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FIGURE 1. The arrow points to a "step-off" deformity of the anterior aspect of C2 at the base of the odontoid, compatible with a fracture.

A 50-year-old man with a serious pain in the neck

CASE

A 50-year-old male presented with neck pain, which he described as beginning at the base of the skull and radiating downward. Three weeks previously, he had had a four-wheeler accident but never sought medical attention. He had no neurologic or sensory deficits on examination, but the upper neck was tender to palpation posteriorly and range of motion was limited with passive movement of the head and neck. Radiography of the cervical spine was performed (see Figure 1). **What does the radiograph show?**

DISCUSSION

Figure 1 demonstrates a "step-off" deformity of the anterior cortex of the C2 vertebral body at the base of the odontoid process. The radiograph reveals that the odontoid process is anteriorly subluxed by approximately 2 mm.

CT of the cervical spine was performed to confirm the fracture and to evaluate its extent, as well as to look for other fractures that may not have been visible on radiographs. **Figure 2** is a reconstructed CT image in the coronal plane that confirms the fracture of the odontoid process. The fracture is seen to extend into the body of C2, compatible with a type III odontoid fracture. MRI was also performed and showed no evidence of adjacent spinal cord injury or ligamentous injury, but edema at the level of the fracture was seen (see **Figure 3**).

Odontoid fractures comprise about 15% of all cervical spine fractures.[1] Motor vehicle crashes and falls are responsible for most injuries of C2. Diagnosis is important because the morbidity and mortality associated with cervical spine injuries increases with each level as the injury moves higher in the cervical spine.

Symptoms of an odontoid fracture can range from none to mild pain to total paralysis. Many patients with odontoid fractures have no neurologic deficits but may complain of pain and spasms. Neurologic deficits can develop, however, in the weeks to months following injury as a result of delayed or gradual subluxation at the fracture site. Most odontoid fractures occur secondary to flexion with loading on the cervical spine and can result in displacement of the odontoid process anteriorly. Less commonly, there is extension of the cervical spine with loading and posterior displacement of the dens (the odontoid process).

Physical examination should include palpation of the neck to identify deformity and localize pain. Visual inspection should be performed to assess for asymmetry or torticollis. The upper and lower extremities should be tested for neurologic deficits. The shoulder shrug can be used to evaluate function of the trapezius muscle, as this is innervated from the C2 nerve root. The sternocleidomastoid reflex can be tested by tapping on the clavicular end of the sternocleidomastoid muscle to see if it

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contracts. This muscle is also innervated from the C2 nerve root. Rectal tone should be assessed as well.

Radiography is generally used in the initial imaging assessment of the cervical spine. Odontoid fractures are usually best visualized on the anteroposterior open-mouth view. However, occasionally the incisors, the base of the skull, the posterior arch of C1, or the tongue may cast a shadow over the odontoid process, which can simulate a fracture. On the lateral view, prevertebral soft tissue swelling may be the only indication of fracture. The swelling should measure no more than 6 mm in width at the level of C2; swelling greater than 6 mm may indicate a fracture, and CT should be performed. The space between the odontoid process and the anterior aspect of the ring of C1 should be no more than 3 mm in adults and 4 mm in children. This is assessed on the lateral view. The space between the odontoid process and lateral masses of C1 should be symmetric on the open-mouth view.

If radiographs do not demonstrate a fracture but clinical suspicion remains high, CT is usually performed. The initial CT images are acquired in the axial plane. Afterward, reconstructed coronal, sagittal, and/or 3D images can be processed. MRI of the cervical spine can be helpful in characterizing neural, disk, and soft tissue injury (evaluation of the ligaments) and should be performed if neurologic deficits are present. The odontoid process can have variations in appearance radiographically. It can be totally absent (aplastic), hypoplastic, or incompletely fused to the C2 vertebral body (os odontoideum).

Three types of odontoid fractures are recognized. A *type I* odontoid fracture is an oblique fracture through the tip of the dens. It is an avulsion fracture at the site of the insertion of the alar ligament. This type of fracture is considered mechanically stable, but it may be associated with atlanto-occipital dislocation, which is unstable and potentially life-threatening and thus should be excluded.[2,3] Type I fractures are uncommon and comprise approximately 5% of odontoid fractures.

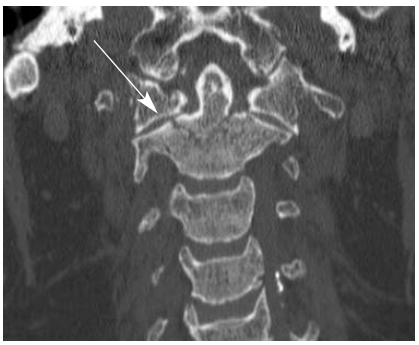

FIGURE 2. A reconstructed CT coronal image demonstrates a fracture of C2 involving the vertebral body, compatible with a type III odontoid fracture.

FIGURE 3. MRI in the sagittal plane demonstrates a fracture through C2 at the base of the odontoid process (thin black area), with surrounding edema (white areas on either side of the black area).

Type II fractures are at the base of the dens. This is the most common site of fracture of the odontoid and is seen in approximately 60% of cases. This type of fracture is associated with a high incidence of nonunion, as the blood supply to the dens is often disrupted.[4] Nonunion can occur in up to 30% to 50% of patients. The risk of nonunion is higher when any of the following are present: comminution of the fracture at the base of the odontoid process, greater than 2 mm of displacement, posterior displacement, older age, delayed diagnosis, and redislocation. Type II odontoid fractures are considered unstable and frequently will be treated with surgical fusion, particularly because of the high risk of nonunion.[5]

Type III odontoid fractures extend into the vertebral body of C2. A type III fracture is considered stable, and the patient typically does well with conservative treatment and immobilization. The blood supply in this type of fracture usually is not disrupted; therefore, the incidence of nonunion is much less than with a type II fracture. On a lateral radiograph, a type III fracture can be distinguished from a type II fracture by evaluating for disruption of the "ring shadow" of the axis; when present, this disruption of the ring shadow indicates a type III fracture.[6]

Other injuries that may be associated with fractures of the dens include fractures of the atlas (C1), transverse ligament rupture, and pharyngeal injury.[2] Complications seen with odontoid fractures include nonunion, malunion, infection, pseudoarticulation formation, airway injury or compromise, hardware failure, and neurovascular injury. Close clinical follow-up, including physical examination and imaging studies, are important to ensure that adequate alignment and proper healing take place. JAAPA

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