SURGICAL TREATMENT OF THORACOLUMBAR VERTEBRAL FRACTURES

(Comporison of the Instrumentation Systems With Hook - Rod, Tranpedicular Screw - Rod and Reverse Hook - Transpedicular Screw - Rod Combination)

Serhan ÖZLÜ* Erbil AYDIN* Mehmet ÇITAK*
Mert TÜZÜNER* İ. Teoman BENLİ* Serdar AKALIN*

Conservative treatment of unstable thoracal and lumbar vertebral fractures results in severe local kyphosis or changes in sagittal contours in long term follow-up. This study evaluates 89 thoracolumbar vertebral fractures operated between December 1989 and May 1993 in the orthopaedic Clinics of Ankara Social Security Hospital. The mean follow-up was 30.2 months with a minimum of 12 months. The stabilization of fractures were maintained with hook-rod construction in 28 patients in whom Cotrel-Dubousset Instrumentation (CDI) was used. Thirty patients had AO Fixator Intern; a transpedicular screw-rod construction. The vertebral fractures in the remainin 31 patients were stabilized with transpedicular screw-reverse hook-rod construction by using Texas Scottish Rite Hospital (TSRH) system. Preoperative sagittal index at the fracture level was 24.7°±6.5° in patients treated with CDI, 25.1°±8.2° with AO Fixator Intern and 28.7°±3.4° with TSRH system. Postoperative correction rates for CDI, AOIF and TSRH system were 66.8%±26.7, 68.4~±23.2 and 79.3%±19.5 respectively. Postoperative sagittal index at the thoracolumbar junction were in physiologic limits in all of the patients treated with TSRH system, while this rate was 70% for the AOIF and 64.3% for CDI. Because that the best spinal canal decompression and the lowest complication rate was achieved in the TSRH system group, it is concluded that transpedicular screw-reverse hook combinations is the best construction type for the stabilization of unstable thoracolumbar fractures.

INTRODUCTION

The most important cause of vertebral instability is trauma. According to Denis' 3 column theory, always 2 columns must be injured for instability (5). Instability is a risk for both neurologic compromise and progressive vertebral deformity. Treatment of vertebral instability is surgical correction, stabilization and fusion (8).

The aim of the surgical stabilization is to reduce the fracture, to gain vertebral stability and to increase the volume of neural canal either for neurologic healing or preservation of the neurological status (17).

In this paper we analysed the results of 89 surgically treated patients with three different spinal instrumentation systems.

PATIENTS AND METHODS

We evaluated the results of 89 thoracolumbar vertebral fractures treated surgically in 1st and 2nd Departments of Orthopaedics and Traumatology of Ankara Social Security Hospital between December 1989 and December 1992. Mean follow-up period was 42.6 months. 28 of the patients had Cotrel-Dubousset Instrumentation (CDI), 30 had Texas Scottish Rite Hospital Instrumentation (TSRH) and 31 had AO Internal Fixator Instrumentation (AOIF).

Mean age in the CDI group was 38.8 (15-59), female/male ratio was 12/16. Mean age in the TSRH group was 38.8 (26-50), female/male ratio was 6/24, and in the AOIF group mean age was 36.7 (15-52), female/male ratio was 10/21.

All patients were evaluated physically and neurologically on their admittance. In the neurological examination, motor and sensory examination, bulbocavernous reflex and sphincter control examination were performed. If a neurological deficit was observed the level was established and classified according to Frankel's classification (12). All the patients had routine laboratory tests and consultations. Plain radiography and CT was performed. Anterior compression percentage was established according to the criteria of Atlas et al (4). The angle between lines drawn from the lower end plate of upper vertebra and upper end plate of lower vertebra gave us the "local kyphosis angle" (Sagittal LKA ≠ SI Index-SI).

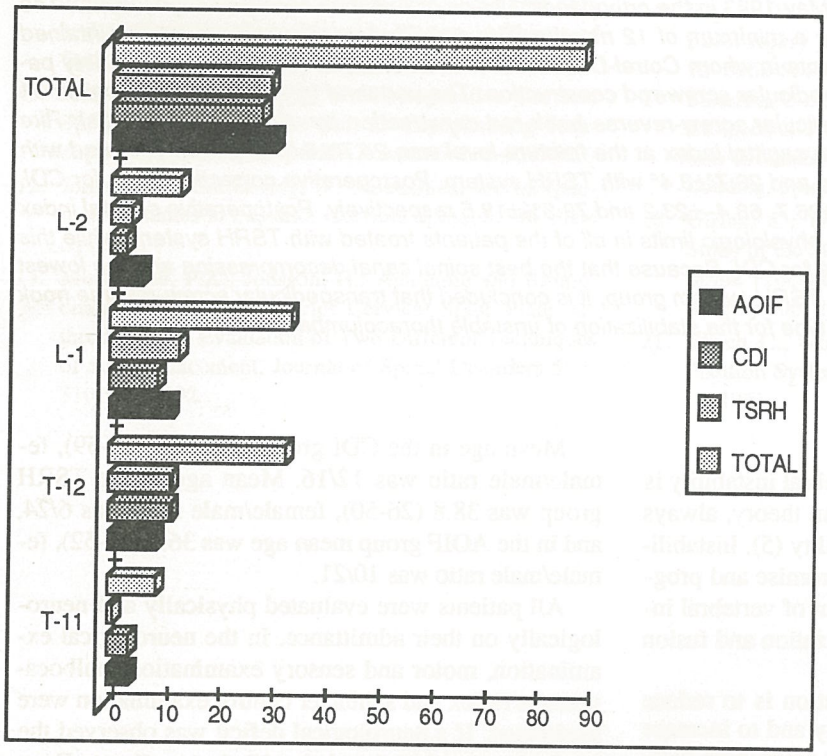
All the patient had CT evaluation preoperatively. The types of the fracture was established and classified according to Dennis. Spinal canal compromise was also evaluated with CT and percentage of compromise was recorded.

Indications for surgical reduction and internal fixation were anterior compression more than 50%, sagittal index more than 15°, spinal canal compromise

* 1st and 2nd Departments of Orthopaedics and Traumatology, Ankara Social Security Hospital, Ankara, Turkey.

Table 1. Distrubation of the patients according to fractured levels.

FRACTURED LEVEL	AOIF	CDI	TSRH	TOTAL
T-11	4	4	1	9
T-12	9	12	12	33
L-1	12	9	13	34
L-2	6	3	4	13
TOTAL	31	28	30	89



more than 30%, flexion distraction fractures, fractures with dislocation and fractures with neurologic compromise.

On the first postoperative day patients were rolled in bed, on the second day they set in their bed and on the third day they were encouraged to walk. Patients with neurologic deficit were encouraged to walk with walking aids, if they didn't have the potential of walking they were mobilized with wheel chair. On the postoperative 13th or 15th day sutures were taken, neurologically intact patients were sent home and the remaining patients were sent to rehabilitation clinic.

All the patients had their follow-up on 1st, 3rd, 6th and 12th postoperative months. After the first yer, follow-up was once in a year.

The patients were evaluated in three groups. In the first group there were patients instrumentated with CDI. In this group only hook-rod constructions were used. These 28 patients had at least 3 and at most 5 mobile segments were fused during the surgery.

The second was the AOIF group in which the fixation was maintained by transpedicular Schanz screw-rod construction. In this group of 30 patients only two mobile segments were fused.

In the third group TSRH instrumentation was used. Proximal part of the construction was either a transpedicular screw with or without an off-set hook or a transversopedicular claw and distal part of the construction was transpedicular screw with or without an off-set hook. In this group at least two at most five mobile segments were fused.

For evaluation preoperative and postoperative values of sagittal index, thoracolumbar junction angle, compression percentages, spinal canal compromise percentages were compared for all goups and the groups were compared with each other with "Difference of two groups' means" (t-test) statistically.

Implant insufficiency, complications, loss of correction were compared for all groups. Thus, according to this data we tried to find out the best construct combination instead of comparing the implant systems.

RESULTS

Distribution of the fracture levels are given in Table-1. 67 (75.3%) of 89 fractures were in T_{12} or L_1 vertebrae. Only the burst type vertebral fractures were included in the study.

Preoperative and postoperative SI, CP, SC values, correction and loss of correction percentages are given in Table-2, 3 and 4. The groups were statistically in-

Table 2. Pre (PR) and postoperative (PO) local kyphosis angles (SI) and correction percentages (COR%) and loss of correction values of SI (CL).

Instrumentation	SI			SI-L
	PR	PO	COR%	
AOIF	24.1° ± 9.1°	8.5° ± 6.1°	65.2 ± 22.1	8.5° ± 6.3°
CDI	23.7° ± 6.8°	10.2° ± 6.9°	67.1 ± 22.9	6.8° ± 3.8°
TSRH	28.5° ± 7.1°	6.1° ± 7.1°	78.7 ± 18.1	4.3° ± 3.9°

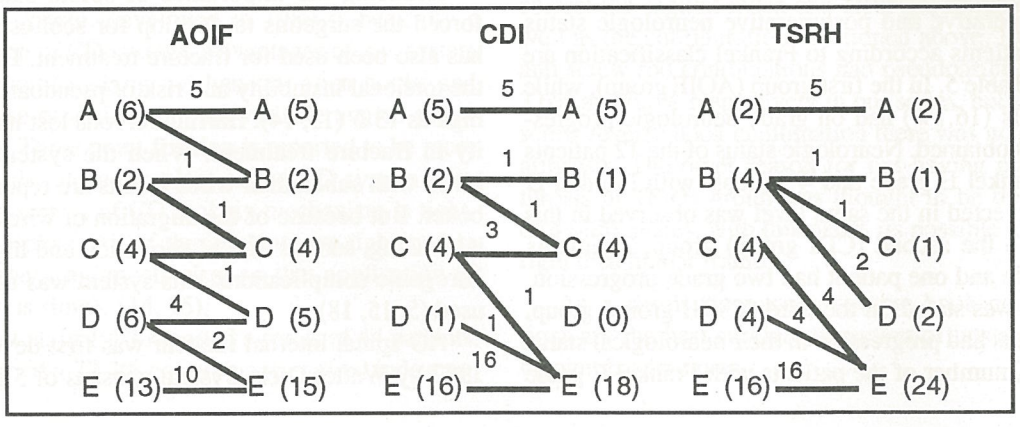
Table 3. Pre (PR) and postoperative (PO) compression of anterior vertebral body height values (CP) and correction percentages (COR%)

Instrumentation	CP		
	PR	PO	COR%
AOIF	52.1 ± 10.6	25.5 ± 7.9	50.9 ± 17.9
CDI	41.6 ± 20.6	24.3 ± 26.6	41.6 ± 16.6
TSRH	48.1 ± 14.3	48.1 ± 14.3	59.3 ± 11.1

Table 4. Pre (PR) and postoperative (PO) spinal canal compromise rates (SC) and postoperative percentages of correction (COR%) in SC.

Instrumentation	CP		
	PR	PO	COR%
AOIF	55.1 ± 15.4	33.1 ± 13.4	39.9 ± 16.1
CDI	48.7 ± 17.4	38.9 ± 13.2	38.9 ± 14.3
TSRH	49.8 ± 18.9	22.1 ± 18.9	55.6 ± 42.2

Table 5. Pre and postoperative neurologic status of the patients according to Frankel Classification.



significant preoperatively. Correction percentages of SI, CP and SC were found to be statistically significant in all groups. When the correction percentages were compared between the groups, there was a statistically significant difference in SI and SC but not in vertebral compression. The TSRH group, in which hook-rod and screw combination was used, had the best values in correction of sagittal index 79.3±19.5% of the patients were in physiologic limits. Between the remaining two groups there was not statistically significant difference in the correction of SI.

Thoracolumbar junctional angle, which is 0°, was found in 16 (51.6%) of the 31 patients treated with TSRH system and it was lower than 15° postoperatively in the remaining 15 (48.4%) patients. 15 degrees is said to be physiological upper limit.

In the hook-rod combination (CDI) group 18 (64.3%) of the 28 patients were within physiological limits postoperatively, and 7 (25%) of them had 0° thoracolumbar junctional angle.

In the screw rod (AOIF) group 21 (70%) out of 30 patients were in the physiological limits of thoracolumbar junctional angles postoperatively and 10 (33.3%) of them were 0°.

The corpus compression percentages are seen in Table 3. Although there was not a statistically significant difference between the groups in the correction of compression postoperatively, best values are held in the hook, screw, rod combination (TSRH) group (59.3±11.1%).

When correction of the spinal canal compromise (SC) is taken into account there was a statistically significant difference between the TSRH group and AOIF and CD group. Correction percentage of spinal compromise in TSRH group was 55.6±11.1% while it was 39.9±16.1% in the AOIF group and 38.9±14.3% in the CD group. Difference between AOIF and CD group were statistically insignificant.

Preoperative and postoperative neurologic status of the patients according to Frankel classification are seen in Table 5. In the first group (AOIF group), while 5 patients (16.7%) had on grade neurologic progression was obtained. Neurologic status of the 12 patients with Frankel E grade and 4 patients with Frankel D were protected in the same level was observed in this group. In the second (CDI group) group, 2 patients one grade and one patient had two grade progression (10.7%) was stated. In the third (TSRH group) group, 12 patients had progression in their neurological status (38.7%), number of the patients with Frankel E grade was increased from 16 to 24 (80%) was established. It was concluded that most potent construct in neurologic recovery was transpedicular screw-reverse hook construction.

Complications are seen in Table 4. Schanz screws of AOIF penetrated the anterior cortex in 4 patients and in 2 patients they were broken. One patient died because of pulmonary embolism on the postoperative 8th day. Because of deep infection in one patient construct was taken out. Two (6.6%) patients had pseudoarthrosis and they were revised with TSRH system. In the follow-up of these 2 patients after the revision there was a solid fusion.

In the CDI group the distal claw was put on the fractured vertebra mistakenly in one patient and the patient was revised on the postoperative third week. There was hook dislodgement in two patients. Two patients had deep infection in the first postoperative year and the construct was taken out. One patient had pseudoarthrosis and was revised with ISOLA instrumentation.

In the TSRH group there was solid fusion in all of the patients. Because of deep infection, instrumentation was removed in one patient on the postoperative 14th month. After implant removal the infection was eradicated by chemotherapy and the patient had a good solid fusion mass. Pull out of the proximal pediculotransvers claw was seen in one patient on the postoperative 3rd month. This patient was revised with transpedicular screws in the fractured and upper vertebrae. Also this patient had a solid fusion.

DISCUSSION

Conservative treatment of unstable thoracolumbar vertebral fractures usually result with collaps in the vertebral body, local kyphosis and malalignment of sagittal contour (5).

Realising the importance of spinal stability has forced the surgeons to develop for scoliosis surgery has also been used for fracture treatment. Because of the torsional instability and risk of pseudoarthrosis, as high as 13% (13, 14). Harrington rods lost its popularity in fracture treatment. When the system is combined with sublaminar wires results are reported to be better. But because of the migration of wires with axial loading, serious loss of correction and high risk of iatrogenic complications, this system was not widely used (5, 15, 18).

AO spinal internal fixateur was first developed in 1982 by Walter Dick. System consists of 5 mm thick

Table 6. Rate of complication of the patients according to different kind of instrumentation.

COMPLICATIONS		AOIF (n : 31)		CDI (n : 28)		TSRH (n : 30)	
		No.	%	No.	%	No.	%
IMPLANT FAILURE	ANTERIOR PENETRATION	4	13.3	-	-	-	-
	BREKAGE OF IMPLANT	6	20	-	-	-	-
	DISLOCATION OF HOOK	-	-	2	7.1	1	3.2
INFECTION		1	3.3	2	7.1	1	3.2
PSEUDOARTROSIS		2	6.6	1	3.6	-	-
EXITUS		1	3.3	-	-	-	-

Schanz screw connected to a 7 mm thick rod. High correction rates with this system were reported in literature. But the difficulty of applying the system to the thoracal region and high rates of screw breakage was reported (10, 11). Despite the advantage of short segment fusion it seems to be inappropriate in restoring the normal sagittal contours (5, 17).

CDI is one of the most widely used system around the world in recent years. In the thoracal and lumbar region the system presents a wide variety of options with its multiple hook and screw designs (7, 9). Weidenbaum and Farcy reported a 52.4% restoration in sagittal index (17). Benli et al reported a 67.1% correction rate in sagittal index (6). System was reported to take more resistant to torsional and axial loads and also to have low loss of correction (17).

TSRH system, developed in 1989 is basically a modification of CD system. Advantages of this system are three point locking mechanism, open hooks and screws, ease of aplication, and variable angled screw placement. Three point fixation is reported to be more rigid than the closed implant of the CD system even when both screws of CD looking mechanism is tightened and broken. All of the implants are tightened to rod with the same mechanism so that application of the system is simple (14, 15).

Altun et al, in 1993 reported a series of 44 patients. They reported a 77.7% correction in sagittal index and 53.7% correction in spinal canal compromise. Neurologic progression in their patients were 20.9 percent and loss of correction was minimal (2).

In this study instead of comparing the systems mentioned above we evaluated the implant combinations that was used in thoracolumbar fractures. Best results were with the proximal claw or screw and distal screw and reverse hook technique. With this technique we had 79.3% of correction of sagittal index and all the patients were in physiological limits of thoracolumbar junctional angle. This configuration gave us the best spinal canal clearence (55.6%) and best progress in neurological status (36.7%).

Hook rod or hook screw combinations couldn't correct the sagittal index and clear the spinal canal as well as the configuration mentioned above. Hook rod and screw rod combinations had pseudoarthrosis rate 3.6% and 6.6% respectively in our series, but in hook-screw reverse hook combination there was no pseudoarthrosis. The other reason for not having pseudoarthrosis in TSRH group was thought to be the strong cross-link plates, with this plates its possible to have a rigid rectangular frame.

As a result claw-screw-reverse hook configurations are the best surgical treatment of unstabile thoracolumbar fractures.

REFERENCES:

1. Akalın S, Kır M, Benli İ.T., et al: Results of the AO spinal internal fixator in the surgical treatment of thoracolumbar burst fractures. Eur Spine J 3: 102-106, 1994.
2. Altun N.S., Benli İ.T., Atik Ş, et al : Preliminary report of TSRH System in the treatmnt of unstable thoracal and lumbar spinal fractures. 19th World Congress, SICOT 93, Seoul, August 28- September 3, 1993.
3. Ashman RB, Herring JA, Johnston CE: Texas Scottish Rite Hospital (TSRH) Instrumentation System. In: The Textbook of Spinal Surgery, Ed: Bridwell KH, DeWarld RL, pp: 219-248, JB Lippincott Company, Philadelphia, 1992.
4. Atlas SW, Regenbogen V, Rogers LF, et al.: The radiographic characterization of burst fractures of the spine. AJR, 147: 575-582, 1986.
5. Bauer RD, Errico TJ: Thoracolumbar spine injuries. In: Spinal Trauma. Ed: Errico JJ, Bauer RD, Waugh T, pp: 911-957, JB Lippincott Company, Philadelphia, 1991.
6. Benli İ.T, Tandoğan NR, Kır M, et al: Cotrel-Dubousset Instrumentation in the treatment of unstabl thoracic and lumbar spine fractures. Arch Orthop Trauma Surg 113: 86-92, 1994.
7. Cotrel Y, Dubousset J: Instrumentation in Spine Surgery, pp: 109-111, Sauramps Medical, Montpellier, 1992.
8. Denis F: Spinal instability as defined by the three-column spine concept in acute spnal trauma. Clin Orthop, 189: 65-79, 1984.
9. Denis F, Winter RB, Lonstein JE: CD superiority in the treatment of frcture dislocations of the thoracic and lumbar spine. In: 6th International Congress on Cotrel-Dubousset Instrumentation. p: 11, Sauramps Medical, Montpellier, 1989.
10. Dick W: The "Fixatuer Interne" as a versatile implant for spine surgery. Spine 12 (9): 882-900, 1987.
11. Farcy JPC, Weidenbaum M, Glassman S.D.: Sagittal index in management of thoracolumbar burst fractures. Spine 15 (9): 958-965, 1990.
12. Frankel HL, Hancock DO, Hyslop G, et al: The value of postural reduction in the initial management of closed injuries of the spine with paraplegia and tetraplegia. Paraplegia, 7: 179-192, 1969.
13. Johnston CE II, Ashman RB, Sherman MC et al: Mechanical consequences of rod contouring and residual scoliosis in sublaminar segmental instrumentation. J Orthop Res 5: 206-213, 1987.
14. Montesano PX, Benson DR: Fractures and dislocations of the spine. The thoracolumbar spine. In: Rockwood and Green's Fractures In Adults. Ed: Rockwood CA Jr., Green DT, Bucholls RW. 3rd Ed, pp: 1358-1392, JB Lippincott Company, Philadelphia, 1992.
15. Sullivan JA: Sublaminar wiring of Harrington distraction rods for unstable thoracolumbar spine fractures. Clin Orthop Rel Res 189: 178-195, 1984.
16. Sutterlin CE: Appication of TSRH instrumentation in trauma. In: TSRH Universal Instrumentation. Ed: Ashman RB, Herring JA, Johnston CE, et al. pp: 115-134, Handley & Associates, Texas, 1993.
17. Weidenbaum M, Farcy JPC: Surgical management of thoracic and umbar burst fractures. In: The Textbook of Spinal Surgery. Ed: Bridwell KH, DeWald RL, 1st Ed., pp: 911-957, JB Lippincott Company, Philadelphia, 1991.
18. Wenger DR, Carollo JJ: The mechanics of thoracolumbar fractures stabilizd by segmental fixation. Clin orthop 189: 89-96, 1984.