North Pacific Surgical Association

The contribution of rib fractures to chronic pain and disability

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Abstract

BACKGROUND: The contribution of rib fractures to chronic pain and disability is not well described. METHODS: Two hundred three patients with rib fractures were followed for 6 months. Chronic pain was assessed using the McGill Pain Questionnaire Pain Rating Index and Present Pain Intensity (PPI) scales. Disability was defined as a decrease in work or functional status. RESULTS: The prevalence of chronic pain was 22% and disability was 53%. Acute PPI predicted chronic pain. Associated injuries, bilateral rib fractures, injury severity score, and number of rib fractures were not predictive of chronic pain. No acute injury characteristics were predictive of disability. Among 89 patients with isolated rib fractures, the prevalence of chronic pain was 28% and of disability was 40%. No injury characteristics predicted chronic pain. Bilateral rib fractures and acute PPI predicted disability. CONCLUSION: The contribution of rib fractures to chronic pain and disability is significant but unpredictable with conventional injury descriptors.

Chronic pain and disability are significant contributors to diminished quality of life following injury. It is estimated that about a third of the population of the United States and Canada suffer from chronic pain. Although cause-specific data are lacking, it is estimated that up to one quarter of the 1 billion disabled individuals worldwide have injury-related disabilities. Economic costs specific to injury-related chronic pain and disability in the United States and Canada are also lacking, but estimates range at least in the tens of billions of dollars per year. Rib fractures are commonly recognized as a significant source of acute pain following injury, but little is known about their specific contribution to chronic pain and disability. Last year we reported that the traditional view that most rib fracture pain resolves within 6 to 8 weeks of injury is incorrect. In this companion report we document the extent of chronic pain and disability in the same cohort of rib fracture patients.

Methods

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

At study entry, the age, sex, race/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/requires care) were determined. Pre-existing comorbidities were recorded and the Charlson Comorbidity Index was calculated.10 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, need for mechanical ventilation, 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 postinjury. The MPQ is a validated instrument designed to provide quantitative measurements of subjective pain that can be treated statistically.11 Twenty questions of pain descriptors are administered to the patient from which the Pain Rating Index (PRI) is calculated. 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.

At 60, 120, and 180 days postinjury (±5 days), subjects were seen in person or contacted by phone to complete another MPQ and the RAND-36 Health Survey. The RAND-36 Health Survey is an extensively validated 36-item questionnaire consisting of 36 questions that evaluates 8 components of health including 4 physical components (physical function, role physical, bodily pain, and general health perception) and 4 mental components (mental health, role emotional, social function, and vitality). Each component is scored on a scale of 0 to 100 where a higher score indicates a more favorable level of health or function. Subjects were asked whether they had returned to employment. Postinjury level of activity and functional status were also determined.

Chronic chest wall pain was defined as an MPQ-PRI ≥ 8 at 180 days postinjury (see our previous report for the rationale of choosing this cutoff level).9 Disability was defined as a decrease in 1 or more levels of work or functional status at 180 days.

Patient demographics, preinjury work and functional status, injury characteristics and initial MPQ-PPI were evaluated with univariate analysis (chi-square test or t test) to determine associations with chronic chest wall pain or disability. Variables with a P value of ≤.2 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 ratios (OR) and 95% confidence intervals (CI) were calculated and a P value of <.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 above.

Results

Two hundred three patients (145 men and 58 women) with a mean ISS of 20 (range 1 to 59) had a mean of 5.4 rib fractures (range 1 to 29). Forty-four patients (22%) had bilateral fractures, 15 (7%) had flail chest, and 92 (45%) had one or more associated injuries with an OIS ≥ 2. 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/ethnicity included White, non-Hispanic (191, 94%), American Indian (7, 3%), Hispanic (3, 1%), and Black, non-Hispanic (1, <1%). One hundred fifty-two subjects (75%) were employed, 27 (13%) were unemployed, and 23 (11%) were retired at the time of injury. One hundred four (51%) subjects reported a vigorous activity level, 66 (33%) a moderate activity level, 24 (12%) an ambulatory activity level, 8 (4%) a sedentary or “requires care” activity level. Functional status reported included physical labor (122, 60%), nonphysical labor (67, 33%), and disabled (13, 6%). The Charlson Comorbidity Index was 0 in 79%, 1 in 8%, 2 in 7%, 3 in 3%, and ≥4 in 2% of patients (range 0 to 7).

One hundred ninety-three (95%) patients were admitted as inpatients >24 hours. Mean length of stay was 8.3 days (range 0 to 56). Mean intensive care unit length of stay 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. No patient received paravertebral or intercostal nerve blocks and none had surgical rib fracture fixation. Chest wall MPQ-PPI and MPQ-PRI on enrollment (9 ± 2 days postinjury) were median 3 (range 0 to 5) and mean 28 ± 16 (range 0 to 70), respectively. Eighty-six percent of patients were discharged to home and 14% were discharged to a skilled nursing facility or other acute care facility. There were 5 deaths all following discharge. Four patients died because of complications relating to their injuries and comorbidities and 1 patient died because of injuries suffered in a subsequent motor vehicle crash.

One hundred sixty-one patients (79%) were followed for 6 months. The prevalence of chronic pain was 22% (35/159
patients) and chronic disability was 53% (86/161 patients). In univariate analysis, only associated injury and acute PPI were associated with chronic pain (P = .03 and .003, respectively). In multivariate analysis, only acute PPI predicted chronic pain (OR = 1.44, 95% CI: 1.01 to 2.07).

In univariate analysis, associated injury, preinjury functional status, bilaterality of fractures, and ISS were associated with chronic disability (P = .0002, .0006, .005, and .0004, respectively). In multivariate analysis, however, no patient or acute injury characteristics were predictive of chronic disability.

Among 89 patients with isolated rib fractures, the prevalence of chronic pain was 28% (25/88 patients) and of chronic disability was 40% (36/89 patients). In univariate analysis, no patient or injury characteristics were associated with chronic pain and in multivariate analysis no characteristics predicted chronic pain. In univariate analysis, preinjury functional status, bilaterality of fractures, and ISS were associated with chronic disability (P = .01, .004, and .02, respectively). In multivariate analysis, bilaterality of fractures (OR = 7.29, 95% CI: 1.14 to 46.39) and acute PPI (OR = 1.83, 95% CI: 1.09 to 3.06) predicted chronic disability.

Table 1 describes the mean RAND-36 Health Survey scores at follow-up all patients and Table 2 describes the mean RAND-36 for isolated rib fracture patients.

### Comments

Although rib fractures are common among injured patients, the long-term natural history of the development of chronic pain and disability associated with rib fractures has not been well studied. In this prospective evaluation of the outcomes of a cohort of patients with rib fractures presenting to the emergency department of a level-1 trauma center, we have shown that approximately a quarter of rib fracture patients have significant chest wall pain 6 months later. In addition, half of all patients and 40% of patients with isolated rib fractures have persistent disability as measured by diminished work or functional capacity. Surprisingly, significant predictors of chronic pain and disability among traditional acute injury characteristics peculiar to rib fractures were difficult to find. For example, the number of rib fractures, chest wall region, and the presence of flail chest were not predictive of chronic pain. Bilaterality of rib fractures was only predictive of chronic disability. The severity of acute pain (within the first 2 weeks) was predictive of chronic pain.

These results mirror the findings of several historical reports and one recent retrospective study. Thirty years ago, Landercasper et al reported the long-term outcomes of a cohort of patients with flail chest. At a mean of 5 years follow-up, only 40% of patients had returned to full-time employment, half complained of chest wall pain, and 38% had experienced a diminishment in their overall level of activity. Similarly, Beal and Oreskovich reported that 64% of patients with flail chest had long-term sequelae including chest wall pain and 22% remained disabled in varying degrees. More recently, Shelat et al retrospectively surveyed a cohort of rib fracture patients similar to ours and likewise found that nearly a quarter of patients had chronic persistent pain 1 year or more following injury. Chronic pain was associated with the regular use of analgesics (26%), work life impairment (35%), and impaired personal quality of life (13%). The presence of chronic pain was not related to age, number of rib fractures, flail chest, hemothorax/pneumothorax, chest tube insertion, and ISS.

Chronic pain is now recognized as a major public health challenge. Chronic pain negatively affects physical functioning, mental health, work productivity, overall quality of life and is associated with a high utilization of health care resources. Estimates of the percentage of the general population afflicted with chronic pain in the United States, Canada, and Europe range from 19% to 37%. Traumatic injury is reported as the primary cause of chronic pain in 12% to 18% of patients. Ponsford et al reported that the presence of chronic pain as well as anxiety, depression, or post-traumatic stress disorder symptoms were the strongest predictors of disability following significant orthopedic trauma. Vles et al reported that 58% of injured patients with an ISS ≥16 had persistent pain at least 1 year following injury. Disability following injury, especially after major trauma, is also common. Dimopoulo et al reported that 47% of survivors of multiple trauma are unable to work 1 year after injury.

Table 1: Mean RAND-36 Health Survey scores at follow-up (all patients)

<table>
<thead>
<tr>
<th>Role physical</th>
<th>Pain</th>
<th>Physical function</th>
<th>General health</th>
<th>Vitality</th>
<th>Social function</th>
<th>Role emotional</th>
<th>Mental health</th>
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<tr>
<td>60</td>
<td>14.8</td>
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<td>48.1</td>
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<td>40.5</td>
<td>56.7</td>
<td>62.3</td>
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<td>120</td>
<td>37.5</td>
<td>59.6</td>
<td>63.6</td>
<td>62.3</td>
<td>50.0</td>
<td>70.6</td>
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</tr>
<tr>
<td>180</td>
<td>48.1</td>
<td>64.7</td>
<td>70.4</td>
<td>64.4</td>
<td>53.1</td>
<td>77.5</td>
<td>74.3</td>
</tr>
</tbody>
</table>

Table 2: Mean RAND-36 Health Survey scores at follow-up (isolated rib fracture patients)

<table>
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<tr>
<th>Role physical</th>
<th>Pain</th>
<th>Physical function</th>
<th>General health</th>
<th>Vitality</th>
<th>Social function</th>
<th>Role emotional</th>
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<tr>
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<td>64.4</td>
<td>55.6</td>
<td>78.9</td>
<td>73.8</td>
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</table>
A continued challenge, then, of developed trauma systems is the identification of means to prevent or at least diminish the development of chronic pain and disability following injury. In this study, we sought to find patient characteristics or acute injury characteristics identifying which rib fracture patients were at greatest risk of chronic problems. Traditional rib fracture descriptive characteristics such as the number of rib fractures and the presence of flail chest were unfortunately not predictive. Whether a descriptive variable associated with rib fractures such as the presence of fracture displacement, distraction, or comminution would be better predictive of a long-term negative outcome cannot be answered by this study. A composite variable with elements of rib fracture numbers as well as degree of severity may also prove useful. The treatment of rib fractures acutely remains an area for improvement, but it will be difficult to develop novel treatments without a better means to predict poor outcome.

Limitations of this study include the heterogeneity of this injured population and the multiple uncontrolled patient and injury characteristics and treatment variables that may confound the development of predictive models. Also, we did not record whether the patient had a pending compensation claim which has been shown to be associated with prolonged recovery of general health following major trauma.\(^{18}\) Insurance status was also not studied. In addition, our study did not extend beyond 6 months and it is expected that many patients with persistent pain and disability at 6 months would improve their outcome while an unknown percentage would stabilize or even deteriorate with the further passage of time.

References


Discussion

Morad Hameed, M.D.: Dr Mayberry’s contributions to our understanding of thoracic trauma span close to 2 decades now. His group’s work has illuminated every aspect of the diagnosis, management, and outcomes of rib fractures. Their research has led the way in efforts to understand a complex and heterogeneous problem, and to identify strategies to reduce its burden. It has been a pleasure to watch this work develop and to be asked to provide commentary on the latest contribution.

This study is a prospective analysis of long-term outcomes in a cohort of 203 patients admitted to an experienced trauma service at a level I trauma center. The prospective design allowed the investigators to evaluate and follow pain and functional outcomes rigorously and in detail. In a thoughtful multivariate analysis, the investigators attempted to define early predictors of adverse long-term outcomes. The study confirmed a high prevalence of pain and chronic disability which persisted over 6 months. Surprisingly, no specific early predictors of these adverse outcomes could be identified as an opportunity for the optimization of early trauma care and rehabilitation. This is an important issue, since our ability to address the staggering burden of chronic pain and disability using targeted early therapies such as NIPPV or rib fracture fixation depends on identifying subsets of patients at risk. My questions focus mainly on how future studies can identify these predictors of outcome.

1. Chest wall trauma is an extremely heterogeneous clinical entity with many characteristics including multiple fractures, displacement, flail chest and thoracic deformity, underlying lung contusion and associated injuries. Considering these features in isolation leads
to the analysis of small numbers within each injury pattern. Did the research group consider using composite predictors in an effort to increase the power of the model to risk stratify patients?

2. Could the study’s pain threshold be too low? If patients with more severe chronic pain were separately analyzed, would it be more likely to identify key determinants of pain?

3. In a univariate analysis, the present pain index appeared to be predictive of chronic pain. This raises the intriguing possibility that better early pain control could lead to lower chronic pain. Is this hypothesis currently being further tested by the group and is it a good topic for further research?

4. Finally, some studies of long-term outcome after trauma have noted in effect of insurance status, with patient on insurance plans often reporting delays in return to work. Did the group look at insurance status as a predictor of self-reported disability?

Dr Mayberry’s work is a much needed stimulus to research on the impact of injury on the huge global burden of disability. As an investigator in a multi center trial on rib fracture fixation, I was delighted to review this paper. I believe it makes an important contribution to our understanding of the long-term effects of thoracic trauma, that will serve to guide our acute care and better understand our long term outcomes.