

## Does kyphosis in healed subaxial cervical spine tuberculosis equate to a poor functional outcome?

### ABSTRACT

**Introduction:** Tuberculosis (TB) of the subaxial cervical spine has a high percentage of morbidity. It accounts for about 10% of cases with the major concerns being quadriplegia and localized kyphosis.

**Aim:** The study aims to provide an insight in the management of subaxial cervical spine TB treated by multiple modalities.

**Materials and Methods:** A retrospective analysis of 91 patients with subaxial cervical (C3–C7) TB was performed. Neurology was assessed by Nurick's grading and pain using the visual analog scale (VAS) (in mm). Radiological evaluation was done with standard anteroposterior and lateral view of the cervical spine at presentation and 3 monthly intervals after intervention. Magnetic resonance imaging was done in all patients. Angle of kyphosis (K angle) was calculated from plain radiographs.

**Results:** Mean age of the patients was 31.5 years. Neurological status was Nurick's Grade 5 in 8, Grade 4 in 15, Grade 3 in 28, Grade 2 in 22, Grade 1 in 7, and further 11 had Nurick's Grade 0. Operative intervention was either anterior, or posterior, or a combination of both depending on extent of vertebral destruction. All patients with Nurick's 5 and 4 improved to 3 or less at final follow-up. The kyphosis angle at presentation ranged from 2 to 58 of with an average kyphosis of 16.05. The postoperative kyphosis was graded as mild (loss of lordosis to 10 kyphosis), moderate (10–30), and severe (>30). Ten patients had mild kyphosis and 6 patients had moderate kyphosis. Mean VAS score at presentation was 45.5 mm which improved to 14.48 mm at follow-up. Patients with mild and moderate kyphosis remained asymptomatic till the last follow-up.

**Conclusion:** Healing of subaxial cervical TB in kyphosis does not necessitate a poor clinical outcome as most patients remain asymptomatic.

**Keywords:** Functional outcome, subaxial cervical tuberculosis, subaxial kyphosis

### INTRODUCTION

Cervical spine is considered an uncommon site of tuberculosis (TB) in the entire spectrum of spinal TB accounting for roughly 3%–5% of all cases.<sup>[1]</sup> Spinal TB still accounts for a large number of cases in the developing countries. The rising epidemic of HIV infections is making this situation worse not sparing even the developed countries. The spectrum of cervical spine TB can be broadly divided into three categories - the craniocervical junction, subaxial cervical spine, and cervicodorsal junction. Each of these three behave differently from each other due to their specific biomechanics hence require different techniques for management. The presence of tubercular etiology forces the subaxial cervical spine into inherent tendency of kyphosis. The presence of kyphosis in the subaxial cervical spine is

generally correlated with a poor functional outcome owing to increased disability and gaze disturbances in severe kyphosis.<sup>[2]</sup> The management of TB in these patients is still considered mainly medical and surgical intervention is generally reserved for cases with progressive neurological

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deficit, unacceptable cervical deformity, and in the presence of severe soft-tissue abscess causing dysphagia and dyspnea. The number of patients with this kind of involvement is easily misdiagnosed and can present commonly with severe cervical deformity. This is particularly common in Asian countries where there is a high prevalence of osteoarticular TB and multi segment spondylodiscitis along with skip lesions is not infrequently found. A positive correlation between cervical kyphosis and poor functional status seems to be a plausible explanation although rarely proven directly in studies. This study aims to find out the functional outcome of patients with healed subaxial cervical spine TB comparing the outcomes of those healing in kyphosis with the ones that do not.

### Aim

The study aims to provide an insight in the management of subaxial cervical spine TB treated by multiple modalities.

## MATERIALS AND METHODS

A retrospective analysis of 91 patients with sub-axial cervical (C3–C7) TB was performed. Neurological examination was assessed periodically by Nurick's grading. Neck pain was assessed using the visual analog scale (VAS) (in mm). Neck disability index was also compared in these patients before starting the treatment and at regular intervals afterwards. Radiological evaluation was done with standard anteroposterior and lateral view of the cervical spine at presentation and regularly 3 monthly intervals after starting the intervention. In case of patients who were operated immediate postoperative radiographs were obtained and then at 3 monthly intervals. Magnetic resonance imaging was done in all patients at the time of presentation. Angle of kyphosis (K angle) was calculated from plain radiographs by standard Cobbs method by drawing two lines-one parallel to lower end plate of C2 and other parallel to lower end plate of C7. Anterior fusion was assessed by plain radiographs. The presence of bridging bone between the diseased vertebra was analyzed and in case of doubt a computed tomographic scan was done. Patients with isolated posterior elements cervical TB, patients who were reoperated and those with cervico dorsal involvement were excluded from the study. All of these patients were followed up for a minimum of 2 years and analyzed at frequent intervals.

## RESULTS

The mean age of the patients was 31.5 years and varied from 7 years to 65 years. Neurological status was Nurick's Grade 5 in 8, Grade 4 in 15, Grade 3 in 28, Grade 2 in 22, Grade 1 in 7, and further 11 had Nurick's Grade 0. The

patients were managed either conservatively (antitubercular chemotherapy alone) or surgical along with chemotherapy. In those with isolated chemotherapy, variable duration bed rest was advised initially at the time of diagnosis for 3–4 weeks. The patients were then mobilized with a soft cervical collar and kept on antitubercular chemotherapy and serial follow-up once on ambulatory chemotherapy. The indications for surgery were to relieve pain, improve neurological impairment, and prevent or correct spinal deformity. Operative intervention was either anterior, or posterior, or a combination of both depending on extent of vertebral destruction. In the series, 49 were female and 42 were male. There were 6 patients in the pediatric age group. All the patients showed improvement in their neurological status. All patients with Nurick's 5 and 4 improved to 3 or less at final follow-up. The kyphosis angle at presentation ranged from 2° to 58° of with an average kyphosis of 16.05°. The average lordosis after surgery was found to be 9.35°, i.e., a mean correction of 25.4°. The postoperative kyphosis was graded as mild (loss of lordosis to 10° kyphosis), moderate (10°–30°), and severe (>30°). Ten patients had mild kyphosis and 6 patients had moderate kyphosis at the time of last follow-up. Mean VAS score at presentation was 44.7 mm in the lordotic group 46.3 in the kyphotic group. Mean neck disability score (NDS) in the lordotic group was 32.5 and in the kyphotic group was 33.7, respectively. All patients showed bony fusion at final follow-up. Follow-up ranged from 24 to 60 months with a minimum duration of 24 months. Patients with mild and moderate kyphosis remained asymptomatic till the last follow-up. None of the pediatric patients had any kyphosis at final follow-up. Out of the 16 patients, who developed kyphosis during treatment 13 patients were undergoing conservatively on ambulatory chemotherapy alone. Two patients had undergone surgical management with anterior debridement and bone grafting alone without plating who developed kyphosis at the time of final follow-up. None of these patients had any local symptoms or worsening of neurological symptoms at the last follow-up. One patient operated with anterior debridement, bone grafting and plating had some amount of cervical kyphosis which was detected on serial radiographs and remained non progressive and neurologically intact at the time of final follow-up. Both the patients required implant removal later on. The mean VAS score at 24 months' follow-up in the patients who had healed in a lordotic alignment was found to be  $13.9 \pm 2.21$ . Similarly, in the patients with an overall kyphotic alignment the score was  $15.06 \pm 2.5$ . This difference was statistically insignificant with a  $P = 0.13$  as calculated by Mann–Whitney U test. The mean NDS in the lordotic group was  $5.6 \pm 1.6$  at 24 months' follow-up and the kyphotic group had a mean score of  $5.8 \pm 1.04$ . This

difference was statistically insignificant with a  $P = 0.4$  by Mann–Whitney U test.

Three cases with different modalities of management have been found to be dedicative of the topic under discussion. The first patient was a 32-year-old male who was diagnosed as a case of C4–C5 tuberculous spondylodiscitis with a rather innocuous looking radiograph [Figures 1 and 2]. He had primary complaints of neck pain and some radiculopathy in the absence of any localizing neurological signs. He was managed conservatively with antituberculous chemotherapy and a cervical collar and went ahead to achieve a solid union [Figures 3 and 4]. He remained asymptomatic at the final follow-up of 30 months with some residual cervical kyphosis of around  $6.4^\circ$ . The second patient was a 44-year-old female with C4–C5 tuberculous spondylodiscitis who underwent anterior debridement and bone grafting alone for worsening neurological symptoms [Figures 5 and 6]. She was kept in a cervical collar postoperatively and developed kyphosis during

the disease [Figure 7]. She eventually healed in about  $21.3^\circ$  kyphosis by 14 months' postoperative and had complete neurological recovery [Figure 8]. The kyphosis remained static and patient was symptom free till the final follow-up of 36 months. The third patient was a 17-year-old female with C4–C5 tuberculous spondylodiscitis who underwent anterior debridement and plating with autologous bone grafting for sudden onset neurological deficit and presented with an initial kyphosis of  $32.9^\circ$  [Figure 9]. Postsurgery, she healed with a final kyphosis of  $8.7^\circ$  at the time of final follow-up of 26 months [Figure 10].

## DISCUSSION

Subaxial cervical spine TB (SCST) is an uncommon site of involvement in the spectrum of osseous TB. The predominant involvement of anterior column in TB makes kyphosis an inevitable outcome in inadequately treated TB. This holds true not only for dorsal spinal TB but also in cervical spine.



Figure 1: T2 sagittal magnetic resonance imaging of Patient 1 demonstrating C4–C5 spondylodiscitis and vertebral body destruction



Figure 2: Plain cervical lateral radiograph at initial presentation of Patient 1 demonstrating cervical kyphotic alignment and retrolisthesis of C4 over C5



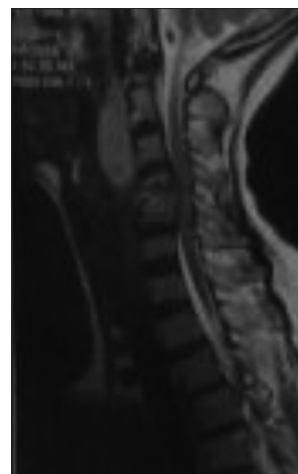
Figure 3: Plain cervical lateral radiograph at final follow-up demonstrating solid bony fusion with cervical kyphosis



Figure 4: T2 Sagittal magnetic resonance imaging at final follow-up demonstrating no residual neurological compression



**Figure 5:** Plain cervical lateral radiograph at initial presentation of Patient 2 demonstrating cervical kyphotic alignment and C4–C5 vertebral body destruction



**Figure 6:** T2 sagittal magnetic resonance imaging of Patient 2 demonstrating C4–C5 spondylodiscitis and vertebral body destruction



**Figure 7:** Plain cervical lateral radiograph of Patient 2 showing kyphotic alignment and good healing at 10 months follow-up



**Figure 8:** Plain cervical lateral radiograph of Patient 2 showing progression of kyphosis at 14 months follow-up

The incidence of cervical spine TB has been on the rise both in developing and developed countries. The reported incidence varies from 2% to 12%.<sup>[3-5]</sup> The cervical spine TB has the potential to cause serious damage to the cervical stability and neurological compromise can occur early in the course of the disease. The small diameter of the spinal canal at these levels also contributes to this fact. The bony destruction can be rapid and if diagnosis is delayed and resultant instability will cause significant neurological compromise. Increasing prevalence of drug resistance is an important factor which needs to be taken into account when dealing with spinal TB.<sup>[6-8]</sup> Antitubercular chemotherapy has been considered the main treatment for spinal TB with surgery being reserved for selected cases. However, 3%–5% of patients of SCST eventually can end up in kyphosis  $>60^\circ$  with conservative management alone.<sup>[9]</sup> Surgical management is mainly reserved for spinal deformity, significant neurological dysfunction and in cases of doubtful diagnosis. Literature concentrating on functional

outcomes in patients of SCST is scarce. This paper aims to elucidate the importance of kyphosis in healed SCST and its role in affecting the functional outcome of these patients.

The line of weight bearing passes through the posterior part of the vertebral bodies in the cervical spine. The cervical spine is involved in supporting the mass of the head while also responsible for allowing a versatile range of motion and maintaining the horizontal gaze of the individual. Therefore, the general course of SCST is obliteration of the normal cervical lordosis and progressive appearance of kyphosis later in the course of disease. Kyphosis is the most common outcome of inadequately treated SCST and it is known to alter the normal functioning and increasing patient morbidity. This becomes important in poor socioeconomic strata of the society where late presentation is an unsaid rule and severe deformities are not uncommon. The close vicinity of important neurovascular structures invites devastating complications early in the course of the



**Figure 9: Plain cervical lateral radiograph at initial presentation of Patient 3 demonstrating moderate cervical kyphotic alignment and C4–C5 vertebral body destruction**



**Figure 10: Postoperative plain cervical lateral radiograph of patient 3 at final follow-up with anterior cervical plate *in situ* and solid bony fusion with residual kyphosis**

disease. It is generally followed that kyphotic outcome of cervical TB requires some kind of surgical intervention to correct the deformity and have a better functional outcome. In most of the studies describing surgical management for healed subaxial cervical TB, the amount of deformity at the time of surgery is significantly high.<sup>[10,11]</sup> The same might not correlate with the patient symptoms and most patients seek advice either for myelopathy symptoms or grotesque deformities affecting their horizontal gaze and activities of daily living. In a study by Liu *et al.*<sup>[11]</sup> on the surgical management of post tubercular kyphotic deformity of the cervical spine, all patients in the group had moderate-to-severe kyphosis with a mean of 42.58°. All of the patients had a lower mean VAS score of 4.5, but the more disabling complaints were related to myelopathy and its associated symptoms with a mean preoperative mJOA of 7.92. The correction of cervical and cervicothoracic kyphosis was considered better, and corrections up to 100% could be achieved at times. In a study by Lukhele *et al.*,<sup>[11]</sup> on the TB of the cervical spine that interpreted that kyphotic deformity of the cervical spine was manifested in 4 out of 8 patients and most with kyphosis had on an average a 50° kyphosis prior to surgery and was reduced to 15° but none had complete restoration of the cervical lordosis. The patient who was managed conservatively on traction had a final kyphosis of 30° and full neurological recovery. Overall, the patients had a good functional outcome despite the presence of some residual kyphosis. TB of the cervical spine takes an even aggressive role in children where the number of segments involved could be more and there is a significant vertebral destruction leading to early significant kyphosis which would need surgical intervention.<sup>[12]</sup> However, this may not be a rule of thumb and conservative management is still an acceptable modality where too many motion segments have

been involved and anterior reconstruction would require too big a graft.

For active cervical spinal TB anterior debridement, if required is considered the gold standard as it allows direct access to the lesion in most cases and adequate neural decompression can be achieved. However, when dealing with kyphosis in the cervical spine, there are a few shortcomings associated with the anterior approach which mainly includes inadequate correction of kyphosis and long-term loss of deformity correction in the absence of anterior instrumentation.<sup>[13]</sup> Most surgeons prefer addition of posterior approach either in isolation or combination for cases where the correction of kyphosis is aimed more than 30°.<sup>[14]</sup> However, the posterior approach does carry a risk of spread of TB to posterior elements which are generally naive to the primary pathological process.

Kyphosis in the cervical spine secondary to TB has a tendency to be more severe as the only natural support occurs at the point where chin touches the sternum and this is frequently accentuated by the involvement of atlantoaxial joints and their subluxation. Severe degrees of kyphosis is not only neurologically disabling but also causes difficulty in painting a horizontal gaze.<sup>[15-17]</sup> This consequently affects ambulation in the patients and can also be associated with difficulty in swallowing and respiration. Cervical kyphosis can be either regional or global and the global is the one responsible for more disabling complaints and poor quality of life.<sup>[18]</sup> Most authors do agree on the indications of surgical intervention in SCST to be dysphasia for solids due to a retropharyngeal abscess, neurologic deficit, instability of the spinal column and progressive kyphosis >30° while on orthotics management. In a study by Govender *et al.*,

the mean kyphosis at presentation was 32° after which the authors decided for a surgical intervention for correction of the neck deformity.<sup>[19]</sup> In their study, the patients who healed with residual kyphosis experienced minor discomfort and required no pain medications for the same. Patients healed with an average kyphosis of 22° at final follow-up and experienced no limitation of mobility, flexion extension, or rotation. They have also reported extensive posterior fusion in one patient with a 52° kyphosis of mid cervical spine after anterior surgery and had severe limitation of neck movement. SCST is an entity which can frequently be unrecognized for a long period especially in the under developed nations and if it is not associated with a deformity.<sup>[20]</sup> This assumes greater importance in endemic countries and in children where communication may not be an easy task and a differential diagnosis should be kept in mind.<sup>[21]</sup> The greater predisposition of children to SCST may be attributed to a slightly different anatomy and altered biomechanics in the region. They have a disproportionately large head, poor muscle control and significant ligament laxity all contributing to an excessive mobility.<sup>[22]</sup> This in addition to the effect of gravity contributes significantly to an overall cervical kyphosis at the end of disease. There is also a potential threat to the further growth of the vertebral bodies due to damage to the growth plate and the end result of the combination of these forces could be erratic and unexpected. This makes it extremely difficult to predict the final outcome in children where significant growth is still remaining and they may be at the receiving end of progressive kyphosis even after the disease has healed completely. There have also been few reports of spontaneous posterior element fusion in few cases and could be the result of existing posterior element disease or immobilization in extension causing a block vertebra like picture. Ideally, all children with existing growth potential should be periodically followed up till adulthood to evaluate progression of deformity and functional outcome. In a study by Lan *et al.*, they have concluded that the mean focal kyphosis at the infected level before surgery was 49.1°.<sup>[23]</sup> The ones with severe kyphosis around 80.7° were corrected to 11.7° postsurgery and reported a good functional outcome in their series.

The same rules do not apply to the cervicodorsal junction which is an area of biomechanical transition and undergoes rapid worsening of kyphosis if left untreated and might require an early surgical intervention especially with severe vertebral body destruction. Similarly, the principles of treatment in craniovertebral junction TB are entirely different and no extrapolation can be expected from the current findings. The maximum lordosis in cervical spine is contributed by the C1–C2 disc space (75%–80%) and the

subaxial spine contributes to the lesser amount.<sup>[2]</sup> There are only a few studies which report the relationship between radiographic parameters in the cervical spine and quality of life. The effects which these radiographic parameters present are not well defined as in the thoracolumbar spine. The majority of available reports are associated with regional measurements of kyphosis. In a study by Jagganathan *et al.* they found no significant relationship between change in segmental kyphosis and postoperative functional status.<sup>[24]</sup> In another important study by Villavicencio *et al.* they evaluated relationship between lordotic alignment and clinical outcomes using normal and lordotically shaped allografts for anterior cervical discectomy and fusion.<sup>[25]</sup> They concluded that improved cervical Cobb angle alignment did not correlate significantly with clinical outcomes. Guérin *et al.* reported that only segmental alignment correlated with clinical outcomes. Nevertheless, there are no clear guidelines about the maximum acceptable cervical kyphosis beyond which patients seem to have severe degree of symptoms.<sup>[26]</sup> It is assumed that some amount of residual kyphosis in healed thoracic spinal TB is acceptable due to the inherent nature of the primary curve to be kyphotic. Healing of SCST in mild-to-moderate kyphosis of up to 30° is generally well tolerated by patients and does not necessitate a poor functional outcome. The need to differentiate milder deformities from more severe ones is of paramount importance especially in low income group countries where aggressive treatment of all healed kyphotic patients may not be possible secondary to lack of facilities for advanced deformity correction surgeries and an unexpectedly higher number of patients who actually require surgical intervention.

## CONCLUSION

In our study, we have demonstrated that mild-to-moderate degrees of kyphosis in healed SCST are accompanied with a fair functional outcome and most patients do not report any long-term disability. The same cannot be extended for severe kyphosis where the deformity is disabling. The situation in children is unpredictable and requires long-term follow-up till the skeletal maturity is achieved. Thus, the general assumption of a poor functional outcome in these patients is far-fetched.

## Limitations

The limitations of the study are the small number of patient size and retrospective type of the study. However, it does substantiate an important concept of functional outcome in healed subaxial cervical spine TB.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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