

Microwave Therapy for Frostbite Management: A Case Series

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Abstract

Microwave body tightening and contouring is a common and efficient cosmetic medical procedure. The current study presents preliminary data about microwave treatment for body contouring where an innovative and unexpected benefit on frostbites was shown. This is a case series on two patients with frostbite treated with microwave therapy. The participants received the treatment for five sessions at 20-day intervals, including the beginning of the study. In addition to being satisfied with the treatment of their skin imperfections, the patients noticed a remarkable and progressive improvement in frostbite on their limbs. Both patients experienced a significant improvement in skin sensation and appearance and no side effects were observed. Our findings confirmed the safety and efficacy of microwave therapy in treating cellulite and skin laxity but rather a positively effect and a significant improvement in the treatment of frostbite as a secondary intention.

Keywords: Microwaves; Body remodelling; Frostbite improvement; Localized adiposity; Secondary intention

Introduction

Although body contouring and tightening with microwaves is a frequent and effective cosmetic medical procedure [1-4], it was demonstrated that this technology is able to improve hands or feet frostbite showing promising results [5]. When tissues are exposed to temperatures below their freezing point, a painful thermal damage known as frostbite develops [6]. The damage is caused by ice crystals that develop in cellular spaces and cells when it is cold, which results in vascular damage to the endothelium of blood vessels, significant damage, and severe long-term and permanent morbidity. Most frequently,

ears, noses, cheeks, and distal upper and lower extremities are affected by frostbite [7].

There is a wide range of frostbite clinical findings, from minor injuries that heal entirely without any repercussions to severe injuries that necessitate amputation of a major limb [8]. Even if there is no significant tissue loss, patients may experience long-term consequences from a frostbite injury. Vasomotor disorders, neuropathic/nociceptive pain, and frostbite arthritis are examples of these [9].

Several interventions for frostbite injuries have been proposed, such as rapid heating, hyperbaric oxygen therapy, thrombolytic (blood-thinning) therapy, sympathectomy (nerve block), vasodilating agents, prostaglandins and other supportive care [10-15], but the benefits and harms of these interventions are unclear. Concerning thrombolytic therapy (tPA) although not all patients are eligible for this therapy [16]. Moreover, adverse events including hot flushes, heart palpitations, nausea and vomiting were frequently reported [17]. Also, iloprost has been used in case studies and can even be administered as an outpatient, with patients returning for daily infusions [14]. Unfortunately, this medication is not available in the United States. The use of hyperbaric oxygen is still debatable. There have been a few documented cases on the use of hyperbaric oxygen in the treatment of severe frostbite injury, but they are few and varied in methodology [18].

tPA and prostacyclin are most effective if used within the first day after tissue rewarming [19]. Pharmacological adjuncts, such as fibrinolytics, have been proposed to minimize tissue damage. Surgical therapy is postponed until there is clear demarcation between healthy and necrotic tissue. Amputation and debridement are performed after the demarcation line is formed but remain highly invasive treatments [20].

Recent published researches [5, 21, 22] demonstrated an initiate deep warming of frostbitten extremities on exposure to low-power microwave radiation and the successful microwave treatment with a frequency of 2.45 GHz of cold injury of patient hands and feet that allowed amputation to be avoided.

The literature review shows that there are not many products so far for local treatment of frostbite, however under the circumstances in which freezing occurs, which are generally high-altitude regions or desolate areas, where medical facilities are of little local development [23].

In this scenario, the Onda system (DEKA M.E.L.A, Florence, Italy), which represents a non-invasive microwaves system to treat skin imperfections, particularly localized adiposity, cellulite, and skin laxity, was found to be effective in improving frostbite in this case series study.

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Case Reports

Investigations

We present two cases: a 48-year-old woman (patient 1) with a body mass index (BMI) of 20, with arms' skin laxity and a 45-year-old woman (patient 2) with a BMI of 18, with cellulite on legs. Specifically, frostbite affected the upper (patient 1) and lower limbs (patient 2) of both individuals.

Treatment

Both patients were treated with Onda system (DEKA M.E.L.A, Florence, Italy). This device is an innovative medical system that utilizes special microwaves (called Coolwaves) able to carry out treatments for cellulite, localized adiposity and skin laxity.

The selective microwave frequency of the device is 2.45 GHz; the localized heat produced by these waves is absorbed by the fat through a biophysical process called "dielectric heating" [24]. At this frequency, skin electrical conductivity is so low that the skin itself becomes almost transparent, allowing therefore the energy to reach subcutaneous fat. This phenomenon ensures that the dermis' superficial layers are shielded from excessive heat. Unlike existing technologies, this device focuses its action on the subcutaneous fat by means of microwaves delivered to the subcutaneous layers by two specifically designed handpieces (a shallow handpiece and a deep handpiece) capable of channelling all energy to the selected target. The deep handpiece is used for the treatment of localized fat and deep cellulite. As for the shallow handpiece thanks to its superficial action it is used for skin tightening and superficial cellulite management. This handpiece produces a superficial and concentrated heating that induces a controlled hyperthermia: as a consequence, there is solubilization of the fibrous collagen and narrowing of most of the superficial collagen fibers in order to obtain a tightening/remodelling of superficial connective tissue. The system has an internal database with pre-programmed treatment protocols for three different applications: cellulite, localized fat, and tightening. The devices' handpieces have a continuous cooling system (temperature set at 5 °C), and can be accessorised with a contact and temperature sensor, which allow the user to protect the superficial skin layers from unwelcome overheating. The participants received the treatment following Onda standard protocol for five sessions at 20-day intervals, including the beginning of the study. The area to be treated was divided into two adjacent squares 15 × 15 cm². The typical treatment time, for each square, was approximately 15 min. For the treatment arm's skin laxity (patient 1), a power of 120 W and an energy dose of 6,000 J were used. For the treatment of leg's cellulite (patient 2), power ranged between 110 and 120 W and the energy dose delivered was 60,000 - 90,000 J. For both treatments, the superficial shallow handpiece was used. In order to carry out a lymphatic drainage, circular movements were performed within each demarcated treatment area, privileging a gradual ascending ad-

vancement along the lower limb and arm in the direction of the lymph node stations, repeating several steps until the exhaustion of the dose set for that area.

Follow-up and outcomes

In addition to being satisfied with the treatment of their skin imperfections, the patients noticed a remarkable and progressive improvement in frostbite on their limbs. Therefore, microwave treatment has positively affected the treatment of frostbites as a secondary intention. Both patients experienced a significant improvement in skin sensation and appearance. The perception of touch is improved, as well as the burning sensation/redness of the skin and muscle/joint stiffness.

No side effects were observed, demonstrating that the treatment is safe and well supported by patients.

Discussion

As already mentioned in the introduction section, the effect of microwave warming in treating frostbites has shown positive results. Of note, the safety and effectiveness of microwave therapy for frostbites have been shown in a large series of patients [21].

Despite this, the microwave therapy used in this study differs and has advantages over the systems described in previous articles. In contrast to the microwave system used in the study by Dunaevskiy and colleagues [21] that is a closed metal chamber with a microwave generator capable of treating only the frosbitten extremities, Onda system is equipped with a handpiece that can be positioned in contact with the patient's skin without causing damage (safety assured both by the presence of a cooling system and by the fact that the handpiece can be accessorised with a contact and temperature sensor) and capable of treating the entire affected limb. It is assumed that the hyperthermia, caused by treatment with Onda, led to an increase in hyperemia of blood vessels resulting in greater tissue oxygenation, not only in the treated area but also all over the interested limb up to the extremities affected by frostbites.

In the study of Dunaevskiy and colleagues [21] all volunteers are only male subjects. Furthermore, as women and children have less "volume" in their extremities, microwave power and procedure duration must be reduced. The Onda System's ability to treat the entire limb overcomes this problem.

Finally, the Onda treatment protocol requires less time than the previous article's microwave system.

Our results demonstrated that interlobular collagen fibers in the septa were reduced and fragmented as a result of controlled hyperthermia; as a consequence, the remodelling of collagen fibres leads to an improvement of skin texture. Indeed, Onda system generates microwaves which interact with biological molecules and creates localized, controlled heat. This is absorbed by selected biological targets, such as fat and collagen septa, leading to dissolution of the deepest collagen fibers, to activate fibroblasts, and improve skin texture [4].

Onda system could play a very crucial role in preventing

permanent damage. The current study presents preliminary data about microwave treatment for body contouring where an innovative and unexpected benefit was shown: our findings confirmed the safety and efficacy of Onda therapy in treating cellulite and skin laxity without finding any adverse effects, but rather a significant improvement in the treatment of frostbite.

In this regard, further treatments will be carried out to better verify the effect of microwaves in improving this condition.

The study limitations are represented by the lack of photographic evaluation or other types of assessments that is related to the fact that the improvement of frostbite was an unexpected event observed following the treatment of cellulite and skin laxity in the patients examined. In future cases, one of these modalities for evaluating frostbite and the benefit of intervention should be used.

Learning points

We would like to highlight the importance of microwaves therapy, which represents a frequent and effective cosmetic medical procedure, also in the improvement of hands or feet frostbite. Several interventions for frostbite injuries have been proposed, such as rapid heating, hyperbaric oxygen therapy, tPA, sympathectomy (nerve block), vasodilating agents, prostaglandins and other supportive care, but the benefits and harms of these interventions are unclear. The effect of microwave warming in treating frostbites has shown positive results, as demonstrated also by our clinical findings. It is assumed that the hyperthermia, caused by treatment with our microwave study device led to an increase in hyperemia of blood vessels resulting in greater tissue oxygenation, not only in the treated area but also all over the interested limb up to the extremities affected by frostbites. The current study presents preliminary data about the safety and efficacy of Onda system for body contouring and frostbite treatment.

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Conflict of Interest

IF and LP are employed at El.En. Group. The remaining authors have no conflict of interest to declare.

Informed Consent

Informed consent was obtained from all subjects involved in the study.

Author Contributions

Conceptualization: BS, LP. Validation and data acquisition: BS, LP. Writing - original draft preparation: LP. Writing review and editing: LP, IF. Supervision: BS, LP, IF. All authors have read and agreed to the published version of the manuscript.

Data Availability

The authors declare that data supporting the study findings are available on request from the corresponding author.

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