



## SHORT-SEGMENT PEDICLE SCREW FIXATION INCLUDING PEDICLE SCREW AT THE FRACTURED LEVEL FOR TREATMENT OF UNSTABLE THORACOLUMBAR FRACTURES

### *STABİL OLMAYAN TORAKOLOMBER VERTEBRA KIRIKLARINDA KIRIK SEVİYEYE PEDİKÜLER VİDA FİKSASYONU İLE KISA SEGMENT FİKSASYON SONUÇ*

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#### SUMMARY:

**Background Data:** Short segment pedicle screw fixation with additional pedicle screws at the fractured level improves stability and provides better correction of deformity. This surgical technique allows anterior column support through indirect reduction.

**Purpose:** The aim of this study was to evaluate the effect of short-segment posterior fixation including pedicle screw at the fractured vertebra.

**Materials-Methods:** Between 1997 and 2013, 25 patients who had treated for unstable thoracolumbar vertebra fracture with using pedicle screw at the fractured level were reviewed retrospectively. All patients evaluated by radiographs, computed tomography and magnetic resonance. Local kyphosis, anterior and posterior wall height were studied on lateral X-ray preoperatively and postoperatively. Functional outcome and pain were assessed by Oswestry Disability Index (ODI) and visual analog scale (VAS) scores. The unpaired Student's t-test and Mann Whitney U test and also, SPSS v.20.0 (SPSS Inc., Chicago, IL, USA) were used for statistical analyses.

**Results:** In this study, the mean age was 52 (20-84). The most common injured area was thoracolumbar spine (%75) and L1 was the most commonly affected vertebra (%43). Preoperative mean anterior wall height was 19 mm (12-27 mm) and posterior wall height was 29 mm (17-38 mm). Postoperative anterior wall height was 27 mm (16-36mm) and posterior wall height was 31 mm (19-38 mm). The mean local kyphosis angle was decreased from 17 degree (8-26 degree) to 2.7 degree (-7,9 degree). Statistically, increase of anterior corpus height and decreasing of the local kyphosis angle have a significant difference (p<0.05). Laminectomy and posterior wall height did not have a significant difference between pre- or postoperatively (p> 0.05). The mean VAS score was 2.2 (0-7) and the mean Oswestry score was 9.8 (3-24).

**Conclusion:** Short-segment pedicle screw fixation with pedicle screw at the fractured level is a safe and effective surgical method for unstable thoracolumbar fractures through improves stability and provides anterior column support.

**Key words:** short-segment pedicle fixation, intermediate screw, thoracolumbar fracture

**Level of Evidence:** Retrospective clinical study, Level III

#### ÖZET:

**Giriş:** Kırık vertebra'nın pedikül vidası ile enstrümente edildiği kısa seviyeli posterior tespit, stabiliteyi artırıcı etki gösterir ve deformitede daha belirgin düzelme sağlar. Son yıllarda ön plana çıkan bu teknik omurganın ön kolonunun indirek olarak destekleme prensibine dayanır.

**Amaç:** Bu çalışmamızda kısa segment posterior tespiti ile birlikte yapılan kırık vida enstrümentasyonunun etkinliğini değerlendirmeyi amaçladık.

**Materyal-Metod:** 1997-2013 yılları arasında stabil olmayan torakolomber omurga kırığı nedeniyle kırık segment enstrümentasyonun da dahil edildiği kısa segment posterior tespit yapılan 25 hasta retrospektif olarak çalışmaya dahil edildi. Hastalar radyolojik olarak direk grafi, bilgisayarlı tomografi ve MR ile değerlendirildi. Ameliyat öncesi ve sonrası lateral grafiyle bölgesel kifoz, omurga cisminin ön ve arka duvar yükseklikleri ölçüldü. Hastalar fonksiyonellik ve ağrı açısından Oswestry Disability Index (ODI) ve visual analog scale (VAS) ile değerlendirildi. Elde edilen değerler Student T-testi (unpaired T-testi) ve Mann Whitney U ile analiz edildi ve istatistiksel anlamlılık değeri % 95 güven aralığı için p<0.05 olarak kabul edildi.

**Sonuçlar:** Çalışmamızda ortalama yaş 52 (20-84) idi. En sık yaralanan bölge torakolomber bölge (% 75) ve en sık yaralanan vertebra ise L1 vertebra idi (% 43). Ameliyat öncesi ortalama omurga ön duvar yüksekliği 19 mm (12-27 mm) ve arka duvar yüksekliği 29 mm (17-38 mm) iken ameliyat sonrası ön duvar yüksekliği 27 mm (16-36 mm) ve arka duvar yüksekliği 31 mm (19-38 mm) idi. Ameliyat öncesi 17 derece (8-26 derece) olan ortalama bölgesel kifoz açısı, ameliyat sonrası 2.7 dereceye (-7-9 derece) geriledi. Ameliyat sonrasında vertebra ön duvar yüksekliğindeki artış ve bölgesel kifoz açısındaki azalma istatistiksel olarak anlamlıydı (p<0.05). Bununla birlikte, laminektomi ve arka duvar yüksekliğindeki değişiklikler istatistiksel olarak anlamlı değildi (p>0.05). Hastaların ortalama VAS skoru 2.2 (0-7) ve ortalama ODI skoru 9.8 (3-24) idi.

**Çıkarımlar:** Kırık vertebra enstrümentasyonunun da dâhil edildiği kısa seviye posterior tespit indirek ön kolon desteği sağlaması ve stabiliteyi artırması nedeniyle instabil torakolomber omurga kırıklarında etkili ve güvenilir bir cerrahi yöntemdir.

**Anahtar Kelimeler:** Kısa segment enstrümantasyon, intermediet vida, torakolomber kırıklar

**Kanıt Düzeyi:** Retrospektif klinik çalışma, Düzey III

## INTRODUCTION:

Spine fractures are serious injuries and usually associated with other major organ system injuries such as bone fractures, head trauma, pulmonary and abdominal injuries<sup>19</sup>. Also 4,5% of patients have noncontiguous vertebral injuries<sup>5</sup>. These fractures are usually caused by high-energy trauma such as fall from height or car crash. Approximately 75% of fractures are seen in the thoracic and lumbar regions, also thoracolumbar junction is the most common injury site<sup>8,15</sup>. Complete neurological injury occurs in 20% of patients and incomplete neurological injury occurs in 15% of patients<sup>25</sup>.

The goal of the treatment in vertebral fractures is to maintain spinal stability and alignment with preserving neurological function. However, the management of the treatment is still under debate, such as surgical versus conservative treatment, timing of surgery, preference of surgical technique<sup>13,24</sup>. Several surgical techniques have been introduced in the literature. There is no consensus on surgical treatment modalities as anterior, posterior, or combined approach<sup>9,30</sup>.

Short segment spinal instrumentation became a popular surgical procedure with using posterior pedicle screw fixation. That is provided better correction of deformity, greater stability that allowed early mobilization<sup>1,16</sup>. Despite these advantages of this surgical technique, it has been associated with loss of reduction and implant failure in some cases<sup>1,18</sup>. Recently, some authors have suggested that inserting pedicle screw at the level of fractured vertebra in a short-segment construct may prevent too early failure and help to improve biomechanical stability<sup>3,17</sup>.

This study evaluates the hypothesis that short segment fusion using pedicle screw combined with additional screw at the level of the fracture vertebra via posterior approach is enough to reduction of vertebral height safely.

## MATERIAL AND METHODS:

We retrospectively evaluated 25 patients (7 females and 18 males) who had undergone short-segment posterior construct with pedicle screws adding index level instrumentation between 1997 and 2013. Patients who have vertebra fracture below T12 were included to study. Patients with vertebra height compression lower than 25% were excluded from the study because of given false results to assess reduction value. Also patients operated via anterior or combined surgery or used hook were excluded from the study.

Neurological status were classified according to ASIA (American Spinal Injury Association) scale 20 patients were neurologically intact (ASIA E), 3 had incomplete deficit (ASIA B, C, D) and 2 had complete neurologic deficit (ASIA A) Standard prophylactic methylprednisolone treatment were applied for the patients with neurologic deficit.

All patients were preoperatively evaluated by radiographs, computed tomography and magnetic resonance, local kyphosis angle by the Cobb method, anterior and posterior wall height were studied on lateral X-ray that taken at preoperatively and control. Patients with neurologic deficit and unstable fractures including injury to posterior ligament complex, >50% loss of vertebral body height, spinal canal compromise greater than 40% and >25% kyphosis were treated through this surgical method<sup>20</sup>. The patients' functional outcome and pain were assessed by Oswestry Disability Index (ODI) and visual analog scale (VAS) scores. The unpaired Student's *t*-test was used for comparison of quantitative results with normal distribution, Mann Whitney U test for results where a normal distribution was rejected. P values of less than 0.05 were considered significant. SPSS v.20.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analyses.

## Surgical Procedure:

All of the patients were operated using a standard posterior midline approach in prone position under general anesthesia. After confirming the fractured vertebra with fluoroscopy following by subperiosteal dissection were applied without damage interspinous or supraspinous ligaments. Proximal facet were protected to prevent proximal junctional kyphosis. Pedicle screws were inserted upper and lower vertebra and also fractured vertebra using freehand technique. All screw replacement confirmed radiologically. The intermediate screws were inserted bilaterally if the pedicle walls were intact that evaluated with CT. We used 6,5 mm diameter titanium poli-axial pedicle screws for lumbar region and T12 vertebra and 5,5 mm diameter titanium poli-axial pedicle screws for upper segments. Spongiosus allograft were used for posterolateral fusion.

## RESULTS:

In this study, 25 patients with mean age was 52 (20-84) was reviewed. 3 patients underwent short posterior pedicle screw fixation including fractured level through one level above and one level below pedicle screw instrumentation and also, other patients treated through 2 level above and one level below. The most common injured area was thoracolumbar spine (75%) and L1 was the most commonly affected vertebra (43%). 6 T-12 fractures, 12 L-1 fractures, 2 L-2 fractures, 3 L-3 fractures and 2 L-4 fractures.

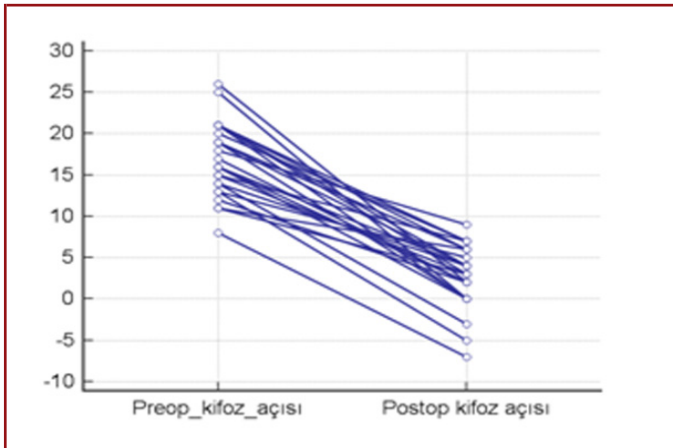
Preoperative radiological parameter that was measured on the lateral X-ray, the mean anterior wall height was 19 mm (12-27 mm) and posterior wall height was 29 mm (17-38 mm). Postoperative radiological value anterior wall height was 27 mm (16-36mm) and posterior wall height was 31 mm (19-38 mm). The mean local kyphosis angle was decreased from 17 degree (8-26 degree) to 2.7 degree (-7,9 degree) (Figure-1 and 2).

According to the statistical analysis, increase of anterior corpus height and decreasing of the local kyphosis angle have a significant difference ( $p < 0.05$ ). Laminectomy and posterior wall height did not have a significant difference between pre- or post-operatively ( $p > 0.05$ ) (Figure-3).

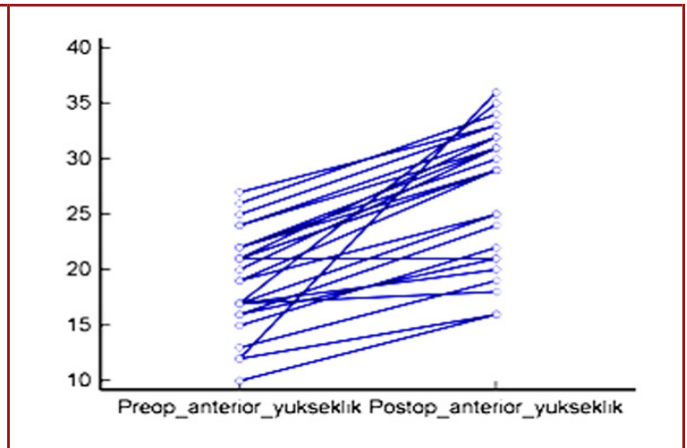
The mean VAS score was 2.2 (0-7) and the mean Oswestry score was 9.8 (3-24). All patients with incomplete neurological

deficit (n: 3) improved to ASIA E. However patients (n: 2) with complete neurologic deficit (ASIA A) did not show any neurologic recovery (Figure-4).

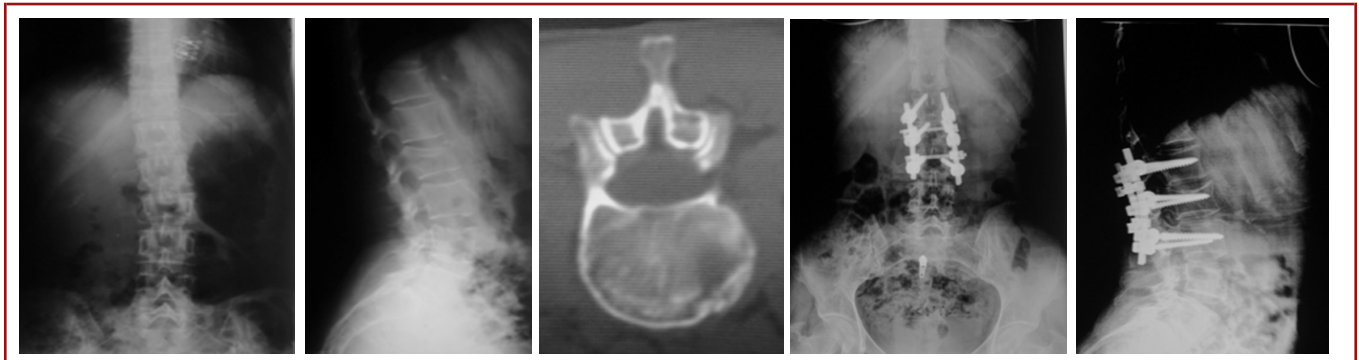
During the final follow-up, all the patients were observed to union at fractured vertebra. Also there was any implant related complication during follow-up. There were 2 superficial wound infection which healed by antibiotics treatment. However, any deep wound infection was not seen (Figure-5).



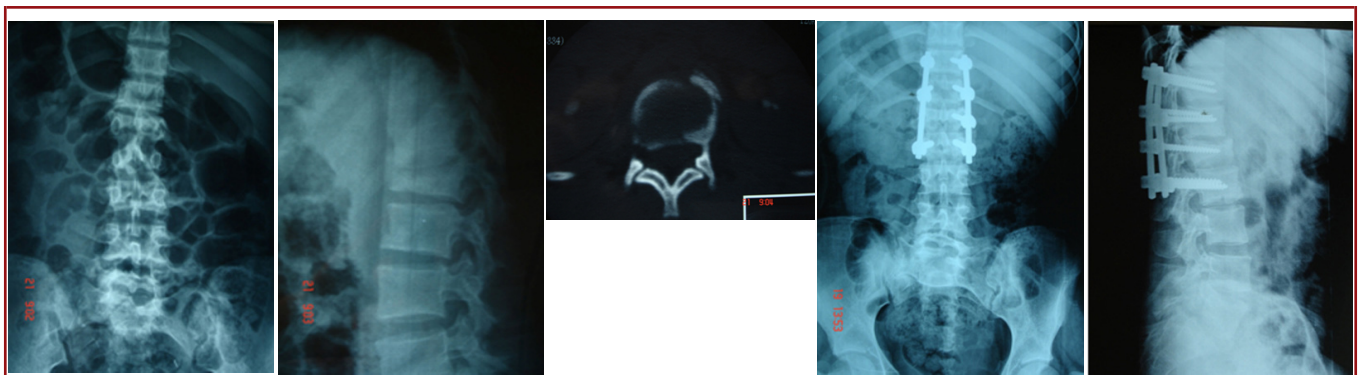
**Figure-1.** Preoperative and postoperative kyphosis angle



**Figure-2.** Preoperative and postoperative anterior wall height

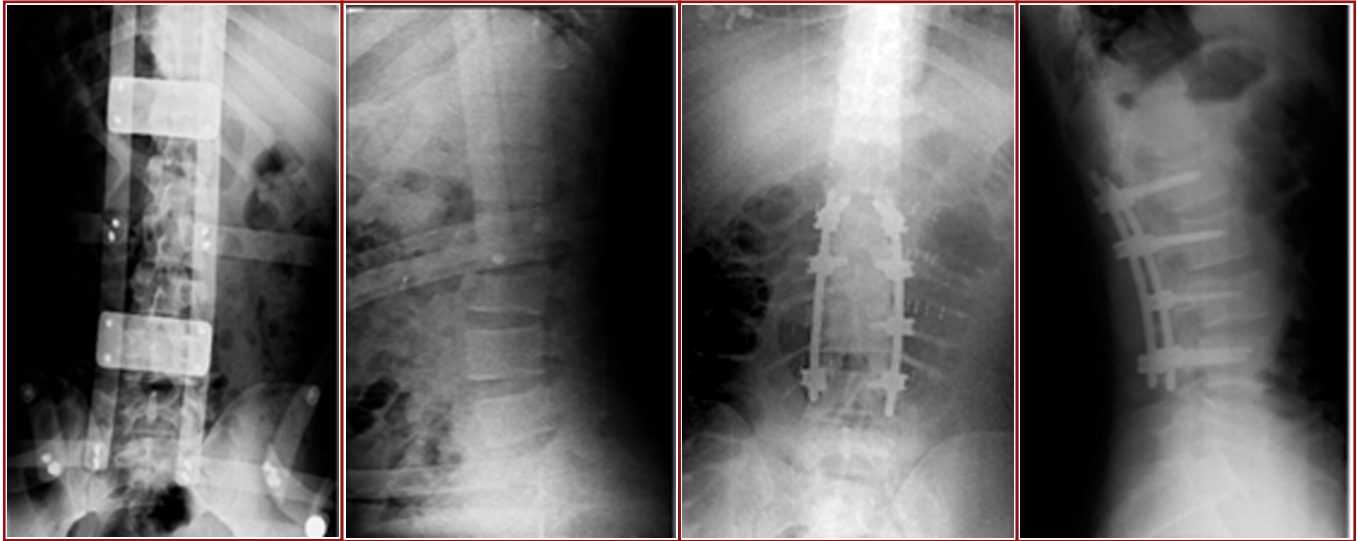


**Figure-3.** 53 years old patient with L2 vertebra fracture treated with one level above and level below instrumentation using pedicle screw at fractured vertebra



**Figure-4.** 27 years old patient with L1 vertebra fracture treated with two level above and one level below instrumentation using pedicle screw at the fractured level





**Figure-5.** 23 years old patient with L3 vertebra fracture treated with two level above and one level below instrumentation using pedicle screw at the fractured level

## DISCUSSION:

Several treatment options have been described for thoracolumbar vertebra fractures include anterior, posterior, or combined fixation techniques<sup>4,26,28,31</sup>. Also, short segment posterior stabilization is a preferable method for stabilizing the unstable thoracolumbar fractures through less surgical dissection, decreased blood loss and surgical time<sup>11,32</sup>. Even though this technique is popular, several authors have suggested that this procedure associated with unacceptable results including loss of reduction and implant failure depends on inadequate anterior column support and increasing anterior vertebral stress on each pedicle screws<sup>27,30</sup>. To support anterior part of the vertebra several technique was described as transpedicular grafting or vertebroplasty<sup>1,7</sup>. An alternative method is to use longer segmental instrumentation to reduce the stress on each pedicle screws. Nevertheless, this procedure have some disadvantages such as longer operation time, more bleeding, remaining less motion segments<sup>21,23</sup>.

In a cadaveric biomechanical study, Norton et al compared long versus short segment instrumentation by using pedicle screws for unstable thoracolumbar fractures and they suggested that long segment instrumentation is more rigid than short segment instrumentation<sup>22</sup>. Similarly, Tezeren et al demonstrated that long segment instrumentation is more effective than short segment instrumentation for management of thoracolumbar fractures in their retrospective clinical study. They suggested that short segment instrumentation would have been more successful when two above and two below pedicle screw were used<sup>29</sup>. However, Baaj et al suggested that even though long segment instrumentation provides more stability than short segment constructs, insertion pedicle screw at the level of

fracture to short segment construct improves stability<sup>2</sup>. Also, Dick et al reported that additional insertion of pedicle screws at the fractured level improve biomechanical stability through supporting anterior column and diminishing stress on each pedicle screws as a popular method of stabilization for unstable thoracolumbar fractures<sup>10</sup>. However, Mahar et al found that short segment pedicle screw fixation with screw at the level of fracture improves biomechanical stability during axial rotation but not during flexion, extension or lateral bending in a cadaveric biomechanical study. The advantages of this procedure include easier operation, short surgery time, less soft tissue dissection and blood loss and finally less morbidity<sup>17</sup>.

In the literature, kyphosis correction after surgery with short-posterior fixation without pedicle screw at the level of fractured vertebra was from 6 degree to 15 degrees. Also, kyphosis correction degree was decreased at follow-up<sup>6,7,17</sup>. Author reported that kyphosis correction loss was related amount of bony communication, fracture displacement and amount of correction of kyphotic deformity<sup>14</sup>. Loss of correction degree on kyphosis angle was better in patients operated with posterior short fixation addition of pedicle screws at the level of fracture<sup>12</sup>. In our study, the mean initial kyphosis correction was 15 degrees after surgery additional insertion of pedicle screw at the fractured vertebra.

In conclusion, short posterior fixation with pedicle screws at the fractured level is one of the effective method for treatment of unstable thoracolumbar fractures, which can improve the stability, maintain the reduction through provide anterior column support and indirect reduction and also achieve better outcomes. This method has advantages such as short operation

time, less soft tissue dissection and blood loss, and also less morbidity. In our opinion, this surgical technique can be used for treatment of unstable thoracolumbar fractures to prevent complications including loss of reduction and implant failure.

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