ORIGINAL ARTICLE

Posterior instrumentation, anterior column reconstruction with single posterior approach for treatment of pyogenic osteomyelitis of thoracic and lumbar spine

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Abstract

Purpose Surgical treatment of thoracolumbar osteomyelitis consists of radical debridement, reconstruction of anterior column either with or without posterior stabilization. The objective of present study is to evaluate a case series of patients with osteomyelitis of thoracic and lumbar spine treated by single, posterior approach with posterior instrumentation and anterior column reconstruction.
Methods Seventeen patients underwent clinical and radiological evaluation pre and postoperatively with latest follow-up at 19 months (8–56 months) after surgery. Parameters assessed were site of infection, causative organism, angle of deformity, blood loss, duration of surgery, ICU stay, deformity correction, time to solid bony fusion, ambulatory status, neurologic status (ASIA impairment scale), and functional outcome (Kirkaldy-Willis criteria).
Results Mean operating time was 207 min and average blood loss 1,150 ml. Patients spent 2 (1–4) days in ICU and were able to walk unaided 1.6 (1–2) days after surgery. Infection receded in all 17 patients postoperatively. Solid bony fusion occurred in 15 out of 17 patients (88 %) on average 6.3 months after surgery. Functional outcome was assessed as excellent or good in 82 % of cases. Average deformity correction was 8 (1–18) degrees, with loss of correction of 4 (0–19) degrees at final follow-up.
Conclusions Single, posterior approach addressing both columns poses safe alternative in treatment of pyogenic vertebral osteomyelitis of thoracic and lumbar spine.

It proved to be less invasive resulting in faster postoperative recovery.

Keywords Vertebral osteomyelitis · Thoracic spine · Lumbar spine · One-stage surgery · Instrumentation

Introduction

Vertebral osteomyelitis is an infrequent disease, with the incidence of 1:100,000–1:250,000 [1–4], and a relatively high mortality rate ranging from 2 to 17 % [4–9]. Treatment of vertebral osteomyelitis is mainly conservative, consisting of long-term antibiotic therapy in accordance with causative microorganism and bracing. On the other hand, there is still a subgroup of patients who require either emergency or elective surgery. The indications for surgery are: epidural abscess formation, progressive neurologic deficit, severe destruction of endplates with mechanical instability or segmental kyphosis, septic pseudarthrosis, severe pain and refractoriness to conservative treatment [10–15]. Radical debridement followed by autologous strut-graft interposition, proposed by Hodgson and Sock in early fifties [16] was considered as a golden standard for vertebral osteomyelitis surgery for many years. In the last two decades, however, the rationale changed from: do not put any foreign material in the infected tissue, to: make the segment as stable as possible [1–3]. Most authors therefore agree that both columns should be addressed either as single- or two-staged surgery [17, 18]. There is still debate whether to employ anterior or posterior route or even to fix spine from both approaches [4, 18].

The aim of the manuscript is to present a case series of patients with osteomyelitis of thoracic and lumbar spine

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treated by single posterior approach with posterior instrumentation and anterior column reconstruction.

Patients and methods

The records of patients, treated for osteomyelitis of thoracic and lumbar spine between January 2006 and June 2011 were revised. Out of 108 patients, 23 were treated operatively. Two patients were treated by single anterior approach, 4 patients with combined approach and remaining 17 patients underwent posterior instrumentation and anterior column reconstruction with posterior approach only. The average age of 17 patients, with posterior only approach, was 66 years (37–28 years); there were 8 female and 9 male patients. The location of infection was thoracic spine in 8 cases, thoracolumbar junction in 2 cases and lumbar spine in 7 cases (Table 1). In 15 cases, the route of infection was hematogenous and in 2 cases postoperative (herniated lumbar disc surgery one case, instrumented lumbar fusion one case). Prior to surgery three patients were treated for ischemic heart disease, three patients for

diabetes mellitus type II, one patient had rheumatoid arthritis and another patient acute myeloid leukemia.

Surgeries were performed through single midline dorsal access over the affected segments. After blunt retraction of paravertebral muscles, transpedicular screws (XIA, Stryker Spine, Allendale, NJ) were put into adjacent vertebrae and secured with rods. Number of instrumented segments was restricted to minimum and determined in relation to severity of bone destruction and intraoperative observation of bone quality. As a rule, only neighboring segments were instrumented in cases where segments just proximal and distal to affected disc could securely be fixed with pedicle screws. In cases of corpectomy/ies at least two proximal and distal segments were instrumented (Table 1). With the affected segments provisionally stabilized, posterior decompression was performed, followed by anterior decompression consisting of evacuation of the affected intervertebral disc (IVD), debridement of terminal endplates or corpectomy/ies in cases of severely destructed vertebral bodies. In order to avoid dural sac injury, special care was taken while dissecting soft tissues from dural sac. Affected segments were approached only from more

Table 1 Preoperative data

| No. of patients	Sex	Age at surgery	Location of infection	Ambulatory status (ability to walk unaided)	ASIA impairment score before/after	Neurologic deficit	Causative bacteria
1	F	58	Th12-L1	Yes	E	No	SA
2	M	41	Th8-Th9	No	B/D	Paraplegia	SA
3	F	70	Th8-Th9	Yes	E	No	Strepto.G (beta-hem.)
4	M	65	L1-L2	Yes		No	Coagulase-Staph.
5	F	66	Th6-Th7, Th7-Th8	Yes	E	No	SA
6	F	69	L4-L5	Yes		Peroneal paresis	Not found
7	M	73	L4-L5	Yes		Yes	SA
8	F	79	Th11-L1	Yes	E	No	Coagulase-Staph.
9	M	58	Th11-Th12	Yes	E	No	*Serratia marcescens*
10	F	69	L4-L5	Yes		Foot extensors paresis	Not found
11	M	72	Th6-Th7-Th8	No	C/D	Spastic paraparesis	SA
12	F	74	Th8-Th9	Yes	E	No	SA
13	M	79	Th4-Th5	No	C/D	Paraparesis, urinary bladder symptoms	SA
14	M	60	L4-L5	Yes		No	Streptocc. C
15	M	37	Th7-Th8	Yes	D/E	Spastic paraparesis	*Propionibacterium acnes*
16	F	82	L4-L5	Yes		No	SA
17	M	72	L3-L4	Yes		No	*Propionibacterium acnes*

SA, *Staphylococcus aureus*; *Strepto. G (beta-hem.)*, Beta hemolytic Streptococcus group G; *Coagulase-Staph.,* Coagulase negative Staphylococcus; *Streptocc. C,* Streptococcus group C

affected side. In cord levels, access was enhanced by costotransversectomy and additionally in corpectomy/ies cases by killing the appropriate spinal nerve/s. Either titanium mesh cage (Surgical Titanium Mesh®, DePuy Acromed, Raynham, MA) or PEEK cage (Boomerang®, Medtronic, Minneapolis, MN) (Fig. 1) was used in cases where IVD alone was removed. In cases of corpectomy, expandable titanium cage (VLIFT, Stryker Spine, Allendale, NJ) (Fig. 2) or titanium mesh cage (Surgical Titanium Mesh®, DePuy Acromed, Raynham, MA) (Fig. 3) was used. Bone obtained from posterior elements was put into the cage, at anterior third of IVD or in cases of corpectomy anterior and lateral to the cage. Kyphotic deformity was corrected in cases of disc removal by putting interbody cage of maximal feasible height as anteriorly as possible with posterior compression and in cases of corpectomy/ies by putting expandable cage with appropriate distraction again followed by posterior compression. Drain was left in epidural space until drainage was reduced to less than 50 ml/day for 2 consecutive days.

Antibiotic therapy was administered according to sensitivity testing. It was given parenterally for at least 6 weeks. Thereafter, antibiotics were continued orally for 4 weeks or in cases of elevated C-reactive protein and sedimentation rate until their values returned to normal.

Patients were followed at 1, 3, 6 months and 1 year after surgery. Thereafter, the patients were followed-up at yearly intervals. Latest follow-up was on average 19 months (8–56 months) after surgery. Neurologic workup was performed at the admission and repeated during hospitalization and follow-ups. Patients with upper motor neuron impairment were classified according to ASIA impairment classification [19]. Plain radiographs were taken at each follow-up measuring angle of deformity and time to solid
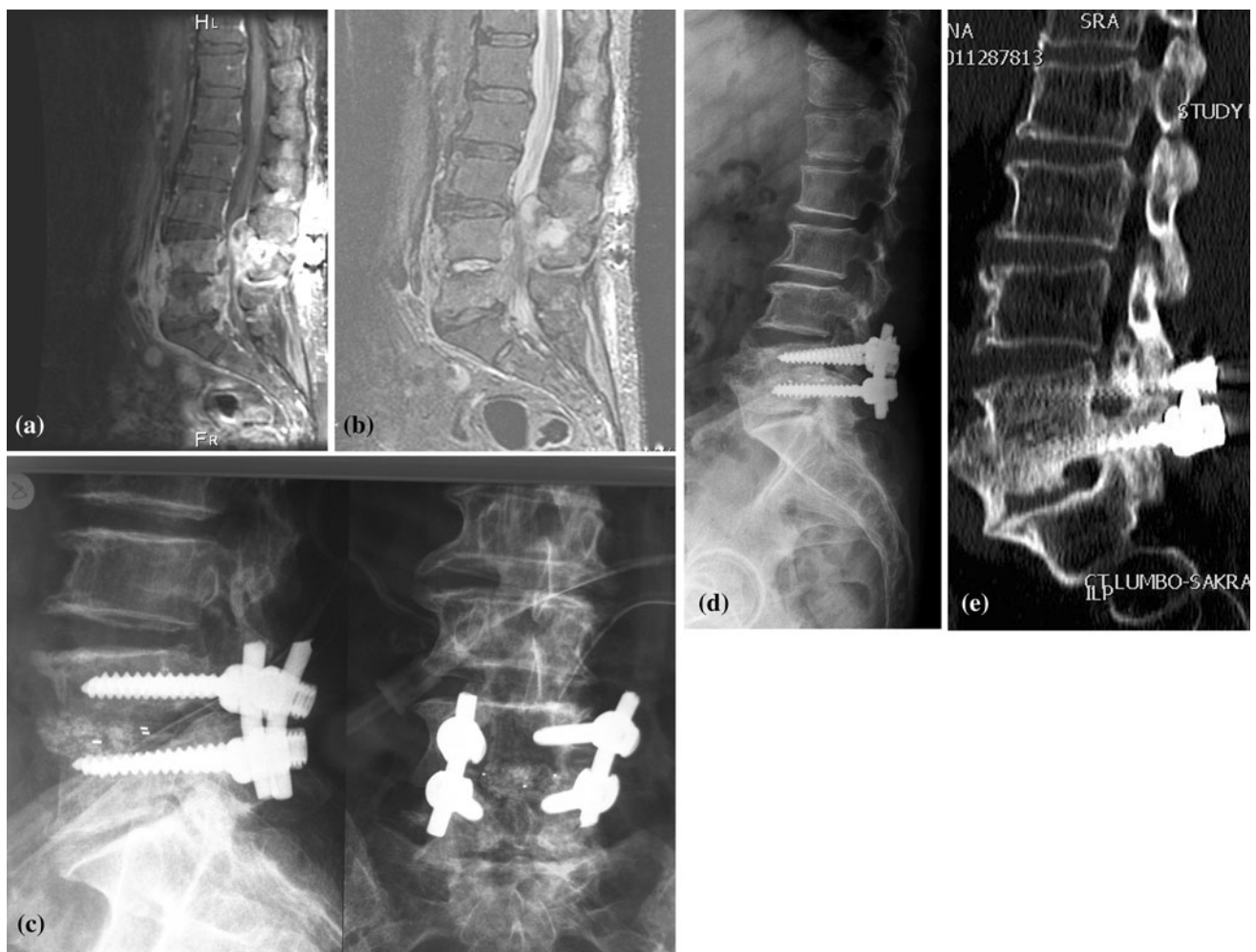
Fig. 1 A 82-year-old woman with post discectomy osteomyelitis of L4-L5 (Patient no. 16). T1-weighted MRI image showed severely narrowed spinal canal due to large epidural abscess (a) while STIR MRI image showed L4-L5 disc infection (b). Comparison of immediate (c) and late postoperative X-rays (d) showed slight posterior migration of cage. Large fusion mass occurred anteriorly (d). CT image also confirmed anterior fusion mass extending to also L5-S1 disc space (e)

Fig. 2 A 72-year-old man with osteomyelitis of Th6-Th7-Th8 (Patient no. 11). T2-weighted MRI image preoperatively showed Th7-Th8 deformation and spinal canal narrowing (**a**). Late postoperative AP (**b**) and lateral (**c**) X-rays showed solid bony fusion over three affected segments

bony fusion. In inconclusive cases bony fusion was assessed by CT scan. Clinical data included duration of surgery, blood loss, time spent in the ICU and ambulatory status before and after surgery. Functional outcome, using Kirkaldy-Willis criteria, was determined for each patient at the end of observation period.

Results

Mean time of surgery was 207 (70–360) min and the mean blood loss 1,150 (400–4,600) ml. The average stay in the intensive care unit after surgery was 2 (1–4) days.

Causative bacteria were found in all but two cases, represented by *Staphylococcus aureus* species (8 cases), followed by Coagulase negative Staphylococci and *Propionibacterium acnes* (both 2 cases), Beta-hemolytic Streptococcus group G, *Serratia marcescens* and Streptococcus C (all 1 case). Infection completely resolved after operative and antibiotic intravenous and per-oral therapy in all 17 patients.

Five surgeries were performed as an emergency procedure due to progressive neurologic deficit. There were four patients with upper motor neuron dysfunction, all at least partially improved postoperatively (Table 1). In two cases improvement was seen immediately after surgery, in further two after a period of rehabilitation. At final follow-up three patients could walk on their own, one with assistance. All three patients with radiculopathy made partial recovery after surgery.

All the patients were ambulatory at the end of observation period. Patients without preoperative upper motor neuron symptoms took 1.6 days (1–2 days) to walk unaided (Table 2).

Surgical procedure resulted in deformity correction of 8 (1–18) degrees on average in 15 patients with fusion. Loss of correction of 4 (0–19) degrees was observed at latest follow-up (Table 2).

Solid bony fusion was achieved in 15 out of 17 patients (88 %) at 6.3 (3–16) months postoperatively. In two patients fusion did not occur at 34 months (Patient no. 8) and 8 months postoperatively (Patient no. 12) (Table 2).

Fig. 3 A 58-year-old woman with vertebral osteomyelitis of Th12-L1 and large epidural abscess formation (Patient no. 1). Preoperative lateral X-ray (**a**), preoperative sagittal T1-weighted MRI (**b**). AP and lateral X-rays (**c**, **d**) 12 months postoperatively demonstrated solid bony fusion
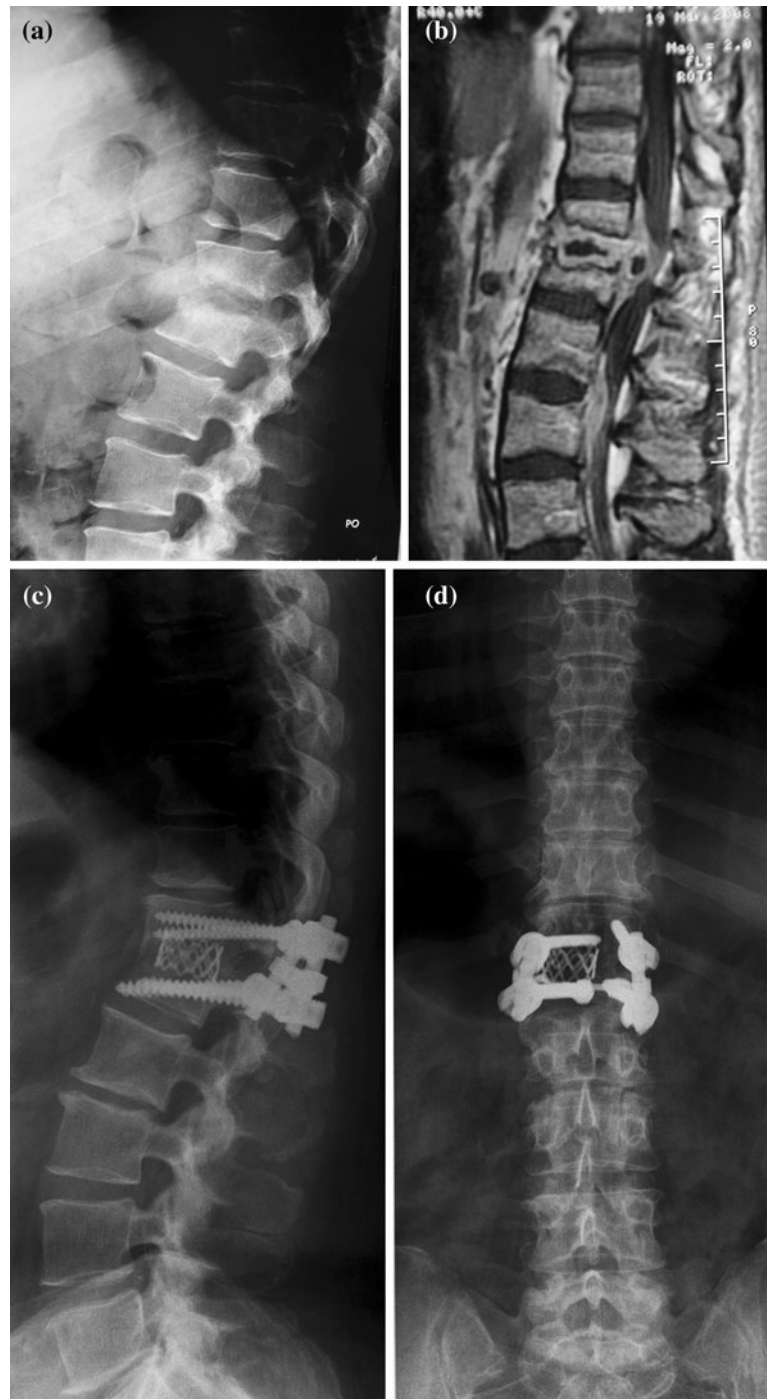
Patient no. 8 presented with vertebral osteomyelitis at age 79 and had severe osteoporosis. After infection resided, she was satisfied with the procedure, however, no solid bony fusion was achieved. 28 months after operation she presented at outpatient clinic with mechanical back pain, where radiography showed pullout of distal pedicular screws. She was a candidate for reoperation, but before that she was hospitalized in a gastroenterology department where she was diagnosed and treated for a gastric cancer.

Patient no. 12 has made a complete recovery and was followed-up until 8th month after surgery. Although she was satisfied with the outcome, she refused further check-ups. At last follow-up, solid bony fusion did not occur and she was therefore considered "non-fused".

Patient self-assessment of the functional outcome, based on the Kirkaldy-Willis criteria, showed excellent result in six patients, good in eight and fair result in three patients (Table 2).

Table 2 Perioperative and follow-up data

No. of patient	Location of infection	Level of fixation	Segm. fused	Cage	Duration of surgery (min)	Blood loss (ml)	Ambulatory status (ability to walk unaided) (days post op.)	Observation time (months)	Angle preoperative (°)	Angle postoperative (°)	Angle end (°)	Bone fusion (months)	Kirkaldy-Willis functional outcome	Intensive care unit (days)
1	Th12-L1	Th12-L1	1	Harms	165	400	1	27	12	11	12	3+	Excellent	1
2	Th8-Th9	Th8-Th9	1	PEEK	160	1,500	With assistance only	16	19	1	20	6+	Good	3
3	Th8-Th9	Th6-Th12	3	VLIFT	225	1500	2	14	35	20	22	4+	Excellent	3
4	L1-L2	L1-L2	1	Harms	185	600	2	8	14	5	1	6	Good	4
5	Th6-Th7, Th7-Th8	Th4-Th10	4	VLIFT	220	900	2	10	27	11	14	8	Good	2
6	L4-L5	L4-L5	1	Harms	150	500	2	56	−8	−16	−16	5	Good	2
7	L4-L5	L4-L5	1	Harms	155	1,500	2	12	−17	−8	−6	6	Good	2
8	Th11-L1	Th9-L1		VLIFT	360	4,600	2	34	10	6	10	No	Fair	4
9	Th11-Th12	Th9-L3	3	VLIFT	185	700	2	47	18	2	8	3	Good	2
10	L4-L5	L4-S1	1	Harms	185	1,000	2	23	−18	−18	−16	5	Excellent	4
11	Th6-Th7-Th8	Th4-Th10	4	VLIFT	285	1,500	14	13	20	19	16	6	Fair	2
12	Th8-Th9	Th7-Th9	1	Harms	230	400	1	8	20	16	26	No	Good	1
13	Th4-Th5	Th4-Th5	1	VLIFT	240	500	11	16	15	8	10	16	Excellent	1
14	L4-L5	L4-L5	1	PEEK	70	500	1	11	−5	−15	−10	4	Excellent	2
15	Th7-Th8	Th5-Th10	2	Harms	300	2,000	5	10	30	14	20	8	Good	2
16	L4-L5	L4-L5	1	PEEK	240	800	1	8	0	−7	−3	5	Fair	2
17	L3-L4	L3-L4	1	Harms	165	600	1	6	6	−6	−1	4	Excellent	2

Three patients died during the observation period, none of the reasons directly connected to vertebral osteomyelitis. Patient no. 4 suffered from leukemia (AML) treated with bone marrow transplantation prior to vertebral osteomyelitis at L1/L2 level. After surgical and antibiotic treatment, he made a beneficial recovery. He had a relapse of leukemia and died 10 months after the procedure due to sepsis originating from a bacterium other than Koagulase negative Staphylococci that caused the spinal infection. He achieved solid bony fusion 6 months after the operation. Patient no. 5 and patient no. 7 died of cardiac reasons 12 and 14 months after surgery. Both recovered completely after surgery, patient's No. 7 neurologic deficit improved after a period of rehabilitation. They were both satisfied with the treatment, and both achieved solid bony fusion.

Discussion

Surgical treatment of thoracolumbar pyogenic osteomyelitis consists of radical debridement, reconstruction of anterior column with or without posterior stabilization aiming for fast postoperative mobilization [11, 18]. Surgical goals could be achieved via different approaches be it anterior, posterior or combined. Most of the reported case series preferred anterior approach [8, 11, 20] or combined approach executed either as one- or two-staged procedure [8, 10, 13, 21, 22]. Posterior approach addressing both column pathology has been widely accepted in tumor surgery [23, 24], yet there are few reports on posterior approach for vertebral osteomyelitis with majority of reported cases dealing with lumbar spine pathology [25–29]. Reconstruction of anterior column was performed mostly using iliac crest bone graft [27–29] or even employing transdiscal osteotomy with vertebral shortening [25]. Present case series, on the other hand, report on posterior approach for one or multilevel thoracic and lumbar pyogenic osteomyelitis utilizing cages for anterior column reconstruction.

Single posterior approach has few important advantages over most standard approaches. Compared to anterior route, one can avoid entering thoracic and/or abdominal cavity with less morbidity for a patient. This could result in fast postoperative recovery, which was demonstrated in our series as patients left intensive care unit on second postoperative day and walked unaided on first or second postoperative day, except for patients with upper motor neuron lesion who required longer rehabilitation. No patient needed bracing postoperatively.

Surgery time in our series was 207 min on average compared to 427 min for combined anteroposterior two-stage approach [30] and 345 min for single-stage anteroposterior approach [21]. Dai et al. [31] reported a short operative time of 168 min utilizing single anterior approach. Nevertheless, besides the anterior approach-related morbidity, some patients needed postoperative external support after fixation of only anterior column. Blood loss was also substantially lower compared to other studies. Combined single-staged procedure was reported to have blood loss of 1,700 ml [20] and double-stage combined approach of 2,700 ml [32] as opposed to 1,150 ml in our series.

In cases of two or more level corpectomies, spinal nerve/s has/ve to be killed to gain access for cage placement. There were two cases of two level and a case of three level corpectomies (Fig. 2) in present series, all in thoracic spine. While there were no clinical consequences following spinal nerve section in our thoracic cases one might expect paresis of distinct lower limb muscles when utilizing posterior approach in lumbar spine. Therefore, anterior or combined approach is to be considered in multilevel osteomyelitis of lumbar spine. Two other contraindications for single posterior approach could be early staged vertebral osteomyelitis in which there is no spread of infection into the spinal canal and substantial psoas abscess.

In the last decade, many studies advocated utilization of titanium cages for anterior column reconstruction in vertebral osteomyelitis without increase of infection recurrence [11, 31–34]. The question is posed, however, whether to use PEEK material in septic osteomyelitis of the spine. Only few reports, with total of 20 patients, exist on successful treatment of vertebral osteomyelitis with PEEK cages [35–37]. Three out of 17 patients in our series were treated with PEEK cages resulting in resolution of infection in all cases. Although small in number, our cases suggest that PEEK cages could be used for anterior column reconstruction in purulent conditions of thoracolumbar spine.

Time to solid bony fusion and percentage of fused cases in present study closely correlate to data from literature. 88 percent of patients achieved solid bony fusion on average 6.3 months postoperatively. Most series report solid bony fusion to occur in over 90 percent of cases [11, 13, 30, 38] and time to fusion from 7.5 to 8.6 months [30, 38, 39]. Kyphosis correction averaged 8 degrees in present series as compared to 12.5 degrees in other series [21]. Deterioration of kyphosis correction of 4 degrees at the latest follow-up did not have clinical consequences in any of the patients.

There are drawbacks and limits to the present study. The cohort is diverse concerning the location, extent of pathology and causative organism. The study is retrospective in its basis and includes no control group, which enabled only descriptive analysis.

Conclusion

Posterior approach poses a safe alternative in treatment of thoracolumbar osteomyelitis. It offers adequate exposure for thorough decompression, debridement, posterior instrumentation and anterior column reconstruction. It has an advantage of being less invasive thereby enabling a patient fast postoperative recovery.

Conflict of interest   None.

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