

# Surgical outcomes of thoracolumbar spinal fixation using cement-augmented pedicle screws in osteoporotic patients

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## ABSTRACT

**Objective:** To evaluate the outcomes of thoracolumbar spinal fixation using cement-augmented pedicle screws in patients with osteoporosis-related thoracolumbar trauma treated at Viet Tiep Hospital. **Subjects and Methods:** A prospective study was conducted on 21 thoracolumbar spinal injuries patients diagnosed with severe osteoporosis who underwent spinal fusion with cement-augmented pedicle screws at Viet Tiep Hospital from January 2022 to January 2025. **Results:** Pain significantly reduced: mean VAS score decreased from  $7.6 \pm 0.7$  preoperatively to  $1.8 \pm 0.6$  at 6-month postoperatively. Functional recovery was improved markedly with mean ODI decreasing from  $69.9 \pm 12.1\%$  preoperatively to  $24.6 \pm 7.7\%$  at 6-month postoperatively. Radiographic analysis showed a marked reduction in both the segmental kyphosis angle (Cobb angle) and the vertebral body kyphosis angle compared to pre-surgery. The most common complication observed was asymptomatic cement leakage. **Conclusion:** Cement-augmented pedicle screw fixation is a safe and effective surgical technique for managing thoracolumbar spine fractures in patients with severe osteoporosis, providing satisfactory pain relief, spinal stability, and functional recovery.

**Keywords:** Cement-augmented pedicle screw fixation, osteoporosis, thoracolumbar spine injury, spinal stabilization.

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## INTRODUCTION

Today, the increase in average life expectancy is accompanied by a significant rise in age-related chronic diseases such as cardiovascular disease, diabetes, and especially osteoporosis. Osteoporosis is becoming a major burden on public health systems due to its increasing prevalence and the serious complications it causes. Among the complications of osteoporosis, Osteoporotic Vertebral Compression Fractures (OVCFs) are highly prevalent, leading to chronic spinal pain, impaired quality of life, and the potential for progressive spinal deformity (kyphosis, scoliosis)<sup>1</sup> - For cases of vertebral

compression without severe instability or neural compression, conservative treatment methods or vertebral augmentation with bone cement (Vertebroplasty/Kyphoplasty) are usually prioritized. However, cases of severe collapse causing spinal instability or neurological deficits require surgical intervention for spinal fixation and correction. The greatest challenge for surgeons in this group of osteoporotic patients is the poor bone quality of the vertebral bodies and pedicles. This significantly increases the risk of mechanical complications after surgery, such as screw loosening, screw pullout, instrumentation failure (implant migration), and non-union, leading to treatment failure and the need for

reoperation<sup>2</sup>. To overcome this drawback, many techniques have been researched and applied, including: using larger diameter screws, dual-threaded screws, expandable screws, the cortical bone trajectory (CBT) technique, and notably, the technique of cement-augmented pedicle screw fixation<sup>3</sup>. The cement-augmented pedicle screw fixation method involves injecting a controlled amount of bone cement into the vertebral body via the pedicle path under fluoroscopic guidance before screw insertion. The bone cement helps enhance the pullout strength and stability of the screw-bone interface, thereby improving the rigidity of the fixation system in an osteoporotic bone environment<sup>3</sup>. This method is highly feasible, easy to perform, and simultaneously provides effective pain relief and significantly reduces the rate of screw loosening in osteoporotic patients. This method is suitable for deployment in community hospitals with relatively adequate equipment. For these reasons, we conducted the study: “Surgical Outcomes of Thoracolumbar Spine Fixation Using Cement-Augmented Pedicle Screws in Osteoporotic Patients” with the following objectives:

1. To describe some clinical and subclinical characteristics of patients with osteoporotic thoracolumbar spine trauma treated at Viet Tiep Hospital from January 2022 to January 2025.
2. To evaluate the surgical outcomes of the cement - augmented pedicle screw fixation technique in the aforementioned group of patients.

## PATIENTS AND METHODS

### Research subjects

The study included 21 patients diagnosed with severe osteoporotic thoracolumbar spine trauma. These patients underwent surgical spinal fixation using cement-augmented pedicle screws at Viet Tiep Hospital during the period from January 2022 to January 2025.

#### *Inclusion Criteria*

Patients with unstable thoracolumbar spine trauma or those presenting with neurological deficits who have severe osteoporosis (Tscore  $\leq -2,5$ ) with an indication for surgery, treated with the cement-augmented spinal fixation technique, and provided informed consent to participate in the study.

#### *Exclusion Criteria*

Patients who could not be followed up post-operatively or did not complete the required post-operative follow-up period or were lost to follow-up.

#### **Study design**

This was a retrospective combined with prospective study, describing a case series with clinical intervention, and without a control group.

#### **Sample Size and Sampling Method**

Total sampling was used, where all eligible patients meeting the inclusion criteria were enrolled in the study.

#### **Data Analysis**

- Data was analyzed using the medical statistical software SPSS 20.0.
- Quantitative variables: Values calculated included the mean ( $\bar{X}$ ), standard deviation (SD), maximum value (Max), minimum value (Min).
- Qualitative variables: The changes in symptoms before and after surgery were compared in percentages using the  $\chi^2$ , T-test is used to compare means. The difference was considered statistically significant when  $p \leq 0,05$ .

## RESULTS

## General Characteristics

**Table 1.** General Characteristics of the Study Cohort

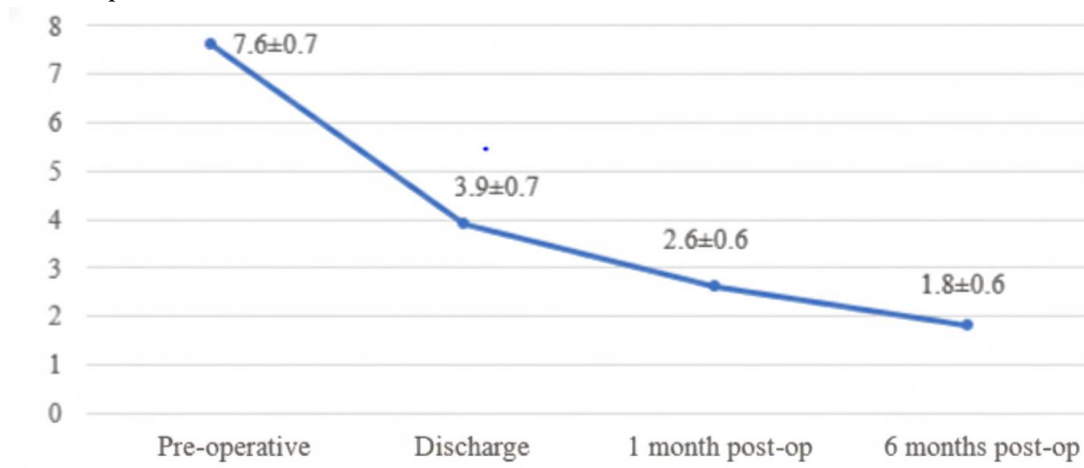
Characteristics	Result
Mean Age	65,2 ± 5,5 (56 – 76)
Gender Distribution	Male: 23,8%; Female: 76,2%
Medical History	Corticoid abuse: 100%
Mechanism of Injury	Due to Falls: 100% (76.2% from Household Accidents; 23.8% from Traffic Accidents)
Mean Tscore	-3,3 ± 0,6 (-2,6 – -4,8)

Clinical presentation: 100% of patients presented with back pain at the level of the injured vertebra. 14.3% of patients reported bilateral lower limb numbness. No cases presented with lower limb weakness or sphincter dysfunction.

Paraclinical presentation: 100% of patients had a single vertebral injury. Regarding fracture morphology: 38.1% of patients had posterior wall rupture causing retropulsion into the spinal canal (spinal canal stenosis); 19.0% had pedicle fracture, and 14.3% had posterior arch fracture.

## Postoperative Outcomes

### Pain Improvement



**Line Graph 1.** Pain level according to the VAS scale

When comparing the pain levels between each pair of time points, the differences were statistically significant ( $p < 0.05$ ). This demonstrates that the surgical method provided a clear, sustained, and significant pain reduction effect.

### Improvement in Thoracolumbar Spine Function

**Table 2.** Oswestry Disability Index (ODI) Score Before and After Operation

Time	Mean ± SD	P
Pre-operation (1)	69,9 ± 12,1	p(1,2) < 0,000
1 Months Post-op (2)	30,0 ± 7,3	p(1,3) < 0,000
6 Months Post-op (3)	24,6 ± 7,7	p(2,3) < 0,000

The mean pre-operative ODI score was 69,9 ± 12,1%. Post-surgery, the ODI score sharply decreased at the 1-month follow-up and continued to show slight improvement at the 6-month

follow-up, decreasing to  $30,0 \pm 7,3$  and  $24,6 \pm 7,7$  respectively. This improvement in spinal function was statistically significant across all paired time points ( $p < 0.05$ ).

#### *Radiographic correction*

**Table 3. Radiographic Correction Results**

Time	Vertebral Kyphosis Angle	Regional Kyphosis Angle
Pre-operation(1)	$18,3 \pm 2,8$	$20,8 \pm 3,2$
6 Months Post-op (2)	$12,8 \pm 1,8$	$14,0 \pm 1,8$
P	$< 0,000$	$< 0,000$

Both the regional kyphosis angle and the vertebral kyphosis angle significantly decreased at 6 months post-operation compared to pre-operation. This radiographic improvement was statistically significant with  $p < 0,05$ .

#### *Postoperative Neurological Recovery*

In this study, 3 patients presented with pre-operative symptoms of leg numbness, classified as ASIA Impairment Scale (AIS) Grade D. At the 6-month post-operative follow-up, all 3 patients demonstrated complete recovery, with the numbness resolving, and were classified as AIS Grade E.

#### *Complications*

The study recorded 4 out of 21 cases (19.0%) experiencing cement leakage. However, none of the cement leakage cases led to clinical symptoms for the patients. Specifically, 1 case of leakage into the disc space, 1 case of leakage into the perivertebral vasculature, and 2 cases of cement leakage towards the anterior vertebral body margin.

## DISCUSSION

### **General Characteristics**

The average age of the studied patient group was  $65,2 \pm 5,5$  years, with a Male-to-Female gender ratio of 1/3,2; means T-score of  $3,3 \pm 0,6$ . These characteristics are entirely consistent with other studies in the field, such as the research by Le Hoang Nha<sup>4</sup> with average age  $67 \pm 6,8$ ; Male-to-Female gender ratio of 1/4,75, and means T-score of  $-3,2$ .

Regarding the mechanism of injury, 100% of cases were due to falls (76.2% from Household Accidents, 23.8% from Traffic Accidents), a mechanism typical for fractures in osteoporotic bone. Notably, 100% of patients had a history of Corticosteroid abuse, a leading risk factor for secondary osteoporosis. Corticosteroid use directly interferes with metabolic processes, impairs

bone formation, and increases bone resorption by affecting the lifespan of osteoclasts and osteoblasts, leading to severe deterioration of bone microstructure<sup>5</sup>.

### **Pain Level Improvement**

Before surgery, patients experienced severe pain (average VAS  $7,6 \pm 0,7$ ), which significantly hindered posture changes and mobility. The surgery provided a clear pain reduction effect immediately post-operation (VAS at discharge:  $3,9 \pm 0,7$ ;  $p < 0,000$ ). This result is consistent with international reports, such as the studies by Dai<sup>6</sup> (pre-op VAS 7.46; post-op 1.83) as well as Le Hoang Nha (pre-op VAS 8.64; post-op 2.69). This pain reduction is explained by two main mechanisms: (1) Spinal fixation surgery restored stability to the unstable spinal segment, improving weight-bearing capacity; (2) The heat generated during the curing

process of the bone cement acts to cauterize the pain-sensing nerve endings in the vertebral body, resulting in rapid pain relief after the intervention<sup>7</sup>. This analgesic effect was maintained and continuously improved at the 1- and 6-month follow-ups.

### **Spinal Function Improvement**

The pre-operative ODI score was very poor  $69,9 \pm 12,1\%$ . Spinal function significantly improved after surgery, with the ODI score decreasing to  $30,0 \pm 7,3\%$  at 1 month and  $24,6 \pm 7,7\%$  at 6 months. This improvement was statistically significant with  $p < 0,05$ . The spinal stability achieved by the cement-augmented screw fixation not only helped reduce pain but also facilitated the patients' ability to perform a proper rehabilitation program. This allows patients to quickly regain their ability to walk and perform daily activities<sup>8</sup>. Our results regarding the improvement of spinal function are consistent with the studies by Kashii<sup>8</sup> and Le Hoang Nha<sup>4</sup>.

### **Radiographic Correction**

After 6 months of surgery, both the vertebral kyphosis angle and the regional kyphosis angle showed a significant and statistically meaningful improvement with  $p < 0,05$ . The vertebral kyphosis angle decreased from  $18,3 \pm 2,8^\circ$  to  $12,8 \pm 1,8^\circ$ ; and the regional kyphosis angle decreased from  $20,8 \pm 3,2^\circ$  to  $14,0 \pm 1,8^\circ$ . The cement-augmented pedicle screw technique effectively fixed the fractured, collapsed, and unstable spinal segment. Furthermore, the use of a long fixation construct during surgery contributed to the correction of the spinal kyphosis angle. This radiographic correction result aligns with previously reported findings in the medical literature, including the study by Le Hoang Nha<sup>4</sup>.

### **Postoperative Neurological Recovery**

The study recorded 3 cases of patients with leg numbness, ASIA Impairment Scale Grade D pre-operation. After 6 months of surgery all 3 patients achieved complete recovery and were classified as AIS Grade E. Due to the timely neural decompression, cases of unstable spinal trauma with neural compression, especially those involving mild spinal cord compression, achieved excellent recovery

### **Complications**

Cement leakage is a common complication in cement augmentation techniques. The causes include the porous bone structure of osteoporotic patients and the presence of the vertebral venous system, which provides pathways for cement to extravasate easily. However, due to tight control under fluoroscopic guidance, the amount of leakage was not significant and did not cause any clinical symptoms. The leakage locations included: leakage into the disc space (1), leakage into the perivertebral vasculature (1), and leakage towards the anterior vertebral body margin (2).

## **CONCLUSION**

Surgical spinal fixation using cement-augmented pedicle screws in patients with severe osteoporotic thoracolumbar spine trauma is a safe and effective method, yielding numerous favorable results. This technique successfully addresses the difficulties of instrumentation failure often encountered when performing spinal fixation on osteoporotic bone.

**Recommendation:** Neurosurgeons should operate quickly and accurately because the cement hardens very rapidly. Caution is required in cases of vertebral body fragmentation, as the cement can easily leak outside.

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### Conflict of interests

The authors declare that there is no conflict of interest regarding the publication of this article.

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None.

### Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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