Use of C1 Lateral Mass and C2 Intralaminar Fixation to Stabilize a 30-Year-Old Odontoid Fracture That Was Causing Myelopathy

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Odontoid fractures occur with a bimodal incidence. They are usually seen after a fall in the elderly or a motor vehicle accident in the young.[1,2] Their sensitive location and potential to destabilize the craniocervical junction can result in neurologic compression. Despite extensive discussions in the literature regarding the epidemiology, imaging, and classifications of odontoid fractures, there has been no consensus on the best treatment options for the type II fracture across various age groups.[3-5]

In this article, we present the case of a patient in whom myelopathy developed more than 30 years after he sustained a type II odontoid fracture in a motor vehicle accident. This case is unique for 2 reasons. First, the prolonged asymptomatic period between initial injury and symptom onset is rare.[6-8] Second, the surgical technique used was a unique modification of prior C1–C2 fixation techniques.

C1 lateral mass fixation was initially described by Goel and Laheri[9] in 1994 and then popularized by Harms and Melcher[10] in 2001. Initially, C1 fixation was paired with C2 pars (pedicle) fixation. However, up to 20% of patients may have vertebral artery anatomy that precludes safe C2 pedicular fixation.[11] In 2004, Wright[12] described intralaminar fixation of C2 as a potential solution for patients with medialized vertebral arteries that make C2 pedicle screw placement dangerous.

The present case of late myelopathy caused by odontoid nonunion was successfully treated with instrumentation and fusion using C1 lateral mass and C2 intralaminar fixation. We have obtained the patient's informed written consent to publish his case report.

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Case Report

A man in his late 60s presented with the chief complaint of back and leg pain to an orthopedic surgeon. He described the pain as a dull ache at the lumbosacral junction that worsened with prolonged sitting and standing. He denied numbness, tingling, and bowel and bladder changes. His medical history was significant for a neck injury sustained in a motor vehicle accident 30 years earlier. He denied prior surgery for or immobilization of the neck after the initial accident.

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The patient admitted to having difficulties walking over the past several years but attributed this to his lower back. On examination, there was significant guarding. There was upper cervical tenderness with generalized upper extremity hyperreflexia. Bilaterally, there was a positive Hoffmann sign and inverted radial reflex. No specific focal deficits were apparent, strength remained 5/5 throughout, and there was a negative Romberg or finger escape sign. Cervical radiographs showed an odontoid type II fracture with gross instability of almost 8 mm on flexion-extension views (Figure 1). Lumbar radiographs showed spondylosis and a grade II degenerative spondylolisthesis at L4–L5. Magnetic resonance imaging (MRI) of the cervical and lumbar spine was recommended. The patient returned 8 weeks after the initial appointment. The MRI showed the C1–C2 instability and myelomalacia at the C2 level posterior to the odontoid nonunion (Figure 2). A cervical collar was placed, and surgery was recommended, but the patient

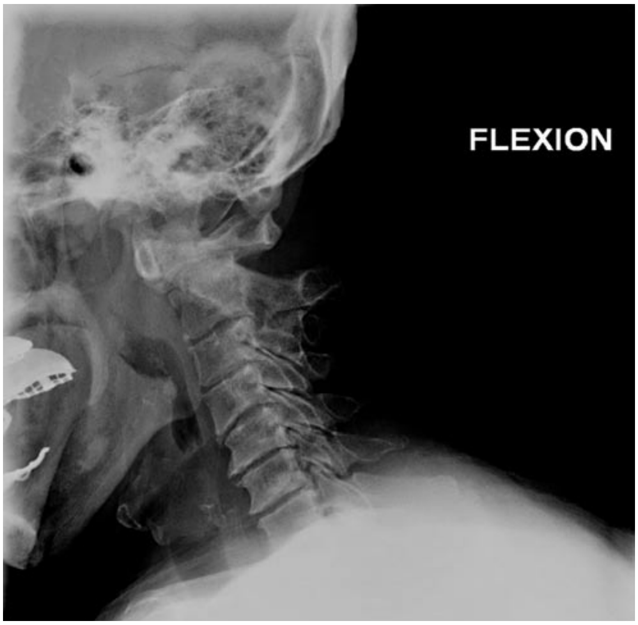

Figure 1. Lateral cervical radiograph in flexion shows gross instability of type II odontoid fracture.

Figure 3. Sagittal computed tomography shows odontoid nonunion with posterior fragments and transverse ligament calcification and hypertrophy.

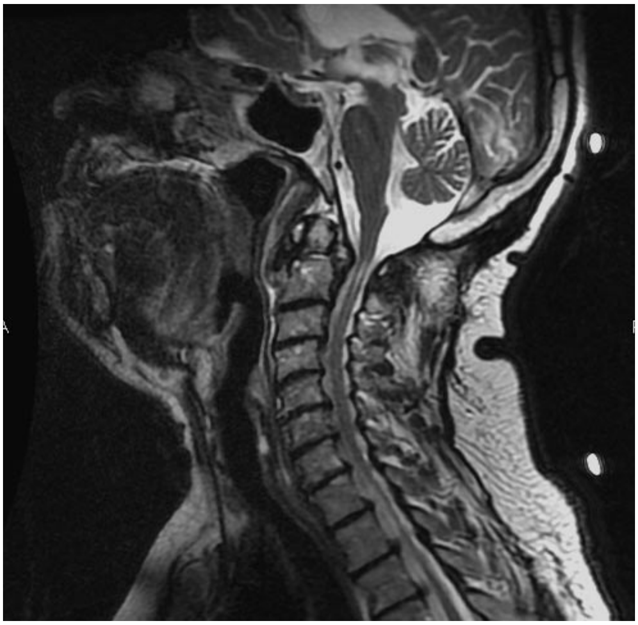

Figure 2. Sagittal T_2-weighted magnetic resonance imaging shows C1–C2 instability and myelomalacia at C2 level posterior to odontoid nonunion.

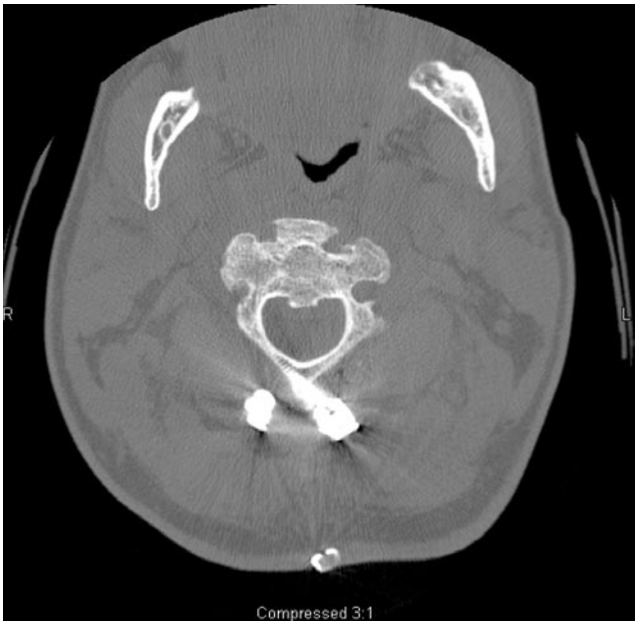

Figure 4. Postoperative axial computed tomography at C2 level shows thin pedicles and medial transverse foramen.

decided to obtain a second opinion considering that his primary complaint was the lower back and not the neck.

The patient did not follow up but instead presented to the emergency department 3 weeks later in a cervical collar and wheelchair with complaints of generalized weakness, neck pain, and inability to ambulate. Physical examination was significant for right arm weakness with decreased tone in addition to low back pain radiating to the lower legs. There were no sensory deficits or changes in bowel or bladder function. Noncontrast computed tomography (CT) of the cervical spine showed a remote, well-corticated, horizontal odontoid fracture. At the cervicomedullary junction was significant spinal canal narrowing caused by posterior fragments and transverse ligament calcification and hypertrophy (Figure 3). Intravenous dexamethasone was given per NASCIC (National Acute Spinal Cord Injury Study) protocol. Shortly thereafter, the leg and arm weakness mildly improved.

Surgical stabilization was recommended because of the risk for paralysis or quadriparesis from this instability. A

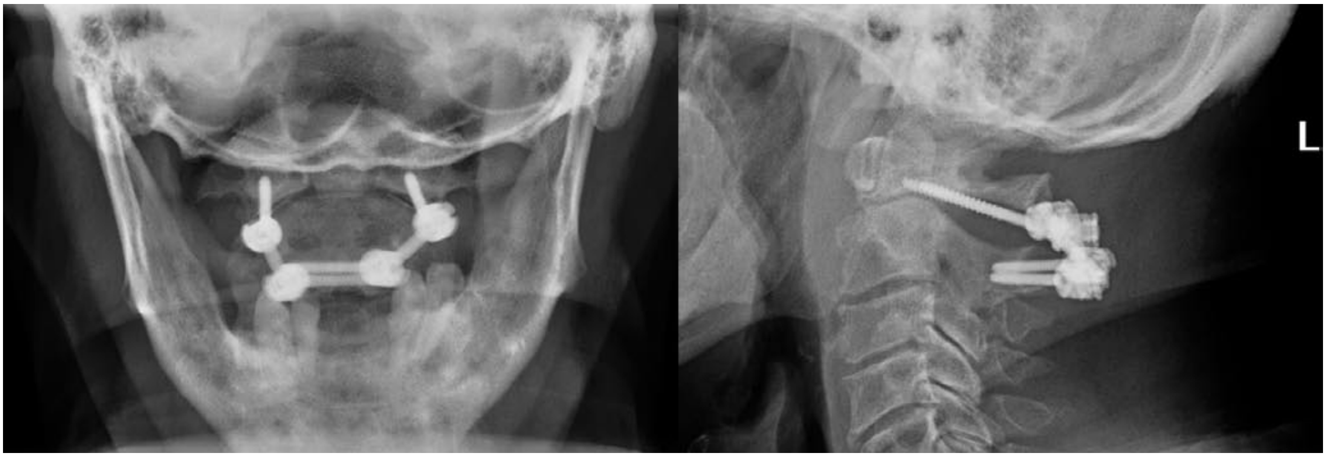

Figure 5. Postoperative open-mouth and lateral radiographs show C1–C2 fusion.

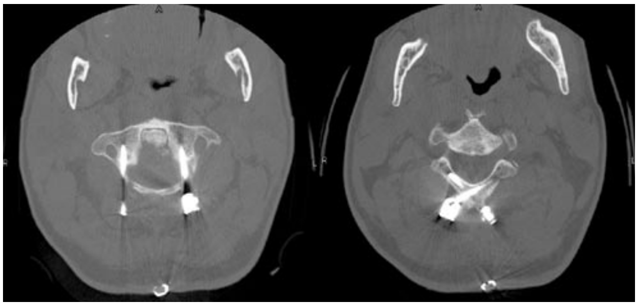

Figure 6. Postoperative axial computed tomography shows C1 lateral mass and C2 intralaminar screw placement.

laminectomy of C1 was considered, but the displacement seen on the flexion radiograph did not demonstrate that this procedure would allow for a wider canal diameter. Therefore, the patient was taken to the operating room for stabilization and fusion of C1–C2. A Mayfield head holder was used for head control, and a posterior approach was taken from C1 down to C2. The C2 nerve was identified and protected through gentle retraction. Axial CT demonstrated that the vertebral artery anatomy at C2 precluded use of the Magerl technique or placement of pedicle screws (Figure 4). The Gallie wiring technique was felt to be a relatively more morbid procedure considering the need for structural autograft and postoperative immobilization. Occipitocervical fusion was too excessive and restrictive considering the effectiveness of segmental fusion without limiting neck range of motion. During surgery, 30-mm screws were placed in the C1 lateral masses while parallel 28-mm screws were placed in the C2 lamina. Each C2 screw was burrowed through to the contralateral lamina to provide secure fixation without the dangers of deeper drilling into thinner pedicles. The facets between C1 and C2 were decorticated. Rods were placed and locked between the C1 and C2 screws. The decorticated surfaces were subsequently grafted with Grafton bone putty (Grafton DBM Putty; Osteotech, Eatontown, NJ). The patient tolerated the procedure well, and there were no perioperative complications.

Postoperative radiographs showed good alignment (Figure 5), as did postoperative CT (Figure 6). There were no complications at the 1- and 2-month follow-up visits. The patient was weaned off the cervical collar comfortably and had transitioned from a walker to a cane at this point.

Discussion

Odontoid fractures constitute 9% to 15% of all cervical spine fractures.[13,14] Although they are uncommon injuries in the general population, there is evidence of increasing incidence in the elderly.[15] Rates of neurologic injuries have ranged from 2% to 27% over multiple studies.[3] Unfortunately, the signs can be subtle, with only about 65% of patients with the injury seeking medical advice, most commonly for neck pain.[16] Displaced type II odontoid fractures are particularly prone to nonunion with nonsurgical treatment.[17] Use of external immobilization with cervical collar or a halo vest has had nonunion rates ranging from 26% to 80%.[3] Furthermore, use of halo-vest treatment in the elderly is associated with significant morbidity and possibly mortality.[18]

Various surgical options exist for the treatment of displaced type II odontoid fractures. Gallie (and later Brooks and Jenkins) C1–C2 wiring techniques provide simple and effective methods of internal fixation of odontoid fractures, with fusion rates ranging from 83% to 100%.[19-21] Disadvantages of wiring fixation included need for structural autograft harvest and the need for postoperative immobilization for an extended time to provide sufficient biomechanical stability.[22] Both features make the procedure more morbid than the one described in this case. Transarticular fixation technique at C1–C2 is effective, with fusion rates consistently recorded at 100%.[23-25] However, use of this technique requires preoperative reduction of deformity and does not account for the variation in vertebral artery seen in up to 20% of patients. Anterior odontoid fixation, first described by Böhler[26] in 1982, recently gained popularity. Its major benefit lies in its allowing for more neck range of motion than traditional methods of odontoid fixation do and without compromising the safety, stability, or nonunion rates.[3] In our patient's case, there were several contraindications to using the anterior screw technique. Specifically, fracture obliquity and the nonunion history precluded use of anterior fixation. These factors would have made direct compression and healing of the fracture site unlikely.

The more superior and medial location of the C1 screws provides benefits, including decreased risk for injuring the vertebral artery, decreased damage to the facet joints, and ability to reduce the fracture after screw placement.[10] O'Brien and colleagues[27] described how segmental fixation at C1–C2 using C2 intralaminar screws allowed for intraoperative reduction of deformity while avoiding the anatomical variability that endangers standard posterior C2 fixation. There have been few in vitro studies, but even fewer clinical studies observing the efficacy of the C2 intralaminar method, since Wright[12] described it in 2004. Several biomechanical studies have not shown any significant difference in stability between this intralaminar technique and pedicle placement.[28-30] In a recent clinical study of 30 cases, Wang[31] reiterated the safety and efficacy of the C2 intralaminar fixation technique. There were no vascular or neurologic injuries, and the improvement rate was 71%. However, this technique was not reported for odontoid fractures specifically.

The present case is unique for multiple reasons. First, the latent period between initial injury and presentation of neurologic deficits is rare in the literature. Congenital anomalies of the odontoid, such as os odontoideum, can also present this way. However, several typical clinical and radiologic features were not present. In os odontoideum, the odontoid is an oval- or sphere-shaped bone that is usually located near the superior end of where a normal odontoid would be. It usually has smooth sclerotic borders and is clearly separated from the rest of the axis by a significant transverse gap. A remote history of trauma is seldom reported by the patient. It is also more commonly associated with other developmental deficits, such as Down syndrome, Klippel-Feil syndrome, and Morquio syndrome.[32]

The intralaminar technique we used is relatively easy, does not endanger the vertebral artery, and does not require a C1 laminectomy.[27] In this particular patient's case, a very medial vertebral artery precluded pedicular or transarticular screw placement. Intralaminar technique is an excellent technique to use for fixation at C2 in such cases. In our experience, it is also useful for inclusion in subaxial constructs.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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