Wiltse TTIF approach for the treatment of single-segment thoracic spinal tuberculosis in the elderly with osteoporosis: a retrospective study of 20 cases

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Research Article

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Abstract

Background

This study aims to explore the clinical efficacy of Wiltse approach transforaminal thoracic interbody fusion (TTIF) for the treatment of single-segment thoracic spinal tuberculosis in elderly patients with and osteoporosis and neurological deficits.

Methods

This is a retrospective analysis of 20 elderly patients who underwent Wiltse approach TTIF in our hospital from January 2017 to January 2019. The follow-up time was 37.15 ± 7.37 months (range 24-48 months); and the preoperative kyphotic angle was $35.41 \pm 6.71^\circ$. The Frankel spinal cord injury classification was used to assess the degree of neurological deficit. Erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) are used to track the activity of tuberculosis (TB). While femoral neck bone mineral density measurement T value (BMD T) was used to assess the degree of osteoporosis.

Result

The 20 elderly patients with spinal tuberculosis (STB) were completely cured without recurrence. The postoperative kyphotic angle was $8.80 \pm 0.79^\circ$, without significant loss of correction at the last follow-up. Bone graft fusion was observed within 6-9 months with all patients reporting that their back pains were relieved. The neurological condition of all patients improved after the operation.

Conclusions

Wiltse TTIF treatment combined with anti-tuberculosis chemotherapy is adequate for obtaining satisfactory healing of single-segment thoracic tuberculosis in elderly patients with osteoporosis.

Background

Tuberculosis (TB) has historically been a serious infectious disease in developing countries [1]. Spinal tuberculosis (STB) accounts for 50% of skeletal tuberculosis and is the most common form of extra pulmonary tuberculosis [2]. Anti-tuberculosis chemotherapy is the primary treatment for STB, but surgical treatment plays an important part in improving kyphosis related clinical manifestations, relieving spinal cord compression and removing abscesses [3, 4].

In 1968, Dr. Wiltse and others proposed a new method for spinal surgical procedures that utilizes the gap between the multifidus muscle and the longissimus muscle. This approach significantly reduces dissection time as well as traction of the multifidus muscle during the operation. It also takes full advantage of the integrity of the posterior bone and ligamentous structure complexes [5]. The Wiltse transforaminal thoracic interbody fusion (TTIF) surgical approach has achieved excellent results in the treatment of intervertebral disc herniation and spinal tuberculosis [6]. However, apart from some case

reports in mainstream academic journals, there are limited reports in available literature with regards to its application in the surgical treatment of single-segment thoracic tuberculosis (SSTTB) in elderly patients with osteoporosis.

In this study, we reviewed the preoperative and postoperative information of 20 SSTTB patients who underwent the Wiltse TTIF in our hospital, with the aim of evaluating the effects of this surgical method on elderly patients with osteoporosis.

Method

Patient inclusion and exclusion criteria

This study was approved by the Ethics Committee of the First Affiliated Hospital of Guangxi Medical University, and written informed consent was obtained from all patients involved. Between January 2017 to January 2019, 20 elderly patients with spinal tuberculosis and osteoporosis were surgically treated by the same surgeon in our hospital. Among them, there were 12 males and 8 females, aged between 65–80 years (70.25 ± 4.19). Diagnosis was based on the following criteria (1) clinical symptoms and signs; (2) computed tomography (CT) and magnetic resonance imaging (MRI) findings; (3) laboratory test results, including hemoglobin (Hb), erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) concentration, as well as tuberculosis antibody (IgG and IgM) and tuberculin skin test; (4) anti-tuberculosis chemotherapy was effective (obvious radiographic changes); (5) Histological microscopy and AFB test (gold standard). The exclusion criteria were as follows: (1) age < 65 years; (2) normal femoral neck bone mineral density measurement T value (BMDT) > -2.5 [7]; (3) no neurological deficits; (4) multi-segment disease or lesions that require anterior bone fusion; (5) Inaccessible para vertebral or deep muscle abscesses and severe kyphotic deformities (greater than 50°). The Frankel classification was used to assess nerve damage; Grade A (complete loss of movement and sensation below the lesion level); Grade B (partial loss of sensation below the lesion level); Grade C (motor and sensory preservation below the lesion level, but with loss of function); Grade D (Movement and sensation below the lesion plane are preserved, but with limited mobility); Grade E (normal function).

Preoperative Procedure

Anti-tuberculous chemotherapy is administered shortly after the suspected clinical diagnosis. Paralyzed patients require immediate surgical treatment. The anti-tuberculosis regimen include HREZ chemotherapy regimen: isoniazid (5-10mg/kg/d), rifampicin (5-10mg/kg/d), ethambutol (15mg/kg/d) and pyrazinamide (25 mg/kg/d), administered 2–4 weeks preoperative. Surgery is only performed when ESR, CRP, and body temperature returned to normal or decreased significantly, and anemia and hypoalbuminemia were completely under control. For osteoporotic patients, calcitriol and calcium carbonate D3 are orally administered pre-operative. Postoperative intravenous infusion of zoledronic acid is given once a year for 3–5 years, until femoral neck bone mineral density are within the normal acceptable limits.

Surgical Technique

The patient is placed in a prone position after general anesthesia, and X-ray of the C-arm used to locate the surgical segment. The distance between the muscle space and the spinous processes are marked according to the preoperative MRI. A posterior midline longitudinal incision is then made and the subcutaneous tissues and fascia carefully separated, until the medial multifidus muscle and the lateral longissimus muscle are separated and the intermuscular space entered. A half lamina retractor can then be used to separate the muscle groups, and the paravertebral muscles striped to reveal the transverse processes, laminae and the interlaminar spaces. A pedicle screw can then be implanted under the guidance of a C-arm. A temporary pre-curved rod can then be placed on the lighter side avoid spinal instability during local debridement and decompression. Unilateral facetectomy and laminectomy can then be performed along the medial pedicle on the symptomatic side or severe paravertebral abscess. When necessary, an adjacent rib can be removed 1.0-1.5cm from the costovertebral joint. A thoracic nerve root can also be sacrificed in case better exposure is needed. Decompression range is generally determined by the degree of spinal stenosis and range of paravertebral abscess. A suitable flushing tube can be inserted into the paravertebral space and flushed until no pus is observed. A curette can then be used to remove the necrotic discs and vertebrae until healthy bleeding bones. Afterwards, thoracic kyphosis can then be carefully corrected. Autographed or allograft bones can be used for posterior fusion of the involved segments following local debridement and decompression. Relatively large bone pieces should be used for the grafting in case of loose or extensive bone defect. An impact graft can also be used to fill the gap (from debridement). Local administration of 1.0g streptomycin and 0.2g isoniazid combination can then be done. Negative pressure drainage is the preferred drainage method. The resected specimens can then be send for postoperative bacterial culture and further pathological diagnosis.

Postoperative Care

When less than 30ml of drainage is observed (usually on POD 3), the negative pressure drainage tube can be removed. Continuous administration of oral HREZ anti-tuberculosis chemotherapy is done until after 6 months postoperative. It is then changed to HRE regimen for the next 9–12 months. Postoperative treatment for osteoporosis is also continued for at least 3 months postoperative. In patients with severe osteoporosis who underwent extensive bone grafting, bed rest for at least 3 months is recommended and the use of braces during limited activities advice in order to promote bone graft fusion and prevent loosening of internal fixation. All patients underwent clinical and radiological examinations during postoperative follow-up at 1st week, 3rd months, 6th months, and 12th months postoperative respectively, after which periodic annual reviews are recommended. To to assess the degree of graft fusion, complete bone union, pseudoarthrosis etc, postoperative follow-up CT is recommended.

Follow-up Indicators And Statistical Analysis

In all cases reviewed, the following indicators were compared to the pre-operation, immediate postoperative and 3rd month post-operation review results. At the last follow-up: (1) kyphotic angle, (2) Frank nerve function grade, (3) ESR and CRP were recorded and compared to the preoperative results. Using SPSS 24.0 software (SPSS, Inc., Chicago, IL, USA), paired T - test was used to for the statistical analysis on the kyphotic angle, ESR and CRP. The Frank neurological function level were statistically analyzed using Wilcoxon signed rank test. The significance level was set at 0.05.

Result

Basic condition

Among these 20 cases reviewed, there were 12 males and 8 females, with an average age of 70.25 ± 4.19 . The involved thoracic segment of are shown in Fig. 1. The average operation time was 155.00 ± 52.92 minutes, and the average intraoperative blood loss was 153.75 ± 41.64 ml. The average length of stay (LOS) was 6.80 ± 1.51 days, and the follow-up period was 37.15 ± 7.37 months. The average BMD T-value was -4.27 ± 1.51 (Table 1). Postoperative complications observed during the review time included; cerebrospinal fluid leakage (1 case), water and electrolyte imbalance (5 cases), superficial wound infection (1 case), and mild intestinal obstruction (2 cases). No complications related to bone grafts and internal fixation were observed. The patient's symptoms were significantly improved after 1st week of anti-inflammatory or symptomatic supportive treatment.

Table 1
General data of patients.

Gender		Age(years)	Operation time (min)	Blood loss (ml)	Hospitalization time(days)	Follow up (months)	BMD (T)
Male	Female						
12	8	70.25 ± 4.19	155.00 ± 52.92	153.75 ± 41.64	6.80 ± 1.51	37.15 ± 7.37	-4.27 ± 1.81

Nervous System State

the neurological symptoms of all the patients gradually improved during the During the follow-up process. The results of the preoperative Frankel classification assessment was as follows: Grade A 1 case; Grade B, 3 cases; Grade C, 7 cases; and Grade D, 9 cases. At the last follow-up, there were only 2 grade D, with the remaining 18 patients with full function recovery (Grade E) (Fig. 2). The results of our statistical analysis showed that there was a significant difference between the preoperative and postoperative Frankel classification at the last follow-up ($P < 0.05$).

Kyphosis, Bone Fusion, Esr And Crp

The average preoperative kyphotic angle was $35.41 \pm 6.71^\circ$; which significantly reduced to $8.80 \pm 0.79^\circ$ postoperative ($P < 0.05$). At the last follow-up, the average kyphotic angle was $9.99 \pm 0.92^\circ$, with a correction loss of $1.18 \pm 0.37^\circ$, and the difference was statistically significant ($P < 0.05$).

The average preoperative ESR and CRP were 68.70 ± 16.76 mm/h and 25.15 ± 9.60 mg/L respectively. The postoperative ESR and CRP were within the normal levels at the last follow-up period. The differences between the preoperative and postoperative (the last follow-up) ESR and CRP were statistically significant ($P < 0.05$). All patients underwent bone grafting and impact drafting with postoperative lateral X-ray/CT used to evaluate the degree of fusion. Adequate bone fusion was observed in all patients within 7.70 ± 1.46 months postoperative (Table 2).

Table 2
Clinical details of surgery

Schedule	Kyphosis angle ($^\circ$)	ESR(mm/h)	CRP(mg/L)	Bony fusion (months)
Pre-operation	35.41 ± 6.71	68.70 ± 16.76	25.15 ± 9.60	7.70 ± 1.46
Post-operation	8.80 ± 0.79	19.85 ± 3.50	9.09 ± 3.01	
3month post-operation	9.23 ± 0.53	8.45 ± 1.73	4.8 ± 1.95	
Final follw-up	9.99 ± 0.92	6.45 ± 1.03	5.1 ± 1.62	

Discussion

Spinal tuberculosis is a common musculoskeletal disease, accounting for about 50% of bone and joint tuberculosis [2]. Despite the continuous efforts by the World Health Organization and local health authorities, tuberculosis is still widespread in most developing countries, affects susceptible individuals including the elderly [8].

Anti-tuberculosis treatment, bed rest and supportive treatment constitute the main treatment options for STB. In cases where no drug treatment is administered, surgical risks are often significantly increased, and so are the mortality, infection transmission and recurrence risks [9]. Since elderly patients often have a variety of accompanying chronic diseases/disorders surgical treatment risks are also significantly increased. Thus, in elderly patients, anti-tuberculosis chemotherapy and conservative treatment are preferred over surgical treatment in order to avoid surgery related risks and complications. This may lead to aggravation of any present spinal deformations and emergence of neurological symptoms [10]. Likewise, prolonged bed rest during conservative treatment not only affects their quality of life, but also comes with its own complications. The ineffective penetration of the tuberculous bone lesions by the anti-tuberculosis drugs results in ineffective or poor treatment outcome. Therefore, for elderly patients, surgical treatment plays an important role in removing necrotic tissues, paravertebral abscess, alleviating neurological manifestations, and improving or stabilizing spinal deformities.

However, there are many controversies with regards to the surgical treatment options for SSTTB in the elderly. Anterior surgery has the advantages of directly removing tuberculous lesions and facilitating bone grafting, but it is not effective in correcting kyphosis and relieving nerve compression [11]. Additionally, the sternum, clavicle, ribs, and mediastinal organs interfere with the surgical operations, which makes the anterior surgery more difficult and prone to intra and postoperative complications. The combined anterior-posterior approach has good clinical effect, however, it involves at least 2 different operative procedures, the operation time is prolonged by several hours, and often result in extensive blood loss, longer postoperative recovery time and many postoperative complications, making it unfit for elderly patients [12].

In the past few decades, posterior surgery has made significant progress in the treatment of spinal tuberculosis. The posterior pedicle screw system is popular as a revolutionary technology for correcting spinal deformities and increasing spinal stability. It has been shown to be effective in treating thoracic spine diseases that cause segmental instability and neurological dysfunction [8].

Posterior transforaminal thoracic interbody fusion (TTIF), originally promoted by Harms et al. [13] is considered an improvement on the posterior thoracic interbody fusion (PLIF) which has helped overcome the problem of excessive nerve retraction and its related complications. However, the traditional TTIF surgical approach requires extensive stripping of the multifidus muscle, which damages the blood supply and innervation of the multifidus muscle, resulting in postoperative degeneration, atrophy, fibrosis and fat deposition of the multifidus muscle. At the same time, it takes has a prolonged operation time. Extensive retraction of the paraspinal muscles, the innermost multifidus muscle groups, results in increase in intramuscular pressure, leading to local hypoxia, and sometimes irreversible ischemic degeneration and necrosis when surgeries are unavoidably prolonged. This often seriously affect the physiological function of the multifidus muscle and increases the risk of chronic postoperative lower back pain [14]. In 1968, Wiltse et al. proposed a novel method, which utilizes the gap between the multifidus and the longissimus muscles. This approach can significantly reduce the damage to the multifidus muscle caused by either dissection or traction, thus maximizing the integrity of the posterior bone and ligamentous structures [5].

In practice, the use of intermuscular TTIF approach for the treatment of spinal tuberculosis in elderly patients with osteoporosis is uncommon. The Wiltse TTIF approach has the following advantages. First, it is anatomically simple, reducing the learning curve for novice surgeons. The natural spaces between the multifidus and the longissimus muscles are utilized instead of crude dissection and extensive retraction of paraspinal muscle complexes, thus avoiding denervation and devascularization of the multifidus muscle which could result in Ischemic degeneration and necrosis. It therefore retains the physiological functions of the multifidus muscle while maintaining spinal stability. This in turn reduces the incidence of postoperative chronic lower back pain increasing postoperative recovery time. Secondly, the Wiltse intramuscular TTIF approach reduces the length of surgery and anesthesia, which in most cases translates to reduced intraoperative blood loss, and reduced overall surgical risks. This can be considered beneficial since most elderly patients often have accompanied medical conditions and comorbidities, most of which can be considered fatal or contraindicated for prolonged operative

treatment. Thirdly, it can achieve comparable the internal fixation similar to PLIF, which helps to stabilize the spinal column and prevent the worsening of kyphosis and its related neurological manifestations. Finally, the surgical area allows the excision of paraspinal abscesses when present, which is conducive for the successful surgical treatment and healing of STB. However, the Wiltse TTIF approach has two main limitations. Firstly, just like the PLIF spinal decompression, there is a risk of increasing spinal cord and nerve root injury. Secondly, anterolateral debridement is difficult to complete, but with the development of anti-tuberculosis drugs, tuberculosis lesions can spontaneously merge and heal, and the thorough debridement of the lesions is not overemphasized [8].

From the results of our study, the following should be the treatment plan for spinal tuberculosis in elderly patients with osteoporosis: In cases of minor or no neurological symptoms in such patients, conservative treatment including bed rest, anti-tuberculosis chemotherapy, anti-osteoporosis treatment should be considered alongside regular (4–8 weeks) MRI and blood sample review and evaluation. Secondly, in elderly patients with severe osteoporosis and aggravated neurological symptoms, pedicle screwing may not be firm, CBT can be performed (bicortical bone screw), after the adjacent vertebral segments without tuberculous lesion has been cemented, or root screws can be used instead. In the case of loose or insecure fixation, the fixated segment can be further extended appropriately. The preservation of the spinous processes and related attachments (including the spinous process, interspinous ligament, lamina and other bony structures) in elderly patients with severe osteoporosis in Wiltse approach can also help to maintain adequate postoperative spinal stability. Lastly, intraoperative specimens can be taken for tuberculous genetic Detection and drug susceptibility and drug-resistance testing. This can help guide postoperative anti-tuberculosis medication.

Conclusion

One-stage Wiltse approach TTIF is feasible and effective for the treatment of SSTTB. In this study, the postoperative clinical and imaging results are very promising, however, the follow-up time is relatively short. In any case, this type of surgical procedure still requires a large number of patients with longer follow-up periods to further confirm our results.

Abbreviations

STSTND: Single-segment thoracic spinal tuberculosis with neurological deficits;

TB: Tuberculosis;

STB: Spinal tuberculosis;

TTIF: Transforaminal lumbar interbody fusion;

ESR: Erythrocyte sedimentation rate;

CRP:C-reactive protein;

BMD T: Bone mineral density measurement T value

CT: Computed tomography

MRI: magnetic resonance imaging.

Declarations

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Availability of data and materials

All datasets on which the conclusions of the manuscript rely were presented in the main paper.

Authors' contributions

HZ and YJS participated in the design of this study and performed the statistical analysis. LYF and LSM drafted the manuscript. QHY and OYF carried out the study and collected important background information. LG and WDL collected the clinical data and follow-up details of this study, and QHY and SHX participated in the study design and helped to draft the manuscript. Abu Moro polished the manuscript. CGH directed the revision of the manuscript, case follow-up, and post-operative management. All authors read and approved the final manuscript. All authors read and approved the final manuscript.

Ethics approval and consent to participate

The study has been approved by the Medical Ethics Committee of the First Affiliated Hospital of Guangxi Medical University. Informed written consent from the patient to participate in the study had been obtained.

Consent to publish

Informed written consent was obtained from the patient for publication of this case report and accompanying images.

Competing interests

The authors declare that they have no competing interests.

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Figures

Figure 1

The level of involved thoracic vertebrae

Figure 2

Neurological status of 20 patients.

Figure 3

A 75-year-old patient with T9/10 lesions who underwent Wiltse TTIF approach. (a and b) The pre-operative imaging data showed T9/10 vertebral destruction with kyphotic deformity and severe spinal cord compressed. (c and d) Intraoperative image of the Wiltse TILF. The postoperative sagittal and coronal CT-scan (e and f) indicated kyphosis correction. X-ray (g) showing good bone fusion and no obvious loss of kyphosis at 3rd month postoperative. Sagittal CT-scan (h) showing satisfactory graft fusion without relapse of STB at 9 month postoperative.