



# Implanting Pedicle Screw in Fractured Vertebra Results in No Adverse Effect on Bone Healing in Thoracic or Lumbar Burst Fracture

## *Kırılmış Vertebralara Pedikül Vidası Yerleştirmek Torasik veya Lomber Patlama (Burst) Kırığında Kemik İyileşmesinde Olumsuz Bir Etki Yapmamaktadır*

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### ABSTRACT

**AIM:** To confirm whether implanting pedicle-screw at the level of fractured vertebra increases adverse effects on fracture healing.

**MATERIAL and METHODS:** CT follow-up was conducted for 28 patients who sustained thoracic or lumbar burst fracture and underwent posterior pedicle-screw instrumentation and reduction including implanting screws into the fractured vertebra at the same time. The time for follow-up CT scan ranged from 1 to 3 years postoperatively.

**RESULTS:** 28 patients underwent final CT scan 1 to 3 years after surgery which revealed good bony fusion within each fractured vertebra and no screw or rod breakage; kyphosis was also not detected.

**CONCLUSION:** Implanting pedicle-screw at the level of fractured vertebra does not have a negative influence on bone healing.

**KEYWORDS:** Spine trauma, Thoracolumbar, Burst fracture, Short segment fixation, Bone healing

### ÖZ

**AMAÇ:** Kırık vertebra seviyesine pedikül vidası implante etmenin kırık iyileşmesi üzerinde advers etkileri arttırıp arttırmadığını belirlemek.

**YÖNTEM ve GEREÇLER:** Torasik veya lomber patlama kırığı yaşayan ve aynı anda kırık vertebraya vida implantasyonu dahil posterior pedikül-vida enstrümantasyonu ve redüksiyon yapılan 28 hastada BT takibi yapıldı. Takip BT taraması için süre postoperatif 1 ila 3 yıl arasında değişti.

**BULGULAR:** 28 hastada cerrahiden 1 ila 3 yıl sonra yapılan BT taramasında her kırık vertebrada herhangi bir vida veya rod kırığı olmadan iyi kemik füzyon görüldü ve kifoz saptanmadı.

**SONUÇ:** Kırık vertebra seviyesine pedikül vida implante etmenin kemik iyileşmesi üzerine negatif bir etkisi yoktur.

**ANAHTAR SÖZCÜKLER:** Omurga travması, Torakolumbar, Patlama kırığı, Kısa segment fiksasyonu, Kemik iyileşmesi

### INTRODUCTION

The invention and application of pedicle-screws have led to tremendous improvement in the treatment of spinal fractures and other spinal diseases (5, 8). The technique has many advantages over previously used techniques in the treatment of spinal fractures, such as the Leque rod, Harrington rod and the U-shaped rod technique (1, 17). The pedicle-screw technique makes short-segment fixation practicable in treating spinal fractures because of adequate strength and stability can be provided by four-screw fixation in most appropriately selected cases for posterior surgery (12). With the wide use of the pedicle-screw technique and accumulation of experience in spinal fracture treatment, some

surgeons creatively implanted screws in fractured vertebra to enhance the strength of fixation without extension of fixed segments, and named the technique "short same-segment fixation" (2). Some authors reported their clinical results to reveal that the added pedicle-screws at the fracture level reduced the implantation failure rate (2, 7). However, whether the inserted screws have a negative influence on fracture healing has not been investigated yet. It is therefore necessary to clarify whether the pedicle-screws in fractured vertebra intervene in the healing process or cause nonunion. We have conducted a serial observation on patients who underwent this kind of treatment to demonstrate the influence of screw implantation at the fracture level on fracture healing.

**MATERIAL and METHODS**

From January 2004 to December 2010, 30 patients who were appropriate candidates for posterior surgical treatment because of thoracic or lumbar spinal burst fractures were admitted in our spinal surgery center. The age of these patients ranged from 23 to 50 years old, 20 were male, 10 female; Thoracic fracture in 5 cases, thoracolumbar fracture in 20 cases, lumbar fracture in 5 cases. The fracture types based on AO classification system were A3.1 in 14 cases (Figure 1A-D), A3.2 in 16 cases (Figure 2A-F). The indications for posterior operation were: 1. the vertebral height loss between 30-50%; 2. the retropulsed fragment in spinal canal less than 50% of sagittal canal diameter; 3. the neurological status was intact or incomplete injury; 4. there was no reversed fracture

fragment in spinal canal; 5. there was no concomitant disc injury adjacent to fractured vertebra (Figure 3A-C).

The concrete procedure steps were similar to standard posterior short-segment instrumentation technique using pedicle-screw and rod fixture. But, one or two pedicle screw(s) was/were implanted into the fractured vertebral body, the screw length and its implanting direction were nonspecific just as manipulation on non-fractured vertebrae. The screw could be located in fractured area. Five or Six pedicle-screws were implanted totally in each patient (Figure 1E, 1F, 2G, 3D, 3E).

Follow-up 3-dimensional CT scan was conducted at least 1 year after operation to confirm fracture healing status.



**Figure 1:** (A-D) Showing L1 incomplete burst fracture with 50% vertebral height loss and classified as subtype A3.1.1. (E, F) showing posterior conventional short-segment fixation combined with insertion of two more screws at the level of fracture (L1), the good height restoration and normal local curvature are achieved. (G, H) one-year follow-up CT scans demonstrating excellent fracture healing.

### RESULTS

2 out of 30 patients were lost for follow-up. 28 patients underwent final CT scan during 1 to 3 years after surgery which revealed good bony fusion within each fractured vertebra and no screw or rod breakage (Figure 1G, 1H, 2H, 2I, 3F), kyphosis was also not detected (Figure 1H, 2H, 3F).

### DISCUSSION

Posterior short-segment fixation and fusion has been used as a routine procedure for several decades to treat thoracolumbar burst fracture and other disorders surgically (3, 10), the success rate of fracture healing is usually relatively high (12, 17). All the same, failed cases are not uncommon because of insufficient restoration in spinal stability provided by short-segment fixation technique through implanting two screws above and two screws below the fracture level in some fracture cases (11, 15, 16). So, some authors tried long-segment fixation to increase the stability and decrease the load share in each pedicle-screw (13, 14). However, long-segment fixation has the intrinsic disadvantage of sacrificing more

motion segments and longer incision. Another technique has therefore emerged as the clinical practice required, which was named "short same-segment fixation", specifically referring to implanting additional one or two pedicle-screws at the fracture level (2), together with two upper and two lower pedicle-screws, and there are 5 or 6 screws totally. The purpose to do so is to improve the strength of fixation and minimize the failure possibility with preservation of motion segment. This modified technique was verified its advantage in biomechanical stability both through cadaveric experiment and clinical practice (2, 6, 7, 10). But, whether implanting screws in fracture vertebra prevents bone fragments from healing is still unclear and has not been reported in existing literatures, thus, the relevant investigation should be done to make the concern clear and sure.

The only reliable method to demonstrate fracture healing status is 3-dimensional computed tomography, which can provide direct insight into interior structure of vertebral body, sagittal and coronal scans are especially useful and definitive in judging overall healing situation in fractured vertebra



**Figure 2:** (A-F) Showing L1 burst-split fracture classified as A3.2.1 subtype, the vertebral body height loss less than 50%, without obvious adjacent disc injury, spinal canal encroachment less than 50%. (G) showing good postoperative restoration in L1 shape and height, the two pedicle-screws in L1 were placed in fractured area. (H, I) three-year follow-up CT scans demonstrating excellent bone healing.

(Figure 1G, 1H, 2H, 2I, 3F). Roentgenogram just can show a rough contour of vertebral body, the real situation within the fractured vertebra cannot be revealed by X-ray. Therefore, 3-dimensional CT scan should be used as the standard method to investigate the bone fusion status in follow-up period. There has been no such investigative report based on large-sample of patients about whether the implantation of screw in fracture vertebra deters bone healing process. From the result gained by CT scan follow-up in our 28 cases, it is possible to say that implanting screws in fracture vertebra in appropriate selected cases poses no negative effect on bone healing potentials. Even though the screws were placed within fracture line in some cases, the fracture healing was also achieved without postponement (Figure 2G, 2H, 3E,

3F). It is important to select the suitable candidate patients for this technique in strict inclusion criteria because the healing potentials is very weak in seriously comminuted burst fracture case such as subtype A3.3 fractures. In this kind of cases, whether implanting pedicle-screw or not in fracture vertebra the ultimate result may be the same - nonunion and failure. So, we suppose the prerequisite conditions applicable to this technique include the following terms: 1. the vertebral height loss not more than 50%; 2. the retropulsed fragment in spinal canal less than 50% of sagittal canal diameter; 3. the neurological status was intact or incomplete injury; 4. there was no reversed fracture fragment in spinal canal; 5. there was no concomitant obvious disc injury adjacent to fractured vertebra. Because if there is one of these happening



**Figure 3:** (A-C) Showing L1 burst-split fracture classified as A3.2.1 subtype, the vertebral body height about 50% in anterior half, spinal canal encroachment less than 50%. (D, E) Postoperative X-ray film showing one screw was placed in fracture level of L1 vertebra and excellent restoration in L1 shape and height were achieved. (F) 2-year CT follow-up scan illustrating perfect bony healing in L1 vertebral body.

in a thoracolumbar burst fracture, the possibility of failure for posterior procedure increases dramatically, and anterior operation may be necessary (4, 9). Some authors reported there still was a certain proportion of failure cases who underwent posterior short same-segment fixation or long-segment fixation procedure, and perhaps inappropriate cases included were the main cause.

In this report, we only focus on the fracture healing status and want to clarify whether insertion pedicle-screw in the fracture vertebra and fracture site arises fracture nonunion, so, the neurological and social function recovery and other complications were not included in this investigation.

### CONCLUSION

Implanting pedicle-screw in fracture level vertebra in type A3.1 and A3.2 thoracic or lumbar burst fractures is a practical technique, and fracture healing is not compromised by screw insertion. Solid union was achieved in this reported group of 28 cases.

### REFERENCES

1. Dickman CA, Fessler RG, MacMillan M, Haid RW: Transpedicular screw-rod fixation of the lumbar spine: Operative technique and outcome in 104 cases. *Journal of Neurosurgery* 77: 860-870, 1992
2. Eno JJ, Chen JL, Mitsunaga MM: Short same-segment fixation of thoracolumbar burst fractures. *Hawaii J Med Public Health* 71:19-22, 2012
3. Esses SI, Botsford DJ, Wright T, Bednar D, Bailey S: Operative treatment of spinal fractures with the AO internal fixator. *Spine* 16:S146-150, 1991
4. Ghanayem AJ, Zdeblick TA: Anterior instrumentation in the management of thoracolumbar burst fractures. *Clinical Orthopaedics and Related Research* 89-100, 1997
5. Gurr KR, McAfee PC: Cotrel-Dubousset instrumentation in adults. A preliminary report. *Spine* 13:510-520, 1988
6. Gurwitz GS, Dawson JM, McNamara MJ, Federspiel CF, Spengler DM: Biomechanical analysis of three surgical approaches for lumbar burst fractures using short-segment instrumentation. *Spine* 18:977-982, 1993
7. Guven O, Kocaoglu B, Bezer M, Aydin N, Nalbantoglu U: The use of screw at the fracture level in the treatment of thoracolumbar burst fractures. *Journal of Spinal Disorders and Techniques* 22:417-421, 2009
8. Hirabayashi S, Kumano K, Kuroki T: Cotrel-Dubousset pedicle screw system for various spinal disorders. *Merits and problems. Spine* 16:1298-1304, 1991
9. Kirkpatrick JS, Wilber RG, Likavec M, Emery SE, Ghanayem A: Anterior stabilization of thoracolumbar burst fractures using the Kaneda device: A preliminary report. *Orthopedics* 18:673-678, 1995
10. Kramer DL, Rodgers WB, Mansfield FL: Transpedicular instrumentation and short-segment fusion of thoracolumbar fractures: A prospective study using a single instrumentation system. *Journal of Orthopaedic Trauma* 9:499-506, 1995
11. McLain RF, Sparling E, Benson DR: Early failure of short-segment pedicle instrumentation for thoracolumbar fractures. A preliminary report. *Journal of Bone and Joint Surgery American* 75:162-167, 1993
12. Parker JW, Lane JR, Karaikovic EE, Gaines RW: Successful short-segment instrumentation and fusion for thoracolumbar spine fractures: A consecutive 41/2-year series. *Spine* 25: 1157-1170, 2000
13. Tezeren G, Bulut O, Tukenmez M, Ozturk H, Oztumur Z, Ozturk A: Long segment instrumentation of thoracolumbar burst fracture: fusion versus nonfusion. *Journal of Back and Musculoskeletal Rehabilitation* 22:107-112, 2009
14. Tezeren G, Kuru I: Posterior fixation of thoracolumbar burst fracture: Short-segment pedicle fixation versus long-segment instrumentation. *Journal of Spinal Disorders and Techniques* 18:485-488, 2005
15. Wang XY, Dai LY, Xu HZ, Chi YL: Kyphosis recurrence after posterior short-segment fixation in thoracolumbar burst fractures. *Journal of neurosurgery Spine* 8:246-254, 2008
16. Xu BS, Tang TS, Yang HL: Long-term results of thoracolumbar and lumbar burst fractures after short-segment pedicle instrumentation, with special reference to implant failure and correction loss. *Orthopaedic Surgery* 1:85-93, 2009
17. Yue JJ, Sossan A, Selgrath C, Deutsch LS, Wilkens K, Testaiuti M, et al: The treatment of unstable thoracic spine fractures with transpedicular screw instrumentation: A 3-year consecutive series. *Spine* 27:2782-2787, 2002