

Short Same-Segment Instrumentation of Burst Thoracolumbar Fractures

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Abstract

Background Data: Long segment fixation has been frequently used for management of burst thoracolumbar fractures of the spine. Concerns about lost motion segments with this type of fixation encouraged the use of a shorter fixation method.

Purpose: The aim of this study is to assess the ability of short segment fixation with pedicle screws at the fractured level to correct deformity, maintain correction and prevent failure in comparison to the traditional long segment fixation.

Study Design: A descriptive retrospective clinical case study involving 40 patients.

Patients and Methods: Forty patients underwent stabilization for unstable thoracolumbar burst fractures. They were divided into two groups; the short segment group and the long segment group. They were operated between June 2012 and May 2016. Participants were evaluated pre-operatively, post-operatively and at 3, 6, 9, and 12 months. Clinical outcome was compared using the modified Mc Nab criteria. Radiological outcome was compared using the Cobb angle measurement of kyphosis.

Results: The two groups were fairly homogeneous and comparable epidemiologically. About 45% of the fractures were at L1 level. The short segment group showed less intraoperative blood loss, shorter operative time and hospital stay. Patients in both groups achieved satisfactory clinical outcome. No difference between the two groups in the mean kyphotic angle correction and the loss of kyphosis correction during follow up. Implant failure was recognized in five patients (12.5%), three patients had short segment fixation and two had long segment fixation.

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Conclusion: Short-segment pedicle screw fixation including the fractured vertebral body is as effective as long-segment pedicle screw fixation for the treatment of unstable thoracolumbar burst fracture. (2016ESJ137)

Keywords: Long segment, Short segment, Fixation, Thoracolumbar spine, Trauma.

Introduction

Management of unstable thoracolumbar fractures remains controversial in spite of an improved knowledge of the morphometric, anatomic and biomechanical features of thoracolumbar vertebrae.^{1,2,4,6-9,12,19,22} The aims of treating vertebral fractures are early recovery of neurological deficit, overcome damaged spinal segments anatomically and accomplish firm and stable fixation for early rehabilitation.²⁰

Posterior short-segment fixation and fusion has been used as a routine procedure for several decades.^{11,18} The success rate of fracture healing is usually relatively high.^{25,35} Nevertheless, 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.^{23,32,34}

So, some authors tried long segment fixation to increase the stability and decrease the load share in each pedicle-screw.^{28,29} However, long-segment fixation has the intrinsic disadvantage of sacrificing more motion segments and longer incision. Another technique has therefore emerged, which was named “short same-segment fixation”, specifically referring to implanting additional one or two pedicle-screws at the fracture level,¹⁰ together with two upper and two lower pedicle-screws, and there are 5 or 6 screws totally. The aim 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.^{10,13,14,18}

The purpose of this study was to assess ability of short segment fixation with pedicle screw at the fractured level to correct deformity, maintain correction and prevent failure in comparison to the traditional long segment fixation.

Patients and Methods

This is a controlled, non-randomized, retrospective, clinical study. Between February 2012 and July 2016, at Suez Canal University Hospital (Ismailia, Egypt) a total of forty consecutive patients were included. All patients had unstable thoracolumbar burst fracture and were indicated for posterior transpedicular screw fixation.

The inclusion criteria were single level fracture between T11 and L2, kyphotic deformity exceeding fifteen degrees, spinal canal compromise of 50% or more, and loss of 50% of anterior body height.

The aim of this study is to document if the fractured vertebra can act as a fulcrum for spinal fixation in cases of thoracolumbar burst fractures. The patients were categorized into two groups: Group 1: included 20 patients who underwent short-segment pedicle screw fixation including the fractured vertebral body. Group 2: included 20 patients who underwent long-segment pedicle screw fixation (two levels above and below the fractured vertebral body).

Preoperative assessment included patient’s history of injury (fall, road traffic accident, or direct trauma), full physical examination and a thorough neurological examination. They were assessed using the American Spinal Injury

Association (ASIA) Impairment Scale. All cases had preoperative X-rays and CT-scans to assess the pedicle intactness and direction and also to plan screw sizes. The kyphotic angle was also measured on X-rays by using Cobb's method. MRI was done in all patients to assess spinal cord injuries and other soft tissue injuries and hematomas.

Surgical Procedure:

Patients were placed in a prone position under general anesthesia. Pedicle screw fixation and reduction was performed under C-arm guidance. All patients had thoracolumbosacral orthosis for postoperative period of three months. (Figure 1)

Per- and Post-operative Data

In both groups of patients, duration of surgery, blood loss, and the duration of inpatient treatment were recorded. Intraoperative and perioperative major and minor complications were assessed.

Patients were followed-up clinically at 3 weeks, 3, 6, 9 and 12 months after surgery. During follow up visit the following data were collected: back pain; neurological status; medication and complications. Assessment of the patient clinical outcome was evaluated using the modified Mc Nab criteria.

All patients had been submitted to X-ray and CT-scan in the first postoperative day to assess proper screws placement and kyphotic angle reduction. Radiological assessment of the kyphotic angle using the Cobb method was performed immediately after surgery and at 3, 6, and 12 months postoperatively.

Results

Pre- and Per-operative Data:

A total of forty patients (twenty in each group) were included in this study. The demographic data of the two study groups are presented

in (Table 1), and showed that the two groups of patients were fairly homogeneous and comparable. The mean age in the short segment group was 27.3 years in comparison to 29.2 years in the long segment group. Seventy five percent of patients were males in the short segment group in comparison to 65% in the long segment group. Table 1 also shows distribution of the operative level by the level of the fracture within the two study groups. Almost 45% of fractures were at L1 vertebra.

The short segment group showed significantly less intraoperative blood loss, shorter operative time and hospital stay: (Table 2)

Post-operative Data:

Patients in both groups achieved satisfactory clinical outcomes according to the modified Mc Nab criteria. In the short-segment group, four (20%), twelve (60%), and four (20%) cases were considered to have excellent, good, and fair outcome, respectively. (Table 3) In the long-segment group, six (30%), ten (50%), three (15%), and one (5%) cases were considered to have excellent, good, fair, and poor outcome, respectively with non-significant difference between both groups in the clinical outcome. (Table 3)

In the short-segment group, the mean kyphotic angle at the immediate postoperative period and at 3, 6, and 12 months postoperatively was $2.6 \pm 11.9^\circ$, $4.1 \pm 13.2^\circ$, $7 \pm 10.9^\circ$, and $9.5 \pm 11.3^\circ$, respectively while in the long-segment group, it was $5.3 \pm 5.8^\circ$, $7.9 \pm 7.4^\circ$, $10 \pm 7.7^\circ$, and $12 \pm 6.5^\circ$, respectively. (Table 3) The average loss of kyphosis correction evaluated at 3, 6, and 12 months postoperatively was $1.5 \pm 3.6^\circ$, $2.9 \pm 5.2^\circ$, and $2.5 \pm 4.4^\circ$ in the short-segment group and $2.6 \pm 4.4^\circ$, $2.1 \pm 6.2^\circ$, and $2 \pm 4.8^\circ$ in the long-segment group, respectively (Table 3), with no significant differences between the two groups ($P > 0.05$).

There was no major complication in the perioperative period. There were four superficial wound infections that required culture and treatment with intravenous antibiotics. There were two cases of deep wound infection in the long segment group.

Implant failure was defined as construct

bending, breakage, loosening or pullout. This was recognized in five patients (12.5%). Three of these had short segment fixation and two had long segment fixation. In three patients failure occurred after bony fusion and the system of fixation was removed. In the remaining two patients revision of spinal fixation was done.

Table 1. Pre-operative Data of The Study Group.

Parameters	Short Segment (N=20)	Long Segment (N=20)	Total (N=40)
Male/Female	15/5	13/7	28/12
Age/yr	27.3	29.2	28.8
Fractured level:			
T11	2	1	3
T12	7	6	13
L1	8	10	18
L2	3	3	6
Follow-up/ months	18	24	21

Table 2. Peri-operative Data of the Study Group.

Parameters	Short segment (N=20)	Long segment (N=20)
Blood Loss (ml)	450±60	750±80
Surgical Time (min)	120±20	140±50
Days in hospital	4.7±2.8	7.4±1.5

Table 3. Assessment of Clinical and Radiological Outcomes.

Parameters		Short segment (N=20)	Long segment (N=20)
Modified Mc Nab Criteria	Excellent	4 (20%)	6 (30%)
	Good	12 (60%)	10 (50%)
	Fair	4 (20%)	3 (15%)
	Poor	0	1 (5%)
Preoperative mean kyphotic angle		20±5.2°	25±5.4°
Postoperative mean kyphotic angle	Immediate	2.6±11.9°	5.3±5.8°
	3 months	4.1±13.2°	7.9±7.4°
	6 months	7±10.9°	10±7.7°
	12 months	9.5±11.3°	126.5°
Postoperatively loss of kyphosis correction	3 months	1.5±3.6°	2.6±4.4°
	6 months	2.9±5.2°	2.1±6.2°
	12 months	2.5±4.4°	2±4.8°

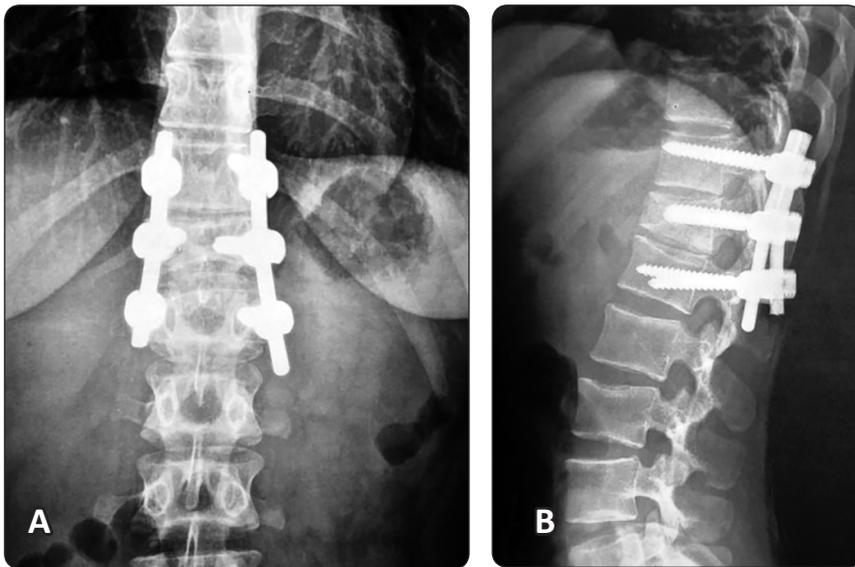


Figure 1.

Six months postoperative follow-up X-ray AP (A) and lateral (B) views of the dorsolumbar spine, with bilateral transpedicular screw fixation of the fractured D12 vertebra with preserved coronal and sagittal balance.

Discussion

Various surgical methods have been used for the treatment of thoracolumbar burst fractures; among them, long-segment posterior pedicle screw fixation was commonly used. Baaj et al,² conducted a study of biomechanical stability of posterior fixation in unstable thoracolumbar junction fractures and reported that long-segment constructs were superior to short-segment constructs with fractured -level included and that short-segment constructs with fractured-level included were superior to those without fractured-level constructs.

Although long-segment pedicle screw fixation provides better biomechanical strength, short-segment (one level above and one level below the fractured vertebral body) including fractured-level pedicle screw fixation has also been widely used. Short-segment constructs provide the advantage of saving motion segments^{21,25,26,29,31}, and it requires a smaller incision and causes less spinal muscle damage during the surgery. Tezeren et al,²⁹ reported that although long-segment fixation had a better outcome of measurements of local kyphosis, sagittal index, and anterior vertebral height compression, short-segment fixation allows

for spinal stabilization while simultaneously preserving as many motion segments as possible, and there was no significant difference in the clinical outcome between short-segment and long-segment fixation. Kim et al,¹⁶ reported that short-segment pedicle screw fixation including the fractured vertebra is an effective surgical method for restoration and maintenance of vertebral column stability in thoracolumbar burst fractures in their study of predictive factors for a kyphosis recurrence following short-segment pedicle screw fixation. They reported the correction loss of $3.7 \pm 2.8^\circ$ of Cobb angle at the last follow-up. Kana et al,¹⁵ reported that reduction of unstable thoracolumbar injuries can be achieved and maintained with the use of short-segment pedicle screw fixation including the fractured vertebra, avoiding the need for anterior reconstruction.

Despite the merits of short-segment fixation, many surgeons have reported that early implant failure and loss of correction are the most important disadvantages of this surgical method.^{13,23,27} In the present study, the loss of kyphosis correction (1.5° , 2.9° , and 2.5° at each follow-up visit) could not be avoided with short-segment fixation. (Table 3) But in comparison

between the two groups, the loss of kyphosis correction progressed at each follow-up with no significant difference between both groups. Furthermore, according to the modified Mc Nab criteria, the clinical outcomes in the short-segment (80%) and long-segment group (80%) were “good” with no significant difference between the two groups.

Many surgeons believe that kyphotic deformity of the thoracolumbar spine precipitates poor clinical outcomes, but the relationship between these two factors is unclear. Some authors advocate that there is no proven association between kyphosis and back pain or functional impairment.^{5,24,33} Consistent with previous studies, the current study showed that loss of kyphosis correction was not significantly different between the long-segment and short-segment group. Kim et al,¹⁷ suggested that short-segment pedicle screw fixation without bone fusion following postural reduction can be an effective and safe operative technique in the management of selected young patients with unstable burst fracture. A 10-year follow-up study by Toyone et al,³⁰ suggested that the benefit of short-segment fixation without fusion for burst fractures involving neurological deficit is that it can preserve thoracolumbar motion without resulting in post-traumatic disc degeneration.

Conclusion

Short-segment pedicle screw fixation including the fractured vertebral body is as effective as long-segment pedicle screw fixation for the treatment of unstable thoracolumbar burst fracture.

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الملخص العربي

التثبيت بالمسامير العنقيه عن طريق الفقره المكسورة فى علاج الكسور الانفجاريه الصدرية القطنيه

البيانات الخلفية: تم استخدام التثبيت طويل القطاع فى علاج الكسور الانفجاريه الصدرية القطنيه لفترة طويله. ولكن مع عيوب فقدان مناطق حركيه كثيره ظهرت الحاجه لاستخدام تثبيت قصير القطاع فى علاج هذه الكسور

الغرض: توضيح النتائج الجراحيه واطهار خبرات الباحثين فى علاج الكسور الانفجاريه الصدرية القطنيه عن طريق التثبيت بالمسامير العنقيه عن طريق الفقره المكسور (تثبيت قصير القطاع) مقارنة مع التثبيت طويل القطاع .

تصميم الدراسه: دراسه لحالات اكلينيكيه على 40 مريض بالغ يعانون من كسور انفجاريه صدرية قطنيه

المرض والطرق: تم اجراء الجراحات من يونيو 2012 الى مايو 2016 . تم متابعه الاعراض والعلامات وملاحظه النتائج الاكلينيكيه. تم اجراء الجراحات اما عن طريق التثبيت بالمسامير العنقيه عن طريق الفقره المكسوره (تثبيت قصير القطاع) فى عشرين مريض مقارنة مع التثبيت طويل القطاع.

النتائج: كانت المجموعتين من المرضى متجانستين من حيث الخصائص الديموجرافيه. اظهر التثبيت قصير القطاع فقدان دم اقل وزمن اقل فى الجراحه. اظهرت المجموعتين نفس النتائج فى المحافظه على زاويه الانحناء والمحافظة على استبدال العمود الفقرى وكذلك فى النتائج الاكلينيكيه.

الاستنتاج: التثبيت بالمسامير العنقيه عن طريق الفقره المكسوره (تثبيت قصير القطاع) يعتبر طريقه جيده وتحمل نفس نتائج التثبيت طويل القطاع فى علاج الكسور الانفجاريه الصدرية القطنيه.