Management of cervical spine injuries in patients with ankylosing spondylitis

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Eleven patients with ankylosing spondylitis and traumatic fracture/dislocation of the spine were identified in a retrospective review of all cases of cervical spine injury treated on the neurosurgical service over a 10-year period. Injury was most often secondary to minor trauma or a motor-vehicle accident, and the level of vertebral involvement was most frequently between C-5 and T-1. Neurological symptoms at presentation ranged from neck pain alone to complete loss of function distal to the level of injury. Initial routine treatment consisted of axial traction for realignment with the minimal weight needed to accomplish this, taking into account the flexion deformity. All patients underwent pluridirectional tomography and/or computerized tomography to delineate the exact sites of injury. Three patients died shortly after admission due to pulmonary complications. The remaining eight patients underwent early posterior stabilization and mobilization in a halo or cervicothoracic brace to achieve fusion. Neurological improvement was achieved in six of these eight cases. The experience described here supports the initiation of axial traction as initial therapy for cervical injuries followed by early surgical stabilization in patients with ankylosing spondylitis. The difficulty of maintaining spinal alignment and the devastating pulmonary problems attendant on conservative management may be obviated by early fusion.

KEY WORDS • ankylosing spondylitis • spinal cord injury • cervical spine injury

ANKYLOSING spondylitis, the term officially adopted in 1963 by rheumatologists in the United States for the disease first described in 1897 by Strümpell and in 1898 by Marie, may result in severe reduction of spinal mobility. The incidence of spinal injury in these patients is relatively low, but when it does occur it is primarily localized to the cervical spine. The rigidly fused “bamboo spine” or “poker spine,” when fractured, behaves somewhat like a long bone, and is subsequently extremely unstable with an associated high risk of neurological deterioration. In the subgroup of spinal-trauma patients with ankylosing spondylitis, the morbidity and mortality rates are disproportionately higher than those with routine cervical spine injuries.

The current study reviews those patients with ankylosing spondylitis treated for traumatic cervical spine injury at our institution in an effort to identify a safe and efficient way to manage these complex cases. The initial treatment, radiographic investigation, medical/surgical management, complications, morbidity, and mortality are discussed.

Summary of Cases

Clinical Material

Eleven patients (two women and nine men) were admitted to the University of Iowa Hospitals and Clinics between April, 1977, and April, 1987, with combined traumatic cervical spine injury and ankylosing spondylitis. The mean age was 67 years (range 38 to 81 years). Each patient had a moderate to severe preexisting flexion deformity of the cervical spine.

The demographic data, preinjury level of function, etiology of the spinal trauma, and mechanism of injury are summarized in Table 1. Three patients required a walker for ambulation prior to their injury; this was necessitated by severe ankylosis of the hips. The trauma in each case was of low intensity. Six patients sustained trauma from falls, one with a major fall approximately 6 feet off a ladder and the remainder with only minor falls while either walking or standing. In none of these falls was there an associated loss of consciousness or significant injury. The remaining five patients were all involved in motor-vehicle accidents; the spinal fracture/
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**TABLE 1**

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs)</th>
<th>Preinjury Level of Activity</th>
<th>Type of Accident</th>
<th>Sex</th>
<th>Type of Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>70, M</td>
<td>ambulatory with walker</td>
<td>fell walking</td>
<td>flexion</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>73, M</td>
<td>ambulatory with walker</td>
<td>fell standing</td>
<td>extension</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>80, M</td>
<td>normal</td>
<td>fell standing</td>
<td>extension</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>73, F</td>
<td>ambulatory with walker,</td>
<td>fell walking</td>
<td>extension</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>paresthesia of hands</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>66, M</td>
<td>normal</td>
<td>MVA</td>
<td>extension</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>81, M</td>
<td>normal</td>
<td>fell 6 ft</td>
<td>extension</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>38, M</td>
<td>normal</td>
<td>MVA</td>
<td>extension</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>55, F</td>
<td>normal</td>
<td>fell walking</td>
<td>extension</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>71, M</td>
<td>normal</td>
<td>MVA</td>
<td>extension</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>71, M</td>
<td>normal</td>
<td>MVA</td>
<td>flexion</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>57, M</td>
<td>normal</td>
<td>MVA</td>
<td>flexion</td>
<td></td>
</tr>
</tbody>
</table>

* MVA = motor-vehicle accident.

Dislocation was the only major trauma they suffered, except for mild head injuries in two. In each case none of the other passengers involved in the accident was injured.

Radiographic studies and/or intraoperative findings revealed several types of structural abnormalities (Table 2). Fracture and/or dislocation occurred at the C1–2 interspace in one patient, the C4–5 interspace in two, the C5–6 interspace in two, the C6–7 interspace in two, and at the C7–T1 level in four patients. All but two injuries were anterior subluxations secondary to hyperextension. Cases 1 and 11 had posterior dislocations secondary to flexion injuries. Multiple levels of involvement were seen in two cases.

**Neurological Deficit**

At admission, the severity of the neurological deficit was rated according to the classification of Frankel, *et al.*, where Grade A includes patients with complete motor and sensory loss; Grade B patients have no motor function, but preservation of sensation; Grade C patients have intact but functionally useless motor function; Grade D includes patients with useful motor power; and Grade E patients are without deficit. At admission, one patient (Case 6) was classified as Grade E, only complaining of neck and interscapular pain (Table 3); seven patients were classified as Grade D, one patient (Case 3) as Grade C, and two patients (Cases 7 and 11) as Grade A.

**Treatment**

All patients were initially placed in axial traction for spinal realignment, except for Case 6, who remained in a Philadelphia collar. The traction vector was superior and anterior to keep the neck flexed, which is normal for these patients (Fig. 1). In nearly all cases, satisfactory reduction was achieved with less than 10 lb of weight. Following realignment all patients underwent either pluridirectional tomography or myelography with or without computerized tomography (CT) to further identify the pathology.

Seven of the 11 patients underwent posterior fusion for permanent stabilization between 1 and 10 days after admission. Another had fusion 4 weeks postinjury after stabilization of his medical problems. In four of these eight patients, a concurrent posterior decompression was performed. Postoperatively, patients were initially maintained in axial traction, followed by early mobilization in a halo or cervicothoracic brace.

**Outcome**

Patients who survived their initial treatment and underwent surgical fusion were discharged with either stable or improving neurological findings (Table 3). Two patients (Cases 8 and 9) had resolution of all deficits, and a third patient (Case 4) recovered all motor function but her sensory deficits persisted. Three patients (Cases 2, 5, and 10) remained in Grade D without change in their motor deficits, but each had resolution
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FIG. 1. Schematic illustration of traction apparatus for treatment of patients with cervical spine injuries and ankylosing spondylitis. An effort was made to keep the neck in a flexed position which we considered was the normal position at rest for these patients. Accordingly, weights and tongs were applied so as to keep the force vector in a superior-anterior direction.

FIG. 2. Plain lateral x-ray film of Case 6. This patient with a C7-T1 anterior subluxation (arrow) was without neurological deficit at the time of admission. Acute respiratory insufficiency developed after 24 hours in the hospital and, after unsuccessful intubation, a tracheostomy was performed. The patient died due to anoxic cerebral damage associated with the protracted intubation episode.

of all sensory deficits. Two patients (Cases 7 and 11) had no recovery of sensory or motor function.

Complications

Three patients suffered neurological deterioration while immobilized. Case 1 had successful realignment of a posterior C6-7 subluxation after the neck was placed in a flexed position; however, due to neck pain, the patient refused this position. Realignment with the neck in minimal extension resulted in a complete T-3 myelopathy, followed by pulmonary complications and death. Another patient (Case 3) aspirated while in traction, despite a functioning nasogastric tube, and suffered a respiratory arrest. Following emergency intubation, during which his neck was extended, a complete C-5 myelopathy developed; aspiration pneumonia and death ensued.

One patient (Case 6) with an anterior C7-T1 subluxation (Fig. 2) and a T-6 compression fracture, but without neurological deficit, was placed at flat bed rest while in a Philadelphia collar. The day following admission he acutely developed an incomplete T-2 myelopathy which partially resolved with axial traction. Acute respiratory insufficiency developed, followed by a respiratory arrest. The patient died secondary to anoxic cerebral damage.

Another patient (Case 7) underwent emergency C3-T1 laminectomy for an epidural hematoma along with a C6-T1 fusion with rib and wire. Postoperatively, he developed recurrent pneumonia and was ventilator-dependent for 2 weeks. At discharge his neurological deficit was unchanged. Three months after being placed in the halo brace, the apparatus was removed without our knowledge at an outside rehabilitation unit. The patient returned 1 year postoperatively with new pain in his neck, left arm, and shoulder; his head was resting on his left shoulder. Reoperation revealed nonunion at C7-T1 on the right. The earlier fusion was taken down and a rectangular Luque rod placed with the cervical spine in a neutral position. At discharge the patient’s neurological status was unchanged and he was placed in a halo vest for 3 months. Since removal of the vest, his fusion has remained stable.

Despite early mobilization following surgical fusion, two other patients (Cases 5 and 11) developed postoperative pneumonia, which responded to antibiotic treatment in both cases.

Discussion

The estimated incidence of ankylosing spondylitis in the general population is 1.4%. Since the first reported case of cervical spinal cord injury associated with ankylosing spondylitis in 1933, similar reports have appeared only sporadically. In patients with ankylosing spondylitis the occurrence of traumatic cervical spine injury is 3.5 times greater than the incidence in the normal population. In several large series of cases with spinal cord injuries, the percentage of patients with associated ankylosing spondylitis has varied between 0.3% and 0.5%.

The characteristic pathological lesions in ankylosing spondylitis are vertebral body osteoporosis, ankylosis
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of the apophyseal joints, intervertebral disc calcification, and ligamentous ossification. The vertebral bodies may develop stress fractures as severe osteoporosis weakens the ankylosed spine. The apophyseal joints undergo progressive destructive changes which lead to eventual ossification, joint narrowing, and ankylosis. Calcification of the anulus fibrosis reduces the movement and elasticity of the intervertebral disc, causing this point to be the site of least resistance when the spine is subjected to trauma. In 13 of 20 patients reported by Weinstein, et al., the fracture began in the interspace. Similar localization to the intervertebral disc was also noted in nine of our 11 patients. The ligamentous fragility and multiple fused vertebral segments cause the fractured ankylosis to resemble a long-bone fracture. In the absence of bone and ligament stability, the only means of spinal stabilization left in these patients is the cervical musculature.

The precipitating trauma may be minor in these cases.9,10,12,16,18,19,25,26,35,36 In our patients who fell, the majority of the injuries occurred in falls while either standing or walking, without significant associated injury. In patients involved in motor-vehicle accidents, we were unable to ascertain whether the patients were using any restraining devices. However, it is noteworthy that no other individuals involved in these accidents were injured, reinforcing the relatively minor nature of the events. These patients should be advised to use aids for ambulation, and to avoid alcohol and chiropractic manipulations.8

As with cervical spine fractures in the general population, traumatic fracture/dislocation in the patient with ankylosing spondylitis usually occurs in the lower cervical spine (C-5 to T-1). Hunter and Dubo16 and Kiwerski, et al.,20 found injury in this region in 40 (83.3%) of 48 cases and 26 (78.8%) of 33 cases, respectively. Similarly, eight (73.0%) of our 11 patients suffered injuries to the C5–T1 region. In our subjects, nine (82.0%) suffered a hyperextension injury. Reports by several authors have implicated hyperextension as the most frequent mechanism of injury. When these patients fall forward, their face customarily strikes the ground first, since the head juts forward due to the severe kyphotic thoracic spine. This impact forces the neck into hyperextension fracturing the brittle spine. If the patient were to fall backward, the flexed neck and head are then forced posteriorly by the weight of the head, again causing a hyperextension injury.

In this patient population, a recent increase in neck pain or an acute change in neurological status, even if no trauma has occurred, are indications for full radiographic study of the vertebral column as multiple spinal fractures, while rare, have been reported.14,22 Our Case 6 suffered spinal fractures in both the cervical and thoracic regions, but had no apparent deficit on presentation. Thus, studies should include the full spine, and not be limited to the symptomatic region. These studies should include plain films, tomography, and CT. Magnetic resonance imaging is often not feasible, and in many of these cases cervical myelography continues to be required to image the spinal cord pathology.

Proper initial treatment of the patient with ankylosing spondylitis and acute cervical trauma is crucial to ensure a successful outcome. Ambulance personnel and emergency room staff should be educated that the routinely recommended neutral position, with the head secured to a back board, can be disastrous in these patients.7 Numerous cases have been described where such care has caused the condition of asymptomatic patients or those with only minor neurological abnormalities to worsen.18,24,36 This can be avoided if the diagnosis of ankylosing spondylitis is suspected in every case where patients voluntarily hold their head in a significant degree of flexion.26 A vacuum cushion can be individually fitted to the patient during transport, and will maintain the normal cervical flexion.32

Once confirmation of a fracture/dislocation is made, patients with ankylosing spondylitis are best treated with axial traction. Use of a collar, as in our Case 6, is clearly inadequate, as this patient soon developed an incomplete myelopathy which led to his death. The traction vector must be placed in a superior and anterior direction such that the patient is realigned to his pre-existing kyphosis, and minimal weight should be used. Placing the neck in an extended position may precipitate neurological decline as it did in our Cases 1 and 3. Even with properly positioned axial traction, the possibility of further neurological deterioration exists, as this means of immobilization still allows for rotational movement.21,24

The halo brace alone has been advocated by many as the optimal mode of treatment, but is not without complications.16,19,32,35,38 While the majority of patients placed in a halo brace achieve spinal fusion without difficulty, failures of union or increased neurological deficit while in the halo brace have been described.16,32,35 In our Case 7 the failure of fusion while in a halo brace was certainly related to premature removal of the vest. Furthermore, the disruption of both the anterior and posterior supporting structures that often accompanies the fracture/dislocation may lead to an instability of such degree that halo fixation is not successful. Pressure ulcerations are more prone to develop beneath the halo vest due to the extensive thoracic kyphosis. This complication can usually be alleviated by scrupulous padding or the use of custom-fitted vests.

Controversy exists as to whether patients with a fracture/dislocation should be treated with external immobilization alone or with surgical fusion followed by external immobilization. A neurological deficit which can be related to radiographic evidence of cord or nerve root compression is a clear indication for a decompressive laminectomy and fusion.14,17,35 After reduction of the malalignment by traction, eight of our 11 patients underwent surgical fusion via a posterior approach. Of this operative group, four patients also underwent decompressive laminectomy. In our limited series, surgical stabilization has produced results compatible with
those seen with external immobilization alone. In an attempt to decrease the risk of respiratory complications, patients are mobilized in a halo brace as soon after surgery as medically feasible.

In our series, pneumonia or respiratory insufficiency developed in six (55%) of 11 patients and was either a major contributing factor or the actual cause of death in three. This is similar to the experience of others. The pulmonary system complications commonly seen in spinal cord injuries are compounded in the patient with ankylosing spondylitis as the lungs are frequently fibrotic and the ribs ankylosed, thus fixing the rib cage.

A spinal epidural hematoma was noted in one of our patients (9%). This would seem much higher than the 1% to 2% incidence of this complication reported for traumatic cervical spine injuries in patients with an otherwise normal spine. Farhat, et al., proposed that ankylosing spondylitis affects the cancellous bone in such a way that, when fractured, there is persistent oozing which may predispose to formation of an epidural hematoma.

Three of our patients died before definitive therapy could be instituted. In each of these cases a complication related to the pulmonary system was the initial event which led to their death. Neurological deficits remained after treatment, or at death, in nine (82%) of the 11 patients. These values are similar to those presented by Foo and Rossier; proposed that ankylosing spondylitis affects the cancellous bone in such a way that, when fractured, there is persistent oozing which may predispose to formation of an epidural hematoma.

Eleven patients with ankylosing spondylitis and acute cervical spine injury were treated over a 10-year period. The incidence of cervical spine fractures was higher in these patients than in the general population. The pathological changes of the cervical spine inherent in ankylosing spondylitis predisposed these patients to spinal fracture and dislocation after relatively minor trauma. Injury occurred more frequently in the lower cervical spine. Neurological improvement was the rule following early surgical stabilization and ambulation in a halo brace in those patients who did not have complete lesions. Complications occurred in one-half of our patients, the majority of which were secondary to respiratory difficulties. The mortality rate was high (27%), again secondary to pulmonary complications.

We recommend a treatment plan for this group of patients consisting of initial axial traction (taking into account the patients’ flexion deformity). Under only extreme circumstances should the neck be placed in a neutral or extended position. Following realignment, the patient should have early surgical stabilization via a posterior approach with early mobilization in a halo brace in an attempt to decrease the respiratory difficulties inherent in these patients.

Conclusions

Eleven patients with ankylosing spondylitis and acute cervical spine injury were treated over a 10-year period. The incidence of cervical spine fractures was higher in these patients than in the general population. The pathological changes of the cervical spine inherent in ankylosing spondylitis predisposed these patients to spinal fracture and dislocation after relatively minor trauma. Injury occurred more frequently in the lower cervical spine. Neurological improvement was the rule following early surgical stabilization and ambulation in a halo brace in those patients who did not have complete lesions. Complications occurred in one-half of our patients, the majority of which were secondary to respiratory difficulties. The mortality rate was high (27%), again secondary to pulmonary complications.

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