Research Article

Surgical treatment of Spondylodiscitis: clinical and surgical outcome of a double -centered experience

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Abstract
Background: Spondylodiscitis is an inflammatory condition of the spine, discs, and Paraspinal tissue. Approximately 3%–5% of all occurrences of osteomyelitis are due to spontaneous spondylodiscitis. Neural component compression, spinal instability due to significant bone loss, severe kyphosis, or failure of conservative treatment are all reasons for surgery. **Study Design:** A Retrospective double -centered comparative cohort study. **Purpose**: To address the clinical and surgical outcomes of patients with bacterial Spondylodiscitis (SD) treated by different methods of fusion through posterior approach
Methods: We retrospectively reviewed all patients who underwent spine surgical operations between 2011 and 2016 at the neurosurgical department of Sohag University hospitals, and the orthopedic department of Mansoura University hospitals. Thirty-one patients received one stage posterior debridement with single level instrumentation of the lumbar or thoracic vertebrae. Reported outcome parameters in this study included Oswestery Disability Index(ODI), the Frankel scale, the cobb angle, fusion rate, the visual analogue score (VAS) of pain, and patient satisfaction. All of which were assessed preoperatively, and postoperatively. **Results:** Thirty one patients including 19 males and 12 females were reported. The patients' mean age was 63.2±13.3. (34-81 years). Abscesses developed in 68 % of patients (21/31), and degeneration of the vertebral body occurred in 58 % of patients (18/31). Thirteen patients had neurological impairments (42%), which were improved in 79 % of those who had surgery. All of the patients were treated with a posterior focus resection, spondylodesis with autogenous bone graft insertion or with a PEEK, or titanium cage implantation, associated with screw, and plate stabilization. In 90.3 % (28/31) of the patients, complete healing was achieved. The ODI score increased from 10 to 38. The mean cobb angle decreased from 13.3 to 10.5 in the auto graft interbody fusion group, and from 15.1 to 7.8 in the interbody cage group. At the most recent follow-up, the VAS ratings were much lower. At the 12-month follow-up, all patients' fusion was verified. More than 84% of our patients evaluated their experience as excellent. Seventy-one percent of patients (22/31) reported no concerns at the follow-up visit. Patients were observed for a duration ranging from 12 to 36 months. There were no relapses or problems throughout this time. **Conclusions**: When conservative management fails, SD necessitates prompt debridement of the focus, as well as decompression and stability via a posterior approach. We addressed improvements in clinical parameters of those patients treated with this technique, and there were no further complications at the last follow-up period.
Keywords: Spondylodiscitis, clinical, surgical, outcome

Introduction
Spondylodiscitis (SD) is a bacterial infection of the vertebrae and intervertebral discs that is extremely uncommon[1]. It can put the patient's life in jeopardy either locally due to severe damage, which is commonly accompanied by neurological impairments, or systemically as a devouring general illness[5]. The most common pathogen is Staphylococcus aureus, which accounts for nearly half of all non-tuberculous cases[3]. Mostly affecting the lumbar then the thoracic and less the cervical spine. SD is difficult to diagnose and affecting a significant percentage of people because of the rising prevalence of diabetes mellitus, rheumatoid arthritis, immune suppression syndrome, alcoholics, concomitant infections, Polytrauma, malignancies, spinal interventions as well as improved neuroimaging

diagnostic tools[1,2]. SD begins at the endplates of the vertebrae and subsequently extends to the intervertebral disc and vertebral body[4]. In most cases, pathogens spread through the bloodstream. The triggering foci aren't always easy to spot. The great majority of spondylodiscitis patients may be treated conservatively with antibiotics (first intravenous, then oral), and immobilization treatments such as spinal orthotics[3]. However, many patients will require surgical intervention if conservative therapy fails or if they develop instability, neurologic impairments, or fulminant sepsis[4]. The surgical management comprises two key steps: first, debridement of contaminated tissue and organism identification (if required); second, intervertebral fusion for stability[4,5]. In reality, the best surgical method is still a subject of debate[6]. So far, the most often utilized approach has been "anterior lumbar interbody fusion (ALIF)," which can be done with or without posterior instrumentation[7,9].

Direct decompression of the spinal cord, restoration of sagittal alignment, and avoidance of kyphosis are all possible with the anterior technique[10]. Although this method has a high rate of fusion success and infection clearance, it necessitates a vast area of exposure, which can lead to vascular, peritoneal, and wound problems[8,11]. The use of posterior debridement, bone grafting, posterior lumber interbody fusion (PLIF), or transforaminal lumbar interbody fusion (TLIF) techniques are described as another approach[5,6]. Although this approach allows direct decompression of the spinal canal and neural components, it restricts access to the vertebral bodies and, as a result, impedes interbody fusion and correction of lordosis[7,8].

Aim of the Work

This study aimed to assess the clinical and surgical outcomes of patients having bacterial Spondylodiscitis, either at thoracic or lumbar region treated through a single posterior spinal approach.

Patients and Methods

In this retrospective cohort study, we investigated at all patients who had spinal procedures between 2011 and 2016 at the neurosurgery department of Sohag University Hospitals and the orthopedic department of Mansoura University Hospitals. At the time of the index surgery, all patients were submitted to full clinical, laboratory and radiological evaluation.

Preoperative: Clinical assessment: (including pain, fever with or without chills, and night sweats). Laboratory investigation: (ESR,CRP, and WBC with differential count whenever possible), and culture-positive index (blood culture, percutaneous biopsy, and/or surgical culture), or histopathological evidence (blood and biopsy) of Spondylodiscitis. Neuro- imaging: (plain X-ray, CT, or MRI), age, sex, ODI, Frankel scale, the cobb angle, the visual analogue score (VAS) of pain.

Operative: All of the patients in the study had a posterior resection of the focus, spondylodesis, and autologous bone graft from iliac crest on one hand or a PEEK cage (EgiFix™ Egypt) filled with a bone graft. substitutes (Zimmer Biomet™), were inserted into the cages to conduct fusion either via posterior lumbar interbody fusion PLIF or TLIF technique. The screws (EgiFix™ Egypt), or (Zimmer Biomet™) were introduced, and the length of the screws was checked by the fluoroscopy (laterally, and AP view), then the rode was locked, a closed system wound drain was inserted, and after meticulous hemostasis, the wound was closed in layers.

Postoperative parameters included ODI, Frankel scale, VAS, cobbe angle, fusion rate, hospital stay, postoperative complication, and patient satisfaction.

Patient satisfaction assessed subjectively as excellent, good, fair, or poor at last reported follow-up visit.

Patients were submitted for routine plain radiographic evaluation on each clinical visit, while CT scan was used in case of reporting any abnormal event including persistent pain or suspected plain radiographic sign. The fusion rate was assessed using the Bridwell grading system.

Follow-ups were scheduled at 6, 12 months and last follow-up post-surgery mostly at 36 months. The Bridwell grading system[10] was used to assess fusion (table 2).

Table (1): The Frankel Scale for Spinal Cord Injury [8].

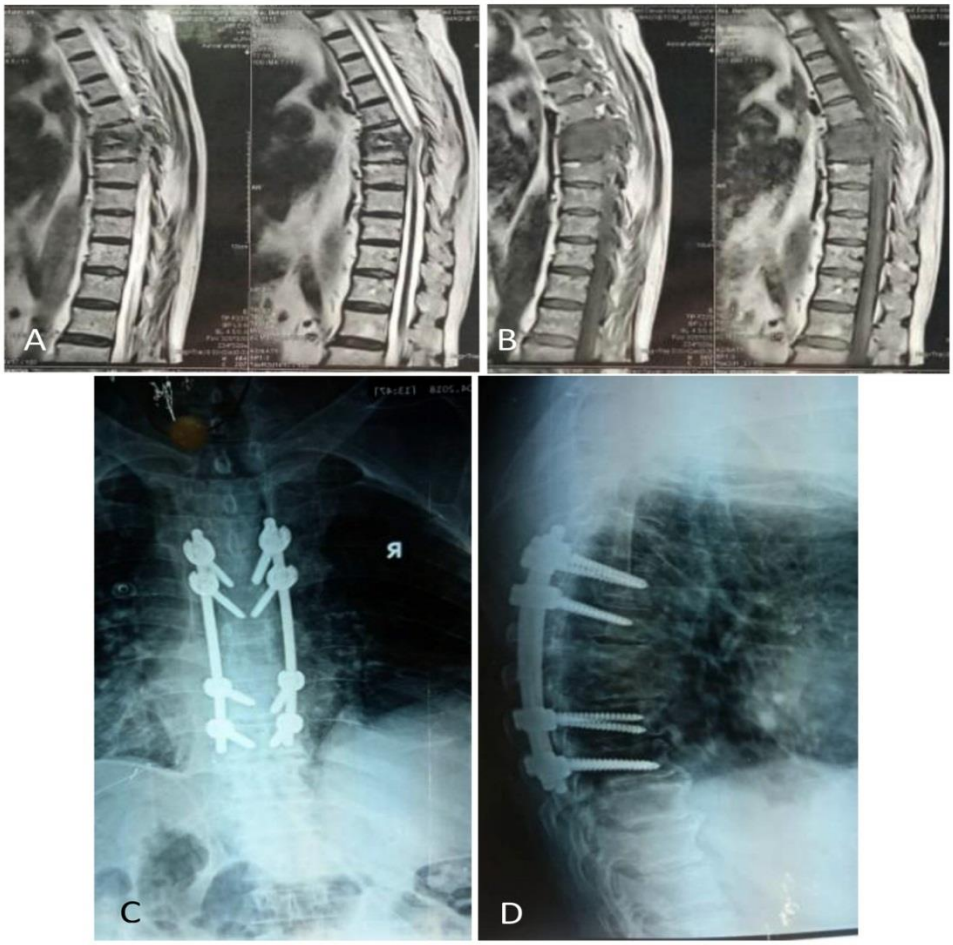
Frankel Scale		
A	**Complete**	lost motor or sensory function below the level of injury
B	**Sensory only**	lost motor function, but some preserved sensory function below level of lesion
C	**Motor non-functional**	Some preserved motor function without ability to walk
D	**Motor functional**	Preserved motor function below level of lesion with ability to walk
E	**Recovery**	Normal motor and sensory function

Statistical Analysis

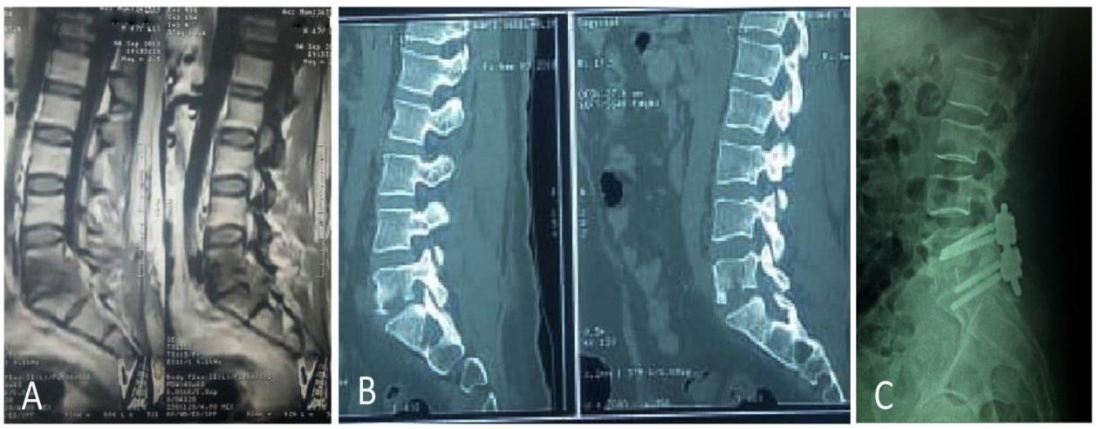
For normally distributed numeric variables, descriptive statistics were reported as mean (SD), whereas for non-normally distributed numeric variables, descriptive statistics were presented as median (IQR), with frequencies and percentages for categorical variables. For normally distributed numeric variables, the independent sample test was used, while for non-normally distributed numeric variables or ordinal variables, the Mann Whitney U test was used. The Chi-square test and Fisher Exact test were employed to test categorical variables. The study was conducted using IBM SPSS statistics software, version 26, and a p-value of 0.05 was considered statistically significant. Friedman's test was performed to see if there was a difference in the ODI over time. Friedman's test was performed to see if there was a difference in the ODI over time. The Bonferroni adjusted P-values, for pairwise comparisons were presented.

Table (2): Bridwell interbody fusion grading system [9].

Grade	Description
I	Fused with remodeling and trabeculae present
II	Graft intact, not fully remodeled and incorporated, but no lucency present
III	Graft intact, potential lucency present at top and bottom of graft
IV	Fusion absent with collapse/resorption of graft



Case 1: Male patient 53 years old with D7 Spondylodiscitis (A) Preoperative T2 MRI (B) preoperative T1 MRI showing the lesion, (C) Postoperative A-P X-ray, and (D) Lateral views showing posterior fixation and debridement with interbody autogenous (iliac crest) graft



Case 2: Female patient 41 years old with L5-S1 Spondylodiscitis (A) PreoperativeT1 MRI (B) Preoperative lumbo-sacral CT showing the affected L5-S1 Spondylodiscitis, (C) Postoperative lateral X-ray showing posterior fixation and debridement with interbody fusion by allograft(PEEK cage).

Results

The patients' mean age was 63.2±13.3 (34-81 years). There was a male predominance; 19 males patients (61.3%). The mean hospital stay was 31.1±8.4 days (5-66 days). The lumbosacral spine was affected in 74% (23/31), and the thoracic spine was affected in 26% (8/31).

All the patients were presented with local pain in the spine 100%, which was more pronounced over the affected level. At the time of presen-tation, twenty patients (64.5%) had a neurological deficit, most of who presented with motor weakness (17 patients with Frankel Scale grade D and 3 patients with Frankel Scale grade C).

Fever with chills was present in 54.8% (17/31) of patients.

Microbiological confirmation of the SD was obtained in 18 patients (58.1%) of the patients. Mycobacterium tuberculosis was the most frequent organism isolated in 10 patients (32.3%), followed by pyogenic infection (5 patients with brucellosis, 2 with Staphylococcus aureus, and 1 with streptococcal infection). Abscess occurred in 67.7% of patients (21/31) and destruction of the vertebral body in 58% (18/31) (Table 3).

Fusion rates were addressed at 6 months,12 months and at last follow-up based upon Bridwell interbody fusion grading system[9]. They were found to be a doubtful fusion in 83.9% of patients at 6 months and found to be a certain fusion at 12 months onwards till last follow-up in all patients of our study (table 4).

Clinical Outcomes: The ODI improved from 10.1 to 38.2. The mean Cobb angle was improved in the auto graft interbody fusion from 13.3 to 10.6, and in the group with interbody cage, it was improved from 15.1 to 7.8.ts. Neurological deficits were improved dramatically in the last follow-up, based upon Frankel scale. Patient satisfaction was ranked as excellent in 26 patients (83.9%), good in 3 patients (9.7%), and was rated as fair in one patient (3.2%) (table 5).

None of the patients suffered from neurological deterioration. The complication rate was 6.4%, with two patients with CSF leakage that responded to conservative measures. One patient (3.2%) died from complications of dialysis (known to be a renal and parkinsonian patient). Table 5 summarizes the clinical and outcome data of the included patients.

Table (3): Demographic and clinical data.

Item		Value	Significance (P value)
Age	**Mean±SD**	63.2±13.3	-
	Median(range)	65(34-81)	-
Gender	**Male**	19(61.3%)	-
	Female	12(38.7%)	-
Levels involved	**Thoracic spine**	8(25.8%)	-
	Lumbosacral spine	23(74.2%)	-
Causative Organism	**Mycobacterium tuberculosis**	10(32.3%)	-
	Brucellosis	3 (9.7%)	-
	Staphylococcus aureus	4 (12.9%)	-
	Streptococci	1(3.1%)	-
Clinical manifestations			
Back pain		31 (100%)	-
Fever		17 (54.8%)	-
Abscess		21(68%)	-

Table (4): Fusion rates at different time points

			Significance (P value)
Fusion at 6 months	**Certain**	26 (83.9%)	<0.001
	Doubtful	5 (16.1%)	-
Fusion at 12 months	**Certain**	31(100%)	-
Fusion at last follow-up	**Certain**	31(100%)	-

Table (5): outcome data of the study population

Item		**Value**	**Significance (P value)**
Destruction of the vertebral body	**Last follow-up**	18(58.1%)	-
VAS scores			
0-3	**Preoperative**	4 (12.9%)	<0.001
	Last follow-up	0 (0.0%)	
4-7	**Preoperative**	15 (48.4%)	<0.001
	Last follow-up	2 (6.5%)	
8-10	**Preoperative**	12(38.7%)	<0.001
	Last follow-up	1(3.2%)	
ODI	**Preoperative**	10.06±2.05	<0.001
	Last follow-up	38.17±6.29	
Frankel grade C	**Preoperative**	3 (9.7%)	-
	Last follow-up	1(3.2%)	-
Frankel grade D	**Preoperative**	17(54.8%)	<0.001
	Last follow-up	2 (6.5%)	
Frankel grade E	**Preoperative**	0 (0.0%)	<0.001
	Last follow-up	17(54.8%)	
Cobb angle (Autograft group)	**Preoperative**	13.33±1.00	<0.001
	Last follow-up	10.55±1.89	
Cobb angle (Interbody cage group)	**Preoperative**	15.11±1.34	<0.001
	Last follow-up	7.83±1.43	-
Patient satisfaction	**Excellent**	26 (83.9%)	-
	Good	3 (9.7%)	-
	Fair	1 (3.2%)	-
Hospital stay	**Mean±SD**	31.06±8.4	-
	Median(range)	31(5-66)	-
Complications	**Dural tear**	2(6.4%)	-
	In-hospital mortality	1(3.2%)	-

SD= standard deviation

Discussion

Spondylodiscitis constitutes a major diagnostic dilemma, due to non-specific symptoms such as back pain, and also non-specific laboratory findings such as elevated inflammatory markers (ESR, CRP and WBC count) with no conclusive evidence of positive blood cultures. The steadily increase in resolution and availability of MRI in

the last few decades had led to earlier diagnosis and improved accuracy[12-13].
Bacterial SD mostly affects the elderly. Our patient population's mean age of 63.2 years is consistent with the literature[11-14].

According to our findings, the levels of spinal involvement decrease in order from the lumbar to the thoracic and cervical spine[15-17].

According to our findings, neurological compression occurs in 33–59% of patients in the literature, which is slightly greater in our study (64.5%). Radicular compression, with uni- or bi-lateral weakness, paresthesias, or paralysis, is the most prevalent symptom. The presence of neurological symptoms should alert the doctor to the possibility of a mass effect caused by an abscess in the epidural space[18].
Tuberculosis (TB) is the most prevalent cause of spinal infection in the globe[19], accounting for 9%–46% of cases in affluent countries[20], which came as similar to our results, in which we reported 32.3% of our patients with this causative organism. S. aureus was also shown to be the most common pathogen, accounting for half of nontuberculous cases (range 20–84%)[21], which was substantially identical to our findings.

The incidence of abscess formation varies, although it has been estimated to be between 35 and 74% in the literature[22, 24, 27]. A study from a neurosurgical unit reported abscess formation in 74% of patients, which is nearly similar as our study (68%). The incidence of epidural abscesses or neurological problems rises in direct proportion to the number of spinal levels involved[22].

The anterior and middle columns are the primarily infected and destroyed areas in SD. The spread began in the disc and progressed through the endplates and into the vertebral bodies[19-21]. For that the anterior approach can offer a direct access to the most affected areas[7, 23-25]. Especially with marked vertebral body destruction with significant loss of disc space height and subsequent radiculopathy or myelo-pathy symptoms[11,22-26]. The anterior and lateral techniques allow for a radical rebuilding of the spine's anterior and middle columns.[8,9-20]. However, this technique has many disadvantages, such as prolonged bed rest, liability for graft collapse with subsequent kyphosis, difficulty during accessing the dorsal and lower lumbosacral spine, and intrinsic risks associated with the anterior approach for spine procedures in general such as ileus, visceral injury, neuro-vascular compromise and/or wound problems[5,26]. Conversely, the posterior approaches can allow direct visualization and access for spinal canal decompression and neural elements, but the need for significant spinal erecti muscle stripping may prevent radical vertebral body and disc debridement[15-21] which is embraced by our study.

Consequently, the posterior technique has been approved by many authors in order to reinforce the construct, and this has been emerged as a promising approach[25-27]. Although this strategy has not been researched as extensively as the anterior approach, most spine surgeons are becoming more familiar with it, gaining expertise, and there is a growing body of knowledge in the literature[5, 6, 28].

Multiple posterior instrumented fusion procedures with greater fusion rates and clearance of contaminated tissue have been documented in the literature[27]. At a mean of 8.6 months after surgery, Tao et al.,[29] found bone fusion in 22 of 23 patients. Lin et al.,[23] reported no infection recurrence in their study which included 48 patients received short segment PLIF, with long segment fixation. They recorded satisfactory outcomes in 83% of their study population, compared with 89% in our study, and no infection recurrence also with longer follow up duration (up to 36 months).

In our study, we present our experience using debridement, interbody fusion with posterior stabilization, either with PLIF or TLIF, to treat patients with lumbar SD. For all patients, cure detected clinically as no symptoms or complication was encountered, and X ray scans showed fusion achievement in 29 out of the 31 patients included. Also, we noticed an improvement in lordosis (both segmental and global), despite the small number of studied group which decreased

the statistical significant comparison of pre and postoperative radiographic measures.

VAS scores improved dramatically at last follow-up which came in similar to Tao et al., 29 where they found that at 2 weeks post operation, the mean VAS score decreased to 2.48 and 0.4 at final follow-up. The mean ODI score improved significantly after the operation 29. Also, Stefan et al., 30 reported The mean ODI to be improved to 21 (range, 12–38).

The mean Cobb angle in our study improved from 13.1º to 11.1º in Stephan[30] research which was comparable to our results.
According to Tao et al.,[29], all patients with neurological deficits preoperatively improved entirely in the final follow-up, which is almost confirmed through our study.
A prospective, randomized comparative study of these surgical approaches has not yet been achieved and would be difficult to implement due to the scarcity and variability of both the etiology and severity of this disease at the time of first presentation. As a result, limited retrospective case series, like our study, remain the most valuable sources of information of the outcomes of various procedures.

Conclusion

Surgical treatment of Spondylodiscitis is still a complex and a challenging exercise. Debridement of the focus, with posterior decompression and stabilization augmented by interbody fusion carry hopeful results. Improvement in clinical and surgical outcomes was observed seriously. High rate of Patient satisfaction treated via this technique, and supported by no serious complications, was identified clearly

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