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RESEARCH ARTICLE

EVALUATION OF FUNCTIONAL AND RADIOLOGICAL OUTCOME OF SYMPTOMATIC OSTEOPOROTIC DORSO-LUMBAR FRACTURES TREATED BY KYPHOPLASTY VERSUS POSTERIOR SPINAL FIXATION

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ABSTRACT

Background: Osteoporotic vertebral compression fractures (OVCFs) commonly affect the dorsolumbar spine and result in pain, kyphotic deformity, and impaired quality of life. While both kyphoplasty and posterior spinal fixation (PSF) are utilized in surgical management, comparative data on functional and radiological outcomes are limited. **Objective**: To evaluate and compare functional recovery and kyphotic correction in patients undergoing kyphoplasty versus posterior spinal fixation (with or without vertebroplasty) for symptomatic osteoporotic dorsolumbar fractures. **Methods**: A prospective observational study was conducted from January 2023 to December 2024 at Civil Hospital Ahmedabad involving 25 patients with symptomatic dorsolumbar OVCFs. Patients undergone kyphoplasty (n=13) or PSF (n=12) based on clinical indications. Outcomes were assessed using the Visual Analogue Scale (VAS), Oswestry Disability Index (ODI), local kyphosis angle, and anterior vertebral body height over 6 months. **Results**: Both groups showed significant improvement in pain and function with no statistical difference in VAS and ODI scores at 6 months. Kyphoplasty demonstrated superior kyphosis correction (8.72° vs. 5.99°, $p<0.001$) and vertebral height restoration (26.57 mm vs. 20.04 mm, $p=0.001$). Kyphoplasty was also associated with shorter operative time, reduced blood loss, and fewer complications. **Conclusion**: Kyphoplasty is a safe and effective minimally invasive procedure providing better kyphotic correction and recovery compared to posterior spinal fixation in selected OVCF patients without instability or neurological deficits.

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INTRODUCTION

Osteoporotic vertebral compression fractures (OVCFs) represent a significant health concern, particularly in the elderly population.[1] Globally, osteoporosis affects over 200 million individuals, and vertebral fractures are the most common clinical manifestation, accounting for nearly half of all osteoporotic fractures. These fractures occur predominantly in the dorsolumbar spine (T10–L2) due to the transitional biomechanics between the relatively rigid thoracic and more flexible lumbar segments.[2] Even minor trauma or routine physical stress in individuals with low bone mineral density can result in wedge compression fractures, leading to severe pain, decreased mobility, spinal deformity, and reduced quality of life.[3] Conservative management—including bed rest, analgesics, bracing, and physical therapy—is usually the first-line treatment for stable OVCFs. However, this approach often fails to relieve pain in a subset of patients, especially those with persistent mechanical instability or progressive kyphotic deformity. In such cases, surgical interventions are considered to provide structural support, restore sagittal balance, and improve functional outcomes.[4,5]

Two commonly employed surgical modalities are kyphoplasty and posterior spinal fixation (PSF) with or without vertebroplasty. Kyphoplasty is a minimally invasive percutaneous procedure involving balloon inflation to restore vertebral body height followed by cement augmentation to stabilize the fracture. It has shown promising results in reducing pain and correcting kyphosis with relatively low complication rates. On the other hand, PSF is traditionally used for unstable fractures or cases with significant posterior wall involvement. It involves the use of pedicle screws and rods to stabilize the affected spinal segments, often supplemented with vertebroplasty to enhance anterior column support.[6,7] While both modalities are widely used, the choice between kyphoplasty and PSF is often determined by factors such as the extent of vertebral collapse, presence of instability, comorbid conditions, and surgeon expertise. However, there is limited prospective comparative data evaluating the functional and radiological outcomes between these two interventions, especially in the Indian population.[8] This prospective study aims to compare kyphoplasty and posterior spinal fixation (with or without vertebroplasty) in the management of

symptomatic osteoporotic dorsolumbar compression fractures. By analyzing clinical parameters such as pain (VAS), functional disability (ODI), and radiological outcomes including kyphotic angle correction and vertebral height restoration, this study seeks to provide evidence-based guidance on optimal surgical strategies for managing OVCFs.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Orthopaedics, Civil Hospital Ahmedabad, between January 2023 and December 2024. It aimed to evaluate and compare the outcomes of kyphoplasty versus posterior spinal fixation (with or without vertebroplasty) in patients with symptomatic osteoporotic dorsolumbar vertebral compression fractures (OVCFs). Patients aged 50 to 90 years with acute symptomatic fractures between T10 and L2 who failed conservative management were included. Exclusion criteria comprised pathological fractures, neurological deficits, cervical involvement, prior spinal surgeries at the same level, multiple vertebral fractures, and fractures older than six weeks. Patients unable to complete a 6-month follow-up were also excluded. After obtaining informed consent, all patients underwent clinical assessment and radiological imaging including plain radiographs and MRI or CT as needed. Fractures were classified using the Genant and AO systems. Patients were assigned to either the kyphoplasty group (n=13) or posterior spinal fixation group (n=12) based on fracture characteristics and clinical judgment. Kyphoplasty was performed under local anesthesia using a transpedicular approach with balloon inflation followed by PMMA cement injection. Posterior fixation was performed under general anesthesia with pedicle screw instrumentation, with or without vertebroplasty augmentation depending on fracture stability. Postoperative care included routine antibiotic prophylaxis and early mobilization with lumbar bracing. Kyphoplasty patients were typically discharged within 24–48 hours, whereas posterior fixation patients remained hospitalized longer due to surgical drain placement and recovery from general anesthesia. All patients received calcium and vitamin D supplements and were followed up at 1 week, 1 month, 3 months, and 6 months. Clinical outcomes were assessed using the Visual Analogue Scale (VAS) for pain and Oswestry Disability Index (ODI) for disability. Radiographic outcomes included local kyphosis angle and anterior vertebral body height measured on lateral spine radiographs. Data were recorded and analyzed using appropriate statistical tools. Continuous variables were expressed as mean ± standard deviation, and categorical data as frequencies and percentages. Intergroup comparisons were made using t-tests or Chi-square tests as applicable. A p-value of less than 0.05 was considered statistically significant.

RESULTS

This study included a total of 25 patients with symptomatic osteoporotic vertebral compression fractures (OVCFs), who were treated using either kyphoplasty (n = 13) or posterior spinal fixation (PSF) with or without vertebroplasty (n = 12). The outcomes were assessed across demographic characteristics, vertebral involvement, comorbidities, operative parameters, complications, neurological status, and both functional and radiological outcomes. The mean age of patients in the kyphoplasty group was 64.7 ± 8.0 years, compared to 65.8 ± 9.5 years in the PSF group (Table 1). The difference was not statistically significant (p = 0.975), and most patients in both groups fell within the 61–70-year age category, reflecting the typical demographic for osteoporotic fractures. Gender distribution also showed no significant variation between groups (p = 0.790), with a female predominance in both cohorts—61.5% in the kyphoplasty group and 66.7% in the PSF group—highlighting the known higher prevalence of osteoporosis among postmenopausal women. Vertebral level analysis(Table 1) revealed that L1 and L2 were the most commonly involved segments in both groups, consistent with the biomechanical vulnerability of the thoracolumbar junction. In the kyphoplasty group, L1 and L2 were each involved in 30.8% of cases, whereas in the PSF group, the involvement was 16.7% and 25.0%, respectively. Fracture morphology as per the Genant classification (Table 1) showed Grade 2 fractures (moderate deformity) as most frequent—53.8% in the kyphoplasty group and 50.0% in the PSF group (p = 0.827). AO classification demonstrated A2 fractures (split or pincer-type) as most prevalent in both groups (69.2% vs. 58.3%, p = 0.814), indicating comparable fracture types between the groups.

Comorbidity analysis (Table 1) showed no significant intergroup differences. Hypertension was the most frequent comorbidity in both groups—observed in 46.2% of the kyphoplasty group and 41.7% of the PSF group—followed by diabetes mellitus (30.8% vs. 33.3%). Other conditions such as hypothyroidism and asthma were distributed evenly and did not differ significantly between groups (p > 0.05 for all), ensuring that the clinical baseline was comparable. Operative parameters (Table 2) showed significant advantages for kyphoplasty in terms of minimally invasive characteristics. The mean operative time was significantly shorter in the kyphoplasty group (62.4 ± 13.7 minutes) compared to the PSF group (157.8 ± 20.2 minutes), with a p-value of <0.001. Similarly, blood loss was significantly less in the kyphoplasty group (68.5 ± 15.7 mL) compared to the PSF group (991.7 ± 230.3 mL), also highly significant (p < 0.001). Hospital stay duration was markedly reduced for kyphoplasty patients (2.2 ± 0.4 days) compared to those undergoing PSF (8.8 ± 4.9 days), with this difference also being statistically significant (p < 0.001). Postoperative complications were more frequent in the PSF group (41.7%) than in the kyphoplasty group (15.4%). The kyphoplasty group reported one case each of asymptomatic cement leakage and transient respiratory distress (7.7% each). In contrast, the PSF group experienced a broader range of complications including excessive blood loss (8.3%), intraoperative arrhythmia (8.3%), ankle-foot weakness (8.3%), and surgical site infections (16.7%). Although the difference in complication rates did not reach statistical significance, kyphoplasty demonstrated a more favorable safety profile. Neurological outcomes (Table 2) assessed via ASIA grading showed that all patients in the kyphoplasty group retained full neurological function (ASIA Grade E), while one patient in the PSF group (8.3%) experienced postoperative deterioration to ASIA Grade D. Though not statistically significant (p = 0.288), this outcome underscores the neurological preservation advantage of kyphoplasty due to its less invasive nature. Functional outcomes (Table 2) assessed over a six-month period using the Visual Analog Scale (VAS) and Oswestry Disability Index (ODI) revealed improvements in both groups. VAS scores decreased from a preoperative mean of 8.54 ± 0.66 to 6.62 ± 0.65 in the kyphoplasty group, and from 8.33 ± 0.78 to 6.25 ± 0.62 in the PSF group (p = 0.1588). ODI scores improved from 59.31 ± 4.56 to 47.77 ± 7.10 in the kyphoplasty

Table 1. Baseline Demographic and Clinical Characteristics of Patients

Variable	Kyphoplasty (n=13)	PSF (n=12)	p-value
Age			
Mean ± SD	64.7 ± 8.0	65.8 ± 9.5	0.975
51–60 years	4 (30.77%)	4 (33.33%)	
61–70 years	6 (46.15%)	5 (41.67%)	
>70 years	3 (23.08%)	3 (25.00%)	
Sex			
Female	8 (61.5%)	8 (66.7%)	0.79
Male	5 (38.5%)	4 (33.3%)	
Fracture Level			
D11	1 (7.7%)	2 (16.7%)	0.769
D12	3 (23.1%)	2 (16.7%)	
L1	4 (30.8%)	2 (16.7%)	
L1, L2	0 (0.0%)	1 (8.3%)	
L2	4 (30.8%)	3 (25.0%)	
L3	1 (7.7%)	1 (8.3%)	
L4	0 (0.0%)	1 (8.3%)	
Fracture classification- Genant			
G1	3 (23.1%)	2 (16.7%)	0.827
G2	7 (53.8%)	6 (50.0%)	
G3	3 (23.1%)	4(33.3%)	
Fracture classification- AO			
A1	2 (15.4%)	2 (16.7)	0.814
A2	9 (69.2%)	7 (58.3%)	
Co Morbidities			
Diabetes	4 (30.8%)	4 (33.3%)	0.891
Hypertension	6 (46.2%)	5 (41.7%)	0.821
Hypothyroidism	2 (15.4%)	1 (8.3%)	0.588
Bronchial Asthma	1 (7.7%)	1 (8.3%)	0.953
Heart Disease	0 (0.0%)	1 (8.3%)	0.288

Table 2. Operative, Functional, Radiological, and Neurological Outcomes

Outcome Variable	Kyphoplasty (n=13) Mean ± SD	Posterior Fixation (n=12) Mean ± SD	Mean Difference	p-value
Operative Parameters				
Duration of Symptoms (days)	15.5 ± 12.2	11.8 ± 10.1	3.7	0.408
Procedure Duration (minutes)	62.4 ± 13.7	157.8 ± 20.2	-95.4	<0.001
Length of Stay (days)	2.2 ± 0.4	8.8 ± 4.9	-6.6	<0.001
Blood Loss (ml)	68.5 ± 15.7	991.7 ± 230.3	-923.2	<0.001
Neurological Stats (ASIA Grading)				
Preoperative ASIA Grade E (%)	13 (100%)	12 (100%)	NA	
Postoperative ASIA Grade E (%)	13 (100%)	11 (91.7%)	NA	0.288
Postoperative ASIA Grade D (%)	0 (0.0%)	1 (8.3%)	NA	
Functional Outcomes				
VAS Pre-op	8.69 ± 0.48	8.58 ± 0.51	0.11	0.585
VAS Post-op 3 mo	4.31 ± 0.89	4.42 ± 0.79	-0.11	0.746
VAS Post-op 6 mo	2.08 ± 0.76	2.33 ± 0.78	-0.25	0.426
VAS Change (Pre to 6 mo)	6.62 ± 0.65	6.25 ± 0.62	0.37	0.159
ODI Pre-op	77.62 ± 6.13	77.67 ± 4.58	-0.05	0.982
ODI Post-op 3 mo	46.00 ± 8.25	49.17 ± 7.11	-3.17	0.313
ODI Post-op 6 mo	29.85 ± 6.66	32.33 ± 5.18	-2.48	0.308
ODI Change (Pre to 6 mo)	47.77 ± 7.10	45.33 ± 2.87	2.44	0.270

group and from 59.17 ± 3.93 to 45.33 ± 2.87 in the PSF group (p = 0.2701). While both interventions led to significant pain reduction and functional recovery, no statistically significant differences were observed between them, indicating that both are effective modalities in short-term functional rehabilitation.

Radiological assessments, however, favored kyphoplasty. Correction of kyphotic deformity was significantly better in the kyphoplasty group (8.72° ± 1.38°) compared to the PSF group (5.99° ± 1.08°), with a p-value of <0.001. Similarly, anterior vertebral body height restoration was superior with kyphoplasty (26.57 ± 4.19 mm) relative to PSF (20.04 ± 4.49 mm), achieving statistical significance (p = 0.001). These findings highlight kyphoplasty's superior efficacy in restoring sagittal alignment and vertebral morphology, which could potentially translate into better long-term spinal mechanics and reduced adjacent segment degeneration.

DISCUSSION

This prospective comparative study evaluated the functional and radiological outcomes of kyphoplasty versus posterior spinal fixation (with or without vertebroplasty) in patients with symptomatic osteoporotic vertebral compression fractures (OVCFs). Twenty-five patients were assessed across multiple clinical and radiological parameters to determine the relative efficacy and safety of both interventions. Key domains discussed include demographic profiles, vertebral fracture patterns, comorbidities, surgical metrics, complications, neurological status, and therapeutic outcomes.

Demographic and Clinical Profiles: The age and sex distribution in both groups reflected typical OVCF demographics. The mean age in both groups (~65 years)

corresponded to the known peak incidence of osteoporotic fractures in individuals over 60 years, due to progressive bone loss with aging.[1,9,10] Similarly, the female predominance in both groups aligns with global epidemiological data that postmenopausal women are at increased risk due to hormonal changes.[4,9,10] These balanced baseline characteristics ensure internal validity in comparative analysis.

Fracture distribution centered on the dorsolumbar junction (L1 and L2), the most vulnerable region due to the mechanical transition between thoracic rigidity and lumbar mobility.[2,8,10] Fracture grading (Genant and AO classifications) indicated a predominance of moderately severe lesions (Genant Grade 2, AO A2), suitable for either percutaneous or open interventions[8,10].

Operative Characteristics and Safety Profile: Kyphoplasty was associated with significantly shorter operative duration, hospital stay, and intraoperative blood loss compared to posterior fixation ($p<0.001$ for all parameters). These findings highlight kyphoplasty's minimally invasive advantage, reducing patient exposure to operative stress, especially in elderly patients with limited physiological reserves[11]. In contrast, the posterior fixation group endured more extensive tissue dissection and surgical manipulation, leading to longer procedures and more blood loss.[10] Postoperative complications were fewer in the kyphoplasty group. Minor events like asymptomatic cement extravasation were observed, consistent with known risks but often without clinical impact.[12] Posterior fixation showed a higher complication rate including infections, transient neurological deficits, and intraoperative arrhythmias, reflecting the complexity and invasiveness of the procedure.[10,13] Neurologically, kyphoplasty preserved function in all patients, while one case of deficit occurred in the posterior fixation group, although not statistically significant.[10,14]

Functional and Radiological Outcomes: Both procedures significantly improved VAS and ODI scores at 6-month follow-up, with no statistically significant difference between groups, indicating similar efficacy in pain relief and functional recovery[10,15]. This reinforces the principle that both procedures achieve mechanical stabilization, which is the cornerstone of symptom relief in OVCFs. Radiological outcomes, however, were superior in the kyphoplasty group. It yielded significantly greater kyphotic angle correction (8.72° vs. 5.99°) and anterior vertebral body height restoration (26.57 mm vs. 20.04 mm) compared to posterior fixation ($p<0.001$ and $p=0.001$, respectively). This is attributed to the balloon expansion technique in kyphoplasty, which restores vertebral morphology prior to cement injection.[5,7,10] Improved sagittal alignment and vertebral height may translate into better biomechanical stability and lower risk of subsequent fractures. While posterior fixation provides robust stabilization, it does not directly reverse vertebral collapse.

Clinical Implications and Literature Correlation: The findings from this study resonate with multiple published works. Kim et al. and Lieberman et al. documented kyphoplasty's effectiveness in correcting vertebral deformity and improving alignment. Similarly, Xue et al. demonstrated comparable clinical results but noted lesser radiological correction in PSF-based interventions, especially in chronic fractures.[10] The benefit of kyphoplasty becomes particularly evident in fresh fractures where restoration potential is higher. Ullrich et al. concluded that combining dorsal stabilization with kyphoplasty might yield optimal outcome taking mobility to account[16].

Limitations

While the study provides valuable insights, limitations include the small sample size, short follow-up duration, and lack of randomization, which may introduce selection bias. Further multicentric trials with larger cohorts and long-term outcome assessment, including adjacent segment fractures and implant longevity, are needed for comprehensive evaluation.

CONCLUSION

In the management of symptomatic OVCFs, both kyphoplasty and posterior fixation are effective in pain relief and functional recovery. However, kyphoplasty demonstrates clear advantages in operative efficiency, safety profile, and radiological correction. For appropriately selected cases—particularly in the elderly with stable fractures—kyphoplasty offers a less invasive yet effective therapeutic alternative to posterior spinal fixation.

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Glossary of Abbreviations

AO - AO Classification
DOA - Date of Admission
DOI - Date of Injury
DOS - Duration of Surgeryfractures
LOS - Length of Stay
ODI - Oswestry Disability Index
ODS - Oswestry Disability Score
OVCF - Osteoporotic Vertebral Compression Fracture
PFSUC - Percutaneous Functional Spinal Unit Cementoplasty
PSF - Posterior Spinal Fixation
PSF + VP - Posterior Spinal Fixation With Vertebroplasty
SCOVF - Symptomatic Chronic Osteoporotic Vertebral
VAS - Visual Analog Score
VCF - Vertebral Compression Fracture

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