Case Report

Stent augmentation of an anterior odontoid screw for type 2 odontoid fracture-dislocation in the elderly population: Report of two cases and literature review

ABSTRACT

The fixation of type 2 odontoid fractures poses significant challenges in the elderly population due to coexistent osteoporosis and communition resulting in a high failure rate with conventional anterior screw fixation. Two elderly patients with unstable odontoid peg fractures and coexistent osteoporosis were treated with stentoplasty and anterior odontoid screw fixation. Additional anterior transarticular C1–2 screws were placed to address C1–2 instability. Both patients made an uneventful clinical recovery. One of the anterior C1–2 screws loosened due to the poor purchase in the osteoporotic bone in one patient. This did not affect the final outcome, and both the patients demonstrated maintained reduction and good alignment of odontoid peg after 2 years of follow-up. There was no intraoperative cement leak, pseudoarthrosis, or loss of reduction. Stentoplasty coupled with the anterior odontoid screw is a safe technique that can provide a biomechanically sound fixation of type 2 odontoid fractures in the presence of osteoporosis and significant communition.

Keywords: Odontoid, screw fixation, stentoplasty

INTRODUCTION

Type 2 odontoid fractures are common in the elderly population.[1] A variety of treatment options exist for their management. Anterior odontoid screw fixation is a safe and quick procedure to manage type 2 variant, thus avoiding complications from external orthosis and halo vest.[2-4] The presence of osteoporosis in this age group increases complication rates of the anterior fixation, especially nonunion and implant failure.[5] Posterior fixation options such as Harm's technique entail unfavorable prone positioning and more extensive surgery causing greater blood loss and infection risks.[6] Various techniques have been tried to make anterior odontoid screw fixation more secure including cement-augmented odontoid screws, balloon kyphoplasty, and triple and quadrangular constructs, but none have tried stentoplasty along with anterior screws as a fixation option in osteoporotic spines.[5,7-11] We describe our surgical technique with a 2-year follow-up of two patients who underwent the aforementioned procedure. This has not been previously described to the best of our knowledge.

Surgical technique

All patients were operated under general anesthesia in the supine position with the head attached to Mayfield clamps. A gag was placed inside the mouth to ensure open-mouth view. We used neuromonitoring as odontoid pegs were posteriorly angulated, and in the presence of instability,

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Submitted: 24-Sep-19 **Accepted:** 06-Nov-19
Published: 23-Jan-20

Access this article online	
Website: www.jcvjs.com	Quick Response Code
DOI: 10.4103/jcvjs.JCVJS_91_19	

How to cite this article: Kapoor S, Herschkovich O, Lucantoni C, Boszczyk B. Stent augmentation of an anterior odontoid screw for type 2 odontoid fracture-dislocation in the elderly population: Report of two cases and literature review. J Craniovert Jun Spine 2019;10:254-8.

deformity correction could potentially lead to cord injury. Two image intensifiers were used simultaneously to give anteroposterior and lateral projections of C1–2 joint and odontoid peg [Figure 1a]. The head was manipulated gently through Mayfield clamps to achieve deformity correction under fluoroscopy guidance. A right-sided Smith–Robinson approach at the C5–6 level was then used to access anterior aspect of the axis base. A low-level approach allowed us to have adequate working space to guide our drills and K-wires in the right trajectory. This was then followed by the placement of vertebral body stent (*Synthes*) in the odontoid peg under fluoroscopy guidance [Figure 1b]. It was ensured that the stent was placed well across the fracture site and proximal to the odontoid base, with its central axis marking the future trajectory of odontoid screw. This was then filled with high-viscosity cement (typically 2 ml) in small increments of 0.2 ml under regular fluoroscopy control. A close watch was kept to spot any leak outside the peg. Stent acted as a barrier to leak and held the cement well within the corpus of an odontoid peg, filling future screw tract. This was followed by the anterior odontoid screw fixation (partially threaded *Synthes*) cannulated over a K-wire before the cement could set fully [Figure 1c and d]. Care was taken to ensure that threads of the screw crossed the odontoid fracture line but stay short of the odontoid tip to prevent creating a potential tract for cement to leak superiorly. This finished the reconstruction of fractured odontoid. Finally, bilateral anterior transarticular screws with washers were placed to stabilize the C1–2 joint [Figure 1e]. The choice of C1–2 transarticular screw was dictated by the C1–2 dislocation rather than the odontoid fracture. In the absence of C1–2 instability, a stentoplasty with trans-odontoid screw alone should be sufficient. We did not record any neuromonitoring alerts in any of our procedures. The final anteroposterior and lateral radiographs were taken before closure over a sutured drain. The hard collar was discontinued postoperatively. The time taken specifically for the stent placement did not exceed 5–10 min.

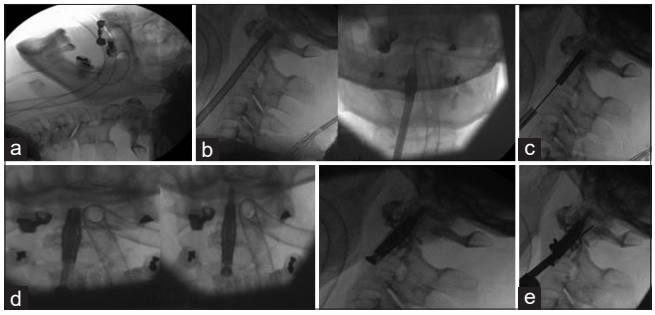

Figure 1: Lateral projections of odontoid peg (a) obtained to allow accurate placement of vertebral body stent (Synthes) in the odontoid peg under fluoroscopy guidance (b). Cementing through the stent is followed by the anterior odontoid screw fixation (partially threaded Synthes) cannulated over a K-wire before the cement could set fully (c and d). Bilateral anterior trans-articular screws with washers were placed to stabilize the C1–2 joint (e)

CASE REPORTS

Case 1

An 84-year-old female presented to the accident and emergency (A/E) department with a history of fall and head hitting the pavement, causing an acute hyperextension injury. She complained of neck pain and weakness on the left side of the body, mainly upper limbs with Medical Research Council Grade 1 power. Computed tomographic (CT) scan of of the neck revealed a posteriorly displaced type 2 odontoid fracture causing canal compromise along with atlantoaxial instability [Figure 2a]. Magnetic resonance imaging revealed cord signal change indicating acute injury and posterior ligamentous disruption [Figure 2b]. After initial immobilization and period of cord rest, she was operated the next day with anterior bilateral C1–C2 transarticular screw fixation, odontoid peg stenting, and screw fixation [Figure 2c]. The collar was removed postoperatively, and mandatory measures were taken to maintain cord perfusion. The patient could not be extubated in the immediate postoperative period and stayed in the critical care unit for a day. She was shifted to the adult high-dependency unit and then to the general ward in the next 2 days. Her neurology improved significantly in the postoperative period and she was subsequently sent to the spinal cord injury rehabilitation unit. At the last follow-up 2 years postoperatively, her neurology in the left upper limbs had improved to Grade 4 power in all myotomes. Her radiographs confirmed good alignment and satisfactory placement of metalwork [Figure 2d]. A CT scan was considered unnecessary in view of good clinical outcome and reassuring radiographs after 2 years. This is in keeping with our institution's policy of ordering CT scans only for strict indications in view of the radiation exposure. Her Nurick score and Japanese Orthopedic Association scores improved

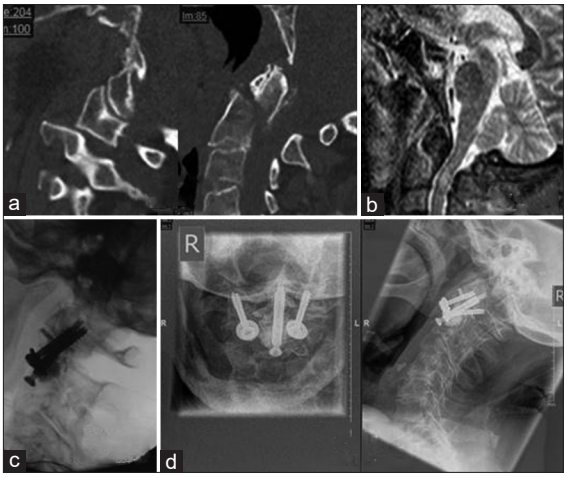

Figure 2: Case 1-displaced type 2 odontoid fracture causing cord compression (a and b) managed with anterior bilateral C1–C2 trans-articular screw fixation, odontoid peg stenting, and screw fixation (c). Good alignment and position of metalwork after 2 years of follow-up (d)

from 2 to 5 and 3 to 14, respectively, at the last follow-up. She was discharged from the spinal care.

Case 2

A 66-year-old female with known osteoporosis presented to the A/E with a history of alcohol intoxication and fall from four flight stairs. She complained of neck pain and was subsequently shown to have a displaced, internally comminuted and posteriorly angulated fracture of the base of odontoid peg extending into the C2 body and atlantoaxial instability [Figure 3a]. There were additional fractures of the anterior arch of the C1 along with rotatory subluxation of C1 over C2. She was immobilized in the collar and taken to the theater. The fracture was subsequently reduced and fixed with bilateral anterior transarticular screws. A stent was placed in an odontoid peg followed by the screw fixation [Figure 3b]. The collar was removed postoperatively. Recovery was uneventful, and she was discharged after routine postoperative standing anteroposterior, lateral, and open-mouth views that showed the good placement of metalwork and adequate fixation [Figure 3c]. She was sent home with a soft collar for comfort. Six months postoperatively, she continued to have a good recovery, but her radiographs showed that the left C1–2 transarticular screw has started to back out, probably as a result of preexisting osteoporosis. The C1–2 alignment was well maintained and odontoid peg was firmly fixed in its original position. We believe that this was made possible by good fix of stent and cemented trans-odontoid screw, which was the principle stabilizing force. In view of good clinical outcome and otherwise well-maintained reduction, it was decided in conjunction with the patient to not perform revision surgery for screw removal. She was kept under follow-up and at the last visit 2 years postoperatively, her radiographs showed unchanged appearances with good clinical outcomes [Figure 3d]. She was subsequently discharged from the spinal care.

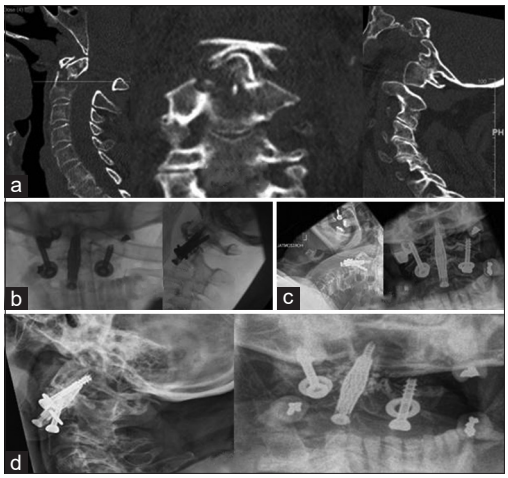

Figure 3: Case 2- comminuted and posteriorly angulated type 2 odontoid peg fracture with atlanto-axial instability (a). Intra-operative (b) and immediate post-operative (c) pictures showing reconstruction of defect and stabilisation of atlanto-axial joint. 6 month post-operative radiograph showing loose left transarticular screw but maintained reduction and fixation of odontoid peg (d)

DISCUSSION

Odontoid fractures in the elderly are associated with high morbidity and mortality.[2] Odontoid fractures are usually the result of hyperflexion or hyperextension injuries to the cervical spine.[1] Most are type 2 fractures and potentially unstable. While there is consensus on surgical management of type 2 fractures in the young population, debate still continues on the most appropriate management option in elderly patients. One of the main downfalls of surgical management with anterior screws is the high rate of implant failure and nonunion resulting from inadequate fixation in the osteoporotic bone.[5] Significant bending forces are produced in extension, which result in anteroinferior cutout of odontoid screw due to the poor counter available to screw head from the osteoporotic base of the odontoid peg.[5,12] Our technique virtually reconstructs the odontoid peg with a fracture spanning stent. This allows the screw to have good purchase throughout with secure fixation and no intraoperative complications of cement leak. This is in addition to the protection from the anteroinferior cutout at odontoid base similar to "nonstent cement technique." There are no previous reports on the use of stents to manage type 2 odontoid fractures in the literature.

Stentoplasty has been shown to be effective in the treatment of vertebral compression fractures.[13,14] Besides providing a strong scaffolding to allow reconstruction of bony defects, they also act as barriers to cement leakage.[13,14] These unique advantages of stents coupled with the availability of minimally invasive kit prompted us to use them in odontoid peg, which has important structures in vicinity. We found stent particularly useful in the presence of internal communition, which produced a large defect in C2 vertebral body in our case 2. Anterior screw fixation alone would have failed to provide compression across the fracture site in the absence of cortical continuity. Cement augmentation alone to support the screw would have required a large amount of cement risking potential leak outside the peg. The stent successfully reconstructed the base and stalk of odontoid peg before the screw was placed to complete fixation. By this virtue, we believe that stents would also be ideal to treat unstable metastatic osteolytic lesion of axis, in which large defects would require a stronger scaffolding to withstand shear forces as the cement alone has been shown to be weakest in resisting shear.[15] Currently, most studies report only vertebroplasty as a treatment option with high rates of cement leak-related complications.[5]

Scholz *et al*. first described the technique of cement-augmented anterior odontoid screw fixation in two patients with extensive osteoporosis.[7] They reported good bone healing and no incidence of screw pullout in both their cases. Kohlhof *et al*. reported a larger study on 24 elderly patients undergoing cement-augmented anterior odontoid screws for type 2 fractures.[5] Three of their patients suffered an early loss of reduction, of which one required revision surgery. They reported one pseudoarthrosis and two malunions in the dorsal angulation. Asymptomatic cement leakage was observed in five of their patients, three into C1–2 joint and two into the fracture line. All their patients were given a soft collar for 8 weeks. They concluded that it is a technically feasible and safe procedure with a low complication rate. Our sample size, though small, highlights the robustness of stent along with cement and screws. Our patients did not require any cervical orthosis postoperatively. In case 2, a short period of soft collar was prescribed to tide over acute neck pain on discovery of the loose C1–2 screw. This was later discontinued. None of our patients suffered any loss of initial reduction and showed maintained reconstruction after 2 years of follow-up. This was in spite of large posttraumatic odontoid displacement and C1–2 instability in both our patients.

Waschke *et al*. reported on their results on 11 elderly patients who underwent anterior cement-augmented screw fixation.[16] They reported no intraoperative cement leak and uneventful recovery in all patients. Most of their patients showed CT-proven bony union at the end of 1 year of follow-up. However, they excluded patients with comminuted fractures and this may have led to better results. In real life, it is common to find a significant communition in osteoporotic patients who sustain C2 type 2 fractures. Inclusion of this group of patients would increase the perioperative complication and pseudoarthrosis rate. We did not consider it as an exclusion criterion, as stents can reliably bridge gaps left by communition and achieve good fixation.

Herren *et al*. reported on their outcome on 16 elderly patients with osteoporosis and type 2 odontoid fractures that they managed with anterior triple/quadruple screw construct to mitigate osteoporosis.[8] They reported one case of implant failure and good outcomes in others. They did not report on the presence of communition in any of their cases. Our technique can address both communition and osteoporosis through a single Jamshidi needle tract, which can be used to place the stent, cement, and cannulated screw.

Kočiš *et al*. reported a similar anterior triple screw construct on 13 elderly osteoporotic patients. In one patient, the implant failed in an early postoperative period requiring a reoperation and in two others ended with pseudoarthrosis, indicating approximately 25% failure rates.

Terreaux *et al*. reported two cases treated with balloon kyphoplasty.[11] In spite of inflating the balloons above and below the fracture, they reported the intraoperative leak of cement, although it did not lead to any clinically significant outcome. They reported good clinical and radiological outcomes. We feel that inflating balloon above the fracture site does not serve any significant purpose as the site, which provides hold to screw is the odontoid base which can be reliably cemented with Jamshidi needle alone. Cement leak still occurred in both the patients.

Our technique is an advancement over cement-augmented anterior screws. It allows the reconstruction of type 2 odontoid fractures with secure fixation even in the presence of significant communition. Coexistent gross C1–2 instability is an additional pathological aspect of these severe injuries, and anterior transarticular screws were added purely to address it. In the absence of gross C1–2 subluxation, a stent with cement-augmented screw alone should be adequate. The only exception would be a fracture line not amenable to anterior screw fixation. In such a scenario, a posterior Harm's type of fixation would be the preferred option.

CONCLUSION

Stentoplasty coupled with the anterior odontoid screw is a safe technique to provide biomechanically strong fixation of type 2 odontoid fractures in the presence of osteoporosis and significant communition. Anterior C1-2 transarticular screws can be added in the presence of C1-2 instability. A stent acts as a barrier to cement leak and safeguards vital surrounding structures. In our experience, the placement of the stent does not lengthen the operative time significantly.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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