %) and therefore a higher impedance (3000 – 5000 Ω/cm2) compared to other tissues such as muscle (water content 70 – 75 % and electrical impedance 100 – 220 Ω/cm2). Due to the impedance of the tissue, the electrical current is converted to thermal energy according to the formula (1), where I = current, Z = tissue impedance, and T = time of application. This relation shows that tissue with a higher electrical impedance is heated more intensively than tissue characterized by a lower impedance[12].

$$\text{Energy (Joules)} = I^2 \times Z \times t \qquad (1)$$

As a result of tissue exposure to heat and mechanical stimulation, the properties of the cell membranes are changed. A higher permeability of the cell membrane, in particular, allows fluids to move rapidly through the membrane and an acceleration of the cell metabolism can be observed[11]. A combination of both energies stimulates the blood circulation and contributes to the formation of new blood vessels (angiogenesis). These alternations lead to the activation of enzymes responsible for the breakdown of fat (lipids) stored in adipocytes. As a direct consequence, the size of fat chambers is significantly reduced[12].

Blood and lymph circulation

Mechanical massage using circular motions towards the lymphatic nodes results in a lymphatic drainage effect, which helps increase the removal of water and metabolic waste from the affected tissue. Proper function of the lymphatic system thus decreases the overall toxic load of the cell.
Sufficient blood supply is one of the main prerequisite for the physiological function of the healthy tissue and the proper healing of impaired tissue including neocollagenesis, neoelastinogenesis and physiological function of the adipocyte metabolism. As mentioned above, blood circulation is promoted by angiogenesis and mechanical stimulation provided by Targeted Pressure Energy and vasodilatation caused by radiofrequency thermal effect. Thermal induced metabolism acceleration and reduction in chamber size concurrently relax the constricted blood vessels.

All the mentioned effects (increase of neocollagen fibers, adipocyte metabolism acceleration, increased waste product removal and blood circulation) produce a thicker and more flexible dermis and cause a reduction of fat chamber size, relaxation of connective septae and an overall improvement in skin condition.

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