Comparison of long segment fixation versus short segment fixation with pedicle screws at the level of the fracture in the management of Thoracolumbar fractures

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Abstract

Background Data: long segment fixation have been frequently used for management of thoracolumber burst fractures of the spine. Concerns about lost motion segment with this type of fixation made the suggestion for a shorter fixation method.

Purpose: To assess ability of short segment pedicle screw fixation to correct deformity, maintain correction and prevent failure in comparison to the traditional long segment fixation.

Study Design: A comparative clinical case study.

Patients and Methods: A total of 46 patients presented with thoracolumbar burst fractures between 2008 and 2012. All cases were operated with posterior fixation and instrumentation. We classified patients into 2 groups, Group A were operated with long segment pedicle screw fixation, and Group B operated with short segment pedicle screw fixation including the fractured level. Fusion was done in all cases using spinous process and laminectomy bone.

Results: The study included 5 (10.9%) females and 41 (89.1%) males. Their age ranged from 24 to 64 years (mean 40 years). Group A (Long segment fixation) included 28 (60.9%) patients and group B (Short segment fixation) included 18 (39.1%) patients. No statistical significance was found between the choice of fixation method and the following parameters: preoperative kyphotic angle, postoperative kyphotic angle (immediate), postoperative kyphotic angle (last follow up), postoperative angle change (immediate) and postoperative angle change (last follow up). We assessed the amount of correction loss in relation to the initial degree of kyphosis correction. A statistically significant relationship could be found between the amount of initial kyphosis correction and amount of correction loss. It has been reported that a greater amount of initial kyphosis angle correction was associated with a lesser amount of correction loss. The implant failure rate was recognized in 5 patients (10.9%). Four of these cases were of the short segment category and one of the long segment category.

Conclusion: Short segment fixation using pedicle screw at the level of fracture, in the thoracolumbar burst fractures; provides comparable correction to long segment fixation. Correction loss can be minimized by proper selection of cases suitable for short segment fixation. Short segment fixation should be reserved to cases with mild to moderate degrees of initial kyphosis. (2013ESJ041)

Key Words: long segment, short segment, fixation, thoracolumbar spine, trauma

Introduction

Thoracolumbar burst fractures are among the common injuries resulting from fall from height and motor vehicle accident. Posterior spinal instrumentation is commonly used for surgical treatment of these fractures.[21] Traditionally, long segment pedicle screw fixation (at least two levels above and below the fractured vertebra) was the most frequently used method, promoting early ambulation and improving kyphosis.[1] With concerns raised about the loss of motion segments with long segment fixation, it was gradually replaced with short segment fixation (one level above and below the fractured vertebra).[15,2,18,19,20] However, many authors[6,13,17] reported high early implant failure rates as well as correction loss with this fixation method. It was suggested by some authors[15,12] that pedicle screw placement at the fractured level would increase load sharing ability and thus stability of the construct.

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

Between 2008 and 2012, 80 patients with the diagnosis of thoracolumbar burst fractures were operated. Forty six of these had no neurological deficit and were included in our study. The inclusion criteria were single level fractures between T10 and L3, kyphotic deformity exceeding 15 degrees, spinal canal compromise of 50% or more, and loss of 50% of anterior body height. We excluded from the study patients who were conservatively treated, those with multiple levels fractures and those with neurological deficits. All cases were operated with posterior pedicle screw fixation. We classified patients into 2 groups, Group A were operated with long segment fixation of at least 2 levels above and 2 levels below the fractured vertebra, and Group B operated with short segment fixation with placement of pedicle screws in the fractured level and one level above and below the fractured level (Figure 1).

Patients were selected for short segment whenever we were able to place safely a screw in the fractured vertebrae bilaterally. Patients with kyphotic angles greater than 25% were fixed with long segment fixation. 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. We performed laminectomy at the level of fracture in all cases. Fusion was done in all cases using spinous process and laminectomy bone. Patients had X-rays in the first postoperative day to assess proper screw placement and kyphotic angle reduction, after one, three, six months and one year.

Results

The study included 5 (10.9%) females and 41 (89.1%) males. Their age ranged from 24 to 64 years (mean 40 years). Group A (Long segment fixation) included 28 (60.9%) patients and group B (Short segment fixation) included 18 (39.1%) patients.

Kyphotic angle:

The preoperative kyphotic angle was 15-35° (Mean=21.5°) and reduced to 4-9° (Mean=5.7°) as seen on the immediate postoperative images. The calculated immediate postoperative angle change was 7-30° (Mean=15.8°). At the last follow up (after one year) the kyphotic angle ranged between 5 and 12° (Mean=8°). The angle change at last follow up was 1-29° (Mean=13.3°). The degree of loss of correction was calculated by subtracting the kyphotic angle at the last follow up from the immediate postoperative kyphotic angle, and this ranged from 0 to 9° (Mean=2.5°). In only two cases, there was no loss of correction and in both long segment fixation was used. A summary of the pre- and postoperative measurements for both fixation methods is shown in table 1.

A univariate and multivariate analysis was done, on the effect of the choice of fixation method on the following parameters: preoperative kyphotic angle, postoperative kyphotic angle (immediate), postoperative kyphotic angle (last follow up), postoperative angle change (immediate) and postoperative angle change (last follow up). No statistical significance was found.

We calculated the amount of initial kyphosis correction as follows: *Percentage of kyphosis correction=amount of correction (degrees)/initial kyphosis anglex100.* We decided that the assessment of the amount of correction loss in relation to the

initial degree of kyphosis correction would be more informative. So we calculated the percentage of correction loss from the initial kyphosis angle as follows: *Percentage of correction loss=correction loss (degrees)/initial kyphosis correctionx100.* In the majority of cases in which long segment fixation was used, the amount of kyphosis correction exceeded 70%. However, the method of fixation did not correlate significantly with the amount of kyphosis correction (P=0.2) (Table 2).

On the other hand, a statistically significant correlation could be found between the method of fixation and amount of correction loss on the last follow up (P=0.008) as shown in Figure 2. Greater amount of correction loss was more prone to occur with short segment fixation. However, the correction loss did not exceed 7° in the short segment fixation group. A statistically significant relationship could be found between the amount of initial kyphosis correction and amount of correction loss (P<0.0001). It was concluded that a greater amount of initial kyphosis angle correction was associated with a lesser amount of correction loss (Figure 3).

A univariate and multivariate analysis of the other factors affecting amount of initial kyphosis angle correction and amount of correction loss but no statistical significance was found.

Implant failure:

Implant failure was defined as construct bending, breakage, loosening or pullout. This was recognized in 5 patients (10.9%). Four of these had short segment fixation and one had long segment fixation. In three of the patients failure occurred after bony fusion with no clinical consequence. The fourth patient was a manual worker who had a fractured rod. The patient had gained 20 kg of weight during 3 months, which added stress to the system, and was reoperated with long segment fixation and weight reduction. The fifth patient suffered a fall from height one month after surgery resulting in broken rods, and was reoperated with long segment fixation (Table 3).Among the three cases in whom fusion had occurred one had long segment fixation and had 90% correction loss but with no clinical consequence so the implant was removed without any other interference. The other two cases had short segment fixation and the correction loss did not exceed 50% (max. loss was 7°) so only implant removal was performed.

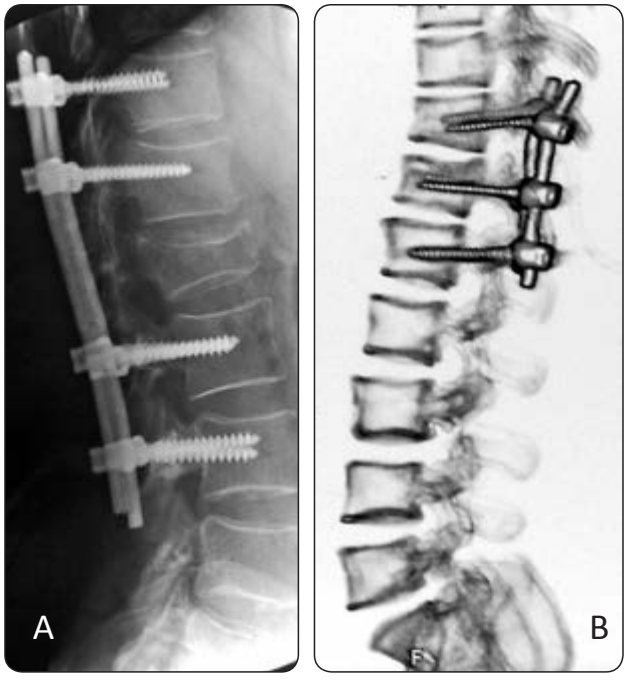

Figure 1. A: Plain radiograph lateral view and B: CT-scan sagittal reformat comparing the screw placement in long segment versus short segment fixation in our study.

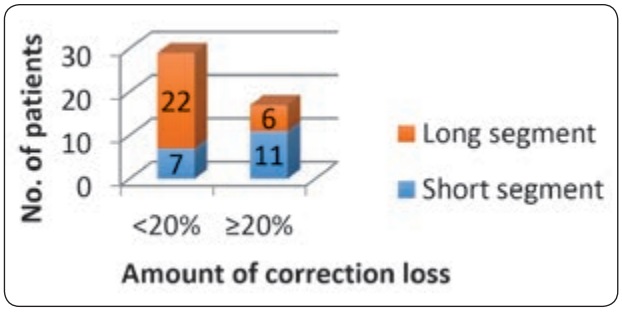

Figure 2. Correlation between the fixation method and amount of correction loss at last follow up.

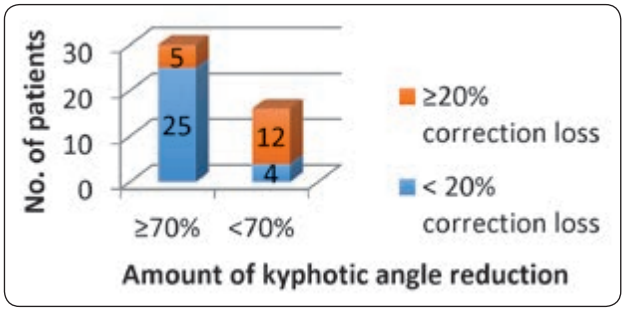

Figure 3. Correlation between amount of initial kyphotic angle correction and amount of correction loss at last follow up.

Table 1. Pre- and Postoperative Radiographic Parameters for Both Fixation Methods.

Parameters	Long Segment	Short Segment
PreOp kyphotic angle	15-35° (Mean=22.4°)	15-28° (Mean=20°)
PostOp kyphotic angle (Immediate)	4-9° (Mean=5.5°)	5-7° (Mean=5.8°)
PostOp kyphotic angle (Last F-Up)	5-12° (Mean=7.7°)	7-12° (Mean=8.4°)
PostOp angle change (Immediate)	7-30° (Mean=16.9°)	9-22° (Mean=14.2°)
PostOp angle change (Last F-Up)	1-29° (Mean=14.5°)	6-19° (Mean=11.6°)
Loss of Correction	0-9° (2.4°)	1-7° (2.6°)

Table 2. Correlation Between Fixation Method and Amount of Kyphosis Correction.

Fixation Method	Kyphosis Correction (%)		Total
	≥70	<70	
Short Segment	10 (56%)	8 (44%)	18
Long Segment	20 (71%)	8 (29%)	28
Total	30	16	46

Table 3. Reported Implant Failure in this Study.

Patient No.	Fixation Type	Failure Type	Reported fusion at failure time	Possible Failure Causes
1	Short segment	Caps loosening, rod slippage	Yes	Non-dynamic system
4	Short segment	Screw breakage	Yes	Non-dynamic system
11	Long segment	Screw pullout	Yes	Non-dynamic system
22	Short segment	Rod breakage	No	Rapid weight gain
23	Short segment	Rod breakage	No	Fall from height

Discussion

Short segment fixation limits the number of segments instrumented to the very minimum necessary to restore sagittal balance, stabilize the fracture and avoid interference with mid- and lower lumbar motion segments. An et al,[4] in a biomechanical study of L2 burst fractures, found no difference in construct stiffness between long pedicle screw constructs (two-above, two-below) and short-segment pedicle screw constructs.

Adding pedicle screws at the fractured vertebrae may theoretically stiffen the construct by splitting the length of the rod that spans from the upper screw to the lower screw into 2 half-length parts. A shorter rod between two points of fixation will create higher stiffness and the additional fixation point can theoretically decrease motion at the metal-bone interface.[5,9]

Guven et al,[12] found that correction and maintenance of the fracture was the best in long-segment fixation with fracture level screw combination. Fracture level fixation was most practical on short-segment fixation. Fixation level was increased while using fracture level screws in short-segment fixation, which lowered the loading force on each screw.

`Mahar et al,[15] concluded that an average of 15° of kyphosis correction could be obtained using limited posterior segmental fixation. This is likely better than traditional, non segmental pedicle screw fixation. This compared to our study in which the average amount of correction for short segment fixation was 14.2°. However, the amount of correction was slightly higher with long segment fixation (16.9°) but no statistical significance was found, which is similar to the findings of Guven et al,[12] who found no statistically significant difference regarding correction between long segment fixation and short segment fixation with pedicle screw at the fractured level. But still more than 70% of cases of long segment fixation had more than 70% kyphosis correction. On the other hand, short segment fixation and poor initial postoperative kyphosis correction were both significantly associated with correction loss. Our explanation may be that the insufficient initial kyphosis correction, which was more common among the short segment group, resulted in greater chance of correction loss. The greater residual kyphotic deformity provides higher anterior vertebral stress on pedicle screws. Thus, the overloading force on the instrument loosens the

screw, causing it to break, dislodge, and disconnect which are mostly seen in short-segment fixation.[6,7,17,18,19] This may lead us to deduce that in cases in which there is a large kyphosis angle or in which short segment fixation cannot produce sufficient kyphosis correction, long segment fixation should be resorted to, may with the inclusion of fractured level as Guven et al, [12] suggested.

Other studies[8,10,11,14] have reported Implant failure rate ranges from 2.5% to 19%. In the current study only two cases required revision of the screws due to extraordinary circumstances mentioned above. In the other three cases failure, bony fusion had occurred by the time of implant failure, the amount of correction loss did not exceed 50% in the short segment fixation group and in the only case of long segment fixation in whom correction loss exceeded 50%, the patient was symptom-free, so no further intervention beyond screw removal was done. Several studies[2,3,13,16,17] have considered 10° or more correction loss or implant failure as criteria of failure, reporting a rate of failure to be 40-45%. Taking these reports into consideration would make the failure rate in this study quite acceptable.

Conclusion

Short segment fixation using pedicle screw at the level of fracture, in the thoracolumbar burst fractures; provides comparable correction to long segment fixation. Correction loss can be minimized by proper selection of cases suitable for short segment fixation. That is cases with mild to moderate degrees of initial kyphosis. Also in cases in which the amount of kyphosis correction is insufficient with short segment fixation, the fixation should be extended including the pedicle of the fractured level to minimize the residual kyphosis.

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الملخص العربي

مقارنة معالجة كسور العمود الفقري الصدرية القطنية بالتثبيت المتعدد المستويات القطعة الطويلة مقارنة بالتثبيت للقطعة القصيرة

البيانات الأساسية: التثبيت طويل القطعة لكسور العمود الفقري للوصلة الصدرية القطنية تستخدم كوسيلة مستحبة لهذا النوع من الكسور. المأخذ الرئيس لهذا النوع من الجراحات هو افقاد المريض لجزء متحرك من العمود الفقري.

الهدف من الدراسة: بيان قدرة التثبيت قصير القطعة مع وضع مثبتات في الفقرات المكسورة على احداث نتائج متساوية مع التثبيت طويل القطعة لكسور الوصلة الصدرية القطنية.

تصميم الدراسة: دراسة مستقبلية لعدد ٤٦ مريض تم علاجهم علاج جراحي لكسور الوصلة الصدرية القطنية بالعمود الفقري في الفترة بين عام ٢٠٠٨ و٢٠١٢.

المرضى وطريقة البحث: تم اجراء جراحات خلفية لكل الحالات.تم تقسيم الحالات الى مجموعتين. الاولى للتثبيت طويل القطعة والثانية للتثبيت قصير القطعة مع وضع مثبتات في الفقرات المكسورة.

النتائج: الدراسة اشتملت على ٤١ ذكر بنسبة ٨٩.١ ٪ و٥ اناث بنسبة ١٠.٩ ٪. تراوحت الاعمار بين ٢٤ و٦٤ سنة عند اجراء الجراحة بمتوسط ٤٠ سنة. المجموعة الاولى اشتملت على ٢٨ مريض (٦٠.٩٪) والثانية على ١٨ مريض (٣٩.١٪). لم يوجد تميز بياني بين نوعي التثبيت والعوامل التالية: درجة انحناء العود الفقري قبل وبعد اجراء الجراحة مباشرة ودرجة الانحناء في اخر متابعة للمرضى ودرجات استعدال العمود الفقري. قمنا في الدراسة بقياس درجات فقدان الاستعدال ووجدنا ارتباط بياني بين درجة الاستعدال الاولى وفقدان الاستعدال في النوعين. توصلنا الى انه كلما زادت درجة الاستعدال الاولي في الجراحة كلما قل فقدان هذا الاستعدال عند المتابعة الدورية. حدث انهيار لانظمة التثبيت في خمسة حالات (١٠.٩ ٪) . اربعة منها للتثبيت قصير القطعة بنسبة ٨٠٪.

الاستنتاجات: التثبيت قصير القطعة للعمود الفقري مع وضع مثبتات في الفقرات المكسورة قد يؤدي لنتائج مضاهية لنتائج التثبيت طويل القطعة في حالات مختارة من كسور الوصلة الصدرية القطنية للعمود الفقري. التثبيت قصير القطعة يفضل في الدرجات البسيطة والمتوسطة من انحناءات العمود الفقري مع هذا النوع من الكسور.