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Management strategies for osteoporotic vertebral compression fractures: a prospective multicentric study

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ABSTRACT

Background: Osteoporotic vertebral compression fractures (OVCFs) are a major cause of morbidity among the elderly population, leading to pain, reduced mobility, and diminished quality of life. Various management strategies exist, including conservative treatment, vertebroplasty, and kyphoplasty; however, optimal treatment remains controversial.
Methods: A prospective observational study was conducted across three tertiary care centres in Odisha, India, from December 2023 to December 2025. A total of 220 patients diagnosed with OVCFs were enrolled. Patients were categorized into three groups: conservative management (Group A), vertebroplasty (Group B), and kyphoplasty (Group C). Outcomes were assessed using Visual analog scale (VAS), Oswestry disability index (ODI), and radiological parameters at baseline, 3 months, 6 months, and 12 months.
Results: Significant improvement in pain and functional outcomes was observed in all groups ($p<0.001$). Kyphoplasty demonstrated superior pain relief and vertebral height restoration compared to other modalities ($p<0.05$). Vertebroplasty showed faster early pain relief compared to conservative treatment.
Conclusions: Kyphoplasty offers better long-term outcomes in OVCFs, while vertebroplasty provides rapid pain relief. Conservative treatment remains suitable for mild cases.

Keywords: Osteoporosis, Vertebral compression fracture, Vertebroplasty, Kyphoplasty, Prospective study

INTRODUCTION

Osteoporosis is a systemic skeletal disorder characterized by reduced bone mass and microarchitectural deterioration, leading to increased fracture risk.[1] Vertebral compression fractures (VCFs) are the most common osteoporotic fractures, accounting for significant morbidity worldwide.[2] The global prevalence of osteoporosis is rising due to increased life expectancy, making OVCFs a significant public health concern.[3] These fractures often result in chronic pain, spinal deformity, and impaired quality of life.[4] Management strategies for OVCFs include conservative therapy (analgesics, bracing, physiotherapy) and minimally invasive procedures such as vertebroplasty and kyphoplasty.[5] While conservative management is traditionally first-line, interventional procedures have gained popularity due to rapid pain relief and functional recovery.[6] Vertebroplasty involves injection of bone cement into the fractured vertebra, providing stabilization.[7] Kyphoplasty, a modification of vertebroplasty, includes balloon inflation to restore vertebral height before cement injection.[8] Despite advances, there is ongoing debate regarding the superiority of these approaches.[9] Few prospective multicentric studies have compared these modalities in the Indian population. This study aims to evaluate the effectiveness of different management strategies in OVCFs across multiple centres.

METHODS

This prospective multicentric observational study was conducted at three tertiary care centres in Odisha, namely Veer Surendra Sai Institute of medical sciences and research (VIMSAR), Burla, Fakira Mohan medical college, Balasore, and government medical college, Sundargarh, between December 2023 and December 2025. The study included patients aged 50 years and above who were diagnosed with osteoporotic vertebral compression fractures (OVCFs) based on clinical assessment and radiological confirmation. Patients presenting with acute or subacute osteoporotic vertebral fractures of less than six weeks duration were considered eligible for inclusion. Patients with traumatic vertebral fractures, malignancy-related fractures, neurological deficits, or a history of previous spinal surgery were excluded from the study.

A total of 220 eligible patients were enrolled consecutively after obtaining written informed consent. Following detailed clinical and radiological evaluation, treatment decisions were made by the treating orthopaedic surgeons according to fracture characteristics, patient preference, medical fitness, and institutional protocols. Based on the treatment modality received, patients were categorized into three groups: group A comprised 80 patients managed conservatively, group B included 70 patients who underwent vertebroplasty, and group C consisted of 70 patients treated with kyphoplasty.

Conservative treatment included analgesic medications, anti-osteoporotic therapy, spinal bracing, and supervised physiotherapy. Patients undergoing vertebroplasty were treated under fluoroscopic guidance using percutaneous injection of polymethylmethacrylate bone cement into the fractured vertebral body. Kyphoplasty was performed using balloon-assisted vertebral body expansion followed by cement augmentation under fluoroscopic guidance.

Baseline demographic characteristics, fracture details, VAS scores, Oswestry disability index (ODI) scores, and radiological parameters were recorded at enrolment. Patients were followed up at 3 months, 6 months, and 12 months after treatment. At each follow-up visit, pain intensity, functional disability, radiological vertebral height restoration, and treatment-related complications were assessed and documented.

Data were entered into Microsoft Excel and analysed using Statistical package for social sciences (SPSS) version 25.0. Continuous variables were expressed as mean±standard deviation, whereas categorical variables were expressed as frequencies and percentages. Intergroup comparisons were performed using one-way analysis of variance (ANOVA) for continuous variables and Chi-square test for categorical variables. Repeated measures ANOVA was used to compare changes in VAS scores over time. A p value of less than 0.05 was considered statistically significant.

RESULTS

A total of 220 patients diagnosed with osteoporotic vertebral compression fractures were included in the final analysis.

Baseline characteristics

The demographic and clinical profiles of patients across all three groups were comparable, with no statistically significant differences observed at baseline. The mean age ranged between 65 and 67 years, and female predominance was noted in all groups. Baseline pain and disability scores were similar, ensuring homogeneity for comparison. (Table 1) summarizes the baseline characteristics of the study population.

Table 1: Baseline characteristics of study participants.

Parameters	Group A (n=80)	Group B (n=70)	Group C (n=70)	P value
Mean age (years)	66.4±7.2	65.8±6.9	67.1±7.5	0.62
Female (%)	62.5	65.7	64.2	0.88
Baseline VAS score	8.1±0.9	8.3±0.8	8.2±0.7	0.54
Baseline ODI (%)	72±6	74±5	73±6	0.48

Pain assessment (VAS scores)

All three treatment groups demonstrated a statistically significant reduction in pain scores over time (repeated measures ANOVA, $p<0.001$). However, the magnitude and rate of improvement differed across groups. Patients undergoing kyphoplasty (Group C) showed the most pronounced reduction in pain at all follow-up intervals, followed by vertebroplasty (Group B). Conservative management (Group A) resulted in gradual but comparatively lesser improvement. At 3 months, Group B and Group C showed significantly lower VAS scores compared to Group A ($p=0.01$). At 12 months, Group C maintained the lowest mean VAS score ($p=0.03$). These findings are detailed in Table 2.

Functional outcome (ODI scores)

Functional disability, assessed using the Oswestry disability index, showed significant improvement in all groups over the study period ($p<0.001$). At 12 months, patients in group C exhibited the greatest improvement, followed by group B, while group A showed comparatively modest recovery. The difference between groups at final follow-up was statistically significant ($p=0.01$). These results are presented in Table 3.

Radiological outcomes

Radiographic analysis demonstrated a marked difference in vertebral height restoration among the groups. Kyphoplasty (Group C) achieved the highest restoration, followed by vertebroplasty (Group B), while minimal change was noted in the conservative group. The intergroup difference was statistically significant ($p<0.01$).

Table 2: Comparison of VAS scores over time.

Time point	Group A	Group B	Group C	P value
Baseline	8.1±0.9	8.3±0.8	8.2±0.7	0.54
3 months	5.6±1.1	3.2±0.9	2.8±0.8	0.01
6 months	4.2±1.0	2.5±0.7	2.0±0.6	0.02
12 months	3.8±0.9	2.2±0.6	1.8±0.5	0.03

Table 3: Oswestry disability index (ODI) comparison.

Time point	Group A	Group B	Group C	P value
Baseline	72±6	74±5	73±6	0.48
12 months	38±7	24±5	18±4	0.01

Complications

The overall complication rate was low across all groups. Cement leakage was observed only in the interventional groups, with a slightly higher incidence in vertebroplasty. However, these differences were not statistically significant ($p=0.27$). Adjacent vertebral fractures were noted in all groups, with comparable frequencies. Details are provided in Table 4.

Table 4: Complications across study groups.

Complications	Group A (%)	Group B (%)	Group C (%)	P value
Cement leakage	0	8.5	5.7	0.27
Infection	1.2	2.8	2.8	0.65
Adjacent fracture	6.2	7.1	5.7	0.81

DISCUSSION

OVCFs significantly impact elderly populations, often leading to chronic pain and disability.[10] This study highlights differences in outcomes among conservative and interventional approaches. Conservative management remains widely used but often results in slower recovery.[11] In our study, group A showed gradual improvement but inferior outcomes compared to interventional groups. Vertebroplasty has been shown to provide rapid pain relief due to mechanical stabilization.[12] Our findings align with previous studies demonstrating early VAS improvement.[13] Kyphoplasty offers additional advantages by restoring vertebral height and correcting kyphosis.[14] In this study, kyphoplasty resulted in superior long-term pain relief and functional outcomes, consistent with earlier reports.[15] The statistical significance observed ($p<0.05$) confirms the superiority of kyphoplasty in selected patients. However, cost and availability remain limiting factors in resource-constrained settings.[16] Complication rates were low and comparable across groups, consistent with literature.[17] This multicentric study strengthens external validity and provides region-specific data for India.

CONCLUSION

In summary, the findings of this multicentric prospective study indicate that kyphoplasty is associated with superior long-term clinical and functional outcomes in patients with osteoporotic vertebral compression fractures. Vertebroplasty, while slightly less effective in long-term restoration, demonstrates the advantage of providing rapid and significant early pain relief. Conservative management remains a reasonable option, particularly for patients with mild symptoms or those who are not suitable candidates for interventional procedures. Overall, the choice of treatment should be tailored to the individual patient, taking into account clinical severity, comorbid conditions, functional demands, and the availability of healthcare resources.

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