DOI: 10.5137/1019-5149.JTN.19363-16.1
Received: 28.10.2016 / Accepted: 22.12.2016
Published Online: 19.01.2017

Turk Neurosurg 28(2):282-287,2018

Original Investigation

Risk Factors and Compression and Kyphosis Rates after 1 Year in Patients with AO type A Thoracic, Thoracolumbar, and Lumbar Fractures Treated Conservatively

Feyza KARAGOZ GUZEY[1], Burak EREN[1], Azmi TUFAN[1], Ozgur AKTAS[1], Cihan ISLER[2], Mustafa VATANSEVER[1], Abdurrahim TAS[1], Eyup CETIN[1], Murat YUCEL[1], Mustafa ORNEK[1]

[1]University of Health Sciences, Bagcilar Training and Research Hospital, Neurosurgery Clinic, Istanbul, Turkey
[2]Istanbul University, Cerrahpasa Medical Faculty, Department of Neurosurgery, Istanbul, Turkey

ABSTRACT

AIM: Conservative treatment is a frequently used treatment modality for traumatic thoracolumbar fractures. However, not many studies evaluating radiological and clinical results of conservative treatment are found. The aim of this study was to determine the risk factors, and compression and kyphosis rates after 1 year in patients with AO type A thoracic, thoracolumbar, and lumbar fractures treated conservatively.

MATERIAL and METHODS: Radiological and clinical results of 79 thoracolumbar fractures in 57 patients, who were treated conservatively, were evaluated one year after trauma. Fractures were classified according to thoracolumbar injury classification and severity (TLICS) score and AO spinal trauma classification system. Compression rate, wedge and kyphosis angles, and sagittal index were calculated in early and late periods after trauma.

RESULTS: Female/male ratio was 25/32, and mean age was 41.7±16.7 years. They were followed for 15.2±4.9 months. Mean compression rates were 19.6% and 25.2%; wedge angles were 10.1 and 12.7 degrees; kyphosis angles were 5.82 and 8.9 degrees; and sagittal indexes were 8.01 and 10.13 in all patients just after trauma and after one year, respectively. Fractures in older patients (>60 years of age) and in patients with osteopenia or osteoporosis, located in the thoracolumbar junction, AO type A2 and A3 fractures, and solitary fractures had higher compression and kyphosis rates at last follow-up.

CONCLUSION: Early mobilization without bed rest for stable thoracolumbar fractures according to the TLICS system is a good treatment option, and radiological and clinical results are usually acceptable. However, fractures in patients older than 60 years, those with osteoporosis or osteopenia, fractures located in the thoracolumbar junction, solitary fractures, and fractures in AO type A2 or A3, are more inclined to increase in compression and kyphosis and may require a closer follow-up.

KEYWORDS: AO spinal trauma classification system, Conservative treatment, Spinal trauma, TLICS system

INTRODUCTION

Traumatic spinal fractures are quite common lesions. In recent years, there has been a trend towards conservative treatment instead of surgery for thoracic, thoracolumbar, and lumbar fractures. This is partly due to the widening usage of a new classification system, thoracolumbar injury classification and severity score (TLICS), described by Vaccaro et al. (7). In this system, most type A fractures of the Arbeitsgemeinschaft für Osteosynthesefragen (AO) classification system, even burst-type fractures in the thoracolumbar junction that had usually been operated on before, are classified within the conservative treatment group

Corresponding author: Feyza KARAGOZ GUZEY
E-mail: fkarag@yahoo.com

if the posterior ligamentous complex is intact. However, in the literature, there are not many studies evaluating radiological and clinical results of patients having been treated conservatively.

In our clinic, we also follow conservatively patients with AO type A thoracic, thoracolumbar, and lumbar fractures if the posterior ligamentous complex is intact and if instability criteria are not met. In order to investigate the long-term results of these patients being followed conservatively, we planned this retrospective study.

■ MATERIAL and METHODS

Hospital records and radiological investigations of patients with traumatic thoracic (T), thoracolumbar (TL), and lumbar (L) fractures followed conservatively in our hospital between January 2011 and April 2015, were evaluated retrospectively, and patients whose radiological control investigations (X-ray study, computerized tomography (CT), or magnetic resonance imaging (MRI)) after 1 year or longer existed in the radiology archive of our hospital, were included in the study. Osteoporotic fractures (AO type A1.3) were excluded, while other type A (A1.1, A1.2, all A2 types and all A3 types) traumatic fractures were included.

In the study period, a total of 345 patients with AO type A fractures (except A1.3) were followed conservatively; however, only for 57 of them radiological control studies after more than 1 year were available in the archive. Therefore, those 57 patients with 79 vertebral fractures were enrolled in this study.

Age, gender, number and locations of fracture, follow-up time, time of usage of corset, time of return to work, and symptoms and signs in the last follow-up of all patients were recorded in the hospital charts. Compression rate (C), wedge angle (W), and regional kyphosis angle (K) were measured and sagittal indexes (S) were calculated on both early posttraumatic and last follow-up radiological investigations for all fractured vertebrae as described by Jiang et al.(3) and as shown in Figures 1A and 1B. In addition, differences between first and last compression rates, wedge angles, regional kyphosis angles, and sagittal indexes were calculated. MRI with short tau inversion recovery (STIR) sequence in the early period after trauma was routinely performed in our clinic for all thoracolumbar spinal injury patients, and therefore, the posterior ligamentous complex was evaluated with MRI in these patients.

The variables were compared according to gender, age, presence of osteopenia or osteoporosis, location (thoracic–T1 to T10, thoracolumbar–T11 to L1, and lumbar–L1 to L5), and also the presence of one or multiple fractures.

For statistical analysis, average and standard deviation were calculated for countable variables, f and Student t tests were used to compare countable variables, and chi-square and Fisher's exact tests were used for uncountable variables according to their subject numbers. p values <0.05 were accepted as significant.

■ RESULTS

Demographic data

There were 57 patients with 79 vertebral fractures. They were followed for 15.2±4.9 months (average±SD, 12-39 months). Female/male ratio was 25/32, and the patients were 41.7±16.7 years old (average±SD). Average ages of the female and male patients were 39.2±19.6 years and 40.6±3.8 years, respectively, and there were no statistically significant differences between the groups (p=0.74).

Forty-one patients were healthy before trauma, while 16 had some chronic illnesses such as hypertension, diabetes mellitus, chronic obstructive lung disease, etc. In 8 patients, osteopenia or osteoporosis were found during their hospitalization or outpatient follow-up. Osteoporotic patients were significantly older than the patients without osteoporosis (mean age 63.1 versus 38.2, respectively, p<0.001).

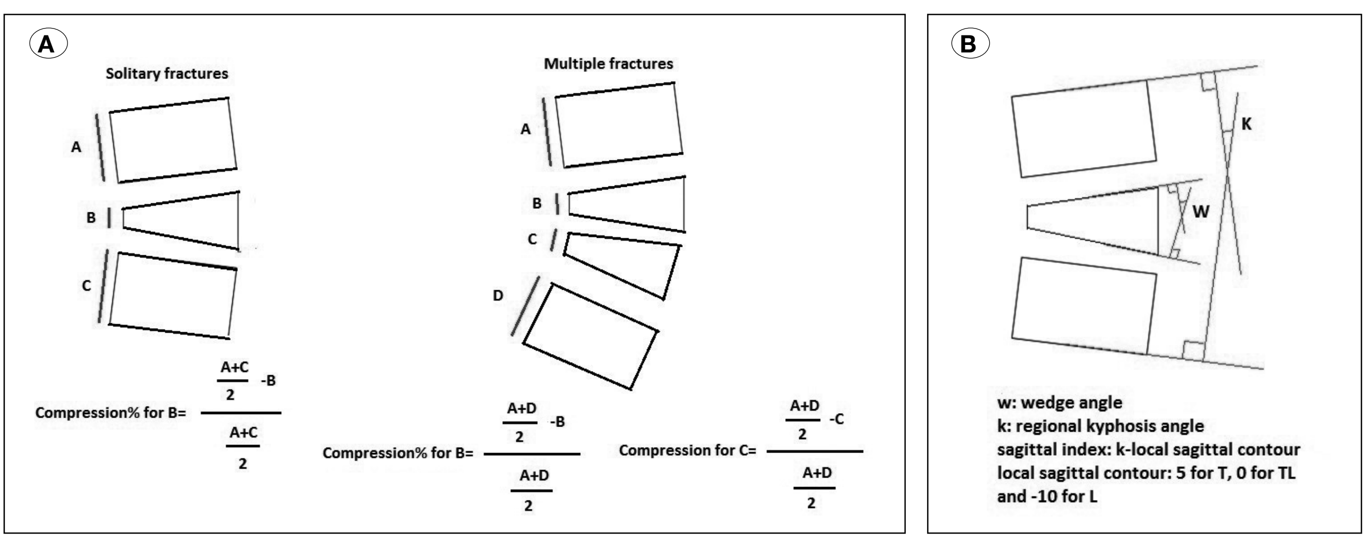

Figure 1: Schematic illustrations of measuring and calculating the compression rates **(A)** and angles **(B)**.

Location and Type of Fractures

There were 49 TL, 20 L, and 10 T fractures. According to AO classification, 49 of the fractures were A1.1 and A1.2, 7 of them were A2.1, A2.2, or A2.3, and 23 were A3.1 or A3.2. Rates of type of fractures in various locations were not statistically different (p=0.85). Locations and types of the fractures are shown in Tables I and II.

Compression Rates and Angles in Early and Late Periods after Trauma

Compression rates, W, K, and S just after trauma and at last follow-up and differences between early and late values for all fractures are shown in Table II. All variables differed significantly, and compressions were increased at follow-up when all fractures were evaluated together.

Type of fracture was an important factor affecting most C and K both in the early and the late periods, and as expected, type A2 and A3 fractures caused more compression (Table II). However, interestingly, almost all of the changes in compression rate and angles during follow-up (dC, dW, and dK) were not significantly different between A2/3 fractures and A1 fractures. The only significantly increased variable was the difference of sagittal indexes (dS) in the early and long-term period after trauma for A2/3 fractures compared to A1 fractures (Table III).

Gender was not a determinative factor for increase of C or K. However, age was a very important factor. When the patients were classified into two groups, >60 years and ≤60 years of age, although the variables just after trauma were not statistically different between two groups, almost all of the variables at last follow-up had significantly deteriorated in the older group (Table III).

There were 7 patients whose C was above 50% and/or whose K was above 30°at last follow-up, and 6 of them were older than 60 years of age. In one of them, there was an intractable back pain, and surgery was offered to her; however, she did not accept. In other patients, there was no significant complaint consistent with the level of fractures.

Compression rate and K did not differ in the early period in various locations (T, TL and L fractures); however, almost all variables were significantly increased in TL fractures compared to T and L fractures at last follow-up (Table III).

Another important factor affecting increase of compression rate was the presence of osteopenia or osteoporosis. Nevertheless, while C, K and W were not statistically different between patients with and without osteoporosis in the early period after trauma, C was statistically higher in patients with osteoporosis at last follow-up (34% versus 23.6%, for patients with and without osteoporosis, respectively; p=0.035). Dangerous compression and/or kyphosis were found in 3 of 8 patients with osteopenia/osteoporosis.

Solitary/Multiple Fractures

There was a single level fracture in 42 patients and multiple fractures in 15 patients (2 levels in 10, 3 levels in 3, and 4 levels in 2 patients). Twelve out of 15 patients with multiple fractures were male and only 3 were female (p=0.0373 with Fisher's exact test). Age was not different in the patients with solitary and multiple fractures (p=0.213). However, the rate of A1 fractures was statistically higher in multiple fractures than in solitary fracture (p=0.0049). Also, for solitary fractures, the rate of TL location was statistically higher than in multiple fractures (p=0.0057).

All C and K values of the solitary and multiple fractures were shown in Table III. It was interesting to see that most variables at last follow-up were better for multiple fractures; in particular, C was more pronounced in solitary fractures (Table III). However, when fracture types were evaluated separately for solitary and multiple fractures, increase of C and angles were not different for type A2 and 3 fractures between solitary

Table I: Type and Location of the Fractures

	T	TL	L	Total
Type A1	4	30	15	49
Type A2	1	4	2	7
Type A3	5	15	3	23
Total	10	49	20	79

***T:** Thoracic; **TL:** Thoracolumbar, **L:** Lumbar.*

Table II: Location of the Solitary and Multiple Fractures

Solitary fractures	n	Multiple fractures	n
T1	0	T10, T11	1
T2	0	T11, L1	1
T3	0	T12, L1	2
T4	1	T12, L3	1
T5	0	L1, L3	2
T6	1	L1, L4	1
T7	0	L2, L3	1
T8	0	L2, L5	1
T9	1	T8, T9, T12	1
T10	0	T10, T11, L1	1
T11	4	L2, L3, L4	1
T12	9	T3, T7, T9, L1	1
L1	19	T12, L1, L2, L3	1
L2	2		
L3	3		
L4	2		
L5	0		
Total	**42**		**15**

Table III: Compression Rates and Angles in Early and Late Period After Trauma for all Fractures

	C1 (a±SD)	C2 (a±SD)	p C1/C2	dC (a±SD)	W1 (a±SD)	W2 (a±SD)	p W1/W2	dW (a±SD)	K1 (a±SD)	K2 (a±SD)	p K1/K2	dK (a±SD)	S1 (a±SD)	S2 (a±SD)	p S1/S2	dS (a±SD)
All fractures	19.6±11.2	25.2±15.0	**<0.001**	6.16±16.27	10.1±4.63	12.07±5.86	**<0.001**	1.97±4.81	5.82±11.66	8.9±13.19	**<0.001**	3.08±5.27	8.01±8.04	10.13 9.5	**<0.001**	2.12±4.49
Types A1	14.7±9.5	19.2±12.2	**0.025**	4.4±13	9.4±4.8	10.3±5.5	**0.046**	1.3±4.4	3.5±12.3	5.3±13.1	**0.03**	1.7±5.3	6.8±9.6	8±9.9	0.255	1.1±6.4
Types A2-3	26±10.4	34.2±14.6	**0.0014**	8.1±12.7	11.7±3.8	14.7±5.3	**0.0042**	3±5.2	9.1±9.8	14.1±11.5	**<0.001**	4.9±4.6	9.6±7.5	14.8±9.4	**<0.001**	5.2±4.5
p (Types A1/A2-3)	**<0.001**	**<0.001**		0.23	**0.011**	**<0.001**		0.136	0.68	0.69		0.91	0.2	**<0.001**		**0.0018**
≤60 years	19.3±11.2	22.5±12.9	**0.018**	3.2±10.8	10.1±4.5	11.2±5	**0.047**	1.1±4.4	5.8±10.9	7.9±12.2	**<0.001**	2.1±4.4	8±8.4	10.1±9.5	**<0.001**	2.1±4.4
>60 years	19±12.9	44.1±17.5	**<0.001**	25.1±11.1	9.6±6.2	17.6±8.6	**<0.001**	8±3.9	5.5±16.7	17.6±8.6	**<0.001**	10±5.5	7.2±12.2	17.2±13.6	**<0.001**	9.3±5.5
p (younger/ older)	0.93	**<0.001**		**<0.001**	0.79	0.057		**<0.001**	0.94	0.107		**<0.001**	0.8	0.051		**<0.001**
TL	18.1±10.7	26.6±10.8	**<0.001**	8.48±13.61	10.86±4.55	13.42±5.74	**<0.001**	2.55±4.78	9.66±4.95	13.62±6.72	**<0.001**	3.95±4.99	9.66±4.95	13.62±6.72	**<0.001**	3.95±4.99
T	29.2±12.5	32.2±14.1	0.239	2.9±7	11.2±2.6	13±4.1	**0.0024**	1.7±4.7	14.8±7.2	18.8±8.5	0.119	4±6.8	9.8±7.2	13.8±8.5	0.119	4±6.8
L	17.3±10.8	17.4±11.2	0.94	0.18±12.5	7.5±5.2	8.2±5.8	0.609	0.6±5.2	-7.6±13.8	-6.6±14.1	0.458	1±5.7	2.3±13.8	3.3±14.1	0.458	1±5.7
p (TL/T and L)	0.28	0.23		**0.017**	0.063	**0.009**		0.19	**0.003**	**0.0013**		0.135	0.056	**0.02**		0.19
Solitary	21.5±10.3	30.2±13.3	**<0.001**	8.71±12.34	11.28±4.31	14±5.34	**0.0024**	2.7±5.4	7±10.3	11.5±11.3	**<0.001**	4.5±5.1	8.5±7.8	12.9±8.7	**<0.001**	4.4±8.2
Multiple	16.7±11.9	19.5±15.0	0.21	2.8±13.03	8.68±4.67	9.77±5.69	0.103	1±3.9	4.4±13.4	5.7±14.5	0.125	1.3±4.9	8±9.9	9±11.6	**0.039**	1±10.3
p (solitary/ multiple)	0.064	**0.001**		**0.047**	**0.013**	**0.0012**		0.14	0.35	0.058		**0.0072**	0.45	0.08		0.066

a±SD: *average± standard deviation; C1 early and C2 late compression rate;* ***dC:*** *difference between C2 and C1; W1 early and W2 late wedge angles, dW difference between W2 and W1; K1 early and K2 late regional kyphosis angles, dK difference between K2 and K1; S1 early and S2 late sagittal indexes, dS difference between S2 and S1.;* ***TL:*** *Thoracolumbar,* ***L:*** *Lumbar;* ***T:*** *Thoracic.*

Statistically significant p values have been highlighted in bold.

and multiple fractures; however, type A1 fractures caused more compression and kyphosis in solitary fractures than in multiple ones.

In 8 patients with multiple fractures, 15 fractures were adjacent, while others were distant from one another. None of the variables were statistically different between adjacent and separate multiple fractures.

Corset Usage and Return to Work

All patients were mobilized with thoraco-lumbo-sacral type (TLSO) or lumbosacral corset according to the location of the fracture on the same day or the day following trauma. The time of corset usage was 4.05±1.1 months (average±SD, 0 to 12 months). Two of the patients with solitary fractures (at T level in one, and TL level in other) declared that they did not use the corset. Return to work or to daily activities without restriction was after 5.7±4.26 months (average±SD, 6 days to 12 months).

According to the hospital records at last follow-up, 7 patients complained of back or lower back pain consistent with the location of the fractures. In only one of them, the pain was intractable and did not diminish with pain medication. Surgery was offered to this patient because C was above 50%, but she did not accept. The K of this patient was 26° at last follow-up. In the others, C was between 7.4 and 45.4%, and K was between 2° and 22° on last follow-up.

DISCUSSION

Many patients are treated conservatively for stable T, TL and L fractures; however, there are not many studies evaluating clinical and radiological results of these patients. Modalities for conservative treatment advocated in the literature are long-term bed rest, mobilization with corset, or casting with or without closed reduction (1). The TLICS system advocating conservative treatment for most burst-type fractures has led to an increase in the rate of conservative treatment of thoracolumbar fractures. In addition, there is a trend towards minimally-invasive treatment modalities for these lesions, even for conservative treatment, as in all medical branches. Therefore, early mobilization with or without corset and without bed rest is increasingly becoming the method of choice. This type of treatment may help prevent complications of long-term bed rest such as muscular atrophy, thromboembolic complications, sacral ulcers, and psychological problems (9). Already, reduction of compression and angulation was provided by closed reduction and casting after trauma could not be maintained at the last follow-up in most cases (9). Willén et al.(10) reported that the immobilization time did not influence the final gibbus angle.

We also preferred early mobilization of the patients with a custom-made thoraco-lumbo-sacral support (TLSO)-type corset or lumbosacral corset, depending on the level of the fractured vertebra, one or two days after trauma for treatment of stable T, TL, or L fractures according to the TLICS system. In this study, we retrospectively evaluated clinical and radiological results of these patients at least 1 year after trauma.

Results of this study showed that AO type A2 and A3 fractures versus AO type A1 fractures, thoracolumbar junction fractures versus thoracic and lumbar ones, fractures in older patients (>60 years) versus those in younger ones, fractures in osteoporotic or osteopenic patients versus those in healthy ones and solitary fractures versus multiple ones had a higher risk for increase of rate of compression and kyphosis at follow-up after at least 1 year. Interestingly, A1 fractures were statistically more compressed if they were solitary, but A2 and A3 fractures showed similar results in both solitary and multiple fractures.

Higher compression and kyphosis values at follow-up period are expected for AO type A2 and A3 fractures rather than A1 fractures, because A2 and A3 fractures cause more severe injuries in the vertebrae. Vorlat et al.(8) reported that disability was 8% worse with each increase of the AO fracture type from A1 to A3. There are few studies investigating the increase of kyphosis angles in thoracolumbar burst fractures. Mumford et al.(5) reported an average increase in kyphosis of 3° and Willén et al.(10) of 6°. In our study, the compression rate was increased from 19.6% to 25.2%, and kyphosis angle from 5.8° to 8.9°. The corresponding values for type A1 fractures were from 14.7% to 19.2% and from 3.5° to 5.3°, and for A2 and A3 fractures from 26% to 34.2% and from 9.1° to 14.1°, respectively. Long-term values of compression rates were significantly higher in type A2 and A3 fractures than in type A1 fractures; however, interestingly, differences between early and late periods were not significantly different between fracture types, except for the difference of sagittal indexes. Therefore, the sagittal index may be a more reliable marker to follow spinal fractures, as proposed by Jiang et al.(3), instead of wedge or regional kyphosis angle.

It was previously reported that TL fractures are more inclined towards compression and kyphosis than T and L fractures (4). Al-Khalifa et al.(1) thought that this difference was due to the center of gravity of the body. At the TL junction, the center of gravity is in the anterior half of the vertebral body, and this causes a trend towards kyphosis. In our study, too, compression rate and kyphosis angles of fractures in the TL junction were statistically higher than in T and L fractures at last follow-up.

Dangerous compression or kyphosis rate (>50% compression, and >30° regional kyphosis, respectively) were not high in our series; there were only 7 patients exceeding these limits. In the series studied by Al-Khalifa et al.(1), 5 out of 60 patients required surgery during conservative follow-up because of excessive increase in kyphosis. In our 7 patients, only one had intractable pain due to the kyphotic fracture, and therefore surgery was offered. The other 6 patients had no severe pain or other complaints requiring surgical treatment. Other studies also reported that radiological results were not always consistent with clinical results (6,11).

It was also interesting to see that 6 of 7 patients with excessive compression and/or kyphosis in our series were >60 years old. It is no surprise that vertebral fractures in older patients have higher compression rates and higher kyphosis angles, possibly due to these patients' low bone quality. Cankaya et al.(2) reported a series consisting of 20 elderly patients (>60 years old) with stable TL compression fractures. After mean 20.1 months follow-up, 4 of them had kyphotic deformity and intractable pain. They also reported that female gender is a risk factor. In our series, too, 5 out of these 7 patients were female; however, the difference between male and female older patients was not significant, possibly due to the small patient number.

In our study, another interesting finding was that solitary fractures tended to develop more compression and higher kyphosis than multiple fractures. This difference may be related to the force causing injury being distributed over several segments and therefore its effect on the vertebrae being less. In this series, especially AO type A1 fractures caused minimal increase in compression and kyphosis if they occurred as multiple fractures. We could not find any other study in the literature comparing compression and kyphosis trends of solitary and multiple fractures.

An important limitation of this study was that the patient number was low because of the retrospective nature of the study. A prospective study with a larger patient group would provide more reliable results. However, this study also gave us some clues to anticipate which patients are at greater risk of developing kyphosis after conservative treatment of stable thoracolumbar spinal fractures. A prospective study may be planned in the light of these indications.

■ CONCLUSION

Early mobilization without bed rest for stable thoracic, thoracolumbar and lumbar fractures according to the TLICS system is a good treatment option, and radiological and clinical results are usually acceptable. However, it should be kept in mind that fractures in patients older than 60 years, fractures in patients with osteoporosis or osteopenia, fractures located in the thoracolumbar junction, solitary fractures, and fractures of AO type A2 or A3 are more liable to increase compression and kyphosis, and hence, require a closer follow-up.

■ REFERENCES

1. Al-Khalifa FK, Adjei N, Yee AJ, Finkelstein JA: Patterns of collapse in thoracolumbar burst fractures. J Spinal Disord Tech 18:410-412, 2005
2. Cankaya D, Yilmaz S, Deveci A, Dundar A, Yoldas B, Toprak A, Tabak Y: Clinical and radiological outcomes of conservative treatment after stable post-traumatic thoracolumbar fractures in elderly: Is it really best option for all elderly patients? Ann Med Surg (Lond) 4:346-350, 2015
3. Jiang SD, Wu QZ, Lan SH, Dai LY: Reliability of the measurement of thoracolumbar burst fracture kyphosis with Cobb angle, Gardner angle, and sagittal index. Arch Orthop Trauma Surg 132:221-225, 2012
4. Krompinger WJ, Fredrickson BE, Mino DE, Yuan HA: Conservative treatment of fractures of the thoracic and lumbar spine. Orthop Clin North Am 17:161-170, 1986
5. Mumford J, Weinstein JN, Spratt KF, Goel VK: Thoracolumbar burst fractures. The clinical efficacy and outcome of nonoperative management. Spine (Phila Pa 1976) 8:955-970, 1993
6. Ozturk I, Erturer E, Sonmez MM, Sari S, Seker A, Seckin MF: Early mobilization with customized TLSO brace in thoracolumbar burst fractures. Acta Orthop Traumatol Turc 46:373-378, 2012
7. Vaccaro RA, Lehman RA Jr., Hurlbert RJ, Anderson PA, Harris M, Hedlund R, Harrop J, Dvorak M, Wood K, Fehlings MG, Fisher C, Zeiller SC, Anderson DG, Bono CM, Stock GH, Brown AK, Kuklo T, Oner FC: A new classification of thoracolumbar injuries: The importance of injury morphology, the integrity of the posterior ligamentous complex, and neurologic status. Spine (Phila Pa 1976)30:2325-2333, 2005
8. Vorlat P, Leirs G, Tajdar F, Hulsmans H, De Boeck H, Vaes P: Predictors of recovery after conservative treatment of AO-Type A thoracolumbar spine fractures without neurological deficit. Spine (Phila Pa 1976) Aug 23, 2010 [Epub ahead of print]
9. Weninger P, Schultz A, Hertz H: Conservative management of thoracolumbar and lumbar spine compression and burst fractures: Functional and radiographic outcomes in 136 cases treated by closed reduction and casting. Arch Orthop Trauma Surg 129:207-219, 2009
10. Willén J, Anderson J, Toomoka K, Singer K: The natural history of burst fractures at the thoracolumbar junction. J Spinal Disord 3: 39-46, 1990
11. Yi L, Jingping B, Gele J, Wu T, Baoleri X, Taixiang W: Operative versus non-operative treatment for thoracolumbar burst fractures without neurological deficit. Cochrane Database Syst Rev 4: CD005079, 2006