A STUDY OF SURGICAL MANAGEMENT OF SPINAL TUBERCULOSIS

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ABSTRACT

BACKGROUND
Tuberculosis has been a major public health problem. As the 20th century began, tuberculosis was a leading cause of death in the Western countries. The development and the introduction of antituberculosis chemotherapeutic agents in the 1940s reduced the death rate. Of all the patients with tuberculosis, nearly 1-3% has involvement of the skeletal system.

MATERIALS AND METHODS
This study was conducted on patients operated for spinal tuberculosis between 2013 and 2016.
Inclusion Criteria- All patients operated for spinal tuberculosis from the cranio-vertebral (CV) junction to the lumbosacral spine. This includes all the types of surgeries performed including decompression procedures to relieve pressure on the spinal cord and all stabilisation procedures done to prevent spinal instability.
Exclusion Criteria- All patients who were treated conservatively.
Preoperative Assessment- The patients were assessed preoperatively with regard to the following- 1. Age and sex. 2. Neurological assessment using the MRC grading of motor power and Nurick’s grading of functional disability for CV junction, cervical and dorsal spine involvement. The ASIA Impairment scale was used for the lumbar spine. 3. Clinical assessment of bladder function. 4. Radiological assessment using x-rays, MRI and CT. 5. Other relevant investigations like CXR, Mantoux test and ESR.
Preoperative Evaluation- About the type of the disease and the extent from radiology including x-rays, CT and MRI, preoperative planning of the surgical approach depending on the extent and location of spinal cord pressure and the need for stabilisation based on peroperative findings.

DISCUSSION
1. CV junction tuberculosis- Two patients underwent surgery. Mean age was 57.5 years, mean duration of symptoms was 4.5 months and incidence was 3.03% (Table 1). The clinical presentation was neck pain in all patients. Other symptoms are radicular pain, quadriparesis and bladder symptoms. All patients had spasticity and paraspinal muscle spasm (Table 2 and 3). One patient had retropharyngeal abscess.
2. Cervical and cervicodorsal spine- Twenty patients underwent surgical treatment. Mean age was 43.2. There was female preponderance (55%) and the mean duration of symptoms was 7.62 months. Incidence was 33.33% (Table 1). Preoperative symptoms were neck pain 95%, radicular pain in 35%, upper limb weakness in 80%, lower limb weakness in 75%, sensory symptoms in 35%, bladder symptoms in 35%, spasticity in 90%, discharging sinus in 10% and paraspinal muscle spasm in 30% (Table 2 and 3). 10% had neck swelling. One patient had past history of pulmonary tuberculosis and one patient had history of contact with tuberculosis (Table 4).
3. Dorsal and dorsolumbar caries- 35 patients were operated upon. Mean age was 39.95 with a female preponderance of 54.28%. Mean duration of symptoms was 4.46 months (Table 1). The chief presenting complaints were back pain in all cases, radicular pain 42.85% and swelling in the back was seen in 4 patients. Upper limb power was normal in all patients. 77.14% had paraparesis and 20% had paraplegia, bladder function was affected in 54.28%. 28.57% had paraspinal muscle spasm. 34 patients had spasticity. Only 4 patients had sinus. Gibbus deformity was seen in 5 (14.28%) patients (Table 2 and 3). 11.4% had pulmonary tuberculosis and 2.85% had history of contact with tuberculosis. One patient had tuberculosis meningitis earlier (Table 4).

CONCLUSION
In all patients who underwent surgical decompression of the spinal cord, there was improvement in the neurological status as evidenced by the progressive improvement in Nurick’s grading, MRC grading for motor power and the ASIA Scoring System. In all stabilised patients, early mobilisation could be done.

KEYWORDS
Spinal Tuberculosis, Surgical Management.

HOW TO CITE THIS ARTICLE: Krishna LK, Hareesh K, Prasad JS. A study of surgical management of spinal tuberculosis. J. Evid. Based Med. Healthc. 2017; 4(48), 2940-2953. DOI: 10.18410/jebmh/2017/583
BACKGROUND
Tuberculosis has been a major public health problem. As the 20th century began, tuberculosis was a leading cause of death in the Western countries. The development and the introduction of antituberculosis chemotherapeutic agents in the 1940's reduced the death rate. Of all the patients with tuberculosis, nearly 1-3% has involvement of the skeletal system.1 Vertebra tuberculosis is the most common form of skeletal tuberculosis. Most series reporting an incidence of up to 50%.2,3 Tuberculosis (TB) of the spine (Pott's disease) is both the most common and most dangerous form of TB infection.

MATERIALS AND METHODS
This study was conducted on patients operated for spinal tuberculosis between 2013 and 2016.

Inclusion Criteria
All patients operated for spinal tuberculosis from the CV junction to the lumbosacral spine. This includes all the types of surgeries performed including decompression procedures to relieve pressure on the spinal cord and all stabilisation procedures done to prevent spinal instability.

Exclusion Criteria
All patients who were treated conservatively.

Preoperative Assessment
The patients were assessed preoperatively with regard to the following-
1. Age and sex.
2. Neurological assessment using the MRC grading of motor power and Nurick’s grading of functional disability for CV junction, cervical and dorsal spine involvement. The ASIA impairment scale was used for the lumbar spine.
4. Radiological assessment using x-rays, MRI and CT.
5. Other relevant investigations like CXR, Mantoux test and ESR.

Preoperative Evaluation
About the type of the disease and the extent from radiology including x-rays, CT and MRI, preoperative planning of the surgical approach depending on the extent and location of spinal cord pressure and the need for stabilisation based on peroperative findings.

RESULTS
In the present study, patients have been categorised into four groups as given below since the clinical picture and treatment strategy varies in each group.
1. Tuberculosis of the CV Junction.
2. Subaxial cervical spine and cervicodorsal spine.
3. Dorsal and dorsolumbar spine.
4. Lumbosacral spine.

CV Junction Tuberculosis
Two patients underwent surgery. Mean age was 57.5 years, mean duration of symptoms was 4.5 months. Incidence was 3.03% (Table 1). The clinical presentation was neck pain in all patients, other symptoms are radicular pain, quadriplegia and bladder symptoms. All patients had spasticity and paraspinous muscle spasm (Table 2 and 3). One patient had retropharyngeal abscess.

Preop Workup
All patients underwent neurological assessment using Nurick’s and MRC grading system (Table 10, 11). Bladder function was assessed clinically. Blood investigations including haemogram, blood biochemistry, ESR, Mantoux test and chest x-ray was done for all patients. Chest x-ray showed no evidence of old PT in any patient, mean ESR was 60% (Table 5).

Imaging Studies (Table 6 and 7)
All patients underwent plain radiography of the CV Junction with dynamic studies and open mouth view. All patients underwent CT scan and MRI was done in all patients. 50% had instability of the CV junction and lytic changes of the vertebral body were seen in all patients (Table 6). The disease was paradiscal in 50% and anterior in 50% (Table 8). The causes of cord compression was epidural abscess and granulation tissue (Table 7).

Surgical Treatment (Table 15)
Two patients underwent anterior approach and decompression of the cord with stabilisation in 50% of cases and without any stabilisation procedure in 50% of cases. Postoperatively, they were continued on rifampicin INH and PZA for nine months followed by INH and PZA for the subsequent nine months. One patient had instability associated with cord compression. One patient underwent anterior decompression by transoral approach and posterior...
fusione y stabilización mediante injerto de cresta iliaca y tornillos y barras de contorno. Un paciente presentó una lesión lytic del dens sin cambios significativos en el aparato vertebral y por tanto se realizó biopsia para la confirmación de la tuberculosis. El dolor cervicomedular se redujo gradualmente al tercer mes y finalmente se recuperó.

**Postoperative Complications**

Uno de los pacientes que había sufrido una operación posterior presentó una fuga lumbar en el período postoperatorio después de la intervención quirúrgica. No hubo deterioro neurológico en el periodo postoperatorio. El paciente fue tratado conservativamente con analgesia y antibioterapia y mejoró.

**Results and Follow-up**

Todos los pacientes presentaron alivio de dolor cervical y radicular. La fuerza motora en los miembros superiores se incrementó de 3.2 a 3.6 en el período preoperatorio y de 3.6 a 3.8 en el período postoperatorio. El dolor radicular y cervical mejoró gradualmente al tercer mes y finalmente se recuperó.

**Cervical and Cervicodorsal Spine**

Veinte pacientes recibieron tratamiento quirúrgico. La edad media fue de 43.2 años. La incidencia de la enfermedad tuberculosa fue de 33.33% (Tabla 1). Los síntomas preoperatorios fueron dolor cervical en 95%, dolor radicular en 35%, debilidad muscular en 80%, dolor lumbar en 75%, síntomas sensomotorios en 35%, infección de la vértebra en 10% y espasmo muscular en 50% (Tabla 2 y 3). Todos los pacientes fueron intubados y se les dio apoyo ventilatorio. No hubo complicaciones importantes.

**Preop Workup**

Todos los pacientes presentaron evaluación neurológica con el sistema de gradación Nurick (Tabla 10, 11). La función vesical fue examinada clínicamente. Las investigaciones en sangre, bioquímicas y ESR mostraron cambios significativos en el período postoperatorio.

**Imaging Studies**

Todos los pacientes fueron sometidos a radiografía cervical y tomografía computarizada de la columna vertebral. Se diagnosticó tuberculosis en 30% de los pacientes. Se realizaron estudios de ADT, rifampicina, INH y PZA durante 9 meses. En los pacientes estabilizados se realizó fusión y estabilización con injerto de cresta iliaca y placa y tornillos. Se realizó biopsia en 20% de los pacientes.

**Postoperative Complications**

No hubo complicaciones graves en el periodo postoperatorio. Un paciente que había sido intervenido posteriormente presentó una fuga lumbar en el periodo postoperatorio después de la intervención quirúrgica. No hubo deterioro neurológico en el periodo postoperatorio. El paciente fue tratado conservativamente con analgesia y antibioterapia y mejoró.

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**Preop Workup**

Todos los pacientes presentaron evaluación neurológica con el sistema de gradación Nurick (Tabla 10, 11). La función vesical fue examinada clínicamente. Las investigaciones en sangre, bioquímicas y ESR mostraron cambios significativos en el período postoperatorio.
improvement over 18 months, the upper limb mean score improved to 5 and that of the lower limbs improved to 4.87 (Table 10). The mean Nurick’s score improved from 2 to 1.50 in the immediate postoperative period and gradually improved to 0.50 at 18 months (Table 11). Bladder function was affected in seven patients and four patients had improved in the immediate postoperative period. During review, all patients had normal bladder functions (Table 13). During review, all patients of the stabilised group had normal alignment of the implant and evidence of bony fusion. No patient of the non-stabilised group had evidence of instability during review and all patients showed evidence of healing on x-rays.

**Dorsal and Dorsolumbar Caries**

35 patients were operated upon. Mean age was 39.95 with a female preponderance of 54.28%. Mean duration of symptoms was 4.46 months (Table 1). The chief presenting complaints were back pain in all cases, radicular pain 42.85% and swelling in the back was seen in 4 patients. Upper limb power was normal in all patients. 77.14% had paraparesis and 20% had paraplegia. Bladder function was affected in 54.28%. 28.57% had paraspinal muscle spasm, 34 patients had spasticity. Only 4 patients had sinus. Gibbus deformity was seen in 5 (14.28%) patients (Table 2 and 3). 11.4% had pulmonary tuberculosis and 2.85% had history of contact with tuberculosis. One patient had tuberculous meningitis earlier (Table 4).

**Preoperative Workup**

All patients underwent neurological assessment using the Nurick’s grading system (Table 11) and the MRC grading system (Table 10). Bladder function was assessed clinically. Blood investigations including haemogram, blood biochemistry, ESR, Mantoux test and chest x-ray was done for all patients. Chest x-ray showed evidence of a pulmonary focus in 2 patients and the mean ESR was 54.28% (Table 5).

**Imaging Studies**

All patients had x-rays. CT scan was done in 4 patients and MRI in 35 patients. There was instability in 22.85%, kyphotic deformity in 31.42% and lytic changes of the vertebral body were seen in 94.28% (Table 6). Paraspinal soft tissue shadow was seen in 14.28%, paraspinal abscess in 31.42% and signal changes in the cord in 14.28%. The causes of cord compression were epidural abscess in 40%, granulation tissue in 80% and bony sequestra in 8.57% (Table 7). Based on radiology, the disease was classified as paradiscal in 62.85%, central type in 2.85% and anterior type in 31.42%, appendicular in 2.85% (Table 8). There was contiguous levels in 94.2%, two level disease in 82.5%, which was the maximum frequency (Table 9).

**Surgical Treatment**

Patients underwent different surgical procedures depending on the type of disease radiologically and based on the clinical findings; anterior decompression with stabilisation was done in 10 patients, 4 patients underwent anterior decompression without stabilisation, posterior decompression with posterior stabilisation was done in 18 patients and posterior decompression without stabilisation was done in 3 patients, (Table 15).

The surgical approaches used anteriorly were-

1. Transclavicular approach for upper dorsal lesions.
2. Transthoracic approach.
3. Thoracolumbar approach.

The posterior approaches used were-

1. Midline posterior approach laminectomy.
2. Costotransversectomy.

The implants that were used for stabilisation were-

1. Titanium plate or pedicle screws in 14 patients.
2. Hartshill rectangle in 4 patients.

The grafts used were rib graft (6 patients) in thoracotomies and thoracolumbar surgery and iliac crest (2 patients) for posterior fusion.

Motor power was assessed using the MRC grading system. All patients had normal power in the upper limbs. Mean MRC grade of both LL was 2.59 preoperatively, which improved to 3.86 postop and gradually improved to 4.86 over 18 months (Table 10). Mean Nurick’s grade preop was 3.35 with moderate spasticity, which improved to 2.40 and over 18 months gradually improved to 01.13 (Table 11). 54.28% had bladder involvement preoperatively, but the majority improved after surgery. Only one continued to have bladder dysfunction at 3 months (Table 13).

Radiological review showed that there was healing in all patients, no instability in the group, which was treated only by decompression without stabilisation and there was no implant failure over 18 months.

**Complications**

**Morbidity**

One patient worsened in paraparesis immediately after thoracotomy and stabilisation. There was no implant failure. The cause of worsening was vascular affection and he gradually improved to Gr3 power.

**Late Complication**

One patient who underwent costotransversectomy and decompression had to be stabilised later due to instability. The same patient had improved to normal power.

**Reactivation of Spinal Tuberculosis**

A young 20 years female who underwent costotransversectomy and stabilisation after completion of ATT got re-admitted with posterior epidural abscess, which was let out through laminectomy and she improved in paraparesis.
Lumbar and Lumbosacral TB
9 patients were operated upon. Mean age was 34.68. There was female preponderance (55.5%) and the mean duration of symptoms was 9 months (Table 1). The presenting symptoms were back pain in all cases, radicular pain in 77.7%, swelling in 11.1%, lower limb weakness in 55.55%, sensory symptoms in 66.66%, bladder involvement in 22.2% and paraspinal muscle spasm in 33.3% (Table 2 and 3). No patient had associated PT or contact.

Preop Workup
All patients underwent neurological assessment using the MRC grading system (Table 10) and the ASIA scoring system. Bladder function was assessed clinically. Blood investigations including haemogram, blood biochemistry, ESR, Mantoux test and chest x-ray was done for all patients. Chest x-ray showed no evidence of old PT, mean ESR was 58.54% (Table 5). Motor power was graded by MRC grading system and all patients were assessed by the ASIA scoring system (Table 19).

Imaging
All patients had MRI and plain radiography. Instability was seen 2 (22.2%) patients and kyphotic deformity in 1 (11.1%) patients. Lytic changes in the vertebral body were seen in 77.7% (Table 6), paraspinal soft tissue shadow was seen in 11.1% and paraspinal abscess in 33.3%. Thecal sac compression due to epidural abscess was seen in 55.5%, granulation tissue in 44.4% and 11.1% had bony sequestra causing compression of the neural elements (Table 7). Based on the radiology, the type of disease was classified as paradiscal in 6 patients, central in 2 patients and appendicular in 1 patient (Table 8). The vertebral levels commonest was 2 levels in 6 patients followed by single level (Table 9).

Surgical Treatment
7 patients underwent posterior decompression with posterior stabilisation, 2 patients underwent posterior decompression without stabilisation. The surgical approaches used were posterior midline approach for decompression and stabilisation. Iliac crest graft was used for fusion in 6 patients and G bone in 1 patient. Implants used were titanium pedicle screws in 5 patients and Hartshill rectangle in 2 patients.

Postop Complication
There was no deterioration in the neurological status and there was no implant failure.
All patients were continued on 18 months ATT as in other groups.

Results and Followup
All patients improved in motor power as evidenced by the MRC grade, which showed progressive improvement from 4.15 at preop to 4.52 postop and gradual improvement to 5 at 18 months (Table 10). ASIA scores also show improvement from preop to 18 months (Table 12). 2 patients had bladder involvement preoperatively and all improved postoperatively. Radiological review showed no implant failure and there was radiological evidence of fusion in all stabilised patients and healing in all the decompressed patients throughout the follow up period.

<table>
<thead>
<tr>
<th>Location</th>
<th>N</th>
<th>Mean Age in Years</th>
<th>Gender</th>
<th>Mean Duration of Symptoms in Months</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Females (%)</td>
<td>Males (%)</td>
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<td>57.5</td>
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<td>1 (50)</td>
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<td>9 (45)</td>
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<td>Dorsal and dorsolumbar</td>
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<td>39.9</td>
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<td>16 (45.72)</td>
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<th>Location</th>
<th>Pain</th>
<th>Radicular Pain</th>
<th>Swelling</th>
<th>Upper Limb Weakness</th>
<th>Lower Limb Weakness</th>
<th>Sensory Symptoms</th>
<th>Bladder Symptoms Present</th>
<th>Lower Cranial Nerve Symptoms</th>
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<td>2 (100)</td>
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<td>1 (50)</td>
<td>0 (0)</td>
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<td>7 (35)</td>
<td>2 (10)</td>
<td>16 (80)</td>
<td>15 (75)</td>
<td>7 (35)</td>
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<td>34 (97.14)</td>
<td>34 (97.14)</td>
<td>19 (54.28)</td>
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<td>1 (11.1)</td>
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<td>5 (55.5)</td>
<td>6 (66.6)</td>
<td>2 (22.2)</td>
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Table 1. Symptoms Preoperative

Table 2. Signs Preoperative
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<tr>
<th>Location</th>
<th>History of PT (%)</th>
<th>History of Contact with PT (%)</th>
<th>History of TB Meningitis Prior to Spinal Disease (%)</th>
<th>History of TBM, Tuberculoma following Spinal Caries (%)</th>
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<td>Cervical and cervicodorsal</td>
<td>20</td>
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<td>1 (5)</td>
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<td>Dorsal and dorsolumbar</td>
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<td>4 (11.4)</td>
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### Table 4. Other Basic Investigations Relevant to Tuberculosis

<table>
<thead>
<tr>
<th>Location</th>
<th>ESR-Mean</th>
<th>Mantoux Test+ (%)</th>
<th>Chest X-Ray Showing Features of PT (%)</th>
<th>HIV By ELISA + (%)</th>
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<td>54.28</td>
<td>0</td>
<td>2 (5.71)</td>
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<td>Lumbar and lumbosacral</td>
<td>9</td>
<td>58.54</td>
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### Table 5. Imaging

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<th>Location</th>
<th>Plain Radiography (%)</th>
<th>CT Scan (%)</th>
<th>MRI scan (%)</th>
<th>Myelogram (%)</th>
<th>Instability By Imaging (%)</th>
<th>Kyphotic Deformity (%)</th>
<th>Lytic Changes in Bone (%)</th>
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<td>2 (100)</td>
<td>2 (100)</td>
<td>0</td>
<td>1 (50)</td>
<td>0</td>
<td>2 (100)</td>
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<tr>
<td>Cervical and cervicodorsal</td>
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<td>20 (100)</td>
<td>1 (5)</td>
<td>20 (100)</td>
<td>0</td>
<td>6 (30)</td>
<td>2 (10)</td>
</tr>
<tr>
<td>Dorsal and dorsolumbar</td>
<td>35</td>
<td>35 (100)</td>
<td>4 (11.4)</td>
<td>35 (100)</td>
<td>0</td>
<td>8 (22.85)</td>
<td>11 (31.42)</td>
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<td>9 (100)</td>
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<td>9 (100)</td>
<td>0</td>
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<td>1 (11.1)</td>
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### Table 6. Imaging Studies CT/MRI

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<tr>
<th>Location</th>
<th>Paraspinal Soft Tissue (%)</th>
<th>Paraspinal Abscess (%)</th>
<th>Signal Changes in the Cord (%)</th>
<th>Cord/Thecal Sac Compression By Epidural Abscess (%)</th>
<th>Cord/Thecal Sac Compression by Granulation Tissue (%)</th>
<th>Cord/Thecal Sac Compression by Bony Sequestra (%)</th>
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<td>4 (20)</td>
<td>4 (20)</td>
<td>0</td>
<td>7 (35)</td>
<td>12 (60)</td>
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<tr>
<td>Dorsal and dorsolumbar</td>
<td>35</td>
<td>5 (14.28)</td>
<td>11 (31.42)</td>
<td>5 (14.2)</td>
<td>14 (40)</td>
<td>28 (80)</td>
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<tr>
<td>Lumbar and lumbosacral</td>
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<td>1 (11.1)</td>
<td>3 (33.3)</td>
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<td>5 (55.5)</td>
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### Table 7. Type of Disease Based on Radiology

<table>
<thead>
<tr>
<th>Location</th>
<th>Paradiscal (%)</th>
<th>Appendicular (%)</th>
<th>Central (%)</th>
<th>Anterior (%)</th>
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<tr>
<td>CV junction</td>
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<tr>
<td>Cervical and cervicodorsal</td>
<td>20</td>
<td>17 (85)</td>
<td>1 (5)</td>
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<tr>
<td>Dorsal and dorsolumbar</td>
<td>35</td>
<td>22 (62.85)</td>
<td>1 (2.85)</td>
<td>1 (2.85)</td>
<td>11 (31.42)</td>
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<tr>
<td>Lumbar and lumbosacral</td>
<td>9</td>
<td>6 (66.6)</td>
<td>1 (11.1)</td>
<td>2 (22.2)</td>
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</tbody>
</table>

### Table 8. Radiology, Number of Vertebral Levels, Contiguous, Skip Levels
<table>
<thead>
<tr>
<th>Location</th>
<th>N</th>
<th>Contiguous Fr (%)</th>
<th>Skip Levels Fr (%)</th>
<th>0-Atypical Fr (%)</th>
<th>1-Single Fr (%)</th>
<th>2-Two Fr (%)</th>
<th>3-Three Fr (%)</th>
<th>4-Four Fr (%)</th>
<th>5-Five Fr (%)</th>
<th>6-Six Fr (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV junction</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1 (50%)</td>
<td>1 (50%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cervical and cervicodorsal</td>
<td>20</td>
<td>19 (95)</td>
<td>1 (5)</td>
<td>0</td>
<td>2 (10)</td>
<td>17 (85)</td>
<td>1 (5)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dorsal and dorsolumbar</td>
<td>35</td>
<td>33 (94.2)</td>
<td>2 (5.7)</td>
<td>0</td>
<td>4 (11.42)</td>
<td>29 (82.5)</td>
<td>2 (5.71)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lumbar and lumbosacral</td>
<td>9</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>3 (33.3)</td>
<td>6 (66.6)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Table 9. Motor Power in Various Groups, MRC Grading, 0-5**

<table>
<thead>
<tr>
<th>Location</th>
<th>N</th>
<th>Preop Mean MRC Grade</th>
<th>Postop Mean MRC Grade</th>
<th>3 Months Mean MRC Grade</th>
<th>9 Months Mean MRC Grade</th>
<th>18 Months Mean MRC Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV junction</td>
<td>2</td>
<td>3</td>
<td>3.5</td>
<td>4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Cervical and cervicodorsal</td>
<td>20</td>
<td>2</td>
<td>2.5</td>
<td>4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Dorsal and dorsolumbar</td>
<td>35</td>
<td>3.35</td>
<td>2.40</td>
<td>2</td>
<td>1.5</td>
<td>1</td>
</tr>
<tr>
<td>Lumbar and lumbosacral</td>
<td>9</td>
<td>3.35</td>
<td>2.5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

**Table 10. Nurick’s Grading in Various Groups**

<table>
<thead>
<tr>
<th>Location</th>
<th>N</th>
<th>Preop Mean Nurick’s Grade</th>
<th>Postop Mean Nurick’s Grade</th>
<th>3 Months Mean Nurick’s Grade</th>
<th>9 Months Mean Nurick’s Grade</th>
<th>18 Months Mean Nurick’s Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV junction</td>
<td>2</td>
<td>3</td>
<td>2.5</td>
<td>2</td>
<td>1.5</td>
<td>1</td>
</tr>
<tr>
<td>Cervical and cervicodorsal</td>
<td>20</td>
<td>2</td>
<td>1.50</td>
<td>1.10</td>
<td>1</td>
<td>.50</td>
</tr>
<tr>
<td>Dorsal and dorsolumbar</td>
<td>35</td>
<td>3.35</td>
<td>2.40</td>
<td>1.84</td>
<td>1.44</td>
<td>1.13</td>
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</table>

**Table 11. ASIA Scoring System for Lumbar and Lumbosacral Tuberculosis Scores A, B, C, D, E**

<table>
<thead>
<tr>
<th>N19</th>
<th>Preop Fr (%)</th>
<th>Postop Fr (%)</th>
<th>3 Months Fr (%)</th>
<th>9 Months Fr (%)</th>
<th>18 Months Fr (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D</td>
<td>7 (77.7)</td>
<td>5 (55.5)</td>
<td>3 (33.3)</td>
<td>1 (11.1)</td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>2 (22.2)</td>
<td>4 (44.4)</td>
<td>6 (66.6)</td>
<td>8 (88.8)</td>
<td>9 (100)</td>
</tr>
</tbody>
</table>

**Table 12. Assessment of Bladder Function**

<table>
<thead>
<tr>
<th>Location</th>
<th>N</th>
<th>Preop Number of Patients with Bladder Involvement (%)</th>
<th>Postop Number of Patients with Bladder Involvement (%)</th>
<th>3 Months Number of Patients with Bladder Involvement (%)</th>
<th>9 months Number of Patients with Bladder Involvement (%)</th>
<th>18 months Number of Patients with Bladder Involvement (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV junction</td>
<td>2</td>
<td>1 (50)</td>
<td>1 (50)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Cervical and cervicodorsal</td>
<td>20</td>
<td>7 (35)</td>
<td>3 (15)</td>
<td>1 (5)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Dorsal and dorsolumbar</td>
<td>35</td>
<td>19 (54.28)</td>
<td>10 (28.57)</td>
<td>1 (2.85)</td>
<td>1 (2.85)</td>
<td>1 (2.85)</td>
</tr>
<tr>
<td>Lumbar and lumbosacral</td>
<td>9</td>
<td>2 (22.2)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
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</table>

**Table 13. Radiological Review Postop 3 Months, 9 Months, 18 Months**

<table>
<thead>
<tr>
<th>Location</th>
<th>N</th>
<th>Not Stabilised X-Ray Healing (%)</th>
<th>Stabilised Implant in Position Graft Fusion (%)</th>
<th>Implant Failure (%)</th>
<th>Not Stabilised X-Ray Healing (%)</th>
<th>Stabilised Implant in Position Graft Fusion+ (%)</th>
<th>Implant Failure (%)</th>
<th>Not Stabilised X-Ray Healing (%)</th>
<th>Stabilised Implant in Position Graft Fusion+ (%)</th>
<th>Implant Failure (%)</th>
<th>Not Stabilised X-Ray Healing (%)</th>
<th>Stabilised Implant in Position Graft Fusion+ (%)</th>
<th>Implant Failure (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV junction</td>
<td>2</td>
<td>1 (50)</td>
<td>1 (50)</td>
<td>0 (50)</td>
<td>1 (50)</td>
<td>1 (50)</td>
<td>0 (50)</td>
<td>1 (50)</td>
<td>1 (50)</td>
<td>0 (50)</td>
<td>1 (50)</td>
<td>1 (50)</td>
<td>0 (50)</td>
</tr>
<tr>
<td>Cervical and cervicodorsal</td>
<td>20</td>
<td>3 (15)</td>
<td>17 (85)</td>
<td>0</td>
<td>3 (15)</td>
<td>17 (85)</td>
<td>0</td>
<td>3 (15)</td>
<td>17 (85)</td>
<td>0</td>
<td>3 (15)</td>
<td>17 (85)</td>
<td>0</td>
</tr>
<tr>
<td>Dorsal and dorsolumbar</td>
<td>35</td>
<td>7 (20)</td>
<td>28 (80)</td>
<td>0</td>
<td>7 (20)</td>
<td>28 (80)</td>
<td>0</td>
<td>7 (20)</td>
<td>28 (80)</td>
<td>0</td>
<td>7 (20)</td>
<td>28 (80)</td>
<td>0</td>
</tr>
</tbody>
</table>
DISCUSSION

Clinical Features

Eighty patients had systemic symptoms such as malaise, pyrexia, loss of appetite and weight and night sweats. Back pain is reported as the predominant clinical feature by many authors.\(^1,3\) In our study group, 98.46% had back pain. Painful paraspinal muscle spasm is reported as a characteristic symptom by many observers. In our study group, 29.9% patients had paraspinal muscle spasm. A soft tissue mass and in late cases a draining sinus maybe the presentation. In our study group, 9.2% patients presented with a sinus. Tuli reported 20% incidence of palpable cold abscess.\(^1,2\) Janssens and de Haller\(^1,4\) had an incidence of 57%. Our study group had an incidence of 12.3%. Angulation of the spine in the form of kyphosis or Gibbus was seen in 95% of the cases reported by Tuli, but in our study group, the incidence of clinical Gibbus was seen only in 7.57%. The other clinical presentations in our study group were upper and lower limb weakness, sensory symptoms and symptoms of bladder involvement.

Neurological Complications in Spinal Tuberculosis

The incidence of neurological involvement in tuberculosis of the spine is reported to be between 10 to 46%\(^5,6\) and is seen mostly in patients with dorsal spine affection.\(^2,5,6\) Neurological involvement can occur at any stage of Pott’s spine and even years later when there had been apparent healing due to stretching of the cord in the deformed spinal canal.\(^7\) In our study group, the majority of patients presented with neurological deficits; maximum in the dorsal group followed by the cervical and lumbar groups (Table 3). Signal changes in the cord were seen in 14.28% of the dorsal group and not in any other group.

In our study group, cord compression was due to epidural abscess, epidural granulation tissue and due to bony sequestra. In the CV junction and the lumbar groups, the majority of patients had cord compression due to

Lumbar and lumbosacral 9 2 (22.2) 7 (77.7) 0

Table 14. Type of Surgical Treatment with Different Combinations

<table>
<thead>
<tr>
<th>Location</th>
<th>N</th>
<th>Anterior Decompression and Anterior Stabilisation Fr (%)</th>
<th>Anterior Decompression without Stabilisation Fr (%)</th>
<th>Anterior Decompression /Biopsy and Posterior Stabilisation Fr (%)</th>
<th>Posterior Decompression with Posterior Stabilisation Fr (%)</th>
<th>Posterior Decompression without Stabilisation Fr (%)</th>
<th>Posterior Decompression and Anterior Stabilisation Fr (%)</th>
<th>Anterolateral Decom. Poster Dcomp</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV Junction</td>
<td>2</td>
<td>0</td>
<td>1 (50)</td>
<td>1 (50)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cervical and cervicodorsal</td>
<td>20</td>
<td>17 (85)</td>
<td>2 (10)</td>
<td>0</td>
<td>0</td>
<td>1(5)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dorsal and dorsolumbar</td>
<td>35</td>
<td>10 (28.57)</td>
<td>4 (11.42)</td>
<td>0</td>
<td>18 (51.42)</td>
<td>3 (8.57)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lumbar and lumbosacral</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7 (77.7)</td>
<td>2 (22.2)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 15. Comparison of Nurick’s Grade Difference between 18 Months and Preop for Groups A and B (A - 0, 1, 2, 3) is Less Severe Deficits and B (4,5) is Severe Deficits

<table>
<thead>
<tr>
<th>Location</th>
<th>N</th>
<th>Difference Between Nurick’s Means Between 18 Months and Preop</th>
<th>T Test</th>
<th>SD</th>
<th>T</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cervical and cervicodorsal</td>
<td>20</td>
<td>-1.31</td>
<td>T</td>
<td>1.17</td>
<td>2.731</td>
<td>0.011</td>
</tr>
<tr>
<td>Dorsal and dorsolumbar</td>
<td>35</td>
<td>-2.5</td>
<td>T</td>
<td>0.53</td>
<td>5.82</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Table 16. The P Values in Both Group Statistically Significant Comparison of MRC Grading (Motor) Difference between 18 Months and Preop for Stabilised and Non-Stabilised Groups

<table>
<thead>
<tr>
<th>Location</th>
<th>N</th>
<th>Difference Between MRC Grade Means between 18 Months and Preop</th>
<th>T Test</th>
<th>SD</th>
<th>t</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Limbs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.039</td>
<td>0.969</td>
</tr>
<tr>
<td>Non-stabilised</td>
<td>1.5750</td>
<td>1.6312</td>
<td>T</td>
<td>0.019</td>
<td>0.985</td>
<td></td>
</tr>
<tr>
<td>Stabilised</td>
<td>1.5867</td>
<td>1.4895</td>
<td>T</td>
<td>0.969</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 17.
epidural abscess followed by granulation tissue or a combination of the two and few patients had compression by bony sequestra. In the cervical and dorsal groups, the majority had cord compression due to epidural granulation tissue followed by abscess and a combination of two. In all the group, compression due to bony sequestra was seen in only a few patients (Table 7). Neurological deficits in almost all the patients was due to cord compression. Signal changes in the cord were seen only in 5 patients in the dorsal group, which comprises 7.57% of the total number of patients (Table 7).

Other than compression, the cause of paraplegia in spinal tuberculosis could be thrombosis of a radicular artery. The artery maybe compressed in an intervertebral foramen or it may be the seat of tuberculous endarteritis. This can account for an occasional case of severe paraplegia of rapid onset. In one of our patients with dorsal spine affection, there was postoperative deterioration of motor power due to vascular cause, which improved later with conservative treatment.

Hodgson et al demonstrated that on rare occasions, the tuberculous process may involve the dura, pia arachnoid and even the spinal cord. Frank meningitis is extremely uncommon. In our study group, one of our patients who presented with spinal tuberculosis was already on treatment for tuberculous meningitis.

Prolonged angulation of the cord over a sharp kyphosis results in thinning of the cord at that level (Figure).

**Imaging Studies**

Plain radiography remains the cornerstone of diagnosis. Spinal tuberculosis is most difficult to recognise radiologically in the earlier stages. Over 50% of trabecular bone is lost before a lesion is conspicuous on a plain film and this process may take 6 months. Tuli et al reported that 30-40% calcium should be lost before a radiolucent area is visible on a plain x-ray. From plain radiography, one is able to study the number of vertebrae involved, skip lesions, type of lesion, paravertebral shadows and kyphoscoliosis. Wedge collapse can cause forward angulation of the spine and when involving a number of adjacent vertebrae, kyphotic deformity results. In our study, we were able to study the number of vertebrae involved, skip lesions, type of lesions, paravertebral shadows, kyphosis and instability (Table 6). The commonest abnormality was lytic changes in the vertebral bodies.

**CT Scan**

Many authors consider CT as the investigation of choice for spinal tuberculosis, since it gives a true picture of vertebral body destruction, intraspinal extension, paravertebral soft tissue mass and extension of involvement into neural arches, etc. In our study group, CT was not done in all patients. CT was used to provide added information as to bilateral pedicular involvement to assess preoperative instability and similarly to rule out laminar involvement so as to plan surgical strategy in appendicular lesions. It was not done for all patients since the majority of patients had MRI, which gives adequate information about cord compression. In situations with bilateral pedicle involvement, axial CT is the best imaging modality, and if present, the spine being unstable, posterior stabilisation is necessary after anterior decompression.

**MRI Scan**

MR imaging has higher sensitivity for early infiltrative disease including endplate changes and marrow infiltration. These images allow excellent definition of epidural, paravertebral and intraosseous abscess and the extent of cord compromise. We found from our study group that the above observations were correct. Other advantages of MRI include high resolution, direct multiplanar imaging, detection of marrow infiltration and early detection of intradural infection. Involvement of paraspinal soft tissue is best seen in coronal sections. MR is also helpful in revealing associated lesions like intraosseous abscess, paraspinal cold abscess, vertebral body and disc collapse, spinal deformity, skip lesions, epidural and intraspinal extensions, involvement and compression of the cord and nerve roots, and appendicular lesions. In our study group, we could analyse similar observations of paraspinal abscess, paraspinal soft tissue and we could analyse the causes of cord compression as due to pressure from abscess, granulation tissue and bony sequestra (Table 7). Tuli et al had reported the incidence of appendicular lesions as less than 5% from plain x-rays, but after using CT or MR imaging, the incidence of posterior element involvement increases to 30% (Jain 1996).

**Laboratory Studies**

Relative lymphocytosis, low Hb and raised ESR are often found in an active stage of the disease. Raised ESR is a nonspecific indicator of inflammation. In our study group, the mean ESR was 63.5 for all the patient groups. Cultures of AFB and direct smear of pathologic material in case of disease of short duration who are presently not on ATT may reveal AFB in about (30-60)%. In the present study group, we had 3.4% patients with positive AFB smear, many of our patients had been already started on ATT by the referring physician, but all patients had histopathology suggestive of tuberculosis aetiology. Absolute diagnosis is made with direct biopsy and cultures of the spinal lesion. In our study group, all patients had histopathology suggestive of tuberculosis aetiology.

**Chemotherapy of Spinal Tuberculosis**

The chemotherapeutic agents used for tuberculosis had already been discussed. Different drug regimens had been suggested by various researchers, but from a bacteriologic point of view, INH and rifampicin in combination are the most effective and the basic combination. To address the primary and secondary drug resistance, a combination of 3 rather than 2 bactericidal drugs should be used initially in an optimal regimen. In our study group, we used a combination of 3 drugs INH, rifampicin and pyrazinamide. All the three drugs are given for the first nine months.
followed by INH and PZA for the subsequent nine months. We have been following the same regimen for CNS tuberculosis also, since we found that the drug regimen is very effective. Ramani et al advocate 5 drugs for 1 year.\textsuperscript{19} We have used ethambutol only in resistant cases due to the reported retrobulbar neuritis due to the drug. We have restricted streptomycin to resistant cases and for injecting into sinuses.

The availability of specific chemotherapeutics have revolutionised the outcome of treatment of spinal tuberculosis, but chemotherapy cannot replace surgical treatment when indicated.

**Surgical Treatment of Spinal Tuberculosis**

The choice of surgical treatment approach and the technique should always depend on the type of the disease, the amount of cord compression whether the compression is from anterior or posterior.

We have discussed in the introduction, different surgical modalities described and practiced in spinal tuberculosis. We have treated conservatively patients with minimal spinal involvement and those with no significant cord compression. Those patients treated conservatively are not included in the present study. All patients who presented to us with neurological deficits and significant compression of the spinal cord/nerve roots underwent adequate decompression to relieve the pressure on neural structures. Radical excision of the bony disease was not the aim of surgery rather decompression of the dura under the microscope was the aim of our surgery. Instability was diagnosed with more than 2 column involvement and with extensive disease where appropriate stabilisation procedures were done. No stabilisation procedure was done as a prophylactic measure to prevent instability later.

We had grouped patients into four categories based on region wise distribution.

**CV Junction**

The incidence of craniovertebral junction tuberculosis is rare\textsuperscript{20,21,22,23,24,25,26} and is seen in less than 1%, but some authors report an incidence of (10-16)%. In our study group, the incidence was 3.03%. We had an incidence of instability in 50% of the patients. Neurological deficits have been reported in 100%.\textsuperscript{20} In our study group, all patients presented with quadriaparesis. Lower cranial nerve paresis was reported in 16% patients in a recent study. We had no patient with cranial nerve palsy. Transoral approach for anterior decompression with good result was reported. The high cervical retropharyngeal approach was reported useful and avoids complication of bacterial contamination by opening of oropharyngeal mucosa. In our study group, 50% underwent transoral decompression and 50% underwent transcervical retropharyngeal approach for decompression. All the above authors advocate posterior fusion and stabilisation for instability. In our study group, 50% underwent successful posterior arthrodesis. All the patients with instability were put on skull traction till being stabilised. Good neurological outcome has been reported following surgical treatment. In our series, definite improvement was seen using Nurick's grade and MRC grading for motor power (Table 11 and 10). All patients had complete pain relief.

**The Subaxial Cervical Spine and Cervicodorsal Tuberculosis**

The cervical spine is best approached by the anterior approach as developed by Smith and Robinson (1958, 1968).

Successful results after anterior approach, decompression and stabilisation using titanium implants was reported by Ramani et al\textsuperscript{19} for subaxial cervical spine. Transclavicular approach was used by the same author for cervicodorsal spine. A small number of the above group underwent anterior decompression without fusion and another few underwent posterior decompression. In our study group, 17 patients underwent anterior decompression and stabilisation, 2 underwent anterior decompression without stabilisation and 1 patient had posterior decompression. We had used transclavicular approach in 1 patient, anterior cervical approach in 18 patients and laminectomy in 1 patient. The majority underwent the anterior procedure because the pathology was anterior in the majority. In our stabilised patients, we had used titanium implants only in all patients. We had no procedure-related complications and no reactivation of the disease. There was no mortality or deterioration. All patients whether stabilised or decompressed had clinical improvement as evidenced by the Nurick's and MRC grading scores (Table 10 and 11). The radiological review also was satisfactory.

In our study group, we subclassified patients with more deficits (grade 4,5) and those with less deficits (grade 0,1,2,3) based on the Nurick's grading system and analysed the difference between the mean Nurick's grade during the study period. There was a steady difference between the two groups with regards to improvement till 18 months (p value was significant (Table 16). It implied that though both the groups had definite steady improvement in neurological outcome, those patients presenting with higher deficits do not improve to normalcy as much as those presenting with lesser deficits. This implies the need for early surgery once neurological deficits set in. Another comparison was done within the groups of the above two groups about the mean difference between the Nurick's scores at 18 months and preoperatively. There was significant difference in the total outcome between the two groups (p value was significant - Table 17). This observation also confirms the need for early surgery before neurological deficits progress.

**Dorsal and Dorsolumbar Tuberculosis**

Regional distribution of spinal tuberculosis shows highest incidence in the dorsal and dorsolumbar spine. Tuli et al report an incidence of 42% in dorsal and 12% in dorsolumbar region. In our study group, the total incidence of dorsal and dorsolumbar combined was 53.03%. The clinical presentation in the majority of patients is rapid paraparesis. In our study group, 97.14% had lower limb weakness and mean duration of symptom was 4.46 months.
Tuli et al report a very high incidence of clinical kyphosis (95%). In our series, the incidence of clinical kyphosis was only 14.28%, but radiological kyphosis was slightly higher (31.42%).

Different approaches have been reported. Transsternoclavicular approach for the anterior decompression and fusion of the upper thoracic spine extracolomic approach intrathoracic transpleural approach have been reported for thoracic tuberculosis. In our series, we have used transthoracic intrapleural approach and thoracoabdominal approaches. Some authors describe posterior vertebral column resection and anterior reconstruction with cage for marked kyphosis and progressive paraplegia. Graft-related problems were reported to be fewer, progression and maintenance of correction of kyphosis was better with adjuvant posterior stabilisation as reported by B. D. Sundaraj. Another series reported recently describes successful treatment of thoracic and lumbar tuberculosis by posterior debridement, grafting and instrumentation. The 5 years and 10 years assessment of debridement and anterior spinal fusion in patients on standard chemotherapy in Hong Kong (MRC study) reports that bony fusion occurs earlier in the radical resection and autologous bone graft for fusion series compared with other series involved with only decompression and ambulatory treatment. By 10 years, there was a mean reduction in the radical series by 1.4 degrees, but in the debridement series, there was a mean increase in the angle by 9.8 degrees. But, in both the series, the patient had a favourable status as per the MRC guidelines. In our study group, the percentage of kyphosis clinically and radiologically was less compared with what was reported by Tuli et al and other observers. The majority of our patients had presented with paraparesis. The indications for surgery in our study group was paraparesis caused by significant cord compression and instability to the spine. 35 patients were operated, 10 underwent anterior decompression and stabilisation, four patients underwent anterior decompression without stabilisation, 18 patients underwent posterior decompression with stabilisation and 3 patients underwent posterior decompression without stabilisation. The surgical approach was decided depending on how the cord was compressed and the stabilisation part was decided by more than 2 column involvement of the spine. All the groups had progressive improvement as evidenced by gradual improvement in the Nurick’s and MRC grades on a time scale.

Similar to the cervical group, we subclassified patients with more deficits (grade 4,5) and those with less deficits (grade 0,1,2,3) based on the Nurick’s grading system and analysed the difference between the mean Nurick’s grades in the two groups separately during the study period. There was a steady difference between the two groups with regards to improvement till 18 months (p value was significant) (Table 16). It implied that though both the groups had definite improvement in neurological outcome, those patients presenting with higher deficits do not improve to normalcy as much as those presenting with lesser deficits. This implies the need for early surgery once neurological deficits sets in. Another comparison was done between the two groups about the mean difference between the Nurick’s scores at 18 months and preop. There was significant difference in the total outcome between the two groups (p value was significant) (Table 17). This observation also confirms the need for early surgery before neurological deficits progress. Other researchers have observed that spinal deformity and paraplegia is more common in cases of delayed diagnosis and management.

**Lumbar and Lumbosacral Tuberculosis**

Tuberculous infection of the lumbosacral region is uncommon. In the present study, we had an incidence of 13.63% (Table 1). Isolated sacral tuberculosis is still rarer in our series. We had no patient with isolated sacral tuberculosis. In contrast with tuberculous spondylitis of other parts of the spine, neurological involvement in lumbosacral disease is rare probably because the vertebral canal is relatively large and contains the cauda equina rather than the spinal cord. The lumbosacral region may accommodate tuberculosis of the spine better than other areas without causing neural compression, because the nerve roots are more resistant to compression than spinal cord and many of the cases can be managed conservatively. In the present study, conservatively managed cases are excluded, but we also had good results with conservative management. In our study group, no patient had clinical gibbus, but radiological kyphosis was seen in 11.1% less compared to cervical and dorsal tuberculosis (Table 6). Indications for surgery in lumbosacral tuberculosis are few and specific. A lesion of uncertain pathology or a patient with significant or progressive neurological deficits are absolute indications for surgery. Relative indications include persistent neurological deficit or persistent pain and instability. Patients who have involvement of anterior and posterior elements also needs to be decompressed and stabilised, because the segments are definitely unstable and can easily produce translational displacement. The standard surgical approach to the lumbosacral region is the extraperitoneal approach, approach from the left side is preferred because left common iliac vessels are longer than the right side and can be retracted across the right side without undue tension. In the present study group, posterior decompression and posterior stabilisation was done in (77.77%) and posterior decompression without stabilisation was done in (22.22%). Iliac crest graft was used for fusion and stabilisation was carried out using titanium plate and screws (55.55%) and Hartshill rectangle (22.22%). Clinical presentation in majority of patients was with distal lower limb weakness (55.55%) of LMN type with sensory signs (66.66%). The incidence of sinus formation in the lumbosacral region is 11.11%. Postoperative recovery in motor weakness was good in all patients irrespective of the kind of surgery done as evidenced by MRC grading (Table 10). The ASIA scoring system also showed good improvement and total recovery in all patients by 9 months (Table 12).
Both conservative and operative treatment resulted in fusion, but there was a higher incidence of kyphosis and trunk shortening in the conservative group as per Hong Kong University Study, 1990. Anterior debridement and fusion with strut graft can reduce the incidence and degree of kyphosis. In our experience, no patient had increased incidence of kyphosis or trunk shortening after decompression without fusion.

Role of posterior surgery in tuberculous spine- In our study group, 48.48% underwent posterior surgery. The indications were different in the different areas affected. At the CV junction, 1.51% underwent posterior surgery for stabilisation and in the cervical and cervicodorsal group 1.51% underwent posterior surgery. In the dorsal and dorsolumbar group, 27.27% underwent posterior decompression with stabilisation, 4.54% underwent posterior decompression without stabilisation. In the lumbar and lumbosacral group, 10.6% underwent posterior decompression with stabilisation and 3.03% underwent posterior decompression without stabilisation. Posterior surgeries were done in presence of instability at the CV junction and associated posterior disease in other study groups. However, in our experience, the indications for combined anterior and posterior surgeries were much less.

Instrumentation in presence of tuberculous infection, the main problem associated with the use of instrumentation in the presence of infection is the formation of a focus of infection that results in persistence. Mycobacterium tuberculosis is less adhesive and produces less biofilm than other bacteria, so the chance of persistence of infection is less with tuberculosis than with other. In our experience, there is no incidence of graft rejection or failure. We have been using plate systems with locking screws in majority patients, since the cost of locking systems have come down.

**Selection of Graft Material**

In our experience, we have used different types of graft material depending on the surgical approach. In the anterior cervical approach, we use the iliac crest graft in transclavicular approach. We used the clavicle as a graft and in thoracotomy and thoracoabdominal approaches, we used rib grafts. In posterior approaches, we have used iliac crest as graft. In our study group, there was good fusion in all the grafts used and we had no incidence of graft resorption or progressive kyphosis after any kind of graft.

**Deformity in Spinal Tuberculosis and Treatment**

In our study group, the incidence of kyphotic deformity was 21.21%. The maximum incidence was in the dorsal group followed by cervical and lumbosacral (Table 6). In our cases, no surgery was planned for correction of deformity. Surgeries were done only for decompression of the spinal cord/nerve roots and for spinal stability. No patient presented with late severe deformity and no extensive resections were done for correction of deformities. It has been reported that continued growth of the posterior elements when the anterior growth plate is arrested leads to progress of the kyphos even after healing of the disease. In our study, the number of children operated was 2. All underwent anterior decompression and stabilisation and there was no incidence of progressive kyphosis in these children due to excess growth of posterior elements after anterior fusion.

Residual kyphosis is common at the end of treatment in spinal tuberculosis as analysed by Tuli et al. In our study group, there was residual kyphosis in a few patients after stabilisation, but no progression of kyphosis. Posterior spinal fusion minimises the progress of the deformity by arresting the growth of the posterior elements (Tuli, et al). Upadhyay et al reported that there is no evidence in their cases to suggest that the growth of posterior elements in the presence of anterior destruction was responsible for progressive deformity.

**Surgery in Children with Spinal Tuberculosis**

In our study group, we had two patients in the paediatric age group who underwent surgery. The surgeries performed were anterior approach, decompression and stabilisation. All patients in our study group had good recovery of the neurological function and spinal stability was achieved. Follow up studies showed clinical improvement progressively and radiological healing was satisfactory. No patient of the paediatric age group had progression of the deformity after anterior surgery alone and none required additional posterior stabilisation.

**CONCLUSION**

The aim of our study is to analyse the results of surgically-treated cases of spinal tuberculosis.

**We were able to arrive at the following conclusions-**

1. In all patients who underwent surgical decompression of the spinal cord, there was improvement in the neurological status as evidenced by the progressive improvement in Nurick’s grading, MRC grading for motor power and the ASIA scoring system (Tables 10, 11, 12). In all stabilised patients, early mobilisation could be done.

2. Once neurological deficits set in with radiological evidence of cord compression, it is ideal to do early decompression of the spinal cord, since we have observed by comparison of patients with severe neurological deficits and those with less severe neurological deficits (in the cervical and dorsal groups). The neurological recovery to normalcy is faster in those with less severe neurological deficits and those with severe neurological deficits do not reach the same status as those with lesser deficits during the 18 months follow up. The statistically significant p values support the above conclusion (Tables 16 and 17).

3. There is no unique surgery or unique approach for the treatment of spinal tuberculosis. The surgical approach and type of surgery is planned based on how the cord is compressed and the amount of instability. We have done anterior/anterolateral and posterior / posterolateral decompression with or without...
stabilisation and combinations of the above surgical strategies depending on individual case requirements. No single surgery was found superior or inferior to any other. The results were similar in all groups as far as neurological recovery was concerned.

4. There is no difference in the neurological improvement between the patients who underwent decompression alone and those who underwent decompression and stabilisation; the neurological grading was compared on an 18 months’ time scale, the differences were not statistically significant as evidenced by the p value (Table 18).

5. The need for newer imaging modalities like MRI in all cases with clinical evidence of cord compression to be overemphasised, since it helps planning of correct surgical strategy and has significantly higher pickup rate of appendicular lesions compared to plain radiography.

6. Anterior pathology being the commonest, anterior approaches for dorsal and lumbar spines are becoming more popular and trainee neurosurgeons need to acquaint themselves with thoracotomies and retroperitoneal approaches. The limited approaches are less morbid and endoscopic approaches for stabilisation are yet to become popular.

7. Unlike in malignancy or in trauma, in spinal tuberculosis, even those with very poor neurological function at presentation, improve to a reasonable grade of neurological function after decompression of the cord. Surgery should always be an option if there is cord compression, even though the patient presents late.

8. Tuberculosis is a systemic disease; even after complete treatment and healing of a spinal focus, reactivation of the disease is possible as tuberculoma and tuberculous meningitis and regular follow up is advisable even after completion of the treatment.

REFERENCES


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