Treatment of Spinal Fractures in Ankylosing Spondylitis

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abstract

Ankylosing spondylitis (AS) is a chronic inflammatory spondyloarthropathy with the potential for progressive spinal stiffness that ultimately makes patients susceptible to spinal fractures with traumatic spinal cord injury from even low-energy trauma. Treatment of patients with AS and spinal fractures (AS+FX) is controversial because, although these patients need especially rigorous stabilization, surgery has been associated with an increased risk of complications and persistent neurological deficits. The purpose of this retrospective case series was to profile patients with AS+FX from a 19-year period within the authors’ county hospital system, including differences of neurological status in patients treated operatively vs nonoperatively.

The study group comprised 11 patients with AS+FX (9 men and 2 women; mean age, 63 years [range, 38-91 years]). The authors reviewed available clinical notes and imaging reports. Six patients had posterior operative fixation, and 5 were stabilized nonoperatively. By the time of either discharge or final follow-up, 3 of the patients treated operatively deteriorated neurologically (2 of them preoperatively) and 3 remained stable. Of the patients treated nonoperatively, 3 remained neurologically intact, 1 deteriorated, and 1 recovered completely. The most common complications in all patients were pneumonia and urinary tract infection. Operative and nonoperative management produced acceptable outcomes in most patients. The authors recommend individualized treatment, accounting for patient preferences and comorbidities.
Ankylosing spondylitis (AS) is a chronic inflammatory spondyloarthropathy with a prevalence ranging between 0.1% and 1.5% in the United States. Ankylosing spondylitis is up to 10 times more prevalent in men than in women. The diagnosis of AS is established by radiographic sacroiliitis and clinical presentation with either inflammatory back pain, reduced lumbar motility, or decreased chest wall expansion. The disease manifests most frequently in the third decade of life, often beginning with enthesopathy in the axial skeleton below the atlantoaxial joint and progressing to ossification of the spinal ligaments, intervertebral disks, endplates, and apophyseal structures. This ossification, together with remodeling of the vertebral bodies, results in a “bamboo spine,” susceptible to the kyphotic “chin-on-chest” position in 45% of patients.

The most common comorbidity in patients with AS is osteoporosis (range, 46%-56%). Decreased bone density and the phenomenon that the fused spine in AS behaves like a long bone when fractured (with a long lever arm about the fracture site) make patients with AS susceptible to spinal displacement, traumatic epidural hematoma, and spinal cord injury. The incidence of fractures in patients with AS is at least 0.4% and has been reported to exceed 10%. Patients with AS have a risk of spinal cord injury that is 11.4 times greater than that of the general population. Fractures most frequently occur from low-impact trauma, such as falling from a standing position onto the ground, which would not cause a spinal fracture in normal individuals. Hyperextension is the most common injury mechanism. Fractures most commonly occur at the C5-C7 vertebrae, most often through an ankylosed intervertebral disk. Neurological deficits from spinal cord injury are more frequent in patients with AS and spinal fractures (AS+FX) than in spinal fracture patients without AS, occurring in up to 92% of patients with AS+FX. At least 3 reasons exist for the high spinal cord injury frequency in this population: fractures are unstable because the ossified ligaments fracture along with the vertebrae, diagnosis of these fractures is frequently delayed, and there is a greater incidence of large epidural hematoma than in individuals without AS.

Treatment of patients with AS+FX is controversial. On one hand, patients with AS+FX may benefit from rigid operative stabilization to prevent secondary displacement and spinal cord injury. On the other hand, surgery is associated with numerous complications because patients with AS tend to be older and have comorbidities. Operative stabilization usually consists of anterior, posterior, or combined anteroposterior fixation, often accompanied by decompression, with the posterior and combined approaches affording the most stability and early patient mobilization. Combined anteroposterior stabilization has also been advocated over posterior stabilization alone due to improved fixation. Nonoperative stabilization consists of external fixation, such as a halo, for 10 to 16 weeks postoperatively until the fracture has healed.

The goal of this retrospective case series was to ascertain a profile for patients with AS+FX, including differences in neurological improvement for those treated operatively vs nonoperatively at Parkland Health and Hospital System, Dallas, Texas, a Level I trauma center.

### Materials and Methods

The Parkland electronic trauma registry was searched for patients with diagnostic codes for both AS and fractures of the vertebral column between 1990 and June 2008. In particular, the International Classification of Diseases, Ninth Revision, (ICD-9) codes 720 (“ankylosing spondylitis”), 805 (“fracture of vertebral column without mention of spinal cord injury”), and 806 (“fracture of vertebral column with spinal cord injury”) were used, and searches were made for patients with codes 720+805 or 720+806; all of the subsets of each of these broad ICD-9 categories were included in the search. These same searches were conducted on billing databases from the same time period to find additional patients. Only patients with AS advanced to the point of spinal fusion who then sustained 1 or more fractures of the vertebral column and were treated within the Parkland system were included in the study.
Review of medical records was conducted with approval of the institutional review board and with all appropriate measures to protect patient privacy. All available clinical notes, imaging studies, and reports of imaging studies of each patient were reviewed. To register neurological status, the authors used the 5-point American Spinal Injury Association (ASIA) impairment scale: A (complete spinal cord injury) through E (intact). The ASIA grade was ascertained from each patient’s clinical notes, all of which recorded motor and sensory examinations and some of which also recorded ASIA scores, which were consistent with the corresponding examinations. Patients underwent standard (anteroposterior and lateral) cervical, thoracic, and lumbar radiography; computed tomography (CT) of the spine; and magnetic resonance imaging (MRI) of the spine. The cervicothoracic junction was assessed by CT, and MRI helped assess for epidural hematoma and spinal cord injury. Spinal fractures and spinal fusion due to advanced AS were documented in radiologists’ notes of 1 or more of the imaging studies (radiography, CT, or MRI) during the initial hospitalization. Not all imaging modalities were obtained for each patient, and not all imaging studies or their corresponding interpretation transcripts were available for review. Some of the imaging studies from early in the study period were film-based and were no longer available for review. The senior author (M.J.B.) independently reviewed the available imaging. Table 1 describes which imaging studies were obtained for each patient and whether their images or interpretation transcripts were available for review.

Fracture healing at final follow-up was documented in the radiologists’ notes of the plain radiographs obtained at that time. Radiographic criteria for assessing fracture fusion were absence of implant loosening, crossing bony trabeculation, and blurring or obliteration of the fracture line. Clinical criteria were resolution of reported pain and no tenderness to palpation. The patients were treated by various attending and resident physicians at Parkland (M.J.B.), without reference to a standardized management protocol.

### RESULTS

From the records of more than 2.8 million patients, only 11 patients (9 men and 2 women; mean age, 63 years [range, 38-91 years]) fit the inclusion criteria. The prevalence of patients with AS+FX in the Parkland system was 0.0004%. In the same Parkland population, 225 patients had AS (prevalence, 0.008%), 5241 patients had vertebral fractures without AS or spinal cord injury (prevalence, 0.002%), and 802 patients with or without AS had vertebral fractures and spinal cord injury (prevalence, 0.03%). The prevalence of vertebral fractures in the AS population was 5%.

Radiologists’ notes documenting spinal fracture and pathologic spinal fusion due to AS on 1 or more radiographs, CT scans, and MRI scans were available for all patients. Radiographic studies by at least 1 of these modalities were available for 5 patients, and the senior author’s interpretation of the available studies independently confirmed the radiologists’ interpretations. The anatomic location of the fractures and the mechanisms of in-

<table>
<thead>
<tr>
<th>Patient No./Age at Injury, y</th>
<th>Fracture Site</th>
<th>Neurological Status, ASIA Grade</th>
<th>Treatment</th>
<th>Time From Admission to Initial Surgery, d</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Admission</td>
<td>Discharge</td>
<td>Final Follow-up</td>
</tr>
<tr>
<td>1/70</td>
<td>T9-T10</td>
<td>E</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>2/56</td>
<td>C2</td>
<td>E</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>3/47</td>
<td>C6 (F-S)</td>
<td>E</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>4/75</td>
<td>T9-T10</td>
<td>E</td>
<td>D</td>
<td>NA</td>
</tr>
<tr>
<td>5/69</td>
<td>L1 (F-D)</td>
<td>E</td>
<td>C</td>
<td>NA</td>
</tr>
<tr>
<td>6/38</td>
<td>C1 (F-S)</td>
<td>E</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>7/77</td>
<td>C6-C7 (F-S)</td>
<td>E</td>
<td>A</td>
<td>NA</td>
</tr>
<tr>
<td>8/47</td>
<td>C5-C6</td>
<td>D</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>9/91</td>
<td>C6-C7</td>
<td>D</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>10/54</td>
<td>C6-C7 (F-S)</td>
<td>D</td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td>11/72</td>
<td>T10-T11 (F-S)</td>
<td>A</td>
<td>A</td>
<td>NA</td>
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</table>

Abbreviations: AF, anterior surgical spinal fixation; ASIA, American Spinal Injury Association; CC, cervical collar; DK, diskectomy; F-D, fracture dislocation; F-S, fracture-subluxation; HT, halo traction; LM, laminectomy; NA, not available; OS, osteotomy; PF, posterior surgical spinal fixation.
successes. The predominant injury mechanism was a motor vehicle collision.

Table 2 summarizes the patients’ neurological status. Eight (82%) patients presented to the hospital on the day of injury. Patient 5 presented 2 days after his motor vehicle collision, during which time his neurological status had remained intact. Patient 4 rested in bed with lower back pain for 1 month after his fall before presenting to Parkland. Patient 6 sought evaluation of a neck deformity and pain present since he had felt a snap in his neck immediately prior to induction during an elective intubation for a nonorthopedic operation 2 years prior to presentation. It was discovered that he had a closed C1 fracture with nonunion and subluxation for which he had not previously sought treatment. However, since the initial injury, his pain level had been stable and his neurological status normal.

Eight (82%) patients sustained a spinal cord injury: 4 at the time of injury and 4 during their hospital stay. Seven patients were neurologically intact on admission, 4 of whom deteriorated neurologically throughout their hospital stay. Three of these 4 (patients 4, 5, and 6) were operatively stabilized, and surgery was planned for the fourth patient (patient 7). None of the 3 patients treated operatively improved neurologically postoperatively. Patient 4 was initially stabilized nonoperatively, developed neurological deficits a few days later, and then immediately underwent surgery. Operative fixation was planned as the initial management for patient 5 but was delayed due to respiratory failure from acute respiratory distress syndrome. He was kept on bed rest, experienced neurological deficit when sitting up in bed, and ultimately underwent operative fixation when pulmonary function had sufficiently recovered. Patient 6 initially underwent traction in a halo for correction of his cervical deformity and then underwent spinal surgery 22 days after admission, but he deteriorated from ASIA-E to -A 2 months postoperatively. This was thought to be due to spinal stenosis visualized at the base of his occiput and attributed to his initial surgery. He did not improve after subsequent surgical interventions. Patient 7 initially used a cervical collar until he was placed in halo traction at 30° of flexion—his prefracture kyphotic posture. The authors were unable to find explicitly stated reasons for initial nonoperative management, but he had numerous complications during his hospitalization that could have made him a poor surgical candidate, including respiratory failure and cardiac arrest. He deteriorated neurologically to ASIA-A due to increasing retrolisthesis, despite attempts to correct the alignment by adjusting the traction. Posterior cervical stabilization was planned, but he requested transfer to another hospital before the surgery could be performed.

Two of the remaining 3 spinal cord injury patients who were neurologically intact at admission (patients 2 and 3) were treated with halo traction on bed rest, a halo vest, and a cervical collar. Nonoperative treatment was chosen for patients 2 and 3 for unspecified reasons; these patients had no prohibitive medical complications or comorbidities and no subluxation or dislocation. The third patient (patient 1) was treated with bed rest because surgery was deemed inappropriate given her comorbidity of stage IIIC ovarian carcinoma resistant to prior debulking surgery and chemotherapy. All 3 were neurologically intact at final follow-up.

Patients 8-11 were neurologically impaired at admission. Patients 8 and 9 underwent surgery as soon as they were medically stabilized. It was unclear why patient 10 was not operatively stabilized. The surgery of patient 11 was delayed because of medical comorbidities. Of these 4 patients, only patient 10, an ASIA-D patient who was stabilized in a cervical collar for 3 months, recovered neurologically. The sole patient presenting with ASIA-A neurological impairment sustained a T10-T11 fracture-subluxation with immediate complete paraplegia after a fall. She was operatively stabilized but did not improve neurologically.

Data from follow-up at a mean of 30 weeks (range, 6-57 weeks) were available for 7 patients (Table 2). All 7 had proper spinal alignment and complete fracture union at final follow-up, as assessed clinically and by radiographs. Only 1 patient (patient 10) had any change in neurological status (complete recovery) since discharge.

Overall, 6 patients were operatively stabilized, all using posterior fixation; 4 were managed with an orthosis and 1 was treated with bed rest. No mortality was found. No operatively treated patient improved neurologically either by discharge or by final follow-up, and 1 patient deteriorated neurologically. Of the patients stabilized only by traction or orthosis, 2 remained intact, 1 (not including patient 4) deteriorated, and 1 completely recovered neurologically. The patient treated with bed rest remained intact.

### Table 3

<table>
<thead>
<tr>
<th>Mechanism of Injury</th>
<th>No. of Patients</th>
</tr>
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<tbody>
<tr>
<td>Motor vehicle collision</td>
<td>5</td>
</tr>
<tr>
<td>Fall from ground level</td>
<td>3</td>
</tr>
<tr>
<td>Aggravated assault</td>
<td>1</td>
</tr>
<tr>
<td>Coughing while in bed</td>
<td>1</td>
</tr>
<tr>
<td>Neck hyperextension during intubation at previous hospitalization</td>
<td>1</td>
</tr>
</tbody>
</table>
All patients treated operatively had nonneurological complications, whereas only 1 nonoperatively treated patient (patient 7) experienced nonneurological complications (Table 4).

**DISCUSSION**

In the study population, AS was exceedingly rare (0.008%), far below the incidence reported in the literature (0.1%-1.5%).\(^1,2\) The incidence of vertebral fractures among patients with AS (5%) is within the reported range of 0.4% to 12%\(^7,8\). The low AS incidence at Parkland may be explained by the fact the hospital services a large indigent population, so AS may be underdiagnosed. Some individuals may not seek medical attention unless their symptoms become debilitating. Even in symptomatic patients, delayed diagnoses have been reported and are attributed to the difficulty of imaging fractures in patients with AS and to the wide differential diagnosis for moderate back pain.\(^15\)

In the current series, mean patient age at the time of fracture was 63 years, which is toward the upper end of the range reported in other series (range, 50-67 years).\(^10,14\) The male:female ratio in the current series was approximately 5:1, corresponding with those reported in other studies.\(^9,17\)

The C5-C7 area is frequently reported to be the most common fracture site, and this was true in the current study.\(^12,14\) However, although many other studies report low-energy falls (from standing) to be the predominant injury mechanism, motor vehicle collision was the most frequent injury mechanism in the current series, followed by falls.\(^8,9,12\) Eight (82%) of the 11 patients in the current series sustained a spinal cord injury. In 3 other series of 11,\(^7\), 12,\(^8\) and 13\(^10\) patients with AS+FX, respectively, the rates of neurological injuries were 90%, 92%, and 62%, respectively; and another large series of 59 patients reported a rate of 47%.\(^13\)

In the current study, the operatively treated group fared no better than the nonoperatively treated group; 1 patient deteriorated after treatment in each group, 1 patient treated nonoperatively improved, and all other patients remained at the same ASIA level after treatment. Of those with follow-up, fractures healed regardless of treatment modality. However, this study was a retrospective case series of a small sample in which patient characteristics were not uniform. Patients were not managed by a specific team of physicians, and a specific management protocol was not adhered to by the various physicians over the 2-decade time period. The latter statement should be emphasized despite the fact that orthopedic and neurosurgical surgeons at the authors’ institution, including the senior author, tend to manage patients with AS+FX operatively. Medical complications and patient preferences were the most common explicitly stated reasons for nonoperative management or delay in operative management in this series. Individual surgeons’ philosophical tendency toward nonoperative management may have applied to the cases where the management rationale was unclear from the chart review.

In a series by Detwiler et al\(^10\) of 11 patients with AS+FX who were similar in age to the patients in the current study, 8 patients underwent posterior fixation, with 6 improving neurologically. However, the main injury mechanisms in Detwiler et al’s\(^10\) patients were fall from standing and “mild” motor vehicle collision (5 patients each), raising the possibility that their surgically treated patients were not as severely injured as those in the current study and, thus, may have been more likely to improve independent of treatment. However, in a series of 13 patients by Weinstein et al,\(^8\) eight of 13 patients remained neurologically stable for at least 2 years after nonoperative treatment, whereas 4 of 5 patients treated operatively experienced neurological complications. However, Weinstein et al\(^8\) reported a 29% mortality rate in 13 patients with AS+FX, suggesting that their patients treated operatively were more severely incapacitated than those treated operatively in the current study. Furthermore, 3 of the current study’s patients treated nonoperatively were intact at initial presentation and remained intact, whereas no such patients existed in the operative group. These 3 patients may have had less structural damage and, thus, may have been more likely to remain intact. However, like the current study, the studies by Detwiler et al\(^10\) and Weinstein et al\(^8\) had small sample sizes and considerable patient heterogeneity.

The fact that all of the current patients with AS+FX treated operatively but only 1 of the patients treated nonoperatively sustained nonneurological complications
cannot support a preference for nonoperative treatment because urinary tract infection and pneumonia are well-known complications of hospitalization for any disease. Pulmonary complications are a major cause of morbidity and mortality in hospitalized patients with AS+FX, likely due to the stiff thoracic cage resulting from rib ankylosis.\textsuperscript{5,8,10,14} The authors recommend that early mobilization and a reduced hospital stay be a priority in treating patients with AS+FX.

In the literature, operative treatment has generally been recommended in cases of unstable fractures or posture, progressive neurological deficits, severe pain, incomplete spinal cord injury that is failing to improve, or other contraindications to nonoperative modalities of spinal stabilization.\textsuperscript{5,14} The abovementioned limitations preclude sufficient evidence from the current study to favor operative treatment. Treatment decisions for patients with AS+FX should be individualized, but in light of the histories of patients 4, 5, and 7, the authors recommend that delay be minimized in initial fracture stabilization and definite treatment of patients with AS+FX. Based on the experiences of patients 4, 5, and 7, it is conceivable that the approach of operatively treating even patients with fractures appearing to be more stable and without spinal cord injury may reduce the incidence of new neurological deficits after admission. However, few rigorous studies support such an approach, and reported success varies.

**CONCLUSION**

The heterogeneity among patients with AS+FX requires that treatment decisions be individualized. Although this series had a small number of patients, the study covered nearly 2 decades of patients with AS+FX from a Level I trauma center serving the Dallas-Fort Worth metroplex. This study’s qualitative description of these patients is appropriate, especially in light of the rarity of such patients. Despite its small size, this series reinforces the need to diagnose and evaluate spinal fractures in patients with AS as early as possible.

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**REFERENCES**


