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Ensuring Corpectomy and Stabilization Effectiveness in Patients Who Underwent Single Posterior Approaches

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ABSTRACT

Introduction: Today, approximately 2 million people worldwide suffer from spinal tuberculosis (STB). In endemic areas, classical STB is often accompanied by spondylodiscitis.

Methods: This study retrospectively analyzed 15 patients diagnosed with STB who were followed up in our clinic from January 2010 to August 2021. The study included a total of 15 patients diagnosed with spondylodiscitis, 7 males and 8 females, with detection of STB bacillus (6 patients) and/or pathological diagnosis of caseous necrosis (15 patients).

Results: Pre-operative neurological examinations of the patients revealed neurological deficits according to the Frankel scale, except in 2 patients. According to the Frankel scale, 8 patients showed improvement, 6 of them did not change, 1 worsened, and 13 had fusion documented on radiological imaging.

Conclusion: Anterior corpectomy and posterior instrumentation may be a safe and effective technique compared with all other surgical interventions applicable in such patients.

Keywords: Thoracic and lumbar Pott's disease, posterior surgical treatment, anterior corpectomy

Introduction

Spinal tuberculosis (STB) is one of the oldest diseases known to exist in humans, documented in Egyptian mummies dating back 5000 years. The first STB case was presented by Percival Pott in 1779 (1). Today, STB disease continues to be seen worldwide despite the developments in good nutrition, easy access to doctors, and treatment procedures. In endemic areas, classical TB is often accompanied by spondylodiscitis. With the recent increase in multidrug resistance in TB, the clinical presentation and treatment modalities have become very complex (2).

Pott's disease is clinically manifested by spinal deformity, mechanical instability, and neurological deficit, and surgical procedures may become mandatory in STBs that do not respond to drug therapy. These interventions range from radiology-assisted abscess drainage to open decompression and restoration (3).

This study presents the clinical, radiological imaging and surgical outcomes of a series of 15 consecutive patients with thoracic or lumbar spondylodiscitis requiring open surgery despite all medical treatment, who underwent debridement including spondylectomy as well as transpedicular posterior stabilization using the posterior approach without anterior opening (lumbotomy/thoracotomy) and aims to convey our experiences in this process.

Methods

The study was approved by the Sakarya University Local Ethical Committee (approval number: E-71522473-050.01.04-92657-570, date: 03.01.2022).

In this study, 15 patients diagnosed with STB based on radiological examination, laboratory tests, and histopathology between January 2010 and August 2021 were retrospectively analyzed.

A total of 15 patients diagnosed with spondylodiscitis, 7 (46.6%) males and 8 (53.4%) females, with detection of TB bacillus (6 patients, 40%) and/or pathological diagnosis of caseous necrosis (15 patients, 100%), were included in the study (Patients with abscess formation on the anterior of the vertebral body far from the site of spondylodiscitis were excluded from the study). Patients' age was 54.6±16.60 (standard deviation).

Demographic distribution, predisposition status, clinical manifestation, comorbidities, microbiological and histopathological diagnoses, and clinical and radiological outcomes of the patients were retrospectively reviewed. The mean follow-up period in our study group was 20.4 months (6-108 months) (Table 1).

Patients with neurological deficits were classified according to the Frankel scale (Table 2) (4).

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Table 1. Length of follow-up, pre-operative and end of follow-up Frankel grades, and surgical procedures in 15 patients

Patient no, (n=15)	Age, (mean ± SD): 54.6±16.60	Diagnosis	Sedimentation, (mean ± SD): 23.53±17.58	CRP, (mean ± SD): 17.86±25.57	Frankel pre-op	Frankel post-op	Follow-up time, (months)	Pre-op-VAS, (mean ± SD): 7.8±0.83	Post-op-VAS (2. month), (mean ± SD): 2.93±0.79
1	31	T6 Pott	8	2	D	E	108	8	3
2	28	T5 Pott	13	3	E	E	16	7	3
3	63	T8-9 Pott	47	35	D	E	19	8	2
4	50	T2 Fracture	6	3	E	E	15	7	3
5	64	T5 Pott	20	13	C	C	6	8	3
6	53	T5 Discitis	70	103	C	A	Died*	9	3
7	70	L2-3 Discitis	6	3	D	E	13	7	2
8	70	T11 Pott	13	8	D	E	19	7	3
9	21	L1 Pott	16	9	D	E	21	7	2
10	50	T12 Pott	12	11	A	A	24	8	3
11	69	T7-8 Pott	40	10	A	A	8	7	2
12	47	L1 Pott	30	29	D	E	6	9	5
13	65	L2 Pott	28	23	D	E	12	8	3
14	69	L2 Pott	22	13	D	E	9	9	3
15	69	T7-8 Pott	22	3	A	A	9	9	4

SD: Standard deviation, CRP: C-reactive protein, Pre-op-VAS: Pre-operative-visual analog scale, Post-op-VAS: Post-operative-visual analog scale score was significantly decreased compared with the pre-operative value ($p<0.001$). *The patient died on the 15th post-operative day because of cardiac problems

Table 2. Frankel classification of neurological lesions

Grade	Frankel scale
Grade A	Complete neurological injury: below injury, no motor or sensory function
Grade B	Preserved sensory sensation only - no motor function below injury; partial sensory function below injury
Grade C	Non-functional preserved motor function: there is practically unused motor function below the injury
Grade D	Preserved motor function: below injury there are motor function able to walk with assistance but strength not normal
Grade E	Normal motor - normal sensory motor and sphincter function may have abnormal reflexes and subjective sensory problems

Pre-operative and post-operative white blood cell count (WBC) [men mean: 9.64 mcL (6.8-16), women mean: 8.11 mcL (6.4-16)], erythrocyte sedimentation rate (ESR) [men: 16 mm/h (6-47), women: 28.97 mm/h (6-70)] and C-reactive protein (CRP) [men: 11.67 (2.7-35) mg/L, women: 11.17 (2.6-40) mg/L] levels of each patient were recorded (Table 3).

All patients were evaluated pre-operatively and post-operatively using bilateral spinal anteroposterior and lateral radiographs, computed tomography (CT), and magnetic resonance imaging (MRI).

The criteria for deciding on the indication for surgery in patients were non-response to treatment despite active treatment of STB (insignificant decrease in sedimentation and CRP, severe pain), destruction of the vertebrae and discs causing instability, increase in kyphosis-spine malalignment, presence or risk of neurologic deficit, and abscess formation.

All patients were administered prophylactic antibiotics (cefazolin 1000 mg IV) pre-operatively, and posterior transpedicular corpectomy and cage were stabilized with posterior transpedicular screw systems in the same session in all patients included in the study. During the pre-operative period, the cartilage endplate of the affected spine and disc was removed up to the healthy bleeding corpus bone, and adequate decompression of the dural sac was achieved. In all patients, debridement was performed as much as possible, and in the presence of abscess formation, abscess drainage was performed in the same session as possible.

During surgery, at least 4 samples were taken from the infective site of all cases for simultaneous culture (Gram-staining, aerobic and anaerobic culture and susceptibility tests, fungal culture, TB appropriate cultures) and histopathological examination.

Table 3. Pre-operative and post-operative total acute phase reactants results

(n=15)	Pre-op and post-op-WBC	Pre-op and post-op ESR	Pre-op and post-op CRP
Men, (n=7)	9.64 mcL (mean ± SD; 6.8-16 mcL)	16 mm/h (mean ± SD; 6-47 mm/h)	11.67 mg/L (mean ± SD; 2.7-35 mg/L)
Women, (n=8)	8.11 mcL (mean ± SD; 6.4-16 mcL)	28.97 mm/h (mean ± SD; 6-70 mm/h)	11.17 mg/L (mean ± SD; 2.6-40 mg/L)

WBC: White blood cells, ESR: Erytrocyte sedimentation rate, CRP: C-reactive protein, SD: Standard deviation

Fusion criteria on multi-planar recon wereas follows: (1) presence of bony trabeculation and (2) presence or lack of bony lucency at the iliac bone graft/vertebral body interface (4).

Results

Of the patients included in the study, 8 (53.4%) were female and 7 (46.6%) were male. The mean ages were 52.71 (21-70) in females and 56.25 (50-69) in males, and the mean year of the group was 54, while the mean age was 58. There were 3 patients [male (M): 2/female (F): 1] between the ages of 21-39, 4 patients between the ages of 40-59 (F: 3/M: 1), 7 patients aged 60 and above (M: 3/F: 4) (Table 1).

Clinical Presentation

A total of 19 vertebral corpus involvements were detected in the patients included in the study. Of the patients, 11 (73.3%) had single-level involvement and 4 (26.6%) had two-level involvement. In the study group, 10 (66.6%) patients had thoracic involvement and 5 (33.3%) patients had lumbar involvement. The most frequently affected vertebrae level was T8, which was involved in 3 patients (20%). In this group, 6 patients (40%) had abscess formation in the soft tissue adjacent to the paravertebral or psoas muscle. The time from the onset of symptoms to diagnosis was approximately 19.75 months (ranged between 1-108 months) (Table 1).

All 15 patients (100%) had local spine pain, and 5 (33%) had additional radicular pain. Radicular pain was unilateral in 3 patients and bilateral in 2 patients. Of the patients, 4 (26.7%) were Frankel A, 1 (6.6%) was Frankel C, and 10 (66.6%) were Frankel E.

In the entire study group, 11 (73%) patients had a poor general condition due to comorbidities. Some of our patients were receiving treatment for the following diagnoses: diabetes mellitus (DM) type 2 and hypertension (HT) (3 patients, 20%), DM type 2 (2 patients, 13%), chronic renal failure (CRF) and HT (2 patients, 13%), CRF (1 patient, 6%), DM type 2, HT and chronic obstructive pulmonary disease (1 patient, 6%), hypothyroidism (1 patient, 6%), 1 had thyroid cancer and Goiter (1 patient, 6%).

Laboratory Results

Pre-operative and post-operative WBC [men mean: 9.64 mcL (6.8-16), women mean: 8.11 mcL (6.4-16)], ESR [men: 16 mm/h (6-47), women: 28.97 mm/h (6-70)], and CRP [men: 11.67 (2.7-35) mg/L, women: 11.67 (2.7-35)] levels of each patient were recorded.

Diagnostic Imaging

STB-specific bone and intervertebral space destructions were observed on bilateral spinal radiographs. Early-stage disc space deterioration and endplate erosion were observed in 4 patients (26.6%), and vertebral corpus damage was observed in 11 (73.3%) patients. Spinal CT scans of 6 (40%) patients revealed collapse of the vertebral corpus, destruction, abscess in the paravertebral and/or psoas region, and spinal cord or dural sac compression due to abscess and bone destruction (Figure 1a). The pre-operative T1W-weighted sagittal and axial MRI of the spine in Figure 1b show bone destruction from the T7 to T8 vertebrae, disc involvement, epidural abscess, and spinal cord compression (Figure 1a, b).

Surgery

In the late stage of STB, clinically painful deformities and progressive neurological deficits occur. The radiological and clinical findings we determined for surgical indication were kyphosis, persistent low back pain, inability to lie in the supine position, and progressive neurological deficits.

In the study group, 10 (66.6%) patients underwent single-level discectomy, corpectomy, and instrumentation, and 5 (33.3%) patients underwent two-level discectomy, corpectomy, and instrumentation. The details of the surgical procedures are given in Table 4.

Patients' Operative and Post-Operative Data

In our study group, the mean blood loss of patients was 630 mL [range: 350-1100 mL (Table 5)], the mean surgical time was 220 min (range: 170-250 min), pre-operative visual analogue scale (VAS) was 7.7% (7-9), and post-operative VAS was 2.8 (2-3), resulting in a 100% reduction in VAS (Table 5). The average length of hospitalization was 13.1 days (6-54 days), and neurological improvement was observed in 88.8% of patients who were not Frankel scale A (Table 1).

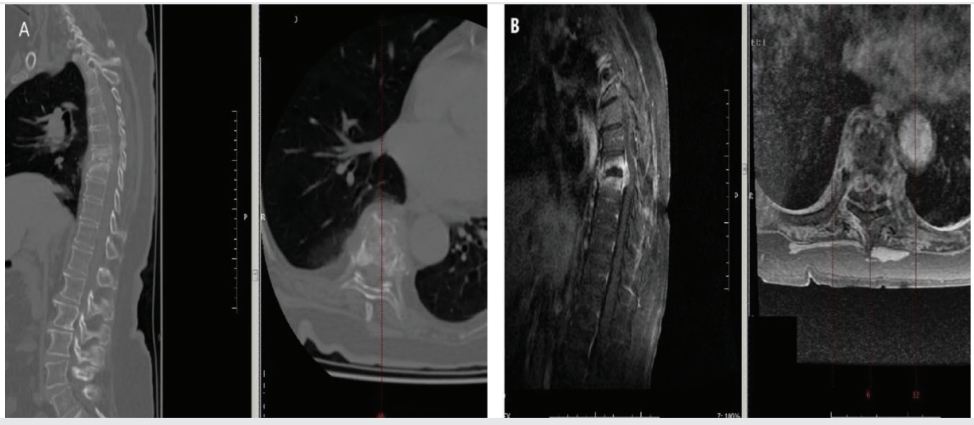

Figure 1. (a) Multi-planar recon in sagittal and axial planes showing T7-8 disc space collapse and T7-8 vertebral corpus destruction (white arrow). (b) Contrast-enhanced magnetic resonance imaging in sagittal and axial planes showing T7-8 compression fractures, T7-8 vertebral corpuses posterior to the epidural space, hyperintense lesion with wide contrast suppressing the spinal cord in T1W sequences, and intense contrast enhancement in T7-8 vertebral corpuses (blue arrow)

Table 4. Surgical procedures performed on patients

Patient no.	Surgical procedures
1	T4-5-8 posterior stabilization, T6 corpectomy, T5-7 cage
2	T3-4-6-7-8 posterior stabilization, T5 corpectomy, T4-6 cage
3	T5-6-7-10-11-12 posterior stabilization, T8-9 corpectomy, T7-10 cage
4	C7-T1-T3-4-5 posterior stabilization, T2 corpectomy, T1-3 cage
5	T2-3-4-7-8-9 posterior stabilization, T6 corpectomy, T4-7 cage
6	T2-3-6-7 posterior stabilization T4-5 corpectomy, T3-6 cage
7	T12-L1-3-4 posterior stabilization, L2 corpectomy, L1-3 cage
8	T7-8-9-12-L1 posterior stabilization, T10 corpectomy, T9-11 cage
9	T9-10-11-L2-3-4 posterior stabilization, L1 corpectomy, T12-L2 cage
10	T10-11-L1-2 posterior stabilization, T12 corpectomy, T11–L1 cage
11	T54-5-6-9-10-11-12 posterior stabilization, T7-8 corpectomy, T6-9 cage
12	T10-11-12-L3-4 posterior stabilization, L1 corpectomy, T12–L1 Fibula Greft
13	T12-L1-3-4 posterior stabilization, L2 corpectomy, L1-3 cage
14	T12-L1-3-4 posterior stabilization, L2 corpectomy, L1-3 cage
15	T4-5-6-9-10-11 posterior stabilization, T7-8 corpectomy, T6-9 cage

Table 5. Surgical time, peroperative amount of bleeding, pathology, and microbiology results

Patient no.	Surgical time (minutes)	Peroperative amount of bleeding (mL)	Pathology	Microbiology
1	210	550	Granulomatous lesion	Culture negative
2	205	600	Granulomatous lesion	Culture negative
3	270	800	Granulomatous lesion	Culture negative
4	170	350	Granulomatous lesion	Culture negative
5	200	450	Granulomatous lesion	Culture negative
6	250	700	Granulomatous lesion	Culture negative
7	170	500	Granulomatous lesion	Culture negative
8	220	550	Granulomatous lesion	Culture negative
9	200	480	Granulomatous lesion	*M. Tuberculosis* positive
10	215	550	Granulomatous lesion	*M. Tuberculosis* positive
11	185	1100	Granulomatous lesion	Culture negative
12	190	770	Granulomatous lesion	*M. Tuberculosis* positive
13	175	800	Granulomatous lesion	*M. Tuberculosis* positive
14	180	700	Granulomatous lesion	*M. Tuberculosis* positive
15	200	810	Granulomatous lesion	*M.Tuberculosis* Positive

Complications

One of our patients died on the 15th day because of poor general of and multi-organ failure. Two patients (13.3%) had wound infections due to chronic diseases, and one patient had pseudoarthrosis in screws. They were treated with appropriate medical treatment.

Clinical Outcomes

Pre-operative neurological examinations of the patients revealed neurological deficits according to the Frankel scale, except in 2 patients (13.3%). According to the Frankel scale, 8 (53.3%) showed improvement, 6 (40%) did not change, and 1 (0.6%) worsened (Table 1).

Radiographic Outcomes

During follow-up, radiological imaging was performed in all patients (Table 1). Fusion was documented in 13 (86%) patients. No instrumentation errors, loosening, fractures, or complications related to the corpectomy cage were observed in any of the patients during follow-up.

Statistical Analysis

Initially, the normality of all variables was evaluated. Means and frequencies were assessed for continuous and categorical variables, respectively.

Sample Case

A 69-year-old female patient who was admitted to the hospital with back pain and inability to walk in November 2020 had a VAS score of 8 and reported fatigue and night sweats. Below the T8 distance, the motor examination outcome was 1/5, sensory examination was anesthetic, and deep tendone reflexes were hypoactive. The patient had HT.

Pre-operative diagnostic tests of the patient revealed standard CRP (3.02 mg/dL, N: 0-5 mg/dL), procalcitonin (0.049 ng/mL, N: 0-0.5 ng/mL), and ESR (12 mm/h, N: 0-30 mm/h) rates. MRI revealed defects in the T7-8 corpus, abscesses in the T7-8 disc and epidural space, inflammation, and granulation reaction of the dura and disc surfaces at the T7-8 level. Intense contrast enhancement at the T7-8 distance was evaluated as compatible with spondylodiscitis. Pre-operative blood culture was obtained from the patient. Mycobacterium tuberculosis appeared in blood cultures. Antituberculosis drugs, Isoniazid 300 mg/day, rifampicin 600 mg/day, etambutol 1500 mg/day, and pyrazinamide 2000 mg/day were started by the infectious diseases department.

T4-5-6-9-10-11 stabilization, T7-8 total corpectomy, and tumor cage fusion surgery were performed in the patient with a posterior approach. Peroperative culture and pathology samples were taken (Figures 2a-d, 3a, b).

The patient's peroperative blood culture was also positive for Mycobacterium tuberculosis. At the 2nd post-operative week, the pathology result was compatible with a granulomatous lesion (Table 4). Physiotherapy was started in the 3rd week. However, there was no change in the motor examination after 2 months of treatment. At the end of the 2nd month, VAS was 3. At the end of the 2nd month, ethambutol and pyrazinamide were discontinued. Maintenance treatment was completed in 7 months with the dual antituberculosis drugs isoniazid (300 mg/day) and rifampicin (600 mg/day). At the end of 9 months of anti- tuberculosis treatment, cure treatment was given.

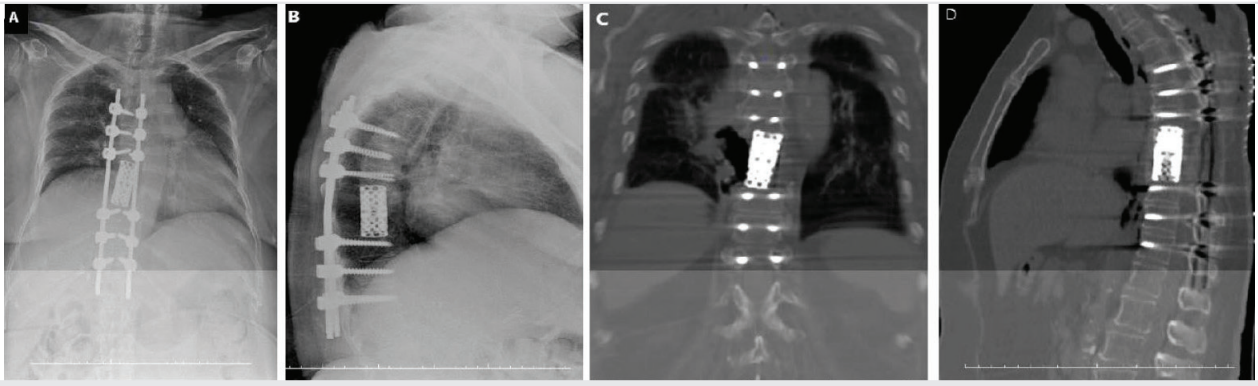

Figure 2. (a, b) Post-operative 3rd-month AP-lateral X-ray showing the T4-11 screw rod system (black arrow) and T7-8 corpectomy cage (green arrow). (c, d) Early post-operative coronal and sagittal MPR-CT showing proper positioning of the T4-11 screw rod system (white arrow) and the T7-8 corpectomy cage (blue arrow)
MPR-CT: Multi-planar recon-computed tomography

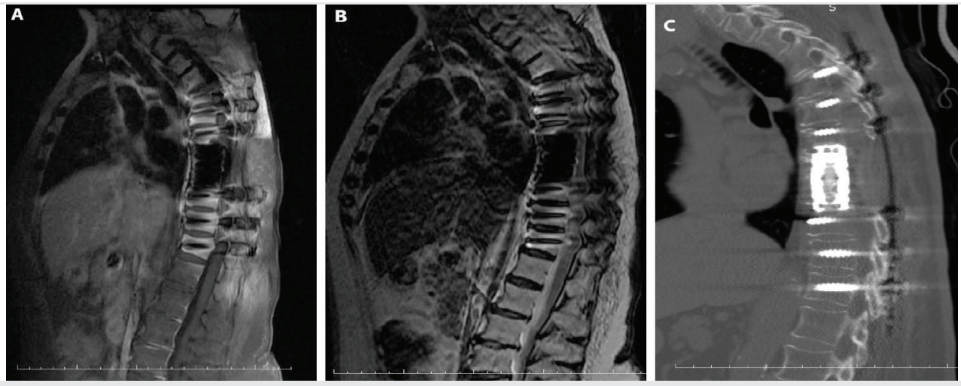

Figure 3. (a) Post-operative 1st-year T1W contrast-enhanced sagittal magnetic resonance imaging (MRI) showed no signs of infection in the disc, vertebral corpuscles, or epidural distance. (b) Unenhanced T1W sagittal MRI showing no evidence of infection. (c) Post-operative 1st-year sagittal multi-planar recon-computed tomography showed no signs of infection

Discussion

While spondylodiscitis is quite common in the general patient population, it usually occurs after osteomyelitis or spine surgery. Discitis occurs in 2% to 7% of osteomyelitis cases (4).

The incidence of spinal infections is gradually increasing because of the increase in the elderly population, immunosuppressive diseases, widespread use of chemotherapy, DM, chronic kidney failure, alcohol consumption, chronic steroid use, and the increase in the number of surgeries worldwide. Among our patients, 3 had DM type 2 and 2 had CRF.

A large literature review on spinal TB reported that most cases occur in Southeast Asia and Africa (2). In the reviewed publications, anti-TB drugs and conservative treatment were the standard treatments. With the exception of spinal instability and neural compression, the role of surgery remains controversial, and definite surgical indications have not been determined (2). The Medical Research Council institution did not offer surgical indications other than abscess, sinus formation due to abscess, and neurological deficit and did not indicate spinal deformities (5,6). However, in many other randomized controlled studies, surgical treatment was the primary choice in the presence of STB, neurological deficit, deformity, and instability, irrespective of the anatomical region (2).

The most feared complication of STB is a neurological deficit, followed by infection-related deformity (7). In conservative treatments, vertebral collapse and kyphosis can be observed up to 15 degrees. Severe deformity is observed in 3%-5% of all cases. Neurological deficit is observed in 10%-40% of cases. Neurological deficits were detected in six (40%) of our patients.

The direction of the surgical approach varies according to the region of spinal involvement. Recent studies recommend anterior approaches that allow stabilization and decompression in the cervical and cervicothoracic spine and rigid posterior interventions that correct deformity in the lower thoracic region and facilitate neural decompression (2,8-10).

Open anterior approaches can significantly limit rehabilitation because of thoracic spine, post-operative pain, and complications. Thoracoscopic interventions were introduced after the 1990s and have been shown to reduce morbidity (11-14). However, these thoracoscopic techniques require special training and experience. The disadvantages of endoscopic interventions include two-dimensional images, disorientation in anatomy, loss of depth sensing, and the requirement of extra investment in thoracoscopic equipment and instruments) (15).

In their series of 10 cases undergoing thoracoscopic interventions, Huang et al. (16) reported a mean blood loss of 485 mL (150-850 mL) and a mean surgical time as 174 minutes (120-240 minutes). Their study

reported a mean kyphotic correction rate of 37.3%. In their series of 23 cases, Jayaswal et al. (17) reported a mean blood loss of 780 mL (330-1180 mL), a mean surgery time as 228 minutes (102-324 minutes) and documented neurological recovery in 94.4% of the cases. Huang et al. (18) reported a mean blood loss of 550 mL (range: 300-1000 mL) the surgery time of 210 min (range: 170-300 min), and showed that back pain was reduced by 92%, and the neurological deficit was reduced by one level in all patients. In our study group, the mean blood loss of patients was 630 mL (range: 350-1100 mL), the mean surgical time was 220 min (range: 170-250 min), pre-operative VAS was 7.7% (7-9), and post-operative VAS was 2.8% (2-3), resulting in a 100% reduction in VAS, and neurological improvement was observed in 88.8% of patients who were not Frankel scale A.

Although minimal or open surgical methods are used for anterior thoracic interventions, it should be noted that the incidence of intervention-specific complications is 24.4-31.3% in the literature (17-21). Apart from general neurological and spinal bone complications, these intervention-specific complications include lung rupture, pulmonary parenchymal damage, atelectasis, respiratory dysfunction, pneumonia, and empyema. In our study, one patient died of to multiorgan failure, whereas others of no complications other than a simple wound infection, which was corrected with medical treatment.

Study Limitations

This retrospective study had some limitations. First, there was no control group with complete spinal infection surgery. Second, the number of patients was too small to cover the entire population.

Dynamic imaging could not be performed before surgery because of pain or neurological deficits. Therefore, pre-operative kyphosis evaluations were made via CT, and then surgery was planned.

Previous studies on Pott's abscesses in the thoracolumbar region have been conducted using the anterior and anterior- posterior combined approaches. There are few studies on the posterior approach. More studies must be conducted on this subject, and contributions should be ensured to the literature.

Conclusion

Approaches to ST may include anterior, posterior, and combined approaches. The anterior approach is a very successful method for stabilizing the anterior column and decompressing the spinal cord. However, anterior approaches have high mortality and morbidity rates. Posterior approaches in spine surgery are used more frequently today because of the increasing experience of spine surgeons. This surgical approach maximizes retention and reconstruction of the spine. Therefore, posterior corpectomy and posterior instrumentation may be a safe, effective, and less invasive technique in such patients. In our study, we observed that we successfully treated ST patients using the posterior approach.

Ethics Committee Approval: The study was approved by the Sakarya University Local Ethical Committee (approval number: E-71522473-050.01.04-92657-570, date: 03.01.2022).

Informed Consent: Retrospective study.

Authorship Contributions: Surgical and Medical Practices - M.K., D.C.; Concept - M.K.; Design - M.K., D.C.; Data Collection or Processing - M.K.; Analysis or Interpretation - M.K.; Literature Search - M.K., D.C.; Writing - M.K., D.C.

Conflict of Interest: No conflict of interest was declared by the authors.

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