Jefferson fracture of the atlas

Report of six cases

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Six cases of Jefferson fracture of the atlas are summarized. None had recognizable neurological signs that resulted from the injury when seen in the hospital. With conservative treatment, pain subsided and the fracture stabilized in a short period in all six patients. None of the patients underwent fusion of the cervical spine.

Key Words • cervical spine injuries • Jefferson fracture • atlas vertebra

From both clinical and radiological points of view, compression fractures of the anterior and posterior arches of the atlas described by Jefferson are unique and interesting injuries of the cervical spine. Unlike most other fractures of the cervical spine, they are not usually associated with neurological deficits and are usually diagnosed easily on simple anteroposterior projections made through the open mouth.

Most Jefferson fractures of the atlas are the result of falls or automobile or diving accidents. They are caused by an axial force to the vertex of the skull which is transmitted through the occipital condyles to the atlas. The purpose of this report is to describe characteristic radiological findings of the Jefferson fracture and stress the importance of the simple radiological examination of the cervical spine in establishing the correct diagnosis.

Summary of Cases

Six cases of Jefferson fracture of the atlas were seen at the University of Alabama Medical Center between 1967 and 1974, four of them within the last year. The increase in incidence probably reflects increased awareness by radiologists of the condition. Three were the result of falls, two from automobile accidents, and one from a diving accident. The pertinent clinical information is summarized in Table 1.

Mechanism of the Injury

When a force is applied to the vertex of the skull, it is transmitted through the occipital condyles to the atlas. There it meets the counter-force of the cervical spine. Thus, the atlas is compressed between occipital condyles and the axis. Because of the sloping surface of the articular facet, the articular
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masses yield to the compressive force by sliding laterally. This results in disruption of the weak atlantic ring at four places, namely, anteriorly and posteriorly to the articular mass on both sides. Rarely there is an associated avulsion fracture of the medial aspect of the lateral mass by a pull of a transverse ligament.

Clinical Findings

When first seen in the emergency room, all patients in this series complained of pain in the suboccipital region and stiff neck. Two had experienced transitory quadriplegia and unconsciousness lasting a few minutes at the time of injury but none had recognizable neurological signs resulting from cord damage when seen in the hospital.

Retropharyngeal hemorrhage occurred in three patients but was not sufficient to cause difficulty in either breathing or swallowing. Laceration at the vertex of the skull resulting from a direct blow was noted in three patients. In one patient, there was an associated linear fracture of the occipital bone.

X-ray Findings

In all six patients, the anteroposterior view of the upper cervical spine through the open mouth revealed lateral displacement of the articular masses of the atlas on both sides (Fig. 1). The amount of the lateral displacement was equal bilaterally and ranged from 2 to 4 mm. The spinous process of C-2 was in normal position (arrow).

FIG. 1. Case 3. Anteroposterior view of the upper cervical spine through the open mouth reveals lateral displacement of the articular masses of the atlas on both sides. The spinous process of C-2 is in normal position (arrow).

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<tr>
<th>Case No.</th>
<th>Age, Sex</th>
<th>Chief Complaints</th>
<th>Neurological Findings</th>
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<tr>
<td>1</td>
<td>25 M</td>
<td>suboccipital pain</td>
<td>paresis of left arm</td>
<td>fall on head</td>
<td>forehead laceration</td>
<td>halter traction; pain subsided in 4 days</td>
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<tr>
<td>2</td>
<td>71 M</td>
<td>suboccipital pain</td>
<td>normal</td>
<td>fall on head</td>
<td>none</td>
<td>no traction; pain subsided in 5 days</td>
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<tr>
<td>3</td>
<td>22 M</td>
<td>suboccipital pain; stiff neck</td>
<td>transitory quadriplegia</td>
<td>diving</td>
<td>linear fracture of occiput, laceration of scalp</td>
<td>halter traction; asymptomatic in 7 days</td>
</tr>
<tr>
<td>4</td>
<td>55 F</td>
<td>suboccipital pain; stiff neck</td>
<td>brief period of unconsciousness</td>
<td>automobile accident</td>
<td>laceration of scalp</td>
<td>halter traction; relief of pain in 4 days</td>
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<td>5</td>
<td>26 M</td>
<td>pain in the neck &amp; hands</td>
<td>normal</td>
<td>fall</td>
<td>bilateral lunate dislocation</td>
<td>Crutchfield tongs; relief of pain over 2 weeks</td>
</tr>
<tr>
<td>6</td>
<td>46 F</td>
<td>pain in the neck &amp; hands</td>
<td>normal</td>
<td>automobile accident</td>
<td>fracture of pubic bone, laceration of scalp</td>
<td>halter traction; relief of symptoms within 1 week</td>
</tr>
</tbody>
</table>

TABLE 1

Summary of clinical data in six patients with Jefferson fracture of the atlas
The lateral view of the upper cervical spine made with a horizontal beam shows a normal relationship between the odontoid process and anterior arch of the atlas in all patients (Fig. 2). A fracture line was not demonstrated on the lateral view in any of the patients. Retropharyngeal soft tissue swelling was noted in three. In one patient a tomogram of the upper cervical spine made in the anteroposterior projection (Fig. 3) demonstrated a small avulsion fracture of the medial portion of the articular mass of the atlas. This was not detectable on plain films. A repeat anteroposterior view of the upper cervical spine made 8 months after injury in one patient showed no change in the amount of the lateral displacement of the articular masses of the atlas. The patient was completely asymptomatic and mobility of the neck was normal.

**Treatment**

All six patients in this series were treated conservatively; with immobilization, pain subsided and the fracture stabilized within a short period in five. In the sixth, a 71-year-old man (Case 2) who refused any form of immobilization, the pain was relieved with bed rest in 5 days. None of the patients underwent fusion of the upper cervical spine.

**Discussion**

Unlike most of the other fractures of the cervical spine, the Jefferson fracture of the atlas may be diagnosed with certainty on an anteroposterior view of the cervical spine through the open mouth. In our series the fracture was diagnosed on this view in all six patients. In a normal cervical spine, the lateral border of the atlas and axis should form a straight line on an anteroposterior view. In the presence of Jefferson fracture, there is lateral displacement of the articular masses of the atlas over axis on both sides, and the spinous process of C-2 is in the midline unless associated with rotation injury. Usually the lateral view of the cervical spine is normal. In some patients, however, it may reveal fracture of the posterior arch of the atlas.

Jacobson and Adler defined atlantoaxial offset as overriding of the articular masses of the atlas and axis on anteroposterior view. Since both medial and lateral offset may be produced in a normal person with varying degrees of rotation and lateral flexion, it is
Jefferson fracture of the atlas is important to examine the position of the spinous process of C-2 in the presence of bilateral lateral offset.\textsuperscript{1,4} If it is in the midline, this means that there is neither rotation nor lateral flexion causing the offset. Therefore, bilateral lateral offset is a result of Jefferson fracture. The other condition in which bilateral offset without rotation or lateral flexion of the neck is seen is anterior atlantoaxial dislocation.\textsuperscript{1} In the latter, the offset is more apparent, because the lateral masses of the atlas are further away from the film than those of the axis. In addition, the lateral view of the cervical spine shows increase in distance between the dens and the anterior arch of the axis.

Although rare, Jefferson fracture of the atlas may be associated with rupture of the transverse ligament that results in subluxation of the atlantoaxial joint. Based on experimental study with anatomical specimens, Spence, \textit{et al.},\textsuperscript{5} concluded that rupture of the transverse ligament is likely in Jefferson fracture if the lateral displacement of the articular masses is greater than 6.9 mm.

In general, Jefferson fracture is not associated with severe neurological deficit. This is because transverse and sagittal diameters of the neural canal are greater at the C-1 level and the articular masses slide laterally away from the cord. Accordingly, the fracture is usually treated conservatively except for an occasional case in which there is associated rupture of the transverse ligament with atlantoaxial dislocation. None of the patients described here required surgery.

Tomograms of the upper cervical spine in anteroposterior projection are helpful in demonstrating the injury, especially when an adequate anteroposterior view of the upper cervical spine is impossible because of trauma to the head and face.

References


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