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Evaluation of a home treatment program for cold hypersensitivity using a classical conditioning procedure in patients with hand and arm injuries

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ABSTRACT

Study design: Case series.
Introduction: A home treatment program using a classical conditioning procedure to decrease cold hypersensitivity has potential to reduce symptoms.
Purpose: To evaluate a home treatment program for cold hypersensitivity using a classical conditioning procedure in patients who are cold hypersensitive after hand and arm injuries.
Methods: A series of 22 patients followed a classical conditioning procedure consisting of exposing the body to cold outdoor temperatures and immersing the hands in warm water, every other day, for five weeks. The McCabe Cold Sensitivity Severity scale (CSS) was used to measure cold hypersensitivity twice before treatment, at four weeks, and at one year after treatment; Likert scales was used for the patients ratings of improvements. A cold stress test was performed to evaluate rewarming capacity in injured fingers.
Results: From the 20 patients, who returned questionnaires at all assessment points, 9 reported a small and three reported a moderate improvement in cold hypersensitivity after treatment. There was a trend toward improvement in the CSS (median 36; interquartile range −19 to 60) and in the rewarming pattern of fingers that were initially slow to rewarm. The improvements were sustained or increased at one-year follow-up.
Conclusion: These preliminary results suggest that the classical conditioning procedure to treat cold hypersensitivity has potential and should be further explored in a trial with more rigorous design.
Level of evidence: IV.

Introduction

Cold hypersensitivity implies an abnormally low threshold to elicit cold-associated symptoms and signs, including pain, aching, numbness, weakness, stiffness, or a feeling of coldness in the hand from either short-term contact with cold objects or mild cooling of the hand.[1,2] Cold hypersensitivity is common after complex upper-extremity injuries and may negatively affect the performance of and involvement in cold-associated activities.[1–3] There are currently no curative treatments for the condition and compensatory strategies, such as the use of hand wear and heating aids, do not sufficiently reduce the symptoms and difficulties related to cold-associated activities.[2,4] A method based on classical (Pavlovian) conditioning reportedly improved cold hypersensitivity in patients with traumatic hand injuries,[5,6] vibration injuries,[5] and primary Raynaud's phenomenon.[6–11] In this method, patients repeatedly expose themselves to cold environments while warming their hands in water (patients are only lightly dressed). According to classical conditioning, a physiological (e.g., vascular),[12] sensory, or emotional[13,14] response may be elicited or modified by stimuli that do not normally elicit the response (conditional stimulus, CS) if first paired with a biologically relevant stimulus to

Ethical approval: The local Medical Ethical Committee South East, Norway, have approved the study (ref 2009/1821b). All the patients gave their written consent to participate in the study.
Conflict of interest: none.

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generate the reaction (unconditional stimulus, US). The new or modified response to the CS is called the conditional response (CR). In the current treatment program, cold environmental temperatures represent the CS, the water warming the hands is the US, and increased skin temperature and thermal comfort in the hands are CRs.

Three studies examined the effects of such classical conditioning procedures on decreasing cold hypersensitivity in patients with hand injuries. Decreased cold hypersensitivity, increased finger skin temperatures, and/or improved rewarming capacity were reported for most of the patients treated in a cold chamber[5,6] or in cold environments in the patients' homes.[6] The aim of the present study was to evaluate a classical conditioning procedure to treat cold hypersensitivity that was administered by the patients at home.

Methods

Patients

Twenty-four patients were recruited from the hand surgery department. The inclusion criteria were: completed surgery for a hand or upper-extremity injury, a minimum age of 18 years, complaints of cold hypersensitivity, protective sensibility (response to Semmes Weinstein monofilament (SWM) 4.31 or thinner) in the distal phalanx of at least one cold hypersensitive injured finger, motivation for the treatment, and ability to understand spoken and written Norwegian. The exclusion criteria were a history of cold-induced angina or other health problems that would discourage cold exposure.

Study design and procedures

We applied a case series design, which is recommended for exploring novel therapeutic strategies and generating hypotheses,[15,16] but is also considered a low level of evidence (IV) in the evidence hierarchy. The local Medical Ethics Committee approved the study and all participants provided informed consent. The patients completed identical questionnaires for measuring cold hypersensitivity twice to ensure that their conditions were stable: four weeks prior to treatment (at home) and the day before treatment (handed out by the secretary at the hospital). After completing the second questionnaire, each patient was tested for tactile sensibility and underwent a cold stress test. The first author administered the cold stress tests, gave treatment instructions, and phoned the participants about a week after the treatment was initiated. The patients were re-tested at the hospital four weeks and one year after treatment.

Assessment of sensory functions

The primary outcome variable was cold sensitivity, measured by the threshold to elicit bothersome symptoms from cold exposure using the Norwegian translation of the McCabe Cold Sensitivity Severity scale (CSS).[17,18] The total score of this four-item questionnaire varies between 0 and 400, with higher scores indicating more severe cold sensitivity. The Norwegian translation of the CSS was conducted according to the recommended guidelines, and pre-testing in patients with hand injuries indicated good content validity.[19] The Swedish translation has shown good test-retest reproducibility, internal consistency, and face validity.[18] The time to relief of symptoms after termination of the cold exposure was measured with a five-point scale (immediately, <5, 5–10, 10–30, and >30 min). A 0–10-point Numeric Rating Scale (NRS) measured pain intensity during cold exposure. We also asked, "Do you experience any changes in cold sensitivity or cold-induced discomfort compared to before the treatment?" The response options were "worse," "no difference/do not know," "some improvement," "moderate improvement," and "large improvement." The sensibility of the distal phalanges was tested after 30 min of acclimatization at room temperature (21–22 °C) using a five-piece SWM kit, according to standardized procedures.[20]

Assessment of activity and compensatory strategies

Cold exposure at work was registered using the McCabe Potential Work Exposure Scale (PWES), whose score ranges from 0–300.[17] The PWES was translated into Norwegian according to the recommended guidelines.[19] The Swedish translation has shown good test-retest reproducibility in patients with hand injuries.[18] We measured working performance using the four-item work module of the Disabilities of the Arm, Shoulder and Hand questionnaire (DASH work), which yields a total score ranging from 0–100.[21] The patients described one "important" and one "typical" cold-associated activity situation, exemplified by "Going outdoors to get the mail without gloves in 15 °C and rain" and "Skiing wearing thick mittens." The patients scored their discomfort and limitations in the specified activities on the NRS: 0 indicated no discomfort and no limitations/problems and 10 indicated extreme discomfort or inability to perform the activities. At follow-up, the same situations were presented in questionnaires without showing the pre-treatment scores. NRSs were also used to assess cold-associated limitations in general: in "work," "leisure," and "other daily activities," respectively (0 indicated no limitations and 10 indicated extreme limitations).

Assessment of rewarming after cold stress

The first author and an assistant performed the cold stress tests. The patients were instructed to abstain from nicotine, coffee, and tea for 12 h prior to testing. In case of deviations from the instructions at the baseline testing, we asked the patients to repeat the procedures at the re-tests. After 1 h of acclimatization (21–22 °C), the patients entered a 23.5–24.5 °C room and were seated in an armchair. 36-gauge T-type copper-constant thermocouples (Tempcontrol Industrial Electronic Products B.V, Nootdorp, Netherlands) were attached with silk tape to the center of the digital pad on all the fingers of both hands or to scar-free skin 1 cm proximal to any amputations. The patients' hands were covered with thin plastic bags and immersed, up to the ulnar styloid in separate containers, in continuously stirred water at 15 °C for 5 min.[22] After the patients withdrew their hands from the water, the plastic bags were removed and the patients placed their arms on the armrests of the chair, supinated, for 20 min of rewarming. The temperatures of each finger were measured every second during the cold stress and rewarming periods; these data were automatically transferred to a computer using a Fluke Hydra logger, series II, model 2620 A and Trendlink software for Fluke (both IKM Instrutek, Sandefjord, Norway). The water temperature was measured using a Comark C22 digital thermometer (Comark Limited, Norwich, UK), and the room temperature was measured with an ordinary digital thermometer placed on a table 2 m from the testing table.

Treatment

The patients conducted the home treatment program from December to January or January to February (2011–2013). All of the assessments were performed between November and April. At the pre-treatment test, the first author briefly described Pavlov's