ORIGINAL ARTICLE

Factors associated with radiographic and clinical outcomes after posterior long-segment instrumentation for neurologically intact thoracolumbar fractures: a single-center retrospective study

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ABSTRACT

BACKGROUND: This study aimed to quantify radiographic correction and long-term maintenance, assess pain and health-related quality of life, and identify factors associated with outcomes after standardized posterior long-segment fixation for neurologically intact traumatic thoracolumbar junction fractures.

METHODS: This single-center retrospective cohort study included consecutive adults with acute traumatic T11–L2 fractures treated between March 2014 and February 2023 with posterior long-segment pedicle screw instrumentation (two levels above and two levels below, including fracture-level screws) without decompression. Patients required at least 24 months of radiographic follow-up, available pre-operative sagittal computed tomography images, and early post-operative and final lateral radiographs. Imaging parameters were vertebral compression angle (VCA) and anterior/posterior vertebral corpus height. Clinical outcomes were final Visual Analog Scale (VAS) and 36-item short form health survey (SF-36) scores, which were assessed cross-sectionally at final follow-up and therefore reflect final health status rather than change from pre-operative levels. Paired comparisons were used for longitudinal imaging changes, and multivariable linear regression with robust standard errors was used to evaluate factors associated with final outcomes.

RESULTS: Seventy-eight patients were included (mean age 40.2±13.9 years; 65.4% male), with a median follow-up of 48 months. VCA changed from 11.75° (7.83–16.48) preoperatively to 4.30° (2.55–6.65) early postoperatively and was 6.00° (4.00–8.80) at final follow-up, indicating limited correction loss over time. Restoration of both anterior and posterior vertebral body heights was observed, with partial loss at final follow-up. Final pain levels were low (VAS 1 [interquartile range=1–1]). In adjusted analyses, AO fracture type was associated with greater VCA loss and poorer SF-36 scores across several domains, particularly for AO type C fractures. However, the number of type C fractures was limited (n=9). Superficial wound infection occurred in 5 patients (6.4%) and resolved with local care and antibiotics; no deep infection, implant failure, revision surgery, or junctional complications were observed.

CONCLUSION: Posterior long-segment fixation for neurologically intact T11–L2 fractures provided substantial early radiographic correction with generally limited long-term loss of alignment and low final pain levels. Nevertheless, radiographic correction did not necessarily translate into complete functional recovery, as reflected by persistent variability in SF-36 domains. Among the variables analyzed, AO fracture type showed the most consistent association with correction loss and patient-reported outcomes. These hypothesis-generating findings suggest that fracture morphology may be associated with outcomes and may help frame post-operative expectations and follow-up discussions in similar patient populations. However, confirmation in larger, prospective, and comparative studies is required.

Keywords: 36-Item short form health survey; AO spine classification; long-segment posterior instrumentation; radiographic correction loss; thoracolumbar fracture; vertebral compression angle.

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INTRODUCTION

Most traumatic thoracolumbar fractures occur at the thoracolumbar junction (T11–L2), a transitional zone where the relatively rigid thoracic spine meets the more mobile lumbar spine.[1] Maintaining sagittal alignment in this region is clinically important, as post-traumatic kyphosis may lead to persistent pain, functional impairment, and reduced health-related quality of life.[2,3] Despite the frequency of these injuries, the optimal surgical strategy remains controversial, particularly regarding the number of motion segments that should be included to balance construct stability with preservation of spinal mobility.[4-6]

The debate between short-segment and long-segment posterior instrumentation has persisted for decades. Meta-analytic evidence suggests that long-segment constructs may provide better maintenance of post-operative correction and lower implant failure rates, although at the expense of greater operative time and blood loss, while disability outcomes may remain similar between approaches.[7] To improve the mechanical performance of shorter constructs while preserving motion segments, the inclusion of intermediate pedicle screws at the fracture level has been proposed. A systematic review and meta-analysis comparing 4-screw and 6-screw constructs found that fracture-level screw augmentation was associated with less correction loss, better radiographic outcomes, and fewer implant failures, despite slightly increased operative time and blood loss.[8] Nevertheless, failure after posterior short-segment instrumentation remains clinically relevant, and greater pre-operative structural severity, particularly higher load-sharing burden, has been consistently associated with an increased risk of such failure. A recent systematic review and meta-analysis confirmed that load-sharing classification (LSC) scores >7, higher pre-operative Cobb angle, and greater vertebral wedge angle are associated with short-segment instrumentation failure.[2] In addition, age ≥65 years and posterior ligamentous complex (PLC) injury have been identified as independent predictors of instrumentation failure in both short- and long-segment constructs.[9] Recent comparative studies have confirmed that long-segment posterior fixation provides similar clinical outcomes to short-segment fixation, albeit with longer operative time and greater blood loss.[10] Furthermore, intermediate (fracture-level) screws have been shown to significantly reduce pedicle screw loosening and instrumentation failure.[11]

Beyond construct selection, fracture morphology itself may play an important role in long-term outcome. The AO spine thoracolumbar injury classification categorizes fractures according to increasing instability, from type A compression injuries to type B distraction injuries and type C translational or rotational injuries.[12] The World Federation of Neurosurgical Societies (WFNS) Spine Committee has recommended that anterior vertebral body height loss >50%, PLC injury, and post-operative Cobb angle >10.5° should be considered when counseling patients about expected outcomes.[13] However, the extent to which AO fracture severity is associated with longer-term radiographic maintenance and patient-reported outcomes after a standardized posterior fixation strategy has not been fully established. In particular, it remains unclear whether more unstable AO type B and C injuries continue to influence outcomes even after stabilization with a uniform long-segment construct.

Therefore, in this retrospective cohort study, we evaluated a standardized posterior long-segment fixation strategy (two levels above and two levels below) with routine fracture-level screw inclusion in a homogeneous cohort of neurologically intact T11–L2 fractures. The aims of this study were to quantify radiographic correction and its long-term maintenance, assess pain and health-related quality of life using the Visual Analog Scale (VAS) and 36-Item Short Form Health Survey (SF-36), and identify factors associated with final radiographic and clinical outcomes, with particular emphasis on AO fracture severity. Given the retrospective design and limited sample size for certain fracture types, these analyses are considered exploratory and hypothesis-generating.

MATERIALS AND METHODS

Study Design and Setting

This single-center retrospective cohort study was conducted at a Level 1 trauma center. Consecutive adult patients who underwent surgical treatment for traumatic thoracolumbar junction fractures between March 2014 and February 2023 were identified and screened for eligibility. Ethical approval was granted by the Ege University Medical Research Ethics Committee (Approval No. 26-3T/1, Date: 05.03.2026), and the requirement for written informed consent was waived due to the retrospective study design. Clinical trial registration was not applicable. All procedures were performed in accordance with the Declaration of Helsinki and applicable institutional regulations.

Participants and Eligibility Criteria

Patients were identified from institutional surgical logs and electronic medical records. Eligible patients were adults (≥18 years) with an acute traumatic fracture at T11, T12, L1, or L2 who were treated with posterior long-segment pedicle screw instrumentation and had at least 24 months of radiographic follow-up, including available pre-operative sagittal computed tomography (CT) images and early post-operative and final lateral radiographs.

Because the present study was designed to evaluate outcomes in a relatively homogeneous cohort treated without neural decompression, only neurologically intact patients were included. Accordingly, all included patients had no documented motor or sensory deficit at presentation (ASIA grade E). Patients with any neurological impairment related to the index injury were excluded.

Additional exclusion criteria were: any decompressive proce-

dure performed at the index surgery (including laminectomy or foraminotomy); pathological or insufficiency fractures (e.g., tumor, infection, or severe metabolic bone disease); prior thoracolumbar surgery that could affect sagittal alignment measurements; multilevel fractures without a clearly definable index vertebra for standardized radiographic assessment; incomplete clinical or imaging records, and follow-up shorter than 24 months. A detailed flow diagram of patient selection is summarized in Figure 1.

A subset of patients included in the present single-center cohort was also included in a previously published multicenter comparative study evaluating fracture-level screw placement. The present study addresses a distinct research question by examining fracture morphology and factors associated with long-term radiographic and patient-reported outcomes in an extended single-center cohort. The previous study is cited to transparently disclose the partial overlap between the study populations.[14]

Surgical Technique and Post-operative Management

All operations were performed under general anesthesia by the same surgical team with the patient in the prone position on a radiolucent table. The surgical indication for neurologically intact patients was based on fracture instability assessed by the treating spine team, including loss of vertebral body height >50%, kyphotic deformity >20°, or canal compromise, in accordance with institutional practice. For the purposes of this study, long-segment fixation was defined as instrumentation spanning two vertebrae above and two vertebrae below the fractured level.

Pedicle screw–rod constructs were applied under fluoroscopic guidance, and indirect reduction maneuvers were used to restore vertebral body height and sagittal alignment. Fracture-level pedicle screws were routinely inserted at the index vertebra as part of the standardized construct in all included patients. No posterior decompression was performed in any patient included in this analysis.

Titanium polyaxial pedicle screw–rod systems (Instinct® Java® Spinal Fixation System, Zimmer) were used. Screw diameter and length were selected according to pre-operative CT-based pedicle anatomy. Patients were mobilized on the 1st or 2nd post-operative day with a thoracolumbosacral orthosis for 8–12 weeks, depending on surgeon preference and fracture characteristics. Weight-bearing was allowed as tolerated, with avoidance of excessive bending, lifting, and twisting during the early post-operative period.

Data Collection and Variables

Demographic and injury-related variables were extracted from the medical records, including age, sex, trauma mechanism, fracture level (T11, T12, L1, or L2), and fracture morphology according to the AO spine thoracolumbar injury classification. AO classification was performed independently by two spine surgeons blinded to clinical outcomes, based on pre-operative CT and radiographs. Disagreements were resolved by consensus. Trauma mechanism was categorized as fall from height or traffic accident. Pedicle screw diameter (5.5 mm vs. 6.5 mm) was also recorded for each patient. Complications were recorded from inpatient charts and follow-up records.

The following definitions were used:

(a). Superficial surgical site infection: Erythema or discharge involving only skin/subcutaneous tissue, requiring oral antibiotics or local wound care

(b). Deep surgical site infection: Infection involving fascia or muscle, requiring surgical debridement or intravenous antibiotics

(c). Implant failure: Visible breakage of rods or screws, or screw loosening defined as a radiolucent halo >1 mm on final radiograph

(d). Revision surgery: Any unplanned return to the operating room for implant-related issues, including removal, replacement, or extension of instrumentation

(e). Proximal junctional kyphosis (PJK): Sagittal Cobb angle >10° between the upper instrumented vertebra and the vertebra two levels above, measured on final lateral radiograph

(f). Adjacent segment disease: New degenerative changes or stenosis at an adjacent level requiring treatment.

Outcomes

The primary outcome was radiographic loss of correction, defined as the change in vertebral compression angle (VCA) from the early post-operative period to final follow-up. This endpoint was selected because maintenance of sagittal alignment is a principal aim of posterior stabilization.

Secondary outcomes were final VCA, final anterior vertebral corpus height (VCH-A), final posterior vertebral corpus height (VCH-P), loss of anterior vertebral height, loss of posterior vertebral height, pain intensity at final follow-up assessed with the VAS, and health-related quality of life at final follow-up assessed with the SF-36. All clinical outcomes were assessed cross-sectionally at final follow-up; therefore, they represent final health status rather than change from pre-operative status.

Clinical Outcome Assessment

Pain intensity was assessed at final follow-up using a 10-point VAS ranging from 0 (no pain) to 10 (worst imaginable pain). Health-related quality of life was assessed at final follow-up using the validated Turkish version of the SF-36 (version 1).[15,16] Eight domain scores were calculated and transformed to a 0–100 scale, with higher scores indicating better perceived health status. The health transition item was not included in domain scoring.

Radiographic Outcome Assessment

Imaging evaluation was performed using pre-operative sagittal CT images and standard lateral thoracolumbar radio-

graphs obtained in the early post-operative period and at final follow-up. The early post-operative radiograph was defined as the first post-operative radiograph obtained during routine clinical care, typically within 3–5 days after surgery. Final follow-up radiographs were those obtained at or beyond 24 months.

Pre-operative VCA, VCH-A, and VCH-P measurements were obtained on sagittal CT images, whereas early post-operative and final follow-up measurements were performed on lateral radiographs. The use of different imaging modalities across time points (CT vs. radiograph) represents a methodological limitation; to assess the potential impact, we performed a sensitivity analysis (described below). All measurements were performed using institutional PACS tools by two independent observers blinded to clinical outcomes. The following parameters were recorded:

A. VCA: Measured on the lateral view as the angle formed by the superior and inferior endplates of the fractured vertebral body

B. VCH-A: Measured as the distance between the superior and inferior endplates along the anterior vertebral cortex

C. VCH-P: Measured as the distance between the superior and inferior endplates along the posterior vertebral cortex.

To characterize post-operative restoration and maintenance over time, we calculated the following derived parameters:

I. VCA correction=VCA~pre~−VCA~early~

II. Loss of correction=VCA~final~−VCA~early~

III. Anterior height restoration=VCH-A~early~−VCH-A~pre~

IV. Anterior height loss=VCH-A~early~−VCH-A~final~

V. Posterior height restoration=VCH-P~early~−VCH-P~pre~

VI. Posterior height loss=VCH-P~early~−VCH-P~final~

Statistical Analysis

Continuous variables were summarized as mean±standard deviation (SD) when normally distributed and as median (Q1–Q3) when non-normally distributed. Categorical variables are presented as number and percentage. Normality was assessed using the Shapiro–Wilk test together with visual inspection of distribution plots.

Within-patient comparisons between pre-operative and early post-operative values and between early post-operative and final follow-up values were performed using paired t-tests or Wilcoxon signed-rank tests, as appropriate. Associations between radiographic correction-loss parameters and patient-reported outcomes were explored using Spearman rank correlation coefficients.

To evaluate factors associated with final radiographic and clinical outcomes, multivariable linear regression models with HC3 robust standard errors were constructed. Candidate variables were selected a priori based on clinical relevance and included AO fracture type, age, sex, trauma mechanism, fracture level, and pedicle screw diameter (5.5 mm vs. 6.5 mm). Regression results are presented as beta coefficients with 95% confidence intervals (CI).

Given the retrospective design, no formal sample size calculation was performed. Because multiple secondary and domain-specific analyses (including eight SF-36 domains) were conducted, these analyses were considered exploratory and hypothesis-generating. We did not apply a formal multiplicity correction (e.g., Bonferroni) to avoid an overly conservative increase in Type II error; however, findings with p-values between 0.01 and 0.05 should be interpreted cautiously as hypothesis-generating rather than definitive. No formal imputation was required because no missing data were present for the primary radiographic outcome measures or for the final VAS and SF-36 assessments among the included patients.

Subgroup analysis

To further explore the association between fracture morphology and outcomes within a more homogeneous group, we performed a post hoc subgroup analysis limited to patients with AO type A fractures (n=42). Multivariable regression models were repeated within this subgroup using the same candidate variables.

Sensitivity analysis for imaging modality

Because pre-operative measurements were obtained from sagittal CT while post-operative and final measurements were obtained from lateral radiographs, we conducted a sensitivity analysis to assess modality-related measurement consistency. In a randomly selected subset of 20 patients, VCA was measured on both pre-operative sagittal CT and available pre-operative lateral radiographs. The mean difference between the two modalities was calculated using a paired t-test.

Additional analysis for screw properties

In addition to screw diameter, we attempted to collect data on screw length and distance from screw tip to anterior vertebral cortex. However, these measurements were not reliably available or standardized across all 78 patients due to variability in imaging quality and the retrospective nature of the study. This limitation is acknowledged in the discussion.

Interobserver reliability for continuous radiographic measurements was assessed using intraclass correlation coefficients based on a two-way random-effects model for absolute agreement. Inter-rater reliability for AO classification was assessed using weighted kappa statistics. A two-sided $p<0.05$ was considered statistically significant. Statistical analyses were performed using IBM Statistical Package for the Social Sciences Statistics version 26.0 (IBM Corp., Armonk, NY, USA).

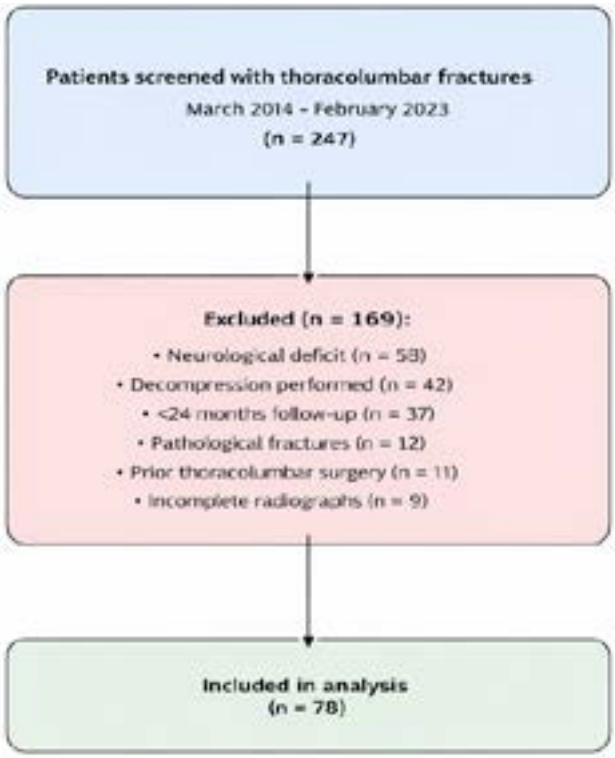

Figure 1. Flow diagram of patient selection for the final study cohort.

RESULTS

Study Population

A total of 78 patients with thoracolumbar junction fractures (T11–L2) treated with posterior long-segment instrumentation met the eligibility criteria and were included in the analysis (Fig. 1). The mean age was 40.2±13.9 years (range, 18–65), and 27 patients (34.6%) were female. The most common trauma mechanism was a fall from height (56/78, 71.8%), followed by traffic accidents (22/78, 28.2%). Fracture levels were L1 in 30 patients (38.5%), T12 in 24 (30.8%), L2 in 17 (21.8%), and T11 in 7 (9.0%). According to the AO classification, 42 fractures were type A (53.8%), 27 were type B (34.6%), and 9 were type C (11.5%). Median follow-up was 48.0 months (Q1–Q3: 36.0–67.8). Pedicle screw diameter was 5.5 mm in 52 patients (66.7%) and 6.5 mm in 26 patients (33.3%) (Table 1A).

Baseline Characteristics Stratified by AO Type

Baseline characteristics stratified by AO type are shown in Table 1B. Pre-operative imaging-based severity differed across fracture types. Median pre-operative VCA was 10.2° (6.8–14.5) in AO type A, 12.8° (8.9–17.2) in type B, and 16.4° (12.1–21.3) in type C (p=0.008). Pre-operative anterior vertebral height was also lower in more severe fracture patterns (p=0.04). Age, sex, and trauma mechanism did not differ significantly across AO groups (all p>0.05).

Sagittal Alignment and Vertebral Height Measurements Over Time

Imaging measurements over time are summarized in Table 2. Pre-operative measurements were obtained from sagittal CT images, whereas early post-operative and final follow-up measurements were obtained from lateral radiographs. The median VCA was 11.75° (7.83–16.48) preoperatively, 4.30°

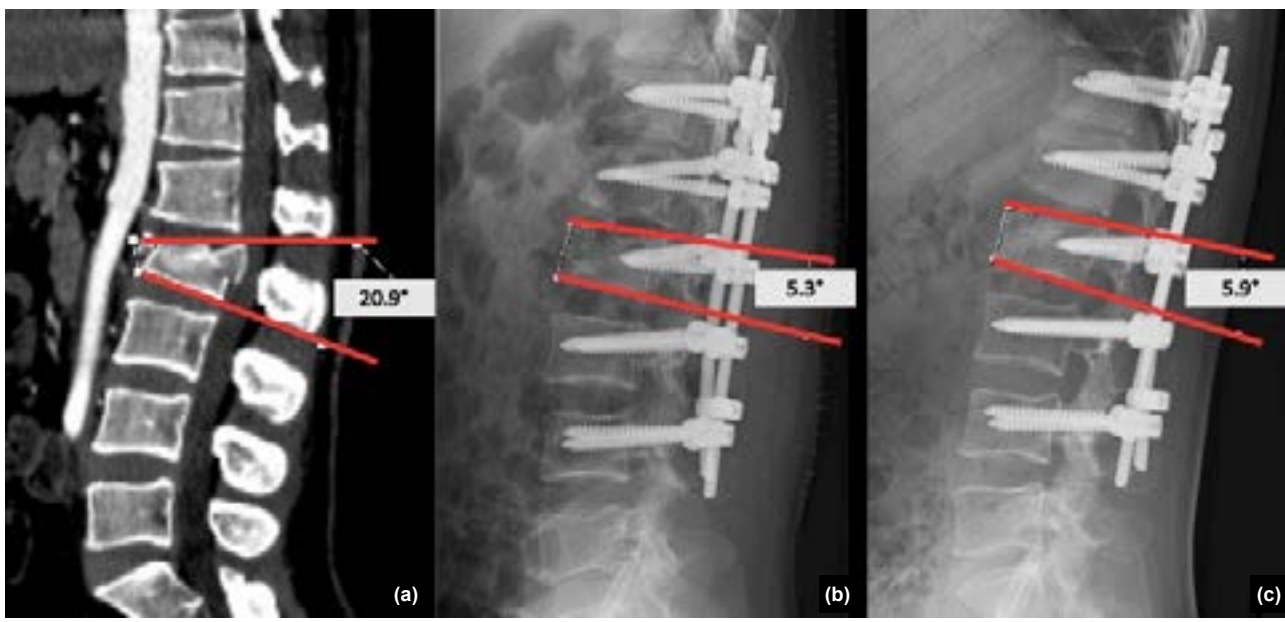

Figure 2. Representative sagittal images of a 34-year-old male patient with an AO type B2 fracture of the L2 vertebra. **(a)** Pre-operative computed tomography image showing measurement of the vertebral compression angle (VCA). **(b)** Early post-operative lateral radiograph showing VCA measurement. **(c)** Lateral radiograph at 32-month follow-up showing VCA measurement at final follow-up.

Table 1A. Baseline characteristics

Variable	Overall (n=78)
Patients, n	78
Age (years), mean±SD	40.2±13.9
Female sex, n (%)	27 (34.6)
Follow-up (months), median (Q1–Q3)	48.0 (36.0–67.8)
Final VAS, median (Q1–Q3)	1 (1–1)
Screw diameter, n (%)	
5.5 mm	52 (66.7)
6.5 mm	26 (33.3)
Mechanism, n (%)	
Fall from height	56 (71.8)
Traffic accident	22 (28.2)
Fracture level, n (%)	
T11	7 (9.0)
T12	24 (30.8)
L1	30 (38.5)
L2	17 (21.8)
AO fracture type, n (%)	
A	42 (53.8)
B	27 (34.6)
C	9 (11.5)

SD: Standard devaition; VAS: Visual Analog Scale. Screw diameter refers to the pedicle screw diameter used at all instrumented levels (including fracture level).

(2.55–6.65) early postoperatively, and 6.00° (4.00–8.80) at final follow-up. The mean absolute correction between the pre-operative and early post-operative assessments was 7.61±4.65°. At final follow-up, the median loss of correction from the early post-operative period was 1.00° (0.40–2.57) (p<0.001).

VCH-A was 15.81±3.61 mm preoperatively, 25.71±3.30 mm early postoperatively (mean change 9.90±4.25 mm, p<0.001), and 22.56±3.61 mm at final follow-up (median loss 2.15 mm [1.00–4.50] from early post-operative, p<0.001). VCH-P was 22.96±3.68 mm preoperatively, 29.72±2.77 mm early postoperatively (mean change 6.76±3.31 mm, p<0.001), and 28.14±2.66 mm at final follow-up (mean loss 1.58±1.04 mm, p<0.001).

When changes over time were examined according to AO fracture type, more severe fracture patterns showed greater early correction but also greater loss over time. In particular, AO type C fractures appeared to show the largest early VCA correction and the greatest subsequent correction loss (Fig. 2). However, these observations regarding AO type C fractures should be interpreted with caution given the small number of such injuries (n=9).

Interobserver Reliability

Interobserver reliability was excellent for imaging measurements. Intraclass correlation coefficient (ICC) values were 0.94 (95% CI, 0.90–0.97) for VCA, 0.91 (95% CI, 0.86–0.95) for anterior vertebral height, and 0.89 (95% CI, 0.83–0.94) for posterior vertebral height. Agreement for AO classification was substantial (weighted κ=0.84, 95% CI, 0.76–0.91).

Table 1B. Baseline characteristics stratified by AO type

Characteristic	AO type A (n=42)	AO type B (n=27)	AO type C (n=9)	p
Age (years)	39.8±14.2	41.1±13.5	39.6±14.8	0.89
Female sex, n (%)	15 (35.7)	9 (33.3)	3 (33.3)	0.97
Fall from height, n (%)	30 (71.4)	19 (70.4)	7 (77.8)	0.91
Preop VCA (°)	10.2 (6.8–14.5)	12.8 (8.9–17.2)	16.4 (12.1–21.3)	0.008
Preop VCH-A (mm)	16.8±3.4	15.2± 3.7	13.9± 3.9	0.04

VCA: Vertebral compression angle; VCH-A: Anterior vertebral corpus height.

Table 2. Radiographic outcomes over time

Measure	Preopera-tive	Early post-operative	Final	Δ Pre→Early	Δ Ear-ly→Final
VCA (°)	11.75 (7.83–16.48)	4.30 (2.55–6.65)	6.00 (4.00–8.80)	7.61±4.65a	1.00 (0.40–2.57)b
Anterior VCH (mm)	15.81±3.61	25.71±3.30	22.56±3.61	9.90±4.25a	2.15 (1.00–4.50)b
Posterior VCH (mm)	22.96±3.68	29.72±2.77	28.14±2.66	6.76±3.31a	1.58±1.04b

Δ Pre→Early represents correction/restoration; Δ Early→Final represents loss from early post-operative to final follow-up. Values are mean±SD or median (Q1–Q3) as appropriate. a p<0.001 for Pre-operative versus Early post-operative (paired test). b p<0.001 for early versus final (paired test). VCA: Vertebral compression angle; VCH: Vertebral corpus height.

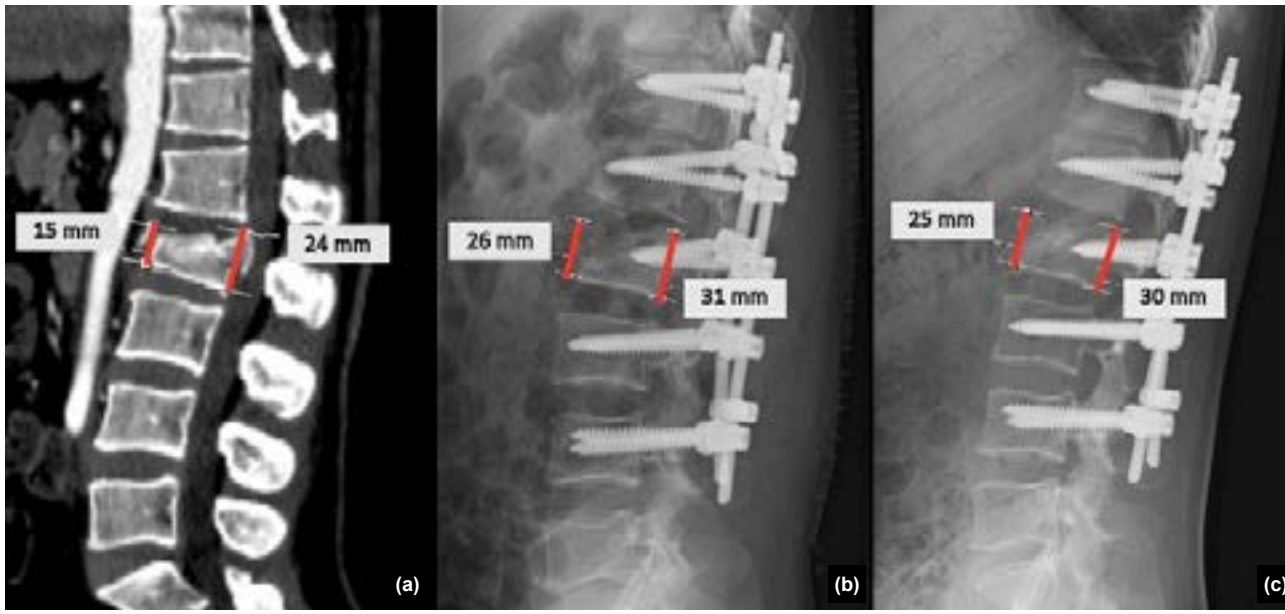

Figure 3. Representative sagittal images of the same patient shown in Figure 2. **(a)** Pre-operative computed tomography image showing measurement of anterior and posterior vertebral corpus heights (VCH-A and VCH-P). **(b)** Early post-operative lateral radiograph showing VCH-A and VCH-P measurements. **(c)** Lateral radiograph at 32-month follow-up showing VCH-A and VCH-P measurements at final follow-up.

Table 4A. Factors associated with final VAS, final VCA, and VCA loss

Predictor	Final VAS	Final VCA (°)	VCA Loss (°)
Age (per year)	−0.01 (−0.02–0.00) p=0.077	0.00 (−0.05–0.06) p=0.862	0.01 (−0.02–0.04) p=0.504
Sex (female vs. male)	0.01 (−0.23–0.25) p=0.939	−0.66 (−2.21–0.89) p=0.403	0.45 (−0.38–1.28) p=0.290
Mechanism (traffic vs. fall)	0.05 (−0.22–0.32) p=0.732	0.32 (−1.62–2.25) p=0.749	0.00 (−0.91–0.92) p=0.995
Fracture level			
T11 versus L1	0.62 (0.14–1.11) p=0.012	0.80 (−2.16–3.77) p=0.596	−0.14 (−1.21–0.94) p=0.804
T12 versus L1	0.23 (−0.03–0.49) p=0.077	1.29 (−0.52–3.11) p=0.163	0.85 (−0.19–1.88) p=0.108
L2 versus L1	0.50 (0.14–0.87) p=0.007	−0.70 (−2.63–1.24) p=0.482	0.36 (−0.47–1.20) p=0.394
AO type			
B versus A	0.01 (−0.26–0.27) p=0.970	−1.13 (−2.62–0.37) p=0.141	1.85 (0.98–2.72) p<0.001
C versus A	0.03 (−0.33–0.39) p=0.874	3.58 (1.03–6.13) p=0.006	4.75 (3.02–6.49) p<0.001
Screw diameter (6.5 mm vs. 5.5 mm)	0.02 (−0.24–0.28) p=0.882	−0.42 (−1.98–1.14) p=0.603	0.31 (−0.52–1.14) p=0.468

VAS: Visual Analog Scale; VCA: Vertebral compression angle. Multivariable linear regression with robust standard errors (HC3). Reference categories: male, fall from height, L1 fracture level, AO type A, screw diameter 5.5 mm. Values are β coefficients (95% confidence intervals). Bold indicates statistical significance (p<0.05). All models adjusted for age, sex, mechanism, fracture level, AO type, and screw diameter

Clinical Outcomes

At final follow-up, pain levels were low overall. Median VAS was 1 (interquartile range: 1–1); 55 patients (70.5%) reported a VAS score of 1, 18 (23.1%) reported 2, and 5 (6.4%) reported 0. No patient reported VAS >2. These represent cross-sectional final pain status, not change from pre-operative levels.

SF-36 domain scores at final follow-up are summarized in Table 3. Median scores were highest for role physical and role emotional, both reaching 100 in the upper range, whereas lower values were observed for vitality and mental health.

Factors Associated with Final Pain and Radiographic Outcomes

Multivariable regression results for final VAS, final VCA, and VCA loss are presented in Table 4A. Final VAS was higher in L2 fractures (β 0.50, 95% CI 0.14 to 0.87; p=0.007) and T11

Table 4B. Factors associated with vertebral height outcomes

Predictor	Final VCH−A (mm)	VCH−A Loss (mm)	Final VCH−P (mm)	VCH−P Loss (mm)
Age (per year)	0.01 (-0.04–0.06) p=0.719	0.02 (-0.01–0.06) p=0.196	0.01 (-0.04–0.07) p=0.587	0.01 (-0.01–0.02) p=0.375
Sex				
(female vs. male)	0.28 (-1.11–1.67) p=0.693	−0.49 (-1.46–0.47) p=0.318	-1.10 (-2.34–0.14) p=0.083	-0.35 (-0.84–0.15) p=0.174
Mechanism				
(traf-fic vs. fall)	-0.36 (-1.74-1.03) p=0.615	−0.24 (-1.26–0.77) p=0.636	-0.09 (-1.35–1.17) p=0.890	0.39 (−0.17–0.94) p=0.172
Fracture level				
T11 versus L1	-1.69 (-4.55–1.17) p=0.246	−0.54 (-2.09–1.01) p=0.491	-0.96 (-3.93–2.01) p=0.527	-0.73 (-1.35–-0.11) p=0.022
T12 versus L1	-2.38 (-4.04–-0.71) p=0.005	0.40 (-0.60–1.39) p=0.434	-1.45 (-2.79–−0.12) p=0.033	-0.64 (-1.27–-0.01) p=0.048
L2 versus L1	0.90 (-0.74–2.54) p=0.281	0.78 (-0.61–2.18) p=0.270	0.14 (-1.63–1.92) p=0.877	-0.33 (-0.98–0.33) p=0.327
AO type				
B versus A	-3.67 (-5.16–-2.19) p<0.001	3.16 (2.12–4.20) p<0.001	-0.76 (-2.11–0.59) p=0.270	0.39 (-0.10–0.87) p=0.117
C versus A	-3.95 (-6.26–-1.64) p<0.001	6.16 (4.16–8.16) p<0.001	-1.31 (-3.79–1.17) p=0.300	0.84 (0.05–1.64) p=0.038
Screw diameter	0.58 (-1.02–2.18) p=0.478	-0.22 (-1.18–0.74) p=0.651	-0.15 (-1.58–1.28) p=0.837	0.08 (-0.42–0.58) p=0.752
(6.5 mm vs. 5.5 mm)				

Multivariable linear regression with robust standard errors (HC3). Reference categories: male, fall from height, L1 fracture level, AO type A, screw diameter 5.5 mm. Values are β coefficients (95% confidence interval). Bold indicates statistical significance (p<0.05). All models adjusted for age, sex, mechanism, fracture level, AO type, and screw diameter. VCH-A: Anterior vertebral corpus height; VCH-P: Posterior vertebral corpus height.

Table 4C. Subgroup analysis: AO Type A fractures only (n=42)

Outcome	β coefficient (95% CI)	p
Final VCA (°)		
L2 versus L1	1.82 (−0.45–4.09)	0.116
Age (per year)	0.02 (−0.06–0.10)	0.612
Screw diameter (6.5 vs. 5.5 mm)	−0.38 (−2.22–1.46)	0.683
VCA loss (°)		
L2 versus L1	1.45 (0.32–2.58)	0.012
Age (per year)	0.01 (−0.03–0.05)	0.581
Screw diameter (6.5 vs. 5.5 mm)	0.22 (−0.69–1.13)	0.633
Final physical functioning (SF 36)		
L2 versus L1	−6.32 (−18.44–5.80)	0.304
Age (per year)	−0.15 (−0.52–0.22)	0.422
Screw diameter (6.5 vs. 5.5 mm)	3.15 (−7.88–14.18)	0.573

CI: Confidence interval; VCA: Vertebral compression angle. Multivariable linear regression with robust standard errors (HC3). Analysis limited to patients with AO type A fractures (n=42). Reference category for fracture level: L1. Reference category for screw diameter: 5.5 mm. Bold indicates statistical significance (p<0.05).

fractures (β 0.62, 95% CI 0.14 to 1.11; p=0.012) compared with L1 fractures. Age, sex, trauma mechanism, AO type and screw diameter were not significantly associated with final VAS.

For sagittal alignment outcomes, AO fracture type was the main variable associated with final deformity and correction loss. Compared with AO type A, AO type C was associated with a higher final VCA (β 3.58°, 95% CI 1.03 to 6.13; p=0.006). VCA loss from the early post-operative period to final follow-up was greater in AO type B (β 1.85°, 95% CI 0.98–2.72; p<0.001) and AO type C (β 4.75°, 95% CI 3.02 to 6.49; p<0.001) than in AO type A.

Regression models for vertebral height outcomes are shown in Table 4B. Final anterior vertebral height was lower in AO type B (β −3.67 mm, 95% CI −5.16–−2.19; p<0.001) and AO type C (β −3.95 mm, 95% CI −6.26–−1.64; p<0.001) compared with AO type A. T12 level was also associated with lower final anterior height (β −2.38 mm, 95% CI −4.04–−0.71; p=0.005). Anterior height loss was greater in AO type B (β 3.16 mm, 95% CI 2.12–4.20; p<0.001) and AO type C (β 6.16 mm, 95% CI 4.16–8.16; p<0.001).

For posterior height outcomes, T12 was associated with lower final posterior vertebral height (β −1.45 mm, 95% CI −2.79–−0.12; p=0.033). AO type C was associated with greater posterior height loss (β 0.84 mm, 95% CI 0.05–1.64; p=0.038), whereas T11 and T12 fractures showed less posterior height loss than L1 fractures.

Subgroup Analysis: AO Type A Fractures Only

To further examine factors associated with outcomes within a more homogeneous fracture group, we performed a post hoc subgroup analysis limited to the 42 patients with AO type A fractures. In this subgroup, the median VCA loss from early post-operative to final follow-up was 0.80° (0.30–1.90). On multivariable analysis, L2 fracture level (compared with L1) was associated with greater VCA loss (β 1.45°, 95% CI 0.32–2.58; p=0.012). No other variables (age, sex, mechanism, and screw diameter) were significantly associated with VCA loss or final SF-36 scores within this subgroup (all p>0.05). These results are presented in Table 4C.

Sensitivity Analysis for Imaging Modality

To assess potential measurement variability due to different imaging modalities (pre-operative CT vs. follow-up radiographs), we compared VCA measurements on pre-operative sagittal CT and available pre-operative lateral radiographs in a randomly selected subset of 20 patients. The mean difference between the two modalities was 0.8° (95% CI −1.2° to 2.8°; p=0.42), indicating acceptable agreement with no systematic bias (Table 5).

Screw Diameter

Pedicle screw diameter (6.5 mm vs. 5.5 mm) was included as a covariate in all multivariable regression models. Screw diameter was not significantly associated with final VCA (β −0.42°, 95% CI −1.98–1.14; p=0.60), VCA loss (β 0.31°, 95% CI −0.52–1.14; p=0.47), final anterior height (β 0.58 mm, 95% CI −1.02–2.18; p=0.48) (Table 4A and B), or any SF-36 domain (all p>0.05; see footnote to Table 6).

Correlation between Radiographic and Clinical Outcomes

Correlations between radiographic correction-loss parameters and SF-36 domains are presented in Table 7. Greater VCA loss was modestly associated with lower physical functioning (ρ=−0.28, p=0.013) and vitality (ρ=−0.24, p=−0.036), whereas no significant association was observed with bodily pain (ρ=−0.11, p=0.34). VCH-A loss showed a non-significant trend toward lower physical functioning (ρ=−0.21, p=0.06) and was not significantly associated with the other SF-36 domains.

Factors Associated with Health-Related Quality of Life

Multivariable regression models for SF-36 domains are shown in Table 6. Adjusted R2 values ranged from 0.309 to 0.482 for most domains, whereas the model for general health explained little variance (adjusted R2=0.036).

AO fracture type showed the most consistent associations across SF-36 domains. Compared with AO type A, AO type B was associated with lower scores in physical functioning (β −13.75, p=0.007), role physical (β −21.54, p<0.001), role emotional (β −27.65, p<0.001), social functioning (β −15.09, p<0.001), vitality (β −14.56, p<0.001), and mental health (β −10.53, p=0.002). AO type C showed larger reductions across multiple domains, including physical functioning (β −34.28, p<0.001), role physical (β −50.42, p<0.001), role emotional (β −45.39, p<0.001), bodily pain (β −27.29, p<0.001), social functioning (β −31.41, p<0.001), vitality (β −29.13, p<0.001), and mental health (β −24.00, p<0.001).

Traffic accidents were associated with lower role emotional scores than falls (β −16.63, 95% CI −32.90 to −0.36; p=0.045). Fracture level also showed domain-specific associations: L2 fractures were associated with lower social functioning (β −9.49, p=0.006) and lower vitality (β −8.09, p=0.038), whereas T11 fractures were associated with lower vitality (β −8.81, p=0.019). No independent predictors were identified for general health. Screw diameter was not significantly associated with any SF-36 domain (all p>0.05).

Complications

Overall, complications were limited. Five patients (6.4%) developed superficial wound infection, all of which resolved with dressing changes and antibiotic treatment. No patient

Table 5. Sensitivity analysis: VCA measured on pre-operative CT versus lateral radiograph (n=20)

Imaging modality	Mean VCA (°)±SD	Mean difference (95% CI)	p*
Pre-operative sagittal CT	12.4°±4.2°	0.8° (−1.2°–2.8°)	0.42
Pre-operative lateral radio-graph	11.6°±4.5°		

Paired t-test. No statistically significant difference between modalities (p=0.42). CT: Computed tomography; VCA: Vertebral compression angle; SD: Standard deviation; CI: Confidence interval.

Table 6. Multivariable linear regression models for SF-36 domains at final follow-up

Predictor	Physical functioning	Role physical	Role emotional	Bodily pain	Social functioning	Vitality	Mental health	General health
AO type B versus A	−13.75	−21.54	−27.65	−7.60	−15.09	−14.56	−10.53	−4.07
	(−23.82–−3.68)	(−33.22–−9.86)	(−41.07–−14.24)	(−16.10–0.91)	(−21.08–−9.10)	(−21.00–−8.12)	(−17.31–−3.75)	(−9.68–1.53)
	p=0.007	p<0.001	p<0.001	p=0.080	p<0.001	p<0.001	p=0.002	p=0.154
AO type C versus A	−34.28	−50.42	−45.39	−27.29	−31.41	−29.13	−24.00	−8.19
	(−42.19–−26.38)	(−74.27–−26.57)	(−62.91–−27.87)	(−43.22–−11.35)	(−41.05–−21.78)	(−36.69–−21.56)	(−33.38–−14.62)	(−16.77–0.39)
	p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	p=0.061
Age (per year)	−0.21	−0.20	0.09	0.16	−0.07	−0.04	−0.09	−0.05
	(−0.50–0.08)	(−0.59–0.20)	(−0.33–0.51)	(−0.16–0.47)	(−0.24–0.10)	(−0.24–0.16)	(−0.32–0.13)	(−0.27–0.17)
	p=0.153	p=0.329	p=0.675	p=0.327	p=0.418	p=0.710	p=0.408	p=0.655
Female versus male	5.04	3.54	2.85	−2.77	−1.50	1.43	1.08	−0.33
	(−3.94–14.03)	(−7.31–14.40)	(−10.89–16.59)	(−11.62–6.08)	(−6.76–3.76)	(−4.70–7.57)	(−5.31–7.48)	(−5.51–4.85)
	p=0.271	p=0.522	p=0.684	p=0.540	p=0.576	p=0.647	p=0.740	p=0.900
Traffic versus fall	4.71	−7.19	−16.63	−2.66	3.43	0.41	2.64	2.41
	(−4.63–14.05)	(−19.89–5.51)	(−32.90–−0.36)	(−12.53–7.22)	(−2.57–9.42)	(−5.38–6.20)	(−4.02–9.31)	(−3.32–8.14)
	p=0.323	p=0.267	p=0.045	p=0.598	p=0.263	p=0.889	p=0.437	p=0.410
T11 versus L1	9.96	9.63	−7.81	7.52	−3.07	−8.81	−7.41	0.90
	(−0.96–20.89)	(−11.37–30.63)	(−31.01–15.39)	(−6.88–21.91)	(−15.13–8.99)	(−16.17–−1.44)	(−19.30–4.48)	(−6.94–8.73)
	p=0.074	p=0.369	p=0.509	p=0.306	p=0.618	p=0.019	p=0.222	p=0.823
T12 versus L1	5.80	−4.30	9.49	4.43	−4.49	−5.42	−6.65	3.49
	(−5.31–16.92)	(−14.14–5.53)	(−2.56–21.54)	(−5.19–14.04)	(−10.72 to 1.73)	(−12.36–1.53)	(−13.71–0.40)	(−2.79–9.77)
	p=0.306	p=0.391	p=0.123	p=0.367	p=0.157	p=0.126	p=0.064	p=0.276
L2 ver-sus L1	9.42	5.65	−8.69	−1.03	−9.49	−8.09	−7.26	5.22
	(−1.58–20.42)	(−11.04–22.34)	(−26.52–9.14)	(−10.44–8.38)	(−16.26–−2.73)	(−15.73–−0.45)	(−15.14–0.61)	(−1.55–11.99)
	p=0.093	p=0.507	p=0.339	p=0.830	p=0.006	p=0.038	p=0.071	p=0.131

Multivariable linear regression with robust standard errors (HC3). Reference categories: AO type A, male, fall from height, L1 fracture level. Values are β coefficients (95% confidence interval). Bold indicates statistical significance (p<0.05). Adjusted R^2 values (not shown) ranged from 0.309 to 0.482 for most domains; the model for general health explained little variance (adjusted R2=0.036). Pedicle screw diameter (6.5 mm vs. 5.5 mm) was included as a covariate in all regression models and was not significantly associated with any SF-36 domain (p>0.05 for all). Data not shown to preserve table clarity. SF-36: 36-item short form health survey

Table 7. Correlation between radiographic correction loss and SF-36 domains at final follow-up

Radiographic parameter	SF-36 domain	Spearman's ρ	p
VCA Loss	Physical functioning	−0.28	0.013
	Vitality	−0.24	0.036
	Bodily pain	−0.11	0.34
VCH-A Loss	Physical functioning	−0.21	0.06

This table presents bivariate correlations between radiographic correction loss parameters and patient-reported quality-of-life domains at final follow-up. Greater loss of vertebral compression angle correction was significantly associated with lower Physical Functioning and Vitality scores, though the correlations were modest in strength. Values are Spearman's rank correlation coefficients (ρ). Anterior height loss showed a borderline inverse association with Physical Functioning, but no statistically significant association with the other SF-36 domains (all p>0.05). Bold indicates statistical significance (p<0.05). VCA: Vertebral compression angle; VCH-A: Anterior vertebral corpus height; SF-36: 36-item short form health survey.

developed deep infection. Using the predefined criteria, no implant failure (screw loosening/breakage), revision surgery, PJK (PJK >10°), or adjacent segment disease was observed during follow-up.

DISCUSSION

Study Strengths and Main Findings

This study has several strengths, including a homogeneous cohort of neurologically intact patients, a standardized long-segment construct with routine fracture-level screw inclusion, long-term follow-up (median 48 months), and the concurrent assessment of both radiographic and patient-reported outcomes with excellent interobserver reliability. The main findings were that sagittal alignment and vertebral body height were substantially restored in the early post-operative period and largely maintained during long-term follow-up, that AO fracture type showed the most consistent association with maintenance of alignment and vertebral body height as well as patient-reported outcomes, and that fracture level and injury mechanism showed some domain-specific associations with pain and SF-36 scores.

Comparison with Turkish Series and Population Norms

Our findings are broadly consistent with previous Turkish series while extending them with longer follow-up and multivariable analysis. Öztürk et al.[17] reported a mean correction loss of 2.1° in patients treated with short-segment instrumentation including fracture-level screws, whereas the present long-segment cohort demonstrated a slightly smaller loss of correction. Although this difference is modest, it may reflect the greater biomechanical stability of longer constructs, which distribute loads across additional motion segments and reduce stress concentration at the fractured vertebra.[7]

With respect to health-related quality of life, previous Turkish thoracolumbar trauma studies have suggested that some SF-36 domains may approach population values during recovery.[18] Using Turkish normative SF-36 data, Physical Functioning scores in the general urban population are approximately 94.7 for adults aged 18–44 years and 81.3 for those aged 45–64 years.[19] Given the mean age of our cohort, the observed physical functioning score indicates relatively favorable long-term recovery. However, the lower vitality and mental health scores suggest that psychosocial and energy-related aspects of recovery may remain affected despite low pain levels and satisfactory radiographic maintenance.[19]

Radiographic Outcomes and Construct Reliability

Radiographically, standardized posterior long-segment fixation achieved substantial early correction. The magnitude of correction observed in our cohort is comparable to that reported in prior long-segment case series and appears greater than that typically reported for short-segment constructs.[7,8,20] These findings are consistent with a recent prospective comparative study, which reported that long-segment fixation achieved similar kyphosis correction and functional outcomes as short-segment fixation, despite longer operative times and greater blood loss.[10] However, it is important to emphasize that radiographic correction does not necessarily correspond to full functional recovery, as patient-reported outcomes are influenced by multiple factors beyond sagittal alignment. Although no comparative treatment arm was included, the overall radiographic profile supports the mechanical reliability of this standardized construct in selected neurologically intact patients.

Equally important is the maintenance of correction over time. In our cohort, correction loss remained limited during follow-up and was below thresholds commonly associated with radiographic failure or clinically meaningful deterioration in previous reports.[21,22] Thus, although late loss of correction was statistically significant, its magnitude appears modest from a clinical perspective.

Within the broader literature on fixation strategy, our findings are in line with reports that long-segment constructs generally provide more durable kyphosis control and lower implant-related failure risk than short-segment fixation, albeit at the cost of greater surgical invasiveness.[7,20] Similarly, Suer et al.[23] reported improved preservation of angular parameters and lower correction loss with longer posterior con-

structs in unstable thoracolumbar junction fractures. Our results add to this literature by showing that even within a uniform long-segment construct, injury morphology continues to influence radiographic durability.

A methodological consideration inherent to this study is the use of different imaging modalities across time points: pre-operative sagittal CT for baseline measurements versus lateral radiographs for early post-operative and final follow-up assessments. The literature on this issue provides important context. Epstein et al.[24] directly compared supine CT and supine plain radiographs in 29 patients with acute thoracolumbar fractures and found a mean difference of only −1.13° (SD 3.76°) in the sagittal plane, with excellent interobserver correlation (ICC 0.91). This suggests that when patient position is the same (supine), modality-related differences are minimal. By contrast, studies comparing supine and standing positions have reported substantially larger differences: Sevin et al.[25] found that standing radiographs showed 6.2° more cervical lordosis than supine CT ($p<0.001$), whereas Zhang et al.[26] reported differences of 8.4°–10.2° for thoracic and lumbar curves when comparing standing radiographs with supine CT in adolescent idiopathic scoliosis. A systematic review by d'Astorg et al.[27] confirmed that standing radiographs exceed supine CT measurements by 11°–16° and supine MRI by 7°–11°, with excellent interobserver agreement across modalities (ICC 0.77–1.00). These findings indicate that the primary source of measurement variability is patient position (supine vs. standing) rather than imaging modality per se.

In the present study, we conducted a sensitivity analysis in a randomly selected subset of 20 patients, comparing VCA measurements on pre-operative sagittal CT and available pre-operative lateral radiographs (both obtained supine). The mean difference between the two modalities was 0.8° (95% CI −1.2° to 2.8°; $p=0.42$), which is consistent with the 1.1° difference reported by Epstein et al.[24] for supine CT versus supine radiographs in thoracolumbar fractures. This difference is also well below the 2°–4° interobserver measurement error for Cobb angle assessments and substantially smaller than the 5°–16° differences attributable to patient position.[28,29] Therefore, while the use of different imaging modalities represents a methodological limitation, the magnitude of modality-related bias in our study appears small, and the observed longitudinal changes in VCA and vertebral height likely reflect true biological remodeling and settling rather than measurement artifact. Nevertheless, future prospective studies should ideally use the same imaging modality (preferably standing lateral radiographs) across all time points to eliminate this potential confounder.

This imaging workflow (pre-operative CT for fracture characterization and lateral radiographs for longitudinal follow-up) has been used in previously published thoracolumbar fracture studies, including Öztürk et al.[17] and Suer et al.[23] This consistency with prior published work provides methodological context but does not eliminate the inherent limitation of cross-modality comparison, which we acknowledge in the limitations section.

Interpretation of AO Fracture Type Findings

As expected, AO type B and C fractures had greater pre-operative kyphosis than type A fractures. However, one key finding of this study is the demonstration that even after a standardized, mechanically robust long-segment construct, AO type remained independently associated with long-term correction loss and multiple domains of patient-reported quality of life, particularly physical functioning, role physical, and vitality. These findings are consistent with prior work identifying LSC score >7 and PLC injury as predictors of failure after short-segment fixation.[2] Ferreira et al.[9] recently reported that PLC injury (which corresponds to AO type B fractures) and age ≥65 years are independent predictors of instrumentation failure even in long-segment constructs. Similarly, the WFNS Spine Committee has recommended that PLC injury and significant vertebral body height loss be used to counsel patients about expected outcomes.[13] The persistence of these associations despite stable instrumentation, together with the observation that AO type C injuries receive long-segment fixation in nearly 90% of cases, suggests that fracture morphology remains clinically relevant and is not fully mitigated by construct choice.[30] Our results are consistent with these recommendations and further show that AO type B and C injuries are associated not only with radiographic deterioration but also with deficits in multiple SF-36 domains.

Injury Severity, Load Sharing, and AO Classification

A central finding of this study is the association between injury severity and radiographic outcome. After adjustment, AO type B and particularly AO type C fractures were associated with greater VCA loss, poorer maintenance of vertebral height, and worse final alignment. This is biologically plausible because more severe injuries involve greater instability, disruption of load sharing, and a higher tendency toward progressive settling despite posterior instrumentation.[2,31] McCormack et al.[32] originally proposed the LSC to predict implant failure after posterior instrumentation, with scores >6 indicating higher risk. Although we did not calculate LSC scores, the AO classification's increasing severity from type A to C parallels the LSC's assessment of comminution and instability. This relationship is further supported by Radcliff et al.,[33] who demonstrated that PLC injury, a defining feature of AO type B fractures, correlates independently with greater loss of vertebral body height, increased kyphosis, and more severe canal compromise, regardless of neurological status.

The pattern observed in AO type C fractures is especially notable. These fractures showed both greater initial deformity and greater correction loss over time. In addition, AO type C injuries are characterized by disruption of both anterior and posterior stabilizing elements together with rotational instability, which may explain why even a well-applied

posterior construct does not fully offset the biomechanical consequences of the initial trauma.[31] This interpretation is also consistent with the broader concept of load sharing in thoracolumbar fractures.[2]

Our findings are in line with the literature linking greater structural severity to mechanical failure and correction loss after posterior fixation. Javadnia et al.[2] identified high structural severity, particularly greater load-sharing burden, as an important predictor of failure in short-segment instrumentation. In their systematic review, pooled analysis showed that patients with PSSI failure had significantly higher LSC scores (mean difference 1.38), pre-operative Cobb angle (mean difference 5.9°), and vertebral wedge angle (mean difference 3.86°). Although the LSC was not calculated in the present cohort, the AO classification captures similar aspects of instability and structural disruption. Qureshi et al.[31] likewise emphasized the importance of careful radiological assessment of fracture severity and load-sharing characteristics in thoracolumbar trauma. Together, these observations suggest that construct choice alone does not fully negate the clinical relevance of fracture morphology.

Complication Profile and Reliability of Measurements

The complication profile was also favorable. Using predefined criteria, no implant failure, screw loosening/breakage, revision surgery, PJK, or adjacent segment-related complications were observed, and the five cases of superficial wound infection resolved with local care and antibiotics without progression to deep infection. This low complication rate compares favorably with published series of both short- and long-segment fixation, where implant failure rates of 9–54% have been reported.[9,34]

The reliability of radiographic measurements is also relevant. Previous studies have shown acceptable inter- and intra-observer reliability for angular measurements in thoracolumbar trauma.[29] The excellent ICC values in the present study support the robustness of the radiographic findings and reduce the likelihood that the observed differences were primarily related to measurement variability.

Fracture-Level Screws and Technical Factors

Because fracture-level screws were used routinely in all patients, this study cannot determine the isolated incremental contribution of that component. However, previous systematic evidence, largely from short-segment studies, suggests that inclusion of intermediate screws at the fracture level may reduce correction loss and implant failure.[4,8] This may also have contributed to the favorable maintenance observed in our cohort. Supporting this, Alimohammadi et al.[35] identified lack of index-level instrumentation as an independent predictor of failure in short-segment fixation (odds ratio 2.21), and Bokov et al.[11] recently demonstrated that intermediate screws significantly reduce pedicle screw loosening in unstable thoracolumbar injuries.

In our analysis, screw diameter (5.5 mm vs. 6.5 mm) was not associated with any radiographic or clinical outcome, indicating that within the range of diameters used, this technical factor did not influence the results. This clinical finding is supported by biomechanical and clinical studies examining screw length at the fracture level. Hirano et al.[36] demonstrated that the pedicle itself contributes approximately 80% of screw stiffness and 60% of pullout strength, suggesting that additional depth into the vertebral body adds little to overall construct rigidity. Weinstein et al.[37] similarly emphasized that anatomic purchase within the pedicle is the primary determinant of screw stability. Kose et al.[38] reported that cantilever reduction with a fracture-level screw effectively restores alignment, but cautioned that excessively long screws may displace anterior fragments in comminuted fractures.

In a clinical comparison of short versus long-segment constructs with intermediate screws, Suer et al.[23] found that longer constructs provided better maintenance of correction, but did not identify screw length as an independent predictor. A prospective randomized trial by Arumugam et al.[39] evaluated 66 patients with unstable thoracolumbar fractures (LSC ≥7) and found that although long intermediate screws provided better immediate kyphosis correction, final outcomes at 2 years were equivalent. Similarly, Perna et al.,[40] in a retrospective cohort of 105 patients with AO spine A3–A4 fractures, reported no significant differences in radiographic alignment or functional outcomes at 12 months when comparing intermediate screw penetration depth <50% versus ≥50%.

Taken together with our finding that screw diameter did not affect outcomes, these studies suggest that when a standardized long-segment construct with fracture-level screws is used, screw length and diameter may be less critical than construct length or fracture morphology. Our own retrospective cohort demonstrated that AO fracture type, not screw dimensions, was the most consistent factor associated with correction loss and patient-reported outcomes.

Pain, Patient-Reported Outcomes, and Residual Deficits

Pain outcomes were favorable overall, with very low final VAS scores and no patient reporting severe residual pain. However, SF-36 scores showed broader variability, and AO fracture severity again emerged as the most consistent factor associated with outcomes across multiple domains. This suggests that long-term recovery after thoracolumbar trauma cannot be fully characterized by pain scores alone. Even with low pain levels and acceptable radiographic maintenance, patients with more severe injuries may continue to experience limitations in function, vitality, social participation, and mental well-being.

The adjusted R2 values of the SF-36 models indicate that a meaningful proportion of the variability in patient-reported outcomes remained unexplained. This likely reflects the multifactorial nature of recovery after thoracolumbar trauma. Psychological factors, coping strategies, occupational de-

mands, rehabilitation adherence, socioeconomic status, and pre-injury function may all contribute to long-term outcomes but were not available in this retrospective design. Briem et al.[41] also emphasized the role of psychosocial and support-related factors in quality of life after thoracolumbar burst fractures, and our results are consistent with that perspective.

These findings also reinforce an important point: radiographic success does not necessarily translate into complete functional normalization. Previous SF-36-based studies have reported persistent deficits in quality of life despite radiographic healing.[41] In a landmark randomized trial, Wood et al.[42,43] found that although surgical treatment provided better radiographic alignment than non-operative care, long-term patient-reported outcomes (including SF-36) were similar between groups, underscoring that radiographic measures alone are insufficient to capture full recovery. In addition, recent systematic evidence in neurologically intact thoracolumbar burst fractures suggests that surgical treatment may improve radiographic alignment without consistently producing superior long-term patient-reported outcomes compared with non-operative care.[44] This underscores the importance of including patient-centered endpoints alongside radiographic measures. It should also be recalled that VAS and SF-36 scores were assessed only at final follow-up and therefore represent cross-sectional health status rather than improvement from pre-operative levels.

Level- and Mechanism-Specific Associations

Beyond fracture morphology, some level- and mechanism-specific associations were observed. These findings should be interpreted cautiously, but they may reflect the distinctive biomechanical behavior of the thoracolumbar junction. The T11 region lies within the transition from the rib-stabilized thoracic spine to the more mobile lumbar spine, whereas L2 is exposed to different loading conditions related to lumbar sagittal motion and load transfer.[45,46] Such regional biomechanical differences may partly explain why some fracture levels showed less favorable pain or vitality profiles. This may be particularly relevant in physically demanding patients, in whom repetitive loading could magnify subtle residual symptoms.[47]

At the same time, the magnitude of the observed level-related pain differences was small and remained below commonly accepted minimal clinically important difference thresholds for spine-related VAS outcomes.[48,49] Accordingly, these findings are best interpreted as statistically detectable but clinically modest. Even so, such differences may still be relevant in selected high-demand patients, including laborers and athletes, who expose the spine to repetitive stress during recovery.[47]

Clinical Implications and Need for External Validation

From a clinical perspective, the present findings suggest that posterior long-segment instrumentation is a reliable option for neurologically intact thoracolumbar junction fractures, providing substantial early correction with generally limited long-term loss of alignment. At the same time, fracture morphology remained an important determinant of both maintenance of correction and patient-reported recovery. In particular, patients with AO type B and especially AO type C injuries may be at greater risk for correction loss and less favorable long-term quality-of-life outcomes. These hypothesis-generating observations are consistent with the WFNS Spine Committee recommendations, which advise that patients with PLC injury and significant VBH loss should be counseled about worse expected outcomes.[13] They may be useful for pre-operative counseling, follow-up planning, and setting post-operative expectations, but they should be confirmed in prospective, external cohorts before being used as definitive prognostic tools.[15]

Limitations

This study has several limitations, some of which are inherent to its retrospective design and have been addressed through additional analyses and cautious interpretation.

First, selection bias is a major concern. The exclusion of patients with neurological deficits, decompressive procedures, or follow-up shorter than 24 months resulted in a highly selected cohort that represents only a subset of our institutional thoracolumbar trauma population. Therefore, the findings are primarily generalizable to neurologically intact, compliant patients with complete radiographic follow-up and should not be extrapolated to more complex injury patterns, patients with neurological impairment, or those managed non-operatively. This selection, however, allowed us to isolate the effect of fracture morphology without confounding by neurological status – an issue identified in prior systematic reviews.[2]

Second, the use of different imaging modalities across time points (pre-operative CT vs. follow-up lateral radiographs) may have introduced measurement variability. In a sensitivity analysis of 20 patients, the mean difference between modalities was 0.8°, suggesting a limited but non-negligible degree of variation. This limitation should therefore be considered when interpreting the absolute values of longitudinal changes. It is also worth noting that this imaging workflow, pre-operative CT for fracture characterization and lateral radiographs for longitudinal follow-up, reflects routine clinical practice and has also been used in previously published studies on thoracolumbar fractures.[17,23] However, this does not eliminate the methodological limitation inherent to cross-modality comparison.

Third, patient-reported outcomes (VAS and SF-36) were assessed only at final follow-up, representing cross-sectional final health status rather than change from pre-operative status. We cannot determine the magnitude of improvement attributable to surgery or the pre-operative baseline quality of life.

Fourth, the absence of a comparative group (e.g., short-segment fixation and non-operative treatment) precludes conclusions regarding the relative superiority of this specific

construct. Our findings should be interpreted as descriptive of outcomes with this technique rather than as evidence of comparative effectiveness.

Fifth, the number of AO type C fractures was limited (n=9), which may have reduced the precision of subgroup estimates and increased the risk of Type II error for some analyses. The findings for type C fractures should be considered exploratory. Therefore, the observed associations involving AO type C fractures require replication in larger, adequately powered cohorts before any firm conclusions can be drawn.

Sixth, multiple statistical comparisons were performed across several radiographic parameters and eight SF-36 domains. While we did not apply formal multiplicity correction to avoid overly conservative Type II error, associations with p-values between 0.01 and 0.05 should be interpreted cautiously as hypothesis-generating rather than definitive.

Seventh, data on screw length and distance from screw tip to anterior vertebral cortex were not reliably available in this retrospective cohort, precluding analysis of these technical factors. Future prospective studies should examine these parameters.

Eighth, return-to-work status, rehabilitation adherence, and longitudinal functional recovery were not analyzed in detail, limiting the assessment of broader functional outcomes.

Finally, the single-center design may limit external validity, and unmeasured confounders (e.g., psychological factors, socioeconomic status, pre-injury activity level) may have influenced the observed associations.

CONCLUSION

In this selected cohort of neurologically intact T11–L2 fractures, standardized posterior long-segment fixation with routine fracture-level screws was associated with substantial early radiographic restoration, generally limited long-term loss of alignment, and low final pain levels. Nevertheless, radiographic correction did not necessarily translate into complete functional recovery, as reflected by persistent variability in SF-36 domains despite satisfactory sagittal alignment. Among the variables examined, AO fracture type showed the most consistent association with correction loss and patient-reported outcomes. These hypothesis-generating findings suggest that fracture morphology may help frame post-operative expectations and follow-up discussions. However, confirmation in larger, prospective, and comparative studies is required.

Ethics Committee Approval: This study was approved by the Ethical approval was granted by the Ege University Medical Research Ethics Committee (Date: 05.03.2026, Decision No: 26-3T/1).

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REFERENCES

1. Hughes H, Carthy AM, Sheridan GA, Donnell JM, Doyle F, Butler J. Thoracolumbar burst fractures: a systematic review and meta-analysis comparing posterior-only instrumentation versus combined anterior-posterior instrumentation. Spine (Phila Pa 1976) 2021;46:E840–E9. [CrossRef]
2. Javadnia P, Ramazani Y, Moradinazar M, Salimi N, Moradi S, Alimohammadi E. Predictors of failure in posterior short segment instrumentation for thoracolumbar burst fractures: a systematic review and meta-analysis. J Orthop Surg Res 2025;20:736. [CrossRef]
3. Rajasekaran S, Kanna RM, Shetty AP. Management of thoracolumbar spine trauma: An overview. Indian J Orthop 2015;49:72–82. [CrossRef]
4. Dobran M, Nasi D, Brunozzi D, di Somma L, Gladi M, Iacoangeli M, et al. Treatment of unstable thoracolumbar junction fractures: short-segment pedicle fixation with inclusion of the fracture level versus long-segment instrumentation. Acta Neurochir (Wien) 2016;158:1883–9. [CrossRef]
5. Mittal S, Ifthekar S, Ahuja K, Sarkar B, Singh G, Rana A, et al. Outcomes of thoracolumbar fracture-dislocation managed by short-segment and long-segment posterior fixation: a single-center retrospective study. Int J Spine Surg 2021;15:55-61. [CrossRef]
6. Basaran R, Efendioglu M, Kaksi M, Celik T, Mutlu İ, Ucar M. Finite element analysis of short- versus long-segment posterior fixation for thoracolumbar burst fracture. World Neurosurg 2019;128:e1109–e17. [CrossRef]
7. Yu D, Zhang Y, Li X, Wang W, Li Z, Xiao J. Efficacy and safety of posterior short-segment versus long-segment pedicle screws fixation for thoracolumbar burst fractures: A systematic review and meta-analysis. Medicine (Baltimore) 2025;104:e42699. [CrossRef]
8. Kapoen C, Liu Y, Bloemers FW, Deunk J. Pedicle screw fixation of thoracolumbar fractures: conventional short segment versus short segment with intermediate screws at the fracture level-a systematic review and meta-analysis. Eur Spine J 2020;29:2491–504. [CrossRef]
9. Ferreira D, Cruz A, Vilela A, Azevedo J, Santos Moreira A, et al. Thoracolumbar fractures: Factors predicting failure of percutaneous short- and long-segment posterior fixation. Brain Spine 2024;5:104151. [CrossRef]
10. Ramkumar MSD, Vinodh J B, Raghuraman T, Chandhuru AK. A comparative analysis of the management of thoracolumbar burst fractures: short-segment posterior stabilization versus long-segment posterior instrumentation. Folia Med (Plovdiv) 2025;67(6). [CrossRef]
11. Bokov AE, Kalinina SY, Kulagina DA, Lopyrina KS, Klinshov VV, Bulkin AA. Factors that influence long term instrumentation stability in patients with unstable thoracolumbar injuries. World J Orthop 2025;16:108161. [CrossRef]
12. Vaccaro AR, Oner C, Kepler CK, Dvorak M, Schnake K, Bellabarba C,

et al. AOSpine thoracolumbar spine injury classification system: fracture description, neurological status, and key modifiers. Spine (Phila Pa 1976) 2013;38:2028–37. [CrossRef]
13. Costa F, Sharif S, Bajamal AH, Shaikh Y, Anania CD, Zileli M. Clinical and radiological factors affecting thoracolumbar fractures outcome: WFNS Spine committee recommendations. Neurospine 2021;18:693–703. [CrossRef]
14. Süer O, Kılıçlı B, Aydemir S, Öztürk AM, Akçalı Ö. Intermediate screw placement improves initial radiographic alignment but not clinical outcomes following long-segment fixation for thoracolumbar fractures. Ulus Travma Acil Cerrahi Derg 2026;32:843–53.
15. Koçyiğit H, Aydemir Ö, Fişek G, Ölmez N, Memiş A. Kısa Form 36 KF 36 nın Türkçe versiyonunun güvenilirliği ve geçerliliği. İlaç ve Tedavi Derg 1999;12:102–6. [Article in Turkish]
16. Ware JE Jr, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. Med Care 1992;30:473–83. [CrossRef]
17. Öztürk AM, Süer O, Aydemir S, Kılıçlı B, Akçalı Ö. The effect of the size of pedicle screw on the long-term radiological and clinical results of short-segment posterior instrumentation in the management of thoracolumbar vertebral fractures. Acta Orthop Traumatol Turc 2024;58:20–6. [CrossRef]
18. Kaymaz B. Treatment of thoracolumbar burst fractures using combined pedicle screw-laminar hook fixation. ACTA Orthop Traumatol Turc 2014;48:152–6. [CrossRef]
19. Demiral Y, Ergor G, Unal B, Semin S, Akvardar Y, Kivircik B, et al. Normative data and discriminative properties of short form 36 (SF-36) in Turkish urban population. BMC Public Health 2006;6:247. [CrossRef]
20. Sapkas G, Kateros K, Papadakis SA, Brilakis E, Macheras G, Katonis P. Treatment of unstable thoracolumbar burst fractures by indirect reduction and posterior stabilization: short-segment versus long-segment stabilization. Open Orthop J 2010;4:7–13. [CrossRef]
21. Kim BG, Dan JM, Shin DE. Treatment of thoracolumbar fracture. Asian Spine J 2015;9:133–46. [CrossRef]
22. Serin E, Karakurt L, Yilmaz E GH. Effects of the different posterior fixation techniques on correction and stabilization of the unstable thoracolumbar vertebral fractures: A clinical study. J Turkish Spinal Surg 2002;1:1–8.
23. Suer O, Aydemir S, Kilicli B, Akcali O, Ozturk AM. Should the level of the posterior instrumentation combined with the intermediate screw be a short segment or a long segment in thoracolumbar fractures with fusion to the fractured segment? Eur J Trauma Emerg Surg 2024;50:1753–63. [CrossRef]
24. Epstein O, Ludwig S, Gelb D, Poelstra K, O'Brien J. Comparison of computed tomography and plain radiography in assessing traumatic spinal deformity. J Spinal Disord Tech 2009;22:197–201. [CrossRef]
25. Sevin IE, Bozdag S, Erisken E, Sucu HK. Comparison of radiography with computed tomography and magnetic resonance imaging in the measurement of cervical lordosis. Medicina (B Aires) 2025;61:1654. [CrossRef]
26. Zhang M, Chen W, Wang S, Lei S, Liu Y, Zhang J, et al. Clinical validation of the differences between two-dimensional radiography and three-dimensional computed tomography image measurements of the spine in adolescent idiopathic scoliosis. World Neurosurg 2022;165:e689–e96. [CrossRef]
27. d'Astorg H, Bourret S, Ramos-Pascual S, Szadkowski M, Le Huec JC. Comparison of Cobb angle measurements for scoliosis assessment using different imaging modalities: a systematic review. EFORT Open Rev 2023;8:489–98. [CrossRef]
28. Morrissy RT, Goldsmith GS, Hall EC, Kehl D, Cowie GH. Measurement of the Cobb angle on radiographs of patients who have scoliosis. Evaluation of intrinsic error. J Bone Joint Surg Am 1990;72:320–7. [CrossRef]
29. Ulmar B, Gühring M, Schmälzle T, Weise K, Badke A, Brunner A. Inter- and intra-observer reliability of the Cobb angle in the measurement of vertebral, local and segmental kyphosis of traumatic lumbar spine fractures in the lateral X-ray. Arch Orthop Trauma Surg 2010;130:1533–8. [CrossRef]
30. Cabrera JP, Guiroy A, Carazzo CA, Yurac R, Valacco M, Vialle E, et al. Unstable thoracolumbar injuries: factors affecting the decision for short-segment vs long-segment posterior fixation. Int J Spine Surg 2022;16:772-8. [CrossRef]
31. Qureshi S, Dhall SS, Anderson PA, Arnold PM, Chi JH, Dailey AT, et al. congress of neurological surgeons systematic review and evidence-based guidelines on the evaluation and treatment of patients with thoracolumbar spine trauma: radiological evaluation. Neurosurgery 2019;84:E28-31. [CrossRef]
32. McCormack T, Karaikovic E, Gaines RW. The Load Sharing Classification of Spine Fractures. Spine (Phila Pa 1976) 1994;19:1741–4. [CrossRef]
33. Radcliff K, Su BW, Kepler CK, Rubin T, Shimer AL, Rihn JA, et al. Correlation of posterior ligamentous complex injury and neurological injury to loss of vertebral body height, kyphosis, and canal compromise. Spine (Phila Pa 1976) 2012;37:1142–50. [CrossRef]
34. Sodhi HBS, Savardekar AR, Chauhan RB, Patra DP, Singla N, Salunke P. Factors predicting long-term outcome after short-segment posterior fixation for traumatic thoracolumbar fractures. Surg Neurol Int 2017;8:233. [CrossRef]
35. Alimohammadi E, Bagheri SR, Joseph B, Sharifi H, Shokri B, et al. Analysis of factors associated with the failure of treatment in thoracolumbar burst fractures treated with short-segment posterior spinal fixation. J Orthop Surg Res 2023;18:690. [CrossRef]
36. Hirano T, Hasegawa K, Takahashi HE, Uchiyama S, Hara T, Washio T, et al. Structural characteristics of the pedicle and its role in screw stability. Spine (Phila Pa 1976) 1997;22:2504–9; discussion 2510. [CrossRef]
37. Weinstein JN, Rydevik BL, Rauschning W. Anatomic and technical considerations of pedicle screw fixation. Clin Orthop Relat Res 1992:34–46. [CrossRef]
38. Kose KC, Inanmaz ME, Isik C, Basar H, Caliskan I, Bal E. Short segment pedicle screw instrumentation with an index level screw and cantilevered hyperlordotic reduction in the treatment of type-A fractures of the thoracolumbar spine. Bone Joint J 2014;96-B(4):541–7. [CrossRef]
39. Arumugam T, Ramachandran K, Shetty AP, Kanna RM, Rajasekaran S. Does the length of the intermediate pedicle screw influence outcome in unstable thoracolumbar burst fractures? A prospective randomized study in India. Asian Spine J 2025;19:784-93. [CrossRef]
40. Perna A, Franchini A, Ricciardi L, Maruccia F, Macchiarola L, Barletta F, et al. Does size matter? Evaluating the impact of intermediate screw length in short-segment fixation of thoracolumbar a3-a4 fractures. J Clin Med 2026;15:2221. [CrossRef]
41. Briem D, Lehmann W, Ruecker AH, Windolf J, Rueger JM, Linhart W. Factors influencing the quality of life after burst fractures of the thoracolumbar transition. Arch Orthop Trauma Surg 2004;124:461–8. [CrossRef]
42. Wood KB, Buttermann GR, Phukan R, Harrod CC, Mehbod A, Shannon B, et al. Operative compared with nonoperative treatment of a thoracolumbar burst fracture without neurological deficit: a prospective randomized study with follow-up at sixteen to twenty-two years. J Bone Joint Surg Am 2015;97:3–9. [CrossRef]
43. Wood K, Buttermann G, Mehbod A, Garvey T, Jhanjee R, Sechriest V. Operative compared with nonoperative treatment of a thoracolumbar burst fracture without neurological deficit. A prospective, randomized study. J Bone Joint Surg Am 2003;85:773–81. [CrossRef]
44. Chou TY, Tsuang FY, Hsu YL, Chai CL. Surgical versus non-surgical

treatment for thoracolumbar burst fractures without neurological deficit: a systematic review and meta-analysis. Global Spine J 2024;14:740–49. [CrossRef]

45. Fernández-de Thomas RJ, De Jesus O. Thoracolumbar spine fractures. Treasure Island (FL): StatPearls Publishing; 2025.
46. Wang W, Pei B, Wu S, Lu D, He P, Ma C, Wu X. Biomechanical responses of human lumbar spine and pelvis according to the Roussouly classification. PLoS One 2022;17:e0266954. [CrossRef]
47. Durmaz MO, Ezgü MC, Evleksiz Karımzada D, Karımzada G. Management of thoracolumbar fractures: clinical, functional, and radiological outcomes in a single institution. J Turkish Spinal Surg 2023;34:124–30. [CrossRef]
48. Copay AG, Glassman SD, Subach BR, Berven S, Schuler TC, Carreon LY. Minimum clinically important difference in lumbar spine surgery patients: a choice of methods using the Oswestry Disability Index, Medical Outcomes Study questionnaire Short Form 36, and pain scales. Spine J 2008;8:968–74. [CrossRef]
49. Parker SL, Mendenhall SK, Shau DN, Adogwa O, Anderson WN, Devin CJ, et al. Minimum clinically important difference in pain, disability, and quality of life after neural decompression and fusion for same-level recurrent lumbar stenosis: understanding clinical versus statistical significance. J Neurosurg Spine 2012;16:471–8. [CrossRef]

ORİJİNAL ÇALIŞMA - *ÖZ*

Nörolojik olarak intakt torakolomber kırıklarda posterior uzun segment enstrümantasyon sonrası radyografik ve klinik sonuçlarla ilişkili faktörler: Tek merkezli retrospektif bir çalışma

AMAÇ: Bu çalışmanın amacı, nörolojik olarak intakt travmatik torakolomber bileşke kırıklarında standartlaştırılmış posterior uzun segment fiksasyon sonrası radyografik düzeltme miktarını ve bu düzeltmenin uzun dönemde korunmasını nicel olarak değerlendirmek, ağrı ve sağlıkla ilişkili yaşam kalitesini incelemek ve sonuçlarla ilişkili faktörleri belirlemektir.

GEREÇ VE YÖNTEM: Bu tek merkezli retrospektif kohort çalışmasına, Mart 2014 ile Şubat 2023 tarihleri arasında dekompresyon yapılmaksızın posterior uzun segment pedikül vida enstrümantasyonu (kırık seviyesine vida yerleştirilmesini de içerecek şekilde, 2 seviye üstü ve 2 seviye altı) ile tedavi edilen, akut travmatik T11–L2 kırığı olan erişkin hastalar ardışık olarak dahil edildi. Hastaların en az 24 aylık radyografik takiplerinin bulunması ve preoperatif sagittal BT görüntülerinin yanı sıra erken postoperatif ve son kontrole ait lateral grafilerinin mevcut olması gerekiyordu. Görüntüleme parametreleri vertebral kompresyon açısı (VCA) ile anterior/posterior vertebra korpus yüksekliği (VCH-A/VCH-P) idi. Klinik sonuç ölçütleri ise son kontroldeki Görsel Analog Skala (VAS) ve SF-36 skorlarıydı ve bu skorlar, preoperatif döneme göre değişimi değil, kesitsel olarak son durumdaki sağlık durumunu yansıtmaktaydı. Boylamsal görüntüleme değişiklikleri için eşleştirilmiş karşılaştırmalar kullanıldı; son sonuçlarla ilişkili faktörleri değerlendirmek amacıyla robust standart hatalarla çok değişkenli lineer regresyon analizi yapıldı.

BULGULAR: Toplam 78 hasta çalışmaya dahil edildi (ortalama yaş 40.2±13.9 yıl; %65.4 erkek) ve medyan takip süresi 48 aydı. VCA, preoperatif dönemde 11.75° (7.83–16.48) iken erken postoperatif dönemde 4.30°'ye (2.55–6.65) geriledi ve son kontrolde 6.00° (4.00–8.80) olarak bulundu; bu durum, zaman içinde sınırlı düzeyde düzeltme kaybına işaret etti. Hem anterior hem de posterior vertebra korpus yüksekliğinde düzelme gözlendi, ancak son kontrolde kısmi kayıp mevcuttu. Son ağrı düzeyleri düşüktü (VAS 1 [IQR 1–1]). Düzeltilmiş analizlerde, AO kırık tipi daha fazla VCA kaybı ve SF-36'nın çeşitli alt boyutlarında daha kötü skorlarla ilişkili bulundu; bu ilişki özellikle AO tip C kırıklarda belirgindi, ancak tip C kırık sayısının sınırlı olduğu (n=9) unutulmamalıdır. Yüzeyel yara enfeksiyonu 5 hastada (%6.4) görüldü ve lokal bakım ile antibiyotik tedavisi sonrasında düzeldi; derin enfeksiyon, implant yetmezliği, revizyon cerrahisi veya junctional komplikasyon izlenmedi.

SONUÇ: Nörolojik olarak intakt T11–L2 kırıklarında posterior uzun segment fiksasyon, anlamlı erken dönem radyografik düzeltme, genel olarak sınırlı uzun dönem hizalanma kaybı ve düşük son ağrı düzeyleri ile ilişkili bulunmuştur. Bununla birlikte, radyografik düzeltme, SF-36 alanlarındaki kalıcı değişkenlikten de anlaşılacağı üzere, mutlaka tam fonksiyonel iyileşme anlamına gelmemektedir. İncelenen değişkenler arasında AO kırık tipi, düzeltme kaybı ve hasta tarafından bildirilen sonuçlarla en tutarlı ilişkiyi gösteren faktör olmuştur. Bu hipotez üreten bulgular, kırık morfolojisinin sonuçlarla ilişkili olabileceğini ve benzer hasta popülasyonlarında postoperatif beklentilerin ve takip planlamasının çerçevelenmesine katkı sağlayabileceğini düşündürmektedir. Ancak bu bulguların daha büyük, ileriye dönük ve karşılaştırmalı çalışmalarla doğrulanması gerekmektedir.

Anahtar sözcükler: AO Spine sınıflaması; posterior uzun segment enstrümantasyon; radyografik düzeltme kaybı; sf-36; torakolomber kırık; vertebral kompresyon açısı.

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