



Original Article

Autologous Bone Graft vs PEEK Cage in Patients with Cervical Spondylotic Myelopathy

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ABSTRACT

Background: Cervical spine stenosis is one of the most common degenerative changes of cervical spondylotic myelopathy (CSM) and results in severe dysfunction of the cervical spinal cord. The conventional treatment of such degenerative cervical spine conditions is anterior cervical discectomy and fusion (ACDF). Strut graft remains the gold standard in ACDF with excellent patient recovery but has many shortcomings. Polyetheretherketone (PEEK) cages have recently become popular as a replacement for strut grafts in patients undergoing ACDF.

Objective: This study was carried out to compare the clinical and radiographic outcomes of autologous bone grafts versus PEEK cages in patients undergoing ACDF surgery.

Materials and Methods: It was a randomized controlled trial conducted at the Neurosurgery Department Punjab Institute of Neurosciences for three years. Patients who consented to be a part of this study and fulfilled our predefined inclusion criteria were recruited and randomized into 2 groups. One group underwent ACDF with auto bone graft whereas the other group underwent ACDF with PEEK cage.

Results: A total of 198 subjects were included in this study. The mean age was calculated as 47.60 ± 9.17 years in the PEEK cage group and 46.74 ± 8.87 years in the Autologous bone graft group. Males accounted for 59.6% of the study population. The fusion rate was found to be higher in the PEEK cage group with a p-value of 0.002.

Conclusion: PEEK cages are superior to strut grafts as they have lesser morbidity after ACDF surgery in patients with CSM.

Keywords: ACDF, PEEK cage, autologous bone graft, cervical spondylotic myelopathy.

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INTRODUCTION

Cervical spondylotic myelopathy (CSM) is an age-related degenerative disease and affects the ligamentous structures, facet joints, vertebrae, and inter-vertebral discs leading to spinal canal stenosis in the region.¹ Bony-spur formation is one of the most common degenerative changes seen in CSM and is often associated with degeneration of the facet and unco-vertebral joints of the cervical spine. CSM is the most frequently encountered pathology in adults with myelopathy. This disease is gradually progressive and despite conservative measures, the patient ends up needing surgical treatment.^{1,2}

The basic approach of anterior cervical spine surgery was first described by Smith & Robinson and they performed an anterior cervical discectomy and fusion (ACDF) procedure using an autologous bone graft.³ After the first application of autologous bone graft in ACDF surgery for CSM, there has been a tremendous development of different graft options and instrumentations, through an anterior approach. In affected segments of the cervical spine, inter-body fusion can be promoted by autologous bone grafts. Initially, an autologous bone graft (tricortical iliac crest bone graft) was used in ACDF surgery. However, various complications like donor-site inflammation, subsidence, retro-pulsion, collapse, or graft dissolution were recorded in autologous bone graft cases. Hence, inter-body fusion cages were developed as an alternative to bone grafts. These cages are designed to contain a bone graft which allows the fusion of adjacent vertebrae.⁴ Polyetheretherketone (PEEK) cages are artificial synthetic cages used in ACDF surgery. Other synthetic cages used in ACDF surgery are made of titanium, ceramic, and carbon fiber-reinforced polymer.⁵ PEEK materials have been extensively used since the 1980s for ACDF and are an excellent choice for spinal fusion owing to their low elastic modulus and radiolucency.^{3,4} Indications for ACDF include cervical radiculopathy or myelopathy secondary to

degenerative disc disease, disc herniation, spondylosis, and spinal stenosis.⁴⁻⁵

After surgery, the clinical performance is assessed by many defined criteria some of which are neck disability index (NDI), visual analog scale (VAS), and Odom's criteria to name a few. Radiographic features are fusion, the height of the inter-vertebral disc, the height of inter-vertebral foramina, subsidence, lordosis, cage or autograft migration, and fusion on radiological investigations to compare the outcome between the PEEK and autologous bone graft (ABG) groups. The rationale of this study is to compare the outcome of autologous bone graft versus PEEK cages in ACDF surgery both radiologically and clinically since we did find paucity in local and national studies which can prove that, which graft option between autologous bone and PEEK cage is better in ACDF surgery in our local population. So, this study will help surgeons to attain the local magnitude and will help to plan better management protocols and standards for such important common cases at the local level. This study was carried out to compare the clinical and radiographic outcomes of autologous bone grafts versus PEEK cages in patients undergoing ACDF surgery.

MATERIALS AND METHODS

Study Design & Setting

A randomized controlled trial was conducted for three years from 19-03-2018 to 19-09-2021 at the Neurosurgery Department, Postgraduate Medical Institute, Punjab Institute of Neurosciences.

Sampling & Randomization

Non-probability consecutive sampling.

Sample Size

The sample size of 198 (99) in each group was calculated by keeping the desired power of study = at 80%, 95% confidence level and mean

anticipated improvement in Nurick's scale in PEEK cage group = 0.7 ± 0.7 , and mean anticipated improvement in Nurick's scale in the autologous bone graft was 1 ± 0.8 .⁶

Inclusion Criteria

The patients with CSM, of age 16-90 years, belonging to both genders were recruited for the present study.

Exclusion Criteria

The patients who had multiple comorbid conditions (diabetes mellitus, history of ischemic heart disease, metabolic syndrome, endocrinopathies), history of previous ACDF surgery, and patients with traumatic cervical spine injuries were excluded from this study.

Data Collection

A total of 198 Patients fulfilling the inclusion criteria were enrolled from wards of the Department of Neurosurgery, Punjab Institute of Neurosciences, Lahore. Informed consent was obtained. Detailed history and physical examination followed by routine investigations i.e. CBC, LFTs, RFTs, Viral markers, X-ray chest along with MRI cervical spine and X-ray cervical spine were performed. Patients were randomly assigned to 2 groups by lottery method. In group A, patients underwent ACDF surgery with autologous bone graft while in group B, patients underwent ACDF surgery with PEEK cage. All the procedures were done by a single surgical team under general anesthesia. Post-operative follow-ups at 6 weeks were done and all outcomes which were clinical performance (Odom's criteria) and radiographic features on X-ray cervical spine flexion-extension view (Fusion) were noted on prescribed Performa and were compared and analyzed in both groups.

Data Analysis

The data was analyzed on a statistical package for social sciences (SPSS) version 25. Quantitative variables were presented as mean and standard deviation whereas qualitative variables were presented in tabulated form. Comparison of both groups for surgical outcome was done by using the chi-square test and t-test according to the nature of outcome variables. The p-value of equal to or less than 0.05 was considered significant. Data was stratified for age, gender, and BMI and post-stratification t-test will be applied for Nurick's scale and chi-square test for fusion taking p value < 0.05 as significant.

RESULTS

A total of 198 (99 in each group) patients fulfilling inclusion and exclusion criteria were selected to compare the outcome of autologous bone graft versus PEEK cages in ACDF surgery in terms of clinical performance and radiographic features.

Age Distribution

Age distribution of the patients was done, and it showed that out of 99 patients, 13.1% (n = 26) were in the age group of 16 – 40 years 60.6% (n = 60) were in the age group of 41 – 65 years and 13.13% (n = 13) were in the age group of 66 – 90 years in PEEK cage group. In the Autologous bone graft group, 12.6% (n = 25) were in the age group of 16 – 40, 63.63% (n = 63) were in the age group of 41 – 65 years and 11.11% (n = 11) were in the age group of 66 – 90 years. The mean age was calculated as 47.60 ± 9.17 years in the PEEK cage group and 46.74 ± 8.87 years in the Autologous bone graft group (Table 1).

Gender Distribution

Gender distribution of the patients was done, and it showed that 28.8% (n = 57) were male whereas 21.2% (n = 42) were females in the PEEK cage

Table 1: Age-wise distribution of subjects.

Age Group	Group		Total
	PEEK	Autologous Bone Graft	
16-40 years	13.1% (n = 26)	12.6% (n = 25)	25.8% (n = 51)
41-65 years	60.6% (n = 60)	63.63% (n = 63)	62.12% (n = 123)
66-90 years	13.13% (n = 13)	11.11% (n = 11)	12.12% (n = 24)
Total	50% (n = 99)	50% (n = 99)	100% (n = 198)

group and 30.8% (n = 61) were male whereas 19.2% (n = 38) were females in the autologous bone graft group (Table 2).

Symptom Severity

The patient's symptoms were classified as per Nurick's scale which was 3.43 ± 0.592 in the PEEK cage group and 2.56 ± 0.57 in the autologous bone graft group (Table 3).

Table 2: Gender-wise distribution of subjects.

Gender	Group		Total
	PEEK	Autologous Bone Graft	
Male	28.8% (n = 57)	30.8% (n = 61)	59.6% (n=118)
Female	21.2% (n = 42)	19.2% (n = 38)	40.4% (n=80)
Total	50% (n = 99)	50% (n = 99)	100% (n=198)

Table 3: Distribution of patients as per Nurick's scale.

Variable	PEEK Cage Group	Autologous Bone Group
Nurick's scale	3.43 ± 0.592	2.56 ± 0.57

Fusion Rate

In our study, the PEEK cage group had a higher fusion rate (64.4%, n = 64) as compared to that of the autologous bone group (38.3%, n = 30). The fusion rate was statistically significant among both groups with a p-value of 0.0002 (Table 4).

Table 4: Comparison of fusion among two groups.

Fusion	Group		Total	p Value
	PEEK	Autologous Bone Graft		
Yes	64.64% (n = 64)	38.3% (n = 38)	39.4% (n = 102)	0.000218
No	35.35% (n = 35)	61.61% (n = 61)	60.6% (n = 96)	
Total	50% (n = 99)	50% (n = 99)	100% (n = 198)	

DISCUSSION

CSM is a general term for usually age-related, wear-and-tear changes affecting the vertebrae, intervertebral disks, the facet, other true joints, and the associated ligaments. CSM is characterized by the degeneration of these structures, often with the formation of bony spurs. The bony spurs grow outward from the vertebral body in an attempt to cover protruding

and non protruding intervertebral disks and do so in response to degenerative changes in the disk and movement of adjacent vertebrae. Spurring can also accompany degeneration of the uncovertebral and facet joints. CSM affects multiple levels of the cervical spine. The accepted standard for the surgical management of CSM is ACDF. Strut graft remains the gold standard in ACDF with excellent patient recovery but has

many shortcomings. Many artificial materials have been tried for inter-body support in ACDF to provide stability and enhance fusion. Polyetheretherketone (PEEK) cages have emerged as the implant of choice for inter-body graft in ACDF.¹⁻³

In a study done by Sharma et al., 70% (n = 84) of the patients ranged between 40 – 59 years of age.⁷ Isogai et al, have reported similar findings where 86.4% (n = 461) of patients had aged below 80 years of age.⁸ Zhang et al, have reported the peak age group for CSM to be 50 – 59 years in their cohort.⁹ All of these studies are in agreement with the current study in which the most common age group is 41-65 years accounting for 62.12% (n = 123) (Table-1). CSM is seen in this age group because of degenerative changes in the disc coupled with facet joint degeneration.

In the present study, males accounted for 59.6% (n = 118) and females accounted for 40.4% (n = 80). Male predominance was reported by Abraham et al, (2021) in their cohort of 100 patients in which males accounted for 71% (n = 71) of the patients.¹¹ Other studies have reported no significant difference between either gender.⁸⁻¹⁰

In the present study, a higher fusion rate was observed in the PEEK cage group as compared to the strut graft group which was found to be statistically significant with a p-value of 0.0002. Similar results were reported by Lied et al, (2010) who reported similar clinical outcomes but better patient satisfaction and higher fusion with the PEEK cage as compared to the bone graft.¹² Cho et al, (2003) have reported higher fusion rates in the PEEK cage group as compared to the autologous bone group with better clinical outcomes.¹³ Jain et al, (2020) have reported a fusion rate of 98% with the lowest re-operation rate in the PEEK cage group.¹⁴ Fatima et al, (2020) reported higher fusion rates and lower pseudoarthrosis rates in patients with allografts as compared to PEEK cage which is in contrast to

our study in which no statistical significance was found among the 2 groups in terms of fusion.¹⁵ Similar findings were reported by Liu et al, (2017) who reported a higher fusion rate in the bone group.¹⁶

LIMITATIONS

This study was limited by a follow-up duration of only six weeks. The implant material used was locally made and did not have any serial numbers on PEEK cages or hardware to document.

RECOMMENDATIONS

Further studies are needed on the topic, with longer follow-up duration to see the long-term outcomes of PEEK versus autologous bone graft in ACDF patients. A large multicentre national study should be conducted to see the trends in our population.

CONCLUSION

In the current study, we compared the outcome of autologous bone graft versus PEEK cages in ACDF surgery in terms of clinical performance and radiographic features. We found Nurick's scale was 3.43 ± 0.592 in the PEEK cage group and 2.56 ± 0.57 in the autologous bone graft group and fusion was 20.2% (n = 40) in the PEEK cage group and 15.2% (n = 30) in autologous bone graft group. We concluded that ACDF is comparable for both fusion techniques. ACDF with PEEK cage is effective and is the fusion technique of choice when compared with autologous bone graft in ACDF surgery for cervical spondylotic myelopathy.

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Additional Information

Disclosures: Authors report no conflict of interest.

Ethical Review Board Approval: The study conformed to the ethical review board requirements.

Human Subjects: Consent was obtained by all patients/participants in this study.

Conflicts of Interest:

In compliance with the ICMJE uniform disclosure form, all authors declare the following:

Financial Relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.

Other Relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

AUTHORS CONTRIBUTIONS

Author's Full Name	Intellectual Contribution to Paper in Terms of:
Ijaz Hussain Wadd, and Ammar Anwer	Study design and methodology, Paper Writing, Analysis of Data and interpretation of results, Literature Review and Referencing, Editing, and Quality Insurer
Liaqat Mehmood Awan	Data Collection and Calculations, Literatures Review and Referencing.
Arsalan Haider, Asif Shabbir, and Zayed Qamar	Analysis of data and interpretation of results, Literature review, and referencing.