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Comorbid mild traumatic brain injury increases pain symptoms in patients suffering from an isolated limb fracture

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ABSTRACT

Objectives: This study seeks to evaluate the effects of a mild traumatic brain injury (mTBI) on pain in patients with an isolated limb fracture (ILF) when compared to a matched cohort group with no mTBI (control group).

Patients and methods: All subjects included in this observational study suffered from an ILF. Groups were matched according to the type of injury, sex, age, and time since the accident. Main outcome measurements were: Standardized semi-structured interviews at follow-up of a Level I Trauma Center, and a questionnaire on fracture-related pain symptoms. Factors susceptible to influence the perception of pain, such as age, sex, severity of post-concussive symptoms, and worker compensation were also assessed.

Results: A total of 68 subjects (36 females; 45 years old) with an ILF were selected, 34 with a comorbid mTBI and 34 without (24/34 with an upper limb fracture per group, 71% of total sample). Patients with mTBI and an ILF reported significantly higher pain scores at the time of assessment (mean: 49 days, SD: 34.9), compared to the control group ($p < 0.0001$; mean difference 2.8, 95% confidence interval 1.8–4.0). Correlational analyses show no significant association between the level of pain and factors such as age, sex, severity of post-concussive symptoms, and worker compensation.

Conclusions: Results suggest that mTBI exacerbate perception of pain in the acute phase when occurring with an ILF, and were not explained by age, sex, post-concussive symptoms, or worker compensation. Rather, it appears possible that neurological sequelae induced by mTBI may interfere with the normal recovery of pain following trauma.

Introduction

According to recent estimates, nearly 30 million individuals suffer from orthopaedic trauma in the United States each year [1]. Orthopaedic trauma is defined as an injury to the musculoskeletal system, such as bones, joints, or ligaments [2]. Among them, fracture is the most common type of injury and typically leads to emergency room visits [3]. Acute severe pain is considered a natural response to a bone fracture and is experienced by 70 to 100% of trauma patients [4–6]. According to the International Association for the Study of Pain (IASP), resolution of acute pain typically aligns with tissue and bone healing, which usually happens within three months following the accident [7]. Of note, acute pain is defined as “the normal, predicted physiological response to an adverse chemical, thermal or mechanical stimulus . . . associated with surgery, trauma and acute illness” [8]. Despite being an integral part of recovery, pain is known to negatively affect quality of life and interfere with return to work [5]. For instance, for a fracture as mild as a distal radius fracture, studies show that more than 75% of patients report at least minimal pain and disability associated to this pain more than 6 months after the injury [9]. Despite early treatment, such as surgical procedure and/or pharmacological treatment, a fair portion of this population carries pain symptoms beyond the expected recovery period, therefore becoming both an important personal and financial burden. Furthermore, acute pain is an important marker of pain chronification such that excessive pain levels in the first weeks of injury can predict transition from acute to chronic pain [10–12].

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Interestingly, mild traumatic brain injury (mTBI) is frequent among patients with an isolated limb fracture (ILF) (24%) and is also known to induce pain such as headaches but also widespread body pain [13–16]. For example, a recent study showed that mTBI can induce bodily pain during the chronic phase (more than 6 months post-injury) in more than 64% of patients with an mTBI [17]. Despite that, most studies interested in the relationship between pain and mTBI have looked at the effects of pain on post-mTBI symptoms [18,19]. Indeed, it is shown that pain can induce similar cognitive symptoms as those observed following mTBI [18]. However, to our knowledge, very few studies, if any, have looked at the effects of comorbid mTBI on acute pain in ILF patients other than headaches within three months of the injury. The scarcity of knowledge on acute pain after mTBI is particularly problematic in polytrauma patients in whom pain represents one of the main obstacles preventing them from resuming an active lifestyle. Indeed, it is possible that bodily pain induced by mTBI exacerbates acute pain after an ILF by interfering with functional recovery. Therefore, we hypothesized that patients with an ILF suffering from a comorbid mTBI will report higher levels of fracture-related pain that at the time of the assessment when compared to a matched ILF cohort without a mTBI.

Methods

Case control subjects selection

Subjects were selected from a previous sample, which consisted of 251 subjects with an ILF (58 subjects with an ILF + mTBI and 193 subjects with an ILF only) from a study conducted by our group and seeking to evaluate the incidence rate of mTBI among an ILF population (For more details [13]). To compare both groups, we proceeded by using a one-on-one matching approach based on the following criteria: 1) age (±5 years); 2) sex; 3) type of injury (fractured bone); 4) time elapsed since accident (±30 days). A match was made when two subjects were from the same sex, born less than five years apart and the time elapsed since the accident did not differ by more than 30 days. Finally, subjects were matched if they had suffered from injuries within the same category, namely proximal upper limb fracture (clavicle, scapula, humerus), distal upper limb fracture (elbow, cubitus, radius, wrist, hand), leg fracture (femur, tibia/peronei), and foot/ankle fracture. The matching process focused primarily on pairing subjects within injury categories, in most cases the same fractured bone. This was done in order to limit possible confounding factors known to affect injury severity, thereby facilitating study interpretation. This matching process led to the formation of 34 identical pairs (See participant flowchart in Fig. 1). The remaining subjects who could not be matched according to abovementioned criteria or who were seen at the orthopaedic clinic more than 3 months post-accident (24 with a mTBI and 159 without a mTBI) were excluded from the present study [13]. This study followed the clinical criteria (loss of consciousness, loss of memory for events immediately before or after the accident and alteration of mental state at the time of the accident) for mTBI established by the American Congress of Rehabilitation Medicine (ACRM), to diagnose all 58 patients with a mTBI [13]. Patients received a diagnosis of mTBI if they presented at least three out of the four ACRM criteria. All patients were screened for mTBI through a semi-structured interview following a standardized procedure for mTBI diagnosis. Open-ended questions were used for patients to report detailed information about the accident, which allowed for spontaneous and unbiased description of the accident and possible symptoms. If not mentioned by the patient, the experimenter then validated whether they had experienced any of the following symptoms previously mentioned. All participants included in the study suffered from an ILF and were 18 years or older. The Rivermead Post Concussion Symptoms Questionnaire was administered at follow-up to assess the severity of symptoms typically observed following a traumatic brain injury such as headaches, sleep disturbances, fatigue, and blurred vision [20]. Participants were excluded if they presented any of the following characteristics: a Glasgow Coma Scale (GCS) below 13 at emergency admission, substance-related intoxication, health complications unrelated to mTBI in the period following the injury, and non-extremity fractures (hip, pelvis, ribs, neck, spinal cord, skull). Furthermore, participants with an associated

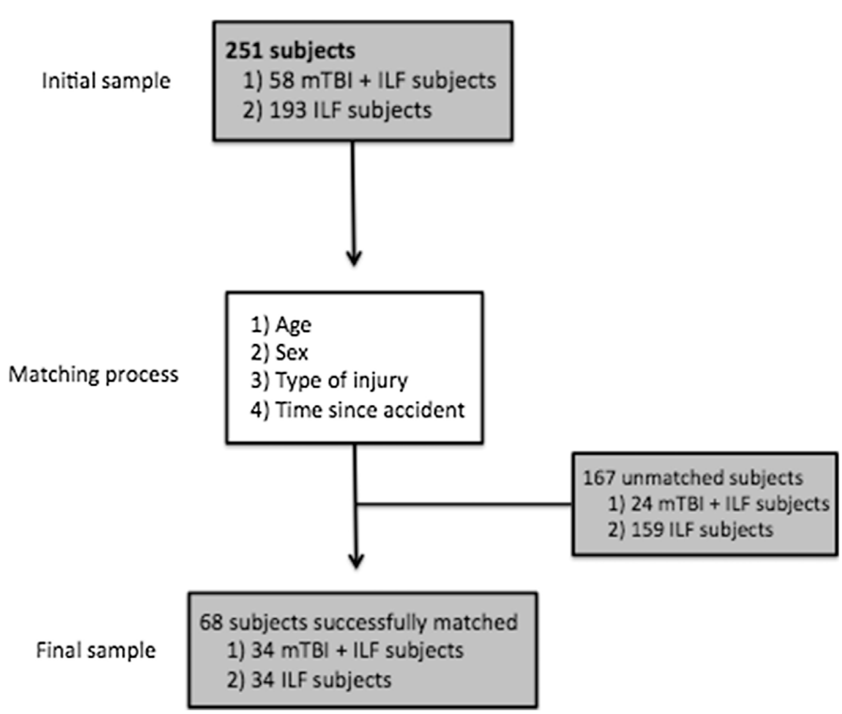

Fig. 1. Participant flowchart.