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Comparison of clinical efficacy between surgical and non-surgical treatments for thoracolumbar type B fractures associated with ankylosing spondylitis

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Abstract

Background: Ankylosing spondylitis (AS) combined with thoracolumbar type B fractures usually presents as unstable injuries, with fractures involving all three columns. Surgical treatment is regarded as the preferred treatment option for this type of fracture. Nevertheless, approximately one-third of patients still opt for non-surgical treatment. Currently, there is a lack of research data comparing different treatment methods for AS patients with thoracolumbar fractures.

Methods: Clinical data were collected from patients with AS complicated by thoracolumbar type B fractures who were treated with either surgical or non-surgical methods at our institution between January 2018 and October 2023. The general data of the two groups were compared, and clinical efficacy-related indicators were recorded, including fracture healing time, Visual Analog Scale (VAS) scores, Oswestry Disability Index (ODI) scores, and the incidence of complications. VAS and ODI scores of the two groups were compared at admission, at 3 months, at 12 months, and at the final follow-up.

Results: There were 37 patients in the surgical group and 33 patients in the non-surgical group. No significant differences were observed in baseline demographic or clinical characteristics between the two groups. The median VAS scores in the surgical group and the non-surgical group at 3 months were 2 (2, 2) and 3 (3, 4), respectively. The median ODI scores in the surgical group and the non-surgical group at 3 months were 20 (18, 22)% and 40 (36, 44)%, respectively. Comparison of the VAS and ODI scores between the two groups revealed that the differences were statistically significant at 3 months. The median fracture healing time was 7 (6, 8) months in the surgical group and 13 (12, 14) months in the non-surgical group. This difference was statistically significant. The complication rate in the surgical group was 18.9%, which was significantly lower than the 57.6% observed in the non-surgical group.

Conclusions: Surgical treatment has obvious advantages in fracture healing, complication rates, and early clinical efficacy, and can promote early rehabilitation of patients. It is the preferred treatment for AS combined with thoracolumbar type B fractures.

Clinical trial number: Not applicable.

Background

Ankylosing spondylitis (AS) combined with thoracolumbar type B fractures usually presents as unstable injuries, with fractures involving all three columns[1–3]. Due to the spinal deformity and osteoporosis in patients with AS, vertebral fractures may occur even under minor external forces[1]. Unlike common thoracolumbar fractures, patients with AS have characteristics such as inflammatory pain, osteoporosis, and spinal fusion[4]. These factors make fractures more likely to be concealed, increasing the risk of missed diagnosis and delayed treatment[1, 5, 6]. If a fracture is not promptly and effectively treated, the fracture ends will continue to bear stress, which may lead to serious complications such as pseudoarthrosis formation, progressive kyphosis, and secondary nerve injury[7, 8].

Surgical treatment is regarded as the preferred treatment option for AS combined with thoracolumbar type B fractures. It can significantly enhance the survival rate of patients, reduce the occurrence of complications, and to a certain extent, improve the neurological function of patients[9, 10]. At present, the posterior approach surgery is mainly chosen for surgical access, and long-segment fixation is a common surgical approach for AS combined with thoracolumbar type B fractures, which is usually recommended[11–13]. However, patients with AS may already have heart and lung function disorders, and the surgical risks and postoperative complications cannot be ignored[11, 14]. Non-surgical treatment is generally suitable for patients with multiple underlying diseases and poor physical conditions that cannot tolerate surgery. It is often associated with a high rate of complications, poor fracture healing, persistent pain, and secondary thoracolumbar pseudoarthrosis[15, 16]. As such, it is generally not recommended as the first choice of treatment. Nevertheless, approximately one-third of patients still choose non-surgical treatment[1, 9].

In recent years, some studies have shown that for patients with ankylosing spinal diseases combined with spinal fractures, there is no significant difference in the efficacy among different treatment methods, and they have emphasized the importance of non-surgical treatment approaches[17, 18]. However, existing studies mostly involve patients with cervical fractures, who have a relatively high incidence of complications, or patients with diffuse idiopathic skeletal hyperostosis, which affects the accuracy of the results[19, 20]. Currently, there is a lack of research data comparing different treatment methods for AS patients with thoracolumbar fractures. Therefore, the present study aims to investigate the optimal treatment strategy by comparing the clinical efficacy of surgical and non-surgical interventions in patients with AS complicated by thoracolumbar type B fractures.

Materials and methods

Patients

This retrospective study was approved by the Institutional Review Board of the Second Affiliated Hospital of Soochow University and Sihong Hospital. All patients provided informed consent, which was documented in writing. Clinical data of patients with AS complicated with thoracolumbar type B fractures who were treated in our institution from January 2018 to October 2023 were collected. Among these patients, 37 were treated with traditional open posterior internal fixation surgery, while 33 received non-surgical treatments such as bed rest. General patient information, including age, gender, trauma history, injured segment, fracture type, Charlson Comorbidity Index (CCI), and C-reactive protein (CRP), was recorded. Upon admission, all patients underwent a comprehensive spinal physical examination, routine X-ray and CT scans, and MRI examinations if nerve injury was suspected. The AO Spine Thoracolumbar Spine Injury Classification System was utilized for the categorization of spinal fractures. Neurological impairments were evaluated using the American Spinal Injury Association (ASIA) grading system.

Inclusion and exclusion criteria

The inclusion criteria were as follows: 1. AS was diagnosed based on the modified New York criteria; 2. the imaging findings were thoracolumbar fractures, and the fracture type is classified as type B; 3. no neurological impairments; 4. patients who received surgical treatment were treated with posterior open internal fixation, while those who received non-surgical treatment were treated with bed rest and brace fixation. The exclusion criteria were as follows: 1. Surgical treatment adopted the combined anterior and posterior approach, or patients chose non-surgical treatments such as massage, manipulation, and traction; 2. patients with AS complicated with cervical spine fractures or fractures in other segments; 3. the incompleteness of radiological information, treatment details, and follow-up data; 4. the patients have severe local kyphosis deformity, vertebral infection, tumors, or other pathological fractures.

Treatment

AS combined with thoracolumbar type B fractures involves three-column injuries and is classified as an unstable fracture. Our research team suggested surgical treatment as the preferred option. However, when formulating the treatment plan, the personal wishes and physical conditions of the patients were also fully considered, and the most suitable treatment plan was ultimately determined.

Non-surgical treatment mainly includes three months of bed rest, thoracolumbar brace fixation, and pain-relieving medication when necessary. Patients are instructed to perform lumbar and back muscle function exercises and lower limb muscle strength training during bed rest, and are encouraged to frequently change positions to actively prevent common complications such as deep vein thrombosis of the lower extremities, pressure sores, pneumonia, and urinary tract infections. Patients are educated about the disease, and are advised to seek medical attention immediately at the hospital if they experience increased pain, changes in pain nature, limb weakness, or abnormal skin sensation. In such cases, surgical treatment may be necessary. For the treatment of AS itself, it is recommended that patients regularly follow up at the rheumatology and immunology outpatient clinic.

The surgical patient underwent a posterior approach surgery in the prone position under general anesthesia. During the positioning process, adjustments should be made according to the patient's spinal morphology, and sufficient soft padding should be provided when necessary to effectively prevent further displacement of the fracture and avoid nerve injury. The C-arm X-ray machine (Siemens, Germany) was used to determine the fracture segment. The area was routinely disinfected and draped. A midline longitudinal incision was made centered on the fractured vertebra, and the length of the incision was selected based on the number of fixation segments. The skin, subcutaneous tissue, and thoracolumbar back fascia were incised layer by layer. The paravertebral muscles were dissected along the spinous processes and laminae to expose the laminae and facet joints. Holes were drilled bilaterally at the pedicles of the vertebral bodies, and guide pins were inserted, followed by puncture and placement of marking pins. The C-arm X-ray machine was used to confirm the good position of the positioning pins. Bone channels were tapped, and an appropriate number of pedicle screws were placed.

The fixed segments were usually 2 to 3 segments above and below the fractured vertebra. For patients with severe osteoporosis, bone cement was used to reinforce the screws during the operation. The C-arm X-ray machine was used to confirm the satisfactory position of the screws. Appropriate-length connecting rods were selected, shaped, and installed with the screws tightened. Hemostasis was performed, the incision was irrigated, 1 to 2 silicone drainage tubes were placed, and the incision was sutured layer by layer.

Evaluation index

The general data of the two groups of patients were compared, and the clinical efficacy-related indicators were recorded, including fracture healing time, pain visual analogue scale (VAS), Oswestry Disability Index (ODI), and the incidence of complications. The VAS and ODI scores of the two groups at admission, 3 months, 12 months, and the last follow-up were compared. Complications included neurological impairments, pneumonia, deep vein thrombosis in the lower extremities, and urinary tract infections. Bone fusion is defined as the blurring of the fracture line on radiographs, the formation of bridging bone, or the appearance of a trabecular pattern across the fracture site on CT imaging[21–23]. Diagnosis time is defined as the period from the occurrence of trauma or symptoms to a clear diagnosis. If it exceeds 24 hours, it is defined as delayed diagnosis[4].

Statistical analysis

All data were analyzed statistically using SPSS 27.0 software. For measurement data, if they conformed to a normal distribution, they were expressed as mean ± standard deviation ($\bar{x} \pm s$), and comparisons between two groups were conducted using the independent samples t-test. If they did not conform to a normal distribution, they were expressed as median [M ($Q1$, $Q3$)], and comparisons between two groups were conducted using the Mann-Whitney U test. For multiple related samples, the Friedman test was used. Count data were expressed as the number of cases or percentages (%), and comparisons between groups were conducted using the chi-square (χ^2) test. A P value < 0.05 indicates that the difference is statistically significant.

Results

All patients were followed up. There were 37 cases in the surgical group, with a median follow-up time of 44 (27, 66) months. There were 33 cases in the non-surgical group, with a median follow-up time of 36 (26, 57) months. There was no significant difference in the general data between the two groups of patients (Table 1).

Table 1
Comparison of General Data Between Surgical and Non-surgical Groups

Number of patients	**Surgical**	**Non-surgical**	$t/z/\chi^2$	*p*
	37	**33**	-	-
Gender			1.493	0.222
Male	34	26		
Female	3	7		
Age (years)	58.9 ± 13.3	60.4 ± 12.3	-0.489	0.627
Trauma history			1.363	0.243
high impact	15	9		
low impact	22	24		
Injured segment			5.473	0.065
thoracic	2	8		
thoracolumbar	27	21		
lumbar	8	4		
Fracture type (AO classification)			0.071	0.965
B1	6	5		
B2	12	10		
B3	19	18		
CCI (point)	2 (1, 4)	2 (1, 4)	-0.156	0.876
CRP (mg/L)	45 (7, 60)	17 (6, 44)	-1.736	0.083
CCI, Charlson Comorbidity Index; CRP, C-reactive protein				

The median diagnosis time for patients in the surgical group was 24 (4, 63) hours, among which 18 cases (48.6%) had delayed diagnosis; for patients in the non-surgical group, the median diagnosis time was 48 (7, 186) hours, and 22 cases (66.7%) had delayed diagnosis. There was no statistically significant difference in the comparison of delayed diagnosis between the two groups of cases. The median hospital stay for patients in the surgical group was 15 (12, 20) days, while that for patients in the non-surgical group was 11 (8, 13) days. A comparison of the median hospital stays between the two groups showed a statistically significant difference. The median fracture healing time in the surgical group was 7 (6, 8) months. In the non-surgical group, 7 patients underwent surgical treatment, 1 patient died, and

the median fracture healing time for the remaining 25 patients was 13 (12, 14) months. There was a statistically significant difference in the median fracture healing time between the two groups. Among the surgical group, 7 patients (18.9%) experienced complications. One patient underwent revision surgery due to loosening of the internal fixation and subsequent vertebral fracture. One patient developed deep vein thrombosis of the lower extremities. Five patients suffered from pulmonary diseases such as pneumonia and atelectasis. The effectiveness rate of treatment was 97.3%. Among the non-surgical group, 19 patients (57.6%) experienced complications. One patient died during the follow-up period due to pulmonary infection and respiratory failure. Two patients with nerve injury secondary to displacement of the fracture ends underwent surgical treatment, with one patient recovering to normal (ASIA C-E grade) and the other not fully recovering (ASIA B-C grade). Three patients developed Andersson injury, with two of them undergoing surgical treatment. Three patients underwent surgical treatment due to inability to tolerate pain, prolonged bed rest, or non-union of the fracture. One patient developed urinary tract infection. One patient developed deep vein thrombosis of the lower extremities and pneumonia. Eight patients suffered from pulmonary diseases such as pneumonia and atelectasis. The effectiveness rate of treatment was 75.8%. There was a statistically significant difference in the incidence of complications between the two groups (Table 2).

Table 2
Comparison of Treatment Conditions Between Surgical and Non-surgical Groups

Delayed diagnosis	**Surgical**	**Non-surgical**	z/χ^2	*p*
			2.312	**0.128**
yes	18 (48.6%)	22 (66.7%)		
no	19 (51.4%)	11 (33.3%)		
Hospital stay (days)	15 (12, 20)	11 (8, 13)	-3.531	<0.001*
Healing time (months)	7 (6, 8)	13 (12, 14)	-6.588	<0.001*
Complication			11.165	<0.001*
yes	7 (18.9%)	19 (57.6%)		
no	30 (81.1%)	14 (42.4%)		
Treatment effect			-	0.01*
effective	36 (97.3%)	25 (75.8%)		
ineffective	1 (2.7%)	8 (24.2%)		

The comparison of VAS scores between the two patient groups showed that the median VAS scores at 3 months were 2 (2, 2) in the surgical group and 3 (3, 4) in the non-surgical group, and the difference was statistically significant (Table 3). The median ODI scores of the surgical group and the non-surgical

group at 3 months were 20 (18, 22)% and 40 (36, 44)%, respectively, and the median ODI scores at 12 months were 13 (11, 18)% and 18 (13, 20)%, respectively. The differences between the two groups were statistically significant at both 3 months and 12 months (Table 4).

Table 3
Comparison of VAS Scores Between Surgical and Non-surgical Groups at Different Time

VAS	Surgical	Non-surgical	*z*	*p*
At admission	7 (6, 8)	7 (7, 8)	-1.666	0.096
3 months	2 (2, 2)[a]	3 (3, 4)[a]	-6.700	<0.001*
12 months	1 (1, 2)[ab]	2 (1, 2)[ab]	-1.904	0.057
Last follow-up	1 (0, 2)[ab]	1 (1, 2)[ab]	-1.389	0.165
χ2	95.71	73.15	-	-
P	<0.001*	<0.001*	-	-

VAS, visual analogue scale; a: significant difference compared with admission VAS; b: significant difference compared with 3-month follow-up VAS; *$P < 0.05$ indicates a statistically significant difference

Table 4
Comparison of ODI Scores Between Surgical and Non-surgical Groups at Different Time

ODI (%)	Surgical	Non-surgical	*z*	*p*
At admission	82 (78, 93)	82 (77, 93)	-0.338	0.735
3 months	20 (18, 22)[c]	40 (36, 44)[c]	-6.670	<0.001*
12 months	13 (11, 18)[cd]	18 (13, 20)[cd]	-3.151	0.002*
Last follow-up	9 (7, 12)[cde]	9 (7, 16)[cde]	-0.484	0.628
χ2	107.20	63.00	-	-
P	<0.001*	<0.001*	-	-

ODI, oswestry disability index; c: significant difference compared with admission ODI; d: significant difference compared with 3-month follow-up ODI; e: significant difference compared with 12-month follow-up ODI; *$P < 0.05$: indicates a statistically significant difference

Discussion

AS combined with thoracolumbar type B fractures is mostly an unstable injury, involving all three columns of the spine. Due to spinal deformity and osteoporosis, patients with AS may suffer vertebral fractures even under minor external force[1, 4, 24, 25]. Studies have shown that the incidence of spinal

fractures in AS patients is about four times that of normal people, mostly low-energy injuries, among which thoracolumbar fractures account for approximately 20% to 40%[1–3, 17]. AS combined with thoracolumbar fractures mostly occurs in the thoracolumbar region of the spine[23]. According to the AO classification of spinal fractures, type B is the most common fracture type in clinical practice, with B3 fractures caused by hyperextension injury are particularly typical. Relevant studies have shown that the incidence of B3 fractures in this group of patients can be as high as 20% to 64%[10, 11, 21, 26, 27]. In this study, low-energy injury was the most common cause of injury, accounting for 59.5% in the surgical group and 72.7% in the non-surgical group; the thoracolumbar region was the most frequently affected area, accounting for 73.0% in the surgical group and 63.6% in the non-surgical group. Additionally, among all cases, B3 fractures had the highest incidence, accounting for 51.4% in the surgical group and 54.5% in the non-surgical group. These results are consistent with previous studies.

Unlike common thoracolumbar fractures, patients with AS combined with thoracolumbar fractures have characteristics such as inflammatory pain, osteoporosis, and spinal fusion, which increase the possibility of fractures being masked, leading to missed diagnoses and delayed treatment[1]. Studies have shown that approximately 17.1% to 65.4% of AS-related vertebral fractures are diagnosed late[1, 5]. Tu et al.[4] found that the average delay in diagnosis for 105 AS patients with spinal fractures was 19.8 days, and among the 33 missed diagnoses, one-third of the patients had secondary nerve damage. Ull et al.[6] found that among 166 AS patients with spinal fractures, 79 (47.6%) were diagnosed late. In this study, the median diagnosis time for the surgical group was 24 (4, 63) hours, with 18 (48.6%) patients experiencing a delayed diagnosis; for the non-surgical group, the median diagnosis time was 48 (7, 186) hours, with 22 (66.7%) patients experiencing a delayed diagnosis, similar to the delayed diagnosis rates reported in previous studies. Although there was no statistically significant difference in the incidence of delayed diagnosis between the two groups, the non-surgical group had a higher trend of delayed diagnosis compared to the surgical group.

At present, clinical comparative studies on different treatment methods for AS combined with thoracolumbar fractures remain relatively scarce. Given the low incidence of this condition, most existing studies have included cases of AS combined with cervical fractures and patients with diffuse idiopathic skeletal hyperostosis to meet statistical requirements. This inclusion has, to some extent, compromised the accuracy of the research findings[9, 28]. Furthermore, patients with poor health conditions who were unable to withstand surgical intervention were also included in the non-surgical treatment group, potentially affecting the accuracy of the results[28]. To enhance the reliability of the research outcomes, this study exclusively enrolled patients with AS combined with thoracolumbar type B fractures, as this fracture type is the most commonly encountered in clinical practice. Additionally, the CCI score was utilized to evaluate the comorbidities of the patients involved in this study. The findings revealed that both the surgical and non-surgical groups had a CCI score of 2 (1, 4), with no statistically significant difference in CCI scores between the two groups ($P > 0.05$). These results indicate that the baseline physical conditions of the patients in the two groups were comparable.

The instability of thoracolumbar fractures combined with AS poses challenges for treatment. Non-surgical treatment is usually only applicable to a small number of stable fractures, mainly including bed rest, brace fixation, and pain medication when necessary[29]. Nakao et al.[16] treated five patients with AS combined with thoracolumbar fractures using brace fixation, but all of them eventually underwent surgical treatment due to increased back pain or nerve damage caused by pseudoarthrosis formation in the later stage. Shaik et al.[30] believe that non-surgical treatment is only suitable for thoracic injuries with intact thoracic complexes. Although Chen et al.[17] and Bäcker et al.[28] demonstrated that for spinal fusion patients with spinal fractures, the treatment outcomes were similar regardless of the treatment approach and emphasized that non-surgical treatment was feasible, their studies included cervical fractures and patients with diffuse idiopathic skeletal hyperostosis, which to some extent affected the accuracy of the results. However, there are few successful cases of non-surgical treatment, and there is no large-sample study to support it. In the absence of surgical contraindications, surgical treatment is generally recommended[1]. In this study, a total of 33 patients were included in the non-surgical treatment group. Under the premise of fully respecting the patients' treatment wishes, all of them were underwent 3 months of bed rest, brace fixation, and other methods, and their treatment effects were closely observed.

Surgical treatment is the preferred approach for AS combined with thoracolumbar fractures, which has been proven to promote fracture healing, reduce complications and mortality, and facilitate the recovery of nerve injury[1, 4, 9, 15]. Posterior long-segment internal fixation is a commonly used treatment method. For clinicians, this surgical approach is more familiar and widely applied. It not only enables multi-point fixation but also effectively performs decompression in the injured area. For patients with significant thoracolumbar kyphosis, deformity correction can be appropriately carried out during fixation and fusion[3, 11–13]. AS patients often have osteoporosis and changes in spinal biomechanics. To achieve more stable fixation and prevent internal fixation failure, the intraoperative fixation usually spans 2 to 3 segments above and below the injured vertebra. For osteoporotic patients, bone cement reinforcement can be provided[21, 31]. This study included a total of 37 patients who underwent posterior surgical fixation. The intraoperative internal fixation segments varied, mostly spanning 2 to 3 segments above and below the fractured vertebra. After surgery, patients were encouraged to get out of bed as early as possible under brace protection.

Previous research results have shown that patients with AS exhibit strong bone formation ability. Repeated mechanical stress and unstable conditions are key factors hindering fracture healing. As long as sufficient stability is provided, fracture healing can be effectively promoted[30, 32]. This study compared the clinical efficacy of surgical and non-surgical treatments for AS patients with thoracolumbar fractures. The results showed that the median fracture healing time (months) in the surgical group was significantly shorter than that in the non-surgical group [7 (6, 8) vs. 13 (12, 14), $P < 0.05$]. This result indicates that surgical fixation not only effectively shortens the fracture healing time but also further confirms the crucial role of stability in the fracture healing process. Additionally, the VAS score [2 (2, 2) vs. 3 (3, 4), $P < 0.05$] and ODI score [20 (18, 22)% vs. 40 (36, 44)%, $P < 0.05$] of the surgical group at 3 months were significantly better than those of the non-surgical group. This result indicates

that surgical treatment not only effectively alleviates early pain in patients but also significantly improves lumbar function, thereby promoting rapid patient recovery. Regarding the occurrence of complications during treatment, the complication rate in the surgical group was 18.9%, significantly lower than 57.6% in the non-surgical group. The most common complications were pulmonary diseases, mainly including pneumonia and atelectasis. In terms of treatment outcomes, in the surgical group, all patients achieved fracture healing except for one who required revision surgery due to loosening of the internal fixation and a subsequent fracture of the lower fixed vertebra. The effective rate of treatment was 97.3%. In the non-surgical group, one patient died during the treatment period, and seven patients were converted to surgical treatment due to the severity of their condition. The remaining patients achieved fracture healing, with an effective rate of treatment at 75.8%. The therapeutic effect of the surgical group was significantly better than that of the non-surgical group.

There were several limitations in our study. First, it was a retrospective study. Second, due to the limitation of sample size, this study only selected common type B fractures for analysis and did not further compare the more detailed fracture types (such as B1, B2, and B3), which to some extent affected the data presentation in the comparison between the two groups of cases. Third, this study did not include patients with nerve injury. The main reason is that such patients usually prefer surgical treatment. If they were included in the study, it might affect the accuracy of the comparison results.

Conclusions

Surgical treatment has obvious advantages in fracture healing, complication rates, and early clinical efficacy, and can promote the early rehabilitation of patients. It is the preferred treatment for AS combined with thoracolumbar type B fractures.

Abbreviations

AS: Ankylosing spondylitis

ASIA: American Spinal Injury Association

CCI: Charlson Comorbidity Index

CRP: C-reactive protein

CT: Computed tomography

ODI: Oswestry disability index

VAS: Visual analogue scale

Declarations

Ethics approval and consent to participate

Ethics committee approval for this article was obtained from the Second Affiliated Hospital of Soochow University and Sihong Hospital, with the number JD-HG-2023-74. Informed consent was obtained from all individual participants included in the study. The whole research process follows the Declaration of Helsinki.

Consent for publication

The patients provided informed consent for the publication of their document imaging, as well as their anonymous and clustered data.

Availability of data and materials

The data used during the present research are available from the corresponding author on request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

XZZ and XHZ contributed to the study conception and design. ZYY, WKZ, GXF, and XYZ contributed to clinical data collection; CHT, ZTZ, and BCS contributed to radiological data analysis; ZYY contributed to statistical analysis; ZYY and WKZ contributed to the writing and editing. All authors have read and approved the final manuscript.

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