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John H. Woodring and Steven J. Goldstein

AJNR Am J Neuroradiol 1982, 3 (3) 239-242
http://www.ajnr.org/content/3/3/239

This information is current as of October 5, 2023.
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Fractures of the articular processes occurred in 16 (20.8%) of 77 patients with cervical spine fractures as demonstrated by multidirectional tomography. Plain films demonstrated the fractures in only two patients. Acute cervical radiculopathy occurred in five of the patients with articular process fractures (superior process, two cases; inferior process, three cases). Persistent neck pain occurred in one other patient without radiculopathy. Three patients suffered spinal cord damage at the time of injury, which was not the result of the articular process fracture itself. In the other seven cases, no definite sequelae occurred. However, disruption of the facet joint may predispose to early degenerative joint disease and chronic pain; unilateral or bilateral facet dislocation was present in five patients. In patients with cervical trauma who develop cervical radiculopathy, tomography should be performed to evaluate the articular processes.

Fractures of the articular processes of the cervical spine have received little attention in the literature. In one recent review of cervical spine trauma, they were dismissed as occurring in fewer than 3% of patients with cervical spine fractures [1]. In our experience, the incidence of these fractures is much greater and they may be associated with significant radiculopathy. We review the clinical and radiographic manifestations of articular process fractures and emphasize the value of tomography in the diagnosis of this entity.

Materials and Methods

During a 3 year period, 120 consecutive patients underwent multidirectional tomography for evaluation of cervical spine trauma. These patients either had fractures evident on preliminary plain films or were clinically suspected of having a fracture despite negative plain films.

The plain films and tomograms were retrospectively and independently interpreted by two observers. Agreement between the two observers was excellent. The clinical record of each patient with an articular process fracture was also reviewed with special attention to initial clinical presentation, treatment, and sequela of the injury.

Results

Of the 120 patients who underwent tomography, 43 had no fracture. In 77 patients, one or more fractures were seen on tomography. Of those 77 patients with cervical spine fractures, 16 had articular process fractures and 61 had fractures of other parts of the vertebral bodies. The articular process fractures were best demonstrated by multidirectional tomography. The preliminary plain films were diagnostic of an articular process fracture in only two patients.

Five of the 16 patients with an articular process fracture had an acute cervical radiculopathy at the level of the fracture (fig. 1). One patient had radicular pain only, two patients had upper extremity weakness without pain. The radiculopathies in these patients involved neural distributions corresponding to the level of articular process fracture. The radiculo-
pathy was associated with fracture of a superior articular process in two cases and of an inferior process in three cases. In two of the three patients with radiculopathy, the pain resolved at 6 weeks and 14 months after injury, respectively. The third patient was lost to follow-up 6 months after injury still complaining of radicular pain. In the four patients with upper extremity weakness, the symptoms persisted until the patients were lost to follow-up (average length of follow-up was 9 months; range 6–18 months). Of those 61 patients in our series with fractures of parts of the vertebral bodies other than the articular processes, only four had a radiculopathy accompanying their injury. Therefore, nerve root compression would appear to be about five times more likely in cases of articular process fracture compared with other fractures of the cervical spine.

In one other case without radiculopathy, the patient complained of severe neck pain at the fracture site for 8 months before being lost to follow-up. These six of 16 patients with articular process fractures in our series had clinically significant sequelae of their fracture. In addition, two patients with bilateral facet dislocation were rendered quadriplegic at the time of injury and one patient with hyperextension injury to the cervical cord developed transient Brown-Séquard syndrome. The neurologic deficits in these three patients did not seem directly related to their articular process fracture; no specific sequelae of the articular process fracture itself occurred. In the other seven patients, the articular process fracture was asymptomatic. In 10 patients the cervical spine was considered to be stable; six patients required surgical fusion because of instability.

In the 16 patients with articular process fractures, a total of 18 fractures were identified. Nine of the fractures were limited to either the superior or inferior articular process (figs. 2 and 3). The other nine fractures extensively involved the lateral mass. In five patients, the fractures were associated with unilateral or bilateral facet dislocation. The level of fracture was as follows: C2 in two cases; C3, C4, and C5 in one case each; C6 in 10 cases; and C7 in three cases. In two patients, fractures occurred at two adjacent levels (C5 and C6 in one; C6 and C7 in the other).

Discussion

Fractures of the articular processes of the cervical spine have been reported as occurring in 3%–11% of patients with cervical fractures [1, 2] on the basis of a series of patients evaluated by conventional plain films. In our series, using multidirectional tomography, we found articular process fractures in 16 (20.8%) of 77 patients with cervical fractures. The plain films were diagnostic of articular process fractures in only two patients; therefore, it would seem likely that the high percentage of patients with articular process fractures in our series was due to the improved accuracy afforded by tomography [3, 4]. If plain films alone had been relied upon, 87.5% of these fractures would not have been detected.

Most articular process fractures occurred in the lower cervical spine. Thirteen of 16 fractures occurred at C6 and C7. The other fractures were evenly distributed between C2 and C5. These figures are in accordance with those previously reported [2, 5]. No fractures of the articular processes of C1 [6] were identified in our series. The fractures that occurred between C3 and C7 were best demonstrated by tomography in the lateral projection (figs. 1–4); however, those fractures at the C2 level were best demonstrated in the anteroposterior projection (fig. 5). In two of our patients, articular process fractures occurred at two levels (C5 and C6 in one and C6 and C7 in the other). To our knowledge, the occurrence of articular process fractures at two adjacent levels has not been previously reported.

Fractures of the articular processes may be isolated to the articular process itself or extend to involve the lateral mass of the vertebra as well [7]. In our series, half of the fractures were limited to either the superior or inferior artic-
ular process; in the other half, the fracture also involved the lateral mass.

Acute cervical radiculopathy has been reported as a complication of articular process fracture in 6%-39% of patients [2, 8]. In our series, five patients (31.3%) developed acute cervical radiculopathy associated with fractures of the articular processes (fig. 1). Although radiculopathy has been reported as occurring more often in fractures of the superior articular process [2, 5, 7], radiculopathy may occur from fractures of either the superior or inferior articular processes [2]. This is explained by the close anatomic relation of the superior and inferior articular processes and the nerve root exiting the intervertebral foramen. The superior and inferior articular processes form the lateral margin of the intervertebral foramen. A fracture through the superior process with anterior displacement of the fragment can result in compression of the nerve root as it lies against the superior process [2, 5, 7]. In cases of inferior process fracture with radiculopathy, there is usually no evidence of anterior displacement of the fracture segment since the superior process of the vertebra below prevents anterior displacement of the inferior process fragment [2]. Transient subluxation at the time of injury or associated hematoma may compress the nerve root as it courses near the inferior process in these cases. This occurs in some cases of superior process fracture as well. Although Nieminen [2] reported a lower occurrence of radiculopathy in cases of inferior articular process fracture, it was more common in our series. However, there does appear to be a greater propensity for the radiculopathy to resolve in cases of inferior articular process fracture compared with radiculopathy associated with superior process fractures [2].

It would seem prudent that all patients with cervical spine trauma who develop an acute cervical radiculopathy undergo multidirectional tomography to evaluate the articular processes at the affected level [5]. While many of these patients may be treated nonsurgically [2], surgical removal of bony fragments from the intervertebral foramen may aid in the recovery of neurologic deficits [2, 5]. Most of these patients are believed to have stable injuries; however, associated instability has led to surgical fusion in some [2]. In our series, six patients (37.5%) required surgical fusion because of associated instability.

Fracture of the cervical articular processes has been shown to be a cause of persistent posttraumatic neck pain due to hypertrophic changes in the apophyseal joints and chronic neck pain [7, 9]. Although we were unable to obtain long-term follow-up to determine the incidence of posttraumatic degenerative disease in our patients, we recently evaluated one patient with prior trauma who developed severe degenerative disease of the involved joints (fig. 6).

Articular process fractures are generally accepted as being produced by forced hyperextension [2, 10] of the cervical spine. The association of articular process fractures with bilateral and unilateral facet dislocation in injuries produced by forced flexion and forced flexion-rotation, respectively [11], has received little attention. In a series of 300 patients with acute cervical injuries, Bohlman [8] described four patients with articular process fractures associated with unilateral or bilateral facet dislocation. In our series of 16 patients, five were associated with unilateral or bilateral facet dislocation (fig. 3) suggesting that the coincidence may be frequent.

Three patients in our series had cervical cord injury. Two had bilateral facet dislocation associated with quadriplegia; one patient had a hyperextension injury with transient...
Brown-Séquard syndrome. The spinal cord injuries in these patients were not believed to be the direct result of the articular process fractures.

REFERENCES