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ORIGINAL STUDY

Is it possible to save one lumbar segment in the treatment of thoracolumbar fractures ?

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Surgical treatment of unstable thoracolumbar fractures is controversial. Most authors reported that short segment fixation led to a high incidence of implant failure and correction loss. On the other hand, long segment fixation has the disadvantage of fusing more segments. We aimed to compare the outcomes of long-segment fixation versus two or three levels above and one level below fixation for acute thoracolumbar fractures.

Twenty six consecutive patients were assigned to two groups. Group 1 included 14 patients treated with long fixation, whereas group 2 included 12 patients treated with two or three levels above and one level below fixation. Fractures were classified according to the Mc Cormack, Magerl and Denis classifications. Clinical (Oswestry questionnaire, Visual analog score) and radiological (Sagittal index, percentage of anterior body height compression, local kyphosis and Cobb angle) outcomes were analysed. The average follow-up for the long and hybrid fixation groups were 28 and 20 months respectively. Clinical scores of both groups at the last follow-up were not significantly different. The preoperative, postoperative and follow-up sagittal index, anterior body height compression, local kyphosis angle and Cobb angle were not significantly different. Correction loss of 3.36 degrees was seen in the long segment fixation group, versus 2.75 degrees in the other group at the last follow-up.

There was no significant difference between the results achieved in the patients who had transpedicular fixation two or three levels above and one level below the fractured vertebra and those who had long segment fixation for thoracolumbar burst fractures.

Keywords : thoracolumbar spine ; fracture ; burst ; surgery.

INTRODUCTION

The surgical treatment of unstable fractures of the thoracolumbar spine remains controversial. Short-segment posterior fixation is the most common and simple method, but in the long term, it has several disadvantages such as re-kyphosis or implant failure with moderate to severe pain (*2*). Long-segment posterior constructs are more stable against deforming forces leading to kyphosis or implant failure, but they have the disadvantage of fusing more segments (*17,24*).

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The Argenson method or 2HS-1SH construct is a special short construct of screws and hooks to fix the two vertebrae above the fracture and the first underlying vertebrae at the thoracolumbar junction fractures (*6,9*). We did not use Argenson's method because of its relatively high complication rate (*6,9*) but, after introduction of the segmental pedicle screw method, we fixed two or three levels above and one level below the fractured vertebrae to protect the construct from high kyphotic forces at the thoracolumbar junction as well as to save one lumbar spinal segment (*19*). We aimed to compare the outcomes of long-segment fixation versus two or three levels above and one level below fixation.

MATERIALS AND METHODS

In this retrospective study, we included 26 patients with acute thoracolumbar fractures, who underwent posterior pedicle screw fixation between December 2005 and March 2008 in our institution. Inclusion criteria were a single-level burst fracture through the T11-L2 vertebrae, < 3 weeks from the time of injury, sagittal index of more than 15 degrees and local kyphosis angle of more than 15 degrees. Patients with osteoporotic fractures, pathologic fractures, or neurologic injury were excluded from the study. The injuries were caused by a fall from a height in 19 cases, a motor vehicle accident in four cases and suicide in three cases. Following a routine examination and radiographs of the spine, computed tomography scan and magnetic resonance imaging of the involved vertebrae were carried out.

Patients were divided into two groups according to the fixation length. Until the end of 2006, we had performed long fixation. After this date, we started to perform two or three levels above and one level below fixation for thoracolumbar fractures. Group 1 included 14 patients treated with fixation two or three levels above and two levels below (long segment), and group 2 included 12 patients treated with fixation two or three levels above and one level below. All the operations were performed by one of the two authors, without any discriminations according to the fixation type. One of two spinal instrumentation systems (Tasarim, Istanbul, Turkey or TST, Istanbul, Turkey) was used in all patients. All patients were operated with a posterior approach using segmental pedicle screws. At surgery, the patients were placed in hyperextended prone position with the abdomen hanging free, thus preventing excessive intraoperative bleeding and achieving a significant initial reduction of the spinal fracture. All pedicle screws were inserted under C-arm guidance. Reduction of the fracture and indirect decompression of the spinal canal were accomplished by the rod contouring and extension and compression-distraction forces before tightening the screws. No discectomy or laminectomy was performed. After the fixation, posterior fusion was encouraged using autologous bone grafts. Patients were discharged after having mobilised without any braces.

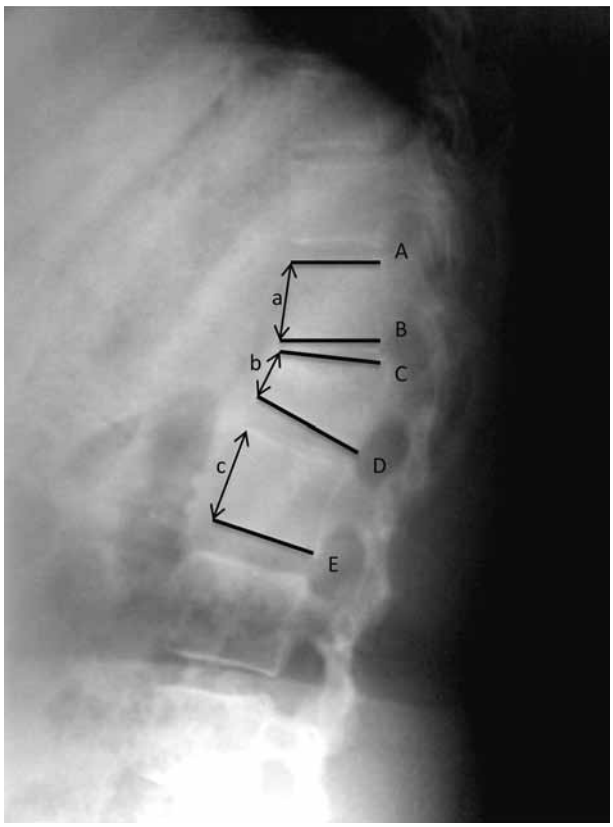

Fig. 1. — Radiographic measurements are shown on the lateral radiograph. Sagittal index was measured as described by Farcy *et al* (*10*) ; angle between lines B and D. Cobb angle is the angle between lines A and E. Local kyphosis angle is the angle between lines C and D. Anterior body height compression was calculated by referring the anterior body height of the fractured vertebral body (b) to the average anterior body height of the intact vertebral body above and below the fracture (a,c).

Clinical and radiographic follow-up was at 2, 4, 6 and 12 months and later once a year. Fractures were classified according to the McCormack (*16*), Magerl (*15*) and Denis classifications (*8*). At final follow-up, Oswestry

Table I. — Patients characteristics, distribution of fractures and radiological fracture classifications of both groups. The mean values in the Load-sharing classification [McCormack et al (16)] are shown. This classification system adds points to produce a total score determined by fracture communition, fracture displacement and need for correction. The Magerl and Denis classification systems are based on fracture mechanism and anatomic localization. MW : Mann-Whitney U test, χ^2 : chi-square test

		Long Fixation	Hybrid Fixation	MW	p
Age (years)		34.79 ± 16.79	34.33 ± 13.75	78.5	0.777
Sex	**Male**	8 (57.1%)	6 (50%)	χ^2 : 0.13	0.716
	Female	6 (42.9%)	6 (50%)		
Level	**T12**	6 (42.9%)	1 (8.3%)	χ^2 : 3.92	0.140
	L1	6 (42.9%)	8 (66.6%)		
	L2	2 (14.3%)	3 (25.0%)		
Magerl classification	**A1**	4 (28.6%)	3 (25.0%)	χ^2 : 2.6	0.457
	A2	1 (7.1%)	1 (8.3%)		
	A3	9 (64.3%)	6 (50.0%)		
	B1	0 (0.0%)	2 (16.7%)		
Denis classification	**A**	1 (7.1%)	1 (8.3%)	χ^2 : 2.58	0.274
	B	13 (92.9%)	9 (75.0%)		
	C	0 (0.0%)	2 (16.7%)		
Mc CormackLoad-sharing classification		5.36 ± 1.28	4.92 ± 1.93	38.5	0.309

Table II. —Clinical scores of two groups at last follow-up (MW:Mann-Whitney U test)

	Long Fixation	Hybrid Fixation	MW	p
Oswestry	2.29 ± 3.71	2.17 ± 2.79	67	0.791
VAS	1.07 ± 2.27	1.33 ± 2.27	79.5	0.598

questionnaire, Visual analog score were compared for each group. Radiologic parameters such as sagittal index (*10*), percentage of anterior body height compression , local kyphosis and Cobb angle were analysed on the preoperative, postoperative and last follow-up radiographs.

Statistics

Statistical testing was performed using Mann-Whitney U test and Chi-square test with NCSS 2007 pocket programme. Friedman's test was used for repeated measurements of multiple groups. A p value of 0.05 was considered significant.

RESULTS

The average follow-up for the long and short fixation groups was 28 and 20 months respectively. Posterior fusion was achieved in all patients. The two groups were similar in age, sex, localization, severity of the deformity and fracture type (Table I).

Clinical outcome was satisfactory in all cases. Clinical scores of both groups at the last follow-up are shown in Table II. Pain was absent or very mild in all the patients, with no significant difference between the two groups.

The preoperative, postoperative and follow-up sagittal index, anterior body height compression, local kyphosis angle and Cobb angle were not significantly different between the groups (Table III). There was a significant improvement in the postoperative measurements of sagittal index, anterior body height compression, local kyphosis angle and Cobb angle, compared to preoperative measurements ($p = 0.0001$). The correction loss was not significantly different between the two groups (3.36°

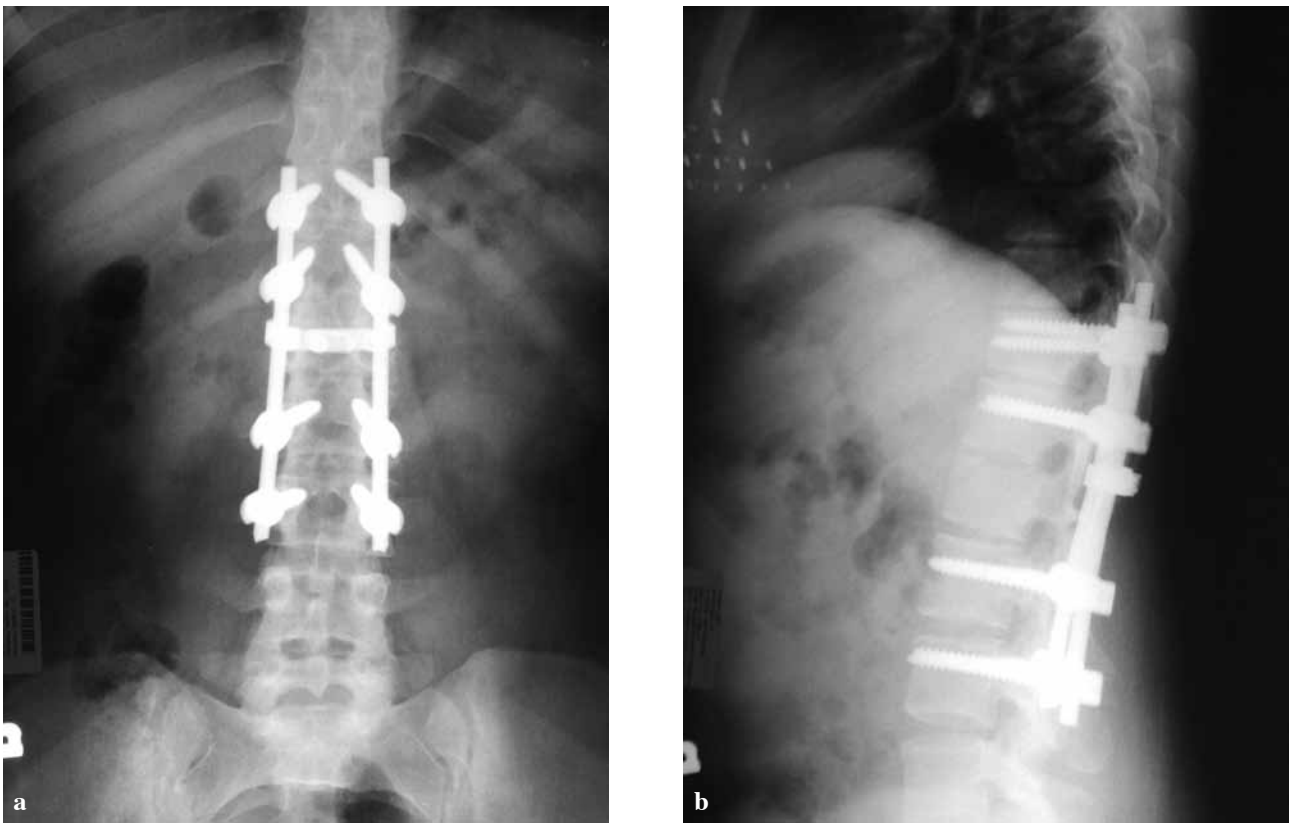

Fig. 2. — 20-year-old female treated with long segment instrumentation : (a) anteroposterior and (b) lateral radiographs at 30 months follow-up.

Table III. —Sagittal index, anterior body height compression, local kyphosis angle and Cobb angle comparisons of the two groups. MW : Mann-Whitney U test

		Long Fixation	**Hybrid Fixation**	**MW**	**p**
Sagittal index	**Preoperative**	19.21 ± 5.87	16.83 ± 4.76	62.5	0.267
	Postoperative	6.07 ± 3.54	8.33 ± 5.4	67	0.380
	Last Follow-up	9.14 ± 4.31	12 ± 5.69	54	0.121
Anterior body height compression	**Preoperative**	40.01 ± 13.96	37.49 ± 13.94	78	0.758
	Postoperative	17.23 ± 5.15	24.51 ± 15.64	54	0.123
	Last Follow-up	20.16 ± 9.13	30.69 ± 16.89	49	0.072
Cobb angle	**Preoperative**	16.07 ± 5.56	11.17 ± 7.86	55	0.135
	Postoperative	6.79 ± 5.04	6.75 ± 8.96	73.5	0.588
	Last Follow-up	11.36 ± 4.65	6.75 ± 9.05	58.5	0.189
Local kyphosis angle	**Preoperative**	20.21 ± 8.02	15.33 ± 5.66	53.5	0.116
	Postoperative	7.57 ± 3.65	8 ± 6.33	83.5	0.979
	Last Follow-up	10.93 ± 4.31	10.75 ± 6.06	80.5	0.857

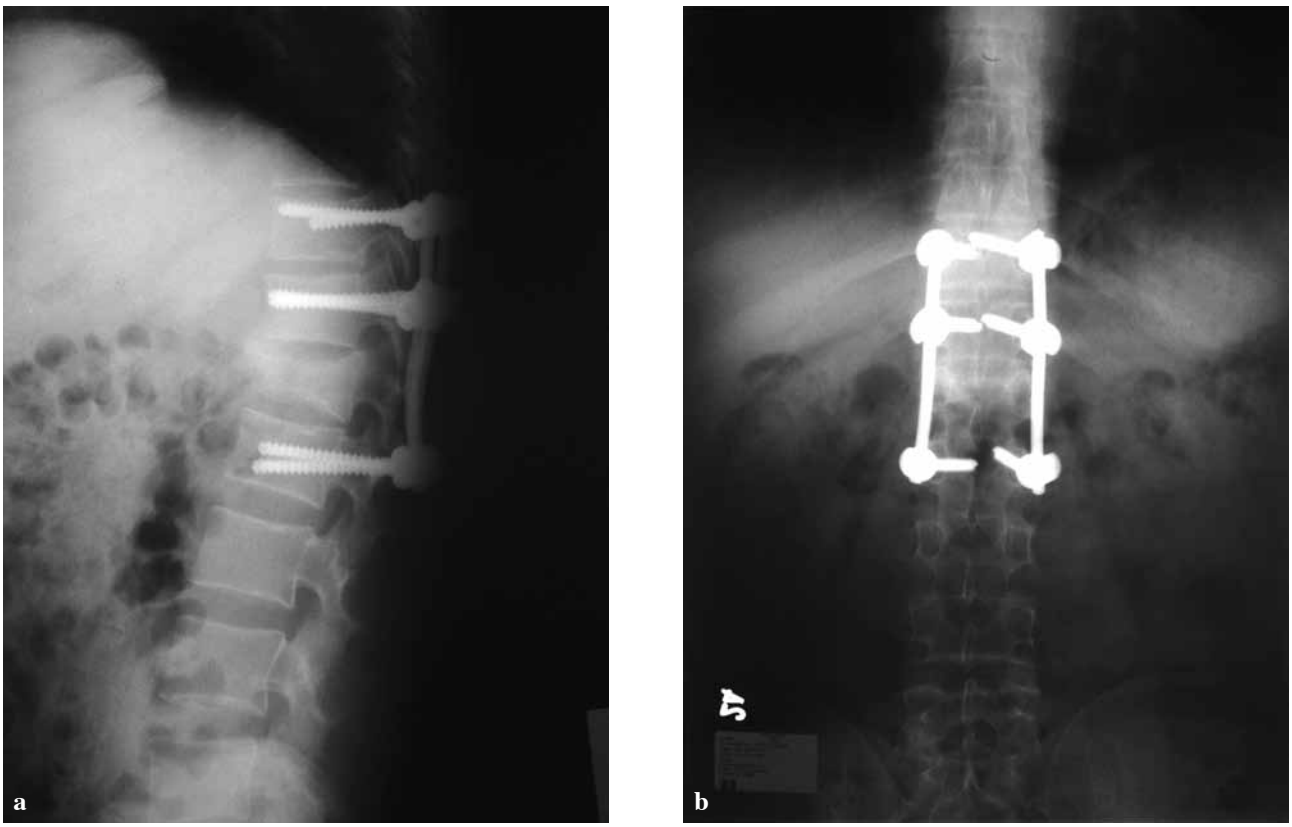

Fig. 3. — 45-year-old male treated with instrumentation two segments above and one segment below the fracture level : (a) anterior and (b) lateral radiographs at the last follow-up.

in the long segment fixation group and 2.75° in the other group). One patient in each group had a correction loss of greater than 10°. At the last follow-up, overall correction had significantly deteriorated in all parameters in both groups ($p = 0.0001$).

There was one superficial infection treated by debridement and antibiotics. Implant failure was not seen in either group. One patient required implant removal because of a prominent implant, after two years.

DISCUSSION

The results of this study show that, in fractures of the thoracolumbar junction, two or three levels above and one level below fixation is as effective as long segment fixation. The thoracolumbar area is unique in that it is a transitional area from a rigid kyphotic thoracic spine to a mobile, lordotic lumbar spine (*2,9*). Therefore short segment fixation does not provide adequate stability and may lead to kyphotic deformity and correction loss (*1,2,3,7,9, 14,18*). Katonis *et al* found that two levels above and one level below fixation of the fracture at the thoracolumbar junction and short segment fixation in the lumbar area provides stability and forms a rigid construct with no correction loss (*12*). Carl *et al* reported that segmental transpedicular fixation two levels above the kyphosis should be used at the thoracolumbar junction where compressive forces act more anteriorly, whereas in the more lordotic middle and lower lumbar spine where the compressive forces act more posteriorly, no implant failure occurred with use of the one above – one below construct (*5*). Consequently, we strongly suggest two or three segments above and one segment below fixation in the fractures of thoracolumbar junction.

The correction loss was not significantly different between the two groups at the last follow-up : 3.36° in the long segment fixation group versus 2.75° in the other group. Postoperative correction loss after posterior fixation has been reported by many authors to range between 0.3° and 15.4° (*1,3,7, 9,12,14,18*). Compared with posterior short-segment instrumentation, the average reduction in kyphosis was less in long-segment instrumentation (*1,3,7,9,12, 14,18*). In fact, kyphosis reduction and maintenance is best achieved by anterior surgery (*11*). However in many series, the degree of kyphotic deformity did not correlate with the clinical outcome (*13,20,23*). Similarly, the present study did not verify a correlation between kyphotic deformity and increased pain.

We did not experience any implant failure in our series. Tezeren and Kuru stated that short segment fixation had a high rate of failure ; on the other hand, long segment fixation prolonged the operative time and significantly increased blood loss (*22*). Altay *et al* also showed that short-segment fixation was associated with implant failure in their study (*2*). By shortening the construct at the bottom, we can reduce the risk of kyphosis recurrence without affecting implant stability. Furthermore, fusing more segments is not a big issue for the thoracic spine because of its relatively smaller motion capacity (*19,21*), whereas in the lumbar spine, every spinal segment is important for motion. Fixing both the thoracic and lumbar spine avoids overstraining the thoracolumbar junction with a tendency to lead to kyphosis (*4,21*). Steib *et al* stated that a short fixation exposes the thoracolumbar junction to overload even more if it is the junction between the fused and unfused segment (*21*). On the contrary, the construct should be shortened at the bottom (*19,21*).

Our study has some limitations : It was not randomised, the authors were not blinded, and the follow-up period was relatively short for some patients. Furthermore, the two groups of patients were operated at two different periods of time, while our technical expertise may have improved over time and this may have favoured the results in group 2. However, the strength of this study arises from the homogeneity of the patient groups ; they were similar in terms of age, activity levels, fracture type and fracture level. In addition, the same surgeons performed the same surgical techniques in both groups.

In conclusion, it is possible to save one lumbar segment in the treatment of thoracolumbar fractures. Fixation two or three levels above and one level below was as effective as long segment fixation in terms of correction loss, kyphosis recurrence and patient satisfaction. Some degree of correction loss was apparent, but it also occurred in the long segment fixation.

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