



Case report

Acupuncture for frostbite sequel — A case report

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ABSTRACT

Introduction: The spectrum of cold injuries is very broad, and treatment is often difficult. This case report describes for the first time the successful treatment of frostbite sequel by acupuncture. Dynamic Infrared Thermography was used to monitor the effect of acupuncture.

Case summary: The patient was a 19 years old previously healthy, non-smoking, female patient. She had no previous history of cold injuries, no other injuries or medical problems, and was not taking any medication. During outdoor military training in February 2015 in the harsh North-Norwegian climate, she noticed that she began to lose feeling in her fingers that during the exercise turned into dark discoloration with blisters. She was diagnosed with a second degree frostbite on the fingertips of both hands. There was spontaneous recovery but when followed up at one year after the problem, she still complained of sensory-motor disturbances and hypersensitivity to cold. During the follow-up, she was examined by DIRT and offered off-label treatment with acupuncture. Local acupuncture points were used to enhance adjacent peripheral blood circulation. Acupuncture based on Traditional Chinese Medicine was added to these points according to the patient's symptom of feeling cold in general. Acupuncture treatments were given once a week for 12 weeks. After treatment, the patient reported slightly less cold sensitivity. There was a clinical improvement in the control of micro-vascularization as shown in the thermographic examinations before and after treatment.

Conclusion: Acupuncture therapy might provide a potential novel and promising treatment for frostbite sequelae.

1. Background

The spectrum of cold injuries is very broad, ranging from minimal tissue damage to major necrosis of the distal limbs with subsequent amputations [1,2]. In addition to the acute morbidity, cold injuries are often associated with long-term sequelae [3,4]. These sequelae are less well studied and treatment is often difficult.

Acupuncture has previously been described to influence the local circulatory mechanisms [5,6]. Dynamic Infrared Thermography (DIRT) has been used to document microvascular effects following acupuncture stimulation [7,8]. Acupuncture as treatment for frostbite sequel has not been presented or published before.

2. Case presentation

The patient was a 19 years old previously healthy, non-smoking, female soldier. She had no previous history of cold injuries, no other

injuries or medical problems, and was not taking any medication.

During outdoor military training in February 2015 in the harsh North-Norwegian climate, she experienced numbness in her fingers that during the exercise turned into grey-blue discoloration with blisters (Fig. 1). The thermographic images were taken at time of the injury (=initial thermography), before acupuncture treatment (=pre-acupuncture thermography), and after 12 weeks of acupuncture treatment (=post-acupuncture thermography) The timeline for the case report is displayed in Table 1.

Even though she had problems in the cold, the patient continued the military exercise, however with instructions to avoid “any kind of cold”. The following night she experienced to be “cold in the tent at night, froze a bit, but no more than usual.”

The next day she visited the military ward and was immediately hospitalized and initially treated with Ibuprofen 600 mg × 4. She was diagnosed with a second degree frostbite on the fingertips of both hands. In the medical records, there are described losses of sensation in

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Fig. 1. The patient's hands.

The patient's frostbite as presented in February 2015.

Notice the blisters containing white/clear fluid, indicating a secondary degree frostbite injury to 1st, 3rd – 4th finger on right hand and 3rd – 4th finger on the left hand. The other fingers are hyperemic and injured with a 1st degree frostbite injury.

Table 1

Timeline for the case history.

February 13th 2015	Frostbite-injury during winter military training
March 10th 2015	Initial thermography
January 5th 2016	Pre-acupuncture thermography
April 12th 2016	Post-acupuncture thermography

all the fingers, however it was noticed that there was normal ability of the peripheral capillary filling. No other pathology was noticed during the clinical examination.

In March 2015, she underwent the initial thermography in order to get an objective measurement of her micro-vascularization and her rewarming ability. The thermographic images at that time showed a delayed rewarming pattern in line with the clinical picture of second degree injury to 1st, 3rd- 4th finger on right hand and 3rd- 4th finger on the left hand. The patient was deemed unfit for outdoor military service and had to leave the combat unit.

Eleven months after the injury, in January 2016, she still had complaints with sensory-motor disturbances including hypersensitivity to cold. The clinical situation gives the impression of a secondary Raynaud phenomenon as a long-term sequel for the patient. She was therefore reexamined with a pre-acupuncture thermography that showed improvement compared to the initial thermography.

3. The dynamic infrared thermographic (DIRT) methodology

The thermographic imaging took place under standardized and stable study conditions. Measurements were made in a room with an ambient temperature of $23 \pm 1^\circ\text{C}$. The maximum air movement in the ceiling close to the air ventilation in- and outlets was 2,2–2,5 m/second, while the airflow at hand-height in the sitting position was less than 0,1 m/s as measured by a TA-5 Thermal anemometer (Serial 089251).

The patient was a non-smoker and did not use sniffing tobacco/snus. She was not allowed to drink caffeine-containing liquid less than 2 h before thermography. She was also instructed not to eat or drink any hot or cold food/beverages less than 1 h before, and not to wash her hands in cold water less 30 min before thermographic imaging. In addition, she was asked not to use ointment, disinfection solution or similar products on hands.

The outdoor temperature during the time of the examinations was around $0 \pm 5^\circ\text{C}$. The patient was wearing outdoor winter clothing to avoid cooling due to cold weather, and to stimulate peripheral vasodilation. The patient was acclimatized for a minimum of 30 min to the indoor room temperature before the thermographic examination. Prior to the cold challenge, the patient reported that she felt warm. Additional obtained facial thermographic images showed the nose was vaso-dilated, presumably due to open arterio-venous anastomoses. All the examinations were performed during early afternoon (1400–1700).

During the thermographic procedure, the patient took off her outdoor clothing. With exposed forearms (shirtsleeves rolled up), she was comfortably seated on a standard office stool whose height could be adjusted to suit her positioning. During the time when thermal images were being recorded, the hands were positioned with palms down on a grid made of thin nylon netting strung on a plastic frame. The nylon grid was positioned 7 cm (± 0.5 cm) above a uniformly heated base plate ($40 \pm 2^\circ\text{C}$) that ensured a thermally uniform and stable background for the thermal imaging. The use of this heated plate was not to warm up the patients hands, but rather to give a clear thermal contrast during thermographic imaging.

Following the initial pre-cooling thermographic imaging, the hands were briefly removed from the nylon grid and each placed inside a thin plastic bag that extended approximately to the elbows. The gloved hands were then simultaneously immersed in 20°C water ($\pm 1^\circ$) for 1 min up to the level of the wrists. Directly following the cold challenge, the plastic bags were removed, and the hands were placed, palm down, on the nylon grid and maintained there for 4 min (the spontaneous rewarming period), during which thermal images were continually recorded at 1 s intervals (Fig. 2).

The infrared (IR) cameras used in the data collection was a FLIR ThermoCAM™ T650C with a thermal resolution of < 20 mk NETD [9]. The emissivity was set to 0.98. We used the rainbow palette in this study. The IR camera was calibrated using a blackbody controller unit with accuracy of $\pm 0.2^\circ\text{C}$. [10]. From the stored data, ThermoCAM ResearchIR® version 3.5 (FLIR Systems AB, USA) software was used to capture and prepare the thermal images.

From the stored data, the ThermoCAM ResearchIR software was used to apply a region of interest (ROI-line) defined as a straight line on the dorsal aspect of each finger, defined to origin from the middle of the nailbed, and proximally to the level of the interdigital web. Using average temperature lines on the dorsum of the fingers as ROI is a well-defined, repeatable region of interest [11]. Different studies in thermography use different ROI's and other areas, or gradient along a line, was considered for our study. Although our selection of a linear ROI is unexplored, we have positive experience with this pragmatic approach in our clinical work and previous research. Test images prior to the study had revealed that the average temperature along these profile lines was very similar when compared to the average temperature within a traced ROI of the entire finger [12]. However, the reliability and reproducibility of our selected ROI is not fully researched yet.

Using the average temperature lines on the dorsum of the fingers as

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