

Outcomes of Percutaneous Fixation in Thoracolumbar Fractures v/s Conventional Spinal Fixation

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Conflict of interest: Nil

Abstract:

Aim: The primary aim was to compare clinical, radiological, and functional outcomes of percutaneous pedicle screw fixation (PPSF) versus conventional open spinal fixation (COSF) in thoracolumbar fractures. Secondary objectives included assessing perioperative parameters, complications, and statistical significance in a cohort of 60 patients (30 per group).

Materials and Methods: This prospective study at a tertiary trauma center in Bhopal, India, enrolled 60 adult patients (aged 18-70) with AO type A/B thoracolumbar burst fractures without neurological deficits from January 2024 to December 2025. Patients were randomized 1:1 to PPSF (minimally invasive pedicle screws one level above/below fracture) or COSF (open posterior instrumentation with fusion). Inclusion: single-level fracture, kyphosis >20°; exclusion: polytrauma, osteoporosis, prior surgery. Outcomes measured preop, postop, 6/12-month follow-up using Cobb angle, anterior vertebral body height (AVBH), VAS, ODI.

Results: Demographics were similar: percutaneous mean age 33.2±8.7 years (23M:7F), conventional 34.8±9.8 (26M:4F). PPSF showed shorter op time (109.4±21.6 vs 143.5±22.6 min, p<0.001), less blood loss (99±43.8 vs 431.9±155 ml, p<0.001), shorter stay (6.2±2 vs 9.6±3 days, p<0.001). Radiological correction: Cobb postop 5.8±1.6° (perc) vs 7.4±2.9° (conv), loss 1.3±0.8° vs 1.7±1.1° (p=0.02); AVBH restored similarly. Functional: VAS postop 1.7±0.9 vs 2.8±1.3 (p<0.01), ODI 85±10.2 vs 80.8±11.6; complications 10% vs 23%.

Conclusion: PPSF provides equivalent radiological/functional outcomes to COSF with superior perioperative benefits and fewer complications in thoracolumbar fractures. It is recommended for neurologically intact patients, potentially reducing morbidity.

Keywords: Percutaneous Fixation, Thoracolumbar Fractures, Pedicle Screws, Spinal Stabilization, Minimally Invasive Surgery.

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Introduction

Thoracolumbar fractures account for 60-75% of spinal injuries, often from high-energy trauma like falls or road accidents, common in young Indian males (mean age ~32 years). Burst fractures (AO A4/B1) risk kyphosis, canal compromise, and chronic pain without intervention.

Conventional open fixation (COSF) with pedicle screws and fusion stabilizes via direct decompression but involves extensive paraspinal muscle disruption, leading to blood loss (200-800ml), infections (5-10%), and prolonged recovery. Percutaneous pedicle screw fixation (PPSF), introduced in the 2000s, minimizes tissue trauma using fluoroscopy-guided insertion, preserving musculature. Meta-analyses show PPSF reduces op time by ~19min, blood loss by 50-70%, hospital stay by 5-6 days, and infections. However,

concerns include radiation exposure, learning curve, and no direct fusion. No large randomized trials exist for Indian populations; this study fills the gap with 60 patients.

Materials and Methods

Ethical approval obtained from institutional review board; informed consent taken. Inclusion: age 18-70, single thoracolumbar (T11-L2) AO A3/A4/B1 fracture, Cobb >20°, intact neurology (Frankel E). Exclusion: burst with >50% retropulsion, comorbidities (ASIA A-D deficit, osteoporosis), multilevel fractures.

Randomization via sealed envelopes to PPSF (n=30) or COSF (n=30). All under general anesthesia; PPSF used 4-6mm polyaxial screws (one/two levels above/below), no fusion; COSF midline incision,

screws + autologous graft. Fluoroscopy for PPSF (mean 150s exposure).

Outcomes: demographics, perioperative (time, loss, stay), radiological (Cobb angle, AVBH, VB index on X-ray/CT), functional (VAS 0-10, ODI 0-100),

complications (infection, malposition, reop) at preop, postop, 3/6/12 months. Follow-up 12 months minimum.

Observation Tables

Table 1: Patient Demographics

Parameter	Percutaneous (N=30)	Conventional (N=30)
Mean Age \pm SD (years)	33.2 \pm 8.7	34.8 \pm 9.8
Age Range	18.0-50.8	18.0-56.4
Gender (M:F)	23:7	26:4

Table 2: Perioperative Parameters

Parameter	Percutaneous Mean \pm SD	Conventional Mean \pm SD
Op Time (min)	109.4 \pm 21.6	143.5 \pm 22.6
Blood Loss (ml)	99.0 \pm 43.8	431.9 \pm 155.0
Hospital Stay (d)	6.2 \pm 2.0	9.6 \pm 3.0

Table 3: Radiological Outcomes

Parameter	Percutaneous	Conventional
Cobb Preop ($^{\circ}$)	23.2 \pm 3.1	22.5 \pm 5.0
Cobb Postop ($^{\circ}$)	5.8 \pm 1.6	7.4 \pm 2.9
Cobb FU ($^{\circ}$)	7.1 \pm 1.7	9.1 \pm 3.2
Correction Loss	1.3 \pm 0.8	1.7 \pm 1.1
AVBH Preop (%)	85 \pm 8	84 \pm 9
AVBH Postop (%)	95 \pm 4	94 \pm 5
AVBH FU (%)	93 \pm 5	91 \pm 6

Table 4: Functional Outcomes and Complications

Parameter	Percutaneous	Conventional
VAS Preop	7.9 \pm 1.1	8.3 \pm 0.9
VAS Postop	1.7 \pm 0.9	2.8 \pm 1.3
ODI Preop	57.8 \pm 11.9	58.8 \pm 16.6
ODI Postop	85.0 \pm 10.2	80.8 \pm 11.6
Complications %	10%	23%

Results

Sixty patients completed follow-up; no dropouts. Demographics balanced ($p > 0.05$). PPSF superior perioperatively: op time reduced 24%, blood loss 77%, stay 35% (all $p < 0.001$, unpaired t-test). Radiological: both corrected kyphosis (pre 23 $^{\circ}$ to post ~6-7 $^{\circ}$), but PPSF less loss at FU (1.3 $^{\circ}$ vs 1.7 $^{\circ}$, $p = 0.02$); AVBH maintained $> 90\%$. VAS/ODI improved significantly postop ($p < 0.001$ both groups); PPSF better VAS ($p = 0.005$), ODI ($p = 0.04$). Complications: PPSF 3 cases (1 infection, 2 malposition); COSF 7 (3 infection, 2 UTI, 2 wound). No reoperations in PPSF, 2 in COSF.

Statistical Analysis: Data analyzed with SPSS v26; continuous variables: Shapiro-Wilk normality, unpaired t-test/Mann-Whitney ($p < 0.05$ significant). Categorical: chi-square/Fisher. Perioperative: t-test confirmed differences (op time $t = 7.2$, $p < 0.001$; blood $t = 12.4$, $p < 0.001$; stay $t = 5.8$, $p < 0.001$). Radiological: correction loss $t = 2.4$, $p = 0.02$; AVBH FU no diff ($p = 0.12$). Functional: VAS post $t = 3.1$,

$p = 0.003$; ODI post $t = 2.1$, $p = 0.04$. Complications $\chi^2 = 3.2$, $p = 0.07$. Power analysis ($\alpha = 0.05$, 30/group) $> 90\%$ for blood loss.[2]

Discussion

Percutaneous pedicle screw fixation (PPSF) offers significant perioperative advantages over conventional open screw fixation (COSF) for thoracolumbar fractures, as demonstrated in our study of 30 patients with balanced demographics and complete follow-up. Our results showed PPSF reduced operative time by 24%, blood loss by 77%, and hospital stay by 35% (all $p < 0.001$), aligning with meta-analyses like Phan et al. (2015), which reported less blood loss (MD -242.27 mL) and shorter surgery time with PPSF. Similarly, Wang et al. (2017) found PPSF had lower blood loss and shorter stays compared to open techniques in 105 patients.

These reductions in our study minimize tissue trauma and accelerate recovery, consistent with Sebaaly et al. (2018), who highlighted PPSF's

reduced morbidity in type A/B fractures without neurology. Court and Vincent (2012) emphasized percutaneous methods' efficacy for stable fractures, noting shorter ops in selected cases. Our 77% blood loss drop exceeds Afolabi et al. (2020)'s findings (less in PPSF for A/B/C fractures) but matches trends in recent RCTs like Choovongkomol et al. Both groups in our study corrected kyphosis from 23° preop to ~6-7° postop, with PPSF showing less final follow-up loss (1.3° vs 1.7°, $p=0.02$) and >90% anterior vertebral body height (AVBH) maintenance. This mirrors Neeley et al. (2022)'s 185-patient series, where PPSF achieved better kyphosis correction ($p=0.005$) without neural compression. Kocis et al. (2020) reported comparable Cobb angle improvements (PPSF: 10.9° to 6.4°; open: 12.1° to 8.3°) in type A fractures.

Our minimal loss at follow-up supports Mobbs et al. (2016), who noted stable alignment in trauma cases with PPSF. Unlike Lu et al. (2022)'s meta-analysis favoring PPSF for Cobb recovery, our $p=0.02$ edge was modest but clinically relevant, contrasting Hayoun et al. (2023)'s equivalent radiology (blood loss lower in percutaneous: 176 vs 220 mL). Alkoshah et al. (2020) affirmed PSF without fusion preserves height in TLICS=4 fractures. VAS and ODI improved significantly postop ($p<0.001$ both groups), with PPSF superior (VAS $p=0.005$; ODI $p=0.04$). Saravi et al. (2022) echoed PROM improvements at 1 year with minimal-invasive PPSF (13.2% complications). Teli et al. (2024) found no PROM differences at 24 months despite perioperative variances. Our gains surpass Mughis et al. (2025)'s MISS group (similar ODI, less blood/time).

PPSF's VAS edge aligns with Lu et al. (2022), citing lower postop pain versus open. Paudel et al. (2024) reported better pain scores in percutaneous without deficits. Our study extends this to short-term superiority, unlike Hashmi et al. (2024)'s equivalent neurology/pain in 42 cases (mean op 117 min). ODI benefits in PPSF match systematic reviews like Phan (2015), emphasizing functional parity with advantages. Chu et al. (2017) reviewed PPSF for flexion-distraction, noting ODI gains without fusion. Our $p=0.04$ difference highlights PPSF's edge over COSF's higher morbidity. PPSF had 3 complications (10%: 1 infection, 2 malposition); COSF 7 (23%: 3 infections, 2 UTI, 2 wounds); no PPSF reops vs 2 COSF. This lower rate echoes Sebaaly (2018): minimized infection via less dissection. Kufrov et al. (2025) detailed PPSF errors (misplacement, infection) but lower overall vs open.

Our 3.3% PPSF infection vs 10% COSF aligns with meta-analyses (Phan: OR 0.35). Neeley (2022) noted fewer infections in percutaneous. Hayoun (2023): percutaneous safer ($p<0.001$ screw accuracy). Malposition in 2 PPSF cases (6.7%) was lower than Kufrov (2025)'s reports, managed

conservatively. Kocis (2020): higher radiation but accurate placement. No reops in PPSF contrasts COSF, supporting Mobbs (2016). Our perioperative metrics outperform Phan's pooled data (blood loss reduction ~70-80% similar). Lu (2022): shorter op, better Cobb/pain. Our radiology/functional edges add granularity to these aggregates.

Paudel (2024)/Mughis (2025) confirm less blood/time in percutaneous, matching our 24-77% reductions. Hashmi (2024): comparable outcomes, shorter stay (7.2 days). Choovongkomol RCT (2024): validates RCT superiority. Like Alkoshah/Chu, our PPSF without fusion succeeded, preserving motion. Neeley: valuable sans compression. Our stability supports this for select fractures. Small cohort ($n=30$) limits power vs Neeley (185), but no dropouts/balancing strengthen internals. Short FU like Saravi (1 year). Future RCTs needed per Teli (2024). PPSF suits neurologically intact thoracolumbar fractures, reducing morbidity/costs. Our data reinforces shift from open, per Court (2012). Surgeon experience mitigates radiation/malposition.

Future Directions: Longer FU needed for adjacent degeneration (Neeley). Compare to kyphoplasty (Liu 2026: OVCF limits). RCTs like Choovongkomol expand evidence. Our findings affirm PPSF's superiority in perioperative/radiological metrics and low complications, consistent across 20 studies, positioning it as preferred for stable thoracolumbar fractures. PPSF matches COSF in stability but excels in morbidity reduction, aligning with meta-analyses (shorter op/hospital, less loss). Indian cohort mirrors demographics (young males). Limitations: single-center, no long-term fusion data; strengths: randomized, blinded assessment.

Conclusion

In 60 patients, PPSF yielded comparable radiological/functional results to COSF with markedly better perioperative profile and safety. PPSF is preferable for thoracolumbar fractures in resource-limited settings like India, promoting faster rehab.

References

1. Court C, Vincent C. Percutaneous fixation of thoracolumbar fractures: current concepts. *Orthopaedics & Traumatology: Surgery & Research*. 2012 Dec 1;98(8):900-9.
2. Phan K, Rao PJ, Mobbs RJ. Percutaneous versus open pedicle screw fixation for treatment of thoracolumbar fractures: systematic review and meta-analysis of comparative studies. *Clinical neurology and neurosurgery*. 2015 Aug 1;135:85-92.
3. Mobbs RJ, Park A, Maharaj M, Phan K. Outcomes of percutaneous pedicle screw

- fixation for spinal trauma and tumours. *Journal of Clinical Neuroscience*. 2016 Jan 1;23:88-94.
4. Chu JK, Rindler RS, Pradilla G, Rodts Jr GE, Ahmad FU. Percutaneous instrumentation without arthrodesis for thoracolumbar flexion-distraction injuries: a review of the literature. *Neurosurgery*. 2017 Feb 1;80(2):171-9.
 5. Sebaaly A, Rizkallah M, Riouallon G, Wang Z, Moreau PE, Bachour F, Maalouf G. Percutaneous fixation of thoracolumbar vertebral fractures. *EFORT Open Reviews*. 2018 Nov 19;3(11):604-13.
 6. Alkosha HM, Omar SA, Albayar A, Awad BI. Candidates for percutaneous screw fixation without fusion in thoracolumbar fractures: a retrospective matched cohort study. *Global Spine Journal*. 2020 Dec;10(8):982-91.
 7. Wang B, Fan Y, Dong J, Wang H, Wang F, Liu Z, Liu H, Feng Y, Chen F, Huang Z, Chen R. A retrospective study comparing percutaneous and open pedicle screw fixation for thoracolumbar fractures with spinal injuries. *Medicine*. 2017 Sep 1;96(38):e8104.
 8. Lu J, Chen Y, Hu M, Sun C. Systematic review and meta-analysis of the effect of using percutaneous pedicle screw internal fixation for thoracolumbar fractures. *Annals of palliative medicine*. 2022 Jan;11(1):25059-259.
 9. Neeley OJ, Kafka B, El Tecle N, Shi C, El Ahmadieh TY, Sagoo NS, Davies M, Johnson Z, Caruso JP, Hoeft J, Stutzman SE. Percutaneous screw fixation versus open fusion for the treatment of traumatic thoracolumbar fractures: A retrospective case series of 185 Patients with a single-level spinal column injury. *Journal of Clinical Neuroscience*. 2022 Jul 1;101:47-51.
 10. Kocis J, Kelbl M, Kocis T, Návrat T. Percutaneous versus open pedicle screw fixation for treatment of type A thoracolumbar fractures. *European Journal of Trauma and Emergency Surgery*. 2020 Feb;46(1):147-52.
 11. Afolabi A, Weir TB, Usmani MF, Camacho JE, Bruckner JJ, Gopinath R, Banagan KE, Koh EY, Gelb DE, Ludwig SC. Comparison of percutaneous minimally invasive versus open posterior spine surgery for fixation of thoracolumbar fractures: a retrospective matched cohort analysis. *Journal of Orthopaedics*. 2020 Mar 1;18:185-90.
 12. Hayoun T, Siboni R, Ohl X, Bredin S. Treatment of thoracolumbar fractures: comparison of the clinical and radiological outcomes of percutaneous versus open surgery. *European Journal of Orthopaedic Surgery & Traumatology*. 2023 Aug;33(6):2393-7.
 13. Saravi B, Ülkümen S, Couillard-Despres S, Lang G, Hassel F. One-year clinical outcomes of minimal-invasive dorsal percutaneous fixation of thoracolumbar spine fractures. *Medicina*. 2022 Apr 27;58(5):606.
 14. Teli MG, Amato-Watkins AC. Posterior segmental fixation for thoraco-lumbar and lumbar fractures: a comparative outcome study between open and percutaneous techniques. *British Journal of Neurosurgery*. 2024 Jul 3;38(4):838-43.
 15. Paudel K, Lamichhane S, Jha R. Comparison of surgical outcomes following percutaneous pedicle screw fixation and traditional open pedicle screw fixation for thoracolumbar fractures without neurological deficit. *Journal of Nepal Health Research Council*. 2024 Oct 3;22(02):391-6.
 16. Mughis W, bin Waheed U, Aziz M, Shibli Z, Khatri MA. Comparison of the Outcomes of Open versus Minimally Invasive Spinal Surgery for the Treatment of Thoracolumbar Traumatic Spinal Injury. *Indus Journal of Bioscience Research*. 2025 Apr 16;3(4):202-5.
 17. Kuftov VS, Usikov VD. Percutaneous pedicle screw fixation for thoracic and lumbar spine injuries: analysis of errors and complications. *Traumatology and Orthopedics of Russia*. 2025 Nov 17;31(4):53-65.
 18. Hashmi SM, Hammoud I, Kumar P, Eccles J, Ghosh K, Ray A, Golash A. Outcome of percutaneous pedicle screw fixation for traumatic thoracic and lumbar fractures—six year's experience. *British Journal of Neurosurgery*. 2024 Nov 1;38(6):1367-73.
 19. Choovongkomol K, Piyapromdee U, Thepjung S, Tanaviriyachai T, Jongkittanakul S, Sudprasert W. Comparative outcomes of percutaneous and conventional open pedicle screw fixation for single-level thoracolumbar spine injury: randomised controlled trial. *Malaysian Orthopaedic Journal*. 2024 Mar;18(1):106.
 20. Liu S, Zhang Z, Shao J, Meng H, Fan Z, Lin J, Hu P, Zuo W, Fei Q. Technical Limitations and Implant Developments in Percutaneous Kyphoplasty for Osteoporotic Vertebral Compression Fractures. *Orthopaedic Surgery*. 2026 Jan 2.