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Original Research Article

# A PROSPECTIVE COHORT COMPARISON OF VERTEBROPLASTY AND SHORT-SEGMENT FIXATION IN NON-OSTEOPOROTIC THORACOLUMBAR BURST FRACTURES

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## Abstract

**Background:** Thoracolumbar burst fractures commonly result from high-energy trauma and pose challenges in achieving optimal spinal stability, pain relief, and functional recovery, particularly in non-osteoporotic patients. While short-segment posterior fixation remains a widely accepted operative method due to its ability to restore alignment and stability, vertebroplasty has emerged as a minimally invasive alternative aimed at reducing perioperative morbidity. However, comparative evidence between these two modalities in non-osteoporotic traumatic burst fractures remains limited. The aim is to compare the clinical, radiological, and perioperative outcomes of percutaneous vertebroplasty and short-segment posterior fixation in the management of non-osteoporotic thoracolumbar burst fractures. **Materials and Methods:** This prospective cohort study included 56 patients with single-level thoracolumbar burst fractures (T11–L2) treated at a tertiary care -Periyar Government Hospital. Patients were allocated into two groups: vertebroplasty (n=28) and short-segment posterior fixation (n=28). Baseline demographic, clinical, and radiological assessments were recorded. Perioperative parameters included operative time, blood loss, fluoroscopy duration, and hospital stay. Radiological outcomes assessed kyphotic angle, vertebral body height restoration, and canal compromise. Clinical outcomes were measured using VAS, ODI, and ASIA grade. Complications were documented for both groups. Statistical analysis was performed using SPSS version 26.0. **Result:** Baseline characteristics were comparable between groups. Vertebroplasty demonstrated significantly shorter operative time (46.18 ± 6.92 vs 104.21 ± 12.37 min, $p<0.001$), reduced blood loss (42.68 ± 11.35 vs 182.57 ± 28.41 mL, $p<0.001$), and shorter hospital stay (2.86 ± 0.71 vs 5.32 ± 1.29 days, $p<0.001$). Short-segment fixation achieved superior radiological outcomes, including greater kyphotic angle correction and higher vertebral body height restoration ($p<0.001$). Both groups showed comparable improvements in VAS, ODI, and ASIA grades with no significant differences in clinical outcomes. Complication rates were low, with asymptomatic cement leakage occurring in 10.71% of vertebroplasty cases and minor wound or hardware-related issues in the fixation group. **Conclusion:** We concluded that vertebroplasty and short-segment fixation both provide effective clinical improvement in non-osteoporotic thoracolumbar burst fractures. Percutaneous Vertebroplasty offers reduced surgical morbidity, while fixation delivers better radiological correction. Combining both techniques may yield superior results but it is still under debate. Treatment should be tailored to fracture characteristics and patient needs.

## INTRODUCTION

Thoracolumbar burst fractures represent a significant subset of spinal injuries in young and middle-aged adults, typically resulting from high-energy trauma such as falls from height or road traffic accidents. These fractures involve failure of the vertebral body under axial load with retropulsion of bone fragments


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into the spinal canal, raising concerns about both mechanical instability and potential neurological compromise. The concept of spinal stability in this region was fundamentally shaped by Denis' three-column model, which highlighted the crucial role of the middle column in determining whether a fracture pattern is stable or unstable and therefore whether surgical intervention is warranted.[1] Advances in imaging and biomechanics have refined our understanding of these injuries, but their optimal management especially in neurologically intact, non-osteoporotic patients remains a subject of ongoing debate. Over time, several classification systems have been developed to better characterize thoracolumbar injuries and guide treatment decisions. Magerl et al. proposed a comprehensive morphologic classification of thoracic and lumbar fractures based on pathoanatomical criteria, distinguishing between compression, burst, flexion-distraction, and rotational injuries.[2] This schema laid the groundwork for later systems by emphasizing the mechanism and severity of structural damage. Building upon this, the AO Spine Thoracolumbar Injury Classification System introduced a more pragmatic and hierarchical framework that integrates fracture morphology, integrity of the posterior ligamentous complex, and neurological status, aiming to standardize communication and improve decision-making for both operative and non-operative care.[3] More recently, international expert groups have reinforced the clinical utility of AO-based and TLICS-based algorithms, recommending that fracture anatomy, patient factors, and neurological findings be thoroughly evaluated before choosing between conservative management and various surgical strategies.[4] Despite these advances in classification, there is still no universal consensus on the best treatment approach for non-osteoporotic thoracolumbar burst fractures without major neurological deficit. Non-operative treatment with bracing and early mobilization may be appropriate for stable fractures, but concerns persist regarding progressive kyphotic deformity, chronic pain, and late instability in certain patterns. Conversely, operative intervention seeks to restore sagittal alignment, decompress the canal when needed, and provide immediate stability to facilitate early mobilization. Posterior short-segment pedicle screw fixation typically involving the vertebra above and below the fracture, with or without inclusion of the fractured level has become one of the most widely used techniques. It preserves motion segments compared with long-segment constructs and can deliver good radiological and functional outcomes, yet issues such as implant failure, loss of correction, and the need for more extensive dissection remain important considerations, particularly in younger patients who may live many decades with their implants.[5] Parallel to these developments in fixation techniques, percutaneous vertebral augmentation procedures have emerged as attractive minimally invasive options for vertebral fractures. Vertebroplasty, originally popularized for painful osteoporotic compression fractures, involves percutaneous injection of polymethylmethacrylate (PMMA) cement into the fractured vertebral body under fluoroscopic guidance, aiming to stabilize micro-motion at the fracture site and provide rapid pain relief. Early reports extended this concept to traumatic non-osteoporotic fractures, demonstrating that in carefully selected cases, vertebroplasty could achieve substantial pain reduction and early mobilization with minimal soft-tissue disruption and short hospital stays.[6] Subsequent series of traumatic spinal compression fractures further supported vertebroplasty as a safe and effective modality, showing consistent improvement in pain scores, functional status, and mobility, while highlighting the generally benign nature of most cement leakages when meticulous technique is used.[7] These findings have prompted increasing interest in vertebroplasty as a potential alternative to instrumented fusion in selected traumatic burst fractures, especially when the posterior elements and ligamentous structures remain largely intact. However, the role of vertebroplasty in non-osteoporotic thoracolumbar burst fractures remains controversial. Critics argue that although cement augmentation provides internal stabilization and analgesia, it may offer limited capacity to restore vertebral body height or correct kyphosis compared with posterior instrumentation, and does not directly address canal compromise in fractures with significant retropulsion. Proponents counter that in neurologically intact patients with relatively preserved posterior ligamentous complex, vertebroplasty can provide sufficient internal stability to allow early mobilization and functional recovery, while avoiding the morbidity associated with open surgery, muscle stripping, and hardware implantation. These divergent perspectives underscore the need for rigorous comparative data evaluating not only clinical outcomes such as pain and disability, but also radiological parameters, complication profiles, and resource utilization.

## MATERIALS AND METHODS

This was a prospective cohort study conducted at a tertiary care -Periyar Government Hospital, designed to compare clinical and radiological outcomes of percutaneous vertebroplasty and short-segment posterior fixation in patients with non-osteoporotic thoracolumbar burst fractures. A total of 56 consecutive, eligible patients presenting to the emergency department and fulfilling the inclusion criteria were enrolled and followed longitudinally. All procedures were performed by Fellowship-trained Spine Surgeon and Chief Ortho- Surgeon under the supervision guidance of Hospital Superintendent following standard institutional protocols for trauma care.

**Patient selection:** Adult patients with a single-level traumatic thoracolumbar burst fracture (T11–L2) confirmed on radiographs and computed


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tomography, who were hemodynamically stable and neurologically intact or with incomplete deficit, were considered for inclusion. Only patients with non-osteoporotic bone quality, assessed clinically and, where indicated, by bone mineral density testing and evaluation of risk factors, were included. Exclusion criteria were osteoporotic fractures, pathological fractures (including neoplastic or infectious etiology), multiple noncontiguous spinal fractures, previous surgery at the affected level, polytrauma precluding early operative management, severe neurological deficit requiring decompression beyond short-segment constructs, and refusal to provide informed consent. Written informed consent was obtained from all patients, and the study protocol was approved by the institutional ethics committee.

**Preoperative evaluation and group allocation:** On admission, detailed demographic data (age, sex, occupation) and injury-related information (mechanism of trauma, time from injury to presentation) were recorded. Baseline clinical assessment included visual analogue scale (VAS) for back pain, Oswestry Disability Index (ODI), neurological status using the American Spinal Injury Association (ASIA) impairment scale, and general physical examination. Radiographic evaluation comprised standing or supine anteroposterior and lateral radiographs, computed tomography for fracture morphology, canal compromise and vertebral body height measurements, and magnetic resonance imaging where necessary to assess posterior ligamentous complex integrity. Patients were allocated into two cohorts based on treating surgeon's decision considering fracture morphology, degree of comminution, canal compromise, and patient preference: a vertebroplasty group and a short-segment posterior fixation group.

**Surgical technique: Percutaneous Vertebroplasty:** Vertebroplasty [Fig 1. & Fig 2) was performed under fluoroscopic guidance in the prone position under general or regional anesthesia. After sterile preparation and draping, Percutaneous bilateral transpedicular access to the fractured vertebra was obtained using Jamshidi needles. Polymethylmethacrylate (PMMA) bone cement of standardized viscosity was prepared and injected under continuous lateral and anteroposterior fluoroscopic control, aiming for homogenous filling of the vertebral body while carefully monitoring for cement leakage. Injection was terminated when adequate filling was achieved, cement reached the posterior third of the vertebral body, or any evidence of extravasation was noted. Skin staplers applied. Patients were observed in the recovery area and mobilized as tolerated using a thoraco-lumbosacral orthosis.

**Surgical technique: short-segment posterior fixation:** Short-segment posterior fixation (Fig 3 & Fig 4) was carried out with the patient in the prone position on a radiolucent table under general anesthesia. A standard midline posterior approach was used to expose the posterior elements one level above and one level below the fractured vertebra. Pedicle screws were inserted bilaterally into the proximal and distal vertebrae using fluoroscopic guidance, and intermediate screws in the fractured vertebra were placed when feasible based on pedicle integrity. Pre-contoured rods were applied, and indirect reduction was achieved via ligamentotaxis, with or without limited decompression depending on canal compromise and neurological status. Posterolateral fusion using autologous local bone graft was performed at the instrumented levels. Wound closure was done in layers over a suction drain as per institutional practice.

**Postoperative care and follow-up protocol:** Postoperatively, all patients received standardized analgesia, prophylactic antibiotics, and deep vein thrombosis prevention as per hospital protocol. Early mobilization was encouraged with a thoraco-lumbosacral brace, and patients were instructed to avoid heavy lifting and extreme spinal flexion. Clinical assessments including VAS and ODI were repeated at predefined outpatient visits, and neurological examination was performed at each contact. Radiographs in anteroposterior and lateral views were obtained postoperatively and at follow-up visits to evaluate maintenance of alignment, vertebral body height, implant integrity, and evidence of fusion or cement stability. Complications such as cement leakage, wound infection, implant failure, adjacent level fractures, and need for revision surgery were systematically documented.

**Outcome measures and parameters:** Primary outcome parameters included improvement in VAS score for back pain and ODI for functional disability from baseline to subsequent follow-up evaluations. Radiological outcomes comprised segmental kyphotic angle measured by Cobb's method, anterior and middle vertebral body height restoration expressed as a percentage of estimated normal height, and degree of spinal canal compromise calculated from computed tomography images. Neurological status was graded using the ASIA scale to document any improvement or deterioration. Perioperative parameters included operative time, intraoperative blood loss, fluoroscopy exposure time, and length of hospital stay. Safety outcomes encompassed intraoperative and postoperative complications, cement leakage patterns (asymptomatic versus symptomatic), wound complications, implant-related problems, and reoperation rates.

**Statistical analysis:** Data were entered into a dedicated spreadsheet and analyzed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were tested for normality using the Shapiro–Wilk test and summarized as mean ± standard deviation or median with interquartile range, as appropriate. Categorical variables were presented as frequencies and percentages. Between-group comparisons for continuous variables were performed using the independent samples t-test for normally distributed data or the Mann–Whitney U test for non-normal


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distributions. Categorical variables were compared using the chi-square test or Fisher's exact test where cell counts were small. Within-group changes over time in clinical and radiological parameters were assessed using paired t-tests or Wilcoxon signed-rank tests as appropriate. A two-tailed p-value of less than 0.05 was considered statistically significant.

## RESULTS

The baseline demographic and clinical characteristics of the study population are presented in [Table 1]. Both groups were comparable across all measured parameters, demonstrating adequate homogeneity at the start of the study. The mean age of patients was similar between the vertebroplasty group (41.82 ± 9.54 years) and the short-segment fixation group (42.39 ± 10.12 years), with no significant difference ($p = 0.81$). Male predominance was observed in both groups, accounting for 64.29% of the vertebroplasty cohort and 67.86% of the fixation cohort ($p = 0.78$). Falls were the most common mechanism of injury, representing 53.57% and 50.00% of cases in the two groups, respectively ($p = 0.79$). Baseline pain and disability levels were also similar, with VAS scores of 8.14 ± 0.92 in the vertebroplasty group and 8.21 ± 1.03 in the fixation group ($p = 0.78$), and ODI scores of 63.89 ± 7.24 versus 64.57 ± 6.98 ($p = 0.70$). Neurological status was largely preserved, with ASIA Grade E recorded in 78.57% of vertebroplasty patients and 82.14% of fixation patients ($p = 0.73$).

Perioperative parameters, summarized in [Table 2], demonstrated significant differences between the two treatment modalities. Vertebroplasty was markedly less time-consuming, with a mean operative time of 46.18 ± 6.92 minutes, compared with 104.21 ± 12.37 minutes required for short-segment fixation ($p < 0.001$). Blood loss was also significantly lower in the vertebroplasty group (42.68 ± 11.35 mL) compared with the fixation group (182.57 ± 28.41 mL) ($p < 0.001$), reflecting the minimally invasive nature of vertebroplasty. Fluoroscopy exposure was higher in fixation procedures (72.18 ± 16.27 seconds) compared with vertebroplasty (58.39 ± 14.54 seconds) ($p = 0.003$). Length of hospitalization further supported the reduced perioperative burden associated with vertebroplasty, with patients discharged earlier (2.86 ± 0.71 days) compared with those undergoing fixation (5.32 ± 1.29 days) ($p < 0.001$).

Radiological outcomes, as presented in [Table 3], demonstrated that both interventions resulted in significant improvements, though short-segment fixation provided superior anatomical restoration. Preoperative kyphotic angles were comparable between groups (18.32 ± 3.48° vs 18.79 ± 3.23°, $p = 0.62$). At final follow-up, fixation achieved greater correction, bringing the kyphosis down to 10.21 ± 2.41°, compared with 11.79 ± 2.57° in the vertebroplasty group ($p = 0.02$). Similarly, anterior vertebral body height restoration was significantly higher in the fixation group (78.39 ± 5.89%) than in the vertebroplasty group (72.46 ± 6.14%) ($p < 0.001$). Although initial canal compromise was similar (31.82 ± 5.38% vs 30.93 ± 5.12%, $p = 0.48$), fixation resulted in better canal clearance at final follow-up (15.68 ± 3.12% vs 18.21 ± 3.64%, $p = 0.01$).

Clinical outcomes assessed through VAS, ODI, and ASIA grading are shown in [Table 4]. Both treatment groups demonstrated substantial clinical improvement, with no statistically significant differences between them. Final VAS scores were 2.11 ± 0.67 for vertebroplasty and 2.43 ± 0.74 for fixation ($p = 0.07$), reflecting strong pain relief in both groups. Functional disability also improved comparably, with final ODI scores of 19.46 ± 5.91 in the vertebroplasty group and 21.68 ± 6.14 in the fixation group ($p = 0.15$). Neurological improvement was observed in a small subset of patients, with ASIA grade enhancement noted in 14.29% of vertebroplasty cases and 21.43% of fixation cases ($p = 0.49$).

Complications and adverse events, summarized in [Table 5], were generally infrequent and minor across both groups. Cement leakage occurred in 10.71% of vertebroplasty patients, though all cases were asymptomatic and required no intervention. The fixation group showed a slightly higher rate of wound-related complications, with wound infections occurring in 7.14% of patients ($p = 0.15$). Implant failure was rare, observed in only one fixation patient (3.57%) ($p = 0.31$). Adjacent level fractures occurred at equal rates in both groups (3.57%). Reoperation was not required in any vertebroplasty patient, whereas one fixation patient (3.57%) required revision surgery ($p = 0.31$).

**Figure 1: Pre-Vertebroplasty (Representative X-ray) L1 Burst fracture with LKA 14.50 & AVBH 9.0mm**


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**Figure 2. Post-Vertebroplasty (Representative X-ray)**
**L1 Burst fracture with LKA 11.10 & AVBH 9.7 mm**

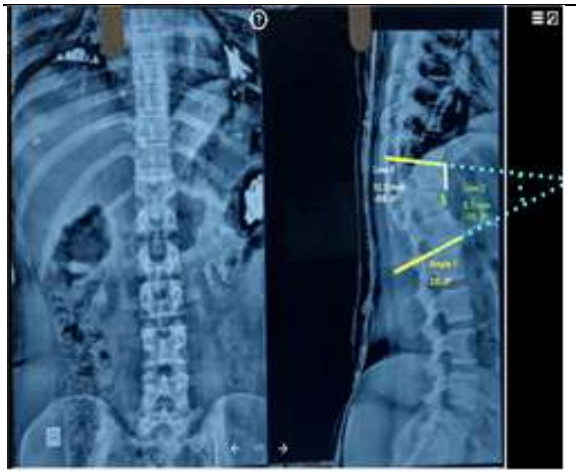

**Figure 3: Pre-SSF (Representative X-ray)**
**D12 Burst Fracture with, LKA 28.30 & AVBH 5.1mm**

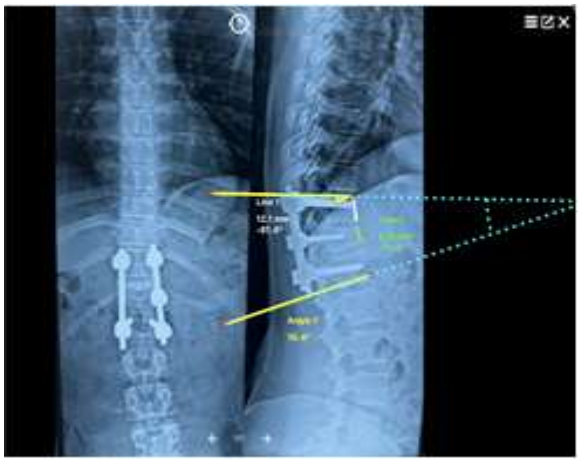

**Figure 4: Post-SSF (Representative X-ray)**
**D12 Burst Fracture with LKA 18.40 & AVBH 8.0mm.**

**Table 1: Baseline Demographic and Clinical Characteristics of Patients (N = 56)**

| Parameter | Vertebroplasty (n = 28) | Short-Segment Fixation (n = 28) | p-value |
|---|---|---|---|
| Age (years, mean ± SD) | 41.82 ± 9.54 | 42.39 ± 10.12 | 0.81 |
| Sex (Male), n (%) | 18 (64.29%) | 19 (67.86%) | 0.78 |
| Mechanism of Injury – Fall, n (%) | 15 (53.57%) | 14 (50.00%) | 0.79 |
| Baseline VAS (mean ± SD) | 8.14 ± 0.92 | 8.21 ± 1.03 | 0.78 |
| Baseline ODI (%) (mean ± SD) | 63.89 ± 7.24 | 64.57 ± 6.98 | 0.70 |
| ASIA Grade E, n (%) | 22 (78.57%) | 23 (82.14%) | 0.73 |

**Table 2: Perioperative Parameters**

| Parameter | Vertebroplasty (n = 28) | Short-Segment Fixation (n = 28) | p-value |
|---|---|---|---|
| Operative Time (min, mean ± SD) | 46.18 ± 6.92 | 104.21 ± 12.37 | <0.001 |
| Blood Loss (mL, mean ± SD) | 42.68 ± 11.35 | 182.57 ± 28.41 | <0.001 |
| Fluoroscopy Time (sec, mean ± SD) | 58.39 ± 14.54 | 72.18 ± 16.27 | 0.003 |
| Hospital Stay (days, mean ± SD) | 2.86 ± 0.71 | 5.32 ± 1.29 | <0.001 |

**Table 3: Radiological Outcomes**

| Parameter | Vertebroplasty (n = 28) | Short-Segment Fixation (n = 28) | p-value |
|---|---|---|---|
| Kyphotic Angle Pre-op (°) | 18.32 ± 3.48 | 18.79 ± 3.23 | 0.62 |
| Kyphotic Angle Final Follow-up (°) | 11.79 ± 2.57 | 10.21 ± 2.41 | 0.02 |
| Anterior Body Height Restoration (%) | 72.46 ± 6.14 | 78.39 ± 5.89 | <0.001 |
| Canal Compromise Pre-op (%) | 31.82 ± 5.38 | 30.93 ± 5.12 | 0.48 |
| Canal Compromise Final Follow-up (%) | 18.21 ± 3.64 | 15.68 ± 3.12 | 0.01 |

**Table 4: Clinical Outcomes (VAS, ODI, ASIA)**

| Outcome | Vertebroplasty (n = 28) | Short-Segment Fixation (n = 28) | p-value |
|---|---|---|---|
| VAS Final Follow-up (mean ± SD) | 2.11 ± 0.67 | 2.43 ± 0.74 | 0.07 |
| ODI Final Follow-up (%) | 19.46 ± 5.91 | 21.68 ± 6.14 | 0.15 |
| ASIA Grade Improvement, n (%) | 4 (14.29%) | 6 (21.43%) | 0.49 |

**Table 5: Complications and Adverse Events**

| Complication | Vertebroplasty (n = 28) | Short-Segment Fixation (n = 28) | p-value |
|---|---|---|---|
| Cement Leakage, n (%) | 3 (10.71%) | — | — |
| Wound Infection, n (%) | 0 (0.00%) | 2 (7.14%) | 0.15 |


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| | | | |
|---|---|---|---|
| Implant Failure, n (%) | — | 1 (3.57%) | 0.31 |
| Adjacent Level Fracture, n (%) | 1 (3.57%) | 1 (3.57%) | 1.00 |
| Reoperation Rate, n (%) | 0 (0.00%) | 1 (3.57%) | 0.31 |

## DISCUSSION

In this prospective cohort of 56 patients with non-osteoporotic thoracolumbar burst fractures, both percutaneous vertebroplasty and short-segment posterior fixation produced substantial clinical improvement, with mean VAS scores improving from around 8 at baseline (8.14 ± 0.92 vs 8.21 ± 1.03) to 2.11 ± 0.67 and 2.43 ± 0.74, respectively, and ODI decreasing from mid-60s (63.89 ± 7.24 vs 64.57 ± 6.98) to approximately 20% (19.46 ± 5.91 vs 21.68 ± 6.14) at final follow-up. These findings align with Elnoamany et al (2015), who reported that percutaneous vertebroplasty as first-line treatment for traumatic non-osteoporotic vertebral compression fractures produced significant and sustained reductions in pain and disability scores, with most patients achieving early mobilization and durable improvement over follow-up.[8]

Perioperative variables in our series clearly favoured vertebroplasty, with mean operative time less than half that of short-segment fixation (46.18 ± 6.92 vs 104.21 ± 12.37 minutes, p<0.001) and markedly reduced blood loss (42.68 ± 11.35 vs 182.57 ± 28.41 mL, p<0.001), along with a shorter hospital stay (2.86 ± 0.71 vs 5.32 ± 1.29 days, p<0.001). Zhang et al (2013) similarly observed significantly shorter operation time (47.8 ± 5.8 vs 84.2 ± 13.9 minutes) and much lower blood loss (10.8 ± 5.6 vs 245.2 ± 74.1 mL) in patients treated with percutaneous kyphoplasty compared with short-segment pedicle instrumentation for a myelic thoracolumbar burst fractures, with early postoperative VAS and ODI also favouring the minimally invasive cement augmentation group.[9]

Radiologically, short-segment fixation in our study achieved greater correction of deformity and canal compromise than vertebroplasty, with final kyphotic angles of 10.21 ± 2.41° versus 11.79 ± 2.57° (p=0.02), anterior body height restoration of 78.39 ± 5.89% versus 72.46 ± 6.14% (p<0.001), and canal compromise reduced to 15.68 ± 3.12% versus 18.21 ± 3.64% (p=0.01). Verlaan et al (2005) demonstrated that combining posterior short-segment instrumentation with balloon vertebroplasty could restore central and anterior vertebral body height to 78% and 91% of estimated intact height, respectively, while providing good fracture reduction and cement filling; our anterior body height restoration in the fixation cohort (78.39%) is comparable to their central height, whereas the vertebroplasty-only group in the present study shows more modest structural restoration, reflecting the absence of supplemental posterior hardware.[10]

Our finding that short-segment fixation offers superior radiological correction but similar long-term pain and disability compared with vertebroplasty echoes the concept that anterior column augmentation combined with posterior instrumentation optimizes biomechanics, yet clinically both strategies can yield satisfactory outcomes. Afzal et al (2008) reported that short-segment pedicle screw instrumentation supplemented by vertebroplasty in lumbar burst fractures achieved effective anterior column support with good maintenance of reduction and vertebral body height over follow-up, supporting the notion that cement augmentation—whether alone or combined with fixation can contribute meaningfully to structural restoration in traumatic burst injuries.[11]

In terms of pain relief, our vertebroplasty and short-segment fixation cohorts showed comparable final VAS scores (2.11 ± 0.67 vs 2.43 ± 0.74, p=0.07), indicating that the more invasive procedure did not translate into superior long-term analgesia. Knavel et al (2009), in a series of traumatic non-osteoporotic compression fractures treated with vertebroplasty, similarly reported substantial and sustained improvement in pain scores and functional status, concluding that vertebroplasty is an effective option even in high-energy traumatic fractures without reliance on extensive posterior instrumentation findings that are consistent with the robust pain relief observed in our vertebroplasty group.[12]

Sagittal alignment and the risk of loss of correction remain important concerns after short-segment pedicle screw constructs. In our short-segment fixation group, kyphotic angle improved from 18.79 ± 3.23° preoperatively to 10.21 ± 2.41° at final follow-up, with no case of clinically significant kyphotic collapse or implant failure beyond a single asymptomatic hardware failure (3.57%). Kim et al (2014) reported that short-segment fixation including the fractured vertebra resulted in improved Cobb angle and vertebral body compression ratio that were largely maintained at a mean of 38.6 months, though kyphosis recurrence was more likely in patients with high load-sharing scores or specific radiological risk factors, underscoring that appropriate case selection and technique can mitigate sagittal deterioration, in line with our relatively stable alignment outcomes.[13]

Functional recovery in the present cohort was favourable in both groups, with ODI improving from around 64% at baseline to approximately 20% at final follow-up (19.46 ± 5.91 vs 21.68 ± 6.14, p=0.15), and no significant intergroup difference. This parallels the conclusions of Aly (2017), whose meta-analysis of short- versus long-segment fixation for thoracolumbar burst fractures found no clear superiority of longer constructs in terms of functional scores, despite differences in radiological parameters, suggesting that preservation of motion segments with short-segment strategies can achieve acceptable function—similar to the comparable ODI outcomes between vertebroplasty and short-segment fixation in our series.[14]


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Complication rates in our cohort were low, with asymptomatic cement leakage in 10.71% of vertebroplasty cases, wound infection in 7.14% and implant failure in 3.57% of fixation cases, and similar adjacent level fracture rates (3.57%) in both groups; reoperation was required in only one short-segment fixation patient (3.57%). Zaryanov et al (2014), in a focused review of cement augmentation in vertebral burst fractures, highlighted that cement leakage is relatively common but usually clinically silent, whereas serious neurological complications are rare when meticulous technique and appropriate indications are observed, and also emphasized that cement augmentation can reduce hardware failure by improving anterior column support—findings that mirror the benign nature of cement leakage and low reoperation rate in our vertebroplasty group.[15]

Finally, our observation that a less invasive cement-based procedure yields clinical outcomes comparable to instrumented short-segment fixation while sacrificing some degree of radiological correction fits within the broader literature comparing constructs of varying extent and rigidity. Assunção Filho et al (2016), in a meta-analysis comparing short and long posterior fixation for thoracolumbar burst fractures, found that although long-segment constructs may provide slightly better maintenance of kyphosis, short-segment fixation offers similar overall clinical outcomes with fewer fused levels, emphasizing the trade-off between maximal radiological correction and motion preservation—an equilibrium that is further extended in our study, where standalone vertebroplasty achieves good pain and functional results with minimal surgical morbidity when carefully selected.[16]

## CONCLUSION

We concluded that both vertebroplasty and short-segment posterior fixation are effective treatment options for non-osteoporotic thoracolumbar burst fractures, providing significant improvements in pain, function, and neurological outcomes. Vertebroplasty offers clear advantages in terms of reduced operative time, blood loss, and hospital stay due to its minimally invasive nature. In contrast, short-segment fixation achieves superior radiological correction, particularly in vertebral height restoration and kyphotic angle improvement. Combining both techniques may yield superior results but it is still under debate. We concluded that the choice between the two techniques should be individualized based on fracture characteristics and patient-specific considerations, as both approaches yield favourable overall outcomes.

## REFERENCES


1. Denis F. The three column spine and its significance in the classification of acute thoracolumbar spinal injuries. Spine (Phila Pa 1976). 1983;8(8):817–831. Lippincott Journals
2. Magerl F, Aebi M, Gertzbein SD, Harms J, Nazarian S. A comprehensive classification of thoracic and lumbar injuries. Eur Spine J. 1994;3(4):184–201. PubMed
3. Dvorak MF, Vaccaro AR, Kepler CK, et al. AOSpine thoracolumbar spine injury classification system: fracture description, neurological status, and key modifiers. Spine (Phila Pa 1976). 2013;38(23):2028–2037. spinaldeformity.com
4. Bajamal AH, Kim SH, Arifianto MR, et al. WFNS Spine Committee Recommendations for the treatment of thoracolumbar spine fractures. Neurospine. 2021;18(4):710–722. e-neurospine.org
5. Tender GC, Serban D, Haid RW Jr. Traumatic spinal fracture treated by vertebroplasty: a case report. J Med Case Rep. 2012;6:390. SpringerLink
6. Hammed A, Ali R, Riaz A, et al. Effectiveness of unilateral percutaneous vertebroplasty for traumatic spinal compression fractures. Medicine (Baltimore). 2023;102(37):e34971. Lippincott Journals
7. Luo ZW, Ye Z, Wang Q, et al. Short-segment fixation and transpedicular bone grafting in the treatment of thoracolumbar fractures: a retrospective study. Front Surg. 2023;9:1039100.
8. Elnoamany H. Percutaneous vertebroplasty: a first line treatment in traumatic non-osteoporotic vertebral compression fractures. Asian Spine J. 2015;9(2):178–184. doi:10.4184/asj.2015.9.2.178. Available from: https://www.asianspinejournal.org/journal/view.php?doi=10.4184/asj.2015.9.2.178 asianspinejournal.org
9. Zhang L, Zou J, Gan M, Shi J, Li J, Yang H. Treatment of thoracolumbar burst fractures: short-segment pedicle instrumentation versus kyphoplasty. Acta Orthop Belg. 2013;79(6):719–725. Available from: https://www.actaorthopaedica.be/assets/2198/19-Zhang_et_al.pdf actaorthopaedica.be+1
10. Verlaan JJ, Dhert WJA, Verbout AJ, Oner FC. Balloon vertebroplasty in combination with pedicle screw instrumentation: a novel technique to treat thoracic and lumbar burst fractures. Spine (Phila Pa 1976). 2005;30(3):E73–E79. doi:10.1097/01.brs.0000152162.64015.fb. Available from: https://pubmed.ncbi.nlm.nih.gov/15682000/ PubMed
11. Afzal S, Akbar S, Dhar SA. Short segment pedicle screw instrumentation and augmentation vertebroplasty in lumbar burst fractures: an experience. Eur Spine J. 2008;17(3):336–341. doi:10.1007/s00586-008-0587-z. Available from: https://pubmed.ncbi.nlm.nih.gov/18193300/ PubMed
12. Knavel EM, Thielen KR, Kallmes DF. Vertebroplasty for the treatment of traumatic nonosteoporotic compression fractures. AJNR Am J Neuroradiol. 2009;30(2):323–327. PMID:19039045. Available from: https://pubmed.ncbi.nlm.nih.gov/19039045/ asianspinejournal.org
13. Kim GW, Jang JW, Hur H, Lee JK, Kim JH, Kim SH. Predictive factors for a kyphosis recurrence following short-segment pedicle screw fixation including fractured vertebral body in unstable thoracolumbar burst fractures. J Korean Neurosurg Soc. 2014;56(3):230–236. doi:10.3340/jkns.2014.56.3.230. Available from: https://pubmed.ncbi.nlm.nih.gov/25368766/ PubMed
14. Aly TA. Short segment versus long segment pedicle screws fixation in management of thoracolumbar burst fractures: meta-analysis. Asian Spine J. 2017;11(1):150–160. Available from: https://www.asianspinejournal.org/upload/pdf/asj-11-150.pdf asianspinejournal.org
15. Zaryanov AV, Park DK, Khalil JG, Baker KC, Fischgrund JS. Cement augmentation in vertebral burst fractures. Neurosurg Focus. 2014;37(1):E5. Available from: https://thejns.org/focus/view/journals/neurosurg-focus/37/1/article-pE5.xml The Journal of Neuroscience
16. Assunção Filho CA, Rodrigues LM, de Moraes FB, et al. Thoracolumbar burst fractures, short x long fixation: a meta-analysis. Coluna/Columna. 2016;15(2):256–264. Available from: https://www.scielo.br/j/coluna/a/RBPbGRv8S8dP33pdpsrPTKR/ scielo.br.




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