Prolonged pain and disability are common after rib fractures

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Abstract

BACKGROUND: The contribution of rib fractures to prolonged pain and disability may be underappreciated and undertreated. Clinicians are traditionally taught that the pain and disability of rib fractures resolves in 6 to 8 weeks.

METHODS: This study was a prospective observation of 203 patients with rib fractures at a level 1 trauma center. Chest wall pain was evaluated by the McGill Pain Questionnaire (MPQ) pain rating index (PRI) and present pain intensity (PPI). Prolonged pain was defined as a PRI of 8 or more at 2 months after injury. Prolonged disability was defined as a decrease in 1 or more levels of work or functional status at 2 months after injury. Predictors of prolonged pain and disability were determined by multivariate analysis.

RESULTS: One hundred forty-five male patients and 58 female patients with a mean injury severity score (ISS) of 20 (range, 1 to 59) had a mean of 5.4 rib fractures (range, 1 to 29). Forty-four (22%) patients had bilateral fractures, 15 (7%) had flail chest, and 92 (45%) had associated injury. One hundred eighty-seven patients were followed 2 months or more. One hundred ten (59%) patients had prolonged chest wall pain and 142 (76%) had prolonged disability. Among 111 patients with isolated rib fractures, 67 (64%) had prolonged chest wall pain and 69 (66%) had prolonged disability. MPQ PPI was predictive of prolonged pain (odds ratio [OR], 1.8; 95% confidence interval [CI], 1.4 to 2.5), and prolonged disability (OR, 2.2; 95% CI, 1.5 to 3.4). The presence of significant associated injuries was predictive of prolonged disability (OR, 5.9; 95% CI, 1.4 to 29).

CONCLUSIONS: Prolonged chest wall pain is common, and the contribution of rib fractures to disability is greater than traditionally expected. Further investigation into more effective therapies that prevent prolonged pain and disability after rib fractures is needed.

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Rib fractures are responsible for a substantial portion of injury-related morbidity in the United States.1,2 Patients sustain rib fractures in circumstances that range from ground-level falls to motor vehicle crashes to industrial or work-related incidents, and they experience a spectrum of outcomes, from a temporary need for pain medication to prolonged and significant disability.3-7 As the number of fractured ribs increases, a patient’s risk for undesired outcomes is increased not only because of other serious injuries but also because of the respiratory complications that
are a direct consequence of the pain and impaired capacity to ventilate.1,8,9 Patients with multiple rib fractures or a flail chest may require mechanical ventilation and are at risk for death.

Current inpatient therapy for rib fractures consists of nonoperative measures that control pain and enable the patient to ventilate. Multiple prospective clinical trials have reported the benefits of aggressive in-hospital pain control and respiratory therapy.10,11 Outpatients are counseled to keep their pain under control, to cough and breathe deeply to prevent the development of pneumonia, and to expect their rib fractures to heal and become relatively pain free in 6 to 8 weeks. However, few prospective studies have validated this oft-quoted expectation. With this prospective observational trial of patients with rib fractures we sought to establish evidence-based pain and disability expectations and to determine acute injury characteristics that may be associated with prolonged rib fracture pain and disability.

Methods

All injured patients evaluated in the Oregon Health & Science University (OHSU) emergency department or inpatient units from July 2005 to January 2008 were screened for rib fractures. Patients with rib fractures confirmed by radiologist interpretation of plain films or computed tomographic scan were contacted for enrollment within 14 days of injury. Exclusion criteria included patients 15 years or younger, non–English-speaking patients, patients determined by the investigators as being unlikely to be able to report pain levels or complete the survey instruments at 60 days (eg, patients with severe head injury, dementia, or delirium), and patients not expected to survive 60 days after injury. Patients or their legally authorized representatives provided informed consent for participation. The Oregon Health & Science University Institutional Review Board approved and monitored the conduct of this study.

At study entry, the age, sex, race or ethnicity, preinjury work status (employed, unemployed, retired), preinjury functional status (physical labor, nonphysical labor, disabled), and preinjury level of activity (vigorous, moderately active, ambulatory, sedentary, or requires care) were determined. Pre-existing comorbidities were recorded and the Charlson comorbidity index was calculated.12 Associated injuries and their corresponding organ injury scale (OIS) were recorded and the injury severity score (ISS) was calculated. The number of rib fractures, bilaterality of rib fractures, the chest wall region where the majority of the rib fractures were located (anterior, lateral, posterior), the presence of flail chest, the need for mechanical ventilation, and the use of epidural pain control and lidocaine patches were also recorded. The McGill Pain Questionnaire (MPQ) was administered to patients who were able to communicate within 7 to 14 days after injury. The MPQ is a validated instrument designed to provide quantitative measurements of subjective pain that can be treated statistically. Twenty questions of pain descriptors are asked of the patient from which the pain rating index (PRI) is calculated.13 Values ranging from 0 to 50 are possible. The present pain intensity (PPI) is based on a scale of 0 to 5 and is calculated from a single question of 6 pain descriptors. The types of analgesics received by the patient in the 24 hours before administration of the MPQ were recorded.

At 2 months (±5 days), participants were seen in person or contacted by phone to complete another MPQ. The types of analgesics used in the preceding 24 hours were again recorded. Patients were asked whether they had returned to employment. Level of activity after injury and functional status were also determined.

Prolonged chest wall pain was defined as an MPQ PRI of 8 or greater at 2 months after injury. In our pilot study, rib fracture pain diminished from approximately 6 of 10 on day 1 to 2.5 of 10 at 60 days (42% drop).6 Mean acute fracture pain determined by the MPQ PRI was approximately 20 of 50.14 A corresponding decrease of 40% would bring the expected PRI to 8. Prolonged disability was defined as a decrease in 1 or more levels of work or functional status at 2 months.

The patient demographic, injury, and pain characteristics listed earlier were evaluated with univariate analysis (chi-square or t test) to determine associations with prolonged chest wall pain or disability. Variables with a P value of .2 or less were selected for inclusion in a multivariate analysis to determine independent associations with prolonged pain or disability. Among variables with significant covariance, only 1 variable was chosen to include in the model. Odds ratio (OR) and 95% confidence interval (CI) were calculated and a P value less than .05 was chosen to indicate statistical significance. Subset analysis for patients with isolated rib fractures (no associated injuries with an OIS ≥3) was repeated as described earlier.

Results

One hundred forty-five male patients and 58 female patients with a mean ISS of 20 (range, 1 to 59) had a mean of 5.4 rib fractures (range, 1 to 29). Forty-four (22%) patients had bilateral fractures, 15 (7%) had flail chest, and 92 (45%) had 1 or more associated injuries with an OIS of 2 or more. The region of the chest wall with the most rib fractures was posterior in 50%, lateral in 26%, and anterior in 24% of patients.

Race and ethnicity included white non-Hispanic (191 patients [94%]), Native American (7 patients [3%]), Hispanic (3 patients [1%]), and black non-Hispanic (1 patient [<1%]). One hundred fifty-two participants (75%) were employed, 27 (13%) were unemployed, and 23 (11%) were retired at the time of injury. One hundred four (51%) reported a vigorous activity level, 66 (33%) a moderate activity level, 24 (12%) an ambulatory activity level, and 8 (4%) a sedentary or “requires care” activity level. Functional status reported included physical labor (122 patients...
[60%], nonphysical labor (67 patients [33%]), and disabled (13 patients [6%]). The Charlson comorbidity index was 0 in 79%, 1 in 8%, 2 in 7%, 3 in 3%, and 4 or more in 2% of patients (range, 0 to 7).

One hundred ninety-three (95%) patients were admitted as inpatients and stayed for more than 24 hours. Mean length of stay was 8.3 days (range, 0 to 56). Mean length of stay in the intensive care unit was 3.8 days (range, 0 to 33). Fifty (25%) patients required mechanical ventilation. Epidural analgesia was used in 18 (9%) patients. Lidocaine patches were used in 29 (14%) patients. Chest wall MPQ PPI and MPQ PRI on enrollment (9 ± 2 days after injury) were a median of 3 (range, 0 to 5) and a mean of 28 ± 16 (range, 0 to 70), respectively. Table 1 lists the types of analgesics received by the patient in the 24 hours before enrollment. Twenty-two percent of patients received 2 or more specific opioids (morphine, hydromorphone, hydrocodone, or fentanyl) or received opioids by different routes of administration simultaneously (intravenous, oral, or patch), or both. No patient received paravertebral or intercostal nerve blocks and none had surgical rib fracture fixation. Eighty-six percent of patients were discharged home and 14% were discharged to a skilled nursing facility or other acute care facility. There were 5 deaths, all occurring after discharge. Four patients died of complications relating to their injuries and comorbidities, and 1 patient died from injuries suffered in a subsequent motor vehicle crash.

One hundred eighty-seven (92%) patients were followed for 2 months. Chest wall MPQ PPI and MPQ PRI at 2 months were a median of 1 (range, 0 to 5) and a mean of 10.6 ± 10.9 (range, 0 to 44), respectively. Table 1 lists the types of analgesics taken by the patient in the 24 hours before the 2-month MPQ. Nineteen percent of patients took 2 or more specific opioids orally and 5% of patients were using a fentanyl patch. One hundred ten patients (59%) had prolonged chest wall pain and 142 (76%) had prolonged disability. In univariate analysis, the following acute patient characteristics were associated with prolonged chest wall pain: enrollment MPQ PPI and MPQ PRI, preinjury functional status, ISS, number of rib fractures, bilateral rib fractures, and associated injuries. The following characteristics were associated with prolonged disability: enrollment MPQ PPI, ISS, number of rib fractures, bilateral rib fractures, and associated injuries. In multivariate analysis, enrollment MPQ PPI was independently predictive of prolonged pain (OR, 1.8; 95% CI, 1.4 to 2.5) and prolonged disability (OR, 2.2; 95% CI, 1.5 to 3.4), and the presence of associated injuries was independently predictive of prolonged disability (OR, 5.9; 95% CI, 1.4 to 29).

Among 111 patients with isolated rib fractures, chest wall MPQ PPI and MPQ PRI at enrollment were a median of 3 (range, 0 to 5) and a mean of 31 ± 14 (range 0 to 70), respectively. One hundred four (94%) patients were followed 2 months or longer. Chest wall MPQ PPI and MPQ PRI at 2 months were a median of 1 (range, 0 to 5) and a mean of 11.3 ± 10.9 (range, 0 to 42), respectively. Sixty-seven (64%) patients had prolonged chest wall pain and 69 (66%) had prolonged disability. In multivariate analysis, enrollment MPQ PPI was independently predictive of prolonged chest wall pain (OR, 1.6; 95% CI, 1.1 to 2.3) and enrollment MPQ PPI (OR, 3.2; 95% CI, 1.8 to 6.5) and ISS were independently predictive of prolonged disability (OR, 1.2; 95% CI, 1.1 to 1.4).

**Comments**

Although rib fractures are notoriously painful, the natural history of rib fracture pain and disability has not been well studied. The expectations that most rib fracture pain resolves by 8 weeks and that rib fractures contribute little to long-term disability have never been subjected to prospective scrutiny. These unvalidated expectations have been an obstacle to the development of treatments that might be expected to improve the outcome of patients with rib fractures. With this prospective observation of a large number of patients with rib fractures presenting to the emergency department and inpatient wards of our hospital, we report that significant chest wall pain and overall disability at or beyond 8 weeks after injury is common. This is true for patients with and those without significant associated injuries, indicating that rib fractures themselves
contribute substantially to prolonged pain and disability. The fact that the most predictive indicator of both prolonged pain and disability is the pain intensity within the first several days after injury is intriguing. These results mirror the findings of Katz et al \textsuperscript{15} who found that the severity of acute pain after thoracotomy predicted long-term pain after thoracotomy. Surprisingly, none of the traditional acute injury characteristics, including the number and bilaterality of rib fractures, were independently predictive of prolonged pain or disability.

These results raise some interesting questions. First, are we doing enough to control pain in the acute phase and if not how could we do better? Acute pain from injury is a challenging problem, but fortunately there are several analgesic modalities available and much progress has recently been made in identifying more optimal management. \textsuperscript{10} Traditional injury pain control is heavily reliant on opioid analgesics. Opioids have been extensively studied, and their benefits and detriments are well described. \textsuperscript{16} Opioids primarily act centrally and at the spinal cord level to mute the neurotransmitter response to ascending pain signals. Common adverse effects of opioids include dysphoria, pruritus, nausea, constipation, delirium, immune suppression, and respiratory depression. Also, in an unknown percentage of patients, opioids cause hyperalgesia, a phenomenon in which acute pain intensity increases with opioid use. Additionally, opioid dependence has become an alarming public health problem in the United States. Many researchers and clinicians have thus described dissatisfaction with the emphasis on opioids and recommend that opioids be used only in conjunction with other analgesic modalities. \textsuperscript{10}

Other medications and modalities available in the clinical evaluation phase for acute injury pain control include aceta-minophen, nonsteroidal anti-inflammatory drugs, the anti-convulsants gabapentin and pregabalin, cannabinoids, topical lidocaine patch, acupuncture, transcutaneous nerve stimulation, and dietary soy. \textsuperscript{17–19} Gabapentin, which most likely works through calcium channel blockade, has an opioid-sparing effect in acute postoperative pain management. \textsuperscript{20} The 5\% lidocaine patch (Lidoderm, Endo Pharmaceuticals, Chadds Ford, PA) is associated with a reduction in pain scores in patients with rib fractures within 24 hours of placement and, interestingly, a sustained reduction in pain that outlasts the duration of therapy. \textsuperscript{19} A randomized trial of the lidocaine patch failed to show a benefit, but this study was underpowered and the investigators did not use enough patches per patient. \textsuperscript{21} Each of these nonopioid medications has a modest analgesic effect on rib fracture pain individually, but their more benign safety profile should encourage clinicians to use them adjunctively to reduce opioid use.

Regional pain control such as epidural catheter analgesia has shown benefit in several prospective trials but is frequently not an option for patients with multiple injuries. \textsuperscript{11,22} Contraindications to epidural catheter placement include thoracic vertebral body or spinal cord injury, coagulopathy, significant brain injury, and the presence of infection; there are numerous relative contraindications as well. Even in centers with an emphasis on epidural pain control, a minority of patients with severe rib fractures receive epidural catheters. \textsuperscript{11,22} A recent meta-analysis raises doubts regarding the clinical effectiveness of epidural pain control for rib fractures in general practice. \textsuperscript{23} Interest in local anesthetic pain control with the “caine” family of amides and esters has recently resurfaced. Truitt et al. \textsuperscript{24} have extensively evaluated continuous intercostal nerve blockade with local anesthetic instilled through a catheter placed at the bedside in the extrathoracic paraspinous region directly over the ribs posteriorly. Compared with historical controls, this modality significantly improved pulmonary function and pain control and shortened hospital length of stay. Eighty percent of patients were discharged home with the catheters in place and returned to the clinic for removal. No other pain medications were used in 92\% of patients. “Caine” analgesics work through blockade of the voltage-gated sodium channels within the neuronal cell membrane. \textsuperscript{25} By binding to receptors on damaged nerves, these drugs attenuate abnormal ectopic discharges, and the transmission of the pain signal is interrupted. Furthermore, sprouting of abnormal nerve fibers can occur in damaged nerves, leading to hyperirritability. Lidocaine has been shown to decrease nerve sprouting in injured nerves. \textsuperscript{26} It can thus be theorized that an early emphasis on local anesthetic analgesia in the acute phase of injury may stabilize damaged neurons, encourage neuronal healing, and diminish neuropathic pain.

Second, if rib fracture pain were better controlled in the acute phase would patients experience less prolonged pain and disability? In response to tissue or nerve injury, neurons in the dorsal horn of the spinal cord and in the brain become sensitized. \textsuperscript{27} Sensitized neurons demonstrate decreased activation thresholds, increased receptive field size, and increased spontaneous activity. Inhibitory interneurons that normally regulate the spinal cord response to excitatory input may also be damaged. These changes are demonstrated both peripherally and centrally and may persist in the long term, contributing to chronic pain. Modalities such as local anesthetics that block the noxious signals at their origin may thus diminish sensitization and the risk of long-term pain.

Third, do differences in pain tolerance account for the development of prolonged pain? Evidence for individual predispositions to chronic pain is accumulating. \textsuperscript{28} The diffuse noxious inhibitory control test administered preoperatively to patients undergoing elective thoracotomy was predictive of chronic post-thoracotomy pain and has been touted as a diagnostic approach that may allow individually tailored pain management. \textsuperscript{29} Fourth, does surgical intervention have a role in acute rib fracture pain management? Certainly there is evidence that rib fracture fixation is beneficial in selected patients with flail chest. \textsuperscript{30} It is likewise possible that select patients with multiple displaced rib fractures that would not anatomically qualify for the diagnosis of flail chest would benefit from
References


Discussion

Paul Lin, M.D. (Spokane, WA).

Dr. Fabricant and his colleagues did a very elaborate study evaluating the long-term pain and disability of more than 200 patients with rib fractures. The 2 subsets of patients, those with associated trauma and those with isolated rib fractures, had self-reported disability rates of 76% and 64%, respectively. It would be interesting to know how this broke down in your different demographics: preinjury work status, preinjury functional status, and preinjury activity level. You state that you asked about return to work status, but this was not reported in your results. I also find it interesting that despite a very high rate of self-reported disability, the median present pain intensity (PPI) at 2 months was only 1, which means half the patient had mild or no pain and the majority of the remaining half had only “discomforting pain” as defined by the McGill Pain Questionnaire (MPQ). I understand that you used a...
pain rating index (PRI) greater than 8 to define prolonged pain. I do not have a very good idea of what a PRI of 8 means. A PPI of 1 on a scale of 0 to 5 is easier for me to comprehend.

There seem to be 2 conflicting statements in your manuscript that you could perhaps clarify for me. You state that the number of rib fractures and bilaterality were associated with prolonged disability, but then you go on to say that the number and bilaterality of rib fractures were not independent predictors of prolonged pain and disability.

Your finding that the best predictor of both prolonged pain and disability is the pain intensity within the first several days after injury is indeed intriguing as you state. Does this mean patients who perceive a lot of pain at time of injury will perceive a lot of pain at 2 months, or do you imply that if we do a better job of managing the acute pain, we can reduce the incidence of chronic pain? If the latter is true, we certainly need to do a better job of pain control early on, not just for the pulmonary complications we usually worry about but also to reduce long-term pain and disability.