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ORIGINAL ARTICLE

Single Stage Surgical Management of Primary Cervical Spondylodiscitis: Minimum 2 years results

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ABSTRACT

Introduction Cervical Spondylodiscitis (CSD) is a serious medical condition that includes spondylitis, discitis, or both. CSD is a dilemma in spine surgery regarding the diagnosis and treatment. Major long-term morbidities or even fatalities may result from any delay in the diagnosis or treatment of the condition. This work is an account of our Institution's experience in the handling of severe and challenging situations. **Methods:** The current study retrospectively evaluated 15 patients who were diagnosed with primary CSD and were managed between May 2018 and July 2021, by single-stage surgical procedure (debridement, anterior corpectomy, and plate fixation with titanium cage with autogenous bone graft) in Zagazig University Hospitals, Zagazig, Egypt. With a minimum of 2 years follow-up (mean 27.4 ±3.9) months, Assessments included preoperative criteria (risk factors, affected levels, symptoms, and signs) and postoperative radiologic and clinical outcomes; VAS (Visual Analogue Scale) and ASIA (American Spinal Injury Association) impairment scale.**Results:** CSD in all the patients was eradicated, and their infection lab tests normalized with no recurrence by the end of the follow-up period. The fusion was achieved in 14 out of 15 patients (93.3%) in the meantime (5.6 ± 2.3SD) months, implant failure and subsequent kyphotic deformity occurred in one patient (6.6%) developed 6 months postoperative. The preoperative mean VAS (8.3 ± 0.88) decreased to a mean of (2.8 ±2) postoperatively, (P value < .001, degree of freedom DF=14). Neurological impairment was observed in 10 participants among whom 7 improved postoperatively (improvement rate was 70%). ASIA scale; improved in 7 patients (46.7%) (p=0.003, DF=14), showed no change in 8 (53.3%), and there was no worsened ASIA scale in any participant postoperative. **Conclusions:** Single Stage Surgical Management of primary Cervical Spondylodiscitis was successful in infection eradication with no recurrence, achieving a favorable fusion rate, realizing satisfactory VAS and ASIA results, with low overall complications.

Key Words: Cervical spondylodiscitis; Spinal infection; anterior corpectomy; cervical fixation; titanium cage

INTRODUCTION

Infection of the spine is an infrequent condition, representing around 1 to 7 % of all cases of osteomyelitis. Moreover, only a smaller proportion, 3 to 6%, of spinal osteomyelitis is limited to the cervical spine. Due to the bigger diameter of the cervical cord concerning the spinal canal and its considerable degree of mobility, any epidural abscess has the potential to provide catastrophic outcomes [1,2].

The majority of patients with CSD can be treated conservatively by immobilization and antibiotics (culture-specific) for 4 to 6 weeks minimum [3,4]. However, in complicated CSD (subdural abscess, neurologic impairment, persistent infection, instability, kyphosis, or any combination of these elements, early surgical intervention is strongly indicated to obtain a successful outcome [5,6]. The ultimate goal of the surgical treatment is to

eradicate the infection, manage neurological affection, and achieve stability preventing kyphosis [7].

After an extensive assessment of the existing literature, we found that the available (up to our best knowledge) recommendations are unclear, even controversial, with no solid guidelines for surgical management; some publications combined primary to postoperative CSD [8], another investigated cervical with dorsal or lumbar levels spondylodiscitis [9], and other researches described different surgical techniques either anterior, posterior or more than one stage procedures [10,11], and with or without fixation [12], thus standardization of the surgical procedures was not possible which is major limitation against achieving consensus among surgeons.

Our hypothesis is that Single Stage Surgical Management of Primary Cervical Spondylodiscitis can eradicate infection and minimize complications Therefore, we conducted this study to provide an account of a minimum 2 years' results of surgical management of Spondylodiscitis in a single institution, only in cervical vertebrae, primary infections only were included, through a standardized single stage (debridement, anterior corpectomy, and plate fixation with titanium cage with autogenous bone graft) aiming to eradicate infection and provide stability with the least possible complications.

METHODS

This retrospective analysis was conducted on 15 CSD patients who underwent single-stage surgical procedures by draining and debriding the affected site with anterior corpectomy and plate fixation with a titanium cage (with bone graft) aiming for fusion, between May 2018 and July 2021. Inclusion criteria for surgical treatment comprised one or more of the following: (1) patients who had persistent CSD, (2) failed medical treatment, (3) neurological affection, and/or (4) confirmed radiological bone necrosis, instability, or epidural abscess.

Ethical approval

The study was approved from the Institutional Ethics of the faculty of medicine. Zagazig University (ZU-IRB#10925-25/7-2024).Written informed consent was obtained from all the participants after explaining the details and benefits as well as risks to them. The study follows the Helsinki Declaration (1975), which is the World Medical Association's guideline of ethics for research involving human subjects

In the majority of instances, the CSD diagnosis could be achieved by the utilization of conventional X-ray imaging. However, the utilization of T1 gadolinium-enhanced MRI is advantageous for the detection of epidural abscesses in patients who have experienced neurologic impairment. In this study, all participants underwent (MRI) to confirm the diagnosis. In addition, computed tomography (CT) scans were utilized to assess the extent of bone damage and instability. Laboratory findings, such as white blood cell counts (WBC) with differential count, The erythrocyte sedimentation rate (ESR), and the C-reactive protein (CRP) were used as biomarkers confirming the diagnosis, assessing the severity of the condition, evaluating antibiotic effectiveness and termination of the antibiotic course (5).

The study sample included 10 males (66.7%), and 5 females (33.3%) with an age mean of 46.6± 14.5 years old (range 21-72). The scope of this study was focused on primary CSD, so post-operative CSD was excluded. The mean duration of symptoms for primary pyogenic CSD was found to be 8 days, but for TB CSD, it was 23.5 days. Comorbidities included: Diabetes Mellitus (DM 3 cases), renal failure (RF 2 cases), ischemic heart disease (IHD 3 cases), alcoholic liver cirrhosis (ALC 2 cases), Immuno-suppressive therapy(IT 2 cases), whereas no comorbidities were detected in 3 cases. The most frequent levels affected by CSD observed was C5-6 and C 3-4 (33.3% each), while the least were C5-6-7 and C4-5-6 (6.6% each) Figure (1). The predominant symptoms were posterior neck pain (PNP) with radiculopathy (40%), and PNP without radiculopathy (26.7%). Neck swelling was noticed in one case. Neurologic impairments were associated with varying degrees of cord compression by epidural abscesses in 10 cases (66.7%), and involved: radiculopathy (40%), paraparesis (20%), and quadriplegia (6.7%). Fever was noted in (53.3%) of cases, on the other hand, (60%) of participants had swallowing difficulties. Radiological detection of the presence of kyphotic deformity was found in (66.7%) of the sample. The details of this patient population are summarized in Table (1).

As a tertiary healthcare facility, all patients were referred to our institution while already undergoing antibiotic therapy. Following the surgical procedure, patients were maintained on empirical intravenous antibiotics. When the patients' hospitalization

duration concluded, they were transitioned to a regimen of oral antibiotics until the outcomes of culture and sensitivity were obtained.

Surgical technique:

A radical debridement and abscess drainage was performed to remove all diseased and necrotic tissues via a conventional anterior cervical approach. Intraoperative tissue sampling for later culture and smear analyses was conducted on the resected vertebral body. Anterior cervical corpectomy (ACC) was done in all subjects. Following a corpectomy and decompression procedure, thorough field irrigation was scrutinized using 3 L of saline with local antibiotic (garamycin 80mg or vancomycin 1gm. Afterward, a cervical titanium cage (filled with an iliac bone graft) was inserted into the void fitting the affected levels with the guidance of fluoroscopy, and a spanning locked anterior plate was used for fixation. The cage in conjunction with the plate subsequently provided an adequate correction of the alignment of the cervical spine, Figure (2).

Statistical Analysis

The criteria of our investigation included: the radiologic achieved fusion, implant failure, and kyphotic deformity recurrence. Clinical outcome scores included preoperative and post-operative VAS (Visual Analogue Scale) score and ASIA (American Spinal Injury Association) impairment scale. The statistical data was coded and analyzed using SPSS 20.0 software (IBM SPSS Inc., Chicago, IL), frequency tables were created for descriptive analysis, and Paired t-test was used to evaluate quantitative variables e.g. pre and post-operative VAS, Chi-square test was employed for the Qualitative variables assessment e.g. pre and post-operative ASIA, and correlations were identified using Pearson´s correlation coefficient(between quantitative variables), and Spearman correlation (between 1 quantitative and 1 qualitative variable) The P-value was set at <0.05 for significant results.

RESULTS

This study was carried out retrospectively on CSD cases operated between May 2018 and July 2021 in a single institute (Zagazig University Hospitals). The scope of our work is to report the results of a minimum of 2 years of follow-up. The mean follow-up period was 27.4 ±3.9 (range 24.2-37.9) months. After the surgical procedure; the infection subsided, and by the end of the antibiotics administration; all CSDs were resolved, which were confirmed by normal ESR, CRP, and WBC count. At the final follow-up visit, no recurrence of infections was detected. The causative bacteria identified in this study were Methicillin-resistant Staphylococcus aureus (MRSA) (n=6), Pseudomonas aeruginosa in (n=1), Methicillin-resistant coagulase-negative streptococcus in (n=1), TB CSD (n=4) and no growth was seen in culture (n=3). The mean period of antibiotics administration was 32.7 (22-66) days with IV (intravenous) antibiotics empirical first, then according to culture and sensitivity and followed by a mean period of 27.3 (12-57) days of oral antibiotics for primary pyogenic CSD, to be stopped if serum CRP measurements were ≤ 5mg/L for four weeks and the WBC and ESR were within normalized ranges. In the TB CSD 4 cases, a mean period of 182.9 days of HERZ; H (isoniazid; INH), E (ethambutol; EMB), R (rifampicin; RMP), Z (pyrazinamide; PZA) were administered.

Regarding the radiological evaluation of the research patients' outcomes, the overall therapeutic approach demonstrated favorable results, the fusion was achieved in 14 out of 15 patients (93.3%) in the meantime (5.6±2.3SD) months, the only non-union case(6.6%) had subsequent implant failure and in turn kyphotic deformity which developed 6 months postoperative, by then the infection already had subsided and patient refused further interventions Table (2).

Regarding clinical outcomes, The preoperative mean VAS (8.3 ± 0.88) decreased to a mean of (2.8 ±2) postoperatively, (P value < .001- degree of freedom DF=14) which is statistically significant. Neurological impairment was observed in 10 participants among whom 7 improved postoperatively. Neurological status pre and postoperative was assessed by the ASIA scale; showing improvement in 7(46.7%), no change in 8 (53.3%) of whom 33.3% had no preoperative impairments and 20% of the neurologically affected group, and there was no worsened ASIA score in any participant postoperative Table (3). Comparing preoperative and post-operative ASIA revealed a statistically significant p-value (p=0.003 -DF=14). The neurological improvement rate was 70%. According to the aforementioned data, satisfactory clinical outcomes were realized.

Correlations were statistically tested between preoperative criteria (age, sex, affected level, symptoms, fever, cord or root compression, Swallowing difficulty, and kyphosis) in addition to post-operative criteria (follow-up period, and identified causative organism) in one hand against

postoperative radiologic outcomes (achieved fusion, and complications) and clinical outcomes (post-operative VAS, and postoperative ASIA) on the other hand, but no significance could be yielded. In this study, there were no reoperated cases, esophageal perforation, mediastinitis, or mortalities. Cases are presented in Figure (3) and Figure (4).

Table (1): Preoperative demographics and clinical data:

case	*Sex*	*Age (yrs.)*	*Co-morbidities*	*Etiology*	**level**	*symptoms*	*fever*	*Swallowing difficulty*	*Cord or root compression*	*Kyphotic deformity*
1	F	50	DM	primary	C6-7	PNP and radiculopathy	N	N	Y	N
2	M	52	RF	primary	C6-7	PNP and radiculopathy	N	N	Y	N
3	M	56	RF	primary	C5-6	PNP and radiculopathy	N	N	Y	Y
4	M	72	IHD	primary	C3-4	Quadriplegia	Y	N	Y	Y
5	M	56	ALC	primary	C5-6-7	Paraparesis	Y	N	Y	Y
6	M	21	ALC	primary	C3-4	Neck swelling	Y	Y	N	Y
7	F	63	IT	primary	C5-6	PNP and radiculopathy	N	Y	Y	N
8	F	26	DM	primary	C3-4	PNP and radiculopathy	N	N	Y	Y
9	F	30	IT	primary	C3-4	PNP and radiculopathy	Y	N	Y	Y
10	F	43	-	primary	C5-6	PNP	Y	N	N	N
11	M	30	IHD	primary	C5-6	PNP	N	N	N	N
12	M	59	DM	primary	C3-4	PNP	N	N	N	Y
13	M	44	IHD	primary	C5-6	PNP	Y	Y	N	N
14	M	49	-	primary	C4-5	Paraparesis	Y	Y	Y	Y
15	M	52	-	primary	C4-5-6	Paraparesis	Y	Y	Y	Y

F; Female, M; Male, PNP; posterior neck pain. DM; Diabetes Mellitus. RF; renal failure, IHD; ischaemic heart disease, ALC; acoholic liver cirrhosis , IT; Immuno- suppressive therapy.

Table (2): Pre and Postoperative criteria and clinical data :

case	Follow Up (months)	pathogen	Antibiotic sensetivity	ASIA Pre	ASIA post	VAS Pre	VAS Post	Achieved fusion	Complications
1	25	MRSA	VM	B	D	9	2	Y	
2	24.2	MRSA	VM+AMG	D	E	7	1	Y	
3	34.5	MRCNS	VM+AMG	C	D	9	3	Y	
4	24.7	MRSA	VM	A	A	9	6	N	implant failure Kyphosis
5	37.9	MRSA	3rdCefa+VM	B	E	8	2	Y	
6	25.5	Mycobacterium tuberculosis	HERZ	E	E	7	1	Y	
7	24.2	P. aeruginosa	3rdCefa+AMG	B	D	7	1	Y	
8	25.5	Mycobacterium tuberculosis	HERZ	C	D	8	2	Y	
9	27.1	Mycobacterium tuberculosis	HERZ	D	E	9	4	Y	
10	29.6	No growth	VM	E	E	8	3	Y	
11	27.1	Mycobacterium tuberculosis	HERZ	E	E	9	2	Y	
12	26.6	MRSA	3rdCefa+VM+AMG +CM	E	E	9	1	Y	
13	25.8	MRSA	VM	E	E	7	1	Y	
14	29.4	No growth	3rdCefa+AMG	B	B	9	7	Y	
15	24.6	No growth	VM	B	B	9	6	Y	

MRSA ; Methicillin resistant staphylococcus aureus , MRCNS ; Methicillin resistant coagulase negative streptococcus, TB; Tuberculosis, P. aeruginosa; Pseudomonas aeruginosa, VM; Vancomycin, AMG; aminoglycoside, 3rd Cefa; 3rd generation cephalosporin, HERZ; H (isoniazid; INH), E (ethambutol; EMB) , R (rifampicin; RMP), Z (pyrazinamide; PZA), CM; Cindamycin

Table (3) : Summary of pre and post operative neurological status according to ASIA scale

Preop	*Numbers Patients*	*Improved (%)*	*No change (%)*	*Worsened (%)*
ASIA A	1	0	1 (100%)	0
ASIA B	5	3 (60%)	2 (40%)	0
ASIA C	2	2 (100%)	0	0
ASIA D	2	2 (100%)	0	0
ASIA E	5	0	5 (100%)	0

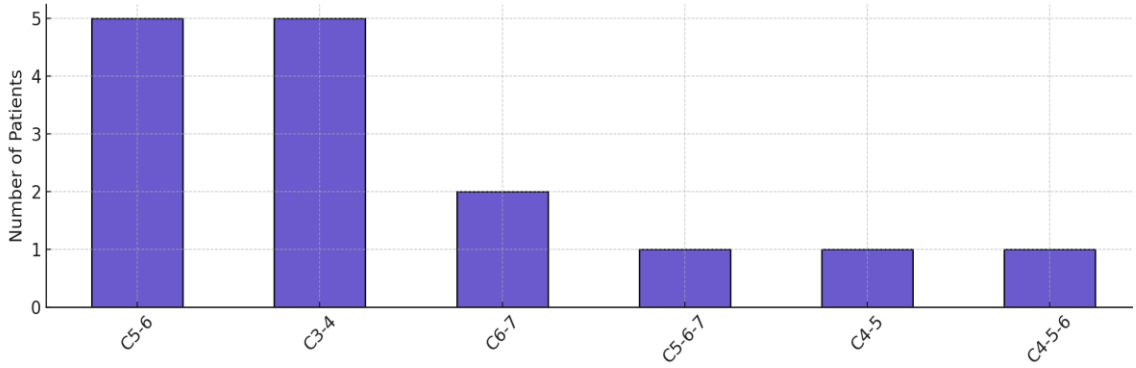


Figure (1) : Number of patients regarding levels of the affected segments.

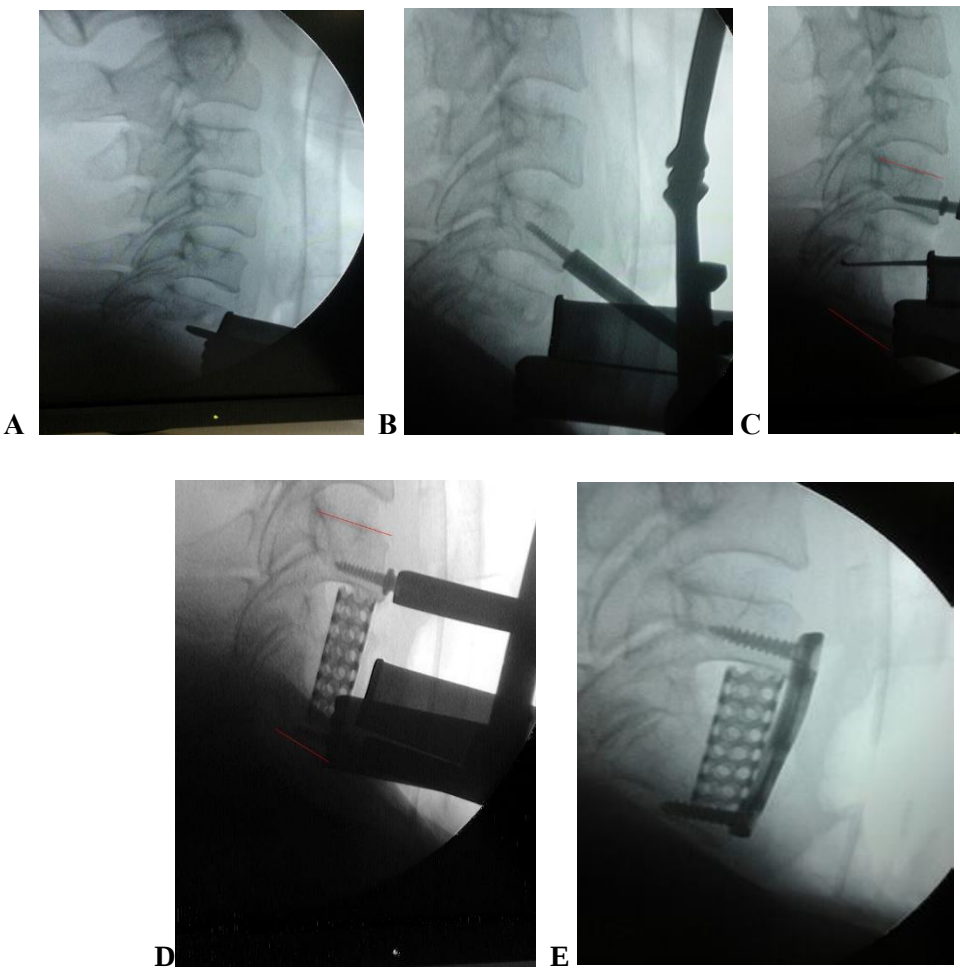
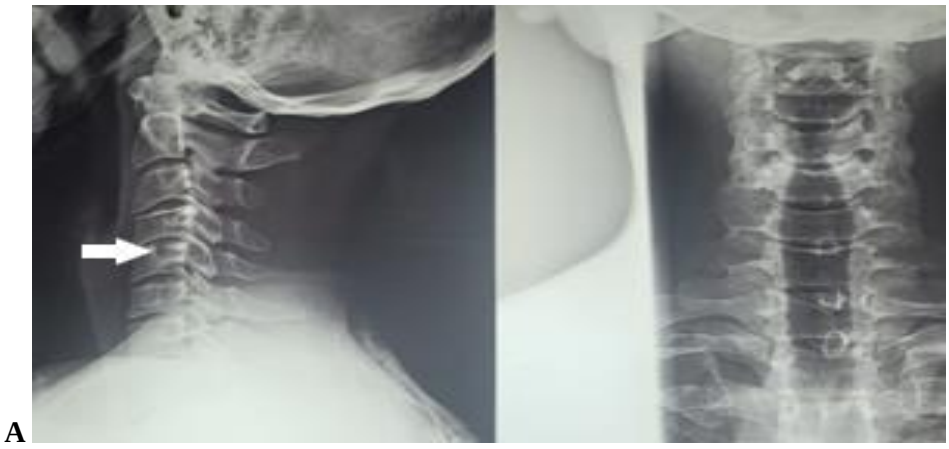


Figure (2) [A,B,C] : sequential c- arm images for distraction ,corpectomy and realignment, []D :Titanium cage applied after alignment restored , [E]: final construct with anterior bridging plate.



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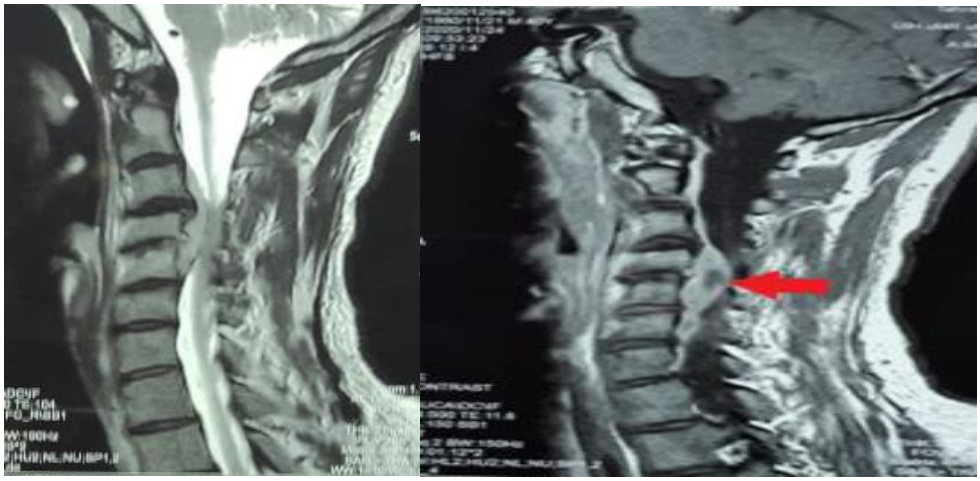
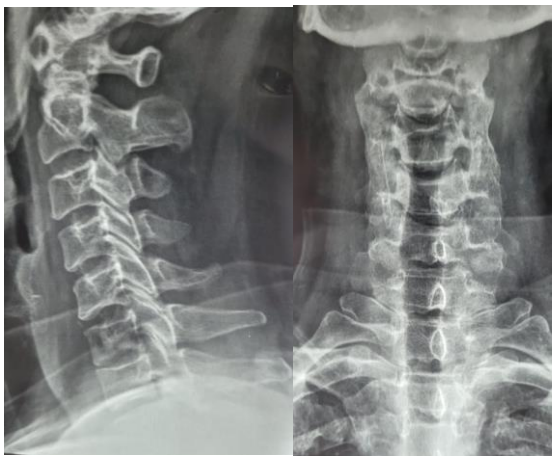


C

Figure (3) [A]: preoperative x-rays anteroposterior and lateral views, upper end plate of C5 is eroded (white arrow) , [B]: T1 and T2 MRI sequences showing C4-5 CSD with abscess formation (red arrow) severely encroaching the spinal cord,[C] : Final follow up x-rays anteroposterior and lateral views .

A



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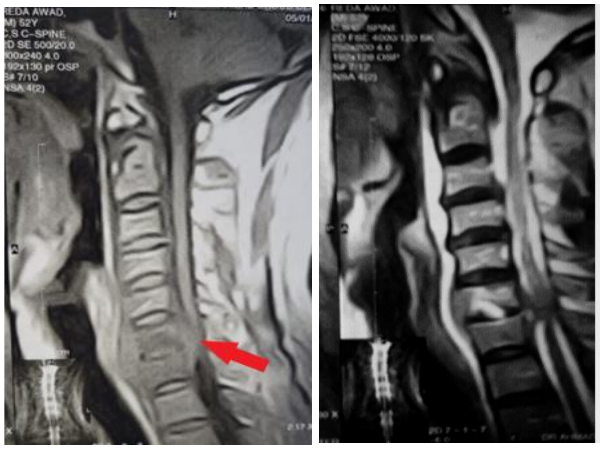


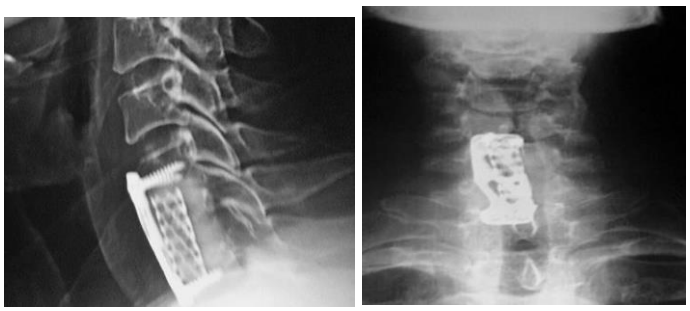
C 

Figure (4)[A]: preoperative x-rays anteroposterior and lateral views, C6-7 segment level affected , [B]: T1 and T2 MRI sequences showing C6-7 CSD with abscess formation (red arrow) severely encroaching the spinal cord, [C] : Final follow up x-rays anteroposterior and lateral views after C6 complete corpectomy and partial C7 corpectomy and plate applied from C5 to C7.

DISCUSSION

Specific CSD like TB is less frequent than Pyogenic non-specific CSD cases [13,14]. We recorded four tuberculous cases, while 11 were non-specific pyogenic CSD. Age mean was 46.6± 14.5 years old (range 21-72) in this study, Which was younger than the mean age in most literature which found that CSD affects mainly geriatric patients [15,16,17] In the current study prevalence of comorbidities may represent an explanation of occurrence of CSD in middle age group.

Conservative treatment is the first line of CSD, which is routinely managed in our institution as outpatient cases. This is only possible as long as they are not indicated for admission, in mild early conditions caused by susceptible organisms with early response to culture-specific antibiotics and cervical immobilization. CSD cases that were managed non-operatively were not included in this study. As a referral tertiary center, Zagazig University hospitals receive mostly complicated CSD cases. These cases had one or more strong indications for surgery. The association between CSD and the presence of major health comorbidities (80% in this study) leaves a little margin of success for conservative management. Health comorbidities lead to organ insufficiency (liver, kidney), decreasing the functionality of antibiotics and increasing the side effects of their prolonged use. In addition, the comorbidities make patient compliance with immobilization questionable, which decreases the chances of stability. Surgery in complicated CSD, contrary to conservative treatment decreases the bacterial load, increases the efficiency of antibiotics, and provides reliable stability [18,19].

The imaging protocol which is adopted in this study was: [1] standard Plain X-ray, which was done in all cases for diagnostic and follow-up
purposes as well. It showed 82% sensitivity, and 57% specificity according to the literature [20], [2] MRI showed 96% sensitivity, and 93% specificity [21], and was mandatory in all patients to establish the diagnosis. Nevertheless, [3] CT images were done only in chosen cases to spot and realize the extent of bone damage and thus for planning preoperatively.

Magnetic resonance imaging (MRI) with contrast is the Gold standard method for accurately diagnosing cases that present both clinical and radiological suspicion [22]. It is particularly useful in ruling out other conditions such as erosive osteochondrosis and tumors [22]. MRI can also effectively detect epidural abscesses, which are visible in up to one-third of cases, with the same reliability as it detects paraspinal abscesses. T1-weighted sequences with contrast are valuable for assessing abscesses formed in soft tissues, and fat-suppressed sequences are suggested for better visualization of vertebral structures [23]. Consistent with previous research [6, 7, 14, 23], we utilized T1 sequences with and without contrast, along with T2 sequences. The degree of bone destruction was assessed using computed tomography (CT) [9, 10]. We consider the ability to perform 3D reconstructions particularly useful for preoperative planning in patients with significant bone damage. While scintigraphy lacks specificity, it is recommended to rule out multilocular infections [12]. According to Moser (24), skeletal scintigraphy has only a supplementary role in diagnosing CSD.

Currently, a variety of treatment methods provide a wide range of therapeutic options, which depend on the severity of the defect, the extent of

instability, abscess presence with or without associated stenosis, and the presence of neurological injuries. In situations where there is no neurological affection and minimal bone loss, conservative management with immobilization through bracing is effective for the thoracolumbar spine [13 19, 29, 25, 26]. Traditionally in literature, for cases lacking instability or severe deformity, anterior debridement with spondylodesis has been recommended [10, 15, 17]. Whereas, Patients with multiple segmental affection or significant bone loss were reported to benefit from a combined approach that includes ventral debridement, bone bridging, and supplementary dorsal fixation [5, 6, 10, 20]. In this study, our rationale did not include dorsal stabilization, and the ventral approach was quite sufficient to debride and bridge defects by cages, and stable fixation was achieved.

Each of the therapeutic regimens mentioned above is paired with antibiotic treatment, which is advised for a duration of 6 to 12 weeks [3, 5, 8, 15, 16]. For TB CSD, a combination therapy involving three or four drugs is recommended for six months, followed by one- or two-drug therapy for an additional 12 to 18 months [27].

Shad et al. (22) observed persistent pathogenic colonization near the removed anterior implants in four out of five cases of CSD one year post-surgery, despite the patients being asymptomatic. On the other hand, other authors have supported the use of titanium implants in anterior spine surgeries for treating spondylodiscitis. Titanium mesh implants, along with anterior plate or rod systems, have been noted as dependable options [4, 10, 16, 24, 26].

Our findings align with earlier studies, indicating that cervical spine spondylodiscitis carries a greater risk of leading to neurological deficits [25, 28, 29]. The rapid worsening of symptoms highlights the critical importance of the time taken to reach a diagnosis, which appears to be one of the key prognostic factors [2, 7, 10, 15, 20, 23, 26, 30, 31].

Given that CSD is associated with high rates of morbidity and mortality [23, 25, 31, 32], early and aggressive surgical intervention is crucial for a favorable outcome. Unlike in the thoracic and lumbar spine, where the conservative option is a well-established and effective tool [11, 17, 29, 33], our data strongly supports surgical treatment for cervical spine spondylodiscitis to prevent complications in this delicate region. Procedures involving radical debridement and stable fusion have shown positive outcomes, including partial or complete resolution of neurological deficits, successful bony fusion, and resolution of inflammation [34, 35]

One key aspect of this study is the relatively short follow-up period (minimum 2 years). All patients were monitored until their infection was fully resolved thereafter, for a minimum of 2 years to assess recurrences, implant, or fusion failures. We had no recurrence by the end of the follow-up period. The fusion was achieved in 14 out of 15 patients (93.3%) in the meantime (5.6 ± 2.3SD) months, implant failure and subsequent kyphotic deformity occurred in one patient (6.6%) developed 6 months postoperative. However, the primary focus of this study was to document and evaluate the routine practice at our institution, compared to the reported practice of other spine centers, rather than to provide long-term patient follow-up data. Moreover, this study included both pyogenic and TB CSD, which differ in their causative pathogens and pathogenesis, though the management of severe cases for both is similar. Other limitations include the relatively small number of patients, so a solid consensus could not be reached. On the other hand, the homogeneity of studying cervical only (not lumbar or thoracic) spondylodiscitis, primary CSD excluding postoperative CSD, in addition to the use of single stage (excluding two or three stage interventions) operative discipline of debridement, anterior corpectomy and plate fixation with titanium cage with autogenous bone graft in all cases with the elimination of the need to posterior surgical approach or the use of varied surgical techniques, represent strength points in the study so that no difficulty to compare variables within the study were met and clear conclusions were achievable. Future studies should become prospective randomized controlled studies to consolidate the outcomes, and should include larger sample size to reach agreeable consensus.

Conclusions:

CSD is an uncommon but serious condition. Its occurrence in the cervical region is linked to high rates of morbidity and mortality, particularly due to the risk of neurological complications. In this study, surgical intervention yielded favorable outcomes for treating this condition, as it reestablished spinal alignment, provided stability, and successfully eradicated the underlying infection. Consequently, partial or complete neurological deficits can be resolved. The procedure

should focus on thorough debridement, achieving bony fusion, restoring proper spinal alignment, and ensuring stable fixation.

Conflict of interest:

The authors declare no conflict of interest.

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