DOI: https://doi.org/10.3329/medtoday.v32i2.48823

ORIGINAL ARTICLE OPEN ACCSESS

Evaluation of Outcome of Decompression and Transpedicular Screw Fixation in the Management of TB of the Thoracolumbar Spine

Md. Faridul Islam*[1], Md. Shahidul Islam Akon[2], Md. Insanul Alom[3], Md. Zahir-Ul Islam[4], Md. Younus Hossain[5], Md. Iqbal Hossain[6]

Abstract

Introduction: *Spinal tubercular infection is the most common and dangerous form of skeletal tuberculosis. Transpedicular instrumentation systems have distinct advantages such as rigid segmental fixation, stabilization of the three column of the spine, least failure at bone metal interface, early post-operative mobilization with efficient nursing care and least complications in the management of tuberculosis of the thoraco-lumbar spine. Objectives was to evaluate the outcome of decompression and transpedicular screw fixation in the management of tuberculosis of the thoracolumbar spine.* ***Materials and Methods:*** *An observational follow-up study. A total no. of 21 patients aged between 19-72 years and both sexes (Male-9, Female-12) was included in the study. Patients diagnosed as tuberculosis of the thoraco-lumbar spine were operated by direct decompression, transpedicular screw fixation and fusion with bone graft and mesh cage in some cases. First follow-up at 1 month after operation and thereafter at 3 and 6 months follow-up was done.* ***Results:*** *This study shows mean±SD age was 40±11.29 years. 57.1% were female and 42.9% were male. Lesion 66.7% were dorsal, 19.0% were lumbar and 14.3% were dorsolumbar. 42.86% were ASIA grade C, 33.33% were ASIA grade D, 9.52% were both ASIA grade B & E and 4.76% were ASIA grade A in preoperative stage. On the other hand in postoperative 61.90% were ASIA grade E, 33.33% were ASIA grade D and 4.76% were ASIA grade B. The difference was statistically significant (P<0.001). Four-fifths (80.95) of the patients had excellent outcome followed by 14.29% good outcome, 4.76% fair and 0% poor outcome.* ***Conclusions:*** *Posterior approach is a minimum surgical intervention that encourages neurological recovery.*

Key words: *Decompression, Transpedicular screw fixation, Thoracolumbar spine TB.*

Number of Tables: 06; Number of Figures: 02; Number of Bibliography: 22; Number of Correspondence: 06.

*1. **Corresponding Author:**
Dr. Md. Faridul Islam
Registrar, Department of Orthopaedic Surgery
Abdul Malek Ukil Medical College, Noakhali.
Email: drmdfislam@yahoo.com
drmdfislam@gmail.com
Mobile: +8801712157397

2. **Dr. Md. Shahidul Islam Akon**
Assistant Professor (Spine Surgery)
Deparment of Orthopaedic Surgery
Dhaka Medical College and Hospital, Dhaka.

3. **Dr. Md. Insanul Alom**
Assistant Professor, Department of Orthopaedic Surgery
Medical College for Women & Hospital, Uttara, Dhaka.

4. **Dr. Md. Zahir-Ul Islam**
Junior Consultant, Department of Orthopaedic Surgery
Rail Way Hospital, Dhaka.

5. **Dr. Md. Younus Hossain**
Assistant Professor, Department of Orthopaedic Surgery
Jashore Medical College, Jashore.

6. **Dr. Md. Iqbal Hossain**
Assistant Professor, Department of Pharmacology
Abdul Malek Ukil Medical College, Noakhali.

Introduction

Tuberculosis (TB) is a common problem in developing countries. Although it is on decline but still present in developed countries due to immigrants from underdeveloped countries[1]. Spinal TB is the most common and dangerous form of skeletal tuberculosis because of its capacity to cause bone destruction, deformity, and paraplegia. It was initially described by Sir Percivel Pott as painful kyphotic deformity of the spine associated with Paraplegia. The disease spread to the spine from primary focus either directly or through blood i.e. intercostal arteries and batson's plexus[2]. Destruction of vertebra starts in cancellous bone and then spread to involve another vertebrae. Usually one motion segment is involved[3]. Differentiating spinal TB from pyogenic and fungal vertebral osteomyelitis as well as primary and metastatic spinal tumors may be difficult when only clinical and radiographic findings are considered. A history of tuberculosis, a positive skin test (its value declines in endemic areas), and an elevated erythrocyte sedimentation rate (ESR) may be useful in the diagnosis of spinal TB[4]. Biopsy plays a valuable role in the diagnosis of spinal TB infection. The use of DNA amplification techniques (polymerase chain reaction or PCR) may facilitate rapid and accurate diagnosis of the disease[5]. Spinal TB is one of the most common causes for a kyphotic deformity in patients from many parts of the world, and particularly in developing countries. There is an average increase in kyphosis of 15 degrees in all patients treated conservatively, and a deformity greater than 60 degrees may develop in 3% to 5% of patients[6]. Development of neurologic deficit and paraplegia after healing of the spinal TB lesion is associated with a worse prognosis than when these complications occur during

Received: 07 February 2020 *Accepted revised version:* 12 August 2020

the active phase of disease[7]. Spinal tubercular infection constitutes 1/3 to 1/2 of all bone and joint tuberculosis. Thoracic and lumbar spine are commonly affected area. 10-40% of patients with thoracic spine tuberculosis may get neurological deficit. Urgent measures are needed to halt progression of destruction and deformity and especially to prevent and overcome paraplegia. Proper selection of drug therapy and operative modalities, however, is needed to optimize functional outcome for each individual case of Pott's disease[8]. Spinal TB is a medical disease and antituberculosis drugs have a main role in the recovery and response of patients[5]. The efficacy of antituberculosis drugs and other conservative means have been shown in several studies for the treatment of spinal TB in the absence of neurologic deficit, instability, and deformity regardless of presence of paravertebral abscess[9]. Adequate early pharmacological treatment can prevent severe complications. Combination of rifampicin, isoniazid, ethambutol, and pyrazinamide for three months followed by combination of rifampicin and isoniazid for a total period of 6, 9, 12 or 18 months is the most frequent protocol used for treatment of spinal TB[7,10]. The "Middle Path Regime" treatment approach reserves surgery for the treatment of complications of the disease. Patients are started on chemotherapy, and initially are managed with bed rest.

Both the erythrocyte sedimentation rate and spinal radiographs are monitored at 3 to 6 month intervals. Patients are mobilized in a brace once their symptoms have subsided and bracing is continued for a total of 18 to 24 months. Subcutaneous abscesses are aspirated, and one gram of streptomycin may be instilled locally. Sinus tracts are excised if they remain after 12 weeks of chemotherapy. Surgical treatment is suggested for an increase in size of a paravertebral abscess despite adequate chemotherapy, involvement of the posterior elements, lack of clinical response after 3 to 6 months of chemotherapy (neurologically normal), lack of neurologic recovery or progression of neurologic deficits after 3 to 4 weeks of chemotherapy, recurrence of disease, mechanical instability, or an uncertain diagnosis[11].

In a randomized controlled trial conducted by the Medical Research Council of the UK, the results of surgery and antituberculosis chemotherapy were compared for management of patients with spinal TB. One arm of the trial showed a small but significant advantage of surgery over chemotherapy in preventing progression of kyphosis, but the other arm did not demonstrate superiority of surgery over chemotherapy during long-term follow-up of the patients[12]. Surgical treatment improves the quality of life and speeds the rehabilitation. The principle of operative management of spinal tuberculosis is to decompress the spinal cord by removing the necrotic tissue and draining of any pus and devitalized tissue followed by immobilization. Yet the infected vertebrae are prone to collapse and they require mechanical support to prevent progressive deformity[6].

Bangladesh, most densely populated country with limited health care facilities, even most of the district hospital including medical college hospitals is lacking in spinal care centers. This prospective study of decompression and transpedicular screw fixation of tuberculosis of spine in thoracic and lumbar region conducted in spine surgery department of DMCH to evaluate the outcome of surgical management of spinal tuberculosis might be beneficial for our people in perspective of our country.

Materials and Methods

This observational follow-up study was done Department of Orthopaedic Surgery, Dhaka Medical College Hospital Dhaka, Bangladesh from July, 2015 to June, 2017.

Inclusion criteria are all patients with tuberculosis of thoracolumbar spine, who were undergone surgery, age-16-80 years, sex - both male and fmale, spinal TB with nuerological involvment and unstable spine due to spinal tuberculosis.

Exclusion criteria are patients with thoracolumbar tuberculosis who were managed conservatively, unstable medical illness that would significantly increase the risk of morbidity and mortality and spinal tuberculosis rather than thoracolumbar region.

Variables of the study: After enrollment of patient and tabulation of the collected data following variables was measured.

A. Demographic variables –

• Age • Sex • Occupation.

B. Clinical variables-

• Clinical feature- Back pain and stiffness, fever, cough, anorexia, weight loss, weakness, night sweating, neurological deficit like paraplegia, spinal deformity, local tenderness.

• Level of involvement.

• Presence of deformity or gibbus.

• Neurological status.

• Ambulatory status.

C. Outcome variables-

• Clinical outcome • Back pain

• Neurological improvement by ASIA grading

• Ambulation • Radiological outcome

• Implant failure • Complications.

• Functional outcome

Operational Definition

1. Tuberculosis of Thoracolumbar Spine: Clinical, radiological & laboratory findigs in favour of tuberculosis of thoracolumbar spinal region is regarded as tuberculosis of thoracolumbar spine.

2. Decompression: Making free of spinal cord & nerve root from compression is called decompression.

3. Transpedicular: Application of pedicular screw through the pedicle of verteba.

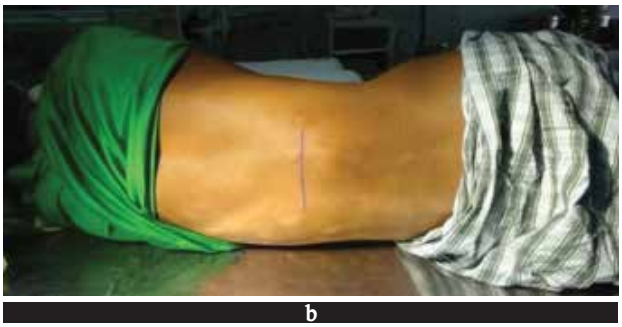
Ethical Approval: The study has been approved by the Ethical Review Committee of Dhaka Medical College, Dhaka. Other ethical issues such as informed written consent from patient or from legal guardian after duly informed was taken. The aims and objectives of the study were explained to the patients in easily understandable local language. They were also informed about the approximate cost of X-Ray, MRI or CT Scan of thoracolumbar spine and implants used for the procedure of treatment. It was assured that the procedure will be helpful for both the doctor and the patients in making rational approach of the case management.

Data Collection: A structured data collection form (Appendix-III, page-v) was developed containing all the variables of interest which was finalized following pretesting. Data were collected by history, clinical examinations, investigation, operative procedure and follow up findings before data collection informed written consent was taken from the patients. Data was collected by the investigor himself.

Data Analysis: Collected data were compiled and presented in the form of tables and charts based on key variables and functional assessment scoring. The analysis of different variables was done according to standard statistical analysis we had done fisher exact test and also mean and SD was measured. The results were analyzed by using statistical package for social science (SPSS) version 20.0. For all analysis level of significance set at 0.05 and P value <0.05 will be considered significant.

Methodology: A total no. of 21 patients with tuberculosis of the thoracolumbar spine, aged between 19-72 years of both sexes (Male-9, Female-12) were selected in the study as per inclusion and exclusion criteria between July, 2015 to June, 2017. Mean age was 40 years with SD ±11 years. A detailed history of the selected patient was taken with thorough general, local and neurological examination was done for proper assessment.

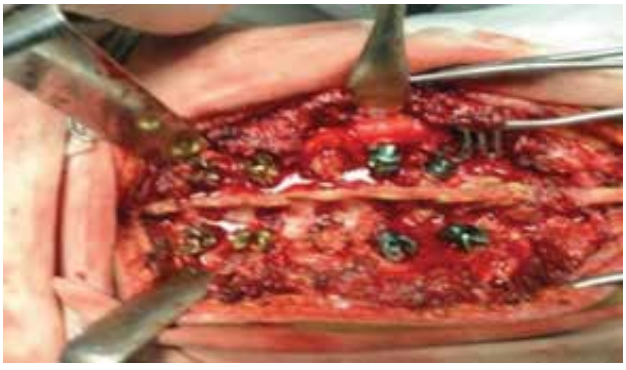
a



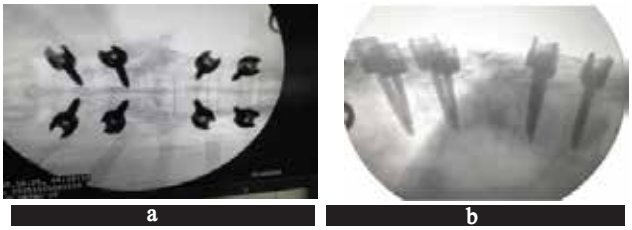
b

Photograph-1: Pre-operative marking, (a) X-ray and (b) over body

All patients were given standard antituberculous chemotherapy for a total of 12 months: Four drugs (isoniazid, rifampicin, pyrazinamide and ethambutol) for 3 months, followed by two drugs (isoniazid and rifampicin) for 9 months and it was extended for 18 months for one patient. Besides this, intravenous antibiotic drug, a 3rd generation cephalosporin, flucloxacilline and amikacin were given for 5-7 days to all patients after surgery.



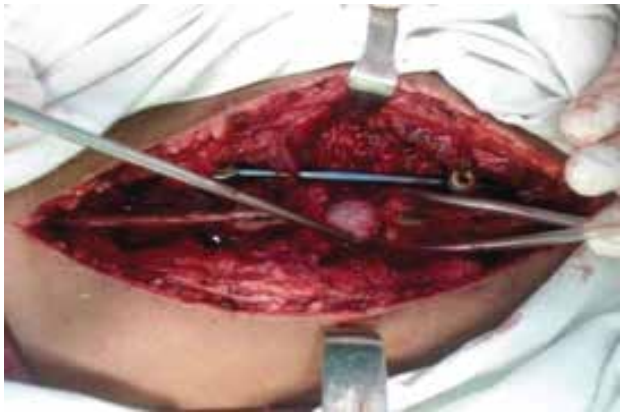
Photograph-2: Placement of Pedicle Screw



a b

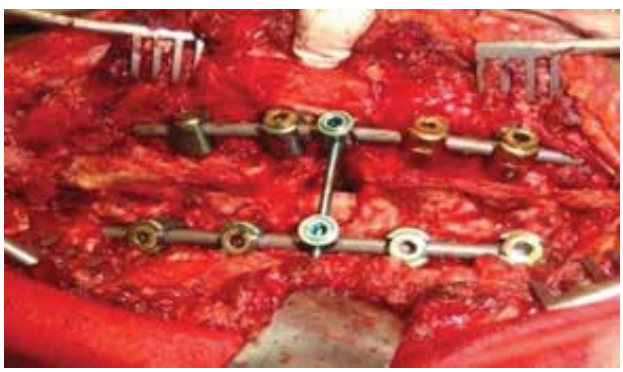
Photograph-3: C-arm view of pedicular screw (a) A/P & (b) Lateral view

Photograph-4: Pus collection



Photograph-5: 360^0 decompression of spinal cord

Photograph-6: Insertion of cage



Photograph-7: Stabilization with Screw and Rod

Immediately post-surgery, routineanteroposterior and lateral radiographs were obtained to assess the extent of decompression and placement of graft and instrumentation. All patients were followed up at 1, 3 and 6 months after surgery. At each follow up clinical evaluation, plain radiographic studies were obtained to determine the fusion status, development or progression of deformity after surgery, and instrumentation failure. Neurological deficit was graded according to ASIA grade. Pain was also assessed according to the following scale: Severe, moderate, mild, and no pain. Functional outcome was assessed according to Modified Macnab criteria.

Postoperative management and follow up:

The principle of postoperative aim were early recovery of motion and functions and return to independent living. Patient was kept in postoperative ward initially and thereafter in general ward or cabin. Patients were allowed to turn the body in bed immediately after operation.

The following postoperative follow up protocol were practiced.

The day of operation:

1. General vital parameters
2. Dressing and drain tube collection, urine output.
3. Neurological condition
4. All patient were administered prophylactic 3rd -generation cephalosporin (ceftriaxone) 1gm, Flucloxacine 500 mg and Amikacin 500 mg intravenously during general anaesthesia and then continued 12 hourly, 6 and 8 hourly respectively for three (05) days postoperatively.

1st postoperative day-

1. General vital parameters
2. Dressing and drain tube collection, urine output.
3. Neurological condition
4. Deep breathing and posture change were advised.
5. Isometric quadriceps exercise (if possible) by pushing knee down and hold for a count of 10.
7. Gluteal exercise (if possible)- Squeeze the buttock together and hold for a count 10.

2nd postoperative day-

1. General vital parameters
2. Dressing and drain tube collection, urine output.
3. Neurological condition
4. Deep breathing and posture change were continued.
5. Isometric exercise continued.
6. Catheter clamping

3rd postoperative day-

1. Drain and catheter were removed (If possible).
2. Check X-ray at the site of operation was done.
3. Allowed to sit in bed with brace and assistance.
4. Begin ambulation with walker with the assistance if possible.

4th-5th Postoperative day-

• If everything was going alright, the patient was discharged with some written instruction as follows.

Patient were discharged with following advice –

• Taylor brace should worn during ambulation.

• Follow up visit at particular date with the discharge certificate, plain x-ray dorsolumbar spine (AP and lateral view) at 1 month, 3 months and 6 months.

• Training and teaching about daily activities like how to sit, how to lie, how to bath how to use toilet and how to use intermittent catheter for bladder if not under controlled.

• Continue the pervious exercise and ambulation activities.

• Ensure a home physiotherapy.

• Orient family to patients needs, abilities, limitations, precaution with family members.

• Give patient a prescription of prophylactic antibiotic and anti tubercular chemotheraphy.

• Limited athletic activity- swimming, cycling and golfing.

• Stitch were removed on 14th postoperative day.

Follow-up:

After discharge from hospital each patient was asked to follow up at OPD.

1. 1st follow-up after 01 month of operation.

2. 2nd follow-up after 03 months of operation and

3. 3rd follow-up at 06 months after surgery.

At each follow up clinical examination of scar, neurological assessment and plain radiographic studies were obtained to determine bony fusion and instrumentation failure.

Upon pre-operative, post-operative, and follow-up clinical assessments, the patients neurologic function graded by using the ASIA grading system (Appendix-IV, page-x), and modified Macnab criteria for the outcome of surgery.

Patient was counseled in every follow up regarding the role of physiotherapy in their rehabilitation.

Outcome evaluation:

Modified Macnab criteria was used for categorization of outcome (Macnab 1971).

Result (Outcome)	Criteria
Excellent	No pain, no restriction of mobility, return to work and level of activity.
Good	Occasional non radicular pain, relief of presenting symptoms, able to return to modified work.
Fair	Some improved functional capacity, still handicapped and unemployed.
Poor	Continued objective symptoms of root involvement, additional operative intervention needed at the index level irrespective of length of postoperative follow up.

For valid statistical analysis, outcome categories were regrouped as: Excellent and good categories were considered as satisfactory; Fair and poor categories were considered as unsatisfactory.

Rehabilitation:

Rehabilitations are one of the achievements of medical science, during the past two decades. These patients need physical, psychological and economic independence and social integration. Medical rehabilitation should start right from the earliest stage of treatment.

Observations

In this study, a total number of 21 patients with tuberculosis of the thoracolumbar spine were operated in the form of direct decompression and long segment spinal fixation. All the patients were clinically evaluated and radiologically investigated. Every patient was followed up regularly up to 6 (Six) months after surgery. The results were assessed on the basis of modified Macnab criteria.

Results

Demographic information:

Table I shows 4.76% were age group ≤20 years, 33.33% were 21-30 years, 19.05% were 31-40 years, 19.05% were 41-50 years , 14.09% were 51-60 years and 9.52% were more than 60 years. The average age was 40 years. Range of age was 19-72 years.

Table -I: Distribution of respondents by age (n=21).

Age in years	Frequency	Percent	Mean±SD
≤20	1	4.76	
21-30	7	33.33	
31-40	4	19.05	40±11.29
41-50	4	19.05	
51-60	3	14.29	
>60	2	9.52	
Total	**21**	**100.0**	

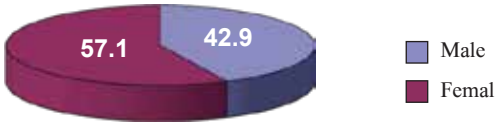


Figure-1: Pie chart of patients by sex (n=21).

Figure shows distribution of patients by sex, 57.1% (n=12) were female and 42.9% (n=9) were male.

An analysis of the different job categories showed that the most impacted group in the samples were 09 (42.86%) housewives, 03 (14.29%) laborers, 03 (14.29%) students, and followed by service holder 02 (09.52%), business man, 01 (04.76%) driver 01 (04.76%) farmers 01 (04.76%) and others 01 (04.76%)(Table-II).

Table-II: Distribution of patients by occupational status (n=21).

Occupational status	Number of patients	Percentage %
Labour	03	14.29
Business man	01	04.76
Service holder	02	09.52
House wife	09	42.86
Student	03	14.29
Driver	01	04.76
Farmer	01	04.76
Others	01	04.76
Total	**21**	**100.00**

Table III shows multiple responses, most of the common clinical presentation was pain (90.5%) then gibbus (57.1%), paraplegia (57.1%), difficulty in walking (28.5%) and weakness (19%).

Table-III: Distribution of patients by clinical presentation (n=21).

Clinical presentation	Frequency	Percentage
Weakness	4	19.0
Gibbus	12	57.1
Pain	19	90.5
Weight loss	4	19.1
Paraplegia	12	57.1
Difficulty to walking	6	28.5

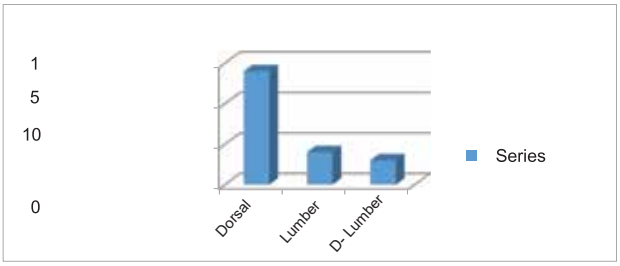


Figure- 2: Distribution of patients by level of involvement of lesion (n=21).

Figure 2 shows distribution of lesion, 66.7% were dorsal, 19.05% were lumber and 14.29% were dorsolumbar.

Table IV shows that maximum 42.9% were grade C in pre-operative state and also 33.3% were grade D, 9.5% were both grade B, & E and 4.8% were grade A in preoperative. On the other hand in postoperative 4.8% were grade B, 33.3% were grade D and 61.9% were grade E.

Table-IV: Distribution of patients by pre &post operative ASIA grade (n=21).

ASIA Grade	Preoperative (n = 21)	Preoperative (n = 21)
Grade A	1 (4.8)	0 (00)
Grade B	2 (9.5)	1 (4.8)
Grade C	9 (42.9)	0 (00)
Grade D	7 (33.3)	7 (33.3)
Grade E	2 (9.5)	13 (61.9)
Total	**21 (100)**	**21 (100)**

Figures in the brackets indicate corresponding %.

Table V shows pre-operatively 6(28.57 %) patients walked without support but had some weakness. 5(23.81%) patients could walk with support and 10(46.62%) patients were bed ridden and also there was no patient who could normally walk in the pre-operative stage. In post-operatively maximum 12(57.14%) patients gained normal walking. 5(23.81%) patients walked without support but had some sort of weakness. 3(14.29%) patients walked with support. And 1(4.76%) was bed ridden but could be moved with wheel chair. Ambulatory status of the patients improved after the operation.

Table-V: Distribution of patients by Ambulatory status pre & post operatively (n=21).

Ambulation	Preoperative		Preoperative	
	No	%	No	%
Normal walking	0	0	12	57.1
Some weakness but can walk without support	6	28.6	5	23.8
Walks with support	5	23.8	3	14.3
Bed ridden patient	10	47.6	1	4.8

Figures in the parentheses indicate corresponding %.

Table VI shows majority (80.95%) of the patients had excellent outcome followed by 14.28% good outcome and 4.76% fair outcome.

Table-VI: Distribution of the patients by functional outcome according to modified Macnab criteria (n=21).

Results	Frequency	Percentage
Excellent	17	80.95
Good	3	14.28
Fair	1	4.76
Poor	0	0

Discussion

In this study maximum (33.33%) cases were 21-30 years group followed by 19.05% were 31-40 years & 41-50 years group, 14.29% were 51-60 years, 9.52 % were > 60 years group and 4.76% were < 20 years group. The mean age was 40±11.29 years. In a similar study found the mean age 41.4±12.5 years13, 44.07±16.57 years[14]. It varies on sample size and study settings. Regarding sex distribution in this study shows 57.1% were female and 42.9% were male. Other similar study found 56% male and 44% female[15] & 48.3% male and 51.7% female[13]. In this study occupational variation were 09 (42.86%) housewives, 03 (14.29%) labourers, 03 (14.29%) students, and followed by service holder 02 (09.52%), business man, 01 (04.76%) driver 01 (04.76%) farmers 01 (04.76%). In this study found most of the common clinical presentation were pain (90.5%) then gibbus (57.1%), paraplegia (57.1%), difficulty to walking (28.5%) and weakness (19%). Others similar study shows majority 15(53.5%) has complain of back pain while weakness in 5(17.8%)[16]. Another study shows 84% were presenting with back pain & 10% with weakness[13]. In Polly's study 53% were having complained of back pain[17]. Regarding distribution lesion, in this study, 66.7% were dorsal, 19.05% were lumber and 14.29% were dorsolumbar. study shows Thoracic spine was involved in 42% of cases, lumbar spine 30% of cases, cervical spine 11% of cases, thoracolumbar 10%, lumbosacral 5% of cases and sacral 2% of cases[18]. Our findings differ with them as we exclude spinal tuberculosis rather than thoracolumbar spinal region.

In this study, preoperative ASIA grade, maximum 42.9% were shown to grade C, 33.3% were grade D, 9.5% were both grade B & E and 4.8% were grade A . On the other hand in postoperative 4.8% were grade B, 33.3% were grade D and 61.9% were grade E. The difference was statistically significant (P<0.001) where CI is 95%. Study shows before starting treatment 1 patient (2.08%) was in ASIA A, 2 (4.16%) were in ASIA B, 9 (18.75%) were in ASIA C, 36 (75%) were in ASIA D and 12 (20%) were in ASIA E[19] . After 6 months of therapy 30 (90%) patients in ASIA D and 5 (55.5%) in ASIA C had complete neurological recovery. Both patients from ASIA B improved to ASIA D. Single patient who was in ASIA A before treatment remained non ambulatory (ASIA C) after treatment. They also found significant difference between before treatment and after 6 months therapy.

This study shows preoperatively, 6 (28.6%) patients walked without support but had some weakness. 5 (23.8%) patients could walk with support and maximum 10 (47.6%) patients were bed ridden in preoperative. In postoperatively maximum 12 (57.1%) patients gained normal walking after the six months. 5 (23.8%) patients walk without support but have some sort of weakness. 3 (14.3%) patient walks with support. Only 1 (4.8%) patient is bed ridden but can be mobilized with wheel chair. Study showed 52% of patients presented in a non ambulatory state, 21% had mild neurologic deficits and 27% had intact neurological function[20]. Our results consistent with this study. In a recently published study among patients with neurologic deficit, significant recovery occurred in 92%, with 74% improving from non-ambulatory to ambulatory status[21].

In this study shows majority (80.95%) of the patients had excellent outcome followed by 14.29% good outcome and 4.76% fair but there are no poor outcome. Similar study shows thirty-four percent of the cases had resolved, 41% improved, 14% remained unchanged, and 9% deteriorated by the last control examination. It was observed that surgical management of spinal tuberculosis in thoracic and lumbar region after final follow up majority were found excellent and good outcome[22].

Conclusion

In case of spinal tuberculosis medical treatment is generally effective. Surgical intervention is necessary in advanced cases with marked bony involvement, abscess formation or paraplegia. ASIA grade were significantly improved in post-operative period. Posterior approach is a minimum surgical intervention that encourages neurological recovery. It concluded that early diagnosis and treatment prevent complication. Surgical procedure especially debridement, posterior decompression, instrumentation with transpedicular screw and rods and fusion are good surgical procedure for the patients with spinal tuberculosis in thoracic and lumbar region.

Conflict of Interest: None.

Acknowledgement

All praises go to Almighty Allah, for the opportunity, energy and perseverance. He has given me to serve the distressed as a physician and to carry out & go in depth of a research work.

I express my respect and deepest sense of gratitude to my respected teacher and guide Professor Dr. Md. Shamsuzzaman, Professor and Head, and Dr. Md. Shahidul Islam Akon, Assistant Professor, Spine Surgery, Department of Orthopaedic Surgery, Dhaka Medical College & Hospital, Dhaka for their valuable, constant guidance and kind co-operation from beginning to completion of this thesis.

Bibliography

1. Rasouli M.R., Mirkoohi M., Vaccaro A.R., Yarandi K.K. & Rahimi-MovagharV. Spinal Tuberculosis: diagnosis and management. Asian Spine J.2012; 6 (4): 294-308.

https://doi.org/10.4184/asj.2012.6.4.294

PMid:23275816 PMCid:PMC3530707

2. Ali M., Khan H.M., Khanzada K. & Usman M. Level of spinal involvement in patients operated for spinal tuberculosis. JPMI. 2012; 26 (4): 443-399.

3. Swanson A.N., Pappou I.P., Cammisa F.P.& Girardi F.P. Chronic infections of the spine: surgical indications and treatments. Clin Orthop Relat Res. 2006; 444: 100-106.

https://doi.org/10.1097/01.blo.0000203447.44146.55

PMid:16523133

4. Nussbaum E. S., Rockswold G. L., Bergman T. A., Erickson D. L. & Seljeskog E. L. Spinal tuberculosis: a diagnostic and management challenge. J Neurosurg.1995; 83 (2): 243-247.

https://doi.org/10.3171/jns.1995.83.2.0243

PMid:7616269

5. Jain A.K. Tuberculosis of the spine: a fresh look at an old disease. J Bone Joint Surg Br. 2010; 92: 905-913.

https://doi.org/10.1302/0301-620X.92B7.24668

PMid:20595106

6. Rajasekaran S. The problem of deformity in spinal tuberculosis. Clin Orthop Relat Res. 2002; 398: 85-92.

https://doi.org/10.1097/00003086-200205000-00012

PMid:11964635

7. Jain A.K. Treatment of tuberculosis of the spine with neurologic complications. Clin Orthop Relat Res.2002; 398: 75-84.

https://doi.org/10.1097/00003086-200205000-00011

PMid:11964634

8. Gulati Y. & Gupta R. Operative treatment of tuberculosis of dorsal and lumbar spine.

Apollo Medicine.2005; 2 (2): 96-100.

https://doi.org/10.1016/S0976-0016(12)60072-6

9. Bakhsh A. Medical management of spinal tuberculosis: an experience from Pakistan. Spine. 2005; 35 (16): E787-E791.

https://doi.org/10.1097/BRS.0b013e3181d58c3c

PMid:20581751

10. Alothman A. , Memish Z.A. & Awada A. Tuberculous spondylitis: analysis of 69 cases from Saudi Arabia. Spine.2001; 26: E565-E570.

https://doi.org/10.1097/00007632-200112150-00020

PMid:11740373

11. Tuli, S.M. Tuberculosis of the skeletal system. 5th edition. New Delhi; India: Jaypee Brothers Medical Publishers (P) Ltd. 2016; 208-209, 247-307.

12. Parthasarathy R., Sriram K., Santha T., Prabhakar R., Somasundaram P.R. & Sivasubramanian S. Short-course chemotherapy for tuberculosis of the spine. A comparison between ambulant treatment and radical surgery: ten-year report. J Bone Joint Surg Br.1999; 81: 464-471.

https://doi.org/10.1302/0301-620X.81B3.0810464

PMid:10872368

13. Ehsaei M., Samini F. &Bahadorkhan G. Pott's disease: Review of 58 cases. Med J of Islamic Rep: of Iran. 2010; 23: 200-206.

14. Park D.W, Sohn J.W, Kim E.H. & Lee J.H. Ha K.K. Outcome and Management of Spinal Tuberculosis According to the Severity of Disease: A Retrospective Study of 137 Adult Patients at Korean Teaching Hospitals. Spine. 2007; 32 (4):E130-E135.

https://doi.org/10.1097/01.brs.0000255216.54085.21

PMid:17304122

15. Kotil K., Alan M.S. & Bilge T. Medical management of Pott disease in the thoracic and lumbar spine: a prospective clinical study. J Neurosurg Spine. 2007; 6: 222-228.

https://doi.org/10.3171/spi.2007.6.3.222

PMid:17355021

16. Siddiqui AI., Abro H.A. &PhulpotoM. Clinico-radiological presentation of the patients with pott's disease, 3 years experience at department of neurology, Chandka Medical College Hospital (SMBBMU) Larkana. Medical Channel. 2013; 19 (4): 14-16.

17. Polly P. & Dunn R. Noncontiguous spinal tuberculosis: Incidence and management.

Eur.Spine J. 2009; 18 (8): 1096-1101.

https://doi.org/10.1007/s00586-009-0966-0

PMid:19357878 PMCid:PMC2899513

18. Godlwana L., Gounden P., Ngubo P. & Nsibande T. Incidence and profile of spinal tuberculosis in patients at the only public hospital admitting such patients in KwaZulu-Natal. Spinal Cord. 2008; 46 (5): 372-374.

https://doi.org/10.1038/sj.sc.3102150

PMid:18317491

19. Gupta A.K., Kumar C., Kumar P., Verma A.K., Nath R. & Kulkarni C.D. Correlation between neurological recovery and magnetic resonance imaging in Pott's paraplegia. Indian J Orthop. 2014; 48: 366-373.

https://doi.org/10.4103/0019-5413.136228

PMid:25143639 PMCid:PMC4137513

20. Rajasekaran S., Vijay K. & Shetty A.P. Single-stage closing-opening wedge osteotomy of spine to correct severe post-tubercular kyphotic deformities of the spine: a 3-year follow-up of 17 patients. Eur Spine J. 2010; 19: 583-592.

https://doi.org/10.1007/s00586-009-1234-z

PMid:20013004 PMCid:PMC2899834

21. El-Sharkawi M.M. & Said G.Z. Instrumented circumferential fusion for tuberculosisof the dorso-lumbar spine. A single or double stage procedure? International Orthopaedics (SICOT). 2012; 36: 315-324.

https://doi.org/10.1007/s00264-011-1401-9

PMid:22072401 PMCid:PMC3282849

22. Jain A.K., Dhammi I.K., Prashad B., Sinha S. & Mishra P. Simultaneous anterior decompression and posterior instrumentation of the tuberculous spine using an anterolateral extrapleural approach. J Bone Joint Surg Br. 2008; 90:1477-1481.

https://doi.org/10.1302/0301-620X.90B11.20972

PMid:18978269