ORIGINAL ARTICLE

Single-staged Surgical Correction of Kyphotic Deformity due to Dorsal Spinal Tuberculosis in Pediatric Patients: Outcome Analysis

Mageswaran Shanmugavelu[1], Makesh Ram Sriraghavan[2], Prabhu Aloy[3], Poornima Kumararaja[4], Sai Vinay Bharadwaj Namala[5]

Received on: 07 December 2023; *Accepted on:* 08 January 2024; *Published on:* xxxx

Abstract

Introduction: Spinal tuberculosis (TB) is more commonly seen in individuals during the first three decades of life, but it can occur at any age. It can result in the collapse of the affected vertebrae, leading to deformities such as kyphosis and sagittal imbalance; the deformity and progression can be worse in the pediatric age-group due to their growth spurt. Neurological complications can occur when the tubercular infection affects the spinal cord or the nerve roots. This typically happens during the active stage of the disease or, in some cases, even after the infection has healed. The surgical approach to spinal TB indeed focuses on achieving specific objectives related to the infectious and structural aspects of the disease. The objective of treatment of kyphotic spinal TB in recent era is to achieve bacteriological quiescence by effective chemotherapy and correction of kyphotic deformity. Development in the field of diagnostic methods and imaging has allowed us to detect TB of the spine in less advanced stages of the disease in most cases. But in spite, few cases present with kyphotic deformity and neurological deficits. The issues that need careful discussion are the identification of children in whom kyphosis should be taken for correction and to reach a consensus on treatment when a patient presents with severe healed kyphosis with or without neural deficit.

Materials and methods: We treated six patients with dorsal spinal TB with kyphotic deformity, of which two cases presented with paraparesis—managed by surgical decompression and posterior stabilization; all the cases were followed up periodically.

Results: All six cases had good radiological and functional outcomes in terms of kyphotic correction and neurological recovery. There was a significant improvement in the mean kyphotic angle; the mean angle decreased from 34.33 (preoperative) to 11.22 degrees, one year after surgery.

Conclusion: This study aimed to evaluate the clinical study efficacy and feasibility of one-stage posterior-only surgical treatment for thoracic spinal TB in adolescents. The multifaceted goals of surgery in spinal TB underscore the importance of a thorough understanding of the disease and a collaborative approach, and it ensures a comprehensive strategy. Thus posterior surgical method is effective in accomplishing debridement, obtaining satisfactory clinical results, correcting kyphotic deformity, and maintaining the correction.

Keywords: Antibiotics, Biopsy, Children, Congenital, Low back pain.

Journal of Orthopedics and Joint Surgery (2024): 10.5005/jojs-10079-1142

Introduction

Tuberculosis (TB) spine lesions in children can indeed be particularly destructive because of the unique characteristics of pediatric vertebral bodies.[1] In children, the majority of vertebral bodies are still cartilaginous and have not fully ossified or turned into bone. This cartilaginous nature makes them more susceptible to the destructive effects of TB infection.[2]

The TB infection in the spine can cause vertebral collapse, deformities, and neurological complications if the spinal cord is affected. Prompt diagnosis and treatment with anti-TB (ATT) medications are crucial to prevent further damage and complications. Even when a tubercular lesion in the spine heals with nonoperative treatment, such as the use of ATT medications, kyphosis can continue to increase, especially in children. This is often due to the damage caused by the infection to the vertebral bodies during the active phase of the disease. [3]

In addition to the destruction of the growth plates, the inflammatory response and healing process that occur during and after TB infection can also contribute to the formation of bony bridges or fusion between adjacent vertebrae, further influencing the development of spinal deformities.[4]

[1–3,5]Department of Orthopedics, Government Thoothukudi Medical College Hospital, Thoothukudi, Tamil Nadu, India

[4]Department of Pathology, ACS Medical College and Hospital, Chennai, Tamil Nadu, India

Corresponding Author: Makesh Ram Sriraghavan, Department of Orthopedics, Government Thoothukudi Medical College Hospital, Thoothukudi, Tamil Nadu, India, Phone: +91 9841617765, e-mail: ram23ortho@yahoo.com

How to cite this article: Shanmugavelu M, Sriraghavan MR, Aloy P, *et al.* Single-staged Surgical Correction of Kyphotic Deformity due to Dorsal Spinal Tuberculosis in Pediatric Patients: Outcome Analysis. J Orth Joint Surg 2024;https://doi.org/10.5005/jojs-10079-1142.

Source of support: Nil

Conflict of interest: None

Materials and Methods

This is a prospective cohort study to assess the radiological and functional outcome in the management of six cases of pediatric dorsal spinal TB with kyphotic deformity done in our hospital from

1st January 2019 to 30th September 2022. We included patients in age-group 12–16 years of age (sputum positive TB) with kyphotic deformity <50° of dorsal vertebra with or without neurological involvement. Patients with other vertebral congenital anomalies and not willing to study were excluded. Antitubercular treatment was started for all cases, and they were taken up for surgery after 1 month of treatment.

Evaluation

All standard norms and protocols were followed. Routine investigations—complete hemogram, erythrocyte sedimentation rate (ESR), and C-reactive protein. Radiographic studies, computed tomography (CT) scans, and magnetic resonance imaging (MRI) of the whole spine were done. A complete clinical evaluation was done and neurology status was documented, the treatment protocol was explained in detail to the parents.

Drug Therapy

Our main concern regarding the under-dosing of individual drugs in ATT for children is monitored under the guidance of the pediatrician and respiratory medicine department. Pediatric patients can experience weight gain and growth during the course of treatment, and adjustments to drug dosages may be necessary to ensure therapeutic efficacy and prevent underdosing.[5] This method of ATT was strictly followed in all the patients for successful outcomes.

Surgical Procedure

In the prone position, through the midline incision, the over dorsal spine is exposed up to two–three segments above and below the lesion so as to place the pedicle screws. A precontoured rod may be placed to temporarily stabilize one side. On the affected side, two to three ribs are removed, and the apex vertebra is decorticated. By moving the temporary stabilizing rod, the same is done on the other side. Thorough debridement was done, and a corpectomy of the involved vertebra was done. Pus drainage was performed, and the samples were sent for biopsy and for an acid-fast bacillus/cartridge-based nucleic amplification test (AFB/CBNAAT). A rib graft was placed for anterior support, followed by posterior stabilization at two levels. Postoperatively, the patient was immobilized with a thoracolumbar orthosis.

Postoperative Protocol and Follow-up

The biopsy confirmed our diagnosis of spinal TB. Injectable 3rd generation cephalosporin antibiotics continued up to 5 days after surgery, then oral antibiotics until suture removal was given. Postoperative X-ray was done on the 2nd day after surgery (Fig. 1). Staplers were removed on the 12th postoperative day, and the patient was discharged with advice on the continuation of ATT treatment up to 1 year from the date of starting therapy and Taylor's brace immobilization up to 3 months after surgery. Both institutional and home physiotherapy were continued. Cases with neurological involvement had good recovery over a period of time after surgery.

The frequency of monitoring and follow-up during TB treatment is an essential aspect of ensuring the effectiveness of the treatment and the well-being of the patient. We had more frequent follow-ups during the initial phase of treatment—fortnightly for the first 3 months and then transitioning to a monthly basis once improvement is observed up to 2 years.

The improvement in pain and fever followed by neurological recovery and a reduction in previously elevated ESR are indeed positive signs during the treatment of TB. These indicators suggest a positive response to the ATT and are important milestones in the recovery process.

Regular imaging assessments, particularly through plain lateral and anteroposterior X-rays of the affected spine, serve as valuable tools for evaluating the response to treatment and tracking the healing process. It's done every month for the first 3 months and subsequently twice a month for the next 1 year.

Results

Demography

Out of six cases, there was an equal number of males and females of age-groups 12–16 years. Two cases in age-group of 12 and 13 years, respectively, and four cases between 14 and 16 years.

Dorsal Spine Involvement

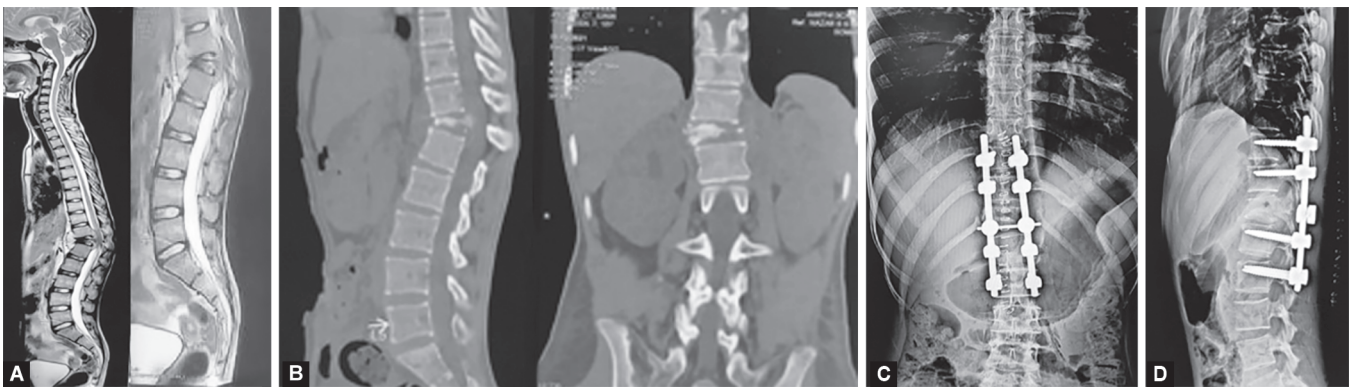
There was the involvement of multiple levels (maximum up to four levels in one case) of the lower dorsal spine, but the common level was between D10 and D12.

Neurology Status

In our study, there was paraparesis in two cases, and both cases recovered well at 4–6 months after surgery. Four cases did not have any neurological deficit.

Kyphotic Angle

There was a considerable decrease in kyphotic angle at 6 months and at 1 year after surgery (Table 1 and Fig. 2).



Figs 1A to D: Shows kyphotic deformity. (A) X-ray dorsal spine; (B) CT image; (C and D) Postoperative corrected deformity

Procedure Performed

We performed a single staged posterior surgical approach for thoracic spinal TB based upon the necessity of debridement (four cases) and for the correction of kyphosis (Table 2).

Calculation of Bone Loss

The deformity was evaluated and compared to the final deformity predicted by Rajasekaran's equation 6 months after surgery (Fig. 3). The expected kyphosis was found to be 60; vertebral body loss was 1.79 with spine at risk signs (retropulsion) patient was planned for costotransversectomy anterior reconstruction with rib graft and posterior stabilization.

Table 1: Shows the mean kyphotic angle

	Mean angle (in degrees)
Preoperative kyphosis	34.33
Postoperative kyphosis	10.8
Kyphosis at 6 months	16.1
Kyphosis at 1 year	11.2

Table 2: Surgical procedures performed

Surgical procedure	*Number of cases*
Costotransversectomy and posterior stabilization	4 cases
Posterior decompression and stabilization	2 cases

Outcome Analysis of this Study

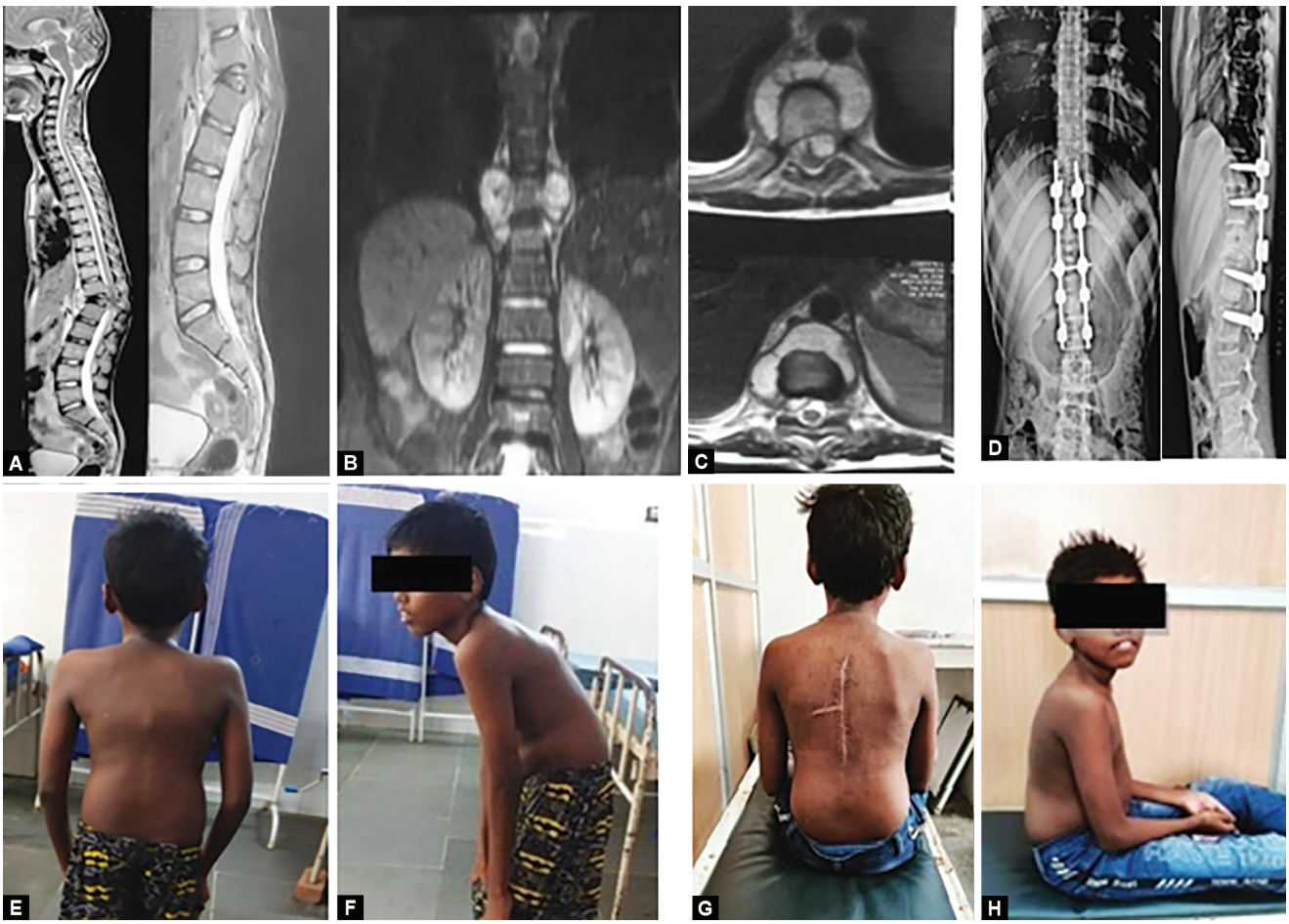
The following table (Table 3) shows the procedure performed, Cobb's angle, and the final outcome of the corrected kyphotic angle 1 year after surgery.

Statistical Analysis

We analyzed the cases based on the sex ratio to the level of vertebral involvement based on the Chi-squared test. There were two cases of two-level dorsal spine involvement and one case of three levels in males compared to one case with two-level involvement to two cases with three level involvement. The calculated *p*-value was 0.5, which shows it was significant. We also analyzed the *p*-value of Cobb's angle in both sexes, preoperatively and postoperatively, and the calculated value was found to be significant.

Discussion

The combination of paraplegia and residual spinal deformity is considered disastrous due to the profound impact on a person's ability to function and lead a normal life. The limited number of papers addressing Pott's paraplegics complicated by severe spinal deformity in pediatric cases reflects the relatively rare and complex nature of such cases.[6–9] Pediatric cases of Pott's paraplegia



Figs 2A to H: (A to C) X-ray and MRI showing kyphotic deformity with paravertebral collection; (D) X-ray at 6 months follow-up; (E and F) Clinical picture with kyphotic deformity; (G and H) After deformity correction

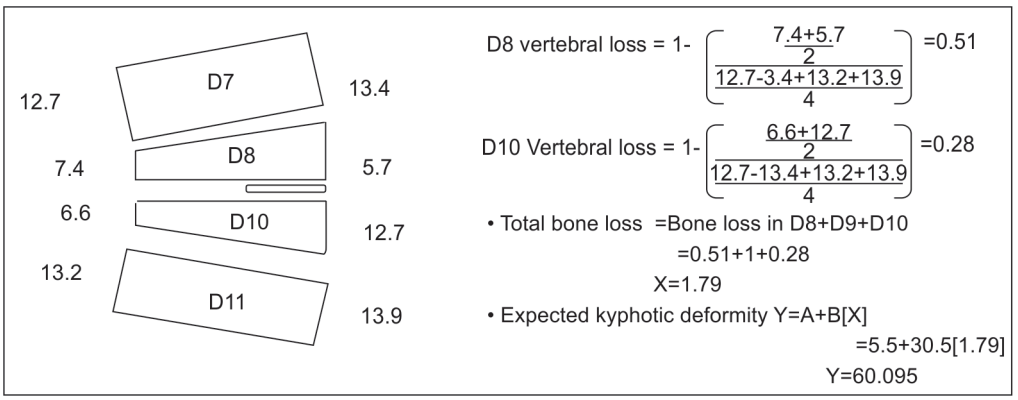


Fig. 3: Showing the calculated vertebral body loss and kyphosis

Table 3: Shows final depicted outcome and corrected Cobb's angle

Age/gender	*Level of dorsal spine involvement*	*Neurological status*	*Procedure performed*	*Cobbs angle (in degrees)*		*Kyphotic angle at 1 year (in degrees)*
				Preoperative	*Postoperative*	
12 years/female	D9–D12	Intact	Costotransversectomy and posterior stabilization	32.7	9.9	8.4
14 years/female	D10–D12	Paraparesis	Posterior decompression and stabilization	38.1	14.7	10.6
13 years/male	D7–D10	Intact	Costotransversectomy and posterior stabilization	37.3	12.1	9.9
15 years/female	D8–D10	Intact	Costotransversectomy and posterior stabilization	36.2	11.3	9.1
16 years/male	D10–D12	Paraparesis	Posterior decompression and stabilization	29.9	8.4	7.2
16 years/male	D10–D12	Intact	Costotransversectomy and posterior stabilization	31.8	8.6	7.3

complicated by severe spinal deformity present unique challenges and considerations, and the literature may be less extensive compared to adult cases.

The objective of this study is to evaluate the efficacy and clinical outcomes of two different treatment approaches for dorsal spinal TB. We present our experience with surgical treatment of a prospective consecutive series of spinal TB and describe their clinical and neurological outcomes.

The information that a spine with tuberculous kyphosis may have a relatively longer vertebral canal than vertebral column suggests that there may be some inherent anatomical characteristics that could influence the feasibility and safety of posterior corrective surgery.[10] However, it's important to note that while such anatomical considerations may be relevant, the decision to proceed with any surgical intervention, including posterior corrective surgery for tuberculous kyphosis, involves a comprehensive assessment and approach.[11]

The advantages of surgical treatment for spinal TB (Pott's disease) are multifaceted and contribute to the comprehensive management of the condition. Here are some key advantages—histological confirmation, early and better healing, correction and prevention of spinal deformity, reducing recurrence rates, promotion of early neurological recovery, stabilization of the spine, optimizing treatment outcomes, and preventing complications.[12]

The study by Oga et al., indicating that tubercle bacilli do not adhere to metal or form biofilm, suggests that surgical instrumentation may be considered safe even in the presence of active TB.[13] If the findings of this study are validated and widely accepted, it could have significant implications for the safety of using surgical implants in the management of spinal TB. The fundamentals of surgical management outlined—adequate decompression and debridement, maintenance and reinforcement of stability, and correcting deformity or halting the progress of deformity—are indeed core principles in the surgical approach to spinal TB. Each of these components plays a crucial role in addressing the complexities associated with the disease.

These fundamentals are often addressed through various surgical procedures, such as anterior debridement and fusion, posterior stabilization, and combined anterior-posterior approaches. The choice of surgical technique depends on factors such as the location and extent of the disease, the severity of the deformity, and the patient's overall health.[14]

The successful accomplishment of surgical objectives like abscess drainage, debridement, and stabilization are integral to the overall management of spinal TB, as per Rajasekaran et al.[15] Debridement alone may not be sufficient to prevent the progression of deformity or improve healing rates, and there are concerns about potential complications, such as physical damage and rapid deformity progression in children. The goal is to achieve optimal infection control, prevent deformity progression, and promote the normal growth and development of the spine in pediatric patients.

The single-stage transpedicular procedure, as reported by Guven et al.[16] and Lee et al.,[17] highlights a surgical approach to correct kyphosis in patients with active spinal TB. The key findings suggest effective deformity repair with no loss of correction until the illness has fully healed. This approach represents a specific surgical technique for addressing spinal deformities associated with active TB.

The study by Gokce et al., describing the use of posterior wedge osteotomy and posterior fusion with the posterior midline method to treat kyphosis in the lower dorsal and dorsolumbar spine, showcases a specific surgical technique for correcting spinal deformities.[18] The reported correction from an angle of 51.1° to 23° highlights the effectiveness of the procedure in achieving a significant reduction in kyphosis.

Our study aimed to correct the kyphotic deformity in dorsal spinal TB and thereby improve the cosmesis for the betterment of the patient's aspect. Also, the neurological status improved considerably.

Conclusion

The goals of treatment in spinal TB are indeed centered on eradicating the disease, preventing or correcting spinal deformity, and addressing neurological deficits.[19] The management of uncomplicated spinal TB is primarily medical, involving the use of anti-TB medications.

We had a few limitations—long-term follow-up is essential to assess the sustained impact of the surgical procedure on spinal deformity, functional outcomes, and the overall well-being of the patient. Additionally, comparing the outcomes with a nonsurgical group helps provide valuable insights into the effectiveness of surgical interventions.

Orcid

Mageswaran Shanmugavelu https://orcid.org/0009-0001-0087-0634
Makesh Ram Sriraghavan https://orcid.org/0000-0001-9161-1672
Prabhu Aloy https://orcid.org/0009-0003-3526-4604
Poornima Kumararaja https://orcid.org/0009-0008-5139-8131
Sai Vinay Bharadwaj Namala https://orcid.org/0009-0005-2054-1749

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