Anterior cervical discectomy and fusion using polyetheretherketone (PEEK) cage

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Abstract

Introduction: There are ways to operate for herniated cervical disc starting from simple discectomy to artificial disc replacement.

Methods and Materials: This is a prospective study of anterior cervical discectomy and fusion with polyetheretherketone (PEEK) age device conducted from January 2016 to September 2019. Age, sex ratio, level of disc prolapses, symptoms, complications of surgery and the outcome was assessed. Neurological assessment was done pre and postoperatively as defined by Odom's criteria and Ranawat et al grading system. Check x-ray was done at three and six months.

Results: The total number of cases was 82, predominantly males (62%). Disc prolapse due to degenerative disease was the most common case (68%). C5-6 was the most often disc prolapse level (40%), followed by C6-7 level (38%) and multiple level disc prolapse in 12%. Applying Ranawat grading system of neurological deficit; at presentation, majority were in Grade II (54%), followed by Grade IIIA (19%). Postoperatively there was reduction in weakness from 54% to 16% in Grade II and from 19% to 8% for Grade IIIA. Majority had excellent and good outcome based on Odom's criteria. The continuity of the graft and the adjacent spinal curvature was also assessed and there was more than 96% fusion rate.

Conclusion: Use of local autograft with a PEEK cage has a benefit of working within the same operative window as the ACDF, thus reducing the infection, bleeding, and pain risks that may be encountered with a second incision. It is very safe to use in single level or multilevel cervical disc prolapse and also saves additional time of harvesting graft from the donor site.

Key words: Anterior Cervical Discectomy and Fusion (ACDF), Casper plate, Cervical disc prolapse, Polyetheretherketone (PEEK) cage.

Introduction

Anterior decompression of the cervical spine was first introduced by Smith and Robinson and it was established by Cloward in 1948.[1]This technique has been accepted as the standard procedure for the treatment of myelopathy and radiculopathy in the cervical spine [2,3] Anterior cervical discectomy with interbody fusion (ACDF) is the surgical procedure of choice for cervical discogenic diseases. Use of anterior iliac bone graft for anterior interbody fusion has been the gold standard for decades. Although highly successful fusion is achieved by autogenous iliac bone graft, various studies have documented iliac donor site complications [4,5] These complications include persistent donor site pain, infection, haematoma formation, iliac crest fracture, and meralgia parasthetica.

To prevent these complications, cages have been studied and applied in humans as potential bone substitutes for autograft in interbody fusion. The criteria required for an ideal cage for cervical interbody fusion are the following: providing immediate stability, maintaining spinal alignment and foraminal height, achieving higher or at least equal fusion success rate, and obviating complications by using autograft. Titanium or carbon fibre cages were widely used for cervical interbody fusion, but subsidence, migration, and structure failure have occurred.[6,7]Polyetheretherketone (PEEK) is a non-

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absorbable biopolymer that has been used in a variety of industries including medical devices. The PEEK cages are biocompatible, radiolucent, and have modulus of elasticity similar to the bone.

This study was to evaluate the clinical and radiographic outcome of patients who underwent anterior cervical discectomy and fusion (ACDF) using polyetheretherketone (PEEK) cage filled with cancellous allograft bone.

Methods and Materials

This is a prospective study of all patients who underwent anterior cervical discectomy and fusion surgery using PEEK cage. This study was conducted at National Trauma Center (NTC), National Academy of Medical Sciences (NAMS) Bir hospital and Department of neurosurgery, Norvic International hospital, Kathmandu, between January 2016 till September 2019. Institutional review board (IRB) approval was taken from the hospitals for the study. Consent was taken from the patients if they were able to write and from the next of kin if they were not able to give consent. Only the cases with degenerative disc disease and traumatic disc prolapse were included in this study. The age, sex ratio, the level of disc prolapses, symptoms, complications of surgery and the outcome based on Odom's criteria and Ranawat classification of neurological deficit was assessed.The surgery was performed when the patient had myelopathy or radiculopathy with progressive neurological deficit, or failure of conservative treatment (a minimum of 3 months). All the operations were done by the same surgeon.

Operative technique: Neurological assessment using Ranawat grading system and Odom's criteria, was done pre- and postoperative. All these patients were kept in a supine position, and the neck was extended at 10-15 degrees. All the surgeries were done from the right side. A fluoroscope was used to confirm the level. A transverse skin incision was used. The anterior cervical disc was approached using the method described by Smith and Robinson. A Caspar screw distractor was used to allow distraction of the disc space throughout the procedure. Under the microscope, the anterior longitudinal ligament and annulus were incised, and the anterior contents of the disc space were removed with curettes and pituitary rongeurs. Care was taken to remove all cartilage from beneath the anterior inferior lip of the rostral vertebral body and to remove a few millimeters of the anterior longitudinal ligament from the rostral vertebral body without use of monopolar cautery. A 2 mm Kerrison punch then was used to remove the anterior inferior lip of the rostral vertebral body, and this bone was saved for grafting. No bone wax was used within the disc space. After all disc space cartilage was removed from the endplates, additional bone was obtained from the uncovertebral joints and posterior vertebral bodies as the decompression proceeded posteriorly. An optimal PEEK cage was selected following completion of discectomy and endplate preparation. Optimal size was selected by using a temporary metallic measurement rod, looking at its grip between the end plates and correct alignment in fluoroscopy. The inner cavity of the PEEK cage was filled with cancellous allograft bone. The PEEK cage with allograft was impacted into disc space for fusion after adequate distraction with the use of Caspar distractor (Figure 1a and 1b).

Fluoroscope was used in all cases after impacting the cage to see its alignment. In multiple level surgeries, additional Casper plating was done (Figure 2a, 2b)

Drain was kept in all the cases and removed after two days.

After surgery, patients with traumatic disc prolapse were asked to wear a hard-cervical brace for 3 months. Check x-ray was done next day and at 3 and 6 months.

Clinical and radiological outcome assessed at 6 months. Fusion was assessed by looking presence of bridging trabecular bone between the endplates, absence of a radiolucent gap between the graft and endplate, absence of or minimal motion between adjacent vertebral bodies on flexion-extension radiographs, and absence of or minimal motion between the spinous processes on flexion-extension radiographs.

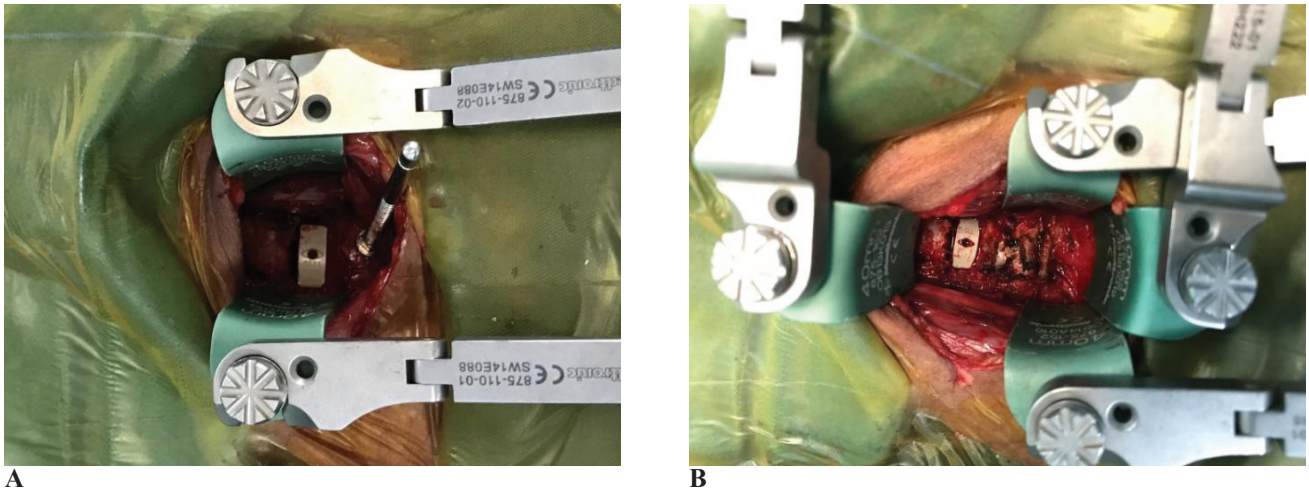
Results

The total number of cases was 82, with predominantly males (62%). The most common age group was between 31 to 50 years with a total of 51 cases (62%). Disc prolapse due to degenerative disease was the most common cause (68%) and rest was because of trauma (32%). C5-6 was the most common level of disc prolapse (40%), followed by C6-7 level with (38%). Disc at multiple levels was present in only 12%.

The most common presenting symptoms was radicular pain (56%) followed by radiculomyelopathy (27%) and myelopathy (17%).

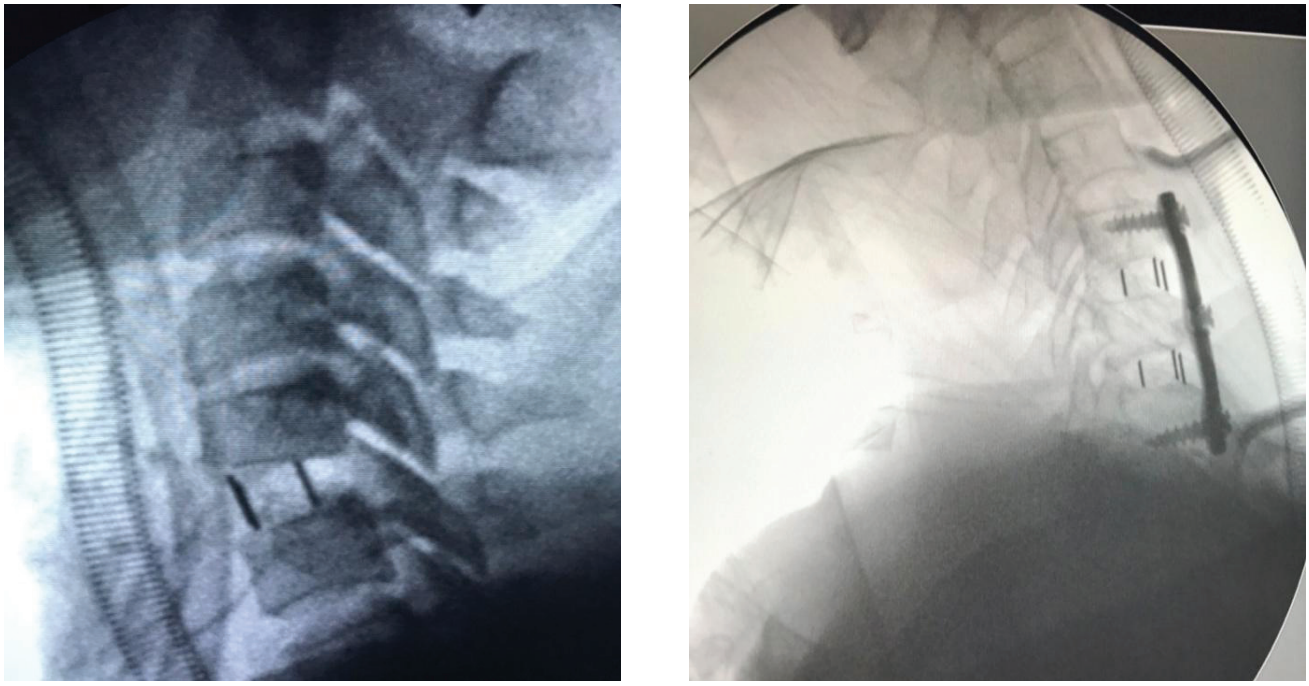
Clinical outcome assessed at 6 months using Ranawat grading system showed majority had Grade II (54%) followed by Grade IIIA (19%) neurological deficit which improved postoperatively (Table 1).

Odom's criteria were also used to evaluate the outcome according to which the majority had excellent and good outcomes. Average operating time was 47 minutes (35-90 minutes). Blood loss was less than 15ml (5ml to 35ml). Overall hospital stay was 5 days (3-7 days). Postoperative periods were uneventful; there were no complications related to this technique.



A B

Figure 1: (A) PEEK cage impacted in space in single level, and (B) double level surgery



A B

Figure 2: (A) Intra operative fluoroscopic images showing PEEK cage alone in single level surgery and (B) use of additional Casper plate in multilevel surgeries

Class	Description	Pre op grading (%)	Post of grading (%)
I	No neural deficit	12%	68%
II	Subjective weakness, dysesthesias and hyperreflexia	54%	16%
IIIa	Objective weakness and long tract signs; patient remains ambulatory	19%	8%
IIIb	Objective weakness and long tract signs; patient no longer ambulatory	15%	8%

Table 1: Ranawat grading of neurological deficit

Discussions

Anterior cervical discectomy and fusion (ACDF) is an established procedure for surgical treatment of cervical radiculopathy and myelopathy secondary to anterior compression from osteophyte or soft disc prolapsed.

Anterior cervical discectomy and decompression with interbody fusion can be a good surgical choice when conservative treatment for cervical disc herniation or cervical spondylosis fails.[9, 10,11,12] Although tricortical autograft harvested from the iliac crest as interbody fusion material can provide satisfactory clinical results and fusion rates[13,14] complication rates at the donor site are around 20%[14,15] and could be a potential disadvantage of this technique. Interbody cages provide initial stability and, by filling the disc space, require less structural bone graft and consequently reduce the morbidity associated with autogenous bone graft harvesting.[16,17,18,19] Different types of cages are available to perform ACDF, including titanium cages, carbon fiber reinforced polymer (CFRP) cages, and polyetheretherketone (PEEK) cages. Donor site complications can be omitted by making use of all of these cage types. Titanium cages can provide mechanical support, initial disc height maintenance, and restoration of sagittal lordosis; however, unfavorable outcomes were reported in some studies.[20,21,22] Kolstad et al. [18] reported several unfavorable outcomes following radiographic parameter analysis after ACDF using a cylindrical titanium cage. In another study, subsidence or migration of the titanium cage were observed, resulting in disc height collapse and kyphotic deformity.[23] Furthermore, metallic cages are radio-opaque, which prevents clear observation of trabecular bone formation and of radiographic fusion signs. Carbon fiber cages (CFC) can be safe and effective, and can lead to restoration of segmental alignment and solid fusion. [24,25] However, high rates of subsidence have been reported following ACDF using CFC (29.2%) in some studies.[26]

The absence of cytotoxicity and mutagenicity were demonstrated for a polyetheretherketone (PEEK) cage in an in vitro study.[27] With biocompatible, nonabsorbable, and corrosion-resistant abilities, the PEEK cage is thought to be a safe biomaterial spacer for spine surgery.[28] Moreover, the modulus of elasticity of PEEK is similar to that of bone.[29] This distinguishing feature is thought to be able to prevent cage subsidence induced by metallic cages. In an in vitro biomechanical study, the stiffness of the PEEK cage was statistically higher than that of the normal motion segment in flexion. The volume-related stiffness of the PEEK cage was higher than that of iliac bone in all directions.[30] These results show that polyetheretherketone could be manufactured as the optimal interbody spacer, providing an adequate volume for bone refilling and immediate mechanical stability in ACDF.[31] The PEEK cage is radiolucent and allows surgeon to better evaluate fusion status on radiographs or CT scans. In our series, all 96% achieved good solid fusion within 6 months using a PEEK cage filled with cancellous allograft bone chips.

Conclusion

PEEK cages alone packed with artificial bone granules can be used safely and effectively for the treatment of single or multi-level cervical disc disease. This method is considered a relatively safe and effective treatment modality. There is currently no consensus on the best surgical treatment method for anterior cervical discectomy, but the goal should be aimed towards achieving best clinical efficacy, restoration of cervical spine alignment, less post-operative complications and avoidance of adjacent segment degeneration.

Conflict of Interest: None
Source(s) of support: None

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