Analysis Of Clinical And Radiological Outcome Post Single-Stage Posterior-Only Correction Surgery Of Kyphotic Deformity In Spinal Tuberculosis

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Abstract

Tuberculosis (TB) is a widespread infectious disease affecting around 2 billion people, with 5 to 15 % showing symptoms. Spinal tuberculosis constitutes 15% of extra-pulmonary TB cases. Patients may face significant deformities and complications, such as neurological deficits and severe pain. Researchers are investigating the clinical and radiological outcomes post single-stage posterior-only correction of kyphotic deformity in tuberculous spondylitis patients. Kyphotic deformity was measured by measuring Cobb angle on sagittal radiograph. The neurological status was assesed using the American Spinal Injury Association (ASIA) Impairment Scale. Functional level was assessed based on the Oswestry Disability Index (ODI). Total of 31 samples were collected averaging 40.8 years in age. The average onset was 7.5 months, and the most affected vertebra was T12. Postoperative Oswestry Disability Index (ODI) scores showed significant improvement (68.13 to 26.32, $p < 0.001$). The ASIA impairment scale assessed neurologic outcomes, showing significant improvement post-surgery, with a notable p value of <0.001. Kyphotic angle reduced significantly from avarage 30.71 degrees preoperatively to 10.31 degrees ($p < 0.001$) postoperatively, with minimal correction loss after 6 months (average 0.54 degrees). The posterior approach for correcting kyphosis deformity in tuberculous spondylitis yields positive clinical and radiologic results. It is recommended as a surgical treatment option, but the choice of technique should be tailored to the individual clinical situation and the surgeon's expertise and resources.

Introduction

Tuberculosis is one of the oldest infectious diseases in humans. About 2 billion people worldwide are infected with tuberculosis, but only about 5% to 15% become symptomatic and the rest become latent infections. In 2017, about 10 million people were reported to be infected with tuberculosis worldwide, with Southeast Asia ranking second with the highest prevalence, at about 226 cases per 100,000 population. Spinal tuberculosis is one of the most common types of extra-pulmonary tuberculosis, accounting for about 15% of all cases. The spine is the osseous part most commonly infected by tuberculosis. Tuberculous spondylitis is caused by Mycobacterium tuberculosis, an acid-resistant, slow-growing aerobic bacillus. The tuberculosis bacillus can remain dormant for a long time. This bacterial infection causes a granulomatous inflammatory reaction, characterized by the presence of caseous necrosis, lymphocytes, epithelioid cells and Langhans cells 1.

Tuberculous spondylitis is one of the common causes of kyphotic deformity. Although medical therapy is effective in controlling tuberculosis infection, patients are at risk of developing an average

deformity increase of 15° and 3% to 5% of patients develop a kyphosis greater than 60°. Severe kyphosis can cause enormous cosmetic and psychological distress in growing children and can result in secondary cardiopulmonary problems and neurological abnormalities. The worst complication of progressive kyphotic deformity is progressive neurological deficit. Neurological complications may be related to the disease itself or the development of the deformity after the disease has resolved. Patients who develop paralysis in the early stages of active tuberculosis require aggressive treatment including pharmacological and surgical treatment. Correction of kyphosis is an operative procedure with a high complication rate, even in experienced hands. It is important that prevention of deformities be an integral part of any treatment in tuberculous spondylitis 2.

There are several options for surgical management of an established deformity. Anterior and combined anterior-posterior procedures have similar rates of deformity correction, fusion and complications. On other hand, the posterior approach is less invasive and less complication than anterior approach. Furthermore, this approach can avoid possible harm to the thoracic or abdominal cavity3.

Methods

The study was conducted at Dr. Wahidin Sudirohusodo Hospital Makassar from November 2023 to November 2024. The protocol of this study has received ethical approval from Hasanuddin University Research Ethics Committee with the approval number 532/Un4.6.4.5.31/PP36/2024. Patients with diagnosis of tuberculous spondylitis were then assessed for preoperative clinical and radiological condition. Patients underwent transpedicular decompression, debridement, posterior instrumentation, and fusion. Post operatively all patient received standardized course of antituberculotic medication. Post operative evaluation was performed in 6 months including the functional, neurological, and radiograph. Kyphotic deformity was measured by measuring cobb angle on sagittal xray. Lesion extent and number of lesions were measured using radiologic examination (Xray, CT, or MRI). The degree of injury was measured using the American Spinal Injury Association (ASIA) Impairment Scale. Functional level was assessed based on the Oswestry Disability Index (ODI). Analysis of preoperative and postoperative ODI scores, preoperative and postoperative ASIA Impairment Scale (AIS) and preoperative and postoperative kyphotic angle using the Wilcoxon test.

Results

General Data

In this study, 14 samples are male, and 17 samples are female. This study found that the average sample age was 40.81 years, while the youngest sample age was 16 years, and the oldest age was 63 years. The average case onset in this study was 7.55 months, while the lowest onset was 2 months and the longest age was 20 months (**Table 1**).

Table 1. Sample Characteristics

Criteria	n = 31
Age	40.81 years (±14.20)
Sex	
Male	14 samples
Female	17 samples
Onset	7.55 months (±4.57)
Number of vertebrae level involved	
1 level	7 cases
2 levels	21 cases
3 levels	3 cases

In this study, research samples with vertebral involvement in tuberculous spondylitis mostly involving 2 levels, namely 21 cases. Tuberculous spondylitis involves 1 level as many as 7 cases and involves 3 levels as many as 3 cases. (**Table 1**). In this study, it was found that the vertebrae most involved in tuberculous spondylitis cases were T12 vertebrae, namely 13 cases. (**Figure 1**).

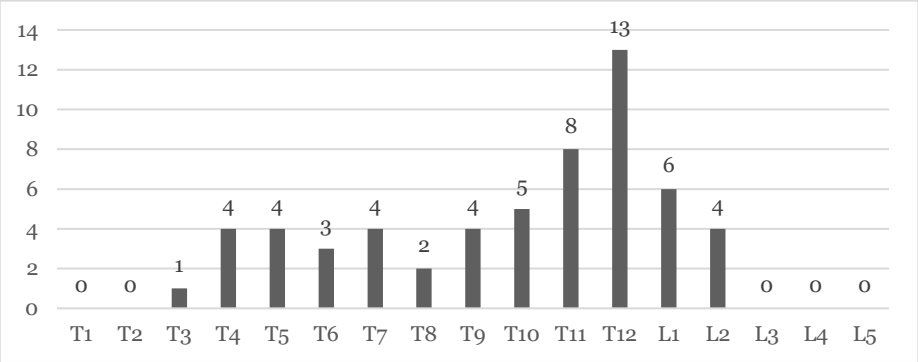

Figure 1. Vertebrae level involved

In this study, the average preoperative kyphotic angle was 30.71 degrees ± 8.62 The average postoperative kyphotic angle was 10.31 degrees ± 3.68. The average degree of kyphotic angle correction was 20.40 degrees ± 7.83. The average 6 months postoperative kyphotic angle was 10.84 degrees. Mean loss of correction after 6 months was 0.55 degrees (**Figure 2**). The average preoperative Kyphotic Angle (KA) in this study was 30.71 ± 8.62. The average 6-month postoperative KA in this study was 10.31 ± 3.68 which is significantly reduced ($p<0.001$) (**Table 2**).

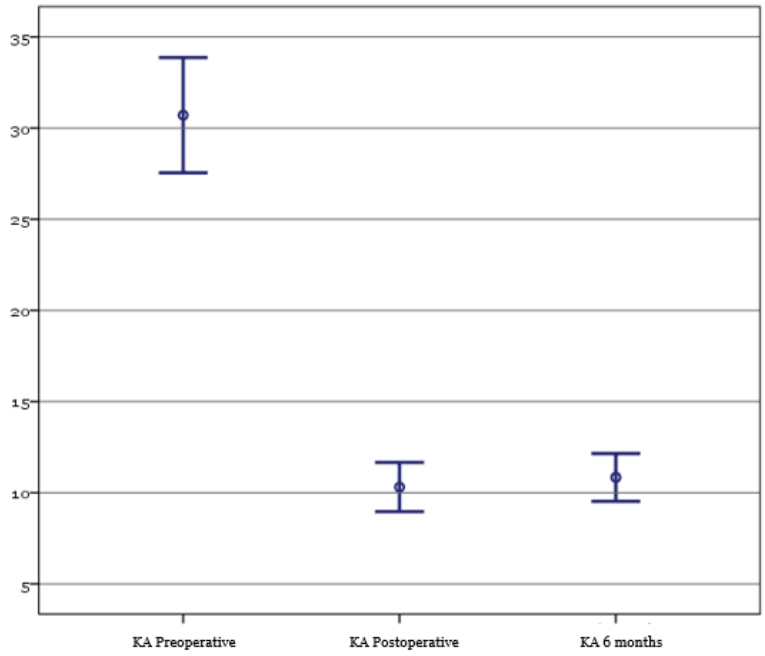

Figure 2. Kyphotic angle. Kyphotic angle was measured pre-operative, immediately post-oeprative and 6 months after the surgery

Table 2. Analysis of preoperative and postoperative ODI, AIS and kyphotic angle

	Preoperative	Postoperative	p-value
ODI	68.13 ± 11.27	26.32 ± 23.14	<0.001*
Kyphotic angle	30.71 ± 8.62	10.31 ± 3.68	<0.001*

*Statistically significant at p<0.05

The average preoperative Oswestry Disability Index (ODI) score in this study was 68.13 ± 11.27. The average 6-month postoperative Oswestry Disability Index (ODI) score in this study was 26.32 ± 23.14 which is significantly reduced (p<0.001) (**Table 2**) (**Figure 3**).

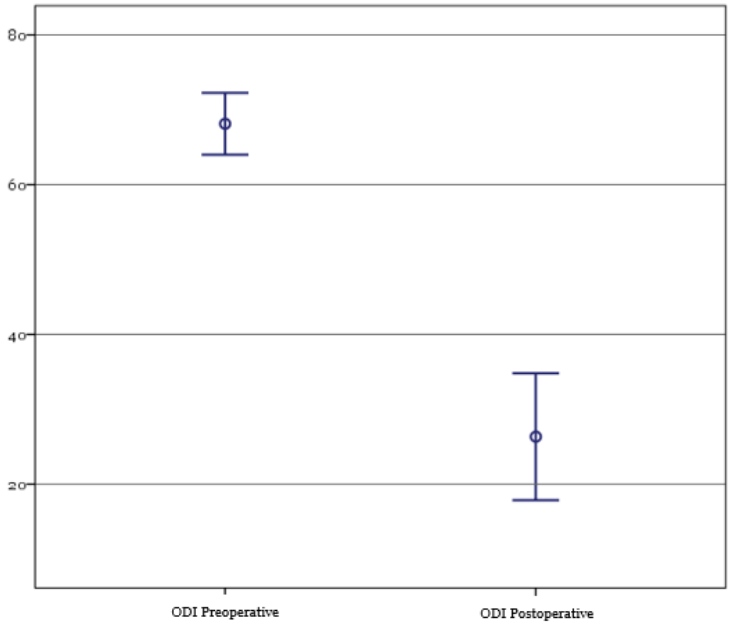

Figure 3. Oswestry Disability Index (ODI). ODI were measured pre-operative and post-operative

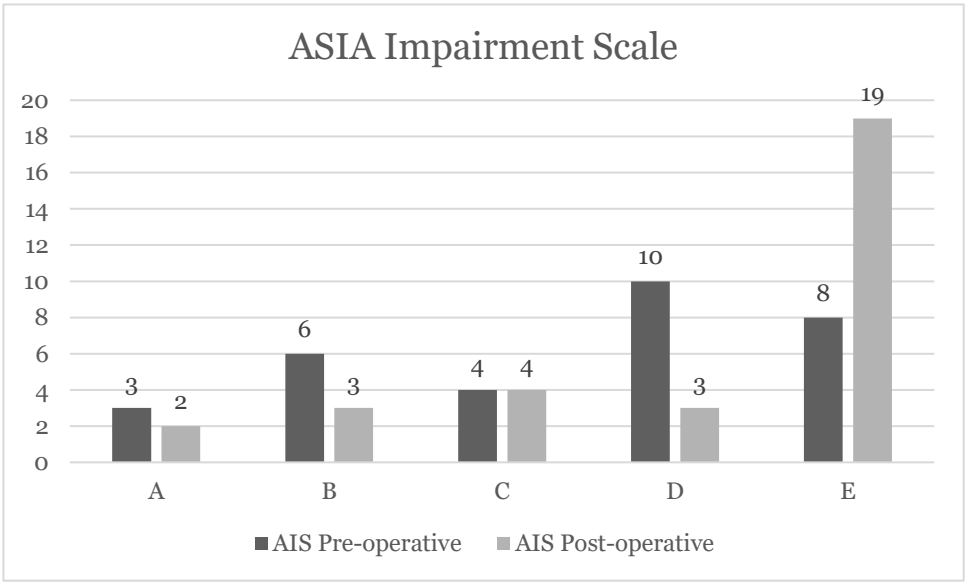

Figure 4. ASIA Impairment Scale (AIS). AIS was measured pre-operative and post-operative

This study found the highest preoperative AIS score was category D, with a total of 10 cases, then category E with 8 cases, then category B with 6 cases, category C with 4 cases and the least category A with 2 cases. The highest preoperative AIS score was category E, with a total of 19 cases, then category C with as many as 4 cases, then categories B and D with 3 cases, and the least category A with 2 cases. In this study, 16 samples had an improvement in AIS by 1 degree in AIS and there was 2 sample that experienced an improvement of up to 2 degrees. Overall, the AIS have significant improvement 6 months post operatively ($p<0.001$) (Figure 4)

Discussion

In this study, it was found that the average sample with spondylitis tuberculosis with kyphotic deformity age was 40.81 years, while the youngest sample age was 16 years and the oldest age was 63 years. The sex distribution is 14 people are male and 17 people are female. This correlates with another study indicate that approximately 84% of patients with tuberculous spondylitis fall within this adult age category, with a mean age reported at around 40.48 years. These demographic trends can be attributed to several interrelated factors such as epidemiologic trends, immune responses, and socio-economic factors such as crowded living conditions, occupational hazards, and lifestyle choices that can compromise immune function 4. This study found that the average case onset in this study was 7.55 months, while the lowest onset was 2 months, and the longest age was 20 months.

In this study, it was found that the vertebrae most involved in tuberculous spondylitis cases were the T12 vertebrae, namely 13 cases and the T1, T2, L3, L4, L5 vertebrae had no tuberculous spondylitis in this study. Another study found that the most common site of tuberculous spondylitis is the lower thoracic and upper lumbar region 5. The anatomical characteristics of the thoracolumbar region contribute to its susceptibility to infection. The thoracolumbar vertebrae have a richer blood supply, which facilitates the hematogenous spread of Mycobacterium tuberculosis, the causative agent of tuberculous spondylitis. This region is particularly vulnerable because the segmental arteries supply two contiguous vertebral bodies, allowing for the potential involvement of multiple vertebrae early in the disease process 3,5.

The best approach to surgery in patients with tuberculous spondylitis is still a matter of debate. Some studies have shown posterior correction to be effective and efficient, but others have shown anterior correction debridement, decompression of the spinal cord, and adequate spinal stabilization 6,7. Posterior correction of the kyphosis deformity in patients with spinal tuberculosis has been shown to be effective in correcting the kyphosis angle and improving patient outcomes. The posterior-only approach is considered safe and effective, with minimal complications such as fixation failure or recurrence of infection. This surgical method is often chosen due to its less invasive nature compared to the anterior approach and has shown significant improvement in the kyphosis angle and patient function 2,8.

The mean preoperative Oswestry Disability Index (ODI) score in this study was 68.13, with a maximum score of 90.00 and a minimum score of 52.00. The mean postoperative Oswestry Disability Index (ODI) score in this study was 26.32, with a maximum score of 76.00 and a minimum score of 6.00. The Oswestry Disability Index is an important tool for measuring the functional challenges faced by patients with tuberculous spondylitis. High ODI scores before treatment show considerable disability, while better ODI scores after surgery or conservative treatment reveal the possibility of recovery and improved quality of life. Using the ODI in clinical practice is crucial for directing treatment choices and assessing patient results. In this study, the analytical test of ODI preoperative and ODI postoperative had a p value of <0.001 which means that there is a significant meaning between the preoperative ODI score and the postoperative ODI score. Another study involving patients with multifocal spinal tuberculosis, ODI scores improved significantly from a preoperative mean of 76.8 to 25.5 one year postoperatively. The posterior approach has been associated with satisfactory clinical and radiological outcomes, including solid bone fusion and significant pain reduction, as evidenced by improved Visual Analog Scale (VAS) scores along with improved ODI. It is important to maintain improved ODI scores and ensure long-term patient recovery 8,9.

The AIS scale is an important tool for assessing neurologic outcomes in patients with spinal tuberculosis undergoing surgery. In this study, the preoperative AIS score of the highest category was identified as category D, encompassing a total of 10 samples, followed by category E comprising 8 samples, then category B with 6 samples, category C with 4 samples, and the least represented category A with 3 samples. In this study, the preoperative AIS score that was recorded as the highest was category E, which included a total of 19 samples, followed by category C with 4 samples, categories B and D each with a total of 3 samples, and category A being the least represented with 2 samples. In this study, alterations in postoperative AIS scores as compared to the preoperative scores were observed in several samples; however, there were also instances where no changes were noted whatsoever. In this study, 16 samples were identified that did not exhibit any changes in their AIS scores. Conversely, there were 13 samples that demonstrated an enhancement in AIS by 1 degree, along with 1 sample that exhibited an improvement of as much as 2 degrees. In this study, the analytic test obtained for preoperative AIS and postoperative AIS has a p value of <0.001 which means that there is a significant meaning between the preoperative AIS score and the postoperative AIS score. In a study involving 34 patients with single-segment thoracic spinal tuberculosis, all patients showed postoperative neurologic improvement, with no recurrence of tuberculosis observed during follow-up 10. Another study involving 45 patients with thoracolumbar tuberculosis and spinal epidural abscess reported improvement in neurologic scores by 1 to 2 levels on the AIS scale, with all patients achieving pain relief and significant reduction in VAS scores. In posterior surgery or tuberculous spondylitis, AIS results generally show significant neurologic improvement 11.

In this study, the average kyphotic angle measured preoperatively was 30.71 degrees, with the maximum angle recorded at 55.30 degrees and the minimum at 20.20 degrees. In this study, the average kyphotic angle measured immediately postoperatively was 10.31 degrees, with the maximum angle being 24.60 degrees and the minimum angle being 5.60 degrees. In this study, the degree of kyphotic angle correction obtained postoperatively was 20.40 degrees, with the maximum degree of change recorded at 46.60 degrees and the minimum at 8.50 degrees. In this study, the average kyphotic angle measured at 6 months postoperatively was 10.84 degrees, with the maximum degree of change being 24.90 degrees and the minimum at 5.90 degrees. In this study, the average loss of correction observed after 6 months postoperatively was 0.55 degrees, with the maximum degree of change being 0 degree and the minimum being 2.90 degrees. In this study, correction through the posterior alone has been shown to significantly reduce the kyphosis angle in patients with spinal tuberculosis. The preoperative kyphotic angle analytic test and the immediate postoperative kyphotic angle had a p value of <0.001 which means that there is a significant meaning between the preoperative kyphotic angle score and the immediate postoperative kyphotic angle. In a study involving 41 patients, the mean preoperative kyphosis angle of 23.8 degrees improved to 8.1 degrees postoperatively, with a slight increase to 12.3 degrees at final control, indicating substantial correction and maintenance of the kyphosis angle over time 12. Another study reported a mean kyphosis angle improvement of 44.3 degrees after single-stage posterior surgery, demonstrating the effectiveness of this approach in achieving significant deformity correction 2.

Conclusion

The posterior approach for correcting kyphosis deformity in tuberculous spondylitis yields positive clinical and radiologic results. It is recommended as a surgical treatment option, but the choice of surgical technique should be individualized, taking into account the specific clinical scenario and potential limitations as well as the operator's familiarity with the method. Further studies needed for long term evaluation of clinical outcome and evaluation of the fusion rate.

Ethics approval

This study was conducted in accordance with ethical principles and guidelines to ensure the protection of participants' rights, safety, and well-being. Ethical approval was obtained from the Institutional Review Board (IRB) of Hasanuddin University prior to the commencement of the study.

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None declared.

Competing interests

All the authors declare that there are no conflicts of interest.

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Underlying data

Derived data supporting the findings of this study is presented as part of the article.

Declaration of artificial intelligence use

We hereby confirm that no artificial intelligence (AI) tools or methodologies were utilized at any stage of this study, including during data collection, analysis, visualization, or manuscript preparation. All work presented in this study was conducted manually by the authors without the assistance of AI-based tools or systems.

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