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Analysis of Factors Related to Neurological Deficit in Thoracolumbar Fractures

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Objective : The purpose of this study is to determine the factors that have effects on the neurological deficit in the patients with thoracolumbar fracture.

Methods : Forty-eight patients were included. Cause of injury, type of injury, time interval, combined injury, kyphotic angle, spinal canal compromise, sagittal diameter, the most narrow sagittal diameter, transverse diameter, the most narrow transverse diameter, and remained height of vertebra body were concerned as the factors. The patients with American Spinal Injury Association(ASIA) impairment scale grade A to D were considered as having neurology while others with ASIA grade E were considered to be without neurology. The patients with ASIA grade A were classified to paraplegia group and the patients with ASIA grade B to E were not thought to be paraplegia. Statistical analysis for these groups were performed.

Results : Spinal canal compromise ($P<0.001$) have correlation with neurological deficit. The most narrow sagittal diameter was smaller in the group with deficit than that in the group without deficit ($P=0.004$). Also, combined injury have correlation with neurology ($P=0.028$). Spinal canal compromise ($P<0.001$), sagittal diameter ($P=0.032$), the most narrow sagittal diameter ($P=0.025$), and Denis type ($P<0.001$) also have correlation with paraplegia.

Conclusion : The factors of percentage of spinal canal compromise, the most narrow sagittal diameter, and combined injury are predictive of neurological deficit. The patients with paraplegia may be predicted by the factors such as type of injury, spinal canal compromise, sagittal diameter, the most narrow sagittal diameter, and Denis type.

KEY WORDS : Spinal fractures · Neurologic manifestation · Spinal canal · Thoracic vertebral · Lumbar vertebral · Thoracolumbar spine.

Introduction

The thoracolumbar spine in which a zone of transition exists between the relatively immobile kyphosis of the thorax and the flexible lordosis of the lumbar region, is vulnerable to traumatic injury. After severe trauma, the majority of thoracolumbar vertebral fractures are related to both compression of the vertebral body and multilevel distraction injuries of the posterior elements. Burst fractures account for approximately 50% of all thoracolumbar fractures that cause a neurological deficit[18]. Most burst fractures of the spine are associated with retropulsion of bony fragments into the spinal canal.

While severe bony retropulsion to the spinal canal makes no neurological deficit in some patients with thoracolumbar burst fracture, some patients have undergone neurological deficit in spite of minimal spinal canal involvement of the bony fragment. This is why quite a lot of reports have been published about the relation between neurological outcome and some factors which were able to be correlated with neurological deficit. Vaccaro et al.[22] reported that the ratio of sagittal-to-transverse diameter was smaller in patients with neurological deficit than that of patients without neurological deficit. Mumford et al.[17] noted positive correlation between the area of compromise to the spinal canal and the midsagittal diameter.

The spinal canal compromise after traumatic spinal fractures has been reported as a reliable factor which has statistically significant correlation with neurological deficit in some reports[10,11,15,22]. However, some researchers have also suggested that the clinical significance of bony encroachment of the canal with reference to neurological outcome was not clear. Mohanty et al[16] reported that there was no correlation between the initial neurological impairment and the degree of spinal canal nar-

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rowing. The relation between the spinal canal diameter and its association with neurological sequelae after trauma has been cited numerous times in the literature[4,6]. Some reports suggest that although surgical removal of bony fragments may restore the spinal canal, it does not improve the chance of neurological recovery[1,5,8,13,20]. It may be interesting to determine the factors on which neurological damage following fractures of the thoracolumbar spine depends. The purpose of this study is to determine the factors that have an effect on the neurological deficit in the patients with thoracolumbar fracture.

Table 1. Clinical data of the thoracolumbar fractured patients

No.	Age	Sex	Cause	Type	level	Time(hr)	Comb	KA	Ht(%)	ASIA	Denis	Canal(%)	SD	TD	SD/TD	MSD	MTD	MSD/MTD
1	44	F	fall	burst	T12	9	X	8	54	E	A	28	9.7	22.4	0.43	5.1	21.1	0.24
2	36	F	fall	burst	L3	12	X	10	62	E	A	33	8.9	17.1	0.52	3.5	16	0.22
3	54	F	MVA	Comp	L1	6	O	8	88	E	B	–	18	19.8	0.91	18	19.8	0.91
4	40	M	MVA	Comp	L3	28	O	8	63	E	A	–	16	17.8	0.9	16	17.8	0.9
5	49	M	fall	burst	L2	3	O	11	75	E	A	38	14.2	24.2	0.59	5.2	24.1	0.22
6	43	M	MVA	Comp	T7	2	O	4	72	E	B	–	21.2	22.8	0.93	21.2	22.8	0.93
7	24	M	MVA	Fx-ds	L3	3	X	16	80	E	B	10	6.3	22.2	0.28	6.3	22.2	0.28
8	31	M	sliding	burst	L1	4	O	28	44	E	A	48	15.4	29.9	0.52	11.7	28.8	0.41
9	58	M	sliding	Comp	L3	48	O	11	30	E	A	–	16.4	18.7	0.88	16.4	18.7	0.88
10	49	F	others	Comp	L2	–	O	14	38	E	A	–	17.5	19.3	0.91	17.5	19.3	0.91
11	29	F	fall	burst	L2	2	X	35	41	E	A	42	10.2	24.4	0.42	8.6	24.4	0.35
12	42	F	MVA	burst	L1	6	O	24	52	E	A	55	13	25.7	0.51	4.6	26.6	0.17
13	28	F	fall	burst	L1	0.5	X	17	59	E	B	47	15.7	27.1	0.58	4.1	24.5	0.17
14	64	M	fall	burst	L1	0.5	X	19	34	E	A	52	14.2	24.4	0.59	3.8	25.3	0.15
15	60	M	sliding	burst	L2	0.5	O	10	74	E	B	25	1.5	21.4	0.07	1.5	21.4	0.07
16	71	F	fall	burst	L2	336	O	17	50	E	A	28	5.1	6.5	0.79	5.1	6.5	0.79
17	37	M	fall	burst	T12	72	X	10	90	E	B	20	13.7	19.8	0.7	7.1	23.9	0.3
18	43	M	MVA	Comp	L2	96	O	7	88	E	B	–	20.3	24	0.85	20.3	24	0.85
19	75	M	others	burst	L4	–	O	3	82	E	B	24	12.8	18.4	0.69	12.8	18.4	0.69
20	23	F	MVA	burst	L2	0.5	X	21	60	E	A	45	10.7	19.3	0.56	10.1	19.5	0.52
21	59	F	fall	burst	L1	5	X	10	40	E	B	27	3.5	9.4	0.37	1.8	9.1	0.2
22	52	M	MVA	burst	L4	0.5	O	15	90	E	A	20	7.8	18.2	0.43	2.5	4.8	0.52
23	54	M	MVA	Comp	L1	1	O	17	63	E	B	–	12.9	17.8	0.72	11.8	17.5	0.68
24	37	M	fall	burst	T10	0.5	X	12	57	E	A	25	7.3	11.7	0.63	1.7	11.1	0.15
25	38	M	fall	Comp	L1	–	O	24	40	E	A	–	20.3	23.6	0.86	20.3	23.6	0.86
26	62	F	fall	burst	L2	120	X	9	65	D	A	60	8.8	21	0.42	5.4	20.1	0.27
27	19	M	fall	burst	L2	0.5	X	12	78	D	B	50	13	22.3	0.58	8.2	21	0.39
28	24	F	MVA	burst	L1	5	X	16	62	D	B	40	14.3	22.1	0.65	5.9	21.6	0.27
29	43	F	fall	burst	L1	5	X	20	27	D	A	56	12.8	27.5	0.47	4	22.2	0.18
30	37	M	fall	burst	L3	3	X	22	42	D	B	74	12.9	24.6	0.52	2.7	23.9	0.11
31	22	F	fall	burst	L2	9	X	17	70	D	B	88	4.4	11.5	0.38	3.1	10.3	0.3
32	71	F	fall	burst	L3	20	O	12	40	D	A	42	9.4	18.6	0.51	6.7	16.6	0.4
33	26	F	MVA	burst	L1	2	X	20	80	D	B	46	6.9	13.4	0.52	2.1	13.3	0.16
34	42	M	fall	burst	L1	0.5	X	18	64	D	A	42	7.4	25.8	0.29	2.5	21.6	0.12
35	42	M	fall	burst	T12	4.5	X	12	58	C	A	45	8.4	23.4	0.36	5.1	22.1	0.23
36	21	F	MVA	burst	L2	9	X	20	54	C	B	60	10.9	27	0.42	3.4	26.7	0.13
37	41	M	fall	burst	L1	0.5	X	21	64	C	A	40	11.7	23.6	0.5	8.9	20.4	0.44
38	64	M	MVA	Comp	T12	1	X	15	80	C	B	–	9.8	14.3	0.68	9.8	14.3	0.68
39	32	M	fall	burst	L1	0.5	X	9	85	C	B	50	11.3	22.8	0.5	7.8	20.7	0.38
40	46	M	MVA	burst	T12	9	X	17	57	C	A	35	13.5	20.3	0.67	10.6	20	0.53
41	41	M	sliding	burst	L4	9	O	11	49	C	A	50	4.4	8.8	0.5	4.4	8.8	0.5
42	36	M	fall	burst	T12	144	X	22	52	A	A	54	10.1	17.2	0.59	7.4	16.5	0.45
43	36	M	MVA	burst	L1	1	X	10	80	A	B	67	6.9	17	0.41	8.6	8.6	1
44	33	M	MVA	Fx-ds	T12	19	O	24	39	A	D	85	5.8	14.5	0.4	4.2	10.5	0.4
45	30	M	MVA	Fx-ds	T12	0.5	X	21	64	A	D	85	4.6	6.3	0.73	4.6	6.3	0.73
46	41	M	fall	burst	T12	3	X	14	80	A	B	85	6.5	14.5	0.45	5.9	13.2	0.45
47	48	M	MVA	burst	L1	0.5	X	19	57	A	A	90	3.8	22.7	0.17	2.8	15.2	0.18
48	49	F	fall	Fx-ds	T12	–	O	10	75	A	D	74	7.4	19.8	0.37	7.2	19.1	0.38

Time=time interval to treatment, KA=kyphotic angle, Canal=canal compromise, Ht=remain height of vertebral body, SD=sagittal diameter, TD=transverse diameter, MSD=most sagittal diameter, MTD=most transverse diameter, Comb=combined injury, MVA=motor vehicle accident

Patients and Methods

From March 2002 to March 2005, 48 patients with thoracolumbar fractures (23 with and 25 without neurological deficit) were included. Medical records and radiographs were retrospectively examined (Table 1). Sex, age, cause of injury, type of injury, level of injured spine, time interval from the injury to treatment, combined injury, kyphotic angle of injured vertebra, percentage of spinal canal compromise including the canal diameters (sagittal diameter, transverse diameter, the most narrow sagittal diameter, and the most narrow transverse diameter), and remained height of vertebra body were concerned as the factors that may have an effect on the neurological deficit in the patients with thoracolumbar fracture. Thirty patients (62.5%) were male and 18 (37.5%) were female. The mean age was 42.6 years. Twenty-four patients (50.0%) were injured in a fall from a height, 18 patients (37.5%) had injuries related to a motor vehicle accident, and 6 (12.5%) were injured by other causes. The most common site of injury was L1, which accounted for 16 patients (33.3%) of all injuries. There were 35 (73.0%) burst fractures, 9 (19.0%) compression fractures, and 4 (8.0%) fracture-dislocation. Nineteen patients (39.6%) had combined injuries at the time of the accident, 29 (60.4%) did not. Morphological types of all fractures were classified according to the Denis classification (Table 2).

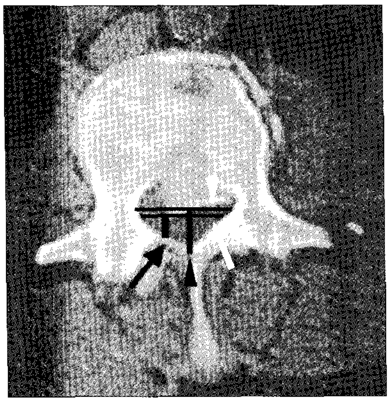

Fig. 1. Measurement of spinal canal compromise. 1) Sagittal Diameter (SD, black arrow head) is the distance between the sagittal border of the posterior dislocated fragment in the midline and the inner cortex of lamina. 2) Transverse Diameter (TD, white arrow head) is a transverse diameter of the spinal canal at the point of midline sagittal border of the osterior dislocated fragment, which meets the SD perpendicularly. 3) The most narrow Sagittal Diameter (MSD, black arrow) is the shortest distance between the lamina and the sagittal border of the posterior dislocated fragment in parallel to the SD. 4) The most narrow Transverse Diameter (MTD, white arrow) is a transverse diameter between laminas at the The MSD point of the posterior dislocated fragment in parallel to the TD.

Neurological evaluation was carried out when the patients came to the hospital and the neurological status was classified according to American Spinal Injury Association's(ASIA) impairment scale.

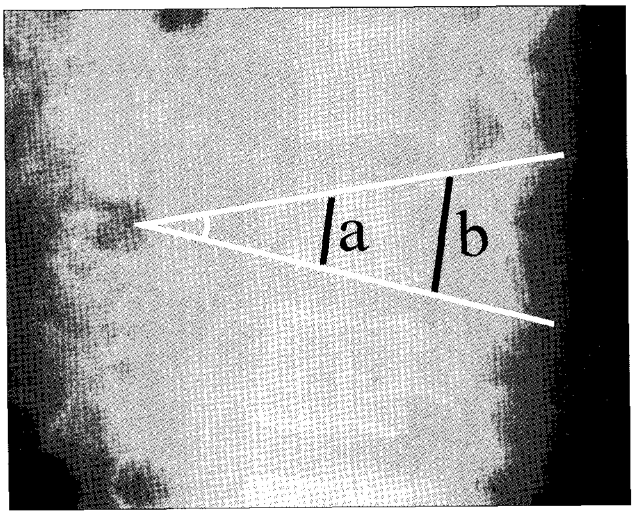

Fig. 2. Measurement of kyphotic angle and remain height of vertebra. 1) Kyphotic angle is measured from the superior endplate to the inferior of the injured vertebra. 2) remained height of vertebra : y = a / b × 100 (%) (a : the height of the most decreased part of fractured vertebra, b : posterior margin of fractured vertebra).

The patients with ASIA grade A, B, C, and D were considered as having neurologic deficits while others with ASIA grade E were considered to be without neurologic deficits. For the analysis of the correlation between the factors and paraplegia, the patients with ASIA grade A were classified to paraplegia group and the patients with ASIA grade B, C, D, and E were not thought to be paraplegia. Seven patients had injuries classified as ASIA grade A, no patient as ASIA grade B, 7 as ASIA grad eC, 9 as ASIA grade D, and 25 as ASIA grade E. The amount of retropulsion (spinal canal compromise) was measured by computed tomographic(CT) scan and the percentage of spinal canal compromise expressed as below[16];

The Percentage of Spinal Canal Compromise :

$a = (1 - x/y) \times 100$

a = percentage of canal compromise

x = mid-sagittal diameter of spinal canal at the level of injury

y = average mid-sagittal diameter of the spinal canal

(one level above and on level below the level of injury)

Also, transverse diameter(TD), the most narrow transverse diameter(MTD), sagittal diameter(SD), and the most n-

Table 2. The Denis Classification System for Spinal Burst Fractures

Type of Fracture	Anterior Column	Middle Column	Posterior Column	Mechanism	Injury
Burst					
Type A	Compression	Compression	None	Axial Load	Fracture of both end plates
Type B	Compression	Compression	None	Axial Load	Fracture of Superior End plate
Type C	Compression	Compression	None	Axial Load and Flexion	Fracture of Inferior End Plate
Type D	Compression	Compression	None	Axial Load and Rotation	Burst Rotation
Type E	Compression	Compression	None	Axial Load and Lateral Flexion	Burst Lateral Flexion

arrow sagittal diameter(MSD) of the spinal canal were measured (Fig. 1).

SD is the distance between the sagittal border of the posterior dislocated fragment in the midline of spinal canal and the inner cortex of lamina. TD is a transverse diameter of the spinal canal at the point of midline sagittal border of the posterior dislocated fragment, which met the SD perpendicularly. MSD is the shortest distance between the lamina and the sagittal border of the posterior dislocated fragment in parallel to SD. MTD is a transverse diameter between laminas at the MSD point of the posterior dislocated fragment in parallel to TD. Kyphotic angle was measured by the technique measuring the angle from the superior endplate to the inferior endplate of the injured vertebra (Fig. 2). The ratio of the remained height of vertebral body was determined by dividing the height of the most decreased part by the height of posterior margin of the vertebra body on plane lateral radiograph (Fig. 2). Statistical analysis comparing those with neurological deficit to those without was performed by Student's t-test. The authors evaluated statistically meaning if p-value is below 0.05.

Table 3. Correlation between factors and neurologic deficits

	ASIA A~D	ASIA E	P-value
Age	40.17±13.8 (yrs)	44.92±14.10 (yrs)	0.899
Cause of Injury			0.38
Fall	13 (56.5%)	11 (44%)	-
MVA	9 (39.1%)	9 (36%)	-
Sliding	1 (4.3%)	3 (12%)	-
Other	0 (0%)	2 (8%)	-
Type of Injury			0.174
Burst	19 (82.6%)	16 (64%)	-
Comp	1 (4.3%)	8 (32%)	-
Fx-dis	3 (13 %)	1 (4%)	-
Combined Injury			*0.028
with	4 (17.4%)	15 (60%)	-
without	19 (82.6%)	10 (40%)	-
Time interval	16.96±37.07 (hrs)	25.86±68.94 (hrs)	0.324
Kyphotic angle	16.09± 4.47 (degree)	14.40± 7.81 (degree)	0.082
Remain Height of VB	60.57±14.80 (%)	62.20±19.40 (%)	0.5
Canal compromise	57.95±20.61 (%)	35.11±13.00 (%)	*<0.001
SD	8.91± 4.7 (mm)	12.52± 5.7 (mm)	0.207
TD	19.09± 5.4 (mm)	20.23± 6.1 (mm)	0.474
SD/TD	0.48± 0.23	0.63± 0.30	0.376
MSD	5.70± 2.1 (mm)	9.48± 3.8 (mm)	*0.004
MTD	17.09± 4.6 (mm)	19.64± 5.2 (mm)	0.783
MSD/MTD	0.38± 0.18	0.49± 0.23	0.801
Denis type			0.097
A	10	15	-
B	10	10	-
C	0	0	-
D	3	0	-
E	0	0	-

Results

There are some factors that have the correlation with the patient's neurological def icit (Table 3). The factor, percentage of spinal canal compromise, has statistically significant correlation with neurology ($P<0.001$). Mean percentage of the spinal canal compromise was 57.95±20.61% in the group with neurological deficit and 35.11±13.00% in the group without neurology.

The the most narrow sagittal diameter(MSD) at the injured spinal canal was significantly smaller in the group with deficit (5.70±2.1mm) than that in the group without deficit (9.48±3.8mm, P=0.004). MSD had a statistically significant difference between the patients with neurological deficit (ASIA A,B,C, and D) and the patients without neurological deficit (ASIA E), which means it is predictive of neurological deficit. In case of sagittal diameter(SD), however, the group with deficit was 8.91±4.7mm and the group without deficit was 12.52±5.7mm. There was no correlation between SD and neurological deficit (P=0.207). Another factor that has statistically significant correlation with neurology is the combined injury (P=0.028). Other factors such as age, cause of injury, time interval from the injury to treatment (patients with neurology=16.96±37.07 hours, patients without neurology=25.86±68.94 hours, P=0.324), kyphotic angle of injured vertebra (with neurology=16.09±4.47 degree, without neurology =14.40±7,81 degree, P=0.082), and remain height of vertebra body (with neurology=60.57±14.80 %, without neurology= 62.20±19.40%, P=0.500), there are no significant correlation with the neurological deficit.

The ratio of sagittal-to-transverse diameter(SD/TD) at the injured spinal canal was smaller in patients who had a neurolgocial deficit (0.48±0.23) than the ratio in those who had no deficit (0.63±0.30). However, it is not significantly different (P=0.376). The mean transverse diameter(TD) at the level of injury in the group with a deficit was 19.09±5.4mm, compared with a mean transverse diameter(TD) in the group without deficit of 20.23±6.1mm (P=0.474). In a different point of view, there are some factors that have the correlation with paraplegia (Table 4). Percentage of spinal canal compromise ($P<0.001$), sagittal diameter (SD, P=0.032), and the most narrow sagittal diameter (MSD, P=0.025) have statistically significant correlation with paraplegia. In contrast to the result of correlation with neurological deficit (MSD is a predictive factor, not as SD), SD and MSD may be said to be predictive factors of paraplegia. Although there are a few cases (3 fracture-dislocation patients with neurology and 1 patient without neurology), the type of injury has statistical significance (P=0.001) which means that the patients with fracturedislocation are apt to be paraplegia (ASIA grade A). Also, Denis type of fractures ($P<0.001$) is a factor which has correlation with paraplegia. Patients with higher Denis type of fractures (Denis type D or E) have more chance to be paraplegia.

Discussion

There are several opinions and studies concerning the correlation between the factors, especially spinal canal compromise, and neurological deficit. Matsuura et al.[14] found that patients with a neurological deficit in the cervical spine have a significantly smaller sagittal diameter and a significantly larger transverse diameter on post-traumatic CT images than those without a neurological deficit. Kang et al.[9], in a study of 288 patients with a fracture or dislocation of the cervical spine, used plain radiographs to demonstrate a significant correlation between the space available for the spinal cord at the level of injury, sagittal diameter, and severity of neurological deficit.

In the thoracolumbar spine, several authors have established a positive correlation between the area of compromise to the spinal canal and the midsagittal diameter[2,17,22]. Kim et al.[11] noted a correlation between percentage of canal impingement at the thoracolumbar junction and neurological deficit. Additionally, they found that, in patients with neurological deficit, the presence of disrupted posterior elements indicated an improved possibility of neurologic recovery. Fontijne et al[7] carried out a detailed statistical analysis of 139 burst fractures and found a positive correlation between the degree of narrowing of the spinal canal measured by the axial-CT and neurological dysfunction. These authors reported that in narrowing of 25, 50, and 75%, the probability of neurological deficit was 29, 51, and 71% in the thoracolumbar spine and 14, 28, 48% in the lumbar spine, respectively.

Some authors have noted that there is no correlation between the initial neurological impairment and the degree of spinal canal narrowing[8,21]. Dall and Stauffer[3] reviewed 14 consecutive patients with T12 or L1 burst fractures and did not find a correlation between the initial fracture pattern or the amount of spinal canal compromise, determined by CT scan, and neurological injury. Also, there was no statistically significant correlation between the degree of canal encroachment and initial neurological deficit[16]. These studies reveal suggestions that initial impact to the spinal cord determines

Table 4. Correlation between factors and plegia

		ASIA A	ASIA B~E	P-value
Age		39±7.30 (yrs)	43.24±14.84 (yrs)	0.102
Cause of Injury				0.583
	Fall	3 (42.9%)	21 (51.2%)	–
	MVA	4 (57.1%)	14 (34.1%)	–
	Sliding	0 (0%)	4 (9.8%)	–
	Other	0 (0%)	2 (4.9%)	–
Type of Injury				*0.001
	Burst	4 (57.1%)	31 (75.6%)	–
	Comp	0 (0%)	9 (22 %)	–
	Fx-dis	3 (42.9%)	1 (2.4%)	–
Combined Injury				0.519
	with	2 (28.6%)	17 (41.5%)	–
	without	5 (71.4%)	24 (58.5%)	–
Time interval		27.29±52.32 (hrs)	20.62±56.69 (hrs)	0.79
Kyphotic angle		17.14± 5.78 (degree)	14.88± 6.53 (degree)	0.885
Remain Height of VB		63.86±15.55 (%)	61.00±17.59 (%)	0.635
Canal compromise		77.14±25.37 (%)	32.93±12.63 (%)	*<0.001
SD		6.44± 2.05 (mm)	11.54± 4.71 (mm)	*0.032
TD		16.00± 5.17 (mm)	20.31± 5.37 (mm)	0.698
SD/TD		0.45± 0.21	0.58± 0.42	0.901
MSD		5.81± 2.06 (mm)	7.99± 5.70 (mm)	*0.025
MTD		12.77± 4.55 (mm)	19.39± 5.65 (mm)	0.664
MSD/MTD		0.51± 0.25	0.43± 0.28	0.09
Denis type				*<0.001
	A	2	23	–
	B	2	18	–
	C	0	0	–
	D	3	0	–
	E	0	0	–

the future neurological outcome. The degree of spinal canal narrowing dose not reflect the initial impact or dynamical change at the time of trauma but shows only the final resting position of the vertebral body fragments after the trauma[19]. Axial-CT scan is not proper to be thought as a predictive method of patients' neurological deficit because there are many other factors which are not seen exactly on axial-CT scan such as the presence of interstitial lesions, hematomas, section of the spinal cord, and fragments of the intervertebral disc.

Other factors, such as kyphotic angle and remain height of vertebral body, have no correlation with the patients' neurological deficit. As there are many possible ways to measure the kyphotic angle and remain height of fractured vertebrae, the accuracy of the measurement or the correlation with the neurology are not evaluated evenly in some studies[12].

There is still no established consensus about these different opinions. However, we have the result that the percentage of spinal canal compromise, especially the most narrow sagittal diameter(MSD) rather than sagittal diameter(SD), has statistically significant correlation with the patients' neurological deficit, even with paraplegia patient in this study.

Combined injury such as other spinal fractures, extremity fractures, brain injury, or multiple system trauma is correlated with neurological deficit in thoracolumbar fractured patients. In contrast to the expectation that we had before the analysis, combined injury has negative correlation, which means that the patients without combined injury have higher chance of neurological deficit. This fact is suggested as a distribution of initial trauma to other parts of body rather than thoracolumbar lesion so that the patients without combined injury have more traumatic stress on thoracolumbar lesion, which makes the patients have neurological deficit. However, this fact needs further study.

Conclusion

The percentage of spinal canal compromise, the most narrow sagittal diameter(MSD), and combined injury are the factors that have an effect on the neurological deficit in the patients with thoracolumbar fracture. And, they are predictive of neurological deficit, especially the most narrow sagittal diameter(MSD). The factors such as type of injury, spinal canal compromise, saggital diameter(SD), the most narrow sagittal diameter(MSD), and Denis type have correlation with paraplegia. The patients with paraplegia after thoracolumbar fracture may be predicted by those factors.

References

1. Bedbrook G : Treatment of thoracolumbar dislocation and fractures with paraplegia. **Clin Orthop 112** : 27-43, 1975
2. Braakman R, Fontijne WP, Zeegers R, Steenbeek JR, Tanghe HL : Neurological deficit in injuries of the thoracic and lumbar spine. **Acta Neurochir 111** : 11-17, 1991
3. Dall BE, Stauffer ES : Neurologic injury and recovery patterns in burst fractures at the T12 or L1 motion segment. **Clin Orthop 233** : 171-176, 1988
4. Dayes LA, Boyd W, Peterson D, Ritland S : The fortune of a capacious spinal canal. **J Natl Med Assoc 71** : 985-987, 1979
5. Durward Q, Schweigel J, Harrison P : Management of fractures of the thoracolumbar and lumbar spine. **Neurosurgery 8** : 555-561, 1981
6. Eismont FJ, Clifford S, Goldberg M, Green B : Cervical sagittal spinal canal size in spine injury. **Spine 9** : 663-666, 1984
7. Fontijne WP, DeKlerk LW, Braakman R, Stijnen T, Tanghe HL, Steenbeek R, et al : CT scan prediction of neurological deficit in thoracolumbar burst fractures. **J Bone Joint Surg 74B** : 683-685, 1992
8. Herndon WA, Galloway D : Neurological return versus cross-sectional canal area in incomplete thoracolumbar spinal cord injuries. **J Trauma 28** : 680-683, 1988
9. Kang JD, Figgie MP, Bohlman HH : Sagittal measurements of the cervical spine in subaxial fractures and dislocations. **J Bone Joint Surg 76A** : 1617-1627, 1994
10. Kim JS, Kim ES, Lee JS, Park YG, Baek SH, Park IS, et al : A Clinical Analysis of the Patients with Thoracolumbar Vertebral Junction Fracture. **J Korean Neurosurg Soc 25** : 2038-2043, 1996
11. Kim NH, Lee HM, Chun IM : Neurologic Injury and Recovery in Patients With Burst Fracture of the Thoracolumbar Spine. **Spine 24** : 290-294, 1999
12. Kuklo TR, Polly Jr DW, Owens BD, Zeidman SM, Chang AS, Klemme WR : Measurement of Thoracic and Lumbar Fracture Kyphosis. **Spine 26** : 61-66, 2001
13. Lemons V, Wagner F, Montesano P : Management of thoracolumbar fractures with accompanying neurological injury. **Neurosurgery 30** : 667-671, 1992
14. Matsuura P, Waters RL, Adkins RH, Rothman S, Gurbani N, Sie I : Comparison of computerized tomography parameters of the cervical spine in normal control subjects and spinal cord patients. **J Bone Joint Surg 71A** : 183-188, 1989
15. Meves R, Avanzi O : Correlation Between Neurological Deficit and Spinal Canal Compromise in 198 Patients with Thoracolumbar and Lumbar Fractures. **Spine 30** : 787-791, 2005
16. Mohanty SP, Venkatram N : Does neurological recovery in thoracolumbar and lumbar burst fractures depend on the extent of canal compromise? **Spinal Cord 40** : 295-299, 2002
17. Mumford J, Weinstein JN, Spratt FK, Goel VK : Thoracolumbar burst fractures. The clinical efficacy and outcome of nonoperative management. **Spine 18** : 955-970, 1993
18. Panjabi MM, Kifune M, Wen L, Arand M, Oxland TR, Lin RM, et al : Dynamic canal encroachment during thoracolumbar burst fractures. **J Spinal Disord 8** : 39-48, 1995
19. Rosenberg N, Lenger R, Weisz I, Stein H : Neurological deficit in a consecutive series of vertebral fracture patients with bony fragments within spinal canal. **Spinal Cord 35** : 92-95, 1997
20. Osebold W, Weinstein S, Sprague B : Thoracolumbar spine fractures-results of treatment. **Spine 6** : 13-34, 1981
21. Starr JK, Hanley EN : Junctional burst fractures. **Spine 17** : 551-557, 1992
22. Vaccaro AR, Nachwalter RS, Klein GR, Sewards JM, Albert TJ, Garfin SR : The Significance of Thoracolumbar Spinal Canal Size in Spinal Cord Injury Patients. **Spine 26** : 371-376, 2001