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## Spinal tuberculosis: with reference to the children of northern India

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**Abstract** *Background:* Tuberculosis is a necrotizing bacterial infection with protean manifestation and wide distribution. There has been a great fall in the prevalence of tuberculosis in the United States since 1990, although the impact of acquired immunodeficiency syndrome (AIDS) has increased the resurgence of tuberculosis (TB). Spinal tuberculosis is the commonest form of skeletal tuberculosis. In this article, an overview of spinal tuberculosis and the personal experience of 19 children with spinal tuberculosis are presented. All the children required surgical intervention, because they manifested neurological deficit. *Pathogenesis and clinical features:* The spinal tuberculosis is a result of hematogenous dissemination from primary focus in the lungs or the lymph nodes. The central type of vertebral tuberculosis spreads along with Batson's plexus of veins, while paradiscal infection spreads through the arteries. The anterior type of vertebral body tuberculosis results from the extension of the abscess beneath the anterior longitudinal ligament and periosteum. Two types of bone and joint tuberculosis are recognized: the caseous, exudative type with abscess formation, which is more common in children, and the granular type is frequent in adults. Only 7 of the 19 children had an abscess, while 10 manifested mainly granulation tissue. Although spinal tuberculosis is an

extradural disease, 2 children had intramedullary granulomas and presented a tumor-like syndrome as rare manifestations. It was interesting to encounter intradural granulation and organized intradural granuloma causing cord compression in 2 children. A frank abscess with clumping of nerve roots was encountered in the cauda of another child without vertebral involvement. There is a controversy regarding the age predilection of the disease; it is documented that it is a disease of adults in affluent countries, and a disease of the first three decades in other regions. *Diagnosis:* Magnetic resonance imaging is extremely useful in diagnosing the difficult and rare sites of disease like the craniovertebral junction. It detects the marrow changes, exudative and granulation types, extra- and intradural disease, and radiological response to treatment in the early follow-up period around 6–8 weeks. *Treatment:* Opinion varies regarding the operative indication for Pott's spine. A large group of surgeons perform debridement and decompression in all cases, irrespective of neurological involvement. Others perform operative decompression only in those patients who do not respond to chemotherapy. We did surgical interventions in children with moderate to severe neurological deficits manifesting radiological compression of their neuraxis. Depending on the site of involvement

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and type of disease the surgical approach was decided in individual cases. Two children with healed Pott's spine also required surgery because of their spinal deformations, which caused gradual neurological

deficits and pain in both. Prognosis depends on many factors; the magnitude of cord compression, duration of neural complication, age and general condition of patient. Fifteen of our children made a remarkable re-

covery. Children with paraplegia also made an excellent recovery of their strength and sensations.

**Keywords** Pediatric · Pott's spine · Spinal tuberculosis

## Introduction

The world at large has nearly 30 million people suffering from tuberculosis. After 1985, many different countries recorded an increase in the number of patients by 10–30% annually. According to an estimate of WHO, tuberculosis kills three million people a year worldwide. It is estimated that India alone has got one-fifth of the world's tuberculosis patients. Thus, there are six million radiologically proven cases of tuberculosis in India [1]. The impact of acquired immunodeficiency syndrome (AIDS) has increased the resurgence of tuberculosis (TB). Skeletal involvement has been noted in nearly 60% of TB cases in HIV-positive patients [2]. Of all the patients suffering from tuberculosis, nearly 1–3% have involvement of the skeletal system. Vertebral tuberculosis is the commonest form of skeletal tuberculosis and it constitutes about 50% of all cases of skeletal tuberculosis in reported series [1]. It is most common during first the three decades, although it can occur at any age between 1 and 80 years [1]. Early diagnosed cases of spinal tuberculosis without neural compression can be treated conservatively by antitubercular chemotherapy and immobilization of the spine. However, the patients manifesting clinical neural compromise and radiological compression of the neuraxis require surgical intervention along with chemotherapy. We performed surgical intervention in 19 children (below 18 years of age) with spinal tuberculosis presenting with the compression of the neuraxis (cord, cauda or nerve roots). The clinical profile, surgical intervention, and outcome of these children are included in this article.

## Pathology and pathogenesis

Like any other type of osteoarticular tuberculosis, the spinal tuberculosis is the result of a hematogenous dissemination from primary focus, may be active or quiescent, apparent or latent, either in the lungs or in lymph nodes of the mediastinum, mesentery or cervical regions, or in the kidneys or other viscera. The strain responsible for skeletal tuberculosis in India is the mainly human type *Mycobacterium tuberculosis* [1]. The infection reaches the skeletal system through vascular channels, generally the arteries, as a result of bacillemia, or rarely in the axial skeleton through Batson's plexus of veins. Simultaneous involvement of the paradiscal part of two contiguous

vertebrae in a typical tuberculous lesion of the spine lends support to the insemination of bacilli through a common blood supply to this region.

In clinical practice, it is customary to explain:

1. The central type of vertebral body disease and "skipped lesions" in the vertebral column. A vertebral disease associated with tubercular meningitis is due to the spread of infection along Batson's plexus of veins
2. Typical paradiscal lesions and vertebral lesions associated with tubercular foci in the extremities are considered to be caused by the spread of disease via the arteries
3. The "anterior type" of involvement of the vertebral bodies seems to be due to the extension of an abscess beneath the anterior longitudinal ligament and the periosteum. The infection may spread up and down, stripping the anterior and posterior longitudinal ligaments and the periosteum from the front and sides of the vertebral bodies. This results in the loss of the periosteal blood supply and distraction of the anterolateral surface of many contiguous vertebral bodies [1]

Two types of bone and joint tuberculosis are recognized: the caseous exudative type, which is characterized by more destruction, more exudation, and abscess formation, and the granular type, which is less destructive, having dry lesions and abscess formation is rare. In clinical practice both types coexist, one predominating the other. Lesions in children are generally of the "caseous exudative type" [1]. Seven of our 19 children had frank extradural pus on exploration or aspiration, while one other child showed purulent granulation tissue at surgery. It was interesting to find a frank small intradural abscess with clumping of nerve roots in the cauda region of one child without any osseous lesions. Granulation tissue was responsible for compression of the theca and cord or nerve roots in 9 out of 19 children, which manifested as an intradural, organized soft granular mass in one child and a firm nodular organized tumor, like intradural tissue attached to thickened dura, in another child. Granulation tissue was extradural in 7 children. The destruction and collapse of vertebral bodies were demonstrated in 11 children. These findings were present in varying combinations, signifying a difficult differentiation between the two types of osseous tuberculosis traditionally described. As per the literature, the osseous tuberculosis passes through:



**Fig. 1** Magnetic resonance (MR) sagittal cut showing destruction of C3, C4 bodies and partial destruction of the C5 body with posterior displacement of residual destroyed bodies, causing severe compression of the cord. Hyperintense cord signals are evident

**Fig. 2** Sagittal MR of same child (as Fig. 1), showing excision of the compressive bony element with bone grafting. The cord is visible normally. No cord signals are seen

1. The inflammatory edema and exudation stage
2. The necrosis and cavitations stage
3. The destruction and deformation stage
4. The healing and repair stage [1]

Two of the present 19 children developed cord and cauda compression on account of spinal deformation and required surgery for their healed spinal lesions, as both of these had received antitubercular chemotherapy for 12 and 18 months respectively. Compressive features developed after 10 months and 3 years respectively following completion of chemotherapy to incapacitate them (Figs. 1, 2). It signifies that healing, whether spontaneous or by therapy, does not always relieve the compression, hence stage 4 of osseous tuberculosis is also prone to surgical interventions in clinical practice.

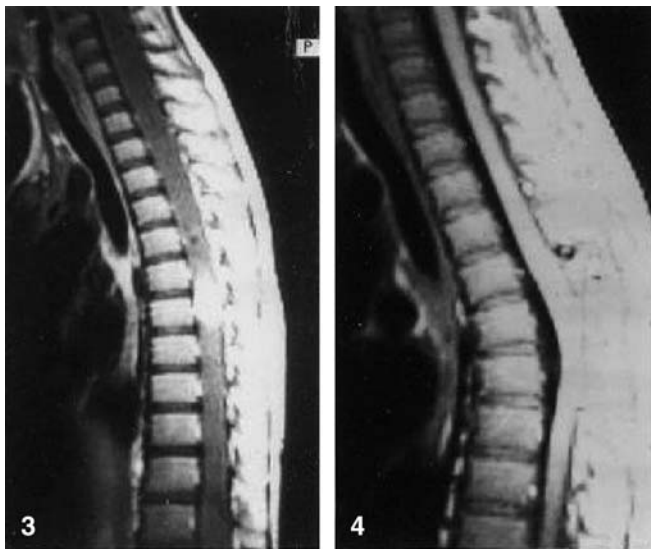
Following infection the initial response observed is the accumulation of polymorphonuclear cells, which are rapidly replaced by macrophages and monocytes (the highly phagocytic members of the reticuloendothelial system). The tubercle bacilli are phagocytosed and broken down, and their lipid is dispersed throughout the cytoplasm of the mononuclear cells, thus transforming them into epitheloid cells. Langhan's giant cells are probably formed by the fusion of epitheloid cells. These are formed only if caseation necrosis has occurred in the lesion and they often contain tubercle bacilli. After about a week, lymphocytes appear and form a ring around the peripheral

part of the lesion. This mass formed by reactive cells of reticuloendothelial tissues constitutes a nodule known as a "tubercle." During the 2nd week caseation occurs in the center of the tubercle by coagulation necrosis. The presence of caseation is almost diagnostic of tuberculosis. A cold abscess is formed by collection of the products of liquefaction and reactive exudation. The cold abscess is mostly composed of serum, leucocytes, caseous material, bone debris, and tubercle bacilli. The wall of the abscess is covered with tuberculous granulation. Osseous destruction takes place by lysis of the bone, which is softened and easily yields under the effect of gravity and muscle action, leading to compression, collapse or deformation of bones. Ischemic necrosis secondary to arterial occlusion also contributes to the osseous and vertebral collapse. As a result of ischemic changes, sometimes sequestration takes place, appearing as "coarse sand" and rarely forming a radiologically visible sequestrum [1].

Twenty percent of cases on routine investigation had evidence of tuberculosis in the viscera or glands or other parts of the skeletal system. TB of the cervical region is uncommon and accounts for just 10% of all cases of spinal TB [3]. Atlantoaxial junctions are the least common sites for presentation of spinal TB, accounting for just 1% of all cases of spinal TB. On review of 29 cases of craniocervical tuberculosis, the destruction of the clivus was seen in 17%, whereas there were abnormal signal intensity changes in 38%, destruction of occipital condyles in 34%, and involvement of the dens of the axis in 62%; the lateral masses were involved in 52% of patients [4]. A case of cervical tuberculosis has been reported recently in a 4-year-old girl who presented with severe vertebral destruction involving four cervical vertebrae and a large abscess with retropharyngeal expansion [5]. We also had a child with C1 and C2 destruction (mainly of the anterior component), where compression was caused mainly by the pus and soft tissue. The pus in this child, though, extended up to the C5 level anteriorly.

Classical spinal TB most commonly affects the lumbar junction, whereas neural arch TB is most common in the cervical and upper dorsal spine. An unusual case of multifocal extensive spinal tuberculosis has been reported in the literature, involving cervical, thoracic and lumbar vertebrae [6].

Edema of the spinal cord due to vascular stasis and toxins is responsible for early neurological deficits. Tubercular osteitis of vertebral bodies with an abscess in the extradural space causing compression of the cord from the anterior aspect is the commonest cause of neurological deficits. Sequestra from vascular portions of diseased vertebral bodies or intervertebral discs may be responsible for the narrowing of the canal and pressure on the cord. Angulation of the diseased spine may rarely lead to the formation of a bony ridge or spur called "internal gibbous" on the anterior wall of the spinal canal. Pathological dislocation may damage the neural structure. The



**Fig. 3** Magnetic resonance sagittal image showing dorsal enhancing intramedullary granuloma in the dorsal cord

**Fig. 4** Post-operative MRI of the same child (as in Fig. 3). No was granuloma seen. The cord is pushed dorsally

extradural thick layer of granulation tissue probably is not an important factor in the causation of paralysis; however, it may contract to cause peridural fibrosis, compressing the neural tissue. Unusually, the infarction of the cord due to endarteritis, periarteritis or thrombosis of an important branch of the spinal artery results in irreversible damage. Unrelieved compression of the spinal cord shows loss of neurons, gliosis, and demyelination in the cord substance of the damaged segment. Up to 50% reduction in the cord's diameter is often compatible with good cord function, while thinning with syrinx or myelomalacia leads to very poor cord function. Rarely, a small tuberculoma or diffuse extradural granuloma of the cord may be responsible for neurological deficits presenting as a spinal tumor syndrome [1]. Two of our 19 children with intramedullary granulomas presented with classical manifestations of intramedullary tumor-like syndrome (Figs. 3, 4). In one child, it was excised without much difficulty because of a good plane of cleavage, while the cord was severely swollen, dark, and edematous in another child, where excision became difficult and a duraplasty was required to accommodate the swollen cord following excision of the granuloma.

### Clinical features

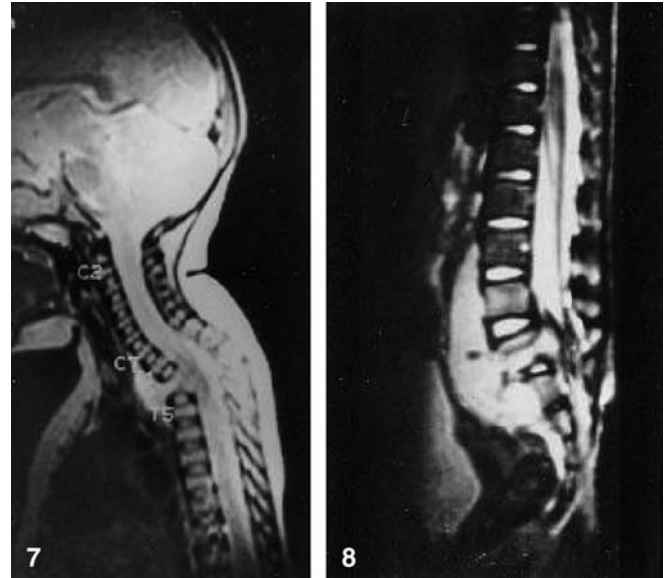
Spinal tuberculosis is most common during the first three decades. It occurs in the first decade of life in 50% of all cases and in only 25% did it appear after the age of 20. Western figures indicate that in affluent countries it is the disease of adults rather than children. Since we operated

on only children, ranging from 1.5–18 years of age (average age 8.6 years), it is difficult to predict the age predilection from our patient population. The usual clinical symptoms in the active stage are malaise, loss of weight, loss of appetite, night sweats, and a rise in temperature in the evening. The spine is stiff and painful on movement, with localized kyphotic deformity and spasm of the vertebral muscles. A cold abscess may be present clinically in 95% of cases; they develop varying degrees of kyphosis at presentation. Sometimes a case of vertebral tuberculosis may present as spinal tumor syndrome. Ankylosing spondylitis with concomitant pulmonary tuberculosis is not uncommon, especially in countries where tuberculosis is endemic. Abscess or sinuses from the cervical or dorsal regions can present themselves far away from the vertebral column along the facial planes or pus may take the course of neurovascular bundles to manifest in the paraspinal region in the back, in the posterior and anterior cervical triangles, along the brachial plexus in the axilla, and along the intercostal space on the chest wall. Abscesses from the dorsolumbar and lumbar spine follow the well-known pattern of tracking down the psoas sheath. These abscesses may be palpable in the iliac fossa, in the lumbar triangle, in the upper part of the thigh below the inguinal ligament or even track down to the knee. Psoas abscesses can give rise to a “hip flexion deformity”-like manifestation. They can manifest as a lump in the iliac fossa, and as a swelling or sinuses in regions far away from the lumbar spine. A large number of patients seek advice only when there is severe pain, marked deformity, or neurological complications. Constitutional symptoms were present only in 8 (42%) of our 19 children, while symptoms of active or inactive tuberculosis of other systems were demonstrated in only 5 (26%) children. In contrast to a high incidence of cold abscesses reported in all age groups, only 7 of our 19 children had frank pus, but one other child had purulent granulation tissue only. One girl with L5–S1 collapse presented to us with a gluteal abscess [7]. Nine children demonstrated granulation tissue responsible for compressing the cord, which was extradural in 7 and intradural in 1 (Figs. 5, 6). One other child manifested an intradural hard granuloma, causing cauda compression to present a tumor-like syndrome. Two children manifested an intramedullary tumor-like presentation. One of these had undergone shunt CSF diversion 4 months back, following the diagnosis of post-tubercular meningitic hydrocephalus. She developed Pott's spine despite having been on three drug regimens of antitubercular treatment. It is reported that a patient, despite receiving antitubercular chemotherapy for intracranial tuberculosis, developed a spinal intramedullary tuberculoma that required surgical decompression [8].

Any part of the spinal column may be affected, but it is most commonly found in the lower thoracic and thoracolumbar regions. About 7% have involvement of more



**Fig. 5** Sagittal MRI showing dense dorsal extradural granulation tissue in the cervicodorsal spine



**Fig. 7** Sagittal MRI showing destroyed D2, D3, and D4 vertebral bodies and posterior angulation of the spine. Note that pus is present anterior and posterior to the cord

**Fig. 8** Sagittal MRI showing destruction of L5 and S1 vertebral bodies with a big pocket of pus anterior to spine



**Fig. 6** Axial MRI showing intradural hyperintense granuloma attached to the dura causing severe cord compression

than one region of the spine, each region being separated by two or three normal vertebrae. However, cervical spine tuberculosis is more common in children. Contrary to the literature, 10 (53%) of our 19 children had disease in the dorsal region, and the upper and mid-dorsal spine was affected in 5 of these 10 (Fig. 7). The cervical spine was involved in 3 children and the lumbar region in 5. Only one child had lumbosacral disease (Fig. 8). Most of the

children showed involvement of two adjacent vertebral bodies. Three bodies were affected in only 4 children. No vertebral bodies were affected in 5 of the 19 children. These 5 children had mainly intradural lesions.

The neurological complication of spinal tuberculosis is reported in 3–43% of cases. Paraplegia most commonly results, due to cord compression and rarely due to compression of the cauda equina. Twenty four percent of patients with cervical spine tuberculosis have varying degrees of neurological deficit. The commonest pathology responsible for paraplegia in developing countries still remains tuberculosis. All the children we analyzed presented with varying degrees of neurological deficit, from moderate disabling weakness to total paralysis of the limb(s) involved, depending on the site of the disease. Tuberculous compressive myelopathy is reported in a 1-year-old boy and we also had a single child of 1.5 years of age presenting with paraparesis due to collapse of the D2, D3, and D4 vertebral bodies with an abscess. Paraplegia may be of early onset, occurring during the active phase of the disease, usually within the first 2 years of onset. The underlying pathologies in most these cases are inflammatory edema, tuberculous granulation tissue, or an abscess. Late onset paraplegia appears many years after the disease has persisted in the spine. The underlying pathologies in most of these cases are caseous tissue, debris, sequester from the vertebral body and disc, internal gibbous, stenosis of the vertebral canal, or severe deformity.

## Investigation

The presence of associated extraspinal tubercular foci depends on the amount of effort put into investigation. The pulmonary, glandular, or visceral lesions are detected in about 12–40% of patients. Our children were investigated mainly for primary pulmonary tuberculosis and only 5 of our 19 children had evidence of either active or healed pulmonary tuberculosis. In routine blood tests, relative lymphocytosis, low hemoglobin, and raised erythrocyte sedimentation rate (ESR) are found in the active stage of the disease. A raised ESR, though, is not proof of an active infection, it is only suggestive of infection. The Montoux test is positive in patients with tuberculous disease of some standing (1–3 months). A negative test in general rules out the disease. Rarely, the test may be negative in the active disease process.

- Microscopic examination of aspiration cytology, needle biopsy, or open biopsy may reveal tubercles in an untreated case
- Direct smear examination of pathological material in untreated cases may reveal the acid fast bacilli in the osseous cavities or destroyed areas in about 10% of cases. Cultures are likely to be positive in 30–60% of such material. Surprisingly, only 3 of our children demonstrated acid fast bacilli in their pus aspirate, from a cold abscess of the gluteal region in 1 and a paraspinal abscess in 2
- Isotope scintigraphy: technetium 99 scintigraphy is extremely sensitive and only misses a small percentage of infections. A scan may show increased uptake in osteoporotic fractures, infections, healing traumatic fractures, or malignancies, and is not therefore diagnostic
- Serological investigations: enzyme-linked immunosorbent assay (ELISA) for an antibody to the mycobacterial antigen demonstrated at a cut-off of 1:32, sensitivity of 94%, and specificity of 100% in the serologic diagnosis of bone and joint tuberculosis. Serological investigation is useful in the differential diagnosis of brucellosis, typhoid, and syphilitic infections

## Radiological investigations

### *X-rays*

The diagnosis can reliably be made on a clinical and radiological basis, particularly in developing countries where tuberculosis is prevalent. The average number of vertebrae involved in children was three. The paradiscal type is the commonest and manifests with narrowing of the disc space as the earliest radiological finding. The first tubercular destruction is not identified on radiology be-

fore the 3rd to 5th month of the infection. The majority of patients have a typical paradiscal lesion characterized by destruction of the adjacent end plates of the vertebral bodies and diminution of the intervening disc. Less than 2% of all spinal lesions may show intact disc space and these are mainly anterior and posterior types of lesions. Isolated involvement of vertebral arches and vertebral processes is observed in fewer than 2% of cases of spinal tuberculosis.

An abscess in the cervical region is usually present as a soft tissue shadow between the vertebral bodies and the pharynx/trachea. The abscess below the level of the D4 vertebra produces a fusiform shape or, if tense, becomes globular. One or both vertebral bodies are usually wedged with forward angulations to produce a kyphotic deformity, which becomes severe with the involvement of more adjacent bodies. The “tall vertebrae” can develop in children because the disease occurs during the growth period (before the disappearance of the growth zone). We did not see any tall vertebrae in our children.

The diseased vertebral body in the central type of infection loses the bony trabeculae and may show the areas of destruction or expansion or concentric collapse. In the anterior type, the infection starts beneath the anterior longitudinal ligament and periosteum; hence, the peripheral portion of the vertebral body shows erosion or shallow excavations on a lateral view. Isolated infection of pedicles, transverse processes, laminae and the spinous process is rare.

### *Myelography*

Myelography is helpful in determining the level of obstruction in patients with paraparesis who have no evidence of the disease. It has now been replaced by magnetic resonance imaging (MRI).

### *Computed tomography scan*

Computed tomography (CT) scan is a useful tool in assessing the destructive lesions of the vertebral column. It is of special help for posterior spinal disease, craniovertebral junction, sacroiliac joint, and for the sacrum, where early lesions are not apparent on X-rays.

### *Magnetic resonance imaging*

Magnetic resonance imaging is extremely useful in the diagnosis of difficult and rare sites like craniovertebral junction disease [9]. It is an excellent modality to judge the cord and soft tissues. It is sensitive to early tuberculous spondylitis, even in patients with normal radiology, because it detects marrow abnormalities before gross

bony destruction. Epidural tuberculous lesions appear to be isointense to spinal cord on T1-weighted images and of mixed intensity on T2-weighted images. The use of gadolinium is promising in detecting disease earlier, as it invariably results in bone enhancement and may assist in making the diagnosis when the rim-enhancing pattern of the soft tissue is demonstrated [10]. A non-caseating granuloma is usually hypointense relative to the brain or spinal cord on T1-weighted images and hyperintense on T2-weighted images. Enhancement is homogenous on contrast. A caseating granuloma with solid caseation appears relatively hypointense or isointense on T1-weighted images and isointense to hypointense on T2-weighted images. The degree of hypointensity depends on the complex relationship between the solid caseation, associated regional fibrosis/gliosis, and macrophage infiltration, and by products and processional cellular infiltrate. A characteristic sequence of image findings aids in the differentiation of cord infection from other intramedullary lesions [11].

The correlation of CT and MRI have made diagnosis of neural arch tuberculosis substantially easier, where plain radiographs and myelograms were found to be non-specific and non-diagnostic [12]. The major advantage of these studies may be the ability to show lytic lesions and adjacent abscess formation. In spinal TB, T1-weighted images show a decreased signal intensity of the involved vertebral bodies and intervening discs, and T2-weighted images show increased signal intensity. In tuberculosis of the posterior element of the spine, MRI is extremely useful in evaluating the extent of involvement and response to therapy of isolated tuberculosis of posterior elements [13].

## Treatment

In usual paradiscal lesions, the compression of the cord takes place anteriorly; therefore, adequate decompression of the cord by an anterior route or through an anterolateral approach is required. Early reconstruction or spinal stability plays an important role in the management of spinal tuberculosis. One-stage anterior interbody autografting and instrumentation in the surgical management of the exudative stage of spinal tuberculosis show more advantages in selected patients, but supplementary posterior fusion should be considered to prevent post-operative kyphosis when this procedure is performed in children [14]. Depending on the site of involvement and type of disease, the mode of surgical approach was decided individually for each of our cases. Laminectomy was performed in 6 cases, of these hemilaminectomies were done in 3, anterolateral decompression was done in 3, ultrasound/CT guided aspiration of pus was carried out in 2 children to relieve their intraspinal pressure, excision of intramedullary granuloma was achieved in 2 and intra-

dural granuloma/granulation in 2 other children. Evacuation of an intradural abscess was required in another child with cauda compromise. A corpectomy of the C3 and C4 vertebral bodies with grafting was required in another child with healed wedge compression, despite the fact that he had been on antitubercular chemotherapy for 10 months (Figs. 1, 2). The child required surgery because he developed myelopathy of recent onset. Another female child, who had undergone laminectomy 4 years back, developed severe radicular pain in the lower limbs and incapacitating low backache. The anterolateral decompression and freeing of nerve roots from collapsed, deformed, and angulated bodies was done. An ill-advised laminectomy for decompression may result in further deterioration in neurological status and kyphotic deformities. The role of costotransversectomy is extremely limited. It is good to drain fluid from an abscess, but inadequate for the removal of solid debris, thick caseous matter, granulation, etc. Development of a severe kyphotic deformity should be minimized by performing posterior spinal fusion, because kyphosis of more than 60% as a rule produces delayed neural complications within 10–15 years of the onset of disease and deformity. In cases of paraplegia with kyphosis of 60% or more, removal of the internal gibbous is mandatory. This may offer improvement in neural deficits, though not a complete recovery. Opinion varies regarding the role of surgery in tubercular paraplegia. A large group of surgeons perform debridement and decompression in all cases of Pott's spine, irrespective of the status of neurological involvement. It is important to note that 4 of our children had strength of grades 0–1 out of 5 in the lower limbs before surgery, which improved to grades 3–5 during follow-up, signifying the role of decompression even in cases of severe compromise of strength.

Others perform operative decompression only in those cases that do not respond to antitubercular chemotherapy. We operated on all our children discussed here, because they presented with moderate to severe neurological deficits. It has been observed that the potential for neural recovery is related to the degree of cord compression. Other authors treated the majority of their adult patients with neural deficits or even without neural deficits by anterior operation and bone grafting. They had significant post-operative mortality of 5.8%; hospital mortality was 2.1% for those without neurological deficits, 6.3% for those with paraparesis, and 10.9% for paraplegics [1]. Such a high mortality rate can be avoided by more restricted indications for surgery and less extensive surgery. It has been observed that the response to anterior decompression is better in patients who had evidence of active disease. We decided the approach according to the maximum site of compression in each case. An absolutely conservative approach to Pott's paraplegia is considered unjustifiable, as valuable time may be lost and irreparable damage of the cord may take place, if deterioration pro-

gresses to complete loss of motor and sensory functions. However, universal radical extirpation seems to be unnecessary.

In general authors who do not decompress every case limit decompression to the following situations:

1. Neurological complications that do not start showing signs of progressive recovery to a satisfactory level after a fair trial of conservative therapy for 3–4 weeks
2. Patients with spinal caries in whom neurological deficits develop during conservative treatment
3. Neurological complications become worse while undergoing antitubercular therapy and rest
4. Recurrence of neurological complications
5. Prevertebral cervical abscesses, neurological signs, and difficulty in deglutition and respiration
6. Advanced cases of neurological involvement such as marked sensory or sphincter disturbances, flaccid paralysis, or severe flexor spasms

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### Prognosis

Prognosis depends on many factors. It is better if there is partial cord compression, if the neural complications are of short duration, if there is early onset cord involvement and neural complications that developed slowly, if the

patient is young, and if his/her general condition is good. Prognosis is poor if cord involvement is complete, if there is longer duration of neural complications, late onset cord involvement, neural complications that developed rapidly, if the patient is older, and if his/her general condition is poor. Fifteen of our children (with a follow-up of 3 months to 3 years, average 14.47 months) made remarkable improvements in their neurological status. Four children did not make a satisfactory and expected recovery. A girl with an intramedullary granuloma improved to grade 5 from grade 1. A child with an intradural abscess and gummed up nerve roots of the cauda remained nearly the same (grade 3) at 6 months' follow-up. Another child with a dorsal destructive lesion and severe compression of the cord improved very minimally and remained dependant. One child with involvement of more than two vertebral bodies and severe compression improved his strength to grade 4 and was able to walk with support at 9 months' follow-up. The other child with an intramedullary granuloma and severe cord edema could also walk with support after 10 months, with persisting dysesthetic pain in the lower limbs.

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