

New Approach to Filling a Corpectomy Defect by Stacking Multiple Peek Cages around a Fibula Strut Graft: A Technical Note

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Abstract

Study background: Fibula strut grafts alone during anterior cervical corpectomies have some inherent vulnerability. In contrast PEEK (Polyetheretherketone) cages are more stable but need separate graft material for interbody fusion. The opportunity therefore exists to combine the positive attributes of a fibula strut graft and a PEEK interbody cage for corpectomy. The authors aim to illustrate the use of stacking multiple PEEK cages around a fibula strut graft for cervical corpectomy.

Methods: We present two illustrative cases of the technique of stacking three PEEK cages around a fibula strut graft (group 1). Cases were compared to cohort of 15 patients (group 2) with 3 level anterior cervical discectomy and fusion (ACDF).

Results: Average age and BMI for group 1 was 52 years and 36.9 kg/m² compared to group 2 average age 59 years and BMI 25 kg/m², p=0.53 and 0.21 respectively. Mean preop VAS neck score in group 1 of 8.5 compared to group 2 of 6.5, p=0.08. Preop NDI in group 1 of 52 compared to group 2 of 43.4, p=0.355. There was no statistical difference in post op outcomes at 6, 12 and 24 months, p>0.05. There was no evidence of construct failure, subsidence, or focal kyphosis in either group which was demonstrated on CT radiograph.

Conclusion: We have illustrated technique of combining the strength of a fibula strut graft for achieving fusion and PEEK cages for stability and favourable modulus of elasticity of that the vertebrae. The assessment of outcome scores demonstrated similar efficacy of treatment. There were no reported major complications in either group. Further application of this approach is the next steps to establish this technique's efficacy.

Keywords: Corpectomy defect; Stacking multiple PEEK cage; technical note

Introduction

Fibula strut grafts have a proven history of effectiveness for anterior cervical corpectomies but are inherently vulnerable to complications such as early or late fracture, dislodgement, displacement, telescoping into the vertebral body, or non-union [1-4]. The settling and resultant segmental kyphosis after multi-level anterior cervical reconstruction has also been documented [5-7]. The risk of graft migration, displacement, or fracture is more likely with more vertebral bodies removed and longer grafts [3,7] and with corpectomies involving a fusion ending at the C7 vertebral body [6]. Newer interbody stabilization options include polyetherketone (PEEK) which has the advantage of greater endplate coverage leading to a more stable construct, and similar modulus of elasticity as bone [8]. However, PEEK cages require separate graft material for interbody fusion. Other options include metal expandable cages [9-11] but these can be bulky, risk adjacent body fracture, and have limited room for bone graft; and therefore, do not provide the most ideal biologic environment [12]. Stacking PEEK cages end to end over a fibular allograft is a novel method to fill the corpectomy void in order to achieve a modulus of elasticity similar to bone, accommodate bone graft substrate, and provide appropriate structural support and height restoration. Here we describe technique steps to stack PEEK cages around fibula strut grafts during ACDF.

Materials and Methods

Illustrative case 1

A 48 year old man referred with a massive C5- 6 herniated disc and Modic endplate changes [13] on magnetic resonance imaging (MRI) and 5-/5 weakness and diminished sensation in the C6 distribution

(Figure 1). This patient's radiculomyelopathy was attributed to the C5-6 herniated disc, and subsequently he underwent ACDF. Six weeks postoperatively the patient still had residual pain and bilateral arm numbness. Repeat MRI illustrated improvement but computed tomography (CT) showed large posterior osteophytes causing residual stenosis at the level of the C5 and C6 endplates along with functional compression at C3-C4. He underwent revision C5 corpectomy and C3-4 ACDF.

Operative technique

Patient is placed supine under general anesthesia with extension of neck. A transverse anterior incision is made at C5 operative level. Exposure of anterior cervical spine using standard technique, and longus colli muscle elevated laterally. Identification of disc space was performed using a probe and fluoroscopy. Distraction pins were then placed in the bodies of C4 and C6. Total discectomy was performed at C4-5, 5-6. A Leksell was then used to perform corpectomy on C5

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Figure 1: Preoperative sagittal MRI patient 1.



Figure 2: Intraoperative photo showing end of fibula graft with remainder within the cages patient 1.

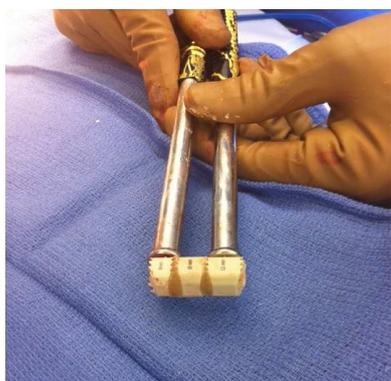


Figure 3: Three PEEK cages stacked around the fibula strut graft with DBM packed in the spaces – patient 1.

vertebral body and Kerrison ronguers used to complete corpectomy. We measured a 30 mm long fibula strut graft. The fibula strut allograft was fashioned and cut in half length wise and placed through the inside of three PEEK cages for a total length of 30 mm (12 mm, 10 mm, 8 mm) (Figures 2 and 3). The remaining space inside the PEEK cages was filled

with autograft and DBM. The combined cages and fibula strut graft were placed in the trough and distraction pins removed to allow the C4 and C6 vertebrae to collapse around the construct. Demineralized bone matrix (DBM) and autograft corpectomized bone were placed alongside the fibula strut graft. DBM was placed in front of the cages and behind the plate at all levels. Disc space was then prepared in standard fashion for C3-4. An 8 mm cage (Eminent Spine, Texas) filled with autograft bone and DBM was placed at C3-4 and A 60 mm cervical plate with appropriate lordotic curve was placed with screws in C3, C4, and C6. (SpineFrontier Inc., Indus Invue Plate).

Illustrative case 2

Our second case presentation is of a 55 year old female with a traumatic fracture-dislocation of C6-7 and a massive herniated disc as well as C5-6 herniated disc (Figure 4). After performing a 2 level discectomy and corpectomy using similar operative technique, the corpectomy trough was prepared. The defect measured 23 mm so on 7 mm and two 8 mm cages were used. A piece of fibular allograft was cut to 23 mm shaved down to fit inside the cages. After packing with DBM, a 37 mm plate was contoured and secured. The patient did well post operatively with maintained neurologic status and uneventful progression to resumption of normal activities at 4 months.

The outcomes of these two patients (group 1) was compared to cohort of 15 patients (group 2) were anterior cervical decompression and fusion was performed using PEEK cages at three consecutive levels. Outcomes included VAS neck scores, NDI and fusion rates.

Statistical analysis was performed using SPSS v.22 IBM Corp, New York.

Results

Average age and BMI for group 1 was 52 years and 36.9 kg/m² compared to group 2 average age 59 years and BMI 25 kg/m², p=0.53 and 0.21 respectively. Mean preop VAS neck score in group 1 of 8.5 compared to group 2 of 6.5, p=0.08. Preop NDI in group 1 of 52 compared to group 2 of 43.4, p=0.355. Post op VAS and NDI scores were assessed at 6 month; 12 month and 24 month follow up. There was no difference noted in outcomes (Tables 1 and 2).

Follow up

The most common complication reported in both groups included residual pain and tingling. At one year our first patient experienced mild residual complaints of neck pain, numbness and tingling but was



Figure 4: Preoperative sagittal MRI patient 2.

Post op VAS	Group 1	Group 2	P values
6 month	5	5.8	0.08
12 month	3.5	4.5	0.48
24 month	4	3.3	0.86

Table 1: Post-operative visual analog scale (VAS) scores.

Post op NDI	Group 1	Group 2	P values
6 month	48	39.2	0.792
12 month	30	32.3	0.142
24 month	23	27.8	0.491

Table 2: Post-operative neck disability index (NDI) scores.

fibular allografts may be at increased risk of graft failure. Patients with a smoking history may be at further risk for unfavorable outcomes without a stable fibula strut graft after corpectomy

PEEK cages have good biomechanical characteristics and a comparable elastic coefficient to that of human bone. ACDF with a PEEK cage has shown good clinical results for single level cervical disorders [17-21]. Stacking multiple cages provides adequate height restoration in a modular construct to fill corpectomy defect with the ease of implant placement. This is a much more cost efficient method than expensive expandable cages. Filling the PEEK cages with fibular allograft strips results in a stable construct by providing an internal frame that prevents the cages from becoming dissociated. The end result of this technique is a corpectomy construct that has a similar elastic coefficient to bone, stability of an expandable cage, modularity to fit the corpectomy defect in a stable and convenient construct.

Our study has demonstrated no statistical difference in outcomes between the patients who were treated with stacked PEEK cage and fibula strut technique compared to patients who had three level ACDF performed. There were no readmissions in either groups but patients noted residual pain although improved. The authors note the limitations of being a small sample with a matched cohort of three levels ACDF.

We have illustrated a new technique in which we combined the favourable attributes of a fibula strut allograft for achieving fusion and PEEK cages for stability and similar modulus of elasticity to that of the vertebrae. As these were both fibula allografts there was no associated



Figure 5A: Postoperative sagittal CT radiograph of patient 1 with stacked PEEK cages in situ.



Figure 5B: Postoperative axial CT radiograph of patient 1.

much improved overall. Our 2nd patient only noted residual pain although markedly improved.

Fusion was achieved at 12 months in 1st patient, 6 months in 2nd patient in group 1. At two year follow up CT showed evidence of graft consolidation consistent with fusion in 1st patient (Figure 5A and 5B) and 2nd patient Figure 6A and 6B. The plate and screws were stably fixed. There was no evidence of construct failure, subsidence, or focal kyphosis. Comparing fusion rate of group 2 fusion was achieved as early as 6 months. At two years follow up CT showed evidence of graft consolidation (Figure 7A and 7B).

Discussion

Although fibula strut grafts are historically an effective option for anterior cervical corpectomy, they are vulnerable to complications as the number of levels decompressed increases [1,3,6,7,14]. Associated donor site morbidity is an additional consideration [15,16]. Patients often have compliance difficulties with cervical bracing when fibula strut grafts are used without plating. Patients with buttress plating of



Figure 6A: Postoperative sagittal CT radiograph of patient 2 with stacked PEEK cages in situ. Indication for surgery was a fracture-dislocation C6-7 and herniated nucleus pulposus C5-6 and C6-7.



Figure 6B: Postoperative axial CT radiograph of patient 2.



Figure 7A: Postoperative sagittal CT radiograph demonstrating fusion.

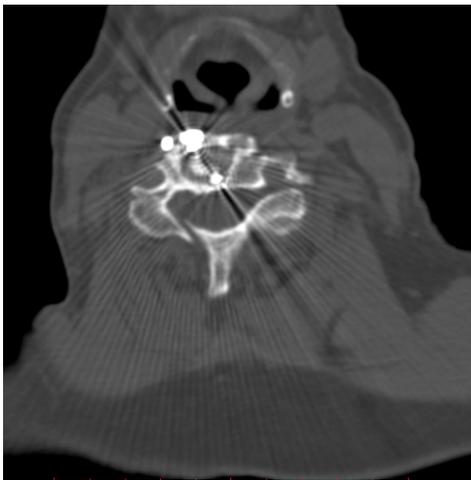


Figure 7B: Postoperative axial CT radiograph demonstrating fusion.

donor site morbidity. The benefits of this technique are intuitive, but further experience and technological investigation with larger sample sizes into stackable PEEK cages combined with osteobiologics are needed to advance this technique's options in the cervical and lumbar spine.

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