In-Hospital Neurologic Deterioration Following Fractures of the Ankylosed Spine: A Single-Institution Experience

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Key words
- Ankylosing spondylitis
- Diffuse idiopathic hyperostosis
- Spinal cord injury
- Trauma

Abbreviations and Acronyms
AS: Ankylosing spondylitis
ASIA: American Spinal Injury Association
DISH: Diffuse idiopathic skeletal hyperostosis
EDH: Epidural hematoma
IQR: Interquartile range
SCI: Spinal cord injury
SLIC: Subaxial Cervical Spine Injury Classification
TLISS: Thoracolumbar Injury Severity Scale

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OBJECTIVE: **To determine the rate and severity of in-hospital neurologic deterioration following vertebral fractures of spinal hyperostosis.**

METHODS: **A retrospective review of 92 fractures in 81 patients with diffuse idiopathic skeletal hyperostosis (42%) or ankylosing spondylitis (58%) was performed. Data on demographics, comorbidities, and fracture and treatment characteristics were recorded. Neurologic presentation and outcomes were categorized using American Spinal Injury Association grades and the modified Rankin Scale. Univariate and multivariate analyses were used to identify risk factors for neurologic deterioration or poor outcome (modified Rankin Scale 4–6).**

RESULTS: **Most fractures (66%) occurred after falls of standing height or less. Presentation was delayed in 41% of patients (median 7 days), and diagnosis was delayed in 21% (median 8 days). Most fractures were extension (60%) or distraction (78%) injuries involving all 3 spinal columns. Median Subaxial Cervical Spine Injury Classification and Thoracolumbar Injury Severity Scale scores were 6 (interquartile range 5–7) and 7 (interquartile range 6–8), respectively. Of patients, 62% underwent open operative fusion either as initial therapy or after failed conservative treatment, 20% had percutaneous instrumentation, and 27% were treated in an external orthosis (52% required open fusion). Neurologic deterioration after presentation occurred in 7 patients (8.6%); 5 of these patients deteriorated after surgical treatment, constituting a 7.6% surgical risk. The presenting American Spinal Injury Association grade and patient age predicted poor outcome at 1-year outcome ($P < 0.001$). Death occurred in 17 patients within 1 year of injury (23%).**

CONCLUSIONS: **Neurologic deterioration during the initial hospitalization after spinal fractures in the setting of diffuse idiopathic skeletal hyperostosis or ankylosing spondylitis is common, and 1-year mortality is high.**

INTRODUCTION

Ankylosing spondylitis (AS) and diffuse idiopathic skeletal hyperostosis (DISH) are clinically distinct entities, but both ultimately result in spinal ankylosis. The ankylosed spine, whether secondary to AS or DISH, is very susceptible to fracture. The incidence of spine fractures in patients with AS is estimated to be 4 times greater than the general population (20). This greater incidence of spine fractures is largely due to the combination of rigidity and osteoporosis that develops in these patients (58). The ankylosed spine often consists of very long fused segments. Under stress, these segments act as lever arms exerting large forces at points in the spine that are already weakened because of poor bone quality (12, 14, 55). Spinal fractures result, which can be quite severe even after minor trauma (26). Because these fractures often follow minor trauma and occur in patients who typically already have long-standing back pain, the diagnosis is often delayed. To make matters worse, these fractures can be missed on plain films and often require computed tomography for diagnosis (25). This delay in diagnosis can lead to later neurologic deterioration secondary to spinal instability or development of epidural hematoma (EDH).

For these reasons, patients with AS and DISH who sustain spine fractures are at high risk of in-hospital neurologic deterioration. A low index of suspicion because of a seemingly minor mechanism and diagnostic imaging challenges may result in dangerously unstable fractures treated without appropriate precautions on admission. However, the degree of danger has been poorly quantified. To date, most of the literature describing patients with AS and DISH with spine fractures has been limited to case reports and smaller case series (26, 42, 58). A large case series and systematic review were published only more recently (9, 57). Our goal was to review our large series of patients with AS or DISH who presented with a spine fracture to investigate further delays in presentation and diagnosis and the rate and cause of secondary neurologic deterioration.

MATERIALS AND METHODS

This study was performed with the approval of the Mayo Clinic Institutional Review Board (10-006769). We performed a search of our electronic medical record using "ankylosing spondylitis" and "diffuse idiopathic skeletal hyperostosis" or "DISH" as key words to identify patients who presented to the Mayo Clinic between January 1994 and February 2012 with a traumatic vertebral fracture of an ankylosed vertebral segment. All patients either previously carried a diagnosis of or met diagnostic criteria for AS (50) or DISH (39).

Data gathered included demographics, gender, age, delay in presentation or diagnosis, traumatic mechanism, fracture level or mechanism, instability, and comorbidities (associated injuries, cardiopulmonary disease, obesity, diabetes). Clinical presentation and initial radiographic studies were reviewed to calculate the Subaxial Cervical Spine Injury Classification (SLIC) system (48) and Thoracolumbar Injury Severity Scale (TLISS) (49). We recorded the details of initial and any subsequent bracing, casting, or surgical treatment. Functional and neurologic data were recorded at presentation, at death or hospital discharge, and at follow-up (3 and 12 months) and included American Spinal Injury Association (ASIA) class (34), bowel and bladder function, ambulatory status, pain, hospital disposition, and modified Rankin Scale score (5). For patients who underwent surgical fusion and for whom imaging studies were available at 1 year, evidence of radiographic arthrodesis was assessed. We performed a univariate analysis to identify risk factors for poor outcome and for neurologic deterioration between presentation and hospital discharge. Statistical analysis was performed using JMP 9.0.2 (SAS Institute Inc., Cary, North Carolina, USA).

RESULTS

Study Population

Between 1994 and 2012, 81 patients presented to our institution with 92 vertebral fractures involving an area of spinal ankylosis. Fractures occurred in the setting of AS (57.6%, n = 53) and DISH (42.4%, n = 39). Patients were predominantly male (81.5%). Baseline characteristics are provided in Table 1. Patients with fractures associated with DISH were older (P < 0.01) and more frequently had preexisting cardiac disease (P < 0.01), diabetes mellitus (P < 0.005), and other traumatic injuries (P < 0.05) compared with patients with AS (Table 2). Rates of closed head injury, underlying pulmonary disease (generally restrictive), and obesity were similar between the 2 groups. Although 3 patients each presented with 2 distinct spinal fractures and another presented with 3 fractures, for the purposes of the analysis, each fracture was treated as an individual entity. After being successfully treated for a spinal fracture earlier in the study period, 4 patients later presented with a second, unrelated traumatic spinal fracture. Between hospital discharge and 3 months after injury, 10 patients (10.9%) were lost to follow-up, and an additional 8 patients were lost to follow-up before the 1-year mark from injury (19.6%).

Table 1. Baseline Demographics for 92 Fractures in 81 Patients with Spinal Ankylosis

Characteristic	
Male gender	75 (81.5%)
Median age, years (range)	75 (59–82)
Ankylosis syndrome	
DISH	39 (42.4%)
Ankylosing spondylitis	53 (57.6%)
Presentation delay	38 (41.3%)
Median delay, days (IQR)	7 (2–15)
Diagnostic delay	19 (20.7%)
Median delay, days (IQR)	8 (3–23)
Trauma mechanism ($n = 89$)	
Fall of standing height or less, or unknown	56 (65.9%)
Fall of more than standing height	8 (9.4%)
Low-speed MVC	10 (11.8%)
High-speed MVC	11 (12.9%)
Fracture level involved	
Occipitocervical junction	1 (1.1%)
Cervical spine	30 (32.7%)
Cervicothoracic junction	5 (5.4%)
Thoracic spine	45 (48.9%)
Thoracolumbar junction	14 (15.2%)
Lumbosacral spine	20 (21.7%)
Columns involved ($n = 90$)	
Anterior	86 (95.6%)
Middle	84 (93.3%)
Posterior	80 (88.9%)
Injury involving ≥2 columns	84 (93.3%)
Injury involving 3 columns	76 (84.4%)
Fracture mechanism ($n = 89$)	
Axial load	8 (9%)
Flexion	30 (33.7%)
Distraction	69 (77.5%)
Extension	53 (59.6%)
Rotation	3 (3.4%)

DISH, diffuse idiopathic skeletal hyperostosis; IQR, interquartile range; MVC, motor vehicle collision.

Presentation and Diagnosis

Of patient with fractures (ie individual patients since some patients have more than one fracture) (n = 38), >40% presented in a delayed fashion after the index event thought to be the cause of the injury. For patients who presented in a delayed fashion, the median delay was 7 days (interquartile range [IQR] 2–15 days) after the initial injury. Not only was presentation to medical attention delayed, but diagnosis also was delayed in 20% of the patient cohort (n = 19). After coming to medical attention, whether at our institution or elsewhere, the diagnosis was delayed for a median of 8 days (IQR 3–23 days) in these 19 patients.

Trauma Mechanism

Most fractures occurred in the setting of relatively minor trauma. Of patient-fractures, 66% (n = 56) occurred as a result of falls from either a standing height or less or the patient could not identify any recent traumatic injury, which occurred in 2 patients. Patient-fractures occurred after a fall from greater than a standing height in 9% (n = 8). Patient-fractures resulted from motor vehicle collisions in 25% (n = 21); approximately half of collisions occurred at less than highway speeds (n = 10), and half were high-speed accidents (n = 11).

Fracture Characteristics

Fractures in this study were identified throughout the spinal axis, although fractures associated with DISH tended to be more common in the thoracic spine or thoracolumbar junction (87.2%), whereas fractures associated with AS were better