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Nature's wrath—The effect of weather on pain following orthopaedic trauma

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ABSTRACT

Background: Despite frequent complaints by orthopaedic trauma patients, to our knowledge there is no data regarding weather's effect on pain and function following acute and chronic fracture. The aim of our study was to investigate the influence of daily weather conditions on patient reported pain and functional status.

Methods: We retrospectively examined prospectively collected data from 2369 separate outpatient visits of patients recovering from operative management of acute tibial plateau fractures, acute distal radius fractures, and chronic fracture nonunions. Pain and functional status were assessed using a visual analogue scale (VAS) and the DASH and SMFA functional indexes. For each visit date, the mean temperature, difference between mean temperature and expected temperature, dew point, mean humidity, amount of rain, amount of snow, and barometric pressure were recorded. Statistical analysis was run to search for associations between weather data and patient reported pain and function.

Results: Low barometric pressure was associated with increased pain across all patient visits ($p = 0.007$) and for patients at 1-year follow-up only ($p = 0.005$). At 1-year follow-up, high temperature ($p = 0.021$) and high humidity ($p = 0.030$) were also associated with increased pain. No significant association was noted between weather data and patient reported functional status at any follow-up interval.

Conclusions: Patient complaints of weather influencing pain after orthopaedic trauma are valid. While pain in the immediate postoperative period is most likely dominated by incisional and soft tissue injuries, as time progresses barometric pressure, temperature, and humidity impact patient pain levels. Affirming and counseling that pain may vary based on changing weather conditions can help manage patient expectations and improve satisfaction.

Introduction

Since the time of Hippocrates, patients suffering from a variety of ailments have noted a link between weather and pain [1]. In our orthopaedic trauma practice, patients frequently complain that their pain following fracture is exacerbated in times of inclement weather, and it is reported that over 50% of people believe that weather influences their health [1]. However, to our knowledge there is no known data-driven substantiation of these complaints within the field of orthopaedic trauma. In the absence of surgeon validation, patients are often left feeling like their symptoms are abnormal or made-up, which can lead to decreased satisfaction with their fracture treatment as a whole. As hospital ratings and reimbursement are increasingly based on patient feedback surveys, the importance of adequate counseling cannot be overstated.

Outside of the orthopaedic trauma subspecialty, weather conditions have been shown to impact health. Low barometric pressure is known to negatively influence a broad array of medical problems ranging from olfactory function to the incidence of myocardial infarction [2–8]. Temperature changes and warmth have been reported to increase the incidence of renal failure and atrioventricular block [9–11]. Precipitation and humidity have

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been shown to influence the incidence of pediatric headaches, asthma, and sickle cell crises [12–14]. Within the field of orthopaedics, data establishing the effects of weather on pain and mobility has been inconsistent and largely limited to patients with osteoarthritis (OA), rheumatoid arthritis (RA), and systemic lupus erythematosus (SLE) [15–23]. A 2011 review of international articles by de Figueiredo et al. concluded that low barometric pressure was associated with increased pain in osteoarthritis patients [15]. This was supported by separate clinical trials by Brennan et al. and McAlindon et al., who both reported that OA related pain is influenced by changes in barometric pressure and cold temperatures [16,17]. Guedj and Weinberger, in a trial of 62 patients, and Patberg and Rasker, in a review of many small trials of less than 100 patients, both reported that high humidly and low barometric pressure increase pain in RA patients [18,19]. Yang et al. in a larger study of 2802 patients with SLE found that both low barometric pressure and precipitation increase pain [20]. However, the topic remains controversial. Strusberg et al. reported that low barometric pressure correlates with decreased rather than increased pain in 151 RA patients, and both Redelmeir and Tversky and Wilder et al., in studies of 18 and 154 patients respectively, denied that weather has any effect on OA pain whatsoever [21–23].

The purpose of our study was to retrospectively investigate the influence of daily weather conditions on patient reported pain and functional status following operative fracture treatment. Our goal was to clearly define the role of weather conditions following orthoapedic trauma so that patients can be better counseled regarding their expectations and experiences following fractures.

Patients and methods

Study design

We retrospectively examined prospectively collected data from 2369 separate outpatient visits of patients recovering from operative management of acute tibial plateau fractures, acute distal radius fractures, and chronic long-bone fracture nonunions. Pain was recorded on a scale of 0–10 using the Visual Analogue Scale (VAS). The functional status of patients treated for distal radius fractures was recorded on a scale of 0–100 using the Disabilities of Arm, Shoulder, and Hand (DASH) questionnaire. The functional status of patients treated for tibial plateau fractures or chronic long-bone fracture nonunions was recorded using the Short Musculoskeletal Functional Assessment (SMFA) questionnaire. All applicable subcategories of the SMFA survey – daily activities, emotional status, mobility, dysfunction, and bothersome – were index analyzed. For each visit date, the mean temperature, difference between mean temperature and expected temperature, dew point, mean humidity, amount of rain, amount of snow, and barometric pressure were recorded. Statistical analysis was run to search for associations between weather data and patient reported pain and function.

Patient data collection

All patient data was obtained from prospectively collected fracture-specific research databases of consecutive patients seen at one of two orthopaedic trauma outpatient offices associated with Level 1 trauma centers (Table 1). Each visit encounter was counted as a separate data-point as weather data was unique for each visit date. There were 850 unique patients in this study. Follow-up intervals ranged from 1 to 60 months, with 85% of recorded patient visits between 1 and 12 months follow-up. Consecutive patients treated for distal radius fractures were prospectively followed from February 2004 until March 2011 (1179 visits). Consecutive patients treated for tibial plateau fractures were prospectively followed from May 2008 until September 2012 (332 visits). Consecutive patients treated for chronic long-bone fracture nonunions were prospectively followed from January 2005 until October 2012 (858 visits). Every patient in each database was used for this study. Patients below 18 years of age at time of treatment were excluded from all databases, and thus consideration in this study. All patients were able to answer study questions. All outcomes surveys were collected orally in office at the time of visit by trained researchers. The selection of the specific validated surveys for each fracture outcome database (VAS, DASH, SMFA) was made prior to the start of this retrospective study. Thus, the authors of this study did <AF>not choose the functional outcomes instruments. Comorbidity data was not uniformly recorded in the databases.

Weather data collection

For each individual patient visit date, we recorded the mean temperature, difference between the mean temperature and expected temperature based on a 17-year average, dew point, mean humidity, amount of rain, amount of snow, and barometric pressure. All weather data was specific to the zip code of the outpatient medical office where patients were seen, and freely obtained from the web-based company “Weather Underground” that compiles weather data from over 42,000 weather stations across the United States (wunderground.com [24]). Actual temperature, expected temperature, dew point, humidity, precipitation, and barometric pressure are all individually recorded by date and zip code by “Weather Underground”. The researcher recording the weather statistics was privy only to the date of patient visit but blinded to the pain and functional scores from each visit.

Details of the weather data are as follows: The mean temperature was calculated as the average temperature over 24 h. The difference in temperature was calculated as the absolute value of the difference (in degrees Fahrenheit) between the mean temperature and the historically expected temperature for each visit day. This was intended to function as a proxy for daily temperatures perceived by patients to be abnormal for the time of year. The mean humidity and dew point were calculated as averages over a 24 h period. Humidity was calculated as relative humidity, which is the ratio of the amount of moisture in the air to the amount that is needed to saturate the air, dependent on temperature. Dew point is an absolute measure of water vapor in the air, and is closely linked to humidity (when dew point = temperature, the humidity is 100%). Barometric pressure was calculated as mean sea level pressure, which corrects for altitude variance between geographic locations. This study was conducted in the New York metropolitan area of the United States, a location with a wide daily variance in barometric pressures. Thus, low barometric pressures were intended to function as a marker for drops in barometric pressure.

Statistical analysis

Statistical analysis was performed by a biomedical statistician to evaluate the relationship between the weather parameters and patient reported pain scores and functional status. Multiple linear regression analyses were performed to identify independent weather factors associated with patient reported pain and function while controlling for all other recorded weather conditions that could be potentially confounding (full cohort n = 2369 visits). Regression analyses were also conducted exclusively on the cohort of patients who had 12 month follow-up after definitive fracture treatment (n = 626 visits). This allowed us to limit the observed effect of post-surgical pain at the initial follow-up visits and control for follow-up time. Univariate analysis of weather variables

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