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Original Research

A Comparative Study between Anterior Cervical discectomy, Fusion & Fixation with Iliac Crest Graft and Plating Versus PEEK Cage and Screws in Cervical Degenerative DISC Disease

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Abstract

Background: Anterior cervical discectomy and fusion (ACDF) is a standard surgical approach for cervical degenerative disc disease (CDDD). Traditional fusion using iliac crest graft with plating is widely practiced, whereas polyetheretherketone (PEEK) cages with screws offer an alternative that may reduce donor-site morbidity and operative complications. This study compares clinical outcomes, complications, and radiological parameters between the two techniques. **Methods:** A prospective comparative study was conducted on 100 patients diagnosed with single or two-level cervical degenerative disc disease. Patients were divided into two groups: ACDF with iliac crest graft and plating (n=50) and ACDF with PEEK cage and screws (n=50). Demographic data, operative parameters, post-operative complications, Visual Analog Scale (VAS) for pain, and radiation exposure were recorded and analyzed. **Results**

- **Demographics:** Mean age was 44.44 ± 10.79 years in the plating group and 41.86 ± 11.24 years in the PEEK group. Male predominance was observed in both groups (74% vs. 66%).
- **Diagnosis Distribution:** Most commonly affected level was C5-6 (54% vs. 58%).
- **Complications:** Hoarseness, stitch abscess, mild dysphagia, persistent symptoms, and wound infection were minimal in both groups. No complications were observed in 43 (86%) of the plating group and 49 (98%) of the PEEK group.
- **Pain Outcomes:** Mean post-operative VAS scores were significantly reduced in both groups at 3, 6, and 12 months, with slightly lower scores in the PEEK group at 3 and 6 months ($p < 0.05$).
- **Radiation Exposure:** ACDF with plating required more intraoperative fluoroscopy compared to PEEK cage (94% vs. 2% requiring ≥ 5 shots).

Conclusion: The PEEK Cage group showed better post operative pain control, fewer donor site complications. PEEK cage is a safe and efficient technique.

Keywords: ACDF, PEEK Cage, Iliac Crest Graft, Cervical Degenerative Disc Disease, Fusion, Postoperative Pain, Radiation Exposure.

Introduction

Anterior cervical discectomy and fusion (ACDF) with fixation has been accepted as an effective surgical procedure in cervical degenerative disc disease (CDD). ACDF with fixation has good clinical outcomes and is comparatively safe, so it has become most commonly performed surgical procedure in CDD. Initially, discectomy with fusion was performed in CDD as times go on with modern implants started performing fixation which gives more stability to graft cervical degenerative disc disease most commonly occurs without preceding trauma, usually associated with herniated discs and occasionally forming spurs cervical radiculopathy referred to the symptoms due to nerve root compression it can be acute, subacute and chronic, can be caused by herniation of nucleus pulposus. Which will cause nerve root, thecal sac and cord compression depending on size and site of herniation which leads to symptoms like brachialgia, paresthesias and weakness.[1]

Stand-alone intervertebral cages made of a range of materials such as stainless steel, titanium, carbon fiber and polyetheretherketone (PEEK),[2,3] can be effective for restoring the intervertebral disc height and lordosis, providing load-bearing support to the anterior column and preventing graft collapse.[2,4] However, nonunion and subsidence into the endplates have been reported as the complications of this procedure,[2,3,5-8] which can eventually result in narrowing of the foramen, nerve root compression, pseudoarthrosis due to cervical instability,[9,10] and adjacent segment degeneration due to the loss of lordosis.[11,12]

The purpose of this study is to clinically compare standard anterior cervical discectomy and fusion with iliac crest grafting and anterior cervical plating versus anterior cervical discectomy fusion and fixation with PEEK cage using VAS score for clinical outcome and KIM's score for fusion.

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The visual analog scale (VAS) of pain intensity consists of a line, most often 100 mm long, with 2 descriptors representing extremes of pain intensity (eg, no pain and extreme pain) at each end. Patients rate their pain intensity by making a mark somewhere on the line that represents their pain intensity, and the VAS is scored by measuring the distance from the "no pain" end of the line.[13]

Kim's stage 1 lumbar fusion classification is end plate preserved stage when end plate is clearly defined directly related to the top and bottom of the cage, graft in the cage is not continuous with bone at end plate; stage 2 is end plate opening stage showed there is an opening with no clear definition of the rim of endplate bone directly above and below the cage, graft in the cage is not continuous with the endplate bone; stage 3 is bilateral sclerosis stage when both the end plates adjacent to the cage showed some sclerosis, graft in the cage is partly continuous with the end plate; stage 4 is fusion bridge formations stage when there is extensive sclerosis on the superior and inferior endplate which is continuous with the graft within and/or adjacent to the cage.[14]

AIM AND OBJECTIVES

To compare surgical procedure and clinical outcome using VAS score in standard anterior cervical discectomy and fusion with iliac crest grafting and anterior cervical plating with anterior cervical discectomy fusion and autologous bone grafts filled PEEK CAGE. And to compare graft fusion with KIMS grading between the two groups.

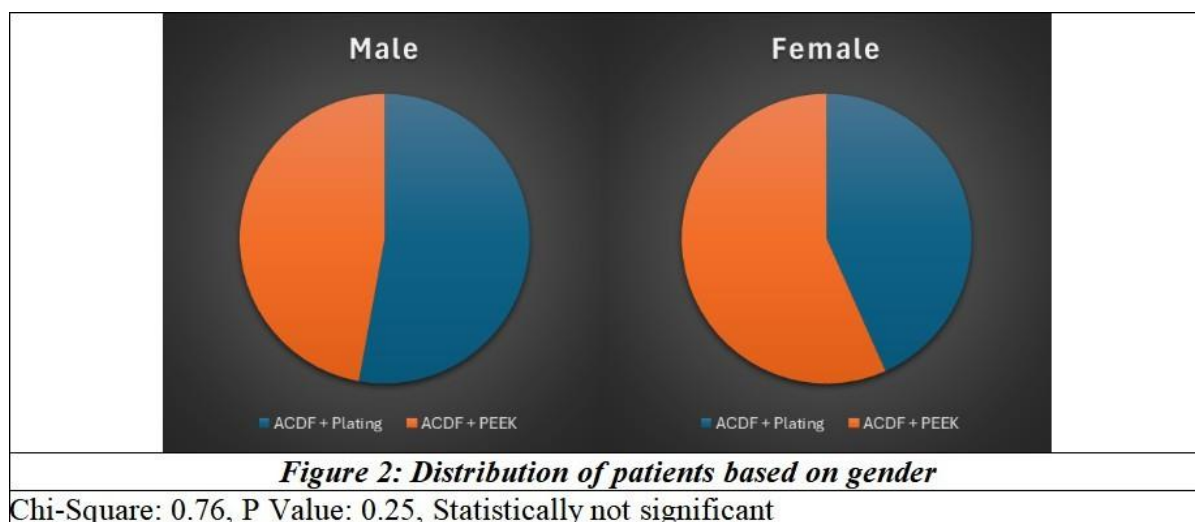
Materials and Methods

This is a Prospective observational study conducted in Shri Balaji institute of neurosciences and trauma, Hubli. From January 2018 to December 2021. Study population includes Patients attending OPD & IPD of Shri Balaji institute of neurosciences and trauma with complaints of cervical degenerative disc disease. Single and double level cervical herniated discs with age less than 70 years were included in study and Multiple level disc herniations, traumatic disc prolapse, infective disease, age more than 70 were excluded. On admission after obtaining consent from patient/patient attendants. Patients randomly made into two groups, one group of patients had undergone ACDF with iliac crest bone graft with anterior cervical plate another group with ACDF with autologous bone grafts filled PEEK cage. All patients were examined in pre and post op period with pre op MRI and radiograph. Pre operative and post op brachialgia with VAS score is analysed and Followup radiographs done to check fusion in regular intervals.

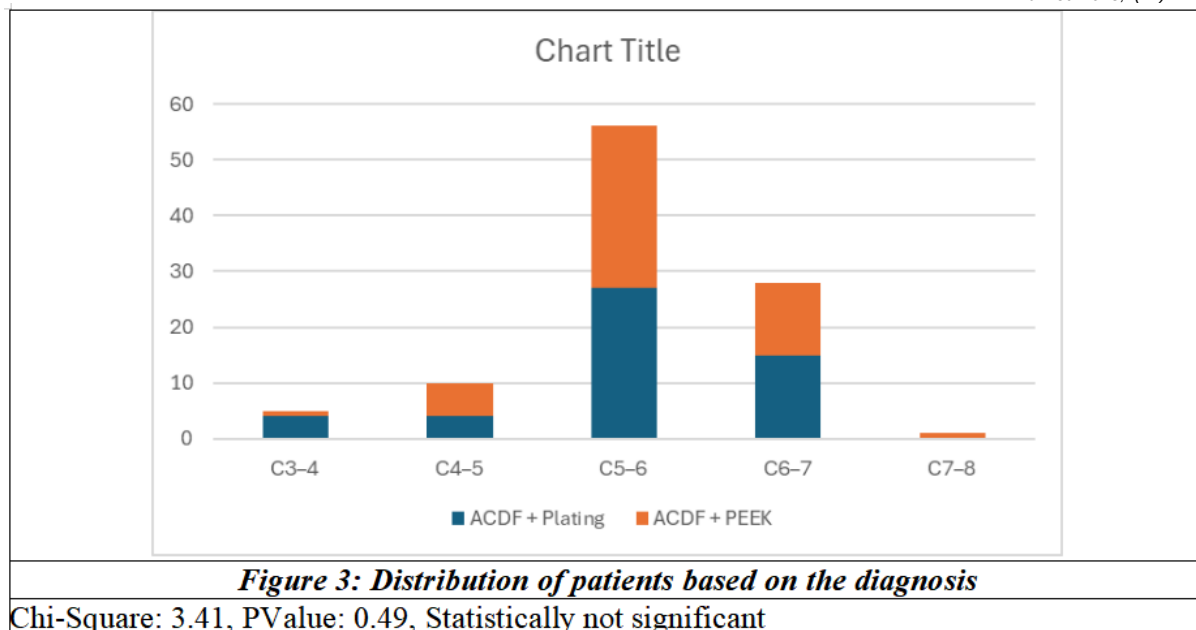
Results

Age Group	ACDF + Plating (n)	ACDF + PEEK (n)	Total
20-30 years	2	7	9
31-40 years	21	20	41
41-50 years	14	13	27
51-60 years	8	6	14
>61 years	5	4	9
Total	50	50	100
Mean $\pm$ SD, Plating: 44.44 $\pm$ 10.79, PEEK: 41.86 $\pm$ 11.24, Overall: 43.15 $\pm$ 11.04			
Chi-Square: 3.23, P Value: 0.51, Statistically not significant			
Table 1: Distribution of patients based on the age group			

Among ACDF + Plating group, majority of the patients belonged to 31-40 years (42%) followed by 41-50 years (28%), 51-60 years (16%), >61 years (10%) and 20-30 years (4%). Among ACDF + PEEK group, majority of the patients belonged to 31-40 years 26 (40%) followed by 41-50 years (26%), 20-30 years (14%), 51-60 years (12%) and >61 years (8%). The association between them was found to be statistically not significant.



Among ACDF + Plating group, males were 74% and females were 26%. Among ACDF + PEEK group, males were 66% and females were 34%. The association between them was found to be statistically not significant.



Among ACDF + Plating group, most common disc involved was C5-6(54%) followed by C6-7 (30%), C3-4 (8%) and C4-5 (8%). Among ACDF + PEEK group, most common disc involved was C5-6 (58%) followed by C6-7 (26%), C4-5 (12%), C3-4 (2%) and C7-8 (2%). The association between them was found to be statistically not significant.

	ACDF with Plating		ACDF with Peek		T Test	PValue
	Mean	SD	Mean	SD		
Pain score(VAS)	7.90	0.79	8.20	0.70	-2.00	0.04

Table 2: Distribution of patients based on the VAS score

Among ACDF + Plating group, mean pain score was 7.90 ± 0.79 . Among ACDF + PEEK group, mean pain score was 8.20 ± 0.70 . The association between them was found to be statistically significant.

			Group		Total
			ACDF with Plating	ACDF With PEEK	
Comorbidities		n	3	1	4
		%	6.0%	2.0%	4.0%
		n	5	6	11
		%	10.0%	12.0%	11.0%
	HTN, DM	n	2	3	5
		%	4.0%	6.0%	5.0%
	Hypothyroidism	n	1	0	1
		%	2.0%	0.0%	1.0%
		n	1	0	1
		%	2.0%	0.0%	1.0%
		n	38	40	78
		%	76.0%	80.0%	78.0%
Total		n	50	50	100
		%	100.0%	100.0%	100.0%

Table 3: Distribution of patients based on the comorbidities

Table 3: Distribution of patients based on the comorbidities

Chi-Square: 3.34, PValue: 0.64, Statistically not significant. Among ACDF + Plating group, DM was present in 6% patients, HTN was present in 10% patients, HTN + DM was present in 4% patients, hypothyroidism was present in 2% patients and IHD was present in 2% patients. Among ACDF + PEEK group, DM was present in 2% patients, hypothyroidism was present in 12% patients and HTN + DM was present in 6% patients. The association between them was found to be statistically not significant.

	ACDF With Plating		ACDF with PEEK		T Test	P Value
	Mean	SD	Mean	SD		
Duration of the Procedure (in min)	116.40	15.87	91.44	3.85	10.80	0.001

Table 4: Distribution of patients based on the duration of the procedure

Among ACDF + Plating group, mean duration of the procedure was 116.4 ± 15.87 min. Among ACDF + PEEK group, mean duration of the procedure was 91.44 ± 3.85 min. The association between them was found to be statistically significant.

	ACDF with Plating		ACDF with PEEK		T Test	P Value
	Mean	SD	Mean	SD		
Blood loss(in ml)	73.000	20.5287	50.000		-	-

Table 5: Distribution of patients based on the amount of blood loss

Among ACDF + Plating group, mean blood loss was 73 ml and among ACDF + PEEK group, mean blood loss was 50 ml.

C-Arm Shoots	ACDF + Plating (n)	ACDF + PEEK (n)	Total
Nil	0	49	49
2 Shoots	0	1	1
5 Shoots	47	0	47
6 Shoots	3	0	3

Total	50	50	100
Table 6: Distribution of patients based on the number of C- Arm shoots			
Chi-Square: 100, P Value: 0.001, Statistically significant			

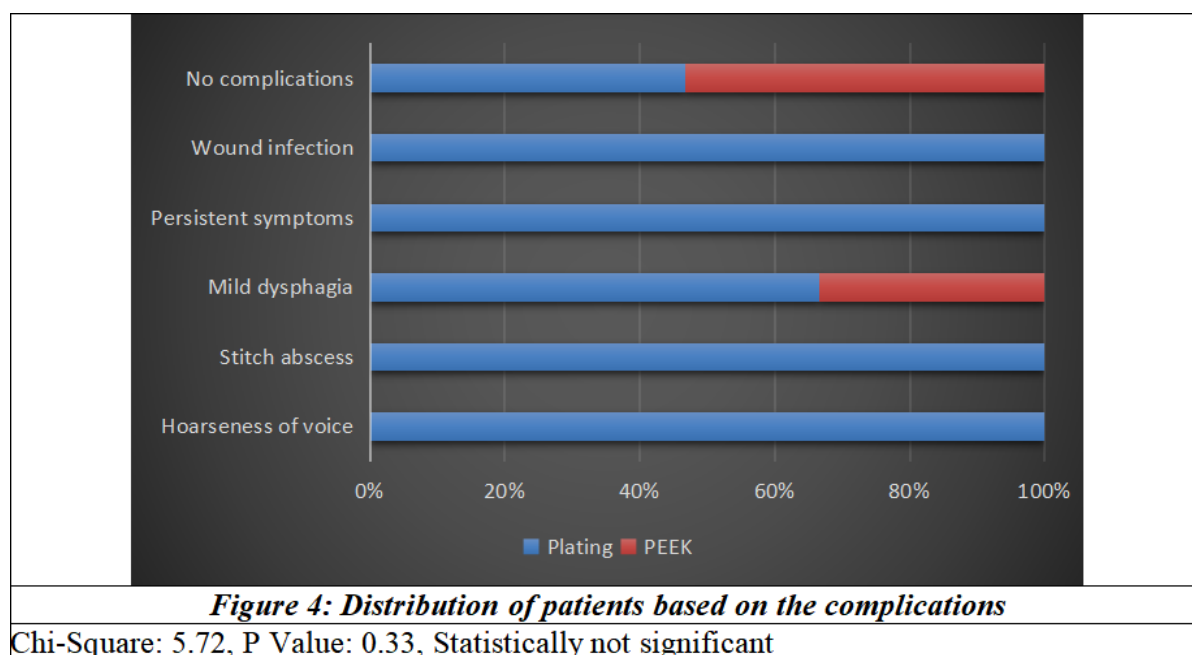
Among ACDF + Plating group, number of C- Arm shoots were 5 in 94% patients and 6 in 6% patients. Among ACDF + PEEK group, number of C- Arm shoots were 2 in 2% patients. The association between them was found to be statistically significant. As shown from the observed data,

ACDF + PEEK → Almost no radiation exposure
ACDF + Plating → 5-6 shoots for most patients

Time Point	ACDF + Plating (Mean ± SD)	ACDF + PEEK (Mean ± SD)	t-test	P-value
3 Months	2.06 ± 1.09	1.60 ± 0.75	2.44	0.01
6 Months	1.42 ± 0.75	1.16 ± 0.37	2.17	0.03
12 Months	0.46 ± 0.50	0.68 ± 0.47	-2.25	0.02
Table 7: Distribution of patients based on the post-operative VAS score				

When comparing post operative VAS score between the 2 groups, statistical significance was found at 3 months, 6 months and 12 months.

Complication	Plating	PEEK
Hoarseness of voice	1	0
Stitch abscess	1	0
Mild dysphagia	2	1
Persistent symptoms	2	0
Wound infection	1	0
No complications	43	49
Table 8: Distribution of patients based on the complications		



Among ACDF + Plating group, complications were hoarseness of voice (2%), hoarseness of voice + stitch abscess (2%), mild dysphagia (4%) and wound infection (2%). Among ACDF + PEEK group, complications were mild dysphagia (2%). The association between them was found to be statistically not significant.

Graft Fusion KIM'S Grade			Group		Total	P Value
			ACDF with Plating	ACDF with PEEK		
3 months	1	n	50	50	100	-
		%	100.0%	100.0%	100.0%	
6 months	1	n	7	48	55	0.001
		%	14.0%	96.0%	55.0%	
	2	n	43	2	45	
		%	86.0%	4.0%	45.0%	
12 months	1	n	0	22	22	0.001
		%	0.0%	44.0%	22.0%	
	2	n	49	28	77	
		%	98.0%	56.0%	77.0%	
	3	n	1	0	1	
		%	2.0%	0.0%	1.0%	
Table 9: Distribution of patients based on the graft fusion Kim's grade						

When comparing graft fusion Kim's grade between the 2 groups, statistical significance was found at 6 months and 12 months.

ACDF using an intervertebral cage has become a popular alternative to prevent the complications of the classic method using a autologous tricortical iliac bone graft and anterior cervical plating, including screw loosening, screw breakage, screw migration and soft tissue injuries. ACDF using an intervertebral cage is credited with promoting instant stability, restoration of the neural foraminal height and inter body fusion by providing an environment for bone growth. PEEK cages are currently the most preferred. Compared with titanium and carbon fibre cages, PEEK cages are more biocompatible and radiolucent, which allows for precise radiological evaluation of bony union.[15]

In this study, among ACDF + Plating group, majority of the patients belonged to 31-40 years (42%) followed by 41-50 years (28%), 51-60 years (16%), >61 years (10%) and 20-30 years (4%). Among ACDF + PEEK group, majority of the patients belonged to 31-40 years (40%) followed by 41-50 years (26%), 20-30 years (14%), 51-60 years (12%) and >61 years (8%). The association between them was found to be statistically not significant. In Ha SK et al.,[10] mean age was 57.4 years (range 43-68 years). In Cabraja M et al.,[16] patients' age at time of surgery ranged from 32 to 74 years, with a mean of 54.3 years. The patients of the PEEK-group were significantly older than the patients of the TTN-group ($p = 0.030$).

In this study, among ACDF + Plating group, males were 74% and females were 26%. Among ACDF + PEEK group, males were 66% and females were 34%. The association between them was found to be statistically not significant. In Ha SK et al.,[10] all patients were males. In Cabraja M et al.,[16] 54 were men and 32 were women

In this study, among ACDF + Plating group, most common disc involved was C5-6 (54%) followed by C6-7 (30%), C3-4 (8%) and C4-5 (8%). Among ACDF + PEEK group, most common disc involved was C5-6 (58%) followed by C6-7 (26%), C4-5 (12%), C3-4 (2%) and C7-8 (2%). The association between them was found to be statistically not significant. In Cabraja M et al.,[16] ACDF was performed in 7 cases at C3/4, in 17 cases at C4/5, in 43 cases at C5/6 and in 19 cases at C6/7.

The VAS is continuous scale comprised of a horizontal or vertical line of 10 cm in length, where one end of the line denotes 0, indicating no pain, and the other end of the line denotes 10, indicating worst pain. A change by 2.5-4.1 in VAS for arm pain is considered beyond the minimal clinical important difference (MCID) and by 2.5-2.6 in 66, 67 VAS for neck pain. Two case-series reported the VAS in filled PEEK cages. Ofluoglu et al.[17] reported a 6.4 mean change in VAS for neck pain and 6.6 mean change in VAS for arm pain at 13 months following ACDF with β -TCP filled PEEK 65 cages. Godlewski et al.[18] found an improvement in the mean VAS by 2.84 at 12 months of follow-up with phosphocalcic hydroxyapatite filled PEEK cages. Regarding empty PEEK cages, Suess et al.[19] reported in an RCT a mean change of 4 (interquartile range 3-6 if fused or 3-4 if not fused) following ACDF at 18 months. The rest of the studies on empty PEEK cages were case series. At mean of follow-up of 27.5 months, Kim et al.[20] found in a case series that ACDF with empty PEEK cages had a mean change of 1.98 for the VAS for neck pain for patients with subsidence and 2.83 for those without subsidence. Furthermore, the mean change for VAS for arm pain was 4.17 for patients with subsidence and 4.32 for those without subsidence. Moreover, Kapetanakis et al.[21] reported in a case series a mean change by 5.1 in VAS neck pain and 6.7 in VAS arm pain scores at 12 months of follow-up with empty PEEK cages. Additionally, Park et al.[22] found out that the change with empty PEEK cages resulted in a mean VAS change for pain by 2.1 points at a mean follow-up of 16 months of patients without subsidence and 21 months for subsidence patients. In this study, among ACDF + Plating group, mean pain score was 7.90 ± 0.79 . Among ACDF + PEEK group, mean pain score was 8.20 ± 0.70 . The association between them was found to be statistically significant. In this study, among ACDF + Plating group, mean duration of the procedure was 116.4 ± 15.87 min. Among ACDF + PEEK group, mean duration of the procedure was 91.44 ± 3.85 min. The association between them was found to be statistically significant. In Cabraja M et al.,[16] operation time ranged from 56 to 150 minutes, with a mean of 84.4 minutes. In Aziz AMA et al.,[23] Operative time observed was 90 ± 15 minutes for group Aa (operated for single level ACDF-SAC), 150 ± 15 minutes for group Ab (operated for two level ACDF-SAC), 150 ± 15 minutes for group Ba (operated for single level ACDF-ACP), and 180 ± 15 minutes for group Bb (operated for two level ACDF-ACP).

In this study, among ACDF + Plating group, mean blood loss was 73 ml and among ACDF + PEEK group, mean blood loss was 50 ml. In Aziz AMA et al.,[23] Mean intra operative blood loss observed was 300 ml for group Aa (operated for single level ACDF-SAC), 350 ml for group Ab (operated for two level ACDF-SAC), 400 ml for group Ba (operated for single level ACDF-ACP), and 550 ml for group Bb (operated for two level ACDF-ACP). Intra operative blood loss was measured using number of soaked gauze pieces and collected blood in suction machine. In this study, when comparing post operative VAS score between the 2 groups, statistical significance was found at 3 months, 6 months and 12 months. In Aziz AMA et al.,[23] results of VAS score showed statistically significant difference.

In this study, among ACDF + Plating group, complications were hoarseness of voice (2%), hoarseness of voice + stitch abscess (2%), mild dysphagia (4%) and wound infection (2%). Among ACDF + PEEK group, complications were mild dysphagia (2%). The association between them was found to be statistically not significant. Fusion with filled cages have also been reported by Farrokhi et al.[24] to cause transient hoarseness of voice in two patients and led to two re-operations for disc disease at a lower level. In Aziz AMA et al.,[20], Dysphagia was noted in one case each per group Ab (operated for two level ACDF-SAC) and Bb (operated for two level ACDF-ACP) which was thought to be due to larger incision length, more oesophageal handling and irritation of oesophagus by plate, which was improved over course of postoperative care days. One case in group Bb showed RLN palsy which was also thought to be due to more soft tissue dissection required for two level cervical plate fixations. There was one case with cage dislocation found in group Bb (operated for two level ACDF-ACP) which was managed by re-operating that patient with anterior cervical plating and cage placement. There was one case of pseudo arthrosis reported in each group Aa (operated for single level ACDF-SAC), and Bb (operated for two level ACDF-ACP) which was mostly due to lack of fusion at the operated level. Pseudo arthrosis led to persistence of neck pain in both cases which were managed conservatively by giving analgesics. They found that there was one case in each group Ba (operated for single level ACDF-ACP) and Bb (operated for two level ACDF-ACP) with iliac crest graft morbidities in the form of mild hernia in group Ba case, which was managed by consulting with general surgeon and discomfort, pain and infection in group Bb (operated for two level ACDF-ACP) case which was managed by reopening of sutures, local debridement, thorough antibiotic wash, longer course of specific antibiotics (2 weeks intravenous and 4 weeks oral) after pus and culture sensitivity report.

In Yang JJ et al.,[15] nonunion was observed in 7 segments (14.9%). A statistically significant difference between the union and nonunion groups was found only for the number of fused segments ($p = 0.001$) and not for the other surgical conditions or radiological parameters. Nonunion did not occur in the 27 segments after one-level fusion (0%) whereas it occurred in 7 (35%) of the 20 segments after two-level fusion ($p = 0.001$). The incidence of subsidence was higher in the nonunion group compared to that in the union group, but the difference was not statistically significant ($p = 0.06$). In Kostas NF et al.,[25] most common complication was the development of isolated postoperative dysphagia, which observed in 9.5% patients. Postoperative hematoma occurred in 5.6%, but required surgical intervention in only 2.4% cases. Symptomatic recurrent laryngeal nerve palsy occurred in 3.1% cases. Dural penetration occurred in 0.5%, esophageal perforation in 0.3%, worsening of preexisting myelopathy in 0.2%, Horner's syndrome in 0.1%, instrumentation backout in 0.1%, and superficial wound infection in 0.1% cases.

In this study, when comparing graft fusion kim's grade between the 2 groups, statistical significance was found at 6 months and 12 months. At 6 months 43(86%) patients in group ACDF with plating had KIM's fusion grade 2 whereas only 2(4%) patients in ACDF with PEEK had KIM's fusion grade 2. At 12 months 49(98%) patients had grade 2 and 1(2%) patient had grade 3 KIM's grade of fusion in ACDF with plating group whereas 22(44%) patients had grade 1, 28(56%) patients had grade 2 and no patient (0%) had KIM's grade 3. Park et al.,[22] Farrokhi et al.,[24] and Kapetanakis et al.,[26] defined fusion by the presence of motion and bone bridging on radiographs. Suess et al.,[19] defined fusion with three parameters consisting of bony bridging, absence of radiolucency at the implant-vertebrae interface, and the lack of motion on

dynamic x-rays. Cho et al.[27] utilised radiographs to assess fusion without any further details on how fusion was objectively measured. In Aziz AMA et al.[23] there was 100% fusion in group Aa (operated for single level ACDF-SAC), Ba (operated for single level ACDF-ACP) patients and it was 75% and 80% in group Ab (operated for two level ACDF-SAC), and Bb (operated for two level ACDF-ACP) respectively. Though there was 100% fusion rate in group Aa, they found that fusion time required in this group was considerably longer than anterior cervical plating cases. In Cabraja M et al.[16] A solid arthrodesis was found in 93.2% of cases in the TTN-group and 88.1% of the PEEK-group ($p = 0.417$). Bone formation was seen in 79.6% of the TTN- group, and in 61.9% of the PEEK group ($p = 0.032$).

Conclusion

Both ACDF with iliac crest graft and plating and ACDF with PEEK cage provide effective relief in cervical degenerative disc disease. The PEEK cage group showed slightly lower post-operative pain scores, fewer donor-site complications, and reduced radiation exposure. PEEK cages are a safe and efficient alternative to traditional plating techniques.

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