

Original Article

## Role of Anterior Cervical Decompression Fusion (ACDF) and Plating in Patients with Lower Cervical Caries Spine

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### ABSTRACT

**Objective:** We assessed the neurologic status of patients with cervical spine caries after anterior cervical decompression fusion and plating in terms of muscle power measured by MRC (medical research council) grade and functional status measured by Nurick grade.

**Materials and Methods:** A descriptive case series study was conducted and 36 subjects with lower cervical spine (C3 – C7) were included with cervical spine caries who needed anterior cervical decompression and plating operated by the department of Neurosurgery, KEMU/Mayo Hospital. The cervical spine TB was confirmed using an MRI plain and contrasted cervical spine. Post-surgical neurological examinations were performed on the 1st, 7th, 21st, and 42nd days and the 3rd and 6th months after surgery. The neurological state was measured in terms of muscle power measured by MRC grades and functional outcome was assessed from Nurick grades.

**Results:** The mean age of the patients was  $37.0 \pm 14.4$  years. The majority of patients had C5 caries spine (28%) and the least had C7 caries spine (14%). Most of the patients had pre-operative MRC grade 3 (41.7%). The majority had Nurick's grade 5 (55.6%). 17% of patients had post-operative hoarseness of voice. 31% of the patients had post-operative dysphasia which improved by 3 weeks. 3% developed a new neurological deficit in the form of deterioration of muscle power measured by MRC grade during 6 months' follow-up time.

**Conclusion:** All follow-up improvements were statistically significant in terms of pre-operative status.

**Keywords:** MRC: medical research council, Nurick grade, Cervical tuberculosis, Nurick's grade, Neurological state, Caries spine, Quadriplegia.

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### INTRODUCTION

Quadriplegia or quadriplegia, due to cervical cord pathology is a very catastrophic condition

that not only causes physical and emotional trauma to patients but also puts a burden on society.<sup>1</sup> Several pathologies can cause compression of the cervical cord resulting in different types of neurological signs and symptoms. The most common pathologies are trauma and caries followed by degenerative and metastatic or primary bone lesions.<sup>2-3</sup> Spinal tuberculosis infections (TB) have been recorded since the time of Egyptian mummies and account for about 1% of tuberculosis cases. It can manifest in a variety of ways that impact not just the spinal cord and its covering, but also the nearby bone and soft tissue parts. The precise and timely diagnosis and treatment requirement has improved outcomes in both deformities and neurology. Spinal tuberculosis infections are becoming more common in endemic areas, affecting people of all ages. Because of immunodeficiency syndromes and intravenous (IV) drug misuse, the condition appears to have grown in occurrence among young people in recent decades, mostly in developing nations.<sup>4</sup> Mostly tuberculous vertebral osteomyelitis affects the dorso-lumbar junction and lumbar spine which reflects the consequences of dorso-lumbar infection<sup>5</sup>. Cervical tuberculosis is a rare disease that happens only in 3 to 5% of all newly diagnosed cases of tuberculosis patients according to the literature,<sup>6-7</sup> it may be confusing with other inflammatory and malignant lesions.<sup>5</sup> Infections in the spine can spread one of two routes. It includes hematogenous spread from distant focus in which tuberculosis and brucellosis are common examples. In adults, the intervertebral disc is devoid of blood supply directly. So, the most of infection that spread through the hematogenous route to disc space, is the result of spread from the adjacent vertebral body. In Discitis due to tuberculosis, the organism approaches the metaphysis of the vertebral body through a hematogenous route. The primary infection is not evident in most tuberculous osteomyelitis. 80% of patients having tuberculosis

of the spine do not have evidence of pulmonary infection.<sup>8</sup>

There are two kinds of vertebral tuberculosis: (i) spondylodiscitis, defined as erosion of two or more contiguous vertebrae and opposing end plates with disc infection and paraspinal collection; and (ii) tuberculosis of the spine, and (ii) a growing recognition of an unusual type of spondylitis without disc involvement<sup>9</sup>. Infection due to tuberculosis may present as an abscess which may be the result of the destruction, caseation, and necrosis of cervical vertebrae.<sup>10</sup> Tuberculosis of the cervical spine can present as pain and restricted movement of the cervical spine, and factors causing compression like pus, destructed vertebrae, and granulation tissues can cause neurological impairment and spinal deformity.<sup>9-10</sup> Early diagnosis and prompt treatment of cervical spine tuberculosis are of utmost importance because of neurological complications and the consequences of the untreated disease are catastrophic. Several management options for lower cervical spine tuberculosis are discussed in the literature. These range from conservative to extensive surgical procedures.<sup>11-12</sup> The introduction of anti-tuberculous treatment reduced death from 10% to 13% but did not prevent related deformity or reduce the paraparesis/quadriparesis rate, which is between 15% and 30%.<sup>16</sup> Surgery is recommended for people who have a neurological disability.<sup>13</sup> Spinal instrumentation can offer support for anterior grafts.<sup>18-19</sup> The most direct approach for the decompression of neurological tissue, stabilization, and reconstruction of the cervical spine can be done by anterior cervical Corpectomy.<sup>14-16</sup>

The anterior cervical approach is now one of the most commonly performed surgical procedures of the spine. It ranges from simple discectomy and single-level corpectomy to multilevel corpectomies. It is a relatively less traumatic approach and provides a direct approach to the anterior aspect of the cervical

spine for pathologies causing compression of the spinal cord from the anterior aspect.<sup>16</sup> Fixation with a plate using the anterior approach provides immediate stabilization, reduces the risk of graft displacement, promotes higher fusion rates, and obviates the need for prolonged postoperative immobilization thus allowing early return to normal activities.<sup>17</sup> The morbidity associated with autologous bone graft harvest has led to the development of bone banking and bone graft substitutes but the use of autograft remains the unequivocal "gold standard" strategy for achieving bony fusion.<sup>18</sup> The ultimate aim of any spinal surgery is improvement in the neurological status of the patient, alleviation of pain, and early rehabilitation. This is achieved by adequate decompression of the neural tissues, mechanical stabilization of the spine, and bony fusion.<sup>19</sup>

Pakistan is a developing country and has a high prevalence of tuberculosis. Patients with quadriplegia and paraplegia due to cervical caries are very devastating conditions for the patient themselves, and their families and put a burden on society. Patients can be saved from permanent disability by treating them through surgical intervention i.e., anterior cervical decompression fusion and plating. The literature review shows patients with cervical caries treated conservatively with anti-tuberculous therapy end in permanent neurologic deficit i.e., quadriplegia, and patients become bedridden for their remaining life. With invent of anterior cervical decompression fusion and plating, patients can be saved from a permanent neurological deficit and hence reduces the burden from families and ultimately from the state. Such studies must be carried out at a government hospital where there is a lack of effective logistics, high infection rates, and generally poor nursing service. External validation is essential in statistical terms to rationalize the technique performed in other locations; hence, this study is relevant to undertake. It is practicable, cost-effective, and time-constrained to be carried out by a

postgraduate student. We hypothesized that the neurologic status of patients with cervical spine caries improves after anterior cervical decompression fusion and plating in terms of muscle power measured by MRC grade and functional status measured by Nurick's grade. The current research aimed to assess the neurologic status of patients with cervical spine caries after anterior cervical decompression fusion and plating in terms of muscle power measured by MRC (medical research council) grade and functional status measured by Nurick grade. The study will allow us better understand the role of ACDF-P in Pakistani setting in lower cervical caries and helps to devise locally accepted treatment guidelines.

Neurological complications are the most crippling complications of spinal TB with incidences ranging from 10 to 43% in various reports. Although advancement in imaging techniques such as MRI has made the diagnosis of spinal TB so easy and effective that patients are treated before they develop any sort of neurological complications. But the dilemma of our age continues with the presentation of a significant population having severe neurological deficits due to spinal TB. The basic challenges for the diagnosis of spinal TB beforehand include the absence of concurrent pulmonary involvement and the unawareness of healthcare personnel in the developed world.<sup>21</sup> Tuli et al,<sup>21</sup> reported that out of a total of 1,074 cases of osteoarticular tuberculosis, 440 cases affected the spine. Spinal tuberculosis can affect any age and gender. When tuberculous disease was ubiquitous throughout the world, spinal tuberculosis was found to be most common in the early 30 years of life.<sup>8</sup> In recent decades, with the near abolition of tuberculosis in developed countries and preventive measures undertaken in poorer countries, there seems to be a shift in the incidence to older age groups.<sup>22</sup> Clinically, spinal TB presents categorically as (1) the systemic illness; (2) the vertebral lesion, and (3) neurologic

involvement along with classic symptoms of tuberculosis such as malaise, pyrexia, loss of appetite and weight, and night sweats. Backache is a chief clinical feature.<sup>23</sup> Patients usually present with stiff, painful necks and spasms of paravertebral muscles. The associated localized muscle spasm is so characteristic, that an experienced physician usually suspects the disease immediately. Angulation of the spine in the form of kyphosis or gibbous was seen in 95% of the cases seen by Tuli et al.<sup>21</sup> Weakness of the legs (69%), gibbous (46%), pain (21%), and a palpable mass (10%) were the most common clinical features seen in the 694 cases reported by Turgut.

## **MATERIAL AND METHODS**

### **Study Design & Setting**

A descriptive case series study was conducted at the Neurosurgery department of Mayo Hospital through OPD. The duration of the study was one year from 01-01-2020 to 31-12-2021 from the date of research proposal approval. The same group of patients was compared before and after the intervention and the efficacy of the intervention (Anterior cervical decompression, fusion, and plating) was seen.

### **Sample Size & Sampling Technique**

A sample size of 36 patients was calculated by using an 80% confidence interval, a 10% margin of error, and by taking an expected percentage of post-operative Nurick's grade '0' in 31.25% of patients. We took 36 patients as our sample. A nonprobability purposive sampling technique was used. Since it was a hospital-based study with no sampling framework available so all consecutive patients with cervical spine tuberculosis meeting inclusion criteria were studied until the sample size was achieved.

### **Inclusion Criteria**

The subjects (12 to 65 years of age) with cervical spine caries who needed anterior cervical decompression and plating operated by the department of Neurosurgery, KEMU/Mayo Hospital were included. Patients of the lower cervical spine (C3 – C7) willing to participate, were included. The patients were referred to the Neurosurgery department of Mayo Hospital from other departments of Mayo hospital were also included. Only data from patients who satisfied the inclusion criteria were obtained. If the patient was capable of providing informed permission, it was obtained from their nearest relatives.

### **Exclusion Criteria**

Individuals having caries of craniocervical junction or C1 – C2 were not included. Patients with lower cervical spine caries (C3 – C7) having no cord compression were excluded. Patients with lower cervical spine caries whose cervical spine is stable or patients who were unfit for general anesthesia were also not included. The patients who were not part of the study were treated according to ward policy, but they were not included in the study.

### **Data Collection Procedure**

Initially, approval was obtained from the University and the Neurosurgery department to gather data. Patients presenting to the Neurosurgery outpatient department of Mayo Hospital, Lahore, with complaints of symptoms linked with cervical spine caries were given a complete history and related neurological evaluation. After collecting a history, an examination was performed, and the cervical spine TB was confirmed using an MRI plain and contrasted cervical spine. All preoperative examinations and anesthetic readiness for general anesthesia were conducted either outdoors or inside. With all investigations completed,

anesthetic fitness was obtained, 1 to 2 pints of blood arranged, and then the patient was placed on the elective surgery list.

Subjects who provided consent were fit for general anesthesia and satisfied the inclusion criteria were then interviewed for a detailed history, and a neurological assessment was done before surgery. Anterior Cervical Decompression is a surgical approach in which the cervical spine was approached from its anterior aspect and compression of the cord due to caries is removed. Fusion is a placement of an autologous bone graft in the gap between two vertebral bodies after debridement and decompression and plating is the placement of a titanium plate and screws to hold the bone graft in place.

Under the supervision of the researcher, post-surgical neurological examinations were performed on the 1st, 7th, 21st, and 42nd days, as well as the 3rd and 6th months after surgery. The patient's neurological evaluation on the first postoperative day was performed in the ward, but the assessment on the seventh, twenty-first, and forty-second days was performed in the neurosurgical ward or outpatient department, depending on the day of operation. The Performa was validated with the assistance of a neurosurgeon and a statistician.

### **Assessment of Neurological & Functional Outcome**

It was measured in terms of Muscle power measured by MRC <sup>38</sup>grade as follows: 0: no contraction; 1: flicker contraction; 2: movement with gravity eliminated; 3: the movement against gravity; 4: the movement against resistance, and 5: normal strength. The functional status according to Nurick grade <sup>39</sup> is as follows: 0: no contraction; 1: flicker contraction; 2: movement with gravity eliminated; 3: the movement against gravity; 4: the movement against resistance and 5: normal strength. Both will be recorded before surgery and on the 1st, 7th, 21st, & 42nd days

and the 3rd, and 6th months after the surgery.

For standardized and unbiased results, the surgery was performed by a senior and expert neurosurgeon only, and all patients were operated on under General Anesthesia with an Endotracheal tube, no leading questions were asked, and events that required intense recall were not asked, all patients giving consent and meeting inclusion criteria in consequent fashion were taken to eliminate selection and sampling bias.

### **Data Analysis Procedure**

The data on cervical spine caries levels, age, and sex were collected on a proforma. The collected data was entered and analyzed by SPSS version 25.0. Quantitative variables like age, MRC score, and Nurick's grades were analyzed as mean and standard deviation. The Post-operative finding was compared with pre-operative status and by paired t-test. Similarly, the association between gender and age with MRC and Nurick's grade was done independent sample t-test. P-value  $\leq 0.05$  will be considered significant. All tests were 2-tailed.

## **RESULTS**

This descriptive study aimed to assess improvement in motor power of cervical spine tuberculosis with Anterior Cervical Corpectomy and Fusion to compare the findings with a similar historic study. This study was conducted on 36 patients with caries spine (C3 to C7 level) admitted to the Neurosurgery department of Mayo Hospital and those referred from other departments of Mayo hospital to the Neurosurgery department.

### **Age & Gender Distribution**

The mean age of the patients was  $37.0 \pm 14.4$  years. Patients' ages ranged from 15 to 61 making



the median age 37.5 years. Sex distribution of the patients was fairly male-dominant (M = 64%, F = 36%).

### Levels of Cervical Caries Spine and MRC & Nurick Grading

The majority of patients had C5 caries spine (n = 10; 28%) and the least had C7 caries spine (n = 5; 14%) (Table 1). Most of the patients had pre-operative MRC grade 3 (n = 15, 41.7%), 1 patient had MRC grade 1 and none had grade 5 power (Table 2). None had pre-operative Nurick's grade 0 or 1, the majority had Nurick's grade 5 (n = 20, 55.6%) (Table 3).

**Table 1:** Level of cervical caries spine (MRI) n = 36.

Level	Percentage
C3	6 (17%)
C4	8 (22%)
C5	10 (28%)
C6	7 (19%)
C7	5 (14%)

**Table 2:** Pre-operative MRC grades.

Grade	Number	Percentage
1	1	2.8
2	9	25
3	15	41.7
4	8	22.2
5	0	0.0

**Table 3:** Pre-operative Nurick classification.

Grade	Number	Percentage
4	7	19.4
3	8	22.2
2	1	2.8
1	0	0.0
0	0	0.0

### Complications

The complication rates were minimal in all patients postoperatively (see Table 4). Among 36 patients, only 6 had post-operative hoarseness of voice (17%). Nearly one-third (31%) of the patients had post-operative dysphasia which improved by 3 weeks. None of the patients had iatrogenic esophageal perforation or tracheal injury. Only 2 (6%) patients had complications related to graft and hardware dislodgement till the follow-up period of 6 months from the 1<sup>st</sup> postoperative days. One person (3%) developed a new neurological deficit in the form of deterioration of muscle power measured by MRC grade during 6 months' follow-up time. Infection rates (6%) and secondary or reactionary hemorrhage rates were also very less (3%).

**Table 4:** Postoperative complications.

Complication	Yes	No
Horsens of voice	17%	83%
Dysphasia	31%	69%
Esophageal perforation	0%	100%
Tracheal injury	0%	100%
Graft/Hardware dislodgement	6%	94%
New neurological deficits	3%	97%
Infection	6%	94%
Bleeding/Hemorrhage	3%	97%

### Comparison of Preoperative MRC Grades with Postoperative MRC Grades

As compared to pre-operative MRC grades on every post-operative follow-up period, the muscle power had increased substantially with p < 0.001 every time. The minimal power (pre-operative) was 2.7 on average which had increased to 4.4 on the last follow-up (6 months). On every increase in the postoperative day, there was a positive increase in muscle power (paired t-test) (Table 5).

**Table 5:** Comparison of preoperative MRC grades with postoperative MRC grades.

MRC	Mean	SD	P value*
Preoperative MRC value	2.7	1.1	-

7 <sup>th</sup> Postoperative day MRC value	2.9	1.2	0.001
14 <sup>th</sup> Postoperative day MRC value	3.1	1.4	0.001
21 <sup>st</sup> Postoperative day MRC value	3.5	1.4	0.001
42 <sup>nd</sup> Postoperative day MRC value	3.9	1.3	0.001
3 <sup>rd</sup> Postoperative month MRC value	4.1	1.4	0.001
6 <sup>th</sup> Postoperative month MRC value	4.4	1.3	0.001

\*P value significant by paired t-test (2-tailed)

### Comparison of Postoperative MRC Grades According to Gender & Age

Although there was a significant improvement in MRC grade in post-operative periods as compared to the pre-operative status it was neither dependent on basis of gender (Table 6) nor age (Table 7) of the patient (p not significant in most of the post-operative follow-up durations).

**Table 6:** Comparison of postoperative MRC grades according to gender.

Post-op	Postoperative MRC Values			t- test Value	P value
	Gender	Mean	SD		
7 <sup>th</sup> POD	Male	3.0	1.1	0.36	0.72
	Female	2.9	1.4		
14 <sup>th</sup> POD	Male	3.4	1.1	1.22	0.23
	Female	2.8	1.8		
21 <sup>st</sup> POD	Male	3.7	1.0	1.50	0.14
	Female	3.0	2.0		
42 <sup>nd</sup> POD	Male	4.3	0.8	2.14	0.04*
	Female	3.4	1.8		
3 <sup>rd</sup> POM	Male	4.4	0.8	1.80	0.08*
	Female	3.6	2.0		
6 <sup>th</sup> POM	Male	4.7	0.8	1.64	0.11
	Female	3.9	1.9		

Key: POD: Post Operative Day; POM: Post Operative Month  
\*P values for independent sample t-test (significant results)

**Table 7:** Comparison of postoperative MRC grades according to Age.

MRC	Mean	SD	P value*
7 <sup>th</sup> Postoperative day	2.9	1.2	0.45
14 <sup>th</sup> Postoperative day	3.1	1.4	0.19
21 <sup>st</sup> Postoperative day	3.5	1.4	0.25
42 <sup>nd</sup> Postoperative day	3.9	1.3	0.54
3 <sup>rd</sup> Postoperative month	4.1	1.4	0.50
6 <sup>th</sup> Postoperative month	4.4	1.3	0.78

\*P values for independent sample t-test (all insignificant results)

### Comparison of Preoperative Nurick Grades with Postoperative Nurick Grades

As compared to pre-operative Nurick’s grade on every post-operative follow-up time, there was an increase in Nurick’s grade (0 being the best and 5 being the worst grade). Pre-operatively average Nurick’s grade was 4.3 which on the last follow-up was 2.3, but still, none of the patients got a grade of 1 or 0. In terms of pre-operative status, all follow-up improvements were statistically significant by paired t-test (p < 0.001) (Table 8).

**Table 8:** Comparison of preoperative Nurick grades with postoperative Nurick grades.

Nurick’s Grade	Mean	SD	P value*
Preoperative	4.3	1.0	-
7 <sup>th</sup> Postoperative day	4.1	1.0	0.001
14 <sup>th</sup> Postoperative day	3.9	1.1	0.001
21 <sup>st</sup> Postoperative day	3.4	1.3	0.001
42 <sup>nd</sup> Postoperative day	2.9	1.4	0.001
3 <sup>rd</sup> Postoperative month	2.5	1.5	0.001
6 <sup>th</sup> Postoperative month	2.3	1.6	0.001

P values (all significant results)

### Comparison of Postoperative Nurick’s Grade according to Gender & Age

Although there was a significant improvement in Nurick’s grade in every follow-up post-operatively the relationship didn’t depend on gender (Table 9) or the age of patients. Improvement of grade

showed the same results despite age or gender (P values insignificant) (Table 10).

**Table 9:** Comparison of postoperative Nurick's grade according to gender.

Post-op	Postoperative Nurick's Grades			t- test Value	P value*
	Gender	Mean	SD		
7 <sup>th</sup>	Male	4.2	1.0	1.1	0.30
POD*	Female	3.9	1.0		
14 <sup>th</sup>	Male	3.9	1.1	0.06	0.95
POD	Female	3.9	1.1		
21 <sup>st</sup> PO	Male	3.4	1.2	-0.16	0.87
D	Female	3.5	1.5		
42 <sup>nd</sup>	Male	2.9	1.2	-0.02	0.98
POD	Female	2.9	1.7		
3 <sup>rd</sup>	Male	2.5	1.4	-0.03	0.98
POM**	Female	2.5	1.8		
6 <sup>th</sup>	Male	2.2	1.5	-0.16	0.87
POM	Female	2.3	1.8		

Key: POD: Post Operative Day; POM: Post Operative Month  
 P values for independent sample t-test (all insignificant results)

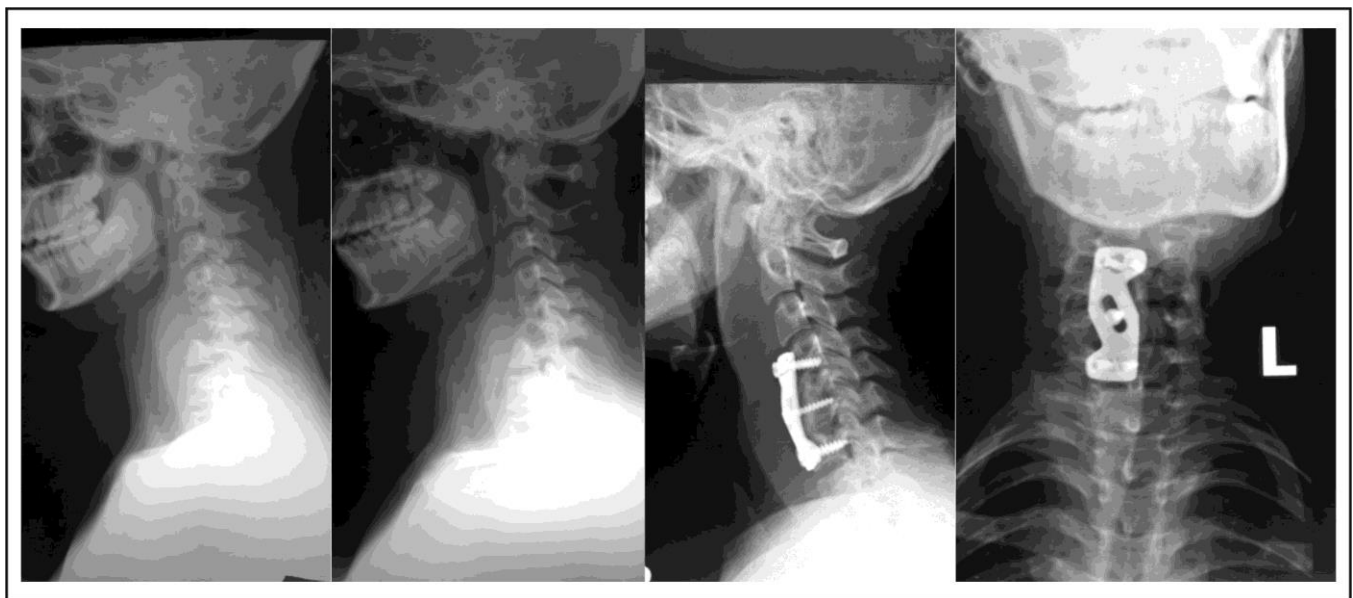
**Table 10:** Comparison of postoperative Nurick's grade according to Age.

Nurick's Grade	Mean	SD	P value
7 <sup>th</sup> Postoperative day	4.1	1.0	0.64
14 <sup>th</sup> Postoperative day	3.9	1.1	0.39
21 <sup>st</sup> Postoperative day	3.4	1.3	0.60
42 <sup>nd</sup> Postoperative day	2.9	1.4	0.62
3 <sup>rd</sup> Postoperative month	2.5	1.5	0.27
6 <sup>th</sup> Postoperative month	2.3	1.6	0.17

P values (all insignificant results)



**Figure 1:** Fusion of cervical vertebrae through anterior approach (Pre-op diseased vertebrae on MRI).



**Figure 2 (a & b):** Pre-op; (c & d): Post-op.



## DISCUSSION

The current study assessed improvement in motor power of cervical spine tuberculosis with Anterior Cervical Corpectomy and Fusion in 36 patients with caries spine (C3 to C7 level). The patients' average age of our patients was 37 years. The majority of patients (28%) had C5 caries spine, whereas just 14% had C7 caries spine. The majority of the patients (41.7%) had a pre-operative MRC grade of 3. The majority (55.6%) had Nurick's grade 5. 17% of patients experienced postoperative hoarseness. 31% of patients experienced post-operative dysphasia, which improved after 3 weeks. During the 6-month follow-up period, 3% acquired a new neurological deficiency in the form of worsening muscular strength as determined by MRC grade. Muscle power has grown significantly in every post-operative follow-up period when compared to pre-operative MRC grades. Every postoperative follow-up time, Nurick's grade increased when compared to the pre-operative Nurick's grade. All follow-up improvements in pre-operative conditions were statistically significant.

A previous study mentioned that patients with spinal caries with severe neurological deficits were treated with corpectomy and fixation.<sup>24</sup> According to this report, 78% of cases had full neurological recovery at twelve months. 44 patients were analyzed in his study with spinal caries with paraplegia or quadriplegia, and 63% of cases show full recovery treated with surgery reported by Tuli et al.<sup>21</sup> Several other studies demonstrated rates of recovery ranging from 53.1 to 83.1% post-surgery.<sup>1,14</sup> A good prognosis after surgery in young patients was noticed in a comparative study by others.<sup>2,25</sup> It was noted that spinal cord ischemia caused by compression can be compensated with dilation of arteries but in elderly patients, the likelihood of ischemia is more due to spinal cord compression that leads to defective recovery of neurological deficit and this is due to arteriosclerosis which reduces arteriolar

dilation.<sup>8,10,5,6</sup> After anterior cervical decompression fusion and plating surgery in 76% of his cases with spinal tuberculosis and paraplegia or quadriplegia having compression at the dorsal spine noticed partial or complete recovery, compared with 83% at other levels. Moon and associates<sup>26</sup> noticed a higher incidence of paraplegia in cases with tuberculosis of the spine involving the dorsal region and noted a recovery in 86% of the latter patients compared with 91% in those with spinal tuberculosis at other levels. It has been reported that the thoracic spine and extramedullary tumors show poor recovery. The narrow diameter of the spinal canal at a thoracic level as compared to the cord explains the given finding. The current series shows a trend toward defective recovery in individuals with compression at the dorsal spine, 81% improved to Frankel D/E compared with 100% in whom compression affected other levels of the spine.<sup>4-5</sup>

Moula et al,<sup>27</sup> noticed that the duration of the neurological deficit did not affect improvement after surgical management whereas Moon<sup>28</sup> noted that in cases with spinal tuberculosis and paraplegia who were treated 6 months after developing neurological deficit shows poor prognosis. Post anterior cervical decompression fusion and plating followed by anti-tuberculous therapy, a large number of patients with tuberculosis of the spine and severe neurological deficits show significant recovery in sensory/motor symptoms like bladder control, spasticity, and pain. Prognosis is poor in older patients more than 52 years of age, in individuals with dorsal pathology, and in cases who were treated by posterior approach for anterior pathology, recovery experienced by cases with Frankel Grade A/B (Grade 0/5 lower limb power on admission) operated with anterior cervical decompression fusion and plating is comparable with that experienced in patients with Frankel Grade C.

The neurological deficit, degree, and extent of the neurological deficit depend on the site of the disease, the direction of spread, and the pathological changes produced<sup>8</sup>. While usually, the symptoms at the beginning of the disease are slow and progressive, in a few patients the paraplegia is sudden in onset and often complete. This is probably due to the higher incidence of neurological morbidity in these cases and to the increasing use of the CT scan and magnetic resonance (MRI).<sup>29</sup> Kumar studied 27 cases of tuberculous involvement of the posterior elements of the spine and proposed a four-point classification based on the site of the lesion, the stage of the lesion, the presence of associated lesions, and neurological deficits. Baibus and Garbuz have, after studying 2,500 patients with tuberculosis of the spine, also classified the neurological condition into five grades.<sup>30</sup>

Carry spine may now be diagnosed quickly thanks to recent developments in technology in spinal MRI. Non-operative therapy has grown more successful, especially in instances discovered early, thanks to anti-tuberculous medications that reach pus, granulation, caseous material, and bone. The indications for surgery, as well as the degree of operative decompression, are well known. Rajasekharan et al,<sup>31</sup> believe that surgery is appropriate in cases of tuberculous infection of the lumbosacral area in children younger than 10 years old since they have a larger kyphosis. When one considers spinal instability related to tuberculosis it is essential to remember that the pathophysiology is different compared to trauma. Pathological fractures, involvement of the anterior and posterior spinal elements, translation or dislocation of the destroyed vertebrae, and long-segment disease with kyphosis should all be considered signs of instability. Mehta and Bhojraj<sup>26</sup> proposed a classification system using MRI, dividing patients into four groups based on the treatment received. In their opinion, the appropriate surgery for each case could be planned based on MRI findings.

Vertebral body lesions should be decompressed anteriorly. A posterior decompression, such as a laminectomy, is not suggested since it eliminates a healthy part of the spinal column and makes the spine unstable. The anterior technique is now established as the preferred strategy in the cervical spine. A transthoracic transpleural technique provides great exposure to the affected segments in the case of thoracic TB. However, in the context of reduced pulmonary function, systemic morbidity factors, and severe illness, the risk of surgery rises, and extrapleural anterolateral exposure may be considered. According to Jain et al., the extrapleural anterolateral technique allows the surgeon to do anterior decompression as well as posterior instrumentation at the same sitting with less morbidity. Retroperitoneally, the lumbar and lumbosacral spines can be reached. Few surgeons have employed video-assisted thoracoscopic surgery (VATS) for short-segment illness where there is no lung disease, and notably for biopsy or decompression of a cold abscess.<sup>32</sup>

The surgeon should be prepared to convert to an open thoracotomy at all times. Jain and Dhammi found, in their review patients underwent anterior or posterior instrumentation for tuberculous spondylitis. Of the cases reviewed, the kyphosis correction on instrumentation was 30–35 degrees pre-operatively to 15–18 degrees post-operatively. On follow-up, the loss of kyphosis correction was a mean of two degrees for those who underwent posterior instrumentation and 2.3 degrees for those patients who underwent anterior instrumentation. While the majority of authors prefer to stabilize the diseased segments using internal fixation, Moorthy et al,<sup>3</sup> found good clinical and radiological outcomes in patients with subaxial cervical spine tuberculosis who were not instrumented. Klockner and Valencia,<sup>33</sup> in a retrospective study, concluded that in single-level disease with no major substance loss, anterior debridement and grafting alone were adequate. They recommend the use of instrumentation in

the presence of multi-level disease and extensive kyphotic deformity. Rajasekaran et al,<sup>31</sup> believe that there is an average increase of 15 degrees of deformity in all patients who are treated conservatively and 3–5% of patients finally have a deformity that is greater than 60 degrees. Surgery, therefore, must be done early and stabilization by instrumentation gives a good result. Various types of implants have become available to the surgeon to internally stabilize the spine. Despite the availability of biomechanically better systems, Jain and Dhammi argued that in some cases, especially in long-segment disease, fixators like the Hartshill rectangle are still a reasonable option as they take purchase against the posterior healthy segment of the vertebra and a single healthy vertebra on either side of the diseased segment could give adequate stabilization. Many authors presently prefer anterior instrumentation done at the same sitting as the debridement<sup>34</sup>.

Ramani et al.<sup>35</sup> reporting on a mean 36-month follow-up of 61 patients with subaxial cervical spine tuberculosis found that anterior reconstruction of the column using titanium plates and locking screws provides segmental stability and is a useful adjunct in preventing a kyphotic deformity. Benli et al,<sup>36</sup> comparing anterior instrumentation systems did not find any significant difference between rod-screw and plate instrumentation systems even at 5 years follow-up. However, some still prefer posterior instrumentation following an anterior decompression. Moorthy et al.<sup>3</sup> proposed surgical management for tuberculosis involving the cervical spine, in their research. The diagnosis was established upon findings on radiology, a Philadelphia collar was applied to immobilize the patients, and bed rest was advised. One patient was placed on cervical traction preoperatively. Then central corpectomy was done in all the patients (in 2 cases it was limited to a diseased bone curettage) with traction over the cervical spine and tricorticate autologous bone graft from

the iliac crest while all kinds of instrumentation were avoided. For one patient who is also having sickle cell anemia, slippage of graft occurs, and the patient re-operated for graft repositioning and posterior stabilization including interspinous wiring and bone graft done two days after the first surgery. Under G/A, the patient was positioned supine with and slight extension of the neck, and an incision along the neck crease was made to reach prevertebral space. Then prevertebral abscess if the present was drained and granulation tissue was curetted. Eroded bone was drilled and removed until the healthy bone was identified in all directions. Violations of normal disc space were avoided as far as possible. Where there is one-third or less body erosion noticed there the residual bone is used to make the surface that can accept graft and results in firm bony fusion. About 16 mm of width was the limit of the decompression. Under the operating microscope, the posterior cortex was drilled to reach the epidural space. The spinal cord was not exposed in any case. Pus collected in the ventral extradural space was evacuated. Granulation tissue in the epidural space was not disturbed to save the dural tube from injury if in any case it is strongly adherent to the dura and only bony elements and disc material compressing the ventral spinal canal were removed. The tricortical autologous graft of bone that has been obtained from the iliac crest was placed under traction. Then after the placement of the drain wound was closed. Postoperatively, three patients were allowed for mobilization just after surgery, the rest of the eleven patients remained on bed rest for 4 to 6 weeks and were mobilized gradually. Philadelphia collar applied for six months. All cases received anti-tuberculous therapy with isoniazid (5 mg/kg daily), rifampicin (10 mg/kg daily), ethambutol (15 mg/kg daily) for the first three months followed by isoniazid and rifampicin for another 15 months.<sup>3</sup>

## CONCLUSION

The majority of the patient was young adults who suffered from cervical caries, where the C5 cervical spine was the most affected vertebrae with the majority having pre-operative MRC and Nurick's grade respectively 3 and 5. Major postoperative complications were hoarseness of voice and dysphasia. Muscle power by MRC grade increased from an average of 3 to 4.4 at the end of 6 months but it was not dependent on gender and age, while Nurick's score decreased from 4.3 to 2.3 at the last follow up which was not dependent on gender and age.

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## Additional Information

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**Ethical Review Board Approval:** The study conformed to the ethical review board requirements.

**Human Subjects:** Consent was obtained by all patients/participants in this study.

### Conflicts of Interest:

In compliance with the ICMJE uniform disclosure form, all authors declare the following:

**Financial Relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.

**Other Relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.



### AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Shahzaib Tasdique	1. Study design and methodology.
2.	Zainab Sarwar	2. Paper writing.
3.	Sania Javed	3. Data collection and calculations.
4.	Samra Majeed	4. Analysis of data and interpretation of results.
5.	Waqas Mehdi	5. Literature review and referencing.
6.	Azam Niaz	6. Editing and quality insurer.