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To Study the Functional Outcome of Vertebroplasty versus Conservative Management in Osteoporotic Fractures

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Learning Point of the Article:

Vertebroplasty provides faster pain relief and better functional recovery in osteoporotic vertebral compression fractures compared to conservative management but carries a higher risk of new fractures, necessitating careful patient selection.

Abstract

Introduction: Osteoporotic vertebral compression fractures (VCFs) significantly affect morbidity and quality of life. While conservative management (analgesics, bracing, and physiotherapy) is standard, vertebroplasty offers a minimally invasive alternative. This study compared the functional outcomes of vertebroplasty and conservative management in patients with osteoporotic fractures.

Materials and Methods: A prospective study of patients (≥60 years) with acute/subacute VCFs assessed pain (visual analog scale) and function (Oswestry disability index) at baseline, 3, 6, and 12 months. Patients underwent either vertebroplasty or conservative management. Statistical analysis included Chi-square and Mann–Whitney U-tests.

Results: Among 162 patients (81 per group), vertebroplasty led to significantly greater pain relief and functional improvement at all follow-ups ($P < 0.0001$). However, new fractures were more frequent in the vertebroplasty group (9.68% vs. 3.23%).

Conclusion: Vertebroplasty provides faster pain relief and better functional recovery but carries a higher risk of new fractures, requiring careful patient selection.

Keywords: Osteoporotic vertebral compression fractures, vertebroplasty, pain relief, conservative management.

Introduction

Osteoporosis, a systemic metabolic skeletal disease, is described as a reduced bone mass, compromised bone quality, and the deterioration of bone microstructure [1]. It is a major public health concern, with one in two women and one in five men experiencing a fragility fracture after the age of 50. Often referred to as a "silent disease," osteoporosis is broadly categorized into primary and secondary types [2, 3].

Osteoporotic fractures or fragility fractures are caused by diminished bone strength and contribute to morbidity and mortality, with some remaining asymptotic while others cause pain and deformity [4]. The incidence rises exponentially with age, most commonly affecting the spine, hip, humerus, and wrist. Vertebral fractures, the most prevalent in postmenopausal women, account for approximately 27% of all osteoporotic fractures in both men and women with an estimated 550,000–700,000 osteoporotic vertebral compression fractures (VCFs) annually. However, accurately quantifying their incidence is challenging, as only 23–33% of VCFs are clinically diagnosed, leaving many cases unrecognized [5, 6].

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Table 1: Characteristics of patients undergoing vertebroplasty versus conservative treatment

Parameters	Vertebroplasty (n=81)		Conservative (81)	
Age	65.36±12.57		68.33±10.27	
New cerebral fracture (n/%)	9	11.11	4	4.94
Radicular compression (n/%)	9	11.11	0	0
DLA incorporation	90.24		79.56	
Work reintegration	73.48		79.56	
Antiresorptive therapy (n/%)	59	72.84	64	79.01
Lumbar T-score	−4.31±0.84		−4.02±0.51	
Hip T score	−3.00±0.57		−2.87±0.74	

Low bone mineral density (BMD) is a major risk factor for vertebral fractures, with the risk increasing more than fourfold for each standard deviation decrease from the mean BMD. The risk of osteoporotic VCFs also rises with age – while 10% of white women aged 50–54 have at least one vertebral fracture, this figure climbs to 50% among women aged 80–84. Furthermore, every 5-year increment in age doubles the risk of vertebral fractures. Despite the availability of effective treatments to reduce fracture risk, only 23% of patients with fragility fractures undergo osteoporosis evaluation and receive appropriate treatment [7, 8].

Effective pain management is crucial for restoring function and improving patient outcomes. However, an optimal and universally accepted treatment strategy for VCF-related pain has yet to be established. Various conservative therapies have been explored, including external bracing, analgesics such as non-steroidal anti-inflammatory drugs and opioids, as well as anti-osteoporotic medications such as bisphosphonates, calcitonin, denosumab, and osteoanabolic agents such as teriparatide. However, the effectiveness of these treatments remains uncertain due to conflicting study results, limited comparative analyses, and low statistical power.

Vertebroplasty, a minimally invasive technique introduced by

Table 2: Inter-group comparison of pain assessment during follow-up using VAS score

Pain scale using VAS at follow-up	Treatment group	
	Vertebroplasty	Conservative
Baseline	69.24±31.05	65.37±33.59
3 months	35.48±9.28	45.14±19.45
6 months	30.52±13.76	34.77±10.84
12 months	34.69±14.88	39.93±16.53
P-value	<0.0001	<0.0001

VAS: Visual analog scale

Deramond in France in the late 1980s for treating aggressive hemangiomas and osteolytic neoplasms, involves the percutaneous injection of bone cement, typically polymethylmethacrylate [8], into a fractured vertebral body. Initially designed for neoplastic conditions, its application later extended to managing osteoporotic compression fractures unresponsive to medical therapy [9]. Early studies reported 70–95% pain relief following vertebroplasty. The exact mechanism by which vertebroplasty alleviates pain remains unclear, though it is hypothesized to involve immediate mechanical stabilization or neuronal damage caused by the heat released during cement polymerization [9].

Comparing conservative management and vertebroplasty highlights differences in recovery time, pain relief, functional outcomes, and complication rates. While vertebroplasty may provide faster pain relief and earlier mobilization, some studies suggest that long-term outcomes are comparable to those of conservative treatment. Despite its widespread use, conflicting

Table 3: Intra-group comparison of pain assessment during follow-up using VAS score (mm) between treatment group

Pain scale using VAS at follow-up	Treatment group		P-value
	Vertebroplasty	Conservative	
Baseline	69.24±31.05	65.37±33.59	0.63
3 months	35.48±9.28	43.14±20.45	0.06
6 months	30.52±13.76	34.77±10.84	0.18
12 months	34.69±14.88	39.93±16.53	0.19

VAS: Visual analog scale

Table 4: Mean comparative Oswestry disability index at follow-up

Follow-up	Oswestry disability index	
	Vertebroplasty	Conservative
Baseline	85.33±12.82	82.47±12.37
3 months	53.66±8.05	58.16±8.72
6 months	35.21±5.28	39.74±5.96
12 months	26.64±4.00	29.32±4.40

Table 5 : Baseline characteristics of the study groups

Characteristic	Vertebroplasty Group	Control Group
SF-36 Score		
Physical Component	25.3 ± 7.8	25.3 ± 7.3
Mental Component	44.8 ± 11.8	41.5 ± 14.1
Pain Scores		
Pain Frequency Index	3.26 ± 0.95	3.48 ± 1.02
Pain Bothersomeness Index	2.98 ± 0.81	3.54 ± 0.92
Quality of Life Measures		
EQ–5D Score	0.62 ± 0.20	0.53 ± 0.19
SOF–ADL Score	10.12 ± 3.11	11.02 ± 3.06

findings have led to ongoing debate regarding vertebroplasty's superiority over conservative management. Some studies report significant pain reduction and functional improvement with vertebroplasty, while others indicate no clear long-term advantage over non-surgical approaches. In addition, further evidence is needed to assess long-term functional outcomes, pain scores, and overall quality-of-life improvements following vertebroplasty.

Given these uncertainties, this study aims to compare the functional outcomes of vertebroplasty versus conservative management in patients with osteoporotic fractures. The findings will contribute to evidence-based clinical decision-making and help optimize treatment strategies for osteoporotic VCFs.

Materials and Methods

Study design and participants

The present study was conducted at Dr. Panjabrao Deshmukh Medical College, Amravati from 2020 to 2025. Patients aged ≥60 with acute or subacute pain underwent diagnostic evaluations for VCFs, including radiographic studies and magnetic resonance imaging assessments.

The rehabilitation program included 20 1-h sessions, conducted Monday to Friday, featuring thermotherapy, electrotherapy, ultrasound, stretching, and muscle-strengthening exercises. Patients were advised on home exercises and heat application. A clinical evaluation followed, with additional treatment as needed. Those attending <80% of sessions were excluded from the study.

Outcome measures

Pain was measured using the visual analog scale (VAS), and function was assessed with the Oswestry disability index (ODI). Data were collected at baseline, 3, 6, and 12 months, while the conservative treatment group was evaluated for pain relief after 6 weeks. Those with persistent pain (>50 mm on VAS) were considered for percutaneous vertebroplasty if they met inclusion criteria, including vertebral collapse of 15–50% without neurological compromise.

Percutaneous vertebroplasty

Patients meeting vertebroplasty criteria and consenting to the procedure underwent percutaneous vertebroplasty performed by attending spinal surgery physicians. Methyl methacrylate cement was injected into the affected thoracic and lumbar segments without any reported complications.

Statistical analysis

Descriptive statistics were used for data analysis. A Chi-square test was applied for categorical variables, while a Mann–Whitney U-test was used for quantitative variables. The Kruskal–Wallis test was employed for repeated comparisons. Statistical analyses were conducted using the Statistical Packages for the Social Sciences v.20.0 (Chicago, IL).

Results

The vertebroplasty group had a mean age of 65.36 years, a higher incidence of new cerebral fractures (9.68%) and radicular compression (9.68%), but better DLA incorporation (90.24%). Work reintegration was slightly higher in the conservative group (79.56% vs. 73.48%). Antiresorptive therapy use was similar, and T-scores were slightly lower in the vertebroplasty group (Table 1).

Vertebroplasty showed greater pain reduction than conservative management, with lower VAS scores at 3, 6, and 12 months. The difference was statistically significant ($P < 0.0001$), favoring vertebroplasty for pain relief Table 2.

Pain reduction was observed in both groups over time. However, intra-group differences were not statistically significant at any follow-up point ($P > 0.05$), indicating similar pain trends within each treatment group Table 3.

Vertebroplasty showed greater improvement in ODI at all follow-ups, with lower scores at 3, 6, and 12 months compared to conservative management, indicating better functional recovery Table 4.

At baseline, both groups had similar SF-36 physical scores. The vertebroplasty group had higher mental component scores, lower pain indices, and a better EQ-5D score than the control group. The SOF-ADL score was lower in the vertebroplasty group Table 5.

Discussion

This study compared functional outcomes of vertebroplasty and conservative management in osteoporotic VCFs. Patients undergoing vertebroplasty reported significant reductions in pain, as measured by the VAS, at 3-, 6-, and 12-month post-treatment. These findings align with previous research by Yang et al. [10] demonstrating that vertebroplasty offers superior pain relief compared to conservative management.

Functional improvement, assessed using the ODI, was more pronounced in the vertebroplasty group at all follow-up intervals. This suggests that vertebroplasty not only alleviates pain but also enhances patients' ability to perform daily activities more effectively than conservative treatment. Yang et al. [11] found that polyvinylpyrrolidone (PVP) was associated with faster pain relief and quicker return to daily activities compared to compute tomography scans.

The incidence of new vertebral fractures and radicular compression was higher in the vertebroplasty group (11.11% vs. 4.94% and 11.11% vs. 0%, respectively). However, despite these complications, vertebroplasty patients demonstrated better incorporation into daily life activities (90.24% vs. 79.56%), though work reintegration was slightly lower compared to the conservative group (73.48% vs. 79.56%). The reasons for this discrepancy are unclear but may be related to persistent discomfort or increased caution in physically demanding tasks post-procedure.

While some studies suggest that vertebroplasty does not increase the risk of new VCFs, Yang et al. [12] found that PVP did not elevate the risk of new VCFs, particularly in vertebrae adjacent to the treated area, when compared to CT scans. However, our findings indicate a higher fracture incidence in the vertebroplasty group, warranting further investigation into patient selection, procedural techniques, and long-term outcomes.

In addition, the vertebroplasty group had lower lumbar (−4.31 ± 0.84 vs. −4.02 ± 0.51) and hip T-scores (−3.00 ± 0.57 vs. −2.87 ± 0.74), indicating more severe osteoporosis, which could partly explain the increased fracture rate. The slightly lower rate of work reintegration despite better daily activity incorporation highlights the need for individualized rehabilitation strategies post-vertebroplasty to optimize long-term functional outcomes.

Overall, while vertebroplasty provides significant pain relief and functional improvement, the higher incidence of complications emphasizes the importance of careful patient selection and long-term follow-up to assess the true risk-benefit profile of the procedure. Further studies are needed to explore the impact of these complications on long-term mobility, quality of life, and reintegration into professional activities.

Limitations

- The study has some limitations, including a short 12-month follow-up that may not fully capture long-term outcomes such as new vertebral fractures and sustained functional improvements
- Selection bias is present since only patients suitable for vertebroplasty were included, limiting generalizability
- The absence of randomization could result in baseline differences between groups, affecting comparison validity
- Confounding factors such as rehabilitation adherence, pain tolerance, and medication use were not adequately controlled. Self-reported pain and functional scores (VAS and ODI) introduce potential bias
- Conservative treatment outcomes vary due to differences in compliance and rehabilitation, complicating comparisons
- Vertebroplasty results may also depend on the surgeon's expertise. In addition, the study lacks a cost-effectiveness analysis, which is essential for healthcare decision-making.

Conclusion

Vertebroplasty appears to offer more rapid pain relief and functional improvement compared to conservative management in patients with OVCFs. However, the potential for increased complication rates necessitates careful patient selection and further research to fully elucidate the risk-benefit profile of this intervention.

Clinical Message

Vertebroplasty is an effective, minimally invasive option for osteoporotic VCFs, offering significant pain relief and functional improvement. However, the risk of new fractures should be considered when selecting patients for the procedure.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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