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Clinical and Radiological Outcomes of Anterior Column Reconstruction Using Titanium Mesh Cage for Dorsolumbar Spine Pathologies

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ABSTRACT

Pathological fractures in the spine, often caused by cancer, infection, or aging, can lead to vertebral compression fractures, resulting in pain, deformity, and neural compromise. Anterior cervical corpectomy with titanium mesh cages is effective for decompression, stabilization, and spinal column restoration in trauma and tumor cases. **Objective:** To evaluate clinical and radiological outcomes of anterior column reconstruction using cylindrical titanium mesh cage for Dorsolumbar spine pathologies. **Methods:** A Descriptive Case Series was conducted at the department of Neurosurgery, Fatima Jinnah Medical University/Sir Ganga Ram Hospital. 60 Patients of either gender, aged 12 to 50 years, presenting with dorsolumbar spine pathologies were included.Pre-operative and post-operative plain X-ray, MRI plain film of Spine and CT Spine (wherever required) was All surgeries were performed by a single surgeon having 10 years of post-fellowship experience. Clinical and Radiological outcomes were assessed after 3 months. The data were analyzed using SPSS version 25.0. **Results:** Total of 60 patients, 36.6% were in age group of 12-30 years and 63.4% were in age group of 31-50 years .There were 60% were male whereas 40% were females. Clinical outcome was excellent in 28.3%, good in 45%, fair in 23.3% and poor in 3.3%. Mean change in intervertebral space height was 1.52±0.19 and mean change in segmental angle was 0.49o ± 0.06o. **Conclusion:** In the current investigation it was concluded that the use of titanium mesh cages in patients with spinal disorders is safe and offering significant improvements in both clinical outcomes and radiological parameters.

INTRODUCTION

Dorsolumbar spine pathologies, including infective, traumatic, and neoplastic conditions, can lead to spinal instability, resulting in compression of the nervous elements and subsequent neurological impairments. The primary goal in managing an unstable dorsolumbar spine is to preserve remaining spinal cord function, restore spinal alignment, optimize neurological recovery, and facilitate early rehabilitation [1, 2]. Optimizing neuronal decompression and maintaining a stable internal fixation are two ways to achieve this [3]. Fixation with allograft and autograft bones with anterior and posterior fixation was a common practice before the use of titanium implants [4]. Cylindrical titanium mesh cages, FDA-approved in 1990, are used for osseous reinforcement and reconstruction, initially proving effective for large segmental long bone defects when combined with bone grafts [5]. Biologically, they support cancellous bone grafts, maintain graft continuity, and enable circumferential reconstitution, while mechanically providing strength with minimal metal, reducing stress shielding. Functionally, they offer immediate limb stability, enabling early weight-bearing. However, their theoretical advantages remain unvalidated

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in standardized experimental models [3, 6]. Titanium mesh cages of different sizes and shapes are now being used successfully to reconstruct spine after corpectomy providing an effective method of treating spine pathologies [7, 8]. Two approaches can be opted for stabilization and fixation of Dorsolumbar spine with having their own merits and demerits. Anterolateral and posterior approaches. While using anterior approach, decompression is done by removing the affected vertebral body and reconstructing the spine using titanium mesh cages. The device often needs to be positioned two levels above and below the lesion site to achieve posterior stability. It is still controversial which of the anterior, posterior and mixed techniques the best is [9, 10]. In extremely unstable thoracolumbar spines, it is generally recognized that anterior decompression and reconstruction with instruments is preferable to fixation with posterior pedicle screws [11]. The Anterior column reconstruction with titanium mesh cages restores spinal stability, relieves neural compression, and facilitates early mobilization. Therefore, the present study was conducted to evaluate clinical and radiological outcomes of anterior column reconstruction using cylindrical titanium mesh cage for Dorsolumbar spine pathologies.

METHODS

A Descriptive Case Series was conducted at the department of Neurosurgery, Fatima Jinnah Medical University/Sir Ganga Ram Hospital Lahore over a period of six months from 08-01-2023 to 08-07-2023 after ethical approval (34-MS-Neurosurgery/ERC). The sample size of 60 was estimated by confidence level of 95% with 9% margin of error and taking and expected percentage of excellent clinical outcome as 95.3% using following formula[12].

$$n = \frac{z^{2} - \frac{a}{2} p(1-p)}{d^{2}}$$

Where:

p = Expected proportion of excellent clinical outcomes (95.3%)

d = Margin of error(9%)

q = 1 – p(4.7%)

Participants of either gender, aged 12 to 50 years, presenting with dorsolumbar spine pathologies were included in the study. Exclusion criteria include patients with American Society of Anesthesiologists (ASA) with grade 3 or above. Impairment Scale grades A and E, as well as those with comorbid conditions such as diabetes mellitus (blood sugar levels exceeding 200 mg/dL) and hypertension (diastolic blood pressure over 100 mmHg). Data were collected from patients meeting the inclusion criteria. 60 Patients were admitted to Neurosurgery department at SGRH after taking written consent for the treatment and surgical procedure. All surgeries were performed by a single surgeon having 10 years of post-fellowship experience. Surgical technique used was anterior thoraco-lumbar for dorsal spine and retro peritoneal in lumbar spine cases. Clinical and Radiological outcomes were assessed after 3 months. Clinical outcomes were evaluated using Modified Macnab's criteria, categorized as Excellent (no pain, no mobility restriction, normal activity), Good (occasional non-radicular pain, symptom relief, modified work), Fair (improved function but still handicapped/unemployed), and Poor (persistent symptoms, need for further surgery at the same level) [13]. Radiological outcomes were assessed via MRI, measuring intervertebral space height (IH) in millimeters and Segmental Angle (SA) in degrees. The MRI scans were conducted with a 1.5 Tesla Siemens Magnetom Avanto machine and using standard spine protocols to obtain intervertebral space height (IH, in mm) and segmental angle (SA, in degrees). Plain films were performed on a Shimadzu RAD speed Pro digital system and when required, CT scans were performed on a 64-slice GE Optima CT660 system. All radiological measurements were completed on a pre-defined proforma by the relevant surgical and radiology teams to maintain consistency and reproducibility of reports. The demographic information, including name, age, gender, and site of pathology, was obtained directly from patients who were enrolled in the study. All relevant details were recorded using a pre-designed proforma at the time of enrollment to ensure accurate documentation. The data were entered and analysed in SPSS version 25.0. Quantitative variables like age, inter-vertebral space height (IH) and Segmental Angle (SA) were calculated as mean and SD. Qualitative variables like gender and clinical outcome were calculated as frequency and percentage. The data were stratified by age and gender to account for potential effect modifiers. The normality of data was assessed by Shapiro wilk test, the comparison of pre and post Change in Inter-vertebral space height (mm) and Segmental angle in degree was analyzed by paired sample t-test. After stratification, an independent sample t-test was, with a p-value ≤ 0.05 considered statistically significant.

RESULTS

In table 1, the majority (63.4%) were between 31-50 years of age, while 36.6% were aged 12-30 years. Regarding gender distribution, 60.0% of the patients were male, and 40.0% were female. Most patients (66.7%) had a BMI within the range of 17-25 kg/m^2, whereas 33.3% had a BMI greater than 25 kg/m^2. The primary causes of dorsolumbar spine pathologies were caries of the spine (56.6%) and trauma (43.4%).

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Table 1: Demographic of Patients

Age Group	Frequency (%)
12-30 Years	22 (36.6)
31-50 Years	38 (63.4)
Gender	
Male	36 (60.0)
Female	24 (40.0)
BMI (Kg/m²)	
17-25	40 (66.7)
>25	20 (33.3)
Causes	
Caries Of the Spine	34 (56.6)
Trauma Of Supine	26 (43.4)

In table 2, the outcomes of anterior column reconstruction showed a mean increase in intervertebral space height of 9.46 ± 1.52 mm and a mean change in segmental angle of 0.72° ± 0.49°. According to Modified Macnab's criteria, clinical outcomes were rated as Excellent in 28.3% of patients, Good in 45%, Fair in 23.3%, and Poor in 3.3%, indicating a predominantly positive response to the procedure. There was significant mean change in intervertebral space height was and segemental angle. p ≤ 0.05 indicates statistical significance.

Table 2: Post Procedure Clinical and Radiological Outcomes of Anterior Column Reconstruction

Variables	Mean ± SD / Frequency (%)		
	Pre	Post	p-Value
Change in Inter-vertebral space height (mm)	9.46 ± 1.52	1.52 ± 0.19	<0.0001
Change in Segmental angle in degree	0.72 ° ± 0.49 °	0.49 ° ± 0.06 °	<0.0001
Clinical Outcome by Modified Macnab's criteria			
Excellent	17 (28.3)		
Good	27 (45)		
Fair	14 (23.3)		
Poor	2 (3.3)		

Results from independent sample t test (*) indicates p ≤ 0.05

In table 3, Stratification of intervertebral space height based on age and gender revealed no significant difference between the age groups, with a mean height of 9.414 ± 1.369 mm for patients aged 12–30 years and 9.497 ± 1.614 mm for those aged 31–50 years (p = 0.842). However, gender stratification showed a trend toward higher intervertebral space height in females (10.188 ± 0.930 mm) compared to males (8.918 ± 1.662 mm), though the difference was not statistically significant (P-value > 0.05).

Table 3: Stratification for inter-vertebral space height with respect to age and Gender

Variable	Age group	Mean ± SD	p-Value
Inter Vertebral Space Height (mm)	12-30 Years	9.414 ± 1.369	0.842
	31-50 Years	9.497 ± 1.613	
	Male	8.918 ± 1.662	0.071
	Female	10.188 ± 0.930	

Results from independent sample t test (*) indicates p ≤ 0.05

In table 4, Stratification of segmental angle based on age and gender showed no statistically significant differences. Patients aged 12–30 years had a mean segmental angle of 0.876 ± 0.522°, compared to 0.646 ± 0.475° in those aged 31–50 years (p = 0.089). Similarly, gender stratification revealed a mean segmental angle of 0.791 ± 0.496° in males and 0.642 ± 0.501° in females (P-value > 0.05).

Table 4: Stratification for Segmental Angle with Respect to Age and Gender

Variable	Age group	Mean ± SD	p-Value
Segmental Angle	12-30 Years	0.876 ± 0.5224	0.089
	31-50 Years	0.646 ± 0.4746	
	Male	0.791 ± 0.4963	0.256
	Female	0.642 ± 0.5014	

Results from independent sample t test (*) indicates p ≤ 0.05

DISCUSSION

Spinal diseases impair the backbone and include conditions like kyphosis, dorsalgia, and cervical spine disorders. Common cervical issues, such as degenerative disc disease, stenosis, and disc herniation, often result from aging and cause pain or numbness. These conditions vary in severity and prevalence. The findings of current study reported that that the majority 36.6% were in age group of 12-30 years and 63.4% were in age group of 31-50 years .There were 60% were male whereas 40% were females Thoracolumbar fractures are more frequent in men, and the peak incidence is observed between 20 and 40 years [14, 15]. In current study it was reported that the primary causes of dorsolumbar spine pathologies were caries of the spine (56.6%) and tumor or trauma (43.4%). Blunt trauma with high energy is the main cause of thoracic spine injuries. 65 of these injuries are due to motor vehicle accidents and falls from height, with sports injuries and violence accounting for the remaining percentage. Other damage such as rib fractures, pneumothorax, hemothorax and, less commonly, large vessel injuries, hemopericardium and diaphragmatic rupture are usually associated with these high velocity injuries [16, 17]. The long bone fractures and head trauma can cause spinal injuries to go unnoticed, seat belt fractures (Chance) and flexion-distraction injuries are often associated with intra-abdominal visceral injuries [18]. Unnoticed thoracic and lumbar spine injuries can occur in up to 36% of cases, especially when there is high-energy physical trauma and a change in mental status [19]. In this study we found that clinical outcome was excellent in 28.3%, good in 45%, fair in 23.3% and poor in 3.3%. It was found that significant mean change in intervertebral space height was 1.52 ± 0.19 and mean change in segmental angle was 0.49 o ±0.06 o. In a

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study, according to clinical outcome, as per Macnab's criteria, 95.3% patients reported excellent outcome [12]. According to radiological outcome, mean inter-vertebral space height was 9.4±2.1 mm pre- operatively and 11.5±1.4 mm after 3 months with a mean change 2.1±0.7 mm and mean segmental angle was 17.9±8.4o pre-operatively and 17.6±5.6o after 3 months with a mean change 0.3 ± 2.8o [20].

CONCLUSIONS

In the present study, we evaluated the clinical and radiological outcomes of anterior column reconstruction using cylindrical titanium mesh cages for dorsolumbar spine pathologies. The findings demonstrate that this technique is safe and reliable, leading to significant improvements in patient recovery and spinal alignment. Overall, cylindrical titanium mesh cages appear effective in restoring spinal stability and promoting favorable early clinical and radiographic outcomes.

Authors Contribution

Conceptualization: MDS
Methodology: MDS, SS, MMH, R
Formal analysis: TA
Writing, review and editing: MDS, TA, SF, AH

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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