

Original Article

Functional outcomes in the management of cervicothoracic junction tuberculosis

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ABSTRACT

Background: We analyzed the clinical and radiological parameters influencing functional outcomes and neurological recovery in patients with cervicothoracic junctional tuberculosis (TB).

Methods: This was a retrospective analysis of 16 cases of cervicothoracic junction (CTJ) spinal TB; 11 patients were managed operatively, while five were managed conservatively. Patients' outcomes were assessed at 1 month, 1 year, and yearly thereafter and included an analysis of multiple outcome scores, various radiographic parameters, and sensitivity or resistance to anti-tubercular therapy.

Results: Patients averaged 25.94 years of age, and typically had three-level vertebral involvement. They were followed for a mean duration of 24 months, and the duration of anti-tubercular therapy averaged 17 months. Patients demonstrated clinical improvement on Japanese Orthopedic Association score and Neck disability index ($P < 0.005$) starting from 1 month following initiation of treatment which continued in subsequent follow-up, along with change in radiological parameters consisting of mean segmental kyphotic angle from 18.98° to 15.13°, C2–C7 SVA from 16.13 mm to 22.61 mm, T1 slope from 22.80° to 14.66°, thoracic inlet angle from 75.35° to 63.25°, neck tilt from 51.81° to 48.33°, and cervical lordosis from 4.66° to -0.44° ($P > 0.05$) at the end of 1 year.

Conclusion: Tuberculous affection of the dynamic CTJ is a challenging scenario in clinical practice and its management involves consideration of disease extent, neurological status, and effort toward restoration of normal alignment of spine in sagittal and coronal plane to get favorable clinical outcomes.

Keywords: ASIA, Cervical sagittal alignment, Cervicothoracic junction, Neck disability index, Thoracic inlet measurement, Tuberculosis

INTRODUCTION

Most cases of spinal tuberculosis (TB) involve the thoracolumbar, followed by the lumbar region, and finally, the cervical region (i.e., <5% of cases).^[5] Pathologies affecting the cervicothoracic junction (CTJ) in particular may result in quadriplegia/neurological deficits, spinal instability, progressive kyphosis, neck shortening, and cosmetic disfigurement. This study is a systematic effort to understand the impact of conservative and operative management of CTJ/TB by evaluating the clinical and radiological parameters.

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MATERIALS AND METHODS

We prospectively evaluated 16 patients with CTJ (i.e., including C7/T1 or both) TB (2015–2020). They averaged 25.94 years of age and had between 1 and 6 vertebral bodies involvement. Of the 16 patients, 11 had surgery, while five were treated conservatively. A diagnosis of TB of the spine was based on microbiologically proven TB (BACTEC MGIT and GeneXpert) with a histopathological confirmation in the operated patients. In the conservatively managed group, the diagnosis was based on radiographic imaging (X-rays and MRI), hematological parameters, and constitutional symptoms. All the patients underwent serial evaluations at admission, 1 month, 1 year, and yearly thereafter. MR studies and supine radiographs were utilized to determine the extent of CTJ involvement and measure the cervicothoracic sagittal parameters.

Assessment of outcome scores

Three outcome measures were used to assess these 16 patients and were documented on admission, at 1 month, 1 year and in the subsequent years. The neck disability index (NDI) was used for the subjective evaluation of the disability experienced.^[4,10] The Japanese Orthopedic Association (JOA) score was used for an objective assessment of the functional and neurological status of the patient.^[2] The American Spinal Injury Association impairment scale was used to document the neurological impairment of the patient at various time frames and classify them from Class A through E.^[7] The cervico thoracic sagittal parameters like segmental kyphotic angle (K), Cervical lordosis, C2-C7 Sagittal vertical axis, T1 slope, Thoracic Inlet Angle and Neck tilt were measured. In cases, where T1 upper endplate was grossly destroyed or ill defined, upper or lower endplate of C7 or lower endplate T1 was used as a substitute for T1S.^[9,12]

Indications for surgery in 11 patients with CTJTB

Indications for surgery in 11 patients included progressive neurological worsening, significant static neurological deficits, kyphotic deformity, biomechanical instability, bowel bladder involvement, and an inadequate response to chemotherapy. Anterior approach (8) consisting of anterior debridement and fusion with tricortical graft or mesh cage, and anterior cervical plate was used.^[6,8,11] Prevertebral abscesses were seen in 14 (87.5%) patients on preoperative MR studies, kyphotic deformity of $>10^\circ$ in 12 (75%) patients, and anterior thecal sac compression in 16 (100%) patients. Posterior approaches, including the use of pedicle screws, lateral mass screws and tapering rod constructs, were reserved for patients with multilevel vertebral body involvement, disease located below the suprasternal notch, and with attendant severe CTJ kyphosis warranting reduction and stabilization [Figure 1].^[1,13,14] Intraoperatively tissue samples

were obtained for histopathological examination, aerobic and anaerobic culture, BACTEC MGIT, and GeneXpert MTB.

Postoperative management

Postoperatively, patients received rehabilitation and bracing (i.e., with cervical extension) until bony fusion was documented on serial radiographs. Patients were assessed with serial supine radiographs at monthly intervals for the 1st year and yearly thereafter.

RESULTS

Outcomes for 11 surgical patients

At the end of 1 year, the mean JOA and NDI improved from 12.18 to 14.18 and 73.55 to 60.00 at the end of 1 month follow-up, and to 15.90 and 52.00 at the end of 1 year, respectively [Table 1].

Sensitivity to antitubercular therapy

Fourteen (87.5%) patients were sensitive to the first line of anti-tubercular therapy, while one patient showed multidrug-resistant Koch's and one extensively drug-resistant TB (MTB strain resistant to even second line of anti-tubercular drugs). The mean duration of anti-tubercular therapy was 17 ± 4.75 months.

Postoperative radiological improvement in 11 surgically treated cases of CTJTB

Patients undergoing cervicothoracic corrective surgery for TB exhibited the following changes in their mean cervical sagittal parameters, postoperatively. Segmental kyphotic angle (K), and cervical lordosis improved; C2–C7 sagittal vertical axis decreased; T1 slope, thoracic inlet angle, and neck tilt showed an increase [Table 2 and Figure 2]. Bony fusion was noted at a mean period of 5.5 months postoperatively, and no change was appreciated in the cervicothoracic radiological parameters in the subsequent follow-ups up to an average of 2 postoperative years.

Table 1: Comparison between JOA and NDI scores on admission, 1-month, and 1-year follow-up ($n=11$).

	On admission Mean (SD)	1-month follow-up Mean (SD)	1-year follow-up Mean (SD)	P-value
JOA score	12.18 (2.67)	14.18 (2.08)	15.90 (1.19)	0.020*
NDI score	73.55 (5.68)	60.00 (7.26)	52.00 (7.74)	<0.001*

JOA: Japanese Orthopedic Association, NDI: Neck disability index.

* $P < 0.05$: Statistically significant result

Nonoperative results in five patients

The five patients treated without surgery showed improvement in the NDI score at 1-month and 1-year follow-up, as well as in the JOA score [Table 3]. Lateral imaging of the CTJ also showed changes in the sagittal parameters from admission to 1-year follow-up. The segmental kyphotic angle (K) worsened; C2–C7 SVA, T1 slope, and TIA decreased; NT increased; and the cervical lordosis remained unchanged [Table 4 and Figure 3]. After 1 year, there were no further change in parameters noted.

Results from the entire cohort

Analysis of all the 16 patients showed that the cervicothoracic sagittal parameters varied from admission to 1-year follow up

Table 2: Comparison between various cervical sagittal parameters and thoracic inlet measurements on admission and at the end of 1-month follow-up (n=11).

	On admission Mean (SD)	1-year follow-up Mean (SD)	P-value
K angle	22.47 (14.35)	15.63 (9.05)	0.177
C2–C7 CSVA	16.10 (7.74)	25.71 (17.14)	0.140
T1 slope	19.92 (16.92)	20.5 (17.72)	0.896
TIA	76.25 (19.09)	79.00 (24.90)	0.527
NT	56.02 (20.77)	57.50 (20.36)	0.701
Cervical lordosis	8.15 (26.62)	1.00 (19.78)	0.155

Table 3: Comparison between JOA and NDI scores on admission, 1-month, and 1-year follow-up (n=5).

	On admission Mean (SD)	1-month follow-up Mean (SD)	1-year follow-up Mean (SD)	P-value
JOA score	15.20 (2.04)	17.00 (-)	17.00 (-)	0.121
NDI score	72.80 (8.31)	59.20 (11.18)	53.60 (12.52)	0.014*
				0.006*

JOA: Japanese Orthopedic Association, NDI: Neck disability index, *P<0.05: Statistically significant result

Table 4: Comparison between various cervical sagittal parameters and thoracic inlet measurements on admission and at the end of 1-year follow-up (n=5).

	On admission Mean (SD)	1-year follow-up Mean (SD)	P-value
K angle	11.32 (10.49)	14.04 (9.83)	0.325
C2–C7 CSVA	16.18 (13.22)	15.78 (11.83)	0.633
T1 slope	29.14 (10.13)	25.40 (10.57)	0.191
TIA	73.38 (10.05)	71.88 (10.44)	0.746
NT	42.56 (4.15)	47.88 (12.12)	0.373
Cervical lordosis	-3.00 (15.96)	-3.64 (22.02)	0.968

as follows, segmental kyphotic angle(K) changed from 18.98° to 15.13°; C2–C7SVA from 16.13mm to 22.61mm; CL from 4.66° to -0.44°. T1S from 22.80° to 14.66°; TIA from 75.35° to 63.25°; NT from 51.81° to 48.33° (P>0.05) [Table 5]. The mean JOA and NDI improved from 13.13 and 73.31 to 15.06 and 59.75 at one month follow up; to 16.27 and 52.50 at one year follow up respectively (P<0.005) [Table 6]. Improvement was also noted on the ASIA impairment scale at 1 month and 1 year follow up (P<0.05) [Table 7].

DISCUSSION

Surgery for CTJTB

The literature on CTJTB is scant and surgery for CTJTB poses a unique challenge. Anti-tubercular therapy is the mainstay of treatment with or without surgical debridement and

Table 5: Comparison between various cervical sagittal parameters and thoracic inlet measurements on admission and at the end of 1-year follow-up (n=16).

	On admission Mean (SD)	1-year follow-up Mean (SD)	P-value
K angle	18.98 (13.97)	15.13 (9.00)	0.283
C2–C7 CSVA	16.13 (9.30)	22.61 (15.99)	0.147
T1 slope	22.80 (15.41)	14.66 (23.08)	0.180
TIA	75.35 (16.49)	63.25 (49.74)	0.324
NT	51.81 (18.27)	48.33 (31.82)	0.626
Cervical lordosis	4.66 (23.85)	-0.44 (19.88)	0.359

Table 6: Comparison between JOA and NDI scores on admission, 1-month, and 1-year follow-up (n=16).

	On admission Mean (SD)	1-month follow-up Mean (SD)	1-year follow-up Mean (SD)	P-value
JOA score	13.13 (2.82)	15.06 (2.17)	16.27 (1.10)	0.003*
NDI score	73.31 (6.33)	59.75 (8.29)	52.50 (9.07)	0.001*
				<0.001*

JOA: Japanese Orthopedic Association, NDI: Neck disability index, *P<0.05: Statistically significant result

Table 7: Comparison of ASIA score over time (n=16).

ASIA score	Preoperative	Postoperative	Follow-up
A	1 (6.3)		
B	2 (12.5)	1 (6.3)	
C	4 (25.0)	2 (12.5)	
D	7 (43.8)	10 (62.5)	7 (43.8)
E	2 (12.5)	3 (18.8)	8 (50.0)
P value	-	0.604	0.031*

*P<0.05: Statistically significant result

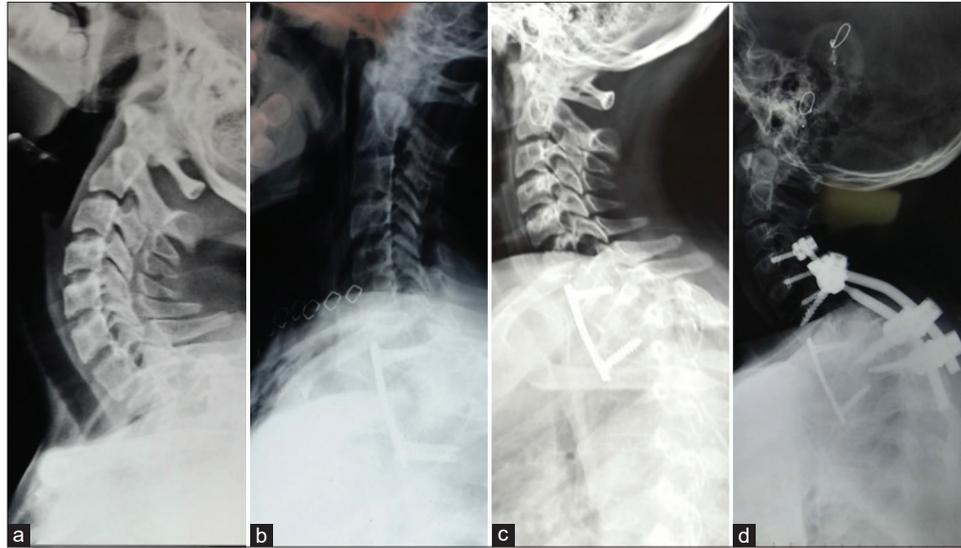


Figure 1: (a) Radiograph showing CTJ kyphosis with hyperlordosis of the cervical spine, (b) anterior cervical plate *in situ* with caudally directed inferior screws, (c) anterior cervical plate *in situ* with cephalad directed inferior screws depicting increased kyphosis due to unabated posterior column growth, and (d) correction of kyphosis with additional posterior instrumentation.

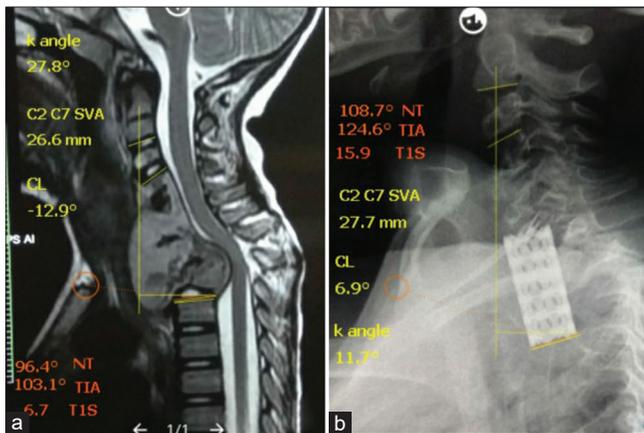


Figure 2: (a) MRI showing tubercular spondylodiscitis of the CTJ with cord compression and (b) lateral radiograph showing mesh *in situ* spanning C6-T1 levels.

stabilization. Li *et al.* reported favorable outcomes in 34 patients undergoing decompression and posterior instrumentation for CTJ metastases.^[3] Zhu *et al.* reported improvement in the JOA, NDI, and ASIA scores in a series of 45 patients with CTJTb managed operatively.^[14] In our series of 16 patients, 11 had surgery and five were treated nonsurgically. Neck shortening, a low hairline, and cosmetic disfigurement were attributed to vertebral body destruction and spinal column shortening. No statistically significant change was seen in the cervical sagittal and thoracic inlet parameters considered in our study. In the operative group, a reduction in the kyphotic angle with improvement in cervical lordosis was seen. In our series of 11 patients managed operatively, four exhibited postoperative complications that included recurrent laryngeal nerve palsy,

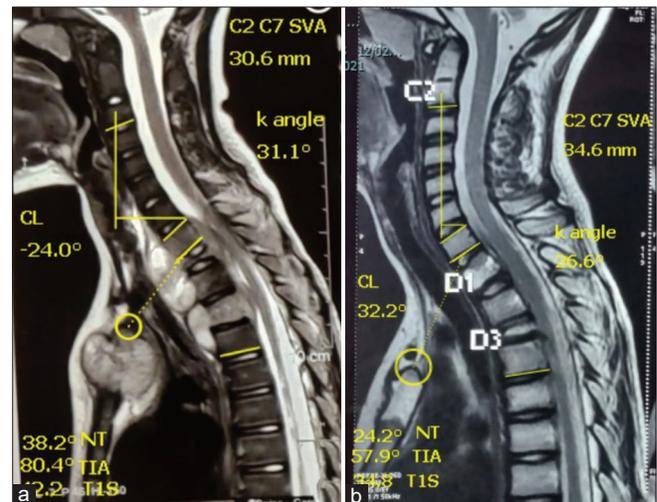


Figure 3: (a) MR sagittal T2W imaging showing CTJ and sternal tuberculosis with prevertebral abscess and (b) resolution of tubercular focus post anti-tubercular therapy for 9 months.

instrumentation failure (2-month postoperative), surgical site infection (i.e., requiring debridement and wound wash), and neurological worsening (i.e., scaled down from ASIA D to ASIA B postoperatively at 1 month and back to ASIA D at 1 year).

Conservative management of CTJTb

For those treated non surgically, on follow-up, they showed an increase in the kyphotic angle, reduction in T1 slope, and increase in neck tilt probably due to settling of the diseased segment. We attribute the improvement in NDI, ASIA, and JOA scores to neurological decompression and eradication of

the tubercular focus by timely institution of anti-tubercular therapy along with bracing.

Most of our patients at the time of presentation had not received any disease-specific treatment because of resource constraints and lack of access to quality health-care services and usually presented to us late with severe kyphosis and neurological deficit with various grades of functional dependence. Anterior approaches offer limited control in realigning the spine in contrast to posterior or combined approaches. Hence, we did not get significant alteration in the radiological parameters as the primary surgical goal was to do neurological decompression with the best possible realignment of spine because patients in our cohort presented quite late in the natural course of disease progression. The author strongly believes that compensatory mechanisms existing at the occipitocervical junction, thoracolumbar junction, and lumbopelvic junction play an important role in reducing the impact of these altered parameters on the overall global sagittal alignment to maintain the cone of economy.

CONCLUSION

CTJTB is a challenging scenario in clinical practice and has favorable outcomes if managed appropriately. Alterations in cervical sagittal parameters and thoracic inlet measurements did not have a significant bearing on the functional outcome in short term.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

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