Weather Intolerance Syndrome – Phenomenon or Myth?

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Introduction

It has long been thought that weather can affect general health and the symptoms of disease. Hippocrates noted an association between rain, wind and chronic disease, and numerous others have made similar observations.[1] In 1887, The American Journal of Medical Sciences documented the case of a man that could predict the comings and goings of storms using phantom limb pain.[14] Weather has been associated with conditions ranging from post-fracture pain to lower back pain. Some patients even claim they can predict the weather.[6,26] Given the long history of interest in this subject, it is surprising that the association is not better understood. Most of what has been published deals with either rheumatic conditions or trauma. Unfortunately, the individual papers do not provide a clear understanding of how weather affects pain from various conditions, or indeed if there is an association at all. The purpose of this paper is to review the literature to gain a better understanding of how pain, especially post fracture pain, is affected by weather.

Definition

In order to determine a relationship with any condition, a strict definition of the condition is required. Unfortunately, a consistent definition for Weather Intolerance Syndrome has yet to be put forth. The etiology and pathophysiology are poorly understood, and the phenomenon is difficult to study in the clinic and the laboratory.[21,30,31] Most of the literature on weather related symptoms have examined effects on either rheumatic conditions or trauma. The trauma researchers have focused on the effects of cold weather while the rheumatic researchers have placed greater emphasis on the effects of the different weather parameters. Trauma researchers have attempted to define syndromes while the rheumatic researchers have preferred the general description of symptoms. The terms 'cold intolerance', 'cold sensitivity', 'trauma induced cold associated symptoms' (TICAS) and 'post-traumatic stress disorder' are examples of terms applied in the context of weather conditions and provoked symptoms. They all relate to the same spectrum of subjective experiences but have been defined differently by different researchers. That said, a number of definitions have been put forth:

"Cold Intolerance" This is defined by Kay as 'an exaggerated or abnormal reaction to cold exposure of the injured part causing discomfort or the avoidance of cold'.[15]

"Intolerance to Cold" has been described as "an icy cold feeling, which can progress to pain, sometimes lasting for several hours after exposure to cold weather."[8]

"Cold Sensitivity" is preferred to "Cold Intolerance" by Craigen.[5] He argues that 'intolerance implies a low threshold to the stimulus beyond which the patient is able to endure, whereas sensitivity implies a heightened awareness of the stimulus in a broad range'.

"Trauma Induced Cold Associated Symptoms", Described by Campbell,[4] this is characterized by the symptoms of pain, stiffness, altered sensibility and color change which can occur in varying combinations or in isolation.

"Post-Traumatic Stress Disorder" Is described by Lithell as 'symptoms that are triggered by exposure to cold and represent any discomfort or problem, and that are perceived by the patient as a sequel to their injury'; whilst admitting that the subjective expression of 'cold intolerance' is too varied for there to be an adequate definition.[18]

In this paper we shall be using the term 'weather intolerance syndrome' as it approaches the subject in a more holistic fashion.

Clinical Impact

Weather intolerance syndrome has been found to be very common in patients with hand problems. Its prevalence following hand injuries has been reported to range from 64-79%.[4,21] Craigen found it in 73% of patients with fingertip injuries and in over 80% following digital amputation with or without reimplantation.[5] Quick found between 34-69% of arthritic patients to be weather sensitive, and Hill reported and an incidence of between 80 and 90% in the same group of patients.[12,26] Weather sensitivity has also been reported in patients with phantom limb pain, scar pain, headaches and gout.[14]

Whether the symptoms decrease or not over the years is still questioned.[8] Many investigators claim that symptoms do decrease but the timing of onset is varied as well as the extent of reduction of symptoms.[21,29,32] Other investigators believe that improvement is dependent upon behavioural modifications.[3,16]

As of yet there is no effective treatment for these patients;

current treatment methods involve pharmacological agents, operations on the autonomic nervous system, biofeedback techniques, classic conditioning, and autogenic training.[3,21]

Weather intolerance syndrome can often be the most bothersome symptom in patients with an otherwise well rehabilitated hand.[5,8] This can lead to a considerable handicap involving a range of symptoms – pain, abnormal sensory perception, joint stiffness and reduced grip strength. This affects a broad range of patients, from those who work outdoors to those that have to work in air-conditioned spaces.[3,8,21]

As of yet there are no methods of objective determination of the overall impairment caused by 'weather intolerance'. So, as of yet, there is no conclusive evidence that the phenomenon is biologically real.[6,26,27,30] The data to date has proven to be very conflicting.

We have a clinical impression that weather affects the symptoms of all patients who have suffered fractures. Patients in our trauma clinic frequently complain of increased symptoms on rainy cold days, and we certainly seem to field more complaints on these days. However, this phenomenon has not been described, and there is no research addressing it. It is possible that everyone just feels worse on rainy days. However, if weather does indeed affect fracture pain, the mechanism may be similar to that suggested for other weather related phenomenon.

Pathophysiology

The pathophysiology of 'weather intolerance syndrome' is a widely debated topic. Several possible mechanisms have been suggested and will be reviewed.

Neurological/Vascular

Engkvist believes that cold induced pain results directly from decreased blood flow.[8] Theoretically cold could increase vascular resistance either directly or through neural mediators. Cold intolerance from denervation could result from hypersensitivity of the vessels themselves or an exaggerated vasoconstrictor reflex evoked from afferent fibres hypersensitive to cold. In both circumstances the increased vasoconstriction would aggravate the patient's symptoms. Moreover, in this view, cold intolerance syndrome has many of the same features as reflex sympathetic dystrophy.

Nancarrow believes that there may be some form of dysfunctional reflex but due to a different reason.[21] He postulates that the initial response to injury is vasoconstriction followed by vasodilatation until the repairing process has been completed. In patients that continue to experience pain, he believes that the vasoconstrictive reflex is severe and prolonged and thus contributes to chronic pain.

Atmospheric Pressure

A number of researchers believe atmospheric pressure to be influential in weather intolerance syndrome. Laborde claims pain occurs because diseased tissues retain fluid causing intracellular pressure to become higher than ambient pressure.[17] Strusberg believes that pain results from pressure induced changes in cytokine pathways.[31] Hydrostatic pressure applied to chondrocytes in culture induces expression of high levels of interleukin 6 and tumour necrosis factor-alpha with changes in cell shape.[31] This modification in cytokine pathways involved in painful sensations could affect the feeling of pain.

Changes in barometric pressure and temperature may increase joint stiffness, triggering subtle movements, which may heighten a nociceptive response.[14] These pressure changes may also cause a transient dys-equilibrium in body pressure that may further sensitize nerve endings. However, Quick takes issue with this view suggesting that only air containing compartments can be affected by atmospheric pressure.[26] As joints have no air bubbles there are no compressible compartments, and taking into account meteorological pressure changes are small, no joint components should react.

Biochemical

Patberg who believes that cold weather decreases pain in rheumatoid arthritis patients, suggests a biochemical origin in that, there may be a relationship between a cool environment and an increase in production of cortisol leading to a decrease in the perception of pain.[23] The concept of a biochemical origin has also been suggested by Quick who believes that atmospheric temperature could warm or cool the joints and directly stimulate temperature sensitive pain receptors, but also that temperature has a number of relevant indirect effects.[26] For example an elevation in temperature causes capillaries to become less permeable in normal subjects. But in rheumatoid arthritis patients this effect is reversed and so could subsequently affect the concentration of circulating factors that hamper or assist the activation of pain receptors. Quick also suggests that this effect could also be related to abnormal thermoregulation.[26]

Temperature

Low temperature could indirectly increase pain by increasing synovial fluid viscosity making joints stiffer and more susceptible to pain from mechanoreceptors.[26] Similarly, joints are comprised of tissues of different density. Cold and damp weather may affect the expansion or contraction of these tissues differently causing pain.[14]

Humidity

Quick suggests that while humidity alone should not affect subcutaneous tissue, low humidity might dry the skin and increase the mechanical stiffness of the joint complex. This ultimately enhances the response from mechanoreceptor sensory pain receptors. He also suggests that humidity might influence the transfer of heat in and out of the skin like sunshine, wind and rain would.[26]

Bone Healing

Craigen believes that it is injury to the bone as opposed to the nerve or arterial damage that is the most important factor

in the injury. He acknowledges that there are cases of severe 'cold intolerance' without bone injury and that the problem is not straightforward. However, he suggests a possible relationship between bone healing and a recovery of cold sensitivity.[5]

Psychological

Quick believes researchers have yet not offered any persuasive hypotheses and that weather related joint pain is a psychological, not a physiological phenomenon. He suggests that weather conditions affect the sensation of joint pain via central nervous pathways susceptible to influence by psychological factors.[26] In other words, people feel worse when the weather is bad.[14,26] Another possibility is that bad weather increases psychological stress, which in turn increases the perception of pain.[17] Still another possibility is that weather affects people's pain simply because they expect it to.[6] People want explanations for their pain. The popularity of the belief along with the saliency of the weather and its many components make it a great explanation.[27]

Clinical Studies

Results from clinical studies examining the different studies concerning 'weather intolerance' are varied, with some studies reporting that weather does cause problems and others suggesting there is no association. Most studies have examined either rheumatic patients or trauma patients and it is worth examining these groups separately.

Rheumatic Patients

Several investigators have found no association between weather and symptoms.[6,10,14,27,30] However the evidence to suggest no or minimal association is weak as the studies all have significant flaws. These include insufficient statistical power, lack of controls, lack of physician derived clinical index, observations taken only twice a month, observer bias and not taking into account that macro-environment measurements can differ significantly from micro-environment.

On the other hand numerous researchers have claimed to find significant correlations between weather and symptoms.[7,9,13,17,25,31] However the evidence for significant association is also weak as once again all the studies have significant flaws. These include lack of statistical power, subjects being aware of weather conditions and hence being subject to unconscious bias in reporting pain, not taking into account that macro-environment measurements can differ significantly from micro-environment and twenty-four hour average readings of weather parameters, instead of dynamic records. Many studies did not look at weather variables in combination, only in isolation.

For example Hollander conducted a rigidly controlled study in a climate-controlled laboratory. This prevented the subjects from being aware of the weather conditions, but the sample size consisted of only eight subjects for a short period of time and the study could not take into account psychological stress and the possibility of a weather factor index.[13]

Strusberg conducted a study with a large number of subjects including controls, weather sensitivity was not mentioned to prevent bias, but the study did not take into account the substantial differences in macroclimate and microclimate as all weather variable readings were taken from the local observatory office.[31] In addition temperature readings were an average of readings taken four times a day and so no account was taken for the possible effects of changing weather variables within the day.

With such conflicting results from flawed studies it is not feasible to draw a conclusion. This is not to say a relationship does not exist – simply that one has not consistently been found. We believe a relationship does exist but selective matching and confirmation bias play a significant role. In support of this Redelmeier found 97 college students did correlate weather to pain, but they correlated them to random conditions.[27] Until statistically sound studies, which possess minimal flaws, repeatedly yield similar results, this relationship with rheumatic patients will always be questioned.

Trauma Disorders

The trauma literature does not question the existence of the relationship unlike the rheumatic category but rather attempts to discover the pathophysiology of the relationship. The literature also does not attempt to find if other weather variables, aside from temperature, play a role in the relationship despite patients reporting weather sensitivity. Overall there is very little literature but the studies have been conducted with significantly greater statistical association, particularly the more recent papers.

Injury Type

Several papers have been written to determine the relationship of 'weather intolerance syndrome' with hand injuries but there has been no literature as yet concerning injuries to other parts of the body.

Craigen investigated the relationship between cold sensitivity and injury type in the hand.[5] Craigen reported the likelihood of a relationship with 'weather intolerance' was highest in bone injuries, then arterial injuries, and then nerve injuries. Amputation was not found to have a strong association. Craigen believes bony injury is the characteristic, which influences the severity of 'weather intolerance' and not amputation. Many researchers have not recorded such a pattern but most acknowledge the presence of this disorder after any type of hand injury.[3,4,18,21] Lithell compared the prevalence between those who had digital replantation and those who received other types of treatment for compound digital injuries and found no difference in the prevalence.[18] Santler found significant higher prevalence of 'weather intolerance syndrome' in patients who had surgical treatment of fractures of the condylar process when compared to non-surgical treatment.[28]

Presence of a Fracture

As with 'injury type' all the literature to date has focused

on the hand. A few researchers have found the presence of a fracture to be linked to 'weather intolerance syndrome.'21,22

The literature as a whole favours the existence of such a relationship in all types of hand injuries, but fractures appear to have particular prominence. Amputations and reimplantations exhibit no significant differences, suggesting the initial trauma to be the cause. We believe fractures do play a significant role but at the same time, the presence of a fracture is not required for there to be a strong relationship.

Conclusion

Although the literature confirming a relationship between weather and symptoms in patients with fractures and rheumatic disease is not strong, we believe a relationship does exist. One only has to spend a rainy day in fracture clinic to be convinced of this. The fact that one has not been convincingly found could be due to a multitude of reasons. Two such reasons include an insufficient number of scientifically sound number of studies and an incomplete understanding of weather. Weather consists of a multitude of known parameters and perhaps some unknown parameters. One such parameter might include a weather index, which could well correlate with pain but as yet is simply beyond the scope of current human knowledge.

To try to understand further this possible relationship, more studies have to be conducted in a more scientific manner. This may well prove to be fruitless but at the very least it may eliminate many uncertainties.

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