



Original Article

# Efficacy of cement-augmented pedicle screw fixation for osteoporotic mid-thoracic vertebral fractures

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Received: 10 September 2023

Accepted: 30 September 2023

Published: 20 October 2023

DOI

10.25259/SNI\_751\_2023

Quick Response Code:



## ABSTRACT

**Background:** Osteoporotic mid-thoracic vertebral fractures (OmTVF), often result in severe pain, and neurological deficits secondary to cord compression. Cement-augmented pedicle screw (CaPS) fixation with posterior spinal decompression (PSD) offers simultaneous decompression with stabilization of these osteoporotic vertebral fractures.

**Methods:** The study involved 32 patients (2022–2023) with T8–T10 osteoporotic vertebral compression fractures resulting in cord compression. All patients underwent CaPS surgery with PSD. Pain reduction was measured using the visual analog scale (VAS), and outcomes with the Oswestry Disability Index, and the American Spinal Injury Association Grades. The local kyphotic angle was also tracked with computed tomography studies performed 1, 3, and 6 months post-operatively.

**Results:** The average pre-operative VAS score was 8.56 mm; this decreased at 1, 3, and 6 months post-operatively to 2.72 mm, 2.03 mm, and 1.44 mm, respectively. In addition, 31 of 32 patients fully recovered within 6 post-operative months.

**Conclusion:** For 31 of 32 patients with T8–T10 osteoporotic vertebral fractures, CaPS fixation with PSD successfully alleviated pain and resulted in significant post-operative neurological recovery.

**Keywords:** Cement-augmented pedicle screw, Mid-thoracic vertebral fractures, Osteoporosis, Posterior spinal decompression

## INTRODUCTION

At present, there are multiple methods for treating osteoporotic mid-thoracic vertebral fractures (OmTVF). Although conservative measures (i.e., <6 points on Blatter Fracture Score) are indicated in some cases, others with significant pain and paraparetic deficits require surgical intervention (i.e. Blatter Fracture Score >6 points).<sup>[8]</sup> Cement-augmented pedicle screw (CaPS) surgery combined with posterior spinal decompression (PSD) offers both stabilization and decompression.<sup>[1,9]</sup>

## MATERIALS AND METHODS

### Study design

This prospective study was performed at a single medical center (2022–2023). It involved 32 consecutive patients with significant neurological deficits attributed to magnetic resonance/

computed tomography (CT) documented thoracic T8–T10 OmTVFs. The diagnosis of osteoporosis was based on World Health Organization criteria<sup>[8]</sup> [Table 1]. All patients underwent CaPS insertion and PSD to address cord compression. They were followed for an average of 8 post-operative months [Table 2]. Patients’ functional recovery was tracked utilizing a visual analog scale, Oswestry Disability Index (ODI), and American Spinal Injury Association (ASIA) Scores, and was accompanied by evaluation of the

kyphotic angle (i.e. assessed with CT performed 1, 3, and 6 months post-operatively).<sup>[10]</sup>

**Statistical analysis**

Data were examined utilizing IBM SPSS (Statistics) software 26.0 (IBM Corp., Armonk, NY, USA). Qualitative variables were shown by frequency and proportions. Wilcoxon signed-rank test assessed inter-group differences.

**Ethical considerations**

The hospital IRB approved data compilation, analysis, and publication of this research.

**RESULTS**

**Outcomes**

Thirty-two patients with spinal cord compression underwent CaPS with PSD for OmTVF from T8 to T10 [Table 3]. There were 4–8 screws applied per patient. The volume of cement used to augment each screw ranges from 1 mL to 4 mL. The surgical time varied from 75 to 210 min. The estimated blood loss ranged from 100 mL to 1500 mL [Figure 1].

**Complications**

The most common complications included leakage of cement around the blood vessels and/or into the canal, or embolization of the lungs (i.e., latter 2 asymptomatic). There was one instance of nerve root damage; that patient’s deficit recovered in 6 months. There were also 5 of 190 misplaced screws.

**Table 1: Patient characteristics and descriptive data.**

Baseline characteristics	OmTVF (n=32) n (%)
Gender	
Male	6 (18.8)
Female	26 (81.2)
Age (mean, SD) (year)	66.3±6.0
BMI (mean, SD) (kg/m <sup>2</sup> )	22.7±2.9
T-score (mean, SD)	-3.2±0.7
Trauma circumstances	18 (56.2)
Factors of osteoporosis risk	
Menopause	24 (75)
Using prolonged corticosteroids	24 (75)
BMI<19	3 (9.4)
Diabetes mellitus	2 (6.2)
Smoking cigarettes	5 (15.6)
Clinical presentation	
Reduced sensation	4 (12.5)
Pain-relief posture	29 (90.6)
Muscle weakness	8 (25.0)
Sphincter disorders	4 (12.5)
Pre-operative VAS score (mean, SD) (mm)	8.6±0.6
Pre-operative ODI index (mean, SD) (%)	78.2±11
Observation period (mean, SD) (month)	8±1.5

SD: Standard deviation, BMI: Body mass index, VAS: Visual analog scale, ODI: Oswestry Disability Index, ASIA: American Spinal Injury Association, OmTVF: Osteoporotic mid-thoracic vertebral fractures

**Table 2: Pre-operative imaging results.**

Variables	OmTVF (n=32) n (%)
Fractures vertebral (%)	
T8	6 (18.8)
T9	12 (37.5)
T10	14 (43.7)
OF classification (%)	
OF 3	15 (46.9)
OF 4	14 (43.8)
OF 5	3 (9.4)
LKA (mean, SD) (°)	19.2±4.2
Vertebral canal stenosis (mean, SD) (%)	32.2±15.6

LKA: Local kyphosis angle, OF: Osteoporotic fractures, SD: Standard deviation, OmTVF: Osteoporotic mid-thoracic vertebral fractures

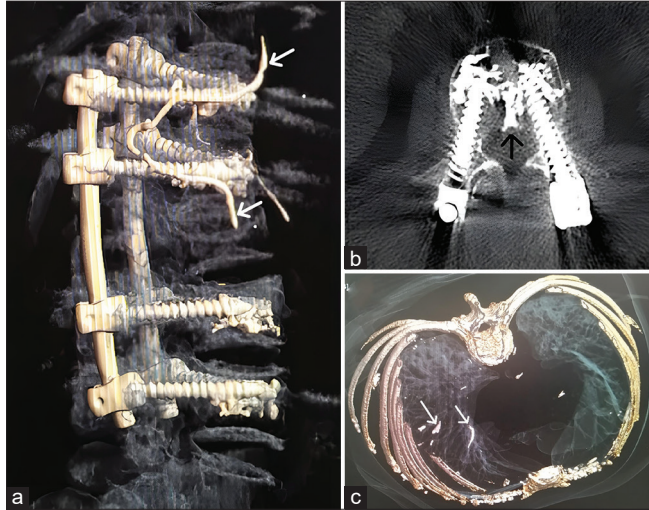
**Table 3: The outcomes of surgery.**

Variables	OmTVF (n=32) n (%)
Number of screws/cases	
4	13 (40.6)
6	7 (21.9)
8	12 (37.5)
Surgical duration (mean, SD) (minute)	117.7±29
Loss of blood volume (mean, SD) (mL)	309.4±254
Screw head position in vertebral body	
80–90	10 (31.3)
> 90	22 (68.7)
Complications	
Cement leak	21 (65.5)
Surrounding the vertebral column	9 (28.2)
Spinal canal	7 (21.9)
Around the blood vessels	6 (18.8)
Pulmonary vascular system	2 (6.3)
Nerve root injury	1 (3.1)
Malpositioned screw: 0.26%	

SD: Standard deviation, OmTVF: Osteoporotic mid-thoracic vertebral fractures

**Post-operation course**

After surgery, the patient experienced significant pain relief at 1 and 3 months post-operatively, and nearly no pain at 6 post-operative months [Table 4]. The ODI improved to moderate



**Figure 1:** Complications of cement leakage after cement-augmented pedicle screw. (a) Leakage into the blood vessels surrounding the vertebral body (white arrow). (b) Leakage into the spinal canal (black arrow). (c) Leakage into the pulmonary blood vessels (white arrow).

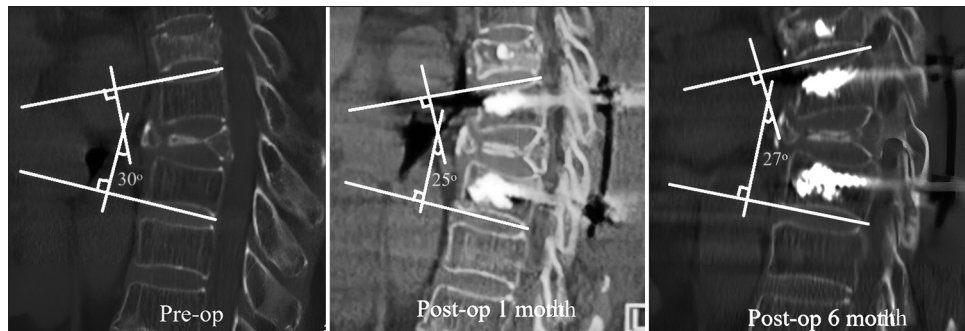
levels at 1 and 3 months and a good level at 6 months [Table 4]. The majority of ASIA Grade D cases fully transitioned to ASIA Grade E after 6 months. Only one pre-operative ASIA Grade A patient with a severe spinal cord injury pre-operatively failed to improve post-operatively [Table 4]. The average post-operative local kyphotic angle was  $13.6^\circ \pm 7$ , this angle remained unchanged at the 6-month follow-up [Figure 2].

**DISCUSSION**

The ultimate goal following treatment for OmTVF is pain reduction or complete pain relief.<sup>[2,5]</sup> CaPS surgery provides immediate spinal stability and leads to effective pain reduction.<sup>[3,6]</sup> Screw fixation through the augmented cemented pedicle for osteoporotic spinal fractures helped to limit screw loosening or pullout by 60%.<sup>[4]</sup> Laminectomy provided adequate cord decompression allowing patients with pre-operative ASIA Grade D stage to fully recover to ASIA Grade E in 6 post-operative months. CaSP also facilitated the correction of the kyphotic angle, restored the physiological curvature of the spine, and limited the future progression of kyphosis-related complications.<sup>[7]</sup>

**Measures to avoid cement-related CaSP complications**

Our most frequent complication for CaSP was cement leakage around the vertebral blood vessels. To prevent



**Figure 2:** A 71-year-old female patient with T8 compression fracture (T-score: -4.2) underwent a surgical procedure involving a cement-augmented pedicle screw and posterior spinal decompression. The preoperative spinal kyphotic angle (left) improved by  $5^\circ$  1 month postoperatively (middle), and increased by an additional  $2^\circ$  at the 6-month follow-up (right).

**Table 4:** The outcomes after surgery.

	Post-operation (n=32)			P-value <sup>a</sup>
	1 month	3 months	6 months	
VAS score (mm) (mean±SD)	2.72±0.8	2.03±0.7	1.44±0.7	<0.05
ODI index (%) (mean±SD)	52.5±11	41.9±12	37.3±12	<0.05
ASIA Grade (cases)				
A	1	1	1	
D	28	10	0	
E	3	21	31	

<sup>a</sup>Wilcoxon signed-rank test. SD: Standard deviation, VAS: Visual analog scale, ODI: Oswestry Disability Index, ASIA: American Spinal Injury Association

cement leakage, we would recommend in the future: (1) verifying the correct positioning of screws within the vertebral body on both anteroposterior and lateral views before cement injection; (2) injecting only 2–3 mL of cement at a time, consistently monitoring with C-arm fluoroscopy; (3) immediately ceasing cement injection if leakage occurs; (4) preparing cement according to the manufacturer's recommended ratios, avoiding excessively liquid mixtures; and (5) and avoided overfilling.

## CONCLUSION

CaPS with PSD successfully achieved significant pain reduction and cord/root decompression with spinal stabilization in 31 of 32 patients with T8–T10 OmTVF.

### Ethical approval

The author(s) declare that they have taken the ethical approval from IRB/IEC.

### Declaration of patient consent

Patients' consent not required as patients' identities were not disclosed or compromised.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

### Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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**How to cite this article:** Nhã LH, Hùng KD. Efficacy of cement-augmented pedicle screw fixation for osteoporotic mid-thoracic vertebral fractures. *Surg Neurol Int* 2023;14:378.

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