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• Original Article •

Treatment of Thoracolumbar and Lumbar Unstable Burst Fractures by Using Combined and Posterior Surgery

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Purpose: The purpose of this research was to analyze the results of the combined and posterior approaches for treating thoracolumbar and lumbar burst fractures and to find an adequate method of treatment.

Methods: We retrospectively analyzed the cases of 46 patients with unstable thoracolumbar and lumbar burst fractures who had been surgically treated. All cases were divided into two groups based on the operation method used. Eleven patients had undergone the combined approach, while 35 patients had undergone the posterior approach. Radiological and clinical evaluations were performed before surgery, after surgery, and at the final follow-up.

Results: The stenotic ratios of the area occupied by the retropulsed bony fragments to the estimated area of the original spinal canal were 68.2% and 45.6% for the combined and the posterior approaches, respectively. No significant differences in the neurological improvement or the corrected state of the sagittal index were noted, but the patients who had been treated with the combined approach group had better results than those who had been treated with the posterior approach group in terms of correction and maintenance of the sagittal index. The average kyphosis corrections at the final follow-up were 15.3 degrees for the patients in the combined approach group and 10.0 degrees for those in the posterior approach group. Surgical time and estimated blood loss were all significantly higher for patients in the combined approach group.

Conclusion: The combined and the posterior approaches showed similar results in the improvements of the neurologic state and the corrected state of the sagittal index. However, use of the combined approach is recommended for patients with severe kyphosis and with severe canal encroachment. [J Trauma Inj 2016; 29: 14-21]

Key Words: Unstable burst fracture, Posterior approach, Combined approach

I. Intorduction

Unstable burst fractures of the thoracolumbar and lumbar spine often require surgical treatment by internal fixation.(1) Generally posterior fixation method is most commonly used, but the anterior fixation method is preferred in the case of severe neural canal involvement by bony fragment. The goals of surgical treatment of thoracolumbar spinal fractures include: 1) decompression of the spinal canal and nerve roots to facilitate neurological recovery, 2) restoration and maintenance of vertebral body height and alignment, 3) obtaining a rigid fixation to facilitate nursing care and to allow early ambulation and rehabilitation, 4) prevention of development of posttraumatic progressive deformity with neurological deficit, and 5) limiting the number of instrumented vertebral motion segments.(2)

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There are many previous studies for the treatment results of unstable thoracolumbar and lumbar burst fractures using the anterior and posterior fixation method, but there are also many different opinions for the optimal treatment method of unstable burst fractures. The aim of this study was to analyze the surgical treatment results of unstable thoracolumbar and lumbar burst fractures by comparing the patients treated by combined anterior-posterior surgery and by posterior surgery only.

II. Materials and Methods

1. Patients

Forty six consecutive patients with thoracolumbar or lumbar unstable burst frature that underwent internal fixation were retrospectively reviewed. The surgeries were performed between January 2009 and December 2014. The study inclusion criteria were traumatic thoracolumbar or lumbar unstable burst frature, and at least 1 years of postoperative radiographic follow-up. The osteoporotic spine fractures due to minor trauma were excluded to limit the impact of osteoporosis on the selection of surgical method. There were 27 male and 19 female patients. The mean age was 40 years (range, 19-58). The mechanism of injury was fall from a height in 31 of the patients, traffic accident in 13, and other mechanisms in 2. Surgical indications were incomplete motor neurologic deficit or instability.

2. Preoperative evaluation and operative timing

All patients had preoperative anteroposterior and lateral radiographs and CT scans. 41 patients (89.1%) had MRI evaluation before undergoing spine surgery. The mean time from injury to surgery was 6.9 days. 13 patients (28.3%) underwent surgery in less than 24 hours after injury, 33 patients (71.7%) underwent surgery in more than 24 hours after injury

3. Spine fracture classification and level

Fractures were classified according to the AO classification system using the radiographs and CT scans. The AO system allows the classification of essentially any injury into a triad of descriptors, reflecting a progressive scale of injury and instability. There are 3 fundamental injury patterns determined by radiographic criteria. Type A represents compression injuries, with damage to the anterior/middle columns. Type B is characterized by anterior and posterior element injuries (3-column) with distraction. The more severe Type C lesions involve anterior and posterior element injuries, with a superimposed rotational deformity resulting from axial torque.(1) In this study, 0 patients were classified in type A (0%), 33 in type B (71.7%), 13 in type C (28.3%). The fracture levels were seven T12 (15.2%), thirteen L1 (28.3%), twelve L2 (26.1%), six L3 (13%), 8 L4 (17.4%), and 0 L5 (0%).

4. Radiologic and neurologic evaluation

The kyphosis angles were measured on lateral radiographs before and after surgery and at the final follow-up. Regional kyphosis was measured from the inferior endplate of the intact vertebra just above to the superior endplate of the intact vertebra just below the fracture (Fig. 1).(3) Mean preoperative regional kyphosis measured 9.0 degrees (range, -8.4

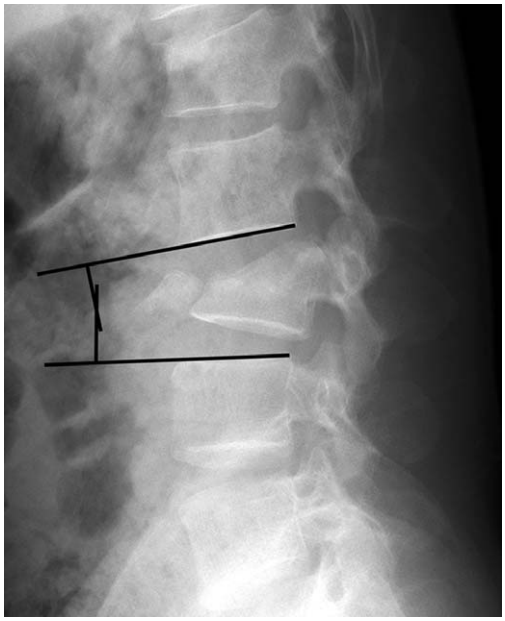

Fig. 1. Regional kyphosis was measured from the inferior endplate of the intact vertebra just above to the superior endplate of the intact vertebra just below the fracture.

to 27). This improved to a mean −5.5 degrees (range, −26.5 to 7.6) kyphosis at the early postoperative radiograph. Final radiographs showed a mean −2.3 degrees (range, −21.6 to 9) of kyphosis. Average follow up period was 15.9 months for the posterior-only surgery group and 14.2 months for the combined anterior and posterior surgery group.

Fig. 2. Ratio of the area of the bony fragments retropulsed into the spinal canal (B) to the estimated area of the original spinal canal (O). B is cross-sectional area of the bony fragments, and O is the estimated crosssectional area of the original spinal canal. The ratio (RBO) is B/O × 100 (%)

Canal compromise was estimated from preoperative CT scans according to the method of Hashimoto (Fig. 2).(4) On the CT slice where the canal was narrowest, the area original spinal canal was estimated (O), and the area occupied by the bony fragments retropulsed into the spinal canal was measured (B). We calculated the ratio (B/O X 100%).

Preoperative and postoperative neurologic status was evaluated using the Frankel impairment scale. Of the 46 patients assessed, 18 (39.1%) were classified as E, 8 patients (17.4%) were classified as D, 15 patients (32.6%) were classified as C, 3 patients (6.5%) classified as B, 2 patients (4.3%) classified as A.

5. Operative procedures

1) Posterior only surgery

Total 35 patients (76.1%) were fixed with pedicle screws and rods posteriorly (Fig. 3). There were 21 male and 14 female patients. The mean age was 39.9 years (range, 19−58). The fracture levels were all between T12 and L5, six T12, seven L1, eleven L2, four L3, seven L4, zero L5. One patient (2.9%) had a complete neurologic deficit and 18 patients (51.4%)

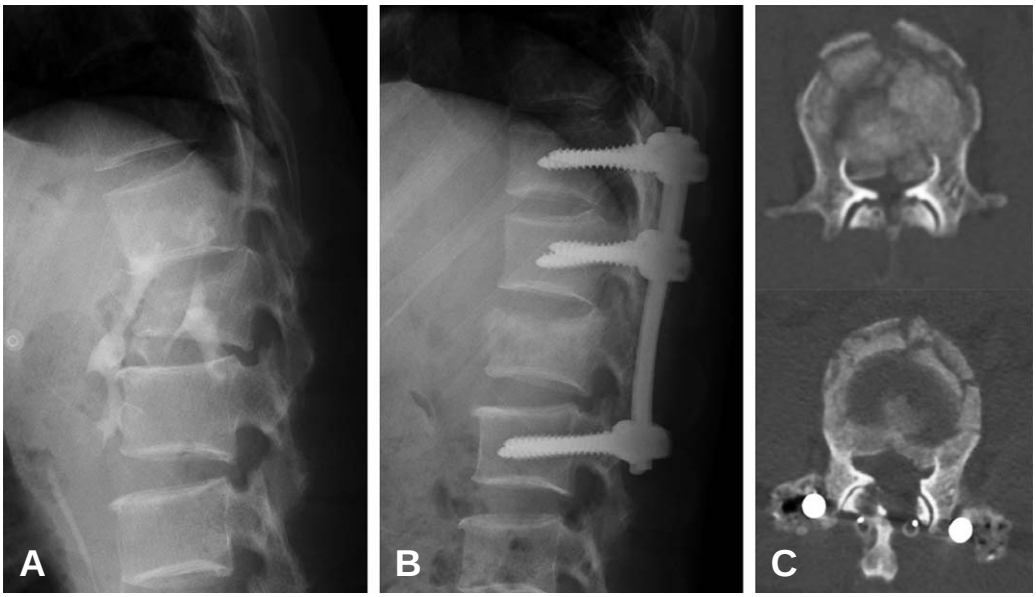

Fig. 3. A 41-year-old man with AO type B and incomplete neurologic deficit. (**A**) Lateral radiograph with segmental kyphosis. (**B**) Postoperative radiograph after posterior surgery. (**C**) Pre- and postoperative CT axial images shows marked decompression of bony fragment in the spinal canal.

had an incomplete deficit, whereas 16 patients (45.7%) were neurologically intact.

2) Combined anterior and posterior surgery

Total 11 patients (23.9%) were treated with anterior decompression, expandable cage placement and posterior fixation using pedicle screws and rods (Fig. 4). There were 6 male and 5 female patients. The mean age was 38.7 years (range, 20–55). The fracture levels were all between T12 and L5, one T12, six L1, one L2, two L3, one L4, zero L5. One patient (9.1%) had a complete neurologic deficit and 8 patients (72.7%) had an incomplete deficit, whereas 2 patients (18.2%) were neurologically intact.

6. Statistical analysis

The statistical analysis was performed with SPSS for windows version 18.0 (SPSS Inc, Chicago, USA). We measured the continuous variable means by

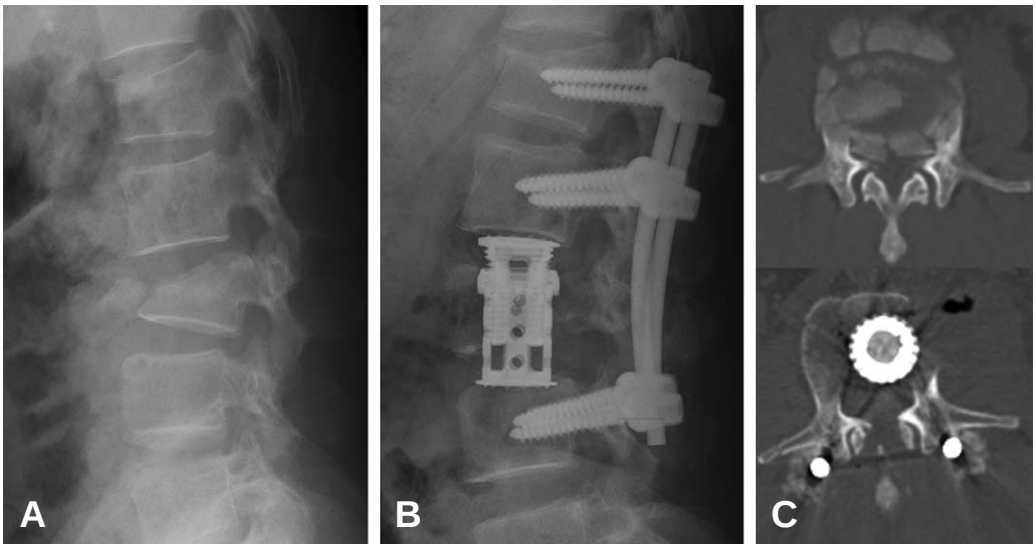

Fig. 4. A 43-year-old man with AO type B and incomplete neurologic deficit. (**A**) Lateral radiograph with anterior translation and segmental kyphosis. (**B**) Postoperative radiograph after anterior and posterior surgery. (**C**) Pre- and postoperative CT axial images shows complete decompression of bony fragment in the spinal canal.

Table 1. Patient demographics and preopertive parameter.

Surgical method	Combined anterior-posterior surgery	Posterior surgery	*p* value
No. of patients	11	35	
Age (mean ± SD)	30.5 ± 14.8	39.9 ± 11.4	0.278
Mean follow-up (days)	478.3 ± 43.6	428.6 ± 35.2	
Male:female ratio	6:5	21:14	
Cause of injury			
fall	8	23	
traffic accident	3	10	
other	0	2	
Neurological status (Frankel grade)			
A	1	1	
B	1	2	
C	7	8	
D	0	8	
E	2	16	

using paired t-test and associations of two categorical variables were defined by using chi-square test. The p value<0.05 was considered to be statistically significant.

III. Results

Preoperative patients data are presented in Table 1 and 2, and postoperative data are summarized in Table 3. In the posterior-only surgery group, segmental kyphosis was corrected from a mean of 7.2 to -6.2 degrees at early postoperative period and maintained at -2.8 degrees at the time of the last follow-up. So the mean corrected angle was 13.4 degrees (p<0.001) and 10 degrees (p<0.001) in the early postoperative period and the last follow-up, respectively. In the combined anterior and posterior surgery group, the initial mean segmental kyphosis was 14.7 degrees and was corrected to -3.2 degrees at early postoperative period and maintained at -0.6 degrees at the time of the last follow-up. So the mean corrected angle was 17.9 degrees (p<0.001) and 15.3 degrees (p<0.001) in the early postoperative period and the last follow-up, respectively (Table 3).

Neurologic deterioration did not occur in any patient. Seventeen of 35 patients (48.6%) with incomplete

Table 2. Fracture level, fracture type by AO classification.

Surgical method	Combined anterior-posterior surgery	Posterior surgery	*p* value
No. of patients	11	35	
Level of injury			
T12	1	6	
L1	6	7	
L2	1	11	
L3	2	4	
L4	1	7	
L5	0	0	
Fracture classification (AO)			
A	0	0	
B	7	26	
C	4	9	
Mean RBO* (SD) (%)	68.2 (12.2)	45.6 (19.4)	0.001

RBO: the stenotic ratios of the area occupied by the retropulsed bony fragments to the estimated area of the original spinal canal

Table 3. Outcome of surgical treatment for unstable burst fractures.

Surgical method	Combined anterior-posterior surgery	Posterior surgery	*p* value
No. of patients	11	35	
Regional kyphosis (mean ± SD)			
preoperative	14.7±6.7	7.2±10.5	0.033
early postoperative	-3.2±7.0	-6.2±10.7	0.380
Change from preoperative	-17.9±5.8	-13.4±6.7	0.058
follow-up	-0.6±7.1	-2.8±10.2	0.504
Change from preoperative	-15.3±5.8	-10.0±8.3	0.059
Neurological improvement ≥ 1 Frankel grade	7	17	0.383
Operation time (minutes)	567.2	305.8	<0.001
Estimated blood loss (ml)	1063.6	498.5	<0.001
Complications			
infection	0	1	
instrumentation failure	0	1	

injuries improved at least 1 Frankel grade at follow-up in posterior only surgery group, and seven of 11 patients (63.6%) with incomplete injuries improved at least 1 Frankel grade at follow-up in combined anterior and posterior surgery group.

There were no statistically significant differences in the neurological improvement (p=0.383) and finally corrected state of kyphosis between the 2 groups (p=0.504). But the mean corrected angle of kyphosis was different at the early postoperative period (posterior only group: 13.4 degree, combined anterior and posterior surgery group: 17.9 degree, p=0.058) and at the last follow-up (posterior only group: 10 degree, combined surgery group: 15.3 degree, p=0.059).

The mean surgical time was 305 and 567 minutes (p<0.001) for posterior only surgery and combined surgery groups, repectively. The median estimated blood loss was 498 mL for the posterior only surgery group and 1063 mL for the combined surgery group (p<0.001).

No neurological or vascular complications were encountered in both groups. There were no intra- and postoperative complications in the combined anterior and posterior surgery group. Whereas postoperatively superficial wound infection was seen in 1 patient, and 1 patient needed additional anterior decompression surgery for the insufficient posterior decompression in the posterior alone surgery group. During the follow-up period, implant-related complication (2 screws pull-outs) occurred in 1 patient in the posterior alone surgery group. This patient was revised successfully. At the time of last follow-up there were no signs of implant failure in any of the patients.

IV. Discussion

The main goal of surgical treatment of thoracolumbar or lumbar spinal fractures is decompression of the spinal canal and nerve roots to facilitate neurological recovery and achievement of spinal stabilization with rigid internal fixation.

Several surgical techniques have been introduced for this goal, but optimal treatment for these injuries is controversial. Although some surgeons prefer to utilize posterior indirect decompression and instrumentation techniques others advocate an anterior-only approach to directly decompress the neural elements followed by internal fixation. Still others recommend a combined anterior and posterior approach.(1) The main advantages of the anterior approach are that it allows direct visualization and decompression of the neural elements, and that it allows for direct reconstruction of anterior column support with a load-sharing construct. But patients with pulmonary compromise or morbid obesity may also limit the ability to use an anterior approach. While the obvious advantage of the posterior approach is its familiarity to all spine surgeons, the relative ease at placing pedicle screw instrumentation, and the biomechanical strength of posterior pedicle screw constructs. The approach avoids potential injury to intraabdominal or retroperitoneal structures that are at risk during anterior exposures and the morbidity of performing a thoracotomy and/or taking down the diaphragm to access injuries at the thoracolumbar junction.(5) Moreover, posterior surgery has the advantage of being faster, less expensive and causing less blood loss. In this study, we performed the posterior only surgery if neural decompression was thought to be possible with posterior approach. Our data showed that the technique of decompression (direct or indirect) does not influence the rate of neurological improvement statistically. And some other reports also reported that there were no significant differences in Frankel grade improvement between anterior and posterior surgery.(6-8) However, our result should be interpreted with some caution, because the combined surgery group had more severe narrowing of spinal canal.

In radiologic evaluation, both groups could make about 15 degree of regional kyphosis correction. The mean corrected angle of kyphosis was more in combined surgery group at the early postoperative period and at the last follow-up. The secondary loss of kyphosis correction was not significantly different between both groups. However, data reported in the literature have shown that long-term loss of correction of 1~4 degrees after the anterior approach is reportedly less than after the posterior approach.(9-13) Payer(13) reported that posterior correction usu-

ally achieves complete kyphosis correction, but secondary loss of correction of between 7~16 degrees down to the initial posttraumatic angle is observed predominantly within the first postoperative year, and is mainly due to a collapse of the upper disc and upper half of the burst vertebral body. The use of anterior decompression and anterior instrumentation has the advantages to allows complete decompression of the neural elements, and direct reconstruction of anterior column support with a load-sharing construct at the same time.(14-18) However, the biomechanical study of a single anterolateral fixation reported that the use of an additional dorsal fixation device should be considered for stabilization of a ventral bisegmental defect.(19)

In this study, we fixed 2 levels above and 1 level below the fracture for posterior instrumentation. Posterior instrumentation usually requires fixation of pedicle screws 2 levels above and below the fracture. Advances in spinal instrumentation led to the development of short-segment spinal instrumentation to avoid fusion of uninjured motion segments. The definition of short-segment posterior fixation is controversial. Typically, this refers to fixation 1 level above and 1 level below the fracture (2-motion segments). Some reports comparing long and short segment fixation for thoracolumbar fractures reported that the short segment fixation showed similar postoperative results with conventional posterior instrumentation.(20-22) Moreover, the short segment fixation can minimize spinal levels requiring fusion and have less perioperative morbidity and reduced hospitalization time. Although this approach has several advantages, it has been associated with loss of surgical reduction and instrumentation failure. Although the fixation using pedicle screws is rigid, loss of correction and metal failure can occur by repetitive transmission of body weight if the anterior column is not reconstructed. Some reports indicated instrumentation related problems like loss of correction, implant failure and bony failure after short segment fixation without anterior column reconstruction.(23,24) In this study, there was 1 case of implant-related complication (2 screws pull-outs) in the posterior alone surgery group during the follow-up period, which was revised successfully by extension of fusion below initial level of fusion.

V. Conclusion

In this study, no statistically significant difference was detected between two types of surgery performed in thoracolumbar and lumbar unstable burst fractures in terms of neurologic improvement and radiologic evaluation of kyphosis. Both would be effective treatment methods if they are performed in appropriate cases. The authors recommend the use of combined anterior and posterior surgery in cases of severe neural canal invasion by bony fragment or severe kyphotic deformed state. Otherwise, it is thought to be appropriate performing the posterior only surgery to minimize the surgery time and blood loss.

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