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Medium-term outcome of posterior surgery in the treatment of non-tuberculous bacterial spinal infection

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ABSTRACT

Objective: to evaluate the outcome of posterior spinal stabilization surgery for the management of bacterial spinal infection.
Methods: 21 patients with bacterial infection were managed surgically with posterior stabilization. Outcome measures included neurological status. Follow-up data collected using Spine Tango COMI questionnaires and Euro Qol EQ-5D.
Results: The mean improvement in neurological deficits was 0.91 Frankel grade. Residual symptoms of pain had no or minor effect on the work or usual activities in 52% of subjects, with 88% reported having either no or mid problems with mobility.
Conclusion: Posterior surgery can improve neurological outcome in approximately half of the patients.

1. Introduction

Pyogenic Vertebral Spondylodiscitis (PVS) is a rare, serious condition, which is associated with high rates of morbidity and mortality.[1,2] The annual incidence of PVS ranges from 0.5 to 2.2/100,000 with infection commonly reported as to affecting elderly or chronically ill patients.[1,3] Although there are many micro-organisms that can cause PVS, Staphylococcus aureus is cited as the most common.[4] The causative micro-organisms may reach the spine either by hematogenous seeding (the most common route) or by direct inoculation of the bacteria to the disc space during spine surgery, diagnostic procedures or as a result of penetrating trauma.[3]

PVS usually affects the lumbar and the lower thoracic spine more commonly than others area of the spine.[5–8] In addition PVS is associated with a number of predisposing factors (such as Diabetes Mellitus "DM", Intravenous Drug Use "IVDU" or previous surgery) or with an extra-spinal focus of infection, particularly cutaneous or pulmonary infections.[6,9]

Patients with PVS commonly present with continuous unremitting back or neck pain. Other presenting symptoms may include fever, loss of weight or neurological symptoms.[10] The goals of management of PVS are to relieve pain, control infection, prevent or reverse neurological deficit, maintain stability of the spine and to prevent recurrence of the infection.[9,11] PVS can be managed either by conservative measures (including intravenous or oral antibiotics and immobilization/braces), or by surgical intervention.[12] The surgery may include performing abscess drainage, neurological decompression, debridement of the infected tissue, stabilization with or without fusion.[13]

Traditionally, many surgical approaches had been described for the management of PVS, such as anterior, posterior, or combined anterior and posterior approaches.[14] Although the anterior or combined approach allows for easier access to the anterior column, studies have demonstrated that there is an increased the risk of complications (such as respiratory problems) to debilitated or elderly patients when compared to posterior access.[6,11,15–17] As a results, many authors[18–20] described performing posterior approach only for the surgical management of PVS. However, performing posterior approach with formal debridement of the infected tissue may be associated with a 50%

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Table 1
Patients' demographic data, comorbidities, suspected source of infection and indications for surgery.

Case No.	age	gender	BMI	comorbidities	Suspected source of infection	Indications for surgery
1	73	M	21.4	HT, TIAs, anaemia, CA colon, segmoidectomy.	No suspected source of infection was detected.	Lumbar back pain, spondylodiscitis, mechanical instability, failure of conservative treatment.
2	72	M	23	No documented comorbidities.	No suspected source of infection was detected.	Lumbar back pain, spondylodiscitis, failure of conservative treatment.
3	59	M	23.4	Testicular cyst.	Prostatic biopsy before 5 months, as part of routine checking for suspected prostate cancer.	Thoracic back pain, spondylodiscitis, failure of conservative treatment, kyphosis.
4	51	F	36.3	OSA, HT, Obesity.	No suspected source of infection was detected.	Thoracic back pain, discitis, development of urinary symptoms.
5	59	M	34.1	Type II DM, eye and foot Diabetic disease.	Urinary tract infection (UTI) within 1 month	Lumbar back pain, discitis, SEA, CES, confusion.
6	45	M	24	HCV.	History of Intravenous Drug Abuse (IVDU), (Unknown drug)	Thoracic back pain, Spondylodiscitis, failure of conservative treatment, kyphosis.
7	62	F	18.3	Coeliac dis, pancreatectomy.	Previous complicated laparotomy due to pancreatic fistula.	Lumbar back pain, spondylitis, failure of medical treatment, kyphosis.
8	59	M	21.3	Smoking, HT, stroke, recent weight loss.	No suspected source of infection was detected.	Neck pain, SEA, spondylodiscitis, spinal cord compression, paraplegia, sepsis.
9	42	F	27.7	No documented comorbidities.	No suspected source of infection was detected.	Lumbar back pain, discitis, SEA, septic arthritis.
10	69	M	36	HT,type II DM, BPH.	No suspected source of infection was detected.	Thoracic back pain, Spondylodiscitis, spinal cord compression, paresthesia in the right leg.
11	56	F	33.3	Previous history of lumbar disc problems.	No suspected source of infection was detected.	Neck pain, spondylitis, SEA, spinal cord compression, quadriparesis.
12	51	M	28.5	type I DM, Bilateral below knee amputation.	No suspected source of infection was detected.	Thoracic back pain, discitis, spinal cord compression, paraplegia, failure of medical treatment, kyphosis.
13	71	M	33.6	DM, CKD, AF, stroke.	Transurethral resection of the prostate (TURP), before 6 months	Thoracic back pain, Spondylitis, SEA, failure of medical treatment, spinal cord compression, Kyphosis.
14	48	M	23.8	DM.	chronic ankle infection	Spondylodiscitis, spinal cord compression, failure of medical treatment.
15	52	M	30.4	Type II DM, HT.	Recent foot infection	Thoracic back pain, SEA, spinal cord compression, paraplegia.
16	76	M	28.4	Not available.	Recent chest infection (bronchitis)	Thoracic back pain, spondylodiscitis, SEA, spinal cord compression and worsening neurology.
17	45	M	17.9	Type I DM.	No suspected source of infection was detected.	Lumbar back pain, spondylodiscitis, failure of medical treatment,
18	45	M	27.6	Heavy alcoholic, type II DM, Schizophrenia.	History of Staphylococcus aureus sepsis, 2 months before presentation.	spondylodiscitis, SEA, spinal cord compression, paraplegia.
19	53	M	19.2	IHD with coronary arteries stent.	IVDU (heroin addict)	Neck pain, spondylodiscitis, SEA, C5-6 vertebral collapse, Kyphosis.
20	51	M	26.6	Psoriasis, Type I DM, Anaemia.	Recent pneumonia.	Thoracic back pain, spondylodiscitis, SEA, failure of medical treatment, kyphosis
21	37	M	17.1	HCV, asthma.	IVDU (on Methadone injections, the reason for injections was not documented).	Neck pain, SEA. Spondylodiscitis, spinal cord compression, paraplegia.

M: male; **F**: female; **BMI**: body mass index; **HT**: hypertension; **TIA**: transient ischemic attack; **CA**: cancer; **OSA**: obstructive sleep apnoea; **DM**: diabetes mellitus; **HCV**: hepatitis C virus; **BPH**: benign prostatic hyperplasia; **CKD**: chronic kidney disease; **AF**: atrial fibrillation; **IHD**: ischemic heart disease; **SEA**: spinal epidural abscess; **CES**: Cauda Equina Syndrome.

increase in morbidity 17% increase in mortality,[19,22] due to lengthier operative time and more extensive tissue dissection. Consequently, long posterior fixation without debridement was described by two authors[13,21] to be effective to resolve infection in patients with PVS and it can decrease the risk of complications to the patients.

2. Patients and methods

2.1. Patient sample with inclusion and exclusion criteria

Over a period of 3 years, we had 47 patients who were diagnosed with pyogenic spinal infection of non-tuberculous etiology. 21 patients (17 male and 4 female) included in this study underwent surgery because of failure of a trial of conservative treatment, presence of neurological deficit, Spinal Epidural Abscess (SEA), painful instability or progression of deformity (Table 1). These form the main indications for this surgery.

All patients included in this series were being treated for active de novo pyogenic spinal infection and were managed with posterior fixation without performing the formal debridement. The study excluded patients operated for the late sequel of spinal infection (such as chronic back pain) without active spinal infection at the time of surgery, patients managed by debridement, laminectomy or discectomy without posterior fixation, and patients who underwent inter-body fusion.

The statistical analysis was performed using paired *t*-test and Wilcoxon signed ranks test with using Microsoft Excel 2013 - data analysis pack tool; and the SPSS data analysis program, version 22. A 'P' value less than 0.05 was considered to be statistically significant.

2.2. Surgical techniques

All patients were managed surgically by a posterior approach, posterior decompression (in cases of compressed neural elements), and posterior fixation using pedicle screws (or lateral mass screws) and rod, without performing the formal debridement. The posterior fixation was extended two or three levels above and below the infection (but it spared the infection site).

2.3. Post-operative follow-up

The post-operative data collection recorded any post-operative complications, the need for further intervention, pre and post-operative inflammatory markers (C-Reactive Protein (CRP) and White Blood Cell (WBC).

Neurological state was assessed pre- and post-operatively (before discharge), using the Frankel Grading System (FGS).[22] Bladder and bowel function of all participants were assessed pre- and post-operatively.

2.4. Medium-term follow-up

Medium-term outcomes were evaluated using the Spine Tango Combined Outcome Measure Index (COMI) questionnaire. Patients' data for each of the core set items of the questionnaire was analyzed separately. Then the composed index score was calculated for all the patients. The pre-operative COMI scores were available for 10 patients, and it was compared with their post-operative COMI scores. The patients' Quality of Life (QoL) was evaluated using the Euro Qol EQ-5D format. The medium-term (20 months) EQ-5D data was available for 18 of 21 patients.

3. Results

3.1. Patients' demographic data

The patients' mean age was 56 (37–76) years old. Pain being main presentation in 90% of the patients. One patient presented with paresthesia down his right leg. Motor neurological deficit was evident in 13 patients (62%) at presentation, 5 of them had a paraplegia, 1 had a quadriparesis, and 1 patient Cauda Equina Syndrome (CES). 9 patients (43%) presented with bladder and bowel dysfunction. No patient had a previous history of spinal infection or spinal surgery. One patient reported a previous history of lumbar disc pathology, which had been managed conservatively. 18 patients had one or more co-morbidity, and the suspected source of infection was identified in 12 patients.

The site of infection was more prevalent in the thoracic spine (38%), followed by lumbar region (24%). Of the 21 patients included 11 patients had SEA. The causative microorganisms were isolated from positive pathological sample culture in 16 patients, and Staphylococcus aureus (S.A.) was the most common (isolated in 8 patients). Patients demographic data, comorbidities, suspected source of infection and indications of surgery are shown in (Table 1).

3.2. Management

All patients were managed surgically with posterior fixation, antibiotics were continued after surgery for at least 3 months. The choice and duration of antibiotics were guided by the tissue culture and by the level of post-operative CRP, respectively. Patients were followed-up post-operatively for an average of 20 months.

3.3. Peri-operative issues

Prior to surgery, physical status and morbidity were evaluated using the ASA score of the American Society of Anesthesiologists,[23] (Table 2). No intra-operative complications were reported, post-operative complications were reported in 6 patients (29%), (Table 2). All post-operative complications were resolved before discharge.

3.4. Post-operative follow-up of inflammatory markers and neurological state

After surgery, the mean CRP and WBC values decreased from 76 mg/dl to 29 mg/dl and from 11.9×10^{-9}/L to 7.7×10^{-9}/L, respectively. After discharge, CRP values were monitored for an average of 4.4 months and the mean value at final follow-up was 6.1 mg/dl (P value: 0.000251). 7 out of 13 patients who demonstrated neurological deficit prior to surgery improved post-surgery (Fig. 1). The average improvement in neurological state was 0.92 Frankel grade (range 0–4), (P value = 0.02), 17 patients were able to mobilize (with or without assistance) at discharge (Table 2). Improvement in bladder and bowel symptoms was seen in 4 out of 9 patients after surgery. One patient developed transient incontinence post-surgery, with no bladder or bowel symptoms before surgery, this resolved before discharge.

3.5. Medium-term follow-up, COMI questionnaire and quality of life assessment with Euro Qol EQ-5D system

Following discharge, no patient required re-operation on for a reason related to the infection or its surgical management. At the final follow-up, the whole sample (21 patients) mean COMI score was 4.59. Mean pre-operative COMI score for the 10 patients who had pre-operative COMI score data was 6.39, and the mean value was decreased to 4.05 post-operatively (P value = 0.045), (Fig. 2). The analysis of each set of questions of COMI questionnaire demonstrated that at the final follow-up, 17 patients reported problematic back or neck pain, and the mean Visual Analogue Scale (VAS) was 4.28. The statistical data for other set of the questionnaire are demonstrated in (Table 3).

For the 18 patients who were assessed using the EQ-5D, the mean value was 0.569 (range −0.349 to 1). At the final follow up, there was no problems with mobility in 44% of the patients, and mild mobility problems were reported by 44%. Pain scores were impressing, as 17

Table 2
Morbidity state, intra-operative complications and ambulatory state at discharge.

Case No.	Pre-operative ASA Score (Morbidity)	Intra-operative Blood loss	Post-operative complications	Further intervention	Mobility state at discharge
1	ASA 2	500–1000	Non Applicable (N/A)	(N/A)	Mobilise independently.
2	ASA 2	Unknown	(N/A)	(N/A)	Mobilise independently.
3	ASA 1	100–500	(N/A)	(N/A)	Mobilise independently.
4	ASA 2	100–500	(N/A)	(N/A)	Mobilise independently.
5	ASA 4	500–1000	Post-operative agitation, drowsiness.	Critical care unit admission for close monitoring.	Mobilise with assistance or aids
6	ASA 1	Unknown	(N/A)	(N/A)	Mobilise independently.
7	ASA 4	500–1000	GIT problems.	Critical care unit admission for close monitoring.	Mobilise independently.
8	ASA 4	100–500	(N/A)	(N/A)	Mobilise independently.
9	ASA 3	100–500	Acute respiratory failure and acute hydrocephalus.	Critical care unit admission for close monitoring.	Mobilise independently.
10	ASA 3	100–500	(N/A)	(N/A)	Mobilise independently.
11	ASA 4	< 100	C3-4 spinal abscess with quadriplegia	Re-operation, critical care unit admission	Mobilise with assistance or aids
12	ASA 3	< 100	difficulty in voiding/emptying bladder	extensive neuro-rehabilitation and self catheterisation	Immobilised.
13	ASA 3	100–500	(N/A)	(N/A)	Mobilise independently.
14	ASA 3	100–500	(N/A)	(N/A)	Mobilise independently.
15	ASA 2	500–1000	(N/A)	(N/A)	Immobilised.
16	ASA 3	100–500	(N/A)	(N/A)	Mobilise with assistance or aids
17	ASA 2	100–500	(N/A)	(N/A)	Mobilise with assistance or aids
18	ASA 3	500–1000	(N/A)	(N/A)	Immobilised.
19	ASA 3	100–500	(N/A)	(N/A)	Mobilise with assistance or aids.
20	ASA 2	Unknown	(N/A)	(N/A)	Mobilise with assistance or aids
21	ASA 4	100–500	Respiratory problems, breathing difficulties.	critical care unit admission	Immobilised.

patients reported either having no pain or only mild pain/discomfort, whereas only 1 patient described having severe pain. 72.2% of patients reported having no problems with self-care.

4. Discussion

The results of this retrospective study have demonstrated that the posterior fixation without debridement of the infected tissue resulted in infection resolution in all patients, without recurrence during the follow-up duration. 81% of patients were ambulatory at discharge. Post-operative complications (Table 2) were similar in nature to the complications reported by other studies.[6,17,24] Nonetheless, all complications resolved before discharge and no surgery related mortality was reported.

Pain and neurological deficits were the main indication for surgery in most of the patients. Post operatively also antibiotics were continued as per culture reports and were guided by inflammatory markers. Long rigid posterior fixation of the infected segment, was done to provide stability. It has been documented that better stability allows better antibiotics infusion in to the infected area, which can promote healing.[13] Postoperatively discontinuing antibiotics in the presence of raised inflammatory markers in elderly comorbid patients would be too risky and would have needed a special ethical approval.

4.1. Surgical techniques

The optimal surgical technique in the management of PVS is not well known. The main reason for avoiding a full debridement in this study was the presence of one or more co-morbid conditions (such as, diabetes, previous stroke, ischemic heart diseases with stents, chronic alcohol intake, heavy smoking etc …) in this elderly group which increased the risk of intraoperative and postoperative complications, morbidity and mortality. Although we do agree that in most situation removal of the infected tissue results in a faster recovery, but in PVS which mainly affects the elderly patient with more than one co-morbidity a high rate of mortality (up to 50%) has been reported with a formal debridement.[19] The idea was to have a stable/rigid fixation spine with improved pain and neurology and quality of life with the minimum necessary intervention. The posterior approach was chosen as it is more familiar to most spinal surgeons and long rigid fixations with pedicle screws can be done rather quickly with minimal complications.

Finally, it can be argued that it is better to consider percutaneous fixation in these patients, as it provide adequate stabilization and avoid any additional tissue trauma. However, Percutaneous fixation would be ideal if the cause of pain was instability alone. In our series most of the patients had a compression of the cord or the nerves/neurological deficit which required a decompressive procedure for relief of pain or to improvement of neurology. Also with the minimal access surgery long fixation can be achieved but the addition of bone graft for fusion is difficult. This could lead to implant failure in the future. Therefore long posterior fixation was used to provide stability in the short term and fusion of the involved segments in the long term. Inflammatory markers were normal within 3 months after surgery in all patients.

4.2. Neurological state assessment

Although the surgical approach adopted in this study resulted in an improvement in the neurological state of 54% of those who presented with neurological deficit, the rate was lower than the outcomes reported by Lin et al.[21] (75%) and Mohamed et al.[13] (83%) for similar surgical technique. The ultimate outcome is multifactorial. In fact, the reason for low rate of improvement in neurological state after surgery in the current study was that 46% of the patients who had a neurological deficit presented more than 72 h after the onset of their neurological symptoms. It has been reported by Quinones-Hinojosa et al.[25] that late presentation after the onset of neurological deficit is usually

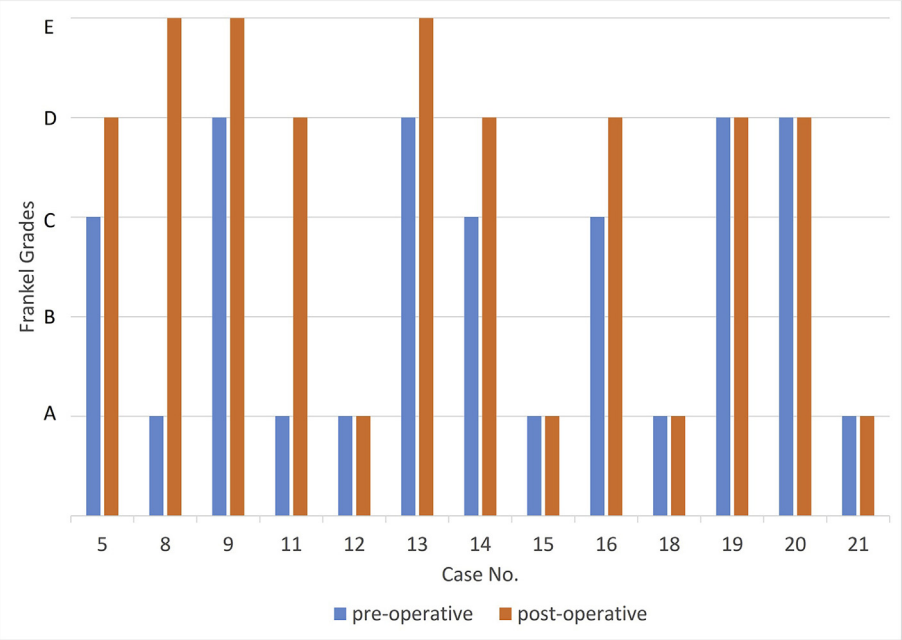

Fig. 1. Frankel grading system before and after surgery for patients who presented pre-operatively with motor neurological deficit.

associated with poor outcome after surgery. Whereas, urgent surgery demonstrated improvements in neurological status in 6 out of 8 patients (75%) who presented within 24 h of the onset of motor (7 patients) or sensory (1 patient) symptoms. Urgent surgery prevented the development of motor neurological symptoms in case No.10, who presented with a recently developed paresthesia down his right leg.

4.3. Medium-term follow-up using SpineTango COMI questionnaire and euro EQ-5D format

One of the challenges of interpreting the evidence base for clinical application to a specific patient group is often that studies adopt differing outcome measures,to assess pain, disability, function and patient satisfaction.[2,7,21]

The results of this study at final follow up demonstrate an increase in COMI score from pre-operative values in all but 2 patients. (cases No. 1 and 11). Case (No. 1), was a known case of colonic carcinoma, which could account for his severe un-remitting back pain (VAS 10), he was infection clear and fully ambulatory at the final follow-up. For case (No. 11), the acute symptoms onset (4 days before surgery) may be the reason why her pre-operative COMI score was lower than its post-operative value (as some elements of COMI questionnaire are designed to assess the patient's condition in the last few weeks, where she was healthy).

To our knowledge, the current study is the largest case series that evaluates the medium-term quality of life and symptom outcome measures following posterior surgery, without debridement, for the management of PVS, with an average follow-up of 20 months. Other

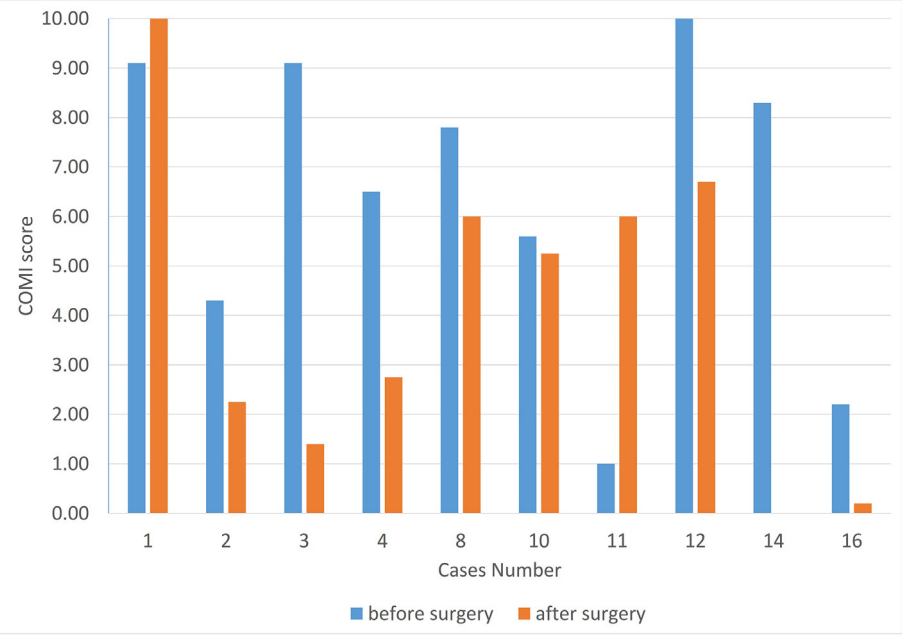

Fig. 2. COMI scores before and after surgery for 10 patients.

Table 3
The patients' data for the different sets of COMI questionnaire.

Back (or Neck) Function		Symptoms Specific Well-being		General Well-being		disabilities			Satisfaction		Outcome of Treatment		
						.....	*Usual Activities*	*Work*					
category	No. of patients (%)	category	No. of patients (%)	category	No. of patients (%)	Category	No. of Patients	No. of Patients	Category	No. of Patients (%)	*Category*	*No. of Patients*
Not at all	6(28.5%)	Very satisfied	4(19.04%)	Very good	5(23.8%)	None	8(38.09%)	11(52.38%)	Very satisfied	15(71.43%)	Helped a lot	14(66.66%)
A little bit	5(23.8%)	Somewhat satisfied	4(19.04%)	Good	3(14.3%)	1–7 days	5(23.8%)	2(9.52%)	Somewhat satisfied	4(19.04%)	Helped	4(19.04%)
moderately	2(9.52%)	Neither satisfied nor dissatisfied	3(14.3%)	Moderate	5(23.8%)	5–14 days	2(9.52%)	1(4.76%)	Neither satisfied nor dissatisfied	2(9.52%)	Helped a little	2(9.52%)
Quite a bit	5(23.8%)	Somewhat Dis-satisfied	5(23.8%)	Bad	5(23.8%)	15–21 days	1(4.76%)	1(4.76%)	Somewhat dis-satisfied	0(0.00%)	Didn't help	1(4.76%)
extremely	3(14.3%)	Very dis-satisfied	5(23.8%)	Very bad	3(14.3%)	> 22 days	5(23.8%)	6(28.5%)	Very dis-satisfied	0(0.00%)	Made things worse	0(0.00%)
total	***21(100%)***		***21(100%)***		***21 (100%)***	***total***	***21(100%)***	***21(100%)***	***total***	***21(100%)***	***total***	***21(100%)***

studies have analyzed the outcomes of this surgery in terms of neurological, radiological and biochemical/hematological outcome but not assessed medium-term quality of life and in particular return to premorbid level of function.[13,21]

4.4. Limitations of the study

The retrospective case series design, may limit the level of evidence of this study. However, due to the rarity of cases of PVS, it is difficult to obtain large patients sample at the same time and follow them prospectively. In spite of the small sample size, which may affect the study external validity, the included sample was homogenous in terms of the causative factors and the management strategy (the same surgical approach). Management guidelines which are followed by the Spinal Centre regarding the patients' selection, the management strategy and the follow-up, were strict enough to ensure that the risk of bias caused by different operating surgeons would be kept to a minimum.

Additionally, medium-term follow-up EQ-5D data was unavailable for three patients. Nonetheless, to date this is the largest dataset to be reported that assesses the medium-term quality of life after PVS surgery. Furthermore, although the pre-operative COMI scores were available for only 10 patients, the post-operative COMI scores may be the most important, as most of the patients presented acutely and didn't have any spinal pathology in the few weeks preceding surgery.

5. Conclusion

Our surgical approach was effective to resolve infection in all patients. The surgery results in more than 50% improvement in the neurological state, and around 81% of the patients were ambulatory at discharge. At the final follow-up, 90% of the patients were satisfied with the outcomes of surgery.

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