Anterior Placement of Cemented Fenestrated Screws in Conjunction with Anterior Reconstruction in Elderly Patients with Severe Vertebral Collapse and Paraparesis

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Abstract

Background: Elderly patients with severe osteoporosis are prone to sustain osteoporotic vertebral compression fractures (OVCF's). Sometimes, they undergo significant vertebral collapse and kyphosis, leading to significant canal compromise and neurological deterioration.

Case Description: We present a case series of three patients, of which two had OVCF's of L1 and L3, respectively, while one patient had Koch's spine D12 and L1. All three cases had severe vertebral collapse leading to kyphosis, severe pain, and canal compromise, neurological deterioration with paraparesis, and bowel bladder involvement. Surgery warranted total corpectomy of fractured vertebrae (anterior vertebral column resection) and reconstruction of the anterior column. Due to the significant degree of osteoporosis, fenestrated screws with bone cement (poly methyl acrylate) were used anteriorly along with vertebral body reconstruction with cage, through a purely anterior approach. This is the first instance of fenestrated screws being used anteriorly to reduce screw pull-out. In view of the strong anterior construct, a posterior surgery to supplement the fixation could be avoided in these thoracolumbar junctional cases.

Results: No patient experienced loosening of implants, nor did any patient experience cement-related complications. Although the present follow-up of these patients is short (12 months), the patients are pain free and independently ambulatory.

Conclusion: Using fenestrated screws in an anterior location allow vertebral reconstruction with a single surgery in elderly patients with severe osteoporosis, reducing chances of screw pull-out. Bone plugs at the tip to help prevent cement extravasation from the vertebral body.

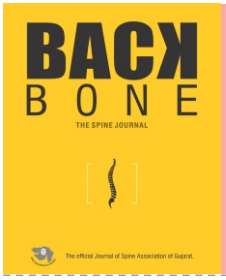
Keywords: Anterior fenestrated screws, Bone cement, Corpectomy, Osteoporotic vertebral compression fracture, Koch's spine, Screw pull-out.

Introduction

Spinal osteoporosis afflicts 42.7% of the Indian population and the incidence continues to grow as we tackle an aging population [1]. Moreover, modern science has increased human longevity in India from 55 years in the 1980s to almost 71 in 2020 [1]. It has been well established that patients with spinal osteoporotic fractures have a lower forced vital capacity (FVC) and forced expiratory volume 1 as compared to patients without fractures [2]. Moreover, each vertebral fracture decreases FVC by 9% [3]. Furthermore, women with vertebral fractures with severe kyphosis were 2–3 times more likely to die of pulmonary causes then those without fractures [4].

Percutaneous vertebroplasty, percutaneous kyphoplasty, VP in conjunction with fixation (standard or fenestrated screws), corpectomy, and fusion are variable options for osteoporotic vertebral compression fracture (OVCF), depending on collapse of the vertebral body [5, 6, 7, 8].

Early studies on cement augmented anterior screws have been published at the turn of the century [9, 10, 11]. Clinical application of fenestrated screws, with a cannulated design, has been in use since 2005 [12]. However, all reports subsequently, have described their clinical use through the transpedicular route [13, 14, 15, 16]. We have used these fenestrated screws through an anterior approach and have placed these screws anteriorly in the vertebral body, for the 1st time.



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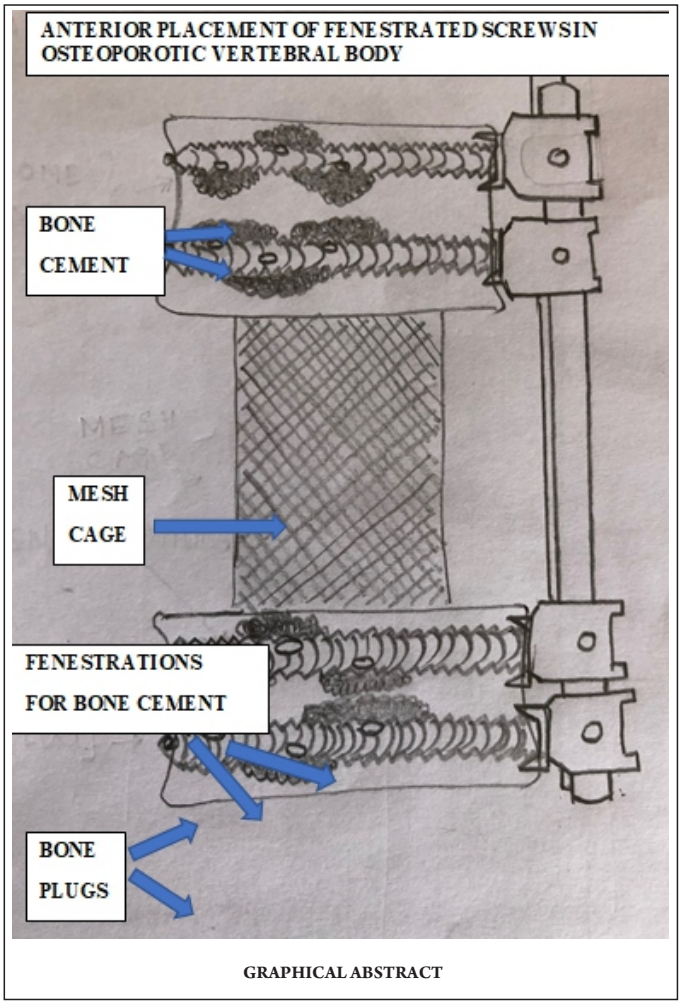

GRAPHICAL ABSTRACT

Case Series

We describe two cases of elderly females with OVCF and one case of Koch's spine with severe vertebral collapse, resulting in severe kyphosis and canal compromise. These patients were managed with a vertebral corpectomy, spinal reconstruction with mesh cage, and bone graft, and stabilized with anteriorly placed fenestrated screws, along with bone cement. This is the first clinical instance of fenestrated screws being placed in an anterior location. All these patients were provided with thoracolumbar brace and were started on anti-osteoporotic medication.

Case 1– A 67-year-old female with back pain, radiating to both legs; following a domestic fall, presented with increasing difficulty in sitting and gradual paraparesis over 2 months. Her MRI revealed significant collapse of L1 vertebral body with compression over cauda equine.

Surgery– She underwent corpectomy of L1 through an anterior approach with stabilization from D12 to L2, with anterior fenestrated screws and cement. L1 was reconstructed with mesh cage and rib graft as well as iliac crest bone graft. Anteriorly placed screws require bi-cortical purchase, so to prevent spillage of cement from the tip of these fenestrated screws, we used bone wax to block the flow of cement. However, the bone wax was not able to withstand the force of the cement, and got dislodged, allowing the cement to spill from tip of screw. In our consecutive patients, we impacted a small piece of bone in the tip of fenestrated screw, which was successful in preventing cement spillage from the tip of screw (Fig. 1).

Case 2– She was a 68-year-old female with back pain, paraparesis, and bowel and bladder involvement for 6 weeks, suspected of having Koch's spine D12-L1.

Surgery- She underwent L1 complete and D12 partial corpectomy with anterior stabilization from D11 to L2 with fenestrated screws and mesh cage reconstruction. We impacted a bone plug over the tip of the fenestrated screws in this case to prevent cement spillage. The screw in D12 was not the fenestrated variety, and hence, not augmented with cement, as there was possibility of some infection in D12; whereas, the screws in D11 and L2 were fenestrated as it was uninfected bone (Fig. 2).

Case 3 - Our third patient was a 60-year-old female with history of rheumatoid arthritis, presented with backache, paraparesis, bladder, and bowel involvement since 4 weeks. She was on steroids for the past 3 months. Her MRI revealed complete collapse of L3 with significant compression over cauda equina.

Surgery- She underwent L3 corpectomy with L2 to L4 stabilization with anteriorly placed fenestrated screws and

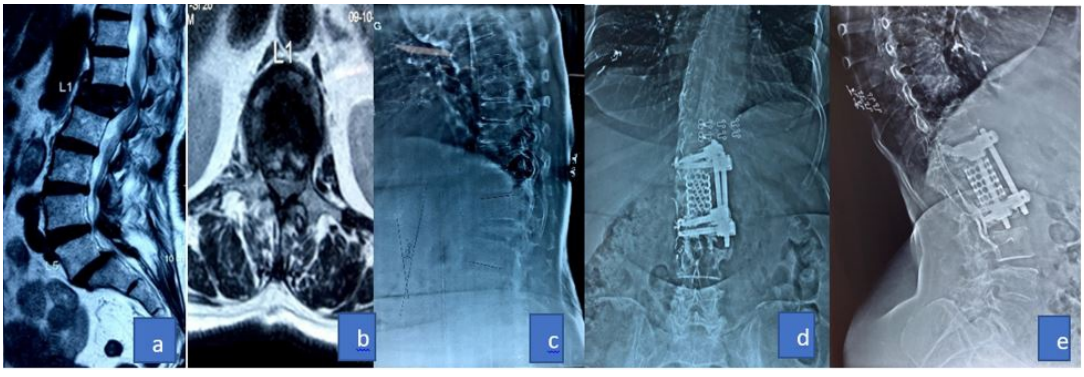

Figure 1: (a) Pre op MRI sagittal scan showing L1 OVCF with collapse and retropulsion with cord compression, (b) Pre op axial scan MRI showing cord compression at L1 level, (c) Pre op lateral x-ray showing L1 compression fracture with severe collapse, (d & e) Post op antero-posterior and lateral x-ray showing L1 corpectomy with D12 to L2 fixation with anteriorly placed fenestrated screws and cement with fusion by mesh cage with local bone graft and rib graft.

Figure 2: (a & b) Pre-op T2 weighted sagittal and axial scan MRI showing D12 & L1 Kochs with severe collapse and cord compression. (c) T1 weighted image showing D12-L1 spondylodiscitis with collapse and collection with cord compression. (d) Pre op axial scan CT at level of L1 showing significant bone destruction and canal compromise, (e & f) Post-op antero-posterior and lateral x-ray showing D12 partial and L1 complete corpectomy with D11 to L2 fixation with anteriorly placed fenestrated screws with cement and fusion with mesh cage and iliac crest bone graft. (g) Histopathology report of biopsy showing tuberculous osteomyelitis.

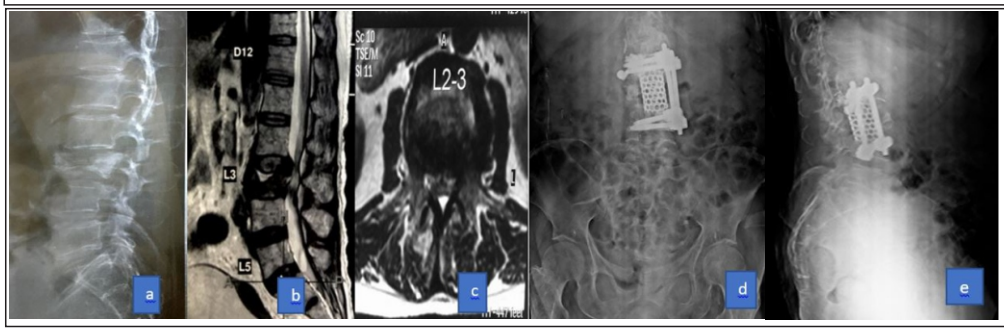

Figure 3: (a) Pre-op lateral x-ray showing L3 OVCF, (b & c) T2 weighted sagittal and axial scan MRI showing L3 OVCF with severe collapse and cord compression. (d & e) Post-op antero-posterior and lateral x-ray showing L3 complete corpectomy with L2 to L4 fixation with anteriorly placed fenestrated screws with cement and fusion with mesh cage and iliac crest bone graft.

bone plug impacted over tip of screw. Mesh cage with iliac crest bone graft was used for anterior reconstruction through anterior retroperitoneal approach (Fig. 3).

Results

All three patients had successful anterior column reconstruction, with stable fixation, despite having poor bone quality. Despite two cases being at the thoracolumbar junction, we were able to accomplish sufficient stability from the anterior construct alone, to avoid a second posterior surgery. None of the patients experienced any cement related complications, such as intra- or post-operative hypotension or drop in oxygen saturation. Case 2 began ambulation on day 4 and has achieved unsupported ambulation in 6 weeks. Neurological improvement was visible at 4 months, in the two patients who presented with paraparesis. Follow-up X-rays at 6 months have shown stable fixation without any collapse or implant loosening. Further follow-up at the 1-year interval demonstrated excellent stability of all three constructs with all patients achieving full unsupported ambulation. The patients will be subsequently evaluated on an annual basis.

Discussion

In patients with OVCF and Koch's spine complicated with severe vertebral collapse, requires complete corpectomy and fusion, which is better achieved with anterior approach and reconstruction of anterior column. However, when confronted with these problems in elderly patients with severe osteoporosis, doubt exists about the long-term stability of the anterior construct alone. Cemented fenestrated screws have been utilized in such patients to provide additional support and albeit in a transpedicular manner [13, 14, 15, 16]. Numerous studies demonstrate that poly methyl methyl acrylate (PMMA) augmentation can increase the screws' pull out strength in osteoporotic and normal vertebrae [17]. PMMA augmented that pedicle screws can improve implant's primary stability and its resistance to axial forces that promote screw pull out [18, 19].

Qi Liao reported good to excellent outcomes in the anterior decompression group up to 94.3%, in a study of anterior decompression on spinal osteoporotic fracture whereas, that of the control group was 78.6% [20]. We improvised the scenario to insert the screws in an anterior location to provide a long-term stable construct, thus avoiding a second posterior surgery. These cannulated screws have holes at the tips to facilitate cement flowering around the screw within the vertebral body. However, using them anteriorly would allow the cement to leak in an extraosseous location. We inserted bone pieces at the tip of the screw to block the cement egress from the tip and facilitate the cement flowering from the remaining fenestrations in the screw to achieve a stable construct. Stable and rigid primary fixation avoided second posterior surgery and implantation.

We did not experience any untoward outcome or incident during the management of these three patients. Although this is a very small series, it allows a new door to be opened in the management of OVCFs with severe collapse, wherein anterior surgery is indicated. This kind of stable construct allows long-term management of the patient with a single surgery and also provides the surgeon with peace of mind.

Although ours is just a small case series of three cases, we shall continue follow-up of these cases and shall be back with a larger series. Our limitation is that we have not been able to compare them with a front and back series for similar such case scenarios.

Conclusion

We, hereby, present anterior placement of fenestrated screws with cement which has not been done or documented by anyone in the past. This is the first clinical instance of fenestrated screws being placed in the thoracolumbar spine in an anterior location. We were able to demonstrate the safety and efficacy of utilizing PMMA augmented fenestrated screws placed anteriorly during the anterior reconstruction of thoracolumbar vertebrae. We were also able to avoid a second posterior approach for these patients with paraparesis, severe canal compromise, and bowel and bladder involvement. This paper opens new avenues for undertaking anterior surgery only in patients with thoracolumbar OVCF & Koch's with severe collapse.

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Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

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