

Predictive Markers in Decision-Making for Screwing the Fractured Thoracolumbar Vertebra in the Short-Segment Instrumentation

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Abstract:

Introduction: In this study, it is aimed to compare the long-term results of patients with short-segment instrumentation where screws were inserted into the fractured vertebra with those of patients with long-segment instrumentation applied by skipping the fractured vertebra and reveal the predictive markers in decision-making for screwing fractured vertebra.

Methods: Patients were separated into two groups, namely, Group A (patients in which the fractured vertebra and vertebrae above and below the fractured vertebra were screwed (short-segment instrumentation, n=22) and Group B (patients in whom the fractured vertebra was not screwed, whereas two vertebrae above and below the fractured vertebra were screwed (long-segment instrumentation, n=27)).

Results: The presence of pedicle fracture, AOSpine Classification Scale score, the height of the fractured vertebra, vertebra height below the fractured vertebra, spinal canal diameter, and duration of stay in hospital were different between the groups, preoperatively ($p<0.05$). Fractured vertebra height, vertebra height below the fractured vertebra, and Karnofsky Performance Scale score were different between the groups in long-term follow-up ($p<0.05$). The preoperative measurement values were similar to each group's postoperative long-term follow-up results. *Logistic regression* analysis revealed that the presence of pedicle fracture, AOSpine Classification Scale score, vertebra height below the fractured vertebra, and spinal canal diameter could be the best parameters in decision-making for screwing fractured vertebra ($p<0.05$).

Conclusions: Both instrumentation procedures were observed to have similar effectiveness in preventing a collapse in fractured vertebra during long-term follow-up. It was thought that the AOSpine Classification Scale score, presence of pedicle fracture, vertebra height below the fractured vertebra, and spinal canal diameter could be used as predictive markers in decision-making for screwing fractured vertebrae. Consequently, it was concluded that patients with pedicle fractures, more height loss in the vertebra below the fractured vertebra, and narrow spinal canal would not be suitable for screwing the fractured vertebra.

Keywords:

thoracolumbar, vertebra fracture, instrumentation, outcome

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Introduction

The aims of thoracolumbar vertebra burst fracture treatment including anterior, posterior, and combined surgical approaches include restoring vertebral column stability and preventing deformity, providing neural canal decompression, and early mobilization¹⁻³.

Spine surgeons have mostly preferred a posterior approach to perform short- or long-segment instrumentation because this method can be easily applied, produces less bleeding, and requires a small incision area⁴⁻⁶. However, de-

spite the advantages of long-segment instrumentation, including tighter fixation and better canal healing, it can result in an immobile spine since more segments are being fixed⁷⁻⁹. To solve this problem, spine surgeons have increasingly started to use short-segment instrumentation with screwing of the fractured vertebra; the advantages of this method, such as mobile segment preservation, kyphosis angle reduction, and anterior vertebral collapse prevention, have been reported^{3,7,10-13}. Furthermore, screws that are inserted into the fractured vertebra can provide a mass effect and prevent vertebral collapse⁸.

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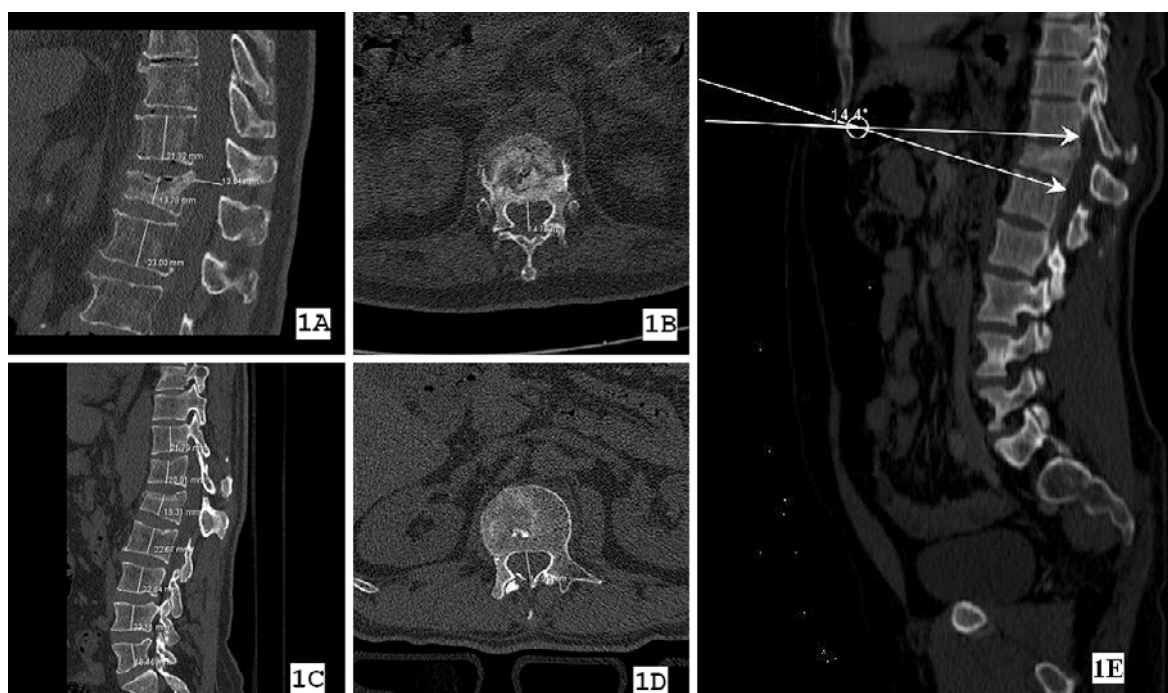


Figure 1. Measurement techniques of vertebral heights and spinal canal diameters are seen on the sagittal and axial CT images of patients with A2 score (1A, 1B) and A3 score (1C, 1D) according to the AOSpine Classification scale and measurement method of the angulation degree of the segment of the fractured vertebra on the sagittal CT image (1E).

Unfortunately, the selection of treatment modalities including either short- or long-segment instrumentations remains controversial^[12,13]. Additionally, no study has been found in the literature that focuses on the determination of the parameters/markers for the prediction of the successful application of this new method to patients with thoracolumbar fracture.

This clinical study was conducted both to compare the long-term results in patients with short-segment instrumentation where screws were inserted into the fractured vertebra with those in patients with long-segment instrumentation applied by skipping the fractured vertebra and to reveal the predictive markers in decision-making for screwing the fractured vertebra.

Materials and Methods

This research was approved by the Institutional Review Board of the authors' affiliated institution.

Patients

This retrospective study included patients who were operated on for T12, L1, or L2 spine fractures due to osteoporotic or high-energy trauma such as falling from a height and/or traffic accident between 2014 and 2021. The patients were separated into two groups as follows:

- **Group A** (patients in whom the fractured vertebra and the vertebrae above and below the fractured vertebra were screwed (short-segment instrumentation), n=22)
- **Group B** (patients in whom the fractured vertebra was

not screwed, whereas the two vertebrae above and below the fractured vertebra were screwed (long-segment instrumentation, n=27)

Patients who had multiple vertebrae fractures, severe head trauma, severe internal organ injuries, pathological vertebrae fracture due to primary or metastatic tumor, and spinal fractures for which they had undergone multiple surgical procedures; those who were not able to be followed up; and pediatric patients (age <16-year-old) were excluded from the study.

Materials

Data of the patients included age, sex, Frankel Classification Scale score, and AOSpine Classification score, which were recorded at the time of admission to the hospital. Measurements were performed on the CT images of the patients obtained at the time of admission to the hospital, presence of the pedicle fracture, pars interarticularis fracture, pedicle diameters of the vertebrae (mm), vertebral body height loss of fractured vertebra (mm), the percentage height loss ratio of the fractured vertebra, vertebral body height loss of the vertebra below the fractured vertebra (mm), vertebral body height loss of the vertebra above the fractured vertebra (mm), the diameter of the spinal canal (mm), application of laminectomy, and angulation degree at the fractured spinal segment (Fig. 1)^[14-16]. The percentage height loss of the fractured vertebra was calculated as follows: the ratio between the height of the vertebra above the fractured vertebra and the height of the fractured vertebra. Then, the ratio between the height of the vertebra below the fractured verte-

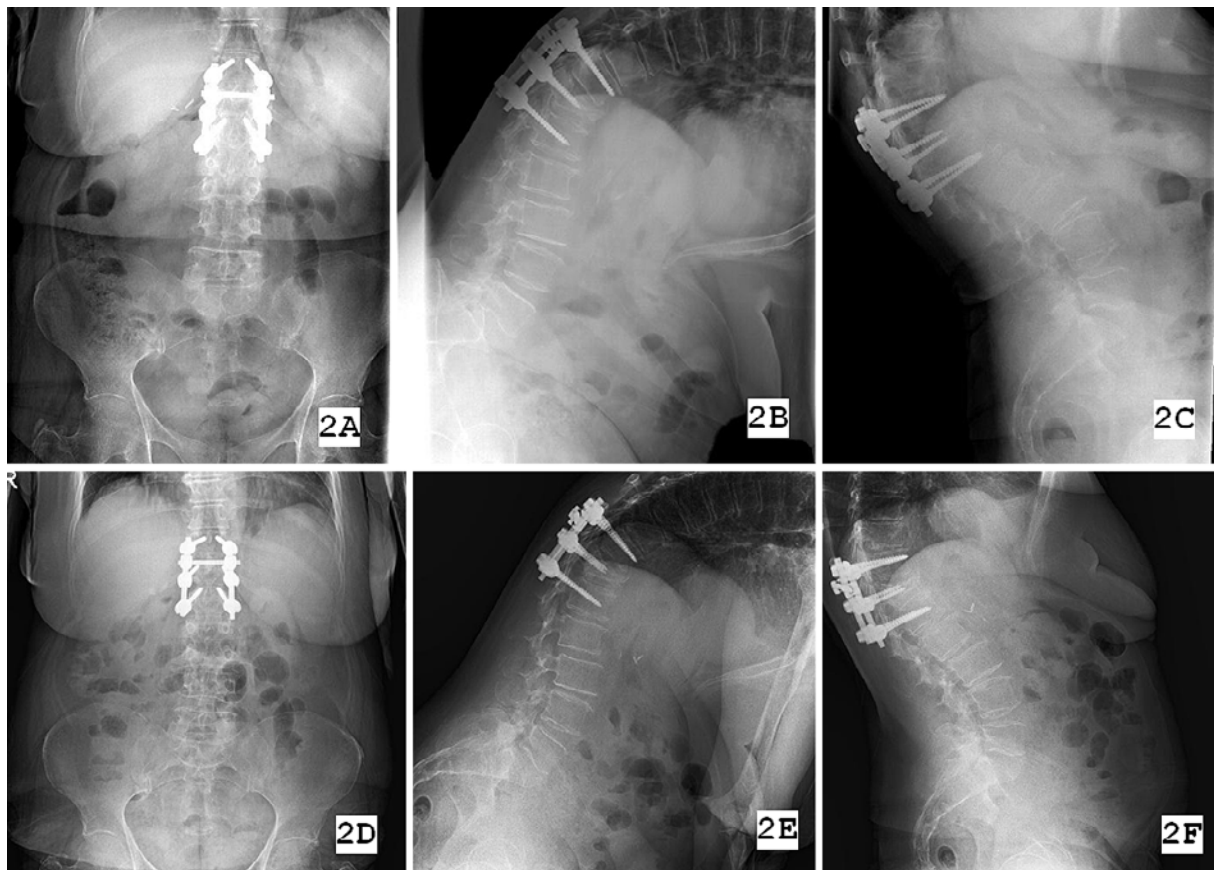


Figure 2. Dynamic X-ray images taken in standing anteroposterior, lateral extension, and lateral flexion in a patient with short-segment instrumentation applied by inserting screws into the fractured vertebra in early postoperative (2A, 2B, 2C) and long-term follow-up periods (2D, 2E, 2F).

bra and the height of the fractured vertebra was calculated. The mean height loss rate in the fractured vertebra was obtained by averaging these values, and this value was included in the study data¹⁷⁾. The diameter of the spinal canal was measured from the anterior to the posterior of the most narrowed section of the spinal canal at the level of the fractured vertebra. The angulation degree at the fractured spinal segment, which reflects kyphotic deformity was measured between the superior and inferior endplates of the fractured vertebra¹⁷⁾. The length of stay in the hospital of the patients was recorded in days.

At the final follow-up visit, the vertebral body height loss of fractured vertebra (mm), the height loss rate of the fractured vertebra (%), vertebral body height loss of the vertebra below the fractured vertebra (mm), vertebral body height loss of the vertebra above the fractured vertebra (mm), angulation degree, and spinal canal diameter (mm) were measured again on CT images. The stability and integrity of the instrumentation applied to the patients were also evaluated using dynamic X-ray images taken in standing anteroposterior, lateral extension, and lateral flexion (Fig. 2, 3). Two surgeons blinded to the patient data evaluated the radiological images of the patients. The functional outcomes of the patients were determined using the Karnofsky Performance Scale, and the duration of follow-up after discharge from the hospital (days) was recorded¹⁶⁾.

Surgical procedure

All surgical procedures were performed under general anesthesia. The patients were placed in the prone position, and the levels above and below the injured segment were exposed using a standard posterior midline approach. Then, short-segment instrumentation including lower, upper, and fractured vertebrae was performed on the patients for whom it was planned for screws to be inserted in the fractured vertebra (Fig. 2). Long-segment instrumentation including the two lower and two upper vertebrae was performed by skipping the fractured vertebra in patients who were not considered for insertion of a pedicle screw into the fractured vertebra (Fig. 3). Bilateral pedicle screws with a diameter of 4.5-6.0 mm and a thread length of 35-50 mm were placed under fluoroscopy in the fractured spine segment. Pedicle screws with the largest possible diameter were used. Ligamentotaxis was applied first with the lordotic maneuver followed by segmental distraction and thus posterior wall decompression was created by indirect reduction¹⁸⁾. Then, kyphosis was corrected by manually approximating the dorsal ends of the screws, and the system was locked with distraction. At least one cross-link was used in each patient. Standard bilateral laminectomy and foraminotomy were performed in both patient groups when CT images showed that the diameter of the spinal canal was narrowed and/or there was a bone frag-

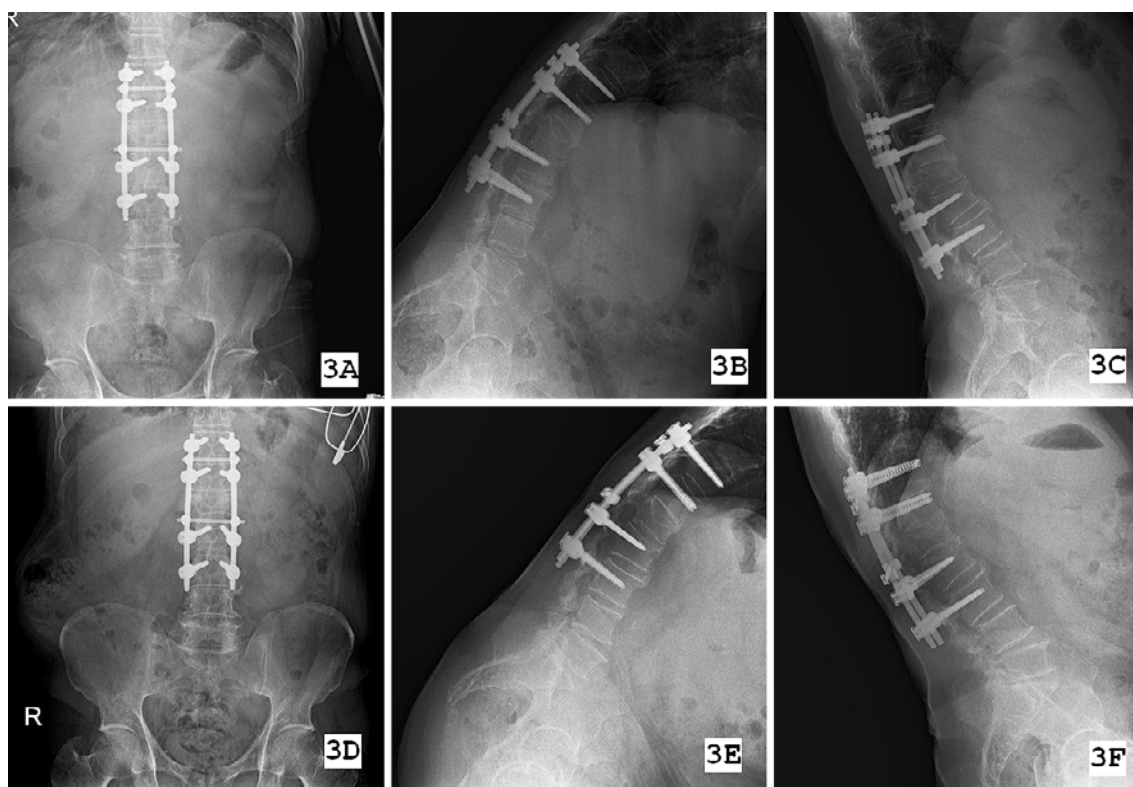


Figure 3. Dynamic X-ray images taken in standing anteroposterior, lateral extension, and lateral flexion in a patient with long-segment instrumentation implemented by skipping the fractured vertebra in early postoperative (3A, 3B, 3C) and long-term follow-up periods (3D, 3E, 3F).

ment exerting pressure on the spinal cord.

Statistical analysis

The categorical variables were analyzed using *Pearson's chi-square* test ($p < 0.05$). The parametric findings were analyzed using the *independent sample t-test* ($p < 0.05$). Non-parametric findings were analyzed using the *Mann-Whitney U* test ($p < 0.05$). To determine the significant difference between the repeated measures for each group, the *paired sample t-test* and *Wilcoxon signed-rank* test were performed ($p < 0.05$). To determine the correlation between parameters of the patients, *Spearman's rho correlation* test was employed ($p < 0.05$). The *ROC curve* test was then applied to determine predictive markers in decision-making for screwing the fractured vertebra ($p < 0.05$). Finally, the *logistic regression* test (backward Wald method) was used to determine the "best predictive parameter" in decision-making for screwing the fractured vertebra ($p < 0.05$).

Results

A total of 49 patients were included in this study. In the preoperative period, the presence of pedicle fracture ($\chi^2 = 8.468$, $p = 0.004$), AOSpine Classification Scale score ($\chi^2 = 12.405$, $p = 0.030$), the height of the fractured vertebra ($t = -2.156$, $p = 0.036$), height of the vertebra below the fractured vertebra ($t = -3.007$, $p = 0.004$), spinal canal diameter ($Z = -3.096$, $p = 0.002$), application of laminectomy ($\chi^2 = 6.566$, $p =$

0.010), and length of stay in hospital ($Z = -2.368$, $p = 0.018$) were found to be different between the two groups (Table 1, Fig. 4).

In the postoperative period, the height of the fractured vertebra ($Z = -2.121$, $p = 0.034$), the height of the vertebra below the fractured vertebra ($Z = -3.176$, $p = 0.001$), and Karnofsky Performance Scale score ($Z = -2.073$, $p = 0.038$) were different between the groups (Table 2, Fig. 4).

When the preoperative and postoperative parameters were compared for each group, it was found that the preoperative measurement values were similar to the postoperative long-term follow-up results in each group (Table 3, Fig. 4).

The correlation analysis results showed a positive correlation between screwing the fractured vertebra and the height of the fractured vertebra ($r = 0.310$, $p = 0.030$), the height of the vertebra below the fractured vertebra ($r = 0.403$, $p = 0.004$), and spinal canal diameter ($r = 0.447$, $p = 0.001$). A negative correlation was found between screwing the fractured vertebra and AOSpine Classification score ($r = -0.437$, $p = 0.002$), pedicle fracture ($r = -0.416$, $p = 0.003$), application of laminectomy ($r = -0.368$, $p = 0.010$), and length of stay in hospital ($r = -0.342$, $p = 0.016$). The AOSpine Classification Scale score negatively correlated with the pars interarticularis fracture ($r = -0.371$, $p = 0.009$) and angulation degree ($r = -0.418$, $p = 0.003$). Pedicle fracture was negatively correlated with the spinal canal diameter ($r = -0.401$, $p = 0.004$). The height of the fractured vertebra was positively correlated with the vertebra height below the fractured vertebra ($r = 0.345$, $p = 0.015$), spi-

Table 1. Preoperative Demographic, Clinical, and Radiological Findings of the Two Patient Groups in the Study.

Variable		Group A	Group B	t/Z/X ²	p
		Mean±SD/ Median (min–max)/ N (%)	Mean±SD/ Median (min–max)/ N (%)		
Age (year)		46.82±16.26	50.78±12.56	0.962*	0.341
Frankel Classification score	1	0 (0.0%)	1 (2.0%)	2.805‡	0.423
	2	0 (0.0%)	0 (0.0%)		
	3	0 (0.0%)	1 (2.0%)		
	4	2 (4.1%)	5 (10.2%)		
	5	20 (40.8%)	20 (40.8%)		
Fractured vertebra	T12	4 (8.2%)	8 (16.3%)	1.078‡	0.583
	L1	11 (22.4%)	13 (26.5%)		
	L2	7 (14.3%)	6 (12.2%)		
Pedicle fracture	No	18 (36.7%)	11 (22.4%)	8.468‡	0.004
	Yes	4 (8.2%)	16 (32.7%)		
Pars interarticularis fracture	No	21 (42.9%)	23 (46.9%)	1.395‡	0.238
	Yes	1 (2.0%)	4 (8.2%)		
AOSpine Classification	A1	4 (8.2%)	3 (6.1%)	12.405‡	0.030
	A2	1 (2.0%)	0 (0.0%)		
	A3	15 (30.6%)	9 (18.4%)		
	A4	2 (4.1%)	12 (24.5%)		
	B1	0 (0.0%)	1 (2.0%)		
	B2	0 (0.0%)	2 (4.1%)		
Height of vertebra (mm)	Upper	22.79±2.21	21.55±2.09	–2.011*	0.050
	Fractured	15.93±3.36	13.38±4.65	–2.156*	0.036
	Below	25.53±2.37	23.48±2.39	–3.007*	0.004
Height loss rate (%)		33.99±13.61	40.78±19.86	1.362*	0.180
Spinal canal diameter (mm)		11.15 (1.70-13.73)	7.88 (3.46-13.53)	–3.096†	0.002
Angulation degree		3.75 (0.5-28.1)	4.80 (0-22.5)	–0.633†	0.527
Pedicle diameter (mm)	Right	6.64±2.21	6.58±1.42	–0.110*	0.913
	Left	7.83±2.53	6.54±1.53	–2.211*	0.032
Laminectomy	No	19 (38.8%)	14 (28.6%)	6.566‡	0.010
	Yes	3 (6.1%)	13 (26.5%)		
Duration of stay in hospital (day)		4 (2–11)	7 (2–44)	–2.368†	0.018

(*) *t* value, independent sample *t*-test; (†) *Z* value, Mann–Whitney *U* test; (‡) *X*² value, Pearson's Chi-square test, *p*<0.05

(SD: standard deviation, min: minimum, max: maximum, N: number of participants, mm: millimeter)

nal canal diameter ($r=-0.309$, $p=0.031$), and negatively correlated with the height loss rate of the fractured vertebra ($r=-0.936$, $p<0.001$). The height loss rate of the fractured vertebra was positively correlated with the angulation degree ($r=0.320$, $p=0.025$), and negatively correlated with the spinal canal diameter ($r=-0.321$, $p=0.024$). The Karnofsky Performance Scale score was positively correlated with the Frankel Classification Scale score ($r=0.517$, $p<0.001$), the height loss rate of the fractured vertebra ($r=0.295$, $p=0.040$), and negatively correlated with the AOSpine Classification Scale score ($r=-0.346$, $p=0.015$).

As a result of the *ROC curve* analysis, if there was no pedicle fracture (area=0.295, $p=0.014$, sensitivity=82%, specificity=59%), the AOSpine Classification Scale score was <A4 (area=0.265, $p=0.005$, sensitivity=100%, specificity

=89%), the height of the fractured vertebra was >14.86 mm (area=0.680, $p=0.031$, sensitivity=73%, specificity=63%), the height of the vertebra below the fractured vertebra was >23.93 mm (area=0.734, $p=0.005$, sensitivity=73%, specificity=63%), and the spinal canal diameter at the fractured vertebra segment was >9.71 mm (area=0.759, $p=0.002$, sensitivity=86%, specificity=70%), it was assumed that a screw could be inserted into the fractured vertebra (Table 4, Fig. 5).

To investigate whether screwing the fractured vertebra could be predicted from the study parameters, *logistic regression* analysis was applied. Concerning the study parameters, the model that predicted screwing the fractured vertebra was found to be statistically significant ($\chi^2=29.899$, $df=4$, $p<0.001$), and the –2 log-likelihood was found to be 37.518.

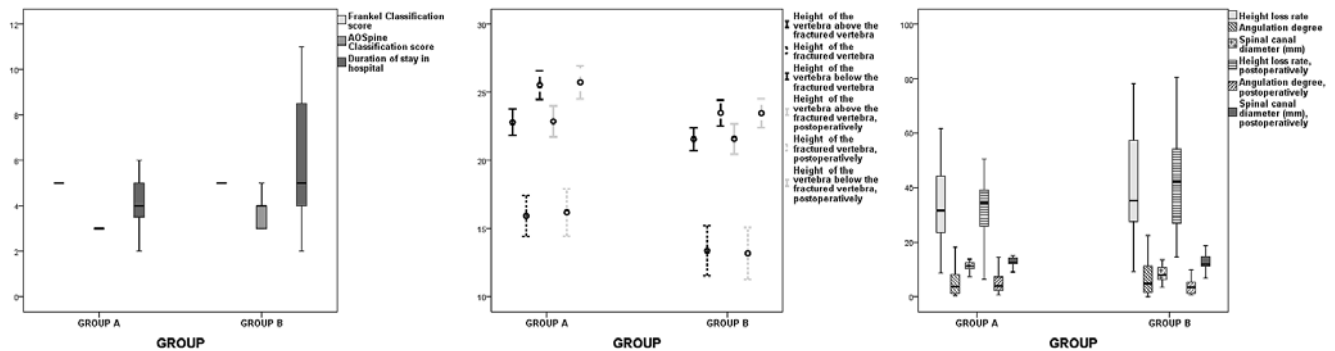


Figure 4. Preoperative period findings of the patients and postoperative long-term follow-up results.

Table 2. Clinical and Radiological Findings Obtained in the Late Postoperative Follow-up of the Two Patient Groups Included in the Study.

		Group A	Group B		
		Mean±SD/ Median (min–max)	Mean±SD/ Median (min–max)	t/Z	p
Height of vertebra (mm)	Upper	22.50 (19.04–29.91)	21.32 (16.80–31.06)	–1.880†	0.060
	Fractured	16.42 (6.74–22.27)	13.24 (4.13–21.72)	–2.121†	0.034
	Below	25.54 (20.38–32.56)	23.07 (19.30–33.05)	–3.176†	0.001
Height loss rate (%)		33.74±14.05	42.32±19.09	1.755*	0.086
Spinal canal diameter (mm)		12.76±1.84	12.76±2.81	0.004*	0.996
Angulation degree		4.00 (0.60–21.00)	3.50 (0.60–23.90)	–0.643†	0.520
Karnofsky Performance Scale score		90 (80–100)	90 (30–100)	–2.073†	0.038
Following-up time (day)		406 (102–1136)	271 (121–1306)	–1.548†	0.122

(*) *t* value, independent sample *t* test; (†) *Z* value, Mann–Whitney *U* test; *p* < 0.05

(SD: standard deviation, min: minimum, max: maximum, mm: millimeter)

The prediction of GROUP B (sensitivity) was 77.3%, and the prediction of GROUP A (specificity) was 85.2%. The overall correctness of estimation was 81.6%. A significant effect was obtained for decision-making for screwing the fractured vertebra using the presence of the pedicle fracture ($B = -2.124$, Wald = 5.266, $p = 0.022$), the AOSpine Classification Scale score ($B = -1.036$, Wald = 4.695, $p = 0.030$), the height of the vertebra below the fractured vertebra ($B = 0.450$, Wald = 5.951, $p = 0.015$), and the spinal canal diameter at the fractured spinal segment ($B = 0.374$, Wald = 5.148, $p = 0.023$). Thus, it was thought that these four parameters could be used as the “best markers” for the prediction of screwing the fractured vertebra (Table 4).

Discussion

It has been assumed that increasing the level of fixation reduces the stress on each pedicle screw and the risk of implant failure^{7,12}. Nevertheless, this technique may include fusing multiple motion segments with larger incisions and thus creates an increased risk of complications. Therefore, short-segment posterior transpedicular instrumentation with screwing the fractured vertebra has recently become the more commonly used surgical technique^{7,10}. Some advantages of this technique include preservation of the spinal

segment movement, shorter operation time, less bleeding, better kyphosis correction, and immediate stability^{7,12}. Furthermore, short-segment instrumentation shows equivalent biomechanical stability as conventional long-segment instrumentation under any loading condition^{13,19–21}.

The present study results showed that in Group A patients, the pedicle fracture occurred less frequently, the AOSpine Classification Scale scores were lower than A4, and the loss of height was less in the fractured vertebra and vertebra below the fractured vertebra. In these patients, the spinal canal diameter was wider, and therefore, fewer laminectomy procedures were applied to these patients. Furthermore, they stayed in the hospital for a shorter time. However, age, sex, Frankel Classification score, presence of pars interarticularis fracture, the height loss rate of the fractured vertebra, and angulation degree were observed to be similar in both groups.

In the long-term postoperative follow-up, it was observed in Group A patients that the height of the fractured vertebra and the height of the vertebra below the fractured vertebra and Karnofsky Performance Scale score were higher than those in the Group B patients. However, the height loss rate of the fractured vertebra, the angulation degree, spinal canal diameter, and the follow-up duration of the patients were similar in both groups. Hence, the long-term follow-up re-

Table 3. Comparison Results of the Findings Obtained in the Preoperative and Late Postoperative Follow-up Periods for Each Group.

		Group A		Group B	
Variable		t/Z	p	t/Z	p
Height of vertebra (mm)	Upper	-0.341†	0.733	-1.538†	0.124
	Fractured	-0.860†	0.390	-1.249†	0.212
	Below	-0.211†	0.833	-0.432†	0.666
Height loss rate (%)		0.094*	0.926	-0.643*	0.526
Angulation degree		-0.146†	0.884	-1.069†	0.285

(*) *t* value, paired sample *t*-test; (†) *Z* value, Wilcoxon signed-rank test, *p*<0.05

Table 4. Parameters That Can Predict the Decision-making in Screwing the Fractured Vertebra.

ROC curve test for screwing fractured vertebra					
Variable	Area	p	Cut-off value	Sensitivity	Specificity
Presence of the pedicle fracture	0.295	0.014	No	82%	59%
AOSpine Classification score	0.265	0.005	<A4	100%	89%
Height of the fractured vertebra	0.680	0.031	>14.86 mm	73%	63%
Height of the vertebra below fractured vertebra	0.734	0.005	>23.93 mm	73%	63%
Spinal canal diameter	0.759	0.002	>9.71 mm	86%	70%
Logistic regression test for screwing fractured vertebra					
Variable	Predicted				
Presence of the pedicle fracture			NO	YES	Percentage
AOSpine Classification score	Observed	NO	23	4	85.2%
Height of the vertebra below fractured vertebra		YES	5	17	77.3%
Spinal canal diameter	Overall percentage				81.6%
Variable	B		Wald		p
Presence of the pedicle fracture	-2.124		5.266		0.022
AOSpine Classification score	-1.036		4.695		0.030
Height of the vertebra below fractured vertebra	0.450		5.951		0.015
Spinal canal diameter	0.374		5.148		0.023

p<0.05

sults were found to be similar in patients whose fractured vertebra was screwed and not screwed.

Additionally, the comparison results showed that in each group, the preoperative loss of height in the fractured vertebra and preoperative height loss of the vertebra above and below the fractured vertebra, the height loss rate of the fractured vertebra, and angulation degree values were similar to the results obtained in the postoperative long-term follow-up. Based on this, it can be concluded that in selected patients, short-segment instrumentation with screwing of the fractured vertebra is as durable, effective, and protective as the traditional method of long-segment instrumentation by skipping the fractured vertebra.

The correlation analysis revealed that the fractured vertebra could be screwed when the AOSpine Classification score was lower than A4 when there was no pedicle fracture when the height of the fractured vertebra and the height of the vertebra below the fractured vertebra was greater and when the spinal canal diameter at the fractured vertebra level was

sufficiently wider. Nevertheless, if the Frankel Classification score was high and the AOSpine Classification score was low at the time of hospital admission, it was believed that the Karnofsky Performance Scale score could be high and these patients had a better quality of life in the postoperative period.

Additionally, *ROC curve* analysis revealed that the presence of pedicle fracture, AOSpine Classification score, the height of the fractured vertebra, the vertebra height below the fractured vertebra, and the spinal canal diameter could each be used as a predictive marker for screwing the fractured vertebra. Finally, *logistic regression* analysis revealed that these predictive markers except for the height of the fractured vertebra could be the best predictive markers in decision-making for screwing the fractured vertebra. From these results, it was concluded that patients with pedicle fractures, low vertebra height of the vertebra below the fractured vertebra, and narrow spinal canal would not be suitable for screwing the fractured vertebra.

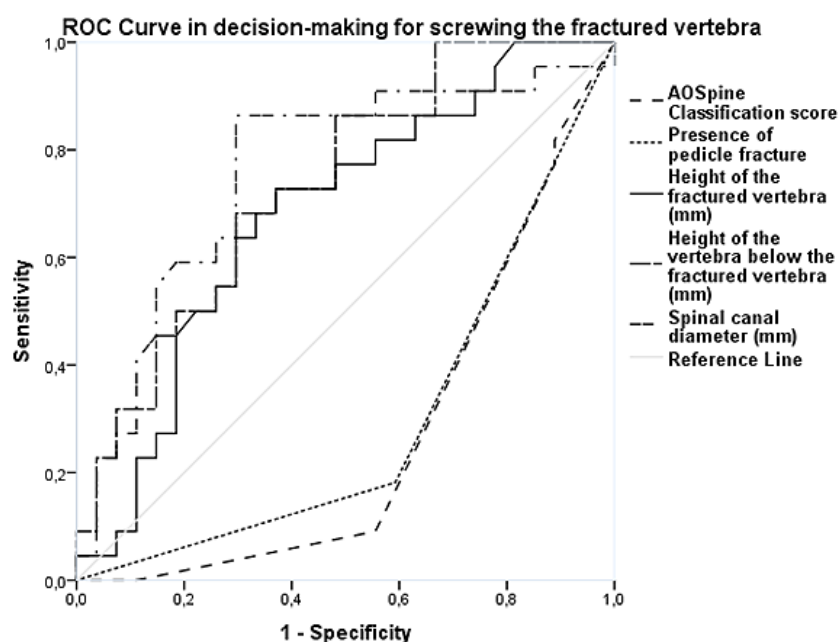


Figure 5. ROC curve plot showing the parameters that can predict the decision-making in screwing the fractured vertebra.

Limitations

There were some limitations in this study. First, this study was conducted in a single center, and it was retrospective in design corresponding to a low level of evidence. Second, a low number of patients and inequality of the patient groups might have caused a statistical power loss. However, at the end of this study, it was concluded that the results are interesting and could shed light on future studies. Third, it could be concluded that 102 days was not long enough for long-term follow-up. However, considering that the instrumentation aims to provide time to heal the vertebral fracture without pathologic collapse or deformity of the spinal column, we think that this time can largely cover the time required for the vertebral fracture to heal¹⁻³⁾. Additionally, we think that this time can still be sufficient time to compare the study results. Finally, because of the retrospective nature of this study, operation time, anesthesia time, length of the incision, and amount of radiation exposure could not be recorded and evaluated. Thus, there is a need for further studies of larger patient series to be able to make more detailed comparisons of the results of long-segment instrumentation by skipping the fractured vertebra and short-segment instrumentation with screwing the fractured vertebra.

Conclusion

In conclusion, it was observed that both instrumentation procedures had similar effectiveness in preventing collapse and instability in the fractured vertebra during long-term follow-up. It was also assumed that the presence of pedicle fracture, AOSpine Classification Scale score, vertebra height below the fractured vertebra, and spinal canal diameter

could be used as best predictive markers in decision-making for screwing fractured vertebra. From these results, it was concluded that patients with a low AOSpine Classification score, no pedicle fracture, no height loss of the vertebra below the fractured vertebra, and a wide spinal canal may be suitable candidates for screwing the fractured vertebra.

Conflicts of Interest: The authors declare that there are no relevant conflicts of interest.

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Author Contributions:

Design: Bulent Bakar and Mustafa Ogden

Definition of intellectual content: Bulent Bakar and Mustafa Ogden

Literature search: Bulent Bakar and Ulas Yuksel

Data acquisition: Mustafa Ilker Karagedik and Ibrahim Umud Bulut

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Statistical analysis: Bulent Bakar

Manuscript preparation: Bulent Bakar

Manuscript editing: Mustafa Ogden and Ulas Yuksel

Manuscript review: Bulent Bakar and Mustafa Ogden

Ethical Approval: Approval for this single-center, retrospective study was granted by the Kirikkale University Clinical Research Ethics Committee. Approval date: 11/03/2021, approval number: 2021.02.25

Informed Consent: Since the study had a retrospective character, the patients were informed that their information

could be used in the study provided that their personal information is protected, and consent was obtained; so, no additional consent was obtained.

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