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Prevalence of cold sensitivity in patients with hand pathology

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Abstract
Background The purpose of this study was to evaluate the prevalence of cold sensitivity in patients with hand- and wrist-related diagnoses.
Methods We included English-speaking adults who were more than 1 month following hand injury or onset of symptoms. Patients were asked if exposure to cold air or water provoked cold-related symptoms and to rank symptom severity (scale 0–10). Statistical analyses evaluated the relationships between the cold sensitivity and independent variables (age, gender, history of trauma, and time from injury/symptoms).
Results There were 197 patients (mean age 49±16 years): 98 trauma and 99 non-trauma cases. Cold-induced symptoms were reported by 34 %, with 10 % reporting severe symptoms. Exposure to cold air is the most common catalyst; mean severity score was 6.7±2.2. Those with traumatic injuries compared to non-trauma diagnoses reported significantly more cold-induced symptoms (p=.04). Using backward linear regression, the significant predictors of cold symptom severity were trauma (p=.004) and time since onset (p=.003). Including only the trauma patients in the regression model, the significant predictor was time since injury (p=.005).
Conclusions Cold-induced symptoms are reported by more than 30 % of hand-related diagnoses, and exposure to cold air was the most commonly reported trigger. The significant predictors of cold-induced symptoms are traumatic injuries and longer time from injury. This study provides evidence of the common problem of cold sensitivity in patients with hand pathology.
Level of Evidence: Prognostic Level II

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Introduction

Cold sensitivity is defined as a response to cold temperatures that results in pain, numbness, tingling, weakness, and/or color changes. Abnormal cold sensitivity occurs following upper extremity trauma. There is wide variability in the prevalence reported in the literature varying from 38 to 83 % in patients following hand trauma [1, 2, 4–6, 10, 15, 16, 21, 22]. Previous studies have identified increased symptoms of cold sensitivity following vascular, tendon, nerve, and bony injuries, and more severe symptoms have been identified in patients with complex trauma and amputation injuries [2, 4–6, 10, 12, 13, 15, 16, 21, 22]. The studies which have reported the occurrence of cold sensitivity in patients with hand-related pathologies are often limited to single diagnostic groups and/or samples of convenience. Therefore, it is difficult to ascertain the overall prevalence of cold sensitivity in patients with hand-related pathology.

The purpose of this study was to evaluate the prevalence of cold sensitivity in patients with hand- and wrist-related diagnoses. A more accurate assessment of the prevalence and severity of this problem will clarify its role in persistent disability after hand injury and motivate appropriate use of resources to study and manage this unsolved problem.

Material and Methods

This prospective cohort study was approved by our institutional Research Ethics Board. The study included adult patients who were seen at a hand clinic more than 1 month following injury or onset of symptoms. We excluded patients

who were unable to understand the questionnaire or who had an upper motor neuron lesion. All data were collected by one investigator at nine clinic days. At these clinics, all patients were invited to participate in this study when the investigator was present, and the investigator had no knowledge of the patient's diagnosis or cold sensitivity status prior to the data collection. To provide an adequate representation of the patient population, we invited 223 patients to participate in the study. The final sample included 197 patients; one patient declined to participate and 25 patients were less than 1 month following injury.

Each patient was asked if exposure to cold air or cold water or holding cold objects provokes pain, discomfort, or onset of other cold-related symptoms and to rate the severity of those symptoms as none, mild, moderate, or severe. Patients who indicated onset of cold-induced symptoms were then asked to identify the source of exposure related to the cold onset and the symptom severity (scale 0–10). This scale was modified from the previously validated Patient-Specific Functional Scale [14, 17, 19, 26, 27].

Data were summarized with means and standard deviations for the continuous variables and frequencies and medians for the categorical variables. Statistical analyses were used to evaluate the relationships between the cold sensitivity and independent variables. Backward linear regression was used to evaluate the predictors of cold symptom severity. The initial model independent variables were chosen a priori and included age, sex, time since injury or symptom onset, and type of injury (trauma vs. non-trauma). A sample size of 197 patients provided sufficient power (0.80) for this study: one main dependent variable (cold symptom severity) and ten subjects per continuous variable or dichotomous categorical variable. Statistical significance was determined at p value 0.05.

Results

There were 197 patients included in this study: 83 men and 114 women (mean age 49±16 years). There were 98 trauma-related and 99 non-trauma-related cases. Cold-induced symptoms were reported by 34 % of this patient sample and severe symptoms were reported by 10 % (n=20) of patients, and the mean cold symptom severity score was 6.7±2.2. Exposure to cold air was reported as the most common catalyst and second was immersion in cold water. There was no statistical difference in the prevalence of cold-induced symptoms between men and women (p=.3) or between patients who were assessed in the summer season (August) compared to months with cooler overall temperatures (p=.065).

Significantly, more patients with traumatic injuries (40 %) compared to non-trauma diagnoses (27 %) reported cold-induced symptoms (p=.04). In patients who reported cold-induced pain, the mean cold symptom severity scores were higher in traumatic injuries (7.2±1.6) compared to non-trauma diagnoses (3.7±2.1). In the regression analysis (dependent variable cold symptom severity), the initial regression model included the following independent variables: age, sex, time since onset, and type of injury (trauma vs. non-trauma). Using backward linear regression, the significant predictors of cold symptom severity were traumatic injuries (β=.22, p=.001) and time since onset (β=.24, p=.003). Including only the trauma patients in the linear regression, the significant predictor of cold symptom severity was time since injury (β=.28, p=.005).

Discussion

In our study, cold-induced symptoms were reported by more than 30 % of patients with hand-related diagnoses with 10 % reporting severe symptoms. Exposure to cold air was most commonly reported as the trigger of cold-induced symptoms. The significant predictors of cold-induced symptoms were traumatic injuries and longer time from injury. Cold sensitivity represents a large burden of illness that can be persistent and continues to evade effective management.

Our study adds to the literature regarding the prevalence of cold sensitivity in patients with hand and wrist pathologies. Previous studies have reported the prevalence of cold sensitivity in specific diagnoses and injuries. One study evaluated patients receiving workers' compensation and reported a high prevalence (90 %) of cold sensitivity with higher rates in those with traumatic injuries [6]. This study had a 30 % overall response rate, and therefore, it is difficult to derive conclusions regarding the occurrence of these symptoms in the total population. In another study that included patients with neuromas, the authors report 90 % of patients with a high cold intolerance symptom score [25]. An investigation of patients with fingertip injuries reported 85 % of patients had cold sensitivity and 12 % with severe symptoms [30]. In a study of patients with metacarpal fractures, 30 % of patients reported cold sensitivity [23]. A study which evaluated different types of immobilization following digital nerve repair found that 43 % of patients reported cold sensitivity [9]. The reported prevalence varies greatly in different studies and may be related to the patient diagnosis and sample selection. Similar to other studies, we found a higher prevalence of cold-induced symptoms in patients with trauma compared to non-trauma hand pathologies and 10 % of the total patient sample reported severe cold sensitivity.

In our study, exposure to cold air was most commonly reported as a cause of cold-induced symptoms and pain. Because of environmental exposures and cold surroundings, it is difficult to avoid exposure to cold air; however, patients may avoid cold water immersion by substituting warmer water temperatures. Multiple studies of cold sensitivity and

clinical evaluations of vascular disorders in the hand have used cold water immersion as a cold stimulus [8, 11, 24, 28]. In our cold chamber laboratory, we are able to control air temperature and humidity and have initiated an investigation to evaluate the responses with cold air exposure compared to cold water immersion as a cold stimulus. In our pilot data of patients with hand fractures, we found that cold air exposure resulted in different skin temperature responses in the injured digits compared to the uninjured digits and lower skin temperatures in the injured digits. With cold water immersion, there was no difference in skin temperatures between the injured and uninjured digits [18]. Immersion in cold water caused rapid vasoconstriction in all digits in response to cooling of the hand. Our preliminary data support different responses in cold air exposures versus cold water immersion. It appears that cold air exposure may provide a more precise assessment of cold sensitivity following hand trauma. Further investigation is required to verify these findings in a greater sample of patients with hand trauma.

Our study included patients selected from a tertiary hand trauma center and included a small number of patients in some diagnostic sub-groups. Since it was not our goal to look for associations between specific injury patterns and the prevalence of cold sensitivity, this study sample may not be representative of all sub-groups of patients with hand-related pathologies and diagnoses. Patients included in our study were evaluated in August and in months with cooler climates, and we found no statistical difference in the prevalence. However, the analysis may have been underpowered to detect statistical difference. Additional studies in other geographic regions, different climates, varied populations, and specific injury patterns would add to the evidence. In this study, we did find a significant difference in cold symptom severity between diagnostic groups; however, the small samples of patients in the sub-groups limit the conclusions that can be made from these results but indicates the need for future study.

This study provides evidence of the prevalence of cold sensitivity in patients with hand pathology. Cold sensitivity creates a large burden of illness, and it is poorly understood with no effective management [2, 3, 6, 7, 16, 20, 29]. As such, we suggest that cold sensitivity of the hand is underrepresented in the hand literature and that more concerted efforts should be made to understand and manage this problem.

Conflict of Interest Christine B. Novak declares that she has no conflict of interest. Steven J. McCabe declares that he has no conflict of interest.

Statement of Human and Animal Rights All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008(5). This study was approved by our institutional Research Ethics Board.

Statement of Informed Consent Informed consent was obtained from all patients for being in the study.

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