Comparison of single posterior debridement, bone grafting, and instrumentation with single anterior debridement, bone grafting, and instrumentation in treatment of thoracic spinal tuberculosis

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Research article

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Abstract

Objective To explore the clinical effect of single posterior debridement, bone grafting, and instrumentation and single anterior debridement, bone grafting and instrumentation in the treatment of thoracic spinal tuberculosis of adult patients.

Methods: A retrospective analysis was made by involving 38 adult patients with thoracic spinal tuberculosis from between June 2013 and December 2015. Of the 38 patients, 21 patients were categorized in single anterior approach group and underwent single posterior debridement, bone grafting, and instrumentation (Group A). The remaining 17 patients were classified in single posterior approaches group (Group B), which received single posterior debridement, bone grafting and instrumentation. Clinical manifestations, laboratory and imaging results of the two groups were analyzed subsequently.

Results: All patients were followed up for 23.9 ± 3.8 m (range, 19–36 m). Bony fusion was achieved in all bone grafts. The operation time and intraoperative blood loss in group B were significantly less than those in group A ($P<0.05$). The VAS scores, ESR, and CRP levels 6 weeks after operation and at the final follow-up were significantly lower than the preoperative levels ($P<0.05$). At the last follow-up, ASIA improvement no significant difference between groups ($P>0.05$). Furthermore, the postoperative and final-follow-up kyphosis angles in group B were both significantly smaller than those in group A ($P<0.05$). Group A had a postoperative angle correction rate smaller than group B, and its postoperative angle loss was greater than group B's ($P<0.05$).

Conclusion: Single posterior debridement, bone grafting, and instrumentation can achieve similar curative effect as single anterior debridement, bone grafting and instrumentation in the treatment of thoracic spinal tuberculosis, but also accompanied by additional advantages of shorter operation time and less bleeding .

Introduction

The incidence of spinal tuberculosis (TB) is increasing in developing countries, and every year, two to three million deaths worldwide are related to spinal TB [1–3]. STB is the most frequent skeletal tuberculosis, accounting for almost 50% of all skeletal tuberculosis cases [4]. Spinal infections can cause destruction and collapse of the vertebral body and further lead to kyphosis and neurological impairment [5]. When the blood supply to the thoracic spinal cord is inadequate because of thoracic spinal canal stenosis, patients suffering from severe destruction of bone or spinal instability are more prone to neurological impairment [6,7].

Although chemotherapy plays a crucial role in spinal TB treatment, it is often necessary to correct kyphosis and improve neurological function through surgical intervention. Surgical treatment for spinal TB mainly includes debridement, kyphosis correction, and reconstruction of spinal stability [8]. The optimal surgical treatment for spinal TB remains controversial. The single anterior approach allows for direct debridement, bone grafting, and instrumentation; yet, outcomes of this approach regarding

kyphosis correction and maintenance are far from satisfactory [8,9]. The single posterior approach is a proven STB treatment of favorable outcomes [10,11], in spite of which it fails to achieve thorough debridement of lesions in the anterior spine.

In this study, a comparative analysis was performed on the clinical outcomes of single anterior and posterior debridement, bone grafting, and instrumentation in treating adult patients with thoracic spinal tuberculosis (TSTB).

Patients And Methods

Basic information

This retrospective study included 38 active pulmonary tuberculosis-free patients who were diagnosed with active spinal TB between June 2013 and December 2015. Clinical diagnosis of active spinal TB was based on clinical features, investigations [high erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP)], radiographic examination [x-ray, computed tomography (CT), and magnetic resonance imaging (MRI)], and pathological examination. Other inclusion criteria are as follows: (1) monosegmental TSTB, with the destruction limited to a single vertebral segment and affecting no more than one vertebral motor unit; (2) progressive neurological impairment; (3) poor outcomes of conservative treatment; (4) serious kyphosis or progression of kyphosis; (5) persistent low back pain. Exclusion criteria consist of (1) postoperative recurrence of TSTB; (2) TSTB combined with serious osteoporosis; (3) TSTB combined with cancer or degeneration of intervertebral disc that might affect the evaluation of clinical outcomes; (4) TSTB combined with severe tuberculosis in other organs (e.g., pulmonary/renal tuberculosis) in a poor nutritional state that might affect the evaluation of clinical outcomes. The ethics review committee of the Shaanxi Provincial People's Hospital approved the study protocol (2012–0125). All the patients provided written informed consent for the use and publication of data for research purposes.

Therapeutic Methods

Preoperative therapy

All patients diagnosed with TSTB were treated by HREZ (300 mg/d isoniazid, 450 mg/d rifampicin, 750 mg/d ethambutol and 1.5 g/d pyrazinamide) for at least two to four weeks before operations.

Operative technique

All patients were intubated under general anesthesia. In group A, the patients were placed in a lateral position, and incisions were placed using the extra pleural or extra peritoneal anterolateral approach. From the severely affected side of the lesion, purulent fluid, dead bone, the diseased vertebra and intervertebral disk tissue, and caseous necrotic tissue were removed radically. In a less severe case, pedicle screws could be inserted in the short-segment fixation and correction of kyphosis deformity. An autogenous iliac bone or rib graft was closely embedded into the intervertebral bone grafting groove (Fig. 1). Patients in group B were placed in a prone position, and a posteromedial incision was made to expose

the vertebral plate, facet joints, and costovertebral joints. After the location of the lesion by C-arm fluoroscopy, pedicle screws were inserted in the normal vertebral body adjacent to the upper and lower affected vertebrae, followed by kyphosis correction. From the costovertebral joints or pedicles of the vertebral arch, the lesion in the anterior vertebral body was removed, so as the dead bone, necrotic intervertebral disc, and caseous necrotic tissue. Then, an autogenous iliac bone graft was embedded into the focal zone (Fig. 2). After the operation, a drainage tube was placed, and then the incision was closed. Following the operation, conventional bacterial cultivation and pathological diagnosis were performed.

Postoperative treatment

Prophylactic antibiotics were used for 72 h, and oral administration of HREZ continued after the operation. Six months later, Pyrazinamide was withdrawn while daily isoniazid, rifampicin, and ethambutol (HRE) were administered for another 10 to 12 months. The drainage tube was removed when 24-h drainage volume was less than 50 ml. Following that, patients were allowed to walk with the support of a mobility aid. At first, non-weight-bearing activity was recommended only. Normal weight-bearing activity was not allowed until confirmation of intervertebral fusion with x-ray and CT examinations.

Evaluation Standard

Visual analog scale (VAS) scores were used for pain assessment. The Frankel grading system was employed in the assessment of pre- and postoperative spinal cord injuries. ESR and CRP levels were assessed to monitor the disease activity. Pre- and postoperative kyphosis angles were measured using the method proposed by a previous study [12]. X-ray and CT examinations were conducted to assess bone graft fusion, loss of correction angle, and internal fixation failure [13]. An analysis was performed on the operation time, intraoperative blood loss, and length of hospital stay in the two groups.

Statistical analysis

The software SPSS 19.0 (SPSS, Inc., Chicago, IL, USA) was used for data analysis. Wilcoxon's signed-rank test was used for assessing the differences between pre- and postoperative American Spinal Injury Association (ASIA) impairment scale scores. The paired t-test was performed to compare pre- and postoperative degrees of kyphosis deformity and ESR and CRP levels. The independent-samples t-test was used to compare the laboratory and physical parameters of the two groups. The Wilcoxon rank-sum test was employed in the analysis of discrepancy in normal distributions. $P < 0.05$ was considered indicative of a significant difference.

Results

Definite diagnosis was established through bacterial cultivation and/or pathological diagnosis in all the 38 cases, and mycobacterium tuberculosis was found in 20 patients. Out of the 38 patients, 21 [10 male and 11 female; mean age 43.5 ± 8.4 years (range, 24–69)] were included in group A while the other 17 patients [8 male and 9 female; mean age 41.4 ± 8.9 years (range, 21–71)] were included in group B. The

mean operation time in group A was 222 ± 38 min, significantly longer than that in group B (174 ± 41 min) ($P < 0.05$). The mean intraoperative blood loss was greater in group A than in group B (600 ± 100 mL vs. 490 ± 110 mL, $P < 0.05$). The mean length of hospital stay was 22 ± 4 d in group A and 22 ± 5 d in group B, with the difference indicating no statistical significance ($P > 0.05$).

The mean time of bone graft fusion was 6.4 ± 0.2 m in group A and 6.5 ± 0.2 m in group B, and the difference was not statistically significant ($P > 0.05$). Varying degrees of paraspinal abscess around the psoas muscle was observed in 19 patients of group A and 14 of group B. It took group A 7.4 ± 0.7 m (range, 6–11 m) and group B 7.2 ± 0.6 m (range, 6–12 m) for the abscess to disappear, and the difference showed no statistical significance ($P < 0.05$). Table 1 lists the sites of lesions and lumbar fusion in the two groups.

Follow-ups were performed 100% in both groups, with the mean duration of follow-up in the entire study population as 23.9 ± 3.8 m (range, 19–36 m). Disruption of wound occurred in one patient in group A, which healed 23 d after redressing and suture; in group B, there was a case of postoperative sinus track formation, and the sinus tract was treated properly and closed four weeks after the operation. A case of breakage of internal fixation was found in group A during a follow-up eight months after the operation. The internal fixation rod was removed after confirmation of bone graft infusion. During the follow-up period, no TB recurrence was reported in either group.

Table 2 shows the pre- and postoperative kyphosis angles, angle correction, angle loss, and angle correction rates of the two groups. Differences between the two groups in the preoperative kyphosis angles lacked statistical significance ($P > 0.05$). The postoperative and final-follow-up kyphosis angles in group B were both significantly smaller than those in group A ($P < 0.05$). Group A had a postoperative angle correction rate smaller than group B, and its postoperative angle loss was greater than group B's. These differences were statistically significant ($P < 0.05$).

All patients had neurological impairment before operations (Frankel Grade C or D, Table 3). At the most recent follow-up, 18 patients in group A and 15 patients in group B had their neurofunctional parameters being brought to the normal range. Between-group differences in the neurofunctional parameters at the final follow-up showed no statistical significance. Yet, significant differences were found between the neurofunctional parameters before operations and at the final follow-up in each group ($P < 0.05$).

Table 4 summarizes the changes in the VAS scores, ESR and CRP levels six weeks after operations and at the most recent follow-up. The VAS scores, ESR, and CRP levels six weeks after operations and at the final follow-up were significantly lower than the preoperative levels ($P < 0.05$). Beyond that, the VAS scores, ESR, and CRP levels were significantly lower than those recorded six weeks after operations ($P < 0.05$).

Discussion

Existing STB treatment mainly includes anti-TB drugs and surgical intervention. Anti-TB drug therapy plays an essential role in treating STB and provides a basis for surgical treatment. The goals of surgical treatment are to eradicate the lesion(s), relieve spinal cord compression, correct kyphosis deformity, and restabilize the spine [8]. Surgery alone, without regular anti-TB treatment, is extremely dangerous and ineffective. Effective surgical treatment is only possible in combination with effective anti-TB drug therapy. It is difficult to relieve spinal cord compression, improve nerve dysfunction and prevent progressive spinal deformity using conservative treatment alone. In contrast, surgery is an effective solution to this problem [14].

It remains a controversial issue which surgical approach to use when accessing the lesion sites. Single-stage anterior debridement, bone grafting, and instrumentation has been widely accepted as the “gold standard” for STB treatment [15] because it allows for thorough removal of lesions, decompression of the anterior structure of the spine, easy bone grafting, kyphosis correction, and reconstruction of spinal stability under direct vision, with the lesions being fully exposed [16]. However, it shows inadequate fixation rigidity and orthopedic strength [8, 9] and imposes a high risk of vascular injury because of poor access to the lesion site [17]. Considering the high exposure, the large wound, and a great risk of hemopneumothorax, this method is not a good choice for patients with multisegmental TSTB [18]. In the present study, the patients who underwent single anterior debridement, bone grafting, and instrumentation in combination with regular anti-TB drug therapy pre- and postoperatively experienced significant improvement in the VAS scores, ESR, and CRP levels as compared to the preoperative levels. Moreover, no serious complications were caused by this approach. Therefore, the anterior approach is a safe and effective option for TSTB treatment under specific circumstances. Despite its benefits, this study found the anterior approach associated with postoperative kyphosis angle loss, which has been agreed upon by other authors [17, 18].

As STB surgical techniques develop, single posterior debridement, bone grafting, and instrumentation have achieved satisfactory outcomes of kyphosis correction and reconstruction of spinal stability, as well as long-segment fixation without creating a serious wound [10,11]. Zhang et al. [19] reported favorable clinical outcomes of TSTB treatment using the single posterior approach. Liu et al. [20] performed posterior debridement, bone grafting, and instrumentation on patients with monosegmental TSTB and achieved satisfactory curative effect, with favorable bone graft fusion and significant improvement in the patients’ Cobb angles. Hassan et al. [21] treated TSTB patients with the anterior and posterior approaches, respectively, and found that the posterior approach outperformed the anterior one in mean operation time, intraoperative blood loss, and blood transfusion; in addition, the single posterior approach produced favorable surgical outcomes by creating a small wound to access the lesion site when treating TSTB. In this study, single posterior debridement, bone grafting, and instrumentation were performed on the 17 patients in group B. Through analysis, these patients experienced significant improvement in their ASIA impairment scale scores and a sharp decrease in their Cobb angles, and ESR levels after the operation. The pre- and postoperative parameters were significantly different ($P < 0.05$), indicating the favorable surgical outcomes of the posterior approach. Besides, there was no statistically significant difference between the two groups in the VAS scores and changes in ESR and ASIA impairment scale

scores. However, the single posterior approach also has its own limitations. To be specific, it is difficult to remove TB lesions radically using the posterior approach; TB bacteria may invade the normal tissue in the posterior structure of the spine; the surgery may bring damage to the normal posterior spine, compromise the spinal stability, interfere the spinal cord and increase postoperative intraspinal scar adhesion. Beyond that, this approach only gives limited exposure of the anterior structure of the spine, and thus it is not an option when there is a large paraspinal abscess. It was stated in our previous study that the single posterior approach had shorter operation time and a smaller volume of intraoperative blood loss compared to the anterior approach [8], and these findings were proved by this study. Through analysis, it is believed that these advantages of the posterior approach are associated with the development of the pedicle screw insertion technique and the posterior approach itself through day-to-day applications, as well as the use of the approach in a large number of short-segment fixation (no more than three segments) cases. Also, it was found that the posterior approach had an angle loss rate smaller than the anterior approach in terms of kyphosis correction, which was reported in another relevant study [21]. The rationale for the use of the posterior approach lies in the removal of the lesion and the sclerotic bone surrounding the lesion to clear the path for anti-TB drugs. As to the residual TB-like lesion and purulent fluid, long-term, standard anti-TB chemotherapy is an effective postoperative solution. This study has some limitations, including the small sample size and the short follow-up. A prospective multicenter randomized comparative study having a larger sample size is needed to investigate the long-term efficacy of the two approaches.

Conclusion

Single posterior debridement, bone grafting, and instrumentation in combination with effective standard anti-TB chemotherapy produce clinical outcomes similar to those of single anterior debridement, bone grafting and posterior instrumentation in treating TSTB. In fact, the single posterior approach has advantages over the single anterior approach, including shorter operation time, and a smaller volume of intraoperative blood loss; also, it clearly outperforms the single anterior approach in kyphosis correction, angle correction rate, and angle loss; in terms of time to bone graft fusion, the between-group difference shows no statistical significance. So far, the patients are in good conditions according to clinical and imaging results. Despite the preliminary results from the short-term follow-up, it is necessary to perform a study based on a long-term follow-up.

Abbreviations

Tuberculosis: TB; VAS: Visual analog scale; ESR: Erythrocyte sedimentation rate; CRP: C-reactive protein; CT: Computed tomography; MRI: Magnetic resonance imaging; Pre-op: pre-operation; Post-op: post-operation; ASIA: American Spinal Injury Association.

Declarations

Ethics approval and consent to participate

Ethical approval from the Ethics Committee of the Shaanxi Provincial People's Hospital was obtained for this study (No. 2012–0125). Each author certifies that all investigations were conducted in conformity with ethical principles. Written informed consent was obtained from all patients included in the study.

Consent for publish

All patients signed informed consent to publish THEIR PERSONAL DETAILS IN THIS ARTICLE.

Availability of data and materials

The datasets supporting the conclusions of this article are included within the article. The raw data can be requested from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

YZ, WL, LG, JZ,and JL participated in the recruitment, data collection and analysis. All authors contributed to the study design and drafting of the manuscript. All authors read and approved the final manuscript.

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Tables

Table 1. Distributions of involved vertebral bodies and thoracic fusion sites

Group	Affected vertebra(e)							Fusion site				
	T3-4	T6-7	T5	T6	T8	T7-8	T10-11	T3-4	T5-6	T6-7	T7-8	T10-11
A (*n* = 21)	2 (9.5%)	2(9.5%)	5 (23.8%)	2 (9.5%)	4 (19.1%)	3 (14.3%)	3 (14.3%)	4 (19.05%)	8 (19.05%)	3 (14.3%)	7 (33.3%)	3 (14.3%)
B (*n* = 17)	3 (17.6%)	2 (11.8%)	2 (11.8%)	1 (5.9%)	3 (17.6%)	2(11.8%)	4 (23.5%)	2(11.7%)	5 (29.4%)	3 (17.7%)	5 (29.4%)	2(11.8%)

Table 2. Kyphosis correction and kyphosis lost in two groups

Group	Pre-operative kyphosis angle(°)*	Post-operation			Final follow-up		
		Kyphosis Angle (°)Δ	Angle Correction (°)†	Correction Rate(%)▲	Kyphosis Angle (°)§	Angle lost (°)□	Lost rate(%)▯
A	26.8 ± 5.7	9.2 ± 3.0	18.9 ± 6.1	70.2 ± 10.5	11.9 ± 2.9	2.1± 0.9	7.2 ± 5.2
B	26.5 ± 4.5	5.6 ± 1.9	21.8 ± 5.4	81.5 ± 11.4	8.2± 2.7	1.1 ±1.0	4.1 ± 4.8

*One-way analysis of variance , compared pre-operative kyphosis angle between two groups, P >0.05

$^{\Delta}$One-way analysis of variance, compared kyphosis angle with pre-operative in two groups, P_A<0.05, P_B <0.05

† One-way analysis of variance, compared angle correction between two groups, P<0.05

▲One-way analysis of variance, compared correction rate between two groups, P<0.05

- One-way analysis of variance, compared kyphosis angle between two groups, P<0.05

□One-way analysis of variance, compared angle lost between two groups, P<0.05

One-way analysis of variance, compared angle lost rate between two groups, P<0.05

Table 3. Neurological recovery according to Frankel grade

	Group A					Group B				
Time point	A	B	C	D	E	A	B	C	D	E
Preoperative			5	16				6	11	
Final follow-up*				3	18				2	15

*P < 0.05 *vs*. preoperative.

Table 4. Measures of surgical outcomes of the two groups

Measure	VAS			CRP (mg/L)			ESR (mm/h)		
	Pre-op	6weeks post-op	Final follow-up	Pre-op	6 weeks post-op	Final follow-up	Pre-op	6 weeks post-op	Final follow-up
Group A	6.2 ± 0.8	2.4 ± 0.6*	0.8 ± 0.4Δ	20.5 ± 4.6	9.2 ± 1.1*	3.2 ± 0.5Δ	38.9 ± 7.5	24.5 ± 1.8*	10.5 ± 0.9Δ
Group B	6.3 ± 0.7	2.4±0.7*	0.7 ± 0.3Δ	19.8 ± 4.0	9.1 ± 1.2*	3.1 ± 0.4Δ	39.1 ± 7.5	22.8 ± 1.9*	9.7±1.0Δ

VAS, Visual Analogue Scale; ESR, Erythrocyte Sedimentation Rate; CRP, C-Reactive Protein; Pre-op, Preoperative; Post-op, Postoperative.

*$P < 0.05$ *vs.* preoperative.

Δ$P < 0.05$ *vs.* 6 weeks postoperative.

Figures

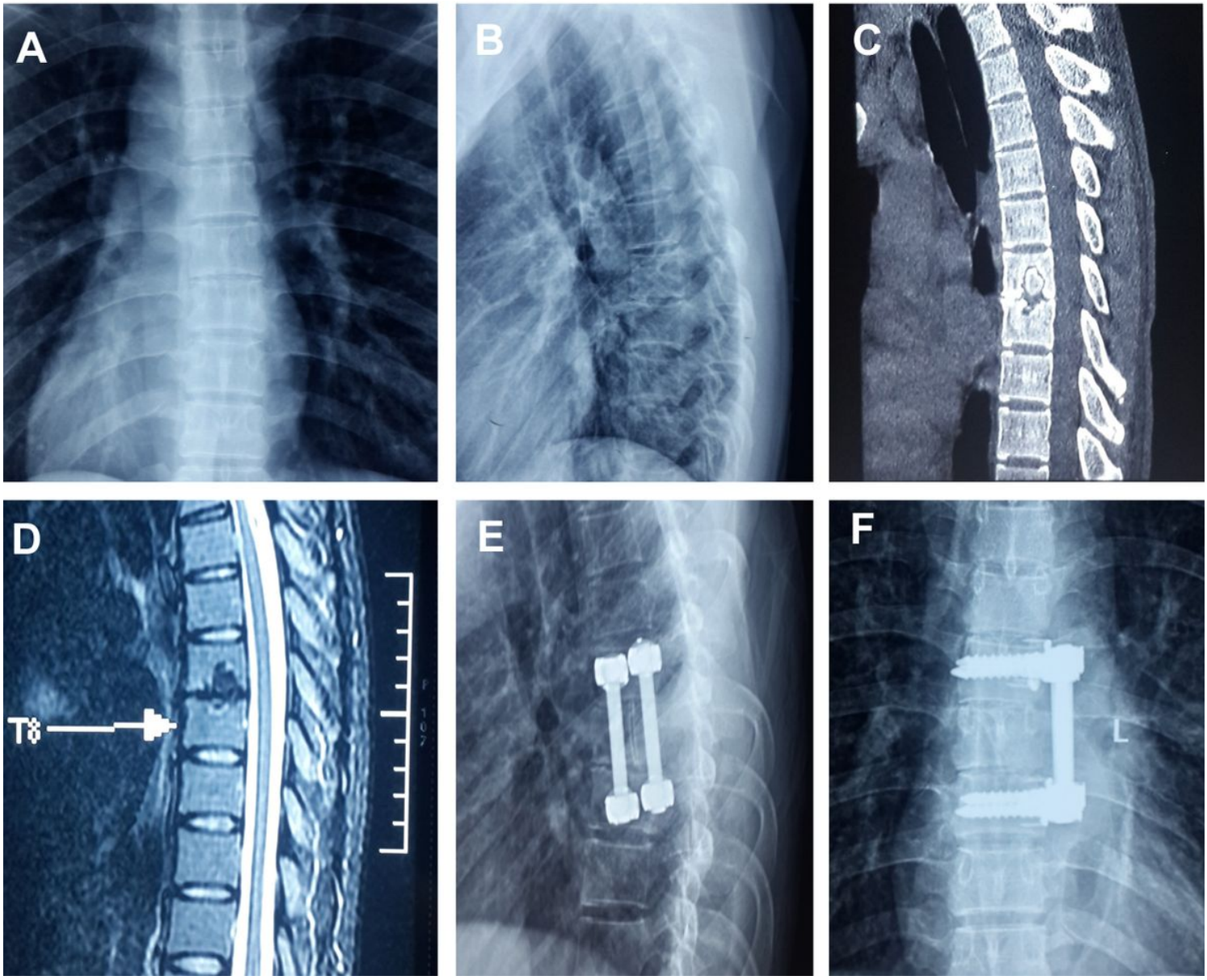

Figure 1

The patient (male; 62 years old) presented thoracic tuberculosis at the T3-4, and underwent single anterior debridement, bone graft fusion, and instrumentation. (a,b): X-ray in the positive and lateral position before surgery. (c,d): preoperative CT and MRI examination. (e,f): X-ray in the positive and lateral position after surgery.

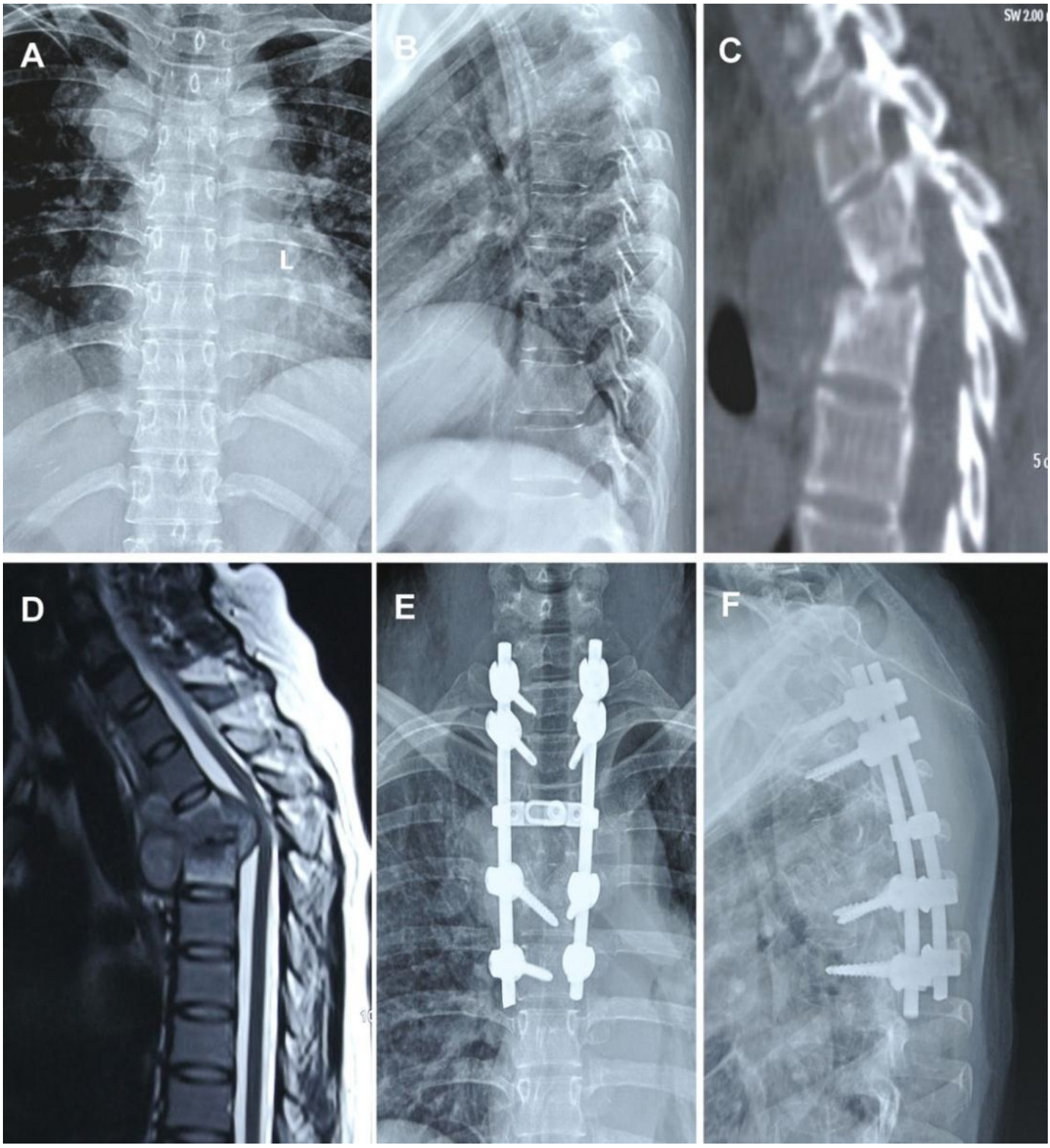

Figure 2

The patient (female; 43 years old) presented thoracic tuberculosis at the T7-8, and underwent single posterior debridement, bone graft fusion, and instrumentation. (a,b): X-ray in the positive and lateral position before surgery.(c,d): preoperative CT and MRI examination. (e,f): X-ray in the positive and lateral position after surgery.