Level-specific thoracic and lumbar transverse process fractures and concomitant orthopaedic injuries: is there an association?

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ABSTRACT

Background:
Transverse process fractures of the spine frequently are observed in trauma patients. Previous studies have commented on associated orthopaedic injuries in patients with transverse process fractures yet most of the literature has focused on associated abdominal and thoracic injuries.

Methods:
A retrospective chart review of 87 trauma patients who presented to our level II trauma center over a 4-year period and had isolated thoracic or lumbar transverse process fractures were evaluated for nonspinal associated orthopaedic injuries.

Results:
Trauma patients with isolated thoracic or lumbar transverse process fractures had an overall incidence of nonspinal associated orthopaedic injuries of 68.9% in our study. There was no significant difference between thoracic and lumbar level fractures with respect to associated orthopaedic injuries (45% compared with 70%, respectively; $P = 0.099$). Lumbar transverse process fractures were more common overall (87.3%). We did find a significantly higher proportion of pelvic ring injuries in patients with L5 transverse process fractures than thoracic fractures (77% compared with 21.5%, respectively; $P < 0.001$). Trauma patients with L4 transverse process fractures also had a higher incidence of acetabular fractures (24.2% compared with 7.4%, respectively; $P = 0.027$). Study patients with an L3 transverse process fracture had a significantly lower proportion of pelvic ring injuries than at other levels (20% compared with 46%, $P = 0.012$).

Conclusions:
Trauma patients with isolated thoracic or lumbar transverse process fractures have a high incidence of nonspinal associated orthopaedic injuries with a significant association of L4 and L5 transverse process fractures with acetabular and pelvic injuries, respectively. These findings should alert treating trauma services to initiate an appropriate workup for these injuries.

Key Words
transverse process, spine, orthopaedic injuries, fracture, trauma

INTRODUCTION

Thoracic and lumbar transverse process (TP) fractures frequently occur in high-energy trauma. This finding is logical given the significant amount of energy required to create such a fracture. Advances in imaging quality and inclusion of helical CT scans in most North American trauma protocols have led to an increased frequency of TP fracture diagnoses. Lumbar-level TP fractures are most common in trauma patients and have been shown to be a marker for other injuries, such as abdominal and pelvic visceral trauma.[1–5] Previous studies have commented on associated orthopaedic injuries,[1–3,5,6] but most of the literature has focused on associated abdominal and thoracic injuries.

At our institution, spine and orthopaedic trauma call duties often fall to the same physician who is in an ideal position to observe and treat both TP fractures and orthopaedic injuries. Therefore, we set out to review the frequency and significance of nonspinal associated orthopaedic injuries (NSAOIs) in trauma patients with isolated thoracic or lumbar TP fractures. To our knowledge, this is the first study to evaluate level-specific thoracic and lumbar TP fractures and associated orthopaedic injuries. We hypothesized that both thoracic and lumbar TP fractures would be significantly associated with specific orthopaedic injuries.

MATERIALS AND METHODS

Patient records of Level A and B trauma activations from 2010–2013 with a diagnosis of isolated thoracic or lumbar

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TP fracture, or both, were retrospectively reviewed after obtaining institutional review board approval. Records were initially screened using our trauma registry database and diagnosis for both TP fractures and orthopaedic injuries were confirmed by imaging, chart review, or both. Selected patient records were included in the study if they were 18 yr or older, were Level A (highest activation) or B trauma activations and had isolated TP fractures in the thoracic or lumbar spine. Patient charts were excluded if they did not meet inclusion criteria or had other fractures of the spinal column, were pronounced dead on arrival, or had incomplete records. Data collected included age, race, mechanism of injury, level and number of TP fractures, and presence of diagnosis-specific orthopaedic injuries. An injury was considered "orthopaedic" if an experienced orthopaedic surgeon and orthopaedic resident considered the injury within the scope of practice of orthopaedics.

Data analysis was performed with the assistance of a statistician (TB) and results were considered statistically significant at $P < 0.05$. After data were grouped and categorized, chi-square or Fisher exact test was used to determine significance.

RESULTS

All patients in our study had cervical, thoracic, and lumbar CT scans to confirm diagnosis and aid in identifying other spine injuries. All patients had a dedicated CT scan of their spine. The spine CT was either ordered by the trauma or orthopaedic service based on suspicion of a spine injury or if a spine fracture was found incidentally on initial CT of the chest, abdomen, or pelvis (Figure 1). Any patient suspected of having concomitant spinal cord injuries during initial evaluation had MRI available for review. Eighty-nine patients met initial inclusion criteria but two were excluded for incomplete records, giving us a total of 87 patients. Of those, 70.1% were men and 29.9% women, which is representative of high-energy trauma populations. Our average age was 42.2 yr (range 18–86 yr). Isolated lumbar-level fractures constituted the majority of our patients (71), while 11 had isolated thoracic level fractures and five had both thoracic and lumbar fractures. Most patients had fractures at multiple levels (53). L2 was the most frequently fractured level (38), followed by L3 (36) and L4 (34). Mechanisms of injury were typical of a trauma population with most (44.8%) resulting from motor vehicle accidents (Table 1).

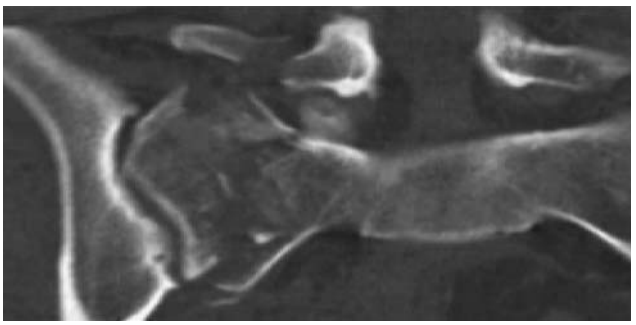

FIGURE 1. Coronal CT of a patient with concomitant L5 transverse process fracture and ipsilateral pelvic fracture.

TABLE 1. Mechanism of injury

Motor vehicle accident	39 (44.8%)
Fall from height	16 (18.3%)
Auto vs. pedestrian	10 (11.4%)
Assault	8 (9.1%)
Motorcycle collision	6 (6.8%)
Off-road vehicle accident	3 (3.4%)
Gunshot wound	3 (3.4%)
Watercraft accident	1 (1.1%)
Pedestrian struck by bicycle	1 (1.1%)

A majority of patients with a TP fracture had an associated orthopaedic injury (68.9%). Pelvic ring injuries were the most common orthopaedic injury observed, occurring in 33.3% of high-energy trauma patients (Table 2). Sacral fractures also were frequently observed; however, they were part of a pelvic ring injury in all but one patient. Femoral and acetabular fractures were also noted at an increased frequency, yet occurring less than half as often as pelvic ring injuries.

Interestingly, neither lumbar nor thoracic level TP fractures alone were found to be significantly associated with orthopaedic injuries as a group. Looking at specific lumbar levels, we found that patients with L5 TP fractures had an increased proportion of pelvic ring injuries (77%, $P < 0.001$). L4 fractures also were a significant marker for fractures of the acetabulum (24.2%, $P = 0.027$). Interestingly, L3 fractures had a significantly lower incidence of pelvic ring injuries compared with other levels ($P = 0.012$). We were unable to find a significant association of thoracic level TP fracture with a specific injury.

TABLE 2. Specific orthopaedic injuries and their frequency

Pelvic ring injuries	29
Sacral fracture (as part of a pelvic ring injury)	27
Femoral fracture	14
Acetabular fracture	12
Ulna fracture	10
Humeral fracture	6
Patellar fracture	4
Distal radial fracture	3
Metatarsal fracture	3
Ankle fracture	3
Proximal tibia fracture	3
Phalangeal fracture (hand)	2
Clavicular fracture	2
Talar fracture	2
Sacral fracture (w/o pelvic ring)	1
Tibial shaft fracture	1
Pilon fracture	1
Tibial plateau fracture	1
Degloving injury	1
Traumatic arthrotomy (knee)	1
Carpal fracture	1
Glenohumeral dislocation	1
Hip dislocation	1
Scapular fracture	1
Metacarpal fracture	1
Midfoot fracture	1
Calcaneal fracture	1
Acromioclavicular separation	1

DISCUSSION

A significant amount of force is required to fracture the TP, which can result from a direct blow or can occur as an avulsion injury secondary to significant muscle contraction. The lumbar TP serves as an origin for both psoas and quadratus lumborum muscles, while the thoracic TP serves as an attachment for multiple muscles and ligaments. While isolated thoracic and lumbar level TP fractures are not associated with neurologic deficits, are not considered unstable injuries, and do not require specialized treatment,[7,8] our investigation has shown an increased frequency of orthopaedic injuries. In fact, we were able to find associations between fracture level and certain injuries.

Thoracic level TP fractures were not shown to be a marker for NSAOIs and only accounted for 12.6% of all fractures, suggesting that these injuries do not occur often and correlations are difficult to find. The lack of association with NSAOIs also may be secondary to the relative distance from parts of the body that are susceptible to orthopaedic injuries, such as an extremity. The force to injure a transverse process must be fairly concentrated in a certain area, suggesting that forces away from the TP are higher or lower but do not have any association with the TP injury. There is also no major anatomical relationship with thoracic TPs and bodily areas of orthopaedic significance.

L2 was the most frequently fractured level followed by L3, both of which are the most commonly affected levels overall. L5 TP fractures were commonly observed with pelvic ring injuries in our series. While the proximity of these two structures is obvious and may partially explain the association, a biomechanical study performed by Pool-Goudzwaard *et al.*[9] showed that sectioning of the iliolumbar ligament increases sagittal plane motion of the sacroiliac joint by 28%.[9]

This study offers an anatomical explanation for the correlation. We are not the first, however, to report this finding. Sturm *et al.*[1] reported a high incidence of pelvic fractures in their series of patients with thoracic and lumbar TP fractures; however, fracture level was not specified.[1] Their data also were based on fractures diagnosed by radiography alone, and some fractures may have been missed. Gilsanz *et al.*[6] also reported an increased frequency of pelvic fractures in high-energy mechanism lumbar TP fractures, but again, fracture level was not reported. Patten *et al.*[2] and Xia *et al.*[3] were some of the first published studies that noted an association between L5 TP fractures and pelvic ring injuries. Our results certainly validate their work. We also found a significant association between L4 TP fractures and fractures of the acetabulum. According to our review, this is the first published evidence of such an association. While we were unable to find a direct anatomical link, the L4 transverse process fracture does appear to be a sentinel marker for acetabular fracture. L3 TP fractures also were found to be negatively associated with pelvic fractures, which also is a novel finding. Future studies will be needed to validate these correlations.

As our patients all sustained high-energy injuries, it is possible that our results are a reflection of the level of violence sustained by trauma patients. While it was not examined in our study, further analysis between mechanism of injury, specific fracture levels and orthopaedic injuries may prove useful. The results of this study do highlight the violent nature of trauma and the multitude of injuries seen in this patient population. As TP fractures require significant force, associated injuries are common. Our results should prompt trauma, spine, and orthopaedic services to be aware of certain orthopaedic injuries seen with TP fractures of the spine. With the increasing utilization of high-quality CT scanning in most trauma centers, isolated TP fracture diagnoses are sure to increase as well. If treating physicians observe an isolated TP fracture, suspicion should be raised to the possibility of pelvic, acetabular, and long bone fractures and the appropriate investigation initiated in a timely manner.

The present study does have limitations. Our sample size was relatively small, which makes it difficult to apply our findings to a large population. Any retrospective study is reliant on accurate record keeping, and initial assessments may prove to be wrong in the future.

In summary, there is a high incidence of associated orthopaedic injuries in high-energy mechanism trauma patients with isolated thoracic or lumbar TP fractures. Specifically, L4 and L5 fractures were seen in higher association with fractures of the acetabulum and pelvic ring injuries, respectively. Any health care provider involved in managing trauma patients should be aware of this association and initiate a timely workup as appropriate.

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