DISLOCATION OF THE ATLAS ON THE AXIS
THE VALUE OF EARLY FUSION OF C1, C2, AND C3*

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The odontoid process of the axis owes its importance to its anatomical location high in the cervical spine. Since fractures of this small process are associated with dislocations of the atlas on the axis, which in turn compress the upper cervical spinal cord, it is not surprising that both morbidity and mortality are high with these injuries. Geoffrey Jefferson24 in 1920 and Osgood and Lund25 in 1928 surveyed 55 of the fractures of the odontoid process reported to that time, the mortality being about 50 per cent. In at least 10 of the fatal cases reviewed by Osgood and Lund death was not immediate but occurred in patients who had become increasingly disabled over weeks, months, or years. Possibly a tendency to report fatal cases at that time made the mortality more apparent than real. By 1945 Hinchey and Bickel26 surveyed the previous literature and added 8 cases of their own, making a total of 120.

Osgood and Lund25 in 1928 discussed a fracture of the odontoid process received by Dr. Lund himself in 1925. His injury was the forerunner to the great increase in the number of fractured odontoid processes reported since then. Dr. Lund’s accident occurred in a Model-T Ford; the tremendous advances in power and speed of automobiles since 1928 are a matter of record. As a result there is an increase in fractures and dislocations of the upper cervical spine associated with severe trauma. Undoubtedly the increasing use of roentgenograms taken of areas in which injury is suspected results in more frequent recognition of abnormalities in the cervical region.

Embryologically the odontoid process arises as a part of the body of the atlas but later fuses with the upper portion of the body of the axis and articulates with the posterior surface of the small body of the atlas. It is held firmly in place dorsally by the transverse ligament of the atlas. In about 25 per cent of people 30 to 50 years old27 there is an incomplete union of the odontoid process with the axis. A small island of cartilage, the vestige of the original intervertebral disc, remains at the base of the odontoid process. This island of cartilage in some cases may contribute to the ease with which dislocations of the odontoid process occur. Under certain circumstances, as in chronic rheumatoid arthritis and in acute pyogenic infec-

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tions around the neck, as well as in trauma, the transverse ligament may rupture, allowing forward dislocation of the atlas on the axis.\textsuperscript{24} Congenital absence of the odontoid process with excessive mobility of the atlas on the axis has been reported a few times.\textsuperscript{17,26,35,37}

Reliable information is not available concerning the frequency of trauma to the upper cervical spine as the cause of immediate death. Life is incompatible with a severe crushing injury to the cervical spinal cord at the level of the atlas and axis; hence, if fractures of the odontoid process cause damage to the spinal cord, such injured patients do not ordinarily come under medical surveillance. The majority of surviving patients with acute fracture of the odontoid process have little or no neurologic disability, and, except for the frequency of associated injuries, the mortality from these lesions, if properly treated, should be negligible. Many patients actually walk into the emergency room.

Plaut,\textsuperscript{31} Schwarz and Wigton,\textsuperscript{36} and others maintain that solid healing of a fractured odontoid process does not occur. Osgood and Lund\textsuperscript{38} stated that 2 patients with such fractures, who died of intercurrent disease, showed firm union of the odontoid process at autopsy. Cone and Turner\textsuperscript{4} reported that 1 patient on whom they performed a fusion of the upper cervical spine displayed firm union of the fractured odontoid process several months later.

Hinchey and Bickel,\textsuperscript{20} however, believed that fractures of the odontoid process rarely unite but there is usually no resultant disability. Cone and Turner\textsuperscript{4} and Osgood and Lund\textsuperscript{38} thought that difficulties commonly arise when there is failure of proper union of these fractures. In 1948 Crutchfield\textsuperscript{13} wrote that fractures of the odontoid process with dislocation do not heal satisfactorily and advised cervical fusion; later\textsuperscript{12} he treated his patients conservatively by maintaining skeletal traction for several weeks, then by using rigid support for about 6 or 8 months.

More recently Amyes and Anderson\textsuperscript{2} surveyed 63 cases of fractures of the odontoid process seen at Los Angeles County Hospital and in their private practice. Their patients were treated by various methods, some by use of skeletal traction and others by application of plaster cast to the neck. They used no set form of therapy in the group, although a rigid steel-reinforced leather collar was recommended after traction was discontinued—‘‘. . . there was a great deal of variation in the length of time the neck support was worn. Each patient was instructed to continue wearing his brace until healing was demonstrated by x-ray.’’ Although they advised follow-up for at least a year, they apparently lost sight of many of their patients before a year had passed. They did not record any late complications, and they considered that only 3 of their patients needed cervical fusion for stabilization of the fracture-dislocation. They frequently used laminographs, both to confirm the fracture of the odontoid process and to determine the progress of healing.

Undoubtedly some fractures of the odontoid process do heal solidly when patients are treated by maintaining skeletal traction for 3 months,