

Research Article

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Comparative study of the clinical effect and safety of anterior surgical approach and posterior surgical approach in the treatment of thoracolumbar spinal fracture

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Abstract: The clinical effect and safety of the anterior surgical approach and posterior surgical approach in the treatment of thoracolumbar spinal fracture was compared. Retrospective analyses of clinical data for 91 patients observed from March 2010 to September 2014 were made. The pre-operation and post-operation comparisons between two sets of Cobb's angle, affected vertebra height, Frankel's classification of spinal nerves, motion functions, and tactile functions showed statistically significant differences ($P < 0.05$). After having the operation, the Cobb's angle and affected vertebra height of the patient in the anterior approach group were both significantly higher than that of patients in the posterior approach group ($P < 0.05$). The bone graft fusion rate of the patients in the anterior approach group 3 months after operation was higher than that of patients in the control group while the status of complications was worse than that of patients in the posterior approach group, both with a remarkable difference ($P < 0.05$). Both the anterior surgical approach and posterior surgical approach have good clinical outcome for spinal fractures but they all have their respective adaption diseases. The key in the treatment of thoracolumbar spinal fractures lies in choosing proper operative approach.

Keywords: spinal fracture, spinal cord injury, thoracolumbar segment, operative approach

1 Introduction

Vertebral columns including Segment T_{10} to L_2 of human body are clinically called thoracolumbar segments, which includes lumbar vertebra protrusion, thoracic vertebra processus aboralis, and many joint connection points that are easy to fracture. The investigation shows that there are 50%~70% of spinal fractures occurring at thoracolumbar segments. Thoracolumbar fractures are mainly composed of four types namely blow-out fractures, bending compression fractures, safety belt fractures, and fracture dislocation. The reasons of fractures are mostly indirect or direct violence actions, such as fall accidents from high places, smashing pressure of heavy goods, traffic accidents and so on. Their principal clinical manifestations are: a local pain, a dystasia, being obstructed in their actions and so on, which has severely affected the life quality of patients. What is more, fractures occurring in Segment T_{10} to L_2 often injure cauda equine and spinal cord, which may result in paraplegia [3-6]. Consequently, patients suffering from thoracolumbar spinal fractures should have a timely and accurate early diagnosis, accept a proper treatment to restore spinal nerve functions, and avoid disabling and causing death. According to the severity of fractures, the two ways of conservative treatment or operative mode should be adopted and an operative treatment can be generally conducted for the severe patients to relieve the oppression of spinal nerves [7,8]. The decompression approach of spinal fracture operations are composed of an anterior approach and a posterior approach. The research is aimed at comparing clinical effects and safety of the two kinds of approach.

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2 Data and methods

2.1 General data

During March 2012 to September 2014, our hospital totally conducted operative treatment for 91 patients suffering from thoracolumbar spinal fractures. After being hospitalized, all the patients were confirmed as a single-cone unstable fracture through an X-ray and CT and all the injuries were green injuries accompanied with spinal cord injuries. There were 47 anterior approach operations (anterior approach group) and 44 posterior approach operations (posterior approach group). There were 26 males and 21 females in the anterior approach group with an age of 25 to 67 years old and an average age of 33.7 ± 7.9 years old. The causes of injuries comprised of the following: 22 cases of falling accidents from high places, 15 cases of traffic accidents, 7 cases of bruises, and 3 cases of others. Fracture positions comprised of the following: T_{1-12} in 18 cases, L_{1-3} in 14 cases, and thoracolumbar combined injuries in 15 cases. Fracture classification was as follows: 27 cases of blow-out fractures, 12 cases of compression-type fractures, and 8 cases of dislocation-type fractures. The Cobb's angle was in the range $23^\circ \sim 36^\circ$ with an average of $23.7 \pm 4.9^\circ$. The Frankel's classification of spinal nerves was as follows: 7 cases of Grade A, 19 cases of Grade B, 16 cases of Grade C and 5 cases of Grade D. There were 25 males in and 19 females in the posterior approach group with an age of 23 to 69 years old and an average age of 35.2 ± 9.4 years old. The injury causes were: 19 cases of falling accidents from high places, 17 cases of traffic accidents, 5 cases of bruises, and 3 cases of others. Fracture positions include: 18 cases of T_{1-12} , 12 cases of L_{1-3} , and 14 cases of thoracolumbar combined injuries. Fracture classification were as follows: 24 cases of blow-out fractures, 13 cases of compression-type fractures, and 7 cases of dislocation-type fractures. The Cobb's angle was in the range $22^\circ \sim 38^\circ$ with an average of $24.4 \pm 5.6^\circ$. The Frankel's classification of spinal nerves was as follows: 8 cases of Grade

A, 19 cases of Grade B, 13 cases of Grade C and 4 cases of Grade D.

The differences in gender, ages, nosogenesis, injured positions, classification of fractures, and the degree of fractures (see Table 1) have no statistical significance.

Ethical approval: The research related to human use has been complied with all the relevant national regulations, institutional policies and in accordance the tenets of the Helsinki Declaration, and has been approved by the authors' institutional review board or equivalent committee.

Informed consent: Informed consent has been obtained from all individuals included in this study.

2.2 Methods

Anterior approach group: A trachea intubation conducted on patients after a general anesthesia. The patient was placed in a side-lying position (the left side or the right side shall be chosen according to fracture positions) to conduct an operation through an approach outside a pleura and an extra-peritoneum (such as one who has a fracture on T_{11} with the 10th rib as an approach). An oblique incision was made along corresponding ribs. The peritoneum was separated to look for pleura reflection. The psoas major muscles were separated to expose the injured spine, including upside and downside scope for respective 2 to 3 vertebral bodies in the rear area of the pleuroperitoneal membrane. Ligature was performed on neighboring blood vessels, and injured spines, vertebral pedicles, and broken bone blocks of neighboring upside and downside intervertebral disc and irruptive centrum were removed. Spinal nerves from the vertebral arch of an injured centrum were decompressed. A distracter was used to correct the angle and restore the height. A bone groove was opened at corresponding positions on and under the injured spines, and prepared ilium bone blocks were embedded with an internal fixation installed.

Table 1: Statistical comparison between general indicators of the two groups

Contrast indicator	Gender	Age	Nosogenesis	Injury position	Classification of fracture	Cobb's angle	Grading of nerves
$F/t/\chi^2$	0.311 [#]	0.745 [#]	1.443	0.678	0.876	0.428 [#]	1.219
P	0.507	0.265	0.218	0.421	0.389	0.412	0.246

Note: # is a t test and the rest is an intra-class variance analysis.

Posterior approach group: A general anesthesia was conducted and then a tracheal intubation was carried out on patients. The operation was performed in prone position, using a C-arm machine to accurately position a spinal injured position, approaching from a mid-point from its rear, and exposing spines at an injured position and respective 1 to 2 segments of centrum upside and downside. The vertebral restoration height was strutted with a ligament from a posterior approach under the C-arm machine. Neighbouring blood vessels were bound with a cross bearing at the entry point of vertebral pedicles, with positioning screws embedded from different angles. A laminectomy was conducted and an outward bone grafting fusion was performed.

The two groups after operations were both installed with a negative pressure drainage apparatus and incisions were closed. Intravenously drip dexamethasone was given for 3 to 4 days cooperating with antibiotics to guard against infection and inflammation. Stitches were taken out during 10 to 14 days after operation. After staying in bed for 30 days, patients started with moderate functional exercise. An X-ray, CT or MR examinations were given at regular intervals. A follow-up visit 2 months after operations was made, and a record was kept of the survey data.

2.3 Evaluation indexes and methods

The manipulative restoration effects, spinal cord injury restoration degree, bone graft fusion effects, and complication conditions according to X-ray, CT or MR examination results and follow-up investigation data before and after operations were evaluated.

The manipulative restoration effects mainly from Cobb's angle and the centrum height was shown where the Cobb's angle is namely a spine-side bend measuring with the overall length piece of spine by an erect position of X-ray;

The spinal cord injury restoration degree was embodied through Frankel's nerve classification as well as touch and motion scores. Frankel's nerve classification is namely sensory and motion retention circumstances bellow damaged surfaces, being divided into 5 grades in total. Touch and motion scores was in accord with a standard of ASIA 2000 and with a normal function score for 100 points [9].

The bone graft fusion effects were evaluated according to the time taking out a bone graft apparatus and lumbago and back pains. Complications mainly included aerothorax, infection, bedsores, paraplegia and so on.

2.4 Statistical method

Software SPSS15.0 was used to make a statistical analysis, and make comparison for the inter-group differences with a t-test and an χ^2 examination. The differences are considered to have a statistical significance when $P < 0.05$.

3 Results

3.1 Manipulative restoration effects

Through a comparison between pre-operation values and post-operation values of Cobb's angle and the affected vertebra height, all the differences are of a statistical significance ($P < 0.05$). Cobb's angle and centrum height from the anterior approach group shall be both reach a dissection position without collapses and an ideal restoration. There are 2 cases with a Cobb's angle for residual convexes or centrum height collapses in the posterior approach group. Both post-operation Cobb's angle and affected centrum height of the anterior approach group are higher than

Table 2: Comparison of manipulative restoration effects in the two groups

Group	n	Cobb's angle (°)			Affected vertebra height (cm)		
		Pre-operation	Post-operation	P	Pre-operation	Post-operation	P
Anterior approach group	47	23.7±4.9	46.2±7.1	<0.05	1.3±0.4	3.2±0.5	<0.05
Posterior approach group	44	24.4±5.6	37.3±6.4	<0.05	1.5±0.6	2.6±0.6	<0.05
t		0.428	12.102	_____	1.732	6.618	_____
P		>0.05	<0.05	_____	>0.05	<0.05	_____

those in the control group, with differences being of a statistical significance ($P < 0.05$). See Table 2.

3.2 Restoration degree of spinal cord injury

In two groups, the pre-operation and post-operation comparison of Frankel’s nerve classification, exercise grading, and touch grading have a significant difference ($P < 0.05$). Except two un-restored cases in the anterior approach group, nerve functions were promoted for 1 to 3 grades. The posterior approach group had retroversion in one case (degrading from Grade B to Grade A), non-restoration in one case and also a promotion in one to three cases. The differences between two groups are of no statistical significance ($P > 0.05$); the two groups of motion and touch ratings are compared to have a significant difference ($P < 0.05$) inside groups and between groups before operations and after operations. See Table 3.

3.3 Bone graft fusion effects

The bone graft fusion ratio of the anterior approach group reached 100% while the bone graft fusion ratio of the posterior approach group was 88.6% (39/44) 3 months after operation. Differences are of statistical significance ($\chi^2 = 3.946, P < 0.05$). Pain in back and loin of patients in the anterior approach group disappeared 3 months after operation while 3 patients (6.7%) had local pains in back and loin in the posterior approach group.

3.4 Complication conditions

There were 2 cases of pneumothorax, 3 cases of post-operative infection, 3 cases of bed sore and 1 case of complete paraplegia occurring in the anterior approach group. There was no pneumothorax during operation, 2 cases of post-operative infection, 3 cases of bed sore, 1 case of

Table 3: Comparison of spinal cord injury restoration degree between the two groups

Item		Group of anterior approach (case)	Group of posterior approach (case)	Statistical value	P
Frankel’s Nerve classification	Pre-operation	A	7	$F = 1.219$	> 0.05
		B	19		
		C	16		
		D	5		
	Post-operation	A	2	$F = 0.877$	> 0.05
		B	7		
		C	9		
		D	21		
		E	8		
	<i>P</i>	—	< 0.05	< 0.05	—
Exercise grading	Pre-operation	39.1±13.2	40.9±15.1	$t = 0.365$	> 0.05
	30d after operation	71.6±15.9	59.3±20.4	$t = 3.486$	< 0.05
	<i>P</i>	< 0.05	< 0.05	—	—
Touch grading	Pre-operation	45.2±16.5	43.8±14.3	$t = 1.789$	> 0.05
	30d after operation	76.0±17.6	63.6±14.9	$t = 6.720$	< 0.05
	<i>P</i>	< 0.05	< 0.05	—	—

paraplegia exacerbation and 1 case of reoccurrence occurring in the posterior approach group. All in all, conditions of complications in the patients in the posterior approach group were better than those of the patients in the anterior approach group ($P < 0.05$).

4 Discussion

4.1 Thoracolumbar Vertebrate Fracture

Thoracolumbar vertebrate is the most active vertebrate in body. Its main structure features are as follows [2,10,11]: (1) Relatively fixed thoracic spinal and relatively active lumber are jointed here; (2) it includes thoracic kyphosis and lumber lordosis; (3) articular protrusion transforms from coronary to sagittal, and multiple stresses join here. Due to its special physiological location, the segment is prone to fractures, which mainly are unstable fractures accompanying spinal cord injury. The fracture is mostly caused by serious traumas like violent strike, traffic accidents, etc. Major clinical manifestations are local pain, lower extremities dysfunctions, skin sensory function decrease, etc. X-ray, CT and MR inspection can diagnose the location, type and severity of the fractures. Operations are needed in releasing nerve compression, correcting spinal deformity, recovering spinal cord function and spinal stability when fracture damages nerve function, fracture-dislocation or severe fractures happen. Surgical options are anterior approach and posterior approach.

4.2 Anterior operation

Anterior operation directly releases compressed spinal cord mainly through spinal reconstruction achieved by bone grafting internal fixation. Its advantages are as follows [12,13]: (1) It can directly correct fractures, completely clean and recover injured spinals; (2) its internal fixation is stable and postoperative spinal correction is effective; (3) it has a clear operation view and the direct spinal releasing is complete, which is conducive to spinal cord nerve function recovery and has little nerve damage; (4) spinal space pressure method can disperse some loads. However, it is complex and has high demands on surgeon. Besides, it may also cause a big incision and massive hemorrhage, damage peritoneum and surrounding nerves, and hugely increase chances of infection and other complications. Moreover, anterior fixation cannot

solely correct curved vertebrate, so massive bone grafting is needed. Therefore the operation should be conducted from the admission passage of the damaged spinal cord, paying close attention to ligating intercostal veins and avoiding pleural and peritoneal damage.

4.3 Posterior operation

Posterior operation mainly resorts to internal fixation of pedicle screw to recover vertebral height by expanding longitudinal ligament to release lumbar spinal compression. Its advantages lie in easy operation, small wound and bleeding. But because it uses indirect decompression, spinal cord releasing is uncompleted and injury of intervertebral disc and longitudinal ligament is hard to recover [12,13]. Moreover, post operation is easy to cause late-onset malformation and pain. Edema should be cleared during the operation.

For these reasons, Cobb angle, injured spinal height, motor and sensory score, bone grafting fusion rate, pain disappearing condition of anterior groups are better than those of posterior groups, but its complications are more than those of posterior groups.

However, by comparing the postoperative and preoperative indexes, the difference of the two groups has statistical significance. The two methods of operations are effective in treating spinal fractures.

4.4 Operation approach selection strategy

Operation approach selection should be based on the condition of fractures. Firstly, an x-ray should be used to distinguish between burst fracture, compressed fracture or dislocation fracture. For compressed or dislocation fracture, the posterior operation can be conducted. For burst fracture and compressed fracture with nerve injury, a CT or MR image should be taken for the condition of fragments projecting into spinal canal. If the projecting amount is over 40% and the longitudinal ligament is seriously damaged, the posterior operation should not be conducted. If spinal cord injury are complete paraplegia and anterior operation cannot fully recover spinal cord functions, the posterior operation should be conducted to reduce injury [14,15].

In conclusion, anterior and posterior operations are effective in reconstructing vertebrates but they have their own limiting factors. The key to treating thoracolumbar vertebrate lies in choosing suitable operation procedures

to correct vertebrate, recover spinal cord nerve function and stabilize vertebrate mucosa.

Conflict of interest statement: Authors state no conflict of interest.

References

- [1] Yan Z., Analysis of Effectiveness of Thoracolumbar Vertebrate Fracture Short Segment Internal Fixation and Relative Factors, D. Hebei Medical University, 2014
- [2] Xingwei P., Clinical Effect Observation of Posterior Treatment of Thoracolumbar Vertebrate Dislocation Fracture, D. Zunyi Medical College, 2013
- [3] Chun Z., Cong Y., Xijing H., Haopeng L., Guoyu W., Quanjing Z., Surgical Treatment Influence of Different Segments of Thoracolumbar Vertebrate Fracture, J. China Journal of Bone and Joint Injury, 2013,03, 207-209
- [4] Zhang Z., Li F., Sun T., An expert consensus on the evaluation and treatment of acute thoracolumbar vertebrate and spinal cord injury in China, J. Neural Regeneration Research, 2013,33, 3077-3086
- [5] Jinguo W., Hua W., Xiaolin D., Yutian L., Treatment of Thoracolumbar Vertebrate Fracture by Transpedicular Morselized Bone Grafting in Vertebrae for Spinal Fusion and Pedicle Screw Fixation, J. Journal of Huazhong University of Science and Technology (Medical Sciences), 2008, 03, 322-326
- [6] Jianwu Z., Yi C., Research on Surgical Treatment of Thoracolumbar Vertebrate Fracture, J. Gansu Medical Journal, 2009, 04, 280-281
- [7] Yuke Z., Shizhan C., Yimin Y., Yu W., Ping H., Xuejun Y., Thoracolumbar Vertebrate Fracture Treatment of Injured Vertebrate Screw Placement Single Segment Fixation, J. Journal of Practical Orthopedics, 2011, 06, 540-542
- [8] Xianrun S., Tao T., Xiaofang Z., Tiannan Z., Guoxi G., Treatment Experience of Unstable Thoracolumbar Vertebrate Fracture Merging Spinal Cord Injury, J. The Orthopedic Journal of China, 2011, 02, 158-161
- [9] Fangyong W., Jianjun L., Yi H., Primary Research on Chinese ASIA2000 Standard Motor Score Validity, J. Chinese Journal of Rehabilitation Theory and Practice, 2005, 11, 65-66
- [10] Duan Y., Seeman E., reduced bone size contributes to the deficit in bone mass in men and women with spinal fractures, A., Gerontological Society of China. Proceedings of the Third International Congress on Osteoporosis, C. Gerontological Society of China, 1999, 1
- [11] Chinese Medical Association, Orthopedics Branch of Chinese Medical Association, 8th Orthopedics Academic Conference of Chinese Medical Association and 1st International COA Academic Conference Paper Abstract Collection, C. Chinese Medical Association, Orthopedics Branch of Chinese Medical Association, 2006,1
- [12] Pengfei J., Clinical controlled research of thoracolumbar vertebrate fracture anterior and posterior decompression treatment merging spinal cord injury, D. Yan'an University, 2013
- [13] Jingsong W., Clinical Analysis of Adult Thoracolumbar Vertebrate Fracture Anterior and Posterior Internal Fixation Treatment, J. China Medical Herald, 2013, 22, 49-51
- [14] Yongdong Q., Zili W., Huiqiang D., Haoning Z., Jianwei S., Weidong J., Research on thoracolumbar vertebrate fracture operation method, J. Ningxia Medical Journal, 2004, 09, 536-538
- [15] Yanshan Z., Clinical Experience of Surgical Treatment for Thoracolumbar Vertebrate Fracture, J. Guide of China Medicine, 2012, 28, 234-235