Loss of Correction in Thoracolumbar Junction Fractures with Posterior Fusion

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Objective: A retrospective study evaluated clinical and radiological results of the patiens with thoracolumbar junction fractures who were operated with posterior instrumentation.
Method: In this study, the loss of correction in 20 consecutive patients who underwent posterolateral spinal fusion with Alici instrumentation for unstable thoracolumbar junction fractures was investigated. According to the outcome of the operations, patients were divided into two groups. The first group comprised those patients (12 patients= 60 %) in whom screws were successfully and correctly inserted and the second included the ones (8 patients, 40 %) with incorrectly inserted screws.
Radiological evaluation was done by measuring anterior height loss (AHL), kyphotic angle (KA) and sagittal index (SI) from conventional lateral radiography, also spinal canal occupation (SCO) from computerized tomography scans pre and postoperatively.
Results: There was statistically significant difference between postoperative AHL values of group 1 and group 2 (early postoperative value p<0.05, late postoperative value p<0.01) and also between early and late postoperative values in both groups (p<0.0001). Although there was no difference between two groups' early postoperative KA and SI values (p>0.05) late postoperative values (p<0.05) were different. On the other hand no statistically significant difference was demonstrated between two groups' postoperative SCO values (p>0.05).
All the patients except three, returned to their jobs following the operation. We have observed solid fusion both clinically and radiologically in all patients. Two patients have developed complications, one had a cerebrospinal fluid fistula, which later resolved spontanously and the other had serious infection and which required removal of the instrumentation.
Conclusion: Posterolateral fusion is recommended to provide original sagittal contour. In long term, functional recovery of patients may favour the surgical option for the treatment of these fractures, despite significant statistical difference between two groups in respect of loss of correction.

Key words: *Thoracolumbar junction fracture, Correction loss*

Thoracolumbar junction (T11-L2) fractures represent most of the spine fractures. Yet, treatment modality of thoracolumbar junction fractures remains controversial. Fracture with neurological or mechanical instability is usually treated surgically. Spine surgeons mostly advocate posterior fusion as the treatment of choice for unstable thoracolumbar junction injuries (1-5). However posterior instrumentation alone might cause implant failure, nonunion and especially loss of correction. In order to save correction, anterior fusion should be added in selected cases. These fractures have great tendency to produce a junctional kyphotic deformity.

Thoracolumbar joint fractures may result by falling, traffic and occupational accidents. These can often be accompanied by multiple organ injuries. The goal of this study was to asses loss of correction in thoracolumbar junction fractures which was operated by posterior fusion with Alici instrumentation.

Material and Method

In this study, 20 consecutive patients who were underwent posterolateral spinal fusion with Alici instrumentation for unstable thoracolumbar junction fractures between January 1995- January 1997 were evaluated according to loss of correction. We have divided our patients in two groups. The patients who had technically successful operations were included in group 1 and the patients whose operations suffered some technical defects, were included in group 2. Our technical defect criteria included any misplaced screws out of the pedicle with plain radiography or computerized tomography (CT) and those which penetrated less than 50 % of lateral distance of vertebral body. Twelve (60 %) patients were in group 1 and 8 (40%) patients were in group 2. Sixteen (80 %) patients were male and 4 (20 %) were female with an average age of 32. The youngest patient was 14 and the oldest was 75 years old. The patients had sustained their fracture due to fall from a height in 9 (45 %), traffic accident in 8 (40 %) and blunt trauma in 3 (15 %) cases. Mean trauma – surgery time was 44 hours (4 hours- 30 days). Each patient was evaluated with anteroposterior and lateral radiographs and CT scan. Kyphotic angle, vertebral body height and sagittal index of each patient's radiographs were evaluated preoperatively and following postoperative 1st week, and 24th month. Also dimensions of spinal canal were evaluated pre- and postoperatively with CT (Table 1).

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Table I. Distrubition of the cases and radiological parameters.

	Name	Sex	Level	Age	PAH (%)	EPAH (%)	LPAH (%)	PKA º	EKA º	LKA º	PSI º	ESI º	LSI º	PSCO (%)	LSCO (%)
1	IK	M	T12	30	38	87	85	19º	9º	11º	19º	9º	11º	25	0
2	AC	F	L1	14	30	78	76	15º	0º	4º	15º	0º	4º	10	0
3	SS	M	L1	32	46	85	78	23º	12º	18º	18º	7º	13º	10	0
4	KA	M	L2	18	44	84	84	21º	8º	8º	21º	8º	8º	40	20
5	ME	M	T12	44	35	84	80	18º	8º	12º	18º	8º	12º	45	30
6	SK	M	T12	56	52	86	84	28º	18º	18º	38º	28º	32º	50	20
7	AA	F	L1	32	45	86	82	25º	10º	14º	20º	5º	9º	25	10
8	CT	F	L1	28	35	88	81	19º	6º	12º	14º	1º	7º	20	0
9	SZ	M	L2	43	53	88	86	27º	12º	12º	27º	22º	22º	25	10
10	KT	F	L1	75	42	81	80	20º	8º	8º	20º	8º	8º	50	20
11	MI	M	L2	45	70	96	92	38º	26º	27º	48º	36º	37º	80	50
12	SO	M	T12	22	65	90	88	35º	22º	22º	25º	12º	12º	70	40
13	AM	M	T12	21	41	80	78	20º	14º	15º	25º	19º	20º	30	10
14	SD	M	L1	40	35	78	68	17º	13º	16º	17º	13º	16º	20	10
15	CT	M	L1	51	35	76	70	18º	12º	16º	23º	17º	21º	50	20
16	AS	M	T12	17	68	84	81	34º	24º	26º	44º	34º	36º	75	40
17	HA	M	L2	20	39	86	78	20º	21º	23º	30º	31º	33º	50	30
18	SO	M	L1	22	40	84	75	21º	18º	21º	21º	18º	21º	25	20
19	AC	M	L1	31	44	71	60	25º	10º	16º	25º	20º	26º	10	0
20	KA	M	L2	23	51	82	72	27º	15º	21º	22º	10º	16º	20	10

M: Male F: Female
PAH: Preoperative anterior height loss, EPAH: Early postoperative anterior height loss, LPAH: Late postoperative anterior height loss, PKA: Preoperative kyphotic angle, EKA: Early postoperative kyphotic angle, LKA: Late postoperative kyphotic angle, PSI: Preoperative sagittal index, ESI: Early postoperative sagittal index, LSI: Late postoperative sagittal index, PSCO: Preoperative spinal canal occupation, LSCO: Late postoperative spinal canal occupation, º : degree

Table II. Mean radiological values.

Groups	Preoperative Mean (minimum-maximum)	Early Postoperative Mean (minimum-maximum)	Late Postoperative Mean (minimum-maximum)
Group 1 AHL	46%(30%-70%)	86%(78%-96%)	83%(76%-92%)
Group 2 AHL	44%(35%-68%)	81%(71%-92%)	73%(60%-81%)
Group 1 KA	24º(15º-38º)º	12º (0º-26º)	14º (8º-27º)
Group 2 KA	23º (17º-34º)	16º(10º-24º)	19º (15º-26º)
Group 1 SI	24º (14º-48º)	12º (0º-36º)	15º (4º-37º)
Group 2 SI	26º (17º-44º)	20º (10º-34º)	24º (16º-36º)
Group 1 SCO	38%(30%-70%)	17%(0%-50%)	-
Group 2 SCO	35%(10%-75%)	18%(0%-40%)	-

AHL: Anterior height loss, KA: Kyphotic angle, SI: Sagittal index, SCO: Spinal canal occupation

Table III. Distrubition of postoperative pain and work status of the patients

Pain Status	Number of patients	Work Status	Number of patients
P1	1	W1	1
P2	3	W2	3
P3	2	W3	2
P4	4	W4	4
P5	5	W5	5

Figure 1 a,b,c: Preoperative, early and late postoperative radiological appearance of a case

The level of fractures were shown in Table I. There were 11 (55 %) burst fractures, 4 (20 %) compression fracture, 3 (15 %) fracture dislocations and 2 (10 %) flexion – distraction injuries. Neurological examination was graded according to Frankel's Scale (6). Three (15 %) patients were evaluated as Frankel A, 1 (5 %) Frankel B, 1 (5 %) Frankel C, 2 (10 %) Frankel D and 13 (65 %) Frankel E. Three (15 %) patients had concomitant upper extremity fractures, 3 (15%) lower extremity fractures, 3 (15 %) head injuries and 2 (10 %) chest trauma. Fifteen patients had 1, 3 patients 2 and 2 patients 3 operations with mean operation time of 3 hours and 24 minutes (2-6 hours). We have performed posterior fusion with Alici instrumentation by harvesting autogenous iliac spongious bone graft in all patients.

A standart posterior approach to the spine was used to expose the site of fracture and the area was stabilized with pedicle screws. In all cases, a cross link system was used to create a quadrilateral construct that provided increased resistance in torsional forces (Figure 1).

Continous variables were tested for normal distrubition by Kolmogorov-Smirnov 1-sample test. The statistical significance of differences between mean values was tested with paired and unpaired t test as apropriate. A 2-tailed p value of <0.05 was considered significant.

Results

Mean follow up period of patients was 22 month (13-42 months). Postoperative improvement was not detected in any patients categorized as Frankel A. All other patients but one who improved from Frankel B to D, were Frankel E. No neural complication was detected after treatment which was confirmed by myelo-CT in doubtful cases.

Radiological Evaluation:

Anterior Height Loss: There was statistically significant difference between postoperative values of group 1 and group 2 (early postoperative value p<0.05, late postoperative value p<0.01) and also between early and late postoperative values in both groups (p<0.001).

Kyphotic Angle: Although there was no significant statistical difference between two groups' early postoperative values (p>0.05); there was a difference in late postoperative values (p<0.05). Also difference was detected between early and late postoperative values of both groups (p<0.01).

Sagittal Index: Although there was no significant statistical difference between two groups' early postoperative values (p>0.05), late postoperative values (p<0.05) were found to be different. Also difference was detected between early and late values of both groups (p<0.01).

Spinal Canal Occupation: As we did not request CT scans in the last follow-ups, we have no late postoperative values. There was no statistically significant difference between two groups' postoperative values ($p>0.05$). However difference was demonstrated between pre- and postoperative values of both groups (group 1, $p<0.001$; group 2, $p<0.01$) (Table II).

Postoperative pain and work status of the patients were evaluated according to Denis's scale (7). This is a five level scale from no pain (P1) to constant, severe pain (P5) and from return to heavy labor (W1) to completely disabled (W5). Our patients' distrubition was shown in Table III. All the patients except three returned to their preoperative jobs.

Two patients have developed complications, one had a cerebrospinal fluid (CSF) fistula, which later resolved spontaenously and the other had serious infection, which required removal of instrumentation.

We had no implant failure in follow up period and despite moderate loss of correction, solid fusions were attained clinically in all patients.

Discussion

Thoracolumbar junctional fractures usually result from axial compression with an associated flexion moment creating a kyphotic deformity in a normally lordotic spine (8). The spine is in kyphosis from L2 and above and axial loads therefore tend to be combined with significant compression of the anterior elements, causing more kyphosis. So, these regional fractures frequently tend to develop kyphosis and one of the aim of the treatment has to be the establishment of original sagittal contour. Loss of correction after surgery might often develop.

After Harrington's instrumentation system, posterior transpedicular screw fixation system was first reported by Boucher in 1959 (9). Later, many systems were reconstructed. These systems control segmental motions in three dimensions, preserve motion segments, avoid long fusions and provide a more stable construct (4,10). The function of transpedicular screw system is to preserve the contour until bony union is achieved. However, a relatively high rate of instrumentation failure has been reported (1,11,12).

Achieving a technical success does not itself justify classifying results as satisfactory after spinal fusion. Evidence for the improvement of the technical outcome by the addition of internal fixation is still unsatisfactory (13,14).

Misplacement of pedicle screw has been reported with unacceptable frequency (15-17). Esses et al (18) reported various complications associated with pedicle screw placement. The most common intraoperative problem was unrecognized screw misplacement in 5.2 % of cases and fracture of the pedicle and CSF leakage in 4.2 % of cases during screw insertion. In current study, 7 (15 %) of 48 screws were detected as misplaced in group 2, which was quite high as screw misplacement, especially in our initial cases. Also one case had a CSF fistula which later resolved spontanously (2.0 %).

Knowledge of the morphometric characteristics of the pedicle is essential for successful pedicle screw fixation. Krag et al (19) has shown that the visualization of the pedicle is reliable with preoperative CT. They advice preoperative CT examination to help choosing appropriate screw diameter before surgery (19). Odgers et al (21) used intraoperative plain radiographs and postoperative CT scans to determine the accuracy of 238 screws inserted from T11 to L5. Twenty four screws penetrated the pedicle and 2 screws penetrated the anterior vertebral body cortex (overall success rate, 89.1%). Castro et al (22) concluded that CT scans are useful for evaluation of postoperative radicular syndromes after lumbar transpedicular fixation. Although Farber et al (23) reported that CT showed 10 times as many screws violating the pedicle cortex as did radiographs which alone may not accurately show pedicle screw placement. Sapkas et al. (16) have shown that in the assessment of proper placement, no statistically significant difference was found using plain radiographs and CT imaging for evaluation of pedicle screw position after surgery. They suggest postmyelographic CT imaging for evaluation of postoperative neurologic deficit in patients undergoing instrumented thoracic and lumbar spine fusion with pedicle screws (16). Pedicle medial violation has been reported in rates varying from 6 % to 28 % (15,20). In their series although a medial violation may occur, the exacerbation of neurologic status is uncommon (5-7 %). Reserve space before nerve root damage occurs is up to 4 mm or even up to 6 mm (22). In the current study, despite high screw misplacement rate, no neurologic exacerbation was observed. Thus this result confirms that opinion.

Loss of immediate postoperative deformity correction after transpedicular screw fixation, ranging from 2.5 degress to 7.1 degress have been reported by several authors (1, 24-26). In the series of Katonis et al (2), the mean loss of SI correction was $2.7^{o} \pm 1.8^{o}$. Their explanation about this loss of correction was a possible distension of the adjacent intervertebral disc above and below the repaired vertebra during the ligamentotaxis (In the current study, mean loss of SI in whole cases was $6.3^{o} \pm 4.7^{o}$ in group $1.9^{o} \pm 3.1^{o}$ and in group 2, $2.2^{o} \pm 3.8^{o}$). In the current study, mean loss SI in whole loses was $6.3^{o} \pm 4.7^{o}$; $9^{o} \pm 3.1^{o}$ in group I and $2.2^{o} \pm 3.8^{o}$ in group 2. These results showed that serious difference of correction loss appeared in group 2 due to technical failure.

In order to prevent implant failure of transpedicular system some authors advices additional hook fixation under the lamina of the inferior pedicle screw level and one level above the cephalad pedicle level (2). The hooks afford less rigid fixation, allowing absorption of some of the stress that may give rise to a fatigue fracture of the screw, while simultaneously opposing pull-out forces which are very strong in the thoracolumbar area. However we had no experience about this technique.

In the study of Katonis et al. (2) thoracolumbar and lumbar sagittal contours were restored within physiological limits in 97 % of the patients. A mean final correction of 28.6 % and 72.3 % was obtained in compression percentage and Gardner angle, respectively. Their opinion about postoperative correction is that the Cotrel-Dubousset instrumentation with the transpedicular screws control the anterior and middle column of the instrumented spine much better than hooks, which are applied to the posterior osseous spinal elements (2).

Thoracolumbar junctional area is very important in providing sagittal mechanical contour. In long term probable kyphotic angulation will lead to the gravity center ventralization.

One of the most important goals of the surgery is the neurologic stabilization of the patients. In our study, no patient attained a poorer status postoperatively.

Posterolateral fusion is recommended to provide original sagittal contour. In long term, functional recovery of patients may favour the surgical option for the treatment of these fractures despite significant statistical difference between two groups in respect to loss of correction and we can express that there was no significant correlation between radiological and clinical results.

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