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The Use of Dry Needling and Infrared Thermography for a Subject with Scar after Surgical Bone Fusion: A Case Report

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Abstract

Background: Infrared thermography in medicine is used to obtain information about biothermokinetic processes in the human body. Dry needling is a physiotherapeutic method that involves needling selected points on the body, which leads to the dilatation of blood vessels, thereby improving oxygenation and increasing the temperature of the treated tissue. The purpose of this study was to demonstrate the effectiveness of dry needling therapy by analysing the temperature changes observed in the scar after surgical bone fusion.

Methods: This study included a 40-year-old female patient with a post-surgical scar from a radius bone fusion at the elbow region and significant pain in the limb. Dry needling was performed once a week for a period of 6 weeks, and temperature changes were recorded with a FLIR A655 SC digital infrared camera during the first and last procedures. A proprietary questionnaire was used to evaluate the effectiveness of the therapy.

Results: Dry needling therapy increases blood flow at the needling area and decreases inflammation and tissue temperature by almost 2.5°C. After 6 weeks of study the pain in the limb completely stopped.

Conclusions: Imaging of human body surface temperature distribution may have diagnostic value in dry needling scar therapy

Keywords: Thermography; Dry Needling; Scar Therapy; Scar Tissue

Introduction

Scar tissue is formed because of wound healing, e.g. after surgical intervention. The process of wound healing and scar tissue formation usually takes one to two years. Extensive disruption of the skin's deep layers can cause damage to the fascia and other soft tissues. This is associated with pain, loss of function, impaired mobility, and gliding within the scar tissue. Untreated scarring disrupts the body's homeostasis, significantly affecting patients' quality of life, mental and physical health [1]. To minimise the impact of the injury, it is important to start scar therapy as soon as possible.

Among the physiotherapy methods that can be used about 2 months after surgery or injury is dry needling. That method is based on the insertion of thin needles, used in acupuncture, with no injection. Needle therapy reduces pain syndromes in muscles, tendons, ligaments, peripheral nerves, fascia, and scar tissue [2,3]. This procedure affects the musculoskeletal, nervous, and circulatory systems. Distinctions can be made between dry needling methods that apply directly to the area of pain, e.g. the targeting of muscle trigger points, or a therapy that involves a global effect on the central nervous system, in which needles are used around the affected tissue. Dry needling therapy results in the blood vessels dilating, thereby improving oxygenation, removing metabolites, and increasing the temperature of the treated tissue.

The implementation of thermographic detection of the examined areas of the patient's body makes it possible to determine the intensity of blood supply to the muscle tissue and to assess the impacts of the applied physiotherapy treatments on its level [4,5]. Infrared thermography (IRT) involves the non-contact evaluation of the temperature distribution on the surface of the body under examination [6]. The method is based on the detection and registration of the emission of infrared radiation from a defined area and the transformation of detecting and registering the emission of infrared radiation from a defined area and transforming this radiation into a visible image. Although increasingly used, IRT still seems to be an undervalued tool in contemporary medicine [7-12].

The dry needling procedure is commonly used to treat myofascial trigger points, providing noticeable results. There are only a few clinical studies of the effect of acupuncture and dry needling on scar tissue [13]. This study hypothesized that dry needling therapy effectively mobilizes scars and restores tissue deformability compared to pre-injury. Therefore, the aim of this case study was to determine the effect of dry needling mainly related to the changes of surface temperature and subjective pain sensations before and after therapy in the scar tissue in a patient with a bone fusion post-surgical scar.

Case Report

Case Description

The subject (woman) was selected from a larger group of patients with surgical scars who were participants in an investigation of dry needling treatment efficacy. She was chosen for this case study because she experienced pain and significant inconvenience in daily life related to the scar. When the study began, she was 40 years old, height: 159 cm, weight: 65 kg. On 22.08.2018 the patient experienced a radial bone fracture. After bone fusion surgery a 90 mm scar remained on the anterior surface of the right elbow. Since 2018, manual therapy and kinesiotherapy for injured limbs have been provided twice a week. Until inclusion in the study, the patient was accompanied by hand pain in daily life.

The patient was informed about the study procedure and contraindications and possible side effects. Subject signed the informed consent form before participation in the study. Approval for the study was obtained from the Bioethics Committee of the Regional Medical Chamber in Szczecin, No. 11/2022, dated 6th October 2022, (Figure 1).

Figure 1: The Postoperative Scar After Radial Bone Fusion.

Dry Needling

The dry needling treatment was performed once a week for 6 following weeks. The therapy was performed during home physiotherapy. Scar tissue was treated by placing needles around the scar and creating mechanical stress. The patient was placed in a recumbent position during the dry needling procedure. Before applying the needles, the area was disinfected with alcohol (15 minutes before the procedure, to evaporate). Before each examination, the patient underwent adaptation to the conditions in which the examination was conducted. Each time, we ensured that the temperature in the room was the same and not variable throughout the study. Then a skilled, trained physical therapist, wearing gloves, inserted needles (0.30 x 30 mm, SOMA dry needling needles made of Japanese surgical steel) around the scar area. Twenty-four needles were used for the procedure each time, which were inserted to a depth of about 5 mm. Each needle was packed separately. Then, the needle was firmly held between the thumb and the second finger and was deeply inserted. Needles were placed along the entire length of the scar. A static technique was used, and the therapy lasted 15 minutes each time (Figure 2).

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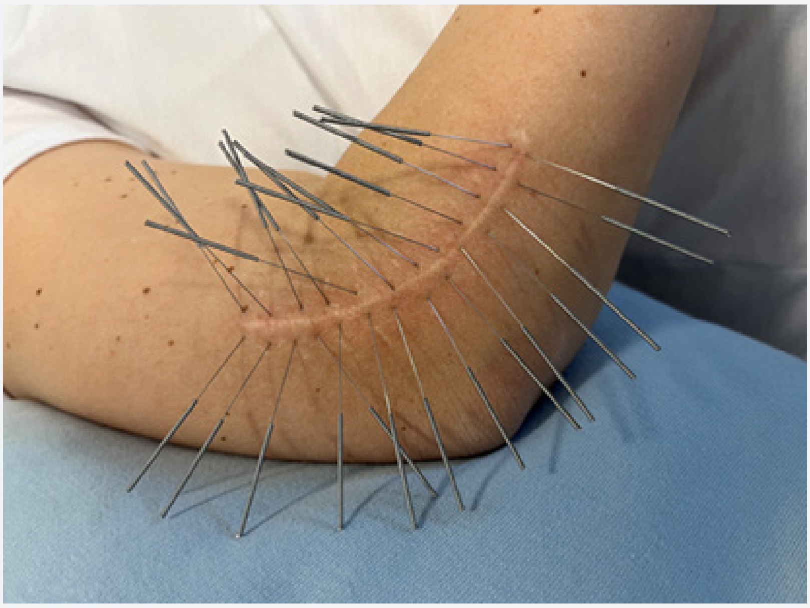

Figure 2: Dry Needling of the Scar in the Right Arm.

Scales Applied

The following scales were used to assess the effectiveness of therapy: Visual Analogue Scale (VAS) and proprietary survey questionnaires. The proprietary survey questionnaire was a modified version of the POSAS (Patient and Observer Scar Assessment Scale) consisting of a section on the patient's scar parameters assessment. POSAS consists of six items scored on a scale from 1 to 10. The sum of the six items gives a total score. Questions were asked about symptoms such as pain, itching, restriction of tissue mobility, stretching, pinching, pricking, and sensitisation/insensitization. All parameters are compared to normal skin. VAS provides a subjective 11-point assessment of pain intensity. It is by far the most popular scale for subjectively assessing pain perception. The proprietary questionnaire consisted of an initial questionnaire (performed on the first day of treatment) and an exit questionnaire (completed on the last day of treatment).

Data Analysis

The original FLIR software (FLIR Tools+) was used to detect the temperature of the scar tissue and analysis the thermograms. The mean, maximum, and minimum temperature of scar and standard deviation (SD) were processed in Microsoft Excel and compared between the first and sixth dry needling procedures. The maximum temperatures of each thermal image were graphically represented on a chart to observe temperature changes during the dry needling procedure. This method permits fine observation of the warming kinetics.

Results

Decrease of scar temperature influenced by dry needling. Mean values, standard deviation, minimum and maximum values obtained from measurements during the first and sixth needling for selected ROIs (regions of interest) are summarized in (Table 1). The maximum temperatures of the patient ROI during all analyses are presented. After six weeks of needling, we observed a change in maximum starting temperature by almost 2.5°C. Interestingly, after 6 weeks of needling, we observe a different pattern of temperature changes during the procedure. During the first session, the highest spike in scar temperature occurred right after the removal of the needles (by 0.68°C), while during the last session (at week 6), it occurred right after needling (by 1.33°C). In both cases, the temperature 15 minutes after removal of the needles was lower than the starting temperature by 0.59°C and 1.05°C, respectively (Figure 3,4,5).

During the first treatment, there was pain when removing the needles (6 on a scale of 0-10). After the needles were removed, there was a burning sensation on the lower border of the scar. The described discomfort disappeared 5 minutes after the removal of the needles. During the study in the second week, there was pain during needle insertion, which disappeared as soon as the needle was inserted into the tissue (in some areas persisted until the next day), in this case, the pain appeared along the entire length of the scar. During the third needle, the pain was now present only within one needle.

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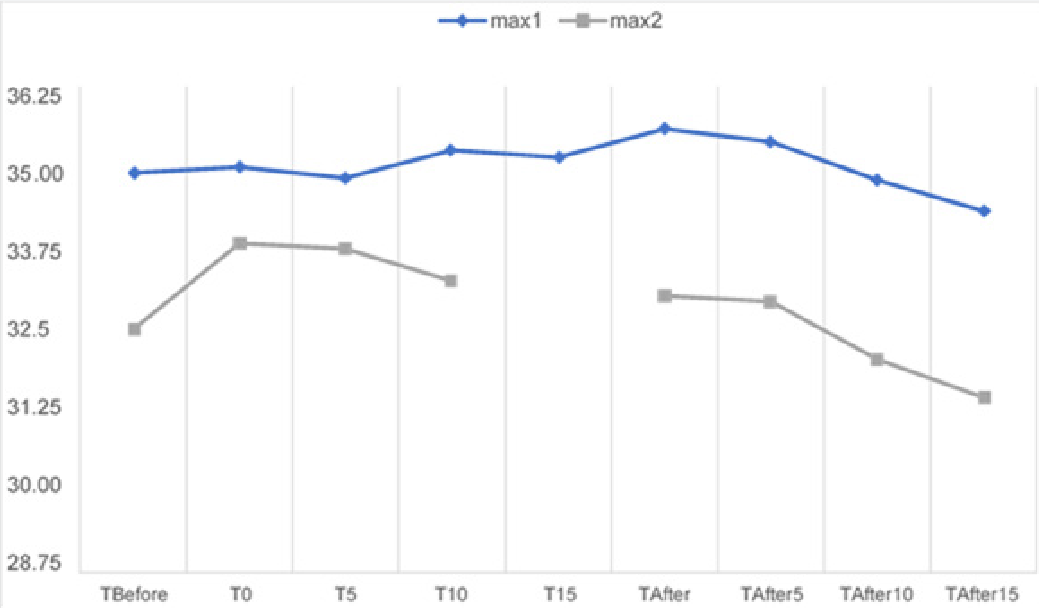

Figure 3: Changes in Maximum Temperature Values During Dry Needling Procedure.

Differences Between First and Sixth Needling. Max1 - Maximum Temperatures Measured During the First Needling; Max2 - Maximum Temperatures Measured During the Sixth Needling. (T_{before} - 15 Min After Thermal Acclimation, Just Before Needling; T_0 - Right After the Needling; T_5 – 5 Min After the Needling; T_{10} – 10 Min After the Needling; T_{15} – 15 Min After the Needling; T_{after} – Right After Removal of the Needles; $T_{after}5$ – 5 Min After Removal of the Needles; $T_{after}10$ – 10 Min After Removal of the Needles; $T_{after}15$ – 15 Min After Removal of the Needles).

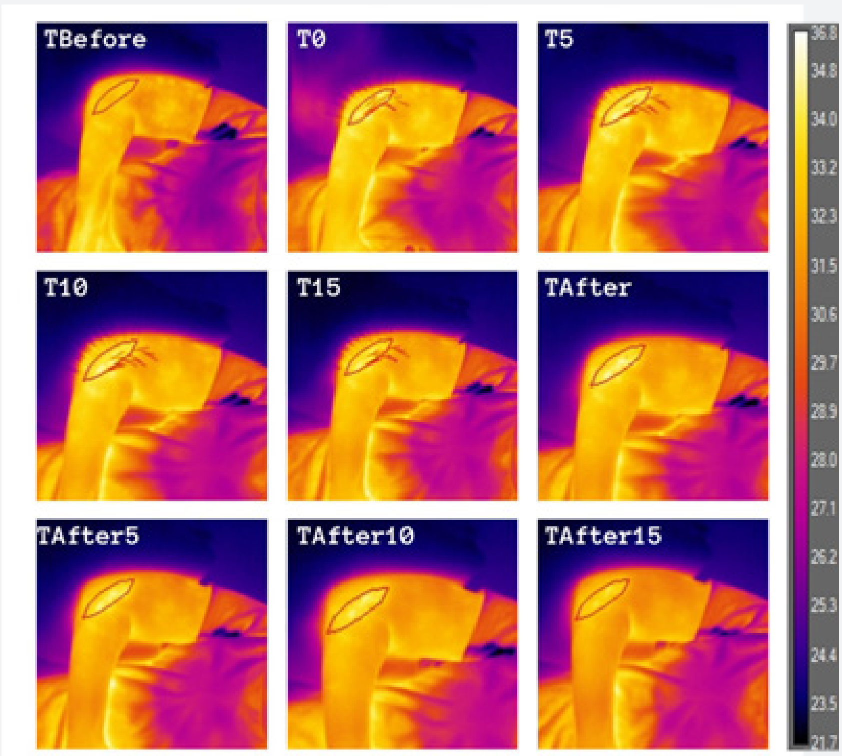

Figure 4: Thermograms with Marked Scar Surface During First Needling.

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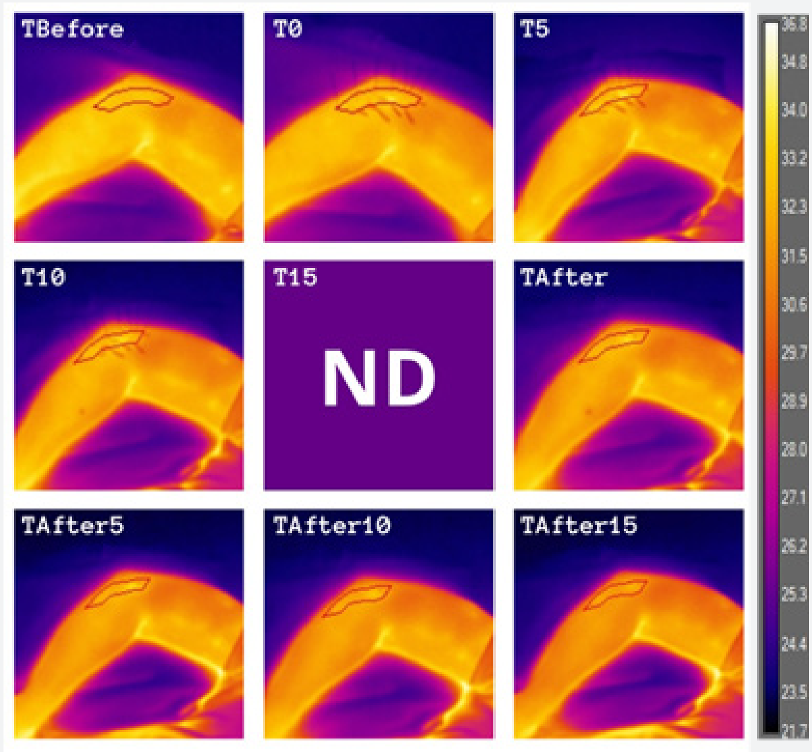

Figure 5: Thermograms with Marked Scar Surface During Sixth Needling.

Table 1: T_{before} - 15 Min After Thermal Acclimation, Just Before Needling; T_0 - Right After the Needling; T_5 – 5 Min After the Needling; T_{10} – 10 Min After the Needling; T_{15} – 15 Min After the Needling; T_{after} – Right After Removal of the Needles; T_{after5} – 5 Min After Removal of the Needles; $T_{after10}$ – 10 Min After Removal of the Needles; $T_{after15}$ – 15 Min After Removal of the Needles; ND – No Data.

	First Needling				Sixth Needling			
	Mean	SD	Min	Max	Mean	SD	Min	Max
T_{Before}	34.27	0.25	33.71	34.92	31.96	0.37	30.53	32.5
T_0	33.38	1.24	29.03	35.01	32.24	0.48	30.98	33.83
T_5	33.71	0.74	30.02	34.84	32.2	0.55	30.28	33.75
T_{10}	33.97	0.75	30.62	35.27	31.92	0.48	30.52	33.25
T_{15}	33.91	0.86	30.4	35.16	ND	ND	ND	ND
T_{After}	34.45	0.44	33.16	35.6	31.71	0.45	30.69	33.02
T_{After5}	34.35	0.45	33.48	35.4	31.52	0.5	30.7	32.93
$T_{After10}$	33.74	0.4	32.26	34.81	31.07	0.35	30.37	32.04
$T_{After15}$	33.45	0.33	32.14	34.33	30.85	0.22	30.35	31.45

Dry Needling's Effectiveness

After the initial and final questionnaires, there was no change in the patient's feelings about the scar tissue itself resulting from the bone fusion surgery. Both at the beginning and end of therapy, the VAS scale remained at 0. Prior to the dry needling series, the patient had attended the following therapies: upper limb massage, elbow joint manual therapy; acupuncture was performed once on the wrist flexors. Therefore, when the patient attempted the dry needling treatment series, the mobility of the tissues within the scar was normal. The patient reported no stinging, hypersensitisation, hypersensitivity, and itching in the scar area. While the patient did not claim any discomfort from the scar tissue itself during the initial survey, she mentioned nagging general pain in the injured limb. The interview revealed that the patient had been experiencing pain in the entire upper limb after forcing it more and during weather changes since the accident.

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The patient reported pain at 6/7 on the VAS scale. After 6 weeks of scar dry needling therapy, the patient reported the disappearance of the above-described upper limb pain (0 on the VAS scale). Thus, we can assume that the pain was correlated with the disturbance of the scar formed after the surgical procedure, resulting in chronic inflammation of the described limb.

Discussion

The treatment program consisted of six dry needling sessions over six weeks. The needles were spaced along the length of the scar tissue after surgical bone fusion. After the dry needling procedures were completed, pain in the limb has been reduced to 0. A lower temperature was observed in the elbow area after dry needling treatment. This may indicate that inflammation in the area has decreased. Despite the favorable clinical and functional outcomes of radial bone fusion, scars are a common postoperative complication [14,15]. Scar tissue is formed in the natural wound healing process [16,17]. Persistent adhesions are likely related to extracellular matrix protein dysregulation. Cyclically stretching fibroblasts may facilitate tenascin-C gene transcription, affect fibronectin and collagen, and modify integrins that are important for mechanical force patterning [18].

The development of superficial post-traumatic dermal inflammation over the scar triggers an inflammatory cascade of wound healing, and the degraded scar collagen is replaced by new type 3 collagen under the epidermis [19,20]. It is occasionally the case that this process is disrupted by factors such as wound infection, poor blood supply, or insufficient nutrients. Such a situation leads to the formation of adhesions, which at a later stage led to contractures, pain, and even entrapment of the nerve in scar tissue [21]. Treatments such as soft tissue mobilization can selectively align collagen chains and thus increase tissue stability. Although work with the scar area is a tremendously important stage in physiotherapy, it is still often skipped by physiotherapists. The discomfort from the scar is often not at the location of the scar, but projects to further parts of the body, so that patients do not connect it to the scar tissue.

Skin temperature has important clinical implications and may occur as a symptom of chronic inflammation going on in the scar after surgical intervention. Inflammatory conditions change the heat flux pattern, resulting in a temperature difference between the inflammation-altered area and the immediate surroundings [22]. Clinical examination tends to favor oral, armpit, and/or rectal temperature measurements. The temperatures of these parts are usually the same as the internal body temperature. The measurement of other body parts, although often skipped, is also of physiological significance [23]. The temperature on the human body's surface is the result of metabolic processes taking place in the tissues beneath the skin's surface, the blood supply to the tissues, the thermal conductivity of the muscles and adipose tissue, and the heat exchange with the environment through the skin [24,25].

The regional skin temperature is highly dependent on the muscle and adipose tissue thickness, as they have a significant effect on the heat conduction from the tissues located deeper. Normal human skin temperature ranges from 33.5 to 36.9°C (92.3 to 98.4°F), although skin temperature is lower for protruding parts, such as the nose, and higher for muscles and active organs [26]. Skin temperature patterns often provide crucial diagnostic data on pathological conditions. Such information may be relevant in deciding further therapeutic treatments [27]. Skin temperatures of the upper limbs are good indicators for predicting thermal sensation and can be used to estimate thermal comfort in terms of physiological mechanisms [28-33]. The upper limb's neutral temperature is 24.7°C, and the top limit is 28.2°C in SET (standard effective temperature) [34]. In the elbow scar region, our patient's initial temperature was 34.92°C, already indicating ongoing inflammation. Indeed, assessing temperature differences is a method that can be used to detect inflammation and assess its extent in patients after surgical bone fusion [35].

In this study, the thermal imaging method was used to show the temperature difference occurring after 6 weeks of dry needling therapy of the scar. Dry needling is a method that stimulates microcirculation, boosts collagen and elastin formation, and stimulates cytokine release. This therapy influences the chemical, biological, and mechanical properties of the scar [36-39]. However, due to the lack of adequate research on the efficacy of needles for surgical scarring, an evaluation of previous research in this area was undertaken. Our study shows that the temperature in the elbow scar area after therapy sessions using dry needling decreased by 2.42°C. The patient's symptoms improved throughout the treatment sessions and the pain in the upper limb area has been eliminated.

Thermal images generated during dry needling therapy demonstrated the applicability of infrared thermography as a measurement technique in the diagnostic process conducted during scar therapy. An important advantage of the thermal imaging application in the examined case is the possibility of conducting an ongoing evaluation of the applied rehabilitation activities, both in terms of intensity and type of steps taken in the patient's recovery process. Based on the reported case and considering the numerous applications of thermography cited in the literature, the use of this measurement technique in dry needling therapy can be recommended.

Conclusions

Dry needling is an effective and rapid treatment for post-surgical scar tissue adhesions. It can be considered as a safe method, provided that the appropriate procedural requirements and the skills of the physiotherapist are met. However, high-quality randomised controlled trials are needed to validate the effectiveness of this method. Infrared thermography can be used to track the progress of dry needling therapy as a valuable tool to support and complement other classic diagnostic methods.

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