C1-2 Fusion Through the Anterior Approach for Failed Odontoid Screw Fixation

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Background context Odontoid peg fractures are common injuries in the elderly population. Salvage of a failed odontoid screw via fusion of C1-2 through the anterior approach hasn't been previously described in the literature.
Purpose We report a salvage of failed odontoid screw fixation by fusion of C1-2 joints through the anterior approach.
Study Design/setting Case report/University hospital
Methods A 67 year old man with atlanto-axial osteoarthritis sustained a low velocity fall, and was found to have a displaced type II odontoid peg fracture as per the Anderson/D'alonzo classification. Initial fixation was achieved by an odontoid screw. This initial fixation was found to have failed after 4 days. To revise the fixation it was decided to conduct transarticular fusion of C1-2 and revise the odontoid screw. This was all carried out through the anterior approach.
Results Odontoid fracture completely healed at 12 weeks, and no complications at 1 year.
Conclusions Atlanto-axial osteoarthritis may lead to increased torque forces on odontoid screws leading to failure. These can be salvaged via fusion of C1-2 through the anterior approach.

Keywords: Odontoid; Fracture; Vertebra; Cervical; Fusion

Introduction

Odontoid fractures occur commonly in a bimodal age distribution[1]. In younger patients the injury is associated with high energy trauma; however fractures in the elderly population are associated with low energy trauma such as falls[2]. Above the age of 70 years, fractures of the odontoid peg are the most common cervical spine injury[3-4], with the majority being type II by the Anderson and D'Alonzo classification[5].

These fractures can be managed conservatively with halo jacket stabilisation, or operative fixation. Indications for operative management include posterior displacement of fracture fragment[6], fracture fragment displacement >4mm[6], age more than 55 years[6], non-union, and disruption of the transverse atlantal ligament[7].

Since the dens has 55% less trabecular bone than the C2 body, and the trabecular bone is needed for callus formation and bone healing, there is an increased risk of non-union of type II peg fracture compared with type III[6]. This has lead some authors to suggest that conservative management be reserved only for patients unable to tolerate general anaesthesia[8]. Operative fixation can be carried out through the anterior or posterior approach, but there is some controversy regarding the optimal approach.

We describe a novel technique whereby failed fixation of an odontoid fracture was salvaged with replacement of the anterior odontoid screw, and C1-2 trans-articular fixation and fusion, all through the anterior approach.

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Case report

A 67-year-old male sustained a low velocity fall from a bicycle, and hit his helmeted head on concrete. The left side of his head struck the floor. He noticed transient weakness and numbness of the right arm and leg. He was initially assessed and discharged from the accident and emergency department with no significant injury. He presented again two days later with continued neck pain. Computed tomographic (CT) imaging of the cervical spine showed features of atlanto-axial osteoarthritis, and a displaced type II odontoid peg fracture (Figure 1). As the displacement was 10mm and the angulation was 19 degrees, surgical management through an anterior approach was decided upon. Fixation was achieved through a right-sided standard anterior approach with an odontoid screw. During the procedure good

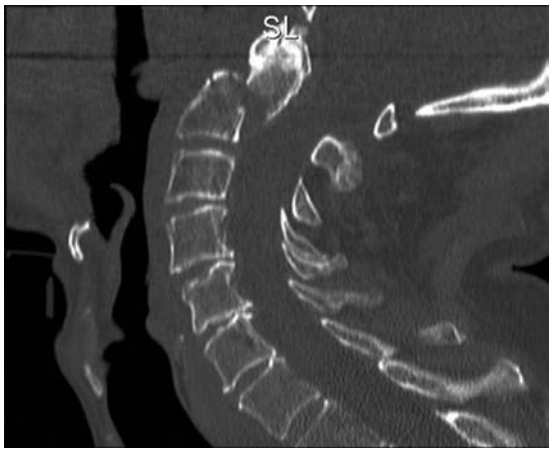

Figure 1. Sagital CT of initial injury, showing displacement of 10mm, and angulation of 19 degrees.

purchase was felt, and intra-operative X-rays showed good position (Figures 2,3). Postoperatively, the patient was managed in a hard collar. Due to increased neck pain, radiographs were taken on the fourth postoperative day, and showed displacement of the odontoid peg (Figure 4). CT showed subtotal displacement of the peg fracture with loss of the original screw position (Figure 5). It was then decided to do a C1-2 transarticular fusion.

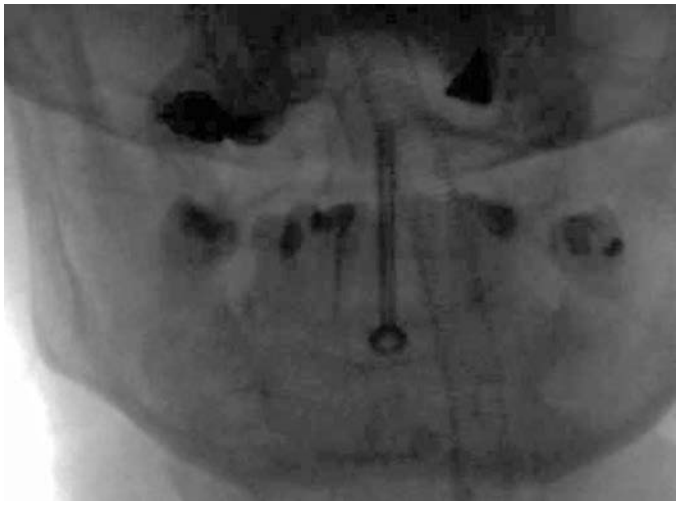

Figure 2. Anterior Posterior (AP) radiograph showing good fracture reduction intraoperativley.

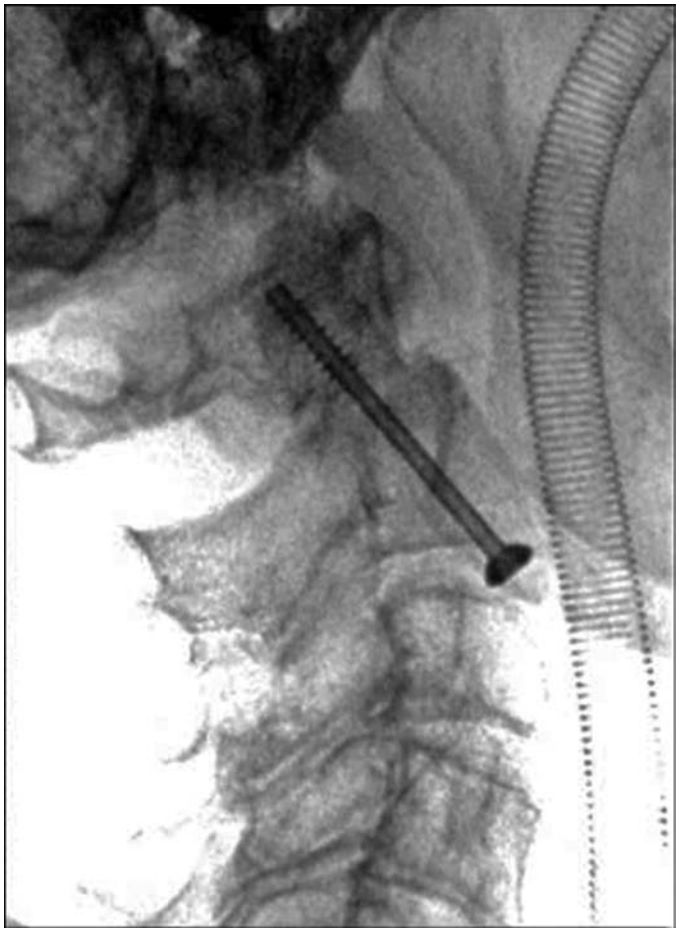

Figure 3. Lateral radiograph showing good fracture reduction intraoperativley.

Conventionally, a C1-2 transarticular fusion would be performed through a posterior approach. Since there was a displaced fracture with an anterior screw in the peg that required removal, it was decided to revise the anterior screw and perform the transarticular screw fixation through the anterior approach.

The procedure was carried out with the patient supine, with the head held in Mayfield skull traction. The same right-sided neck incision was used to approach the C2. The loose odontoid screw was removed. Using the Mayfield skull traction

Figure 4. Lateral radiograph taken on postoperative day four, showing loss of position of initial fixation.

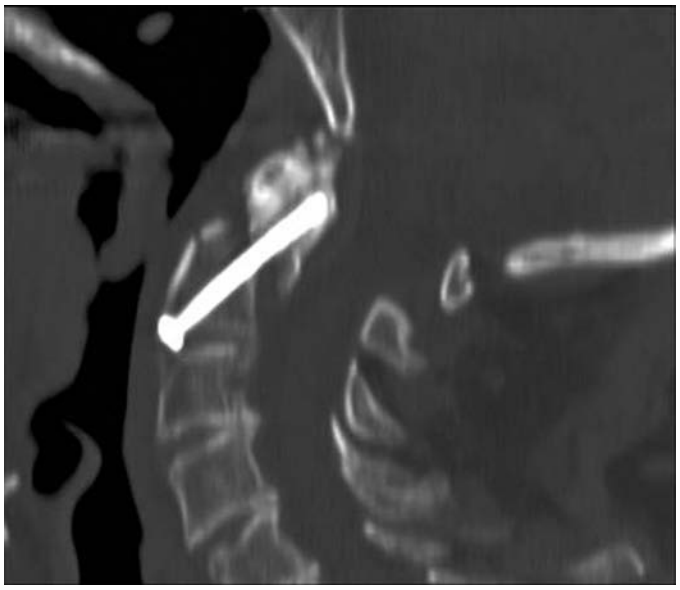

Figure 5. Sagital CT scan showing loss of position on postoperative day 4.

and pressure on the C2 body, reduction of the odontoid fracture was achieved, and confirmed with image intensifier. An AO 4.5 mm cannulated screw was used to fix the odontoid fracture.Anterior C1-2 transarticular fixation was performed as described previously in the literature.The midpoint of the C2 body in the medial third of the C1-C2 articulation, just below the sulcus on the anterior body of C2 was used as the insertion point. A 1.25mm threaded K-wire was advanced into the body of C2 in a posterior and superior direction, with an angle of 20º in the coronal and 30º in the sagittal planes. The atlantoaxial joint was crossed just anterior to its midpoint. The wire was advanced till it reached the subchondral bone of the superior joint surface of the C1 mass articularis. Screw length was then measured and a 4.5mm self cutting cannulated cortical screw was inserted[9]. Post operative xrays show good position (Figures 6,7). Post operatively the neck was immobilised in a hard collar for 12 weeks. Evidence of radiographic healing of the odontoid fracture was noted as early as 6 weeks, and completely healed at 12 weeks. There was no immediate or delayed complications with a further follow-up of 12 months.

Discussion

There is still significant controversy in the literature as to the best surgical management for odontoid fractures. Broadly, two groups can be found with one favouring anterior approach and the others favouring posterior approach for treating odontoid fractures[10-15]. Anterior techniques employ odontoid screw fixation while posterior techniques aim for C1-C2 fusion. The advocates of anterior odontoid screw fixation argue that by fixing the odontoid fracture, the C1-C2 joints are still free to have axial rotation at the atlantoaxial joint[10-12]. However, the authors favouring the posterior C1-C2 fusion for odontoid fractures say that there is no difference in the amount of rotation available in the neck at follow-up between those who had anterior odontoid screw fixation and those who had posterior C1-C2 fusion[16]. Smith et al have described in their practice over the last 20 years a reduction in the use of anterior approach[16].The anterior approach is associated with increased risk of pneumonia, vocal cord, and swallowing problems. The posterior approach is associated with increased blood loss[16], possibly from surgical interruption of the posterior C1-2 venous cavernous plexus[16]. Essentially, there is no difference in the post operative morbidity and functioning between the two approaches[16].

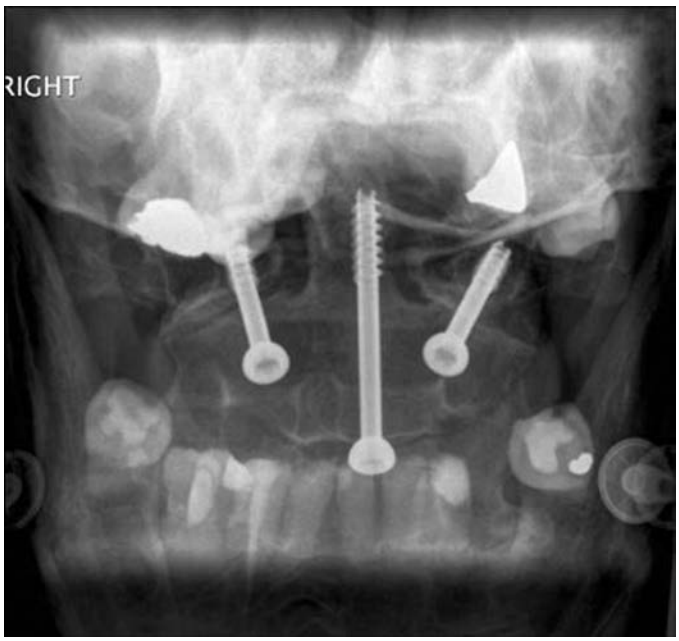

Figure 6. Intraoperative AP radiograph showing C1-2 fusion and revised odontoid screw.

Figure 7. Intraoperative Lateral radiograph showing C1-2 fusion and revised odontoid screw.

Odontoid peg fractures in the elderly are common injuries, and with the increasing number of mobile elderly their incidence looks likely to increase. In the elderly, degenerative osteoarthritis of the cervical spine primarily affects the facet joints below the level of the axis vertebra[17-18]. The decrease in mobility of these segments leads to the atlanto-axial articulation becoming the most mobile segment in the cervical spine[19]. However, recently in 2005, Lakshmanan et al pointed out that there is a difference in the pattern of osteoarthritis affecting the upper cervical spine articulations. In that, the lateral atlantoaxial joints have an incidence of 4% osteoarthritis, but in patients with odontoid peg fractures over the age of 70 years, 90.5% display severe degeneration at the atlanto-odontoid[20]. This relative sparing of the lateral atlantoaxial joints leads to initiation of rotation around a fixed pivot (the atlanto-odointoid), and thus abnormal tourqe forces[20]. This finding is also compounded by the finite element analysis performed by Puttlitz et al where

they showed abnormal rotational forces play an important role in the Type II region of the odontoid process[21]. Hence, fixing the odontoid fracture with an anterior odontoid screw may potentially create the same model where there is mobility at the lateral atlantoaxial joint initiating axial rotation. In the presence of significant atlantoodontoid osteoarthritis where the odontoid process is nearly fused with the anterior arch of the atlas, this axial rotation force may result in the axial force being expended at the fracture site resulting in stress at the anterior odontoid screw. Further, if there is significant atlantoodontoid osteoarthritis resulting in the odontoid process being fixed to the posterior surface of the anterior atlantal arch, there is no advantage in the anterior odontoid screw fixation as there is no gain in the range of axial rotation. A potential solution to this problem of continued mobility at the lateral atlanto-axial joints is the intrarticular fusion of C1-2. In our case with the abnormal torque force eliminated in the second surgery, good union of the odontoid process fracture was achieved as shown in the radiographs taken as early as three months.

We felt that the initial odontoid screw might impair reduction, and as such this was removed through the original anterior incision. It was decided to attempt fusion of C1-2 through the same incision. Routinely C1-2 fusion is carried out through a posterior approach, as described by Magerl[22]. Even though there are reports claiming a fusion success rate of 96-100%, the posterior approach is a technically demanding procedure with significant risks to the vertebral artery and the spinal cord[22-23]. The advantages of the anterior technique employed in our case is that the approach is through a virtual space with limited muscle dissection resulting in less tissue trauma and hence less chance for infection[9]. Further, as the starting point is close to the vertebral foramen and the direction of the targeting wire is away from it, the potential chance of injuring the vertebral artery is theoretically less than the posterior approach where the wire or the screw ends up near the vertebral artery foramen. In addition, setting up and positioning the patient on the operating table is much easier for the anterior approach than rotating the patient for a posterior approach in a trauma situation where the spine is unstable. Last but not the least, this approach is cosmetically pleasing. One possible disadvantage of C1-C2 fusion through the anterior approach is the inability to use bone graft. We have thus shown in our case report that the biomechanical advantage of a C1-C2 fusion can still be achieved in odontoid fractures via an anterior approach in addition to achieving fracture union of the odontoid process.

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