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ORIGINAL ARTICLE

# Surgical treatment of infectious spondylitis in patients undergoing hemodialysis therapy

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**Abstract** Treatment of infectious spondylitis in hemodialysis patients remains a challenge because of comorbidities. This study aimed to evaluate the impact of end-stage renal disease (ESRD) on the clinical manifestations and surgical outcomes of patients with spinal infection. Sixteen patients who underwent surgical intervention were included. There were 3 thoracic and 13 lumbar lesions. All patients presented with intractable back pain at the start of treatment. Six patients had a fever, nine had inflammation at the hemodialysis access site, and six of them had concomitant bacteremia. Ten patients had an elevated leukocyte count. Serological tests indicated an elevation of the C-reactive protein and erythrocyte sedimentation rate level in all patients. Five patients had a neurological compromise. Postoperative complications included two mortalities, two iliac bone graft and implant dislodgement, and one retroperitoneal wound dehiscence. The preoperative mean visual analog scale score was 7.7 (range, 6–9), which improved to 3.4 (range, 2–5) at the final follow-up for 14 surviving patients. Neurological improvement was obtained by at least one grade in four Frankel C category patients. The radiographs revealed a good bony fusion in 12 cases although with a variable bone graft subsidence. In conclusion, early diagnosis of infectious spondylitis is difficult due to latent symptoms. A spine infection should be suspected in hemodialysis patients with severe back pain, even when they are afebrile. Surgical intervention for infectious spondylitis in ESRD patients undergoing hemodialysis can be performed with acceptable outcomes; however, the complication and mortality rates are relative high.

**Keywords** Infectious spondylitis · ESRD · Hemodialysis · Anterior interbody fusion

## Introduction

In recent years, survival of patients with renal failure has dramatically increased due to improvement in hemodialysis materials and techniques. Although the life expectancy of hemodialysis patients has increased, they tend to suffer more skeletal, articular, and spinal complications than previously. Hemodialysis patients are frequently at risk of infection from complications of bacteraemia due to routine skin penetration for blood access [1, 2, 6, 18, 19]. Although less common, spine infection is also a serious complication in hemodialysis patients. Early diagnosis of spine infection and prompt initiation of the appropriate therapy are crucial in ensuring successful treatment and preventing further morbidity.

Early diagnosis of infection and prompt initiation of appropriate antibiotic therapy against the causative organisms are crucial in ensuring successful treatment of infectious spondylitis and preventing further morbidity. Most infectious spondylitis can be treated successfully by appropriate antibiotic therapy. Surgical intervention is only reserved for cases that are unresponsive to antibiotic

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therapy and in patients who have developed progressive spinal deformity or instability, epidural abscesses, or neurological impairment. However, surgical treatment of spine infection in hemodialysis patients remains a challenge because of comorbidities and patients' poor general health. Few reports have addressed the clinical outcomes of surgical intervention in these patients. The aim of this study was to evaluate the impact of end-stage renal disease (ESRD) on clinical manifestations, surgical outcomes, and complications in patients with spinal infection.

## Patients and methods

The ESRD patients included eight males and eight females (age, 50–75 years) undergoing hemodialysis therapy with clinical and radiological signs of acute infectious spondylitis. Initially, these patients were treated with conservative parenteral antibiotic therapy by nephrologists or infection specialists. They were referred to our department for surgical treatment because of being refractory to conservative treatment. They were treated by surgical intervention between January 1997 and July 2006. Patient medical records were reviewed, including outpatient and emergency room notes, admission notes, inpatient progress and nursing notes, procedure notes, surgical reports, radiology reports, pathology reports, and microbiology laboratory results. The cause of renal failure was chronic glomerulonephritis in 4, diabetic nephropathy in 11, and hypertension in 1 patient. The duration of hemodialysis before the onset of spine infection was 3 months to 14 years. Infectious spondylitis was diagnosed from clinical examinations, including elevated erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) levels, and roentgenographic and magnetic resonance imaging (MRI) findings. The infected levels were T4–5 in one, T7–8 in one, T8–9 in one, L1–2 in one, L2–3 in two, L3–4 in three, L4–5 in four, and L5–S1 in three patients. The indications for surgical treatment included the following: (1) drainage of an abscess; (2) a bacteriological diagnosis; (3) treatment of infections refractory to nonoperative treatment; (4) decompression of neural elements in the presence of a neurological deficits; and (5) correction of spinal deformity or instability. The hemodialysis was performed 1 day before and after surgery in accordance with the patient's previous schedule.

Because of the different general conditions and clinical presentations of the patients, the approach of surgery was adjusted according to the individual case. Single anterior surgery was performed in 12 patients initially. An anterior transthoracic or retroperitoneal approach was employed for debridement and anterior interbody fusion. Autogenous tricortical iliac strut bone grafts were used for spinal reconstruction without instrumentation. Four patients received combined surgery including anterior interbody fusion and posterior instrumented fusion. Of them, one had same-day surgery and three patients received staged surgeries with posterior instrumentation and fusion 7 days after the initial anterior fusion procedure. After these operations, microbiological examination served as the basis for administering parenteral antibiotics for at least 6 weeks. The microbiology reports included microscopy and culture findings and any specific pathogens identified by either method. After the surgery, patient wore a custom-made rigid brace for at least 3 months. Ambulation was allowed depending on the general condition of the patient and intensity of the postoperative pain.

Pre- and postoperative clinical symptoms and laboratory data were analyzed for all patients. With the exception of two patients who died during the treatment, the follow-up period for the other 14 were at least 24 months. The clinical outcomes were assessed by careful physical examination, regular serological tests, and serial radiographic studies. The severity of preoperative and postoperative back pain was evaluated by the visual analog scale (VAS). Follow-up plain radiography was undertaken immediately after surgery, at 3, 6, 12, and 24 months to assess the fusion status and the sagittal alignment of the involved segment. Solid bony union was considered if there were visible continuous bony trabeculae between the graft and the adjacent vertebra without radiolucency. The lordotic angle of sagittal alignment was measured by the angle of the perpendicular lines from the upper and lower endplates of the involved fusion segment.

## Results

The most prominent clinical sign of infectious spondylitis in ESRD patients undergoing hemodialysis therapy was back pain. All patients presented with intractable back pain that required narcotic pain control and bed rest. A history of increased body temperature (>37°C) was observed in six patients. Two patients had a high-grade fever (39°C) and four had mild fever around 37–38.5°C. Nine patients had an inflammation at the hemodialysis access site, with six of them showing concurrent bacteremia. Ten patients had an elevated leukocyte count. Serological tests indicated an elevation of CRP and ESR in all patients. Before surgery, the average CRP level was 139.8 mg/dl (range, 20–465.2 mg/dl) and the average ESR level was 108.3 mm/h (range, 51–140 mm/h). Before the operation, five patients had a neurological compromise (1 Frankel A, 4 Frankel C); the other 11 patients were neurologically intact.

At the final follow-up after surgery, back pain was found to improve in all cases. Preoperatively, the VAS had a

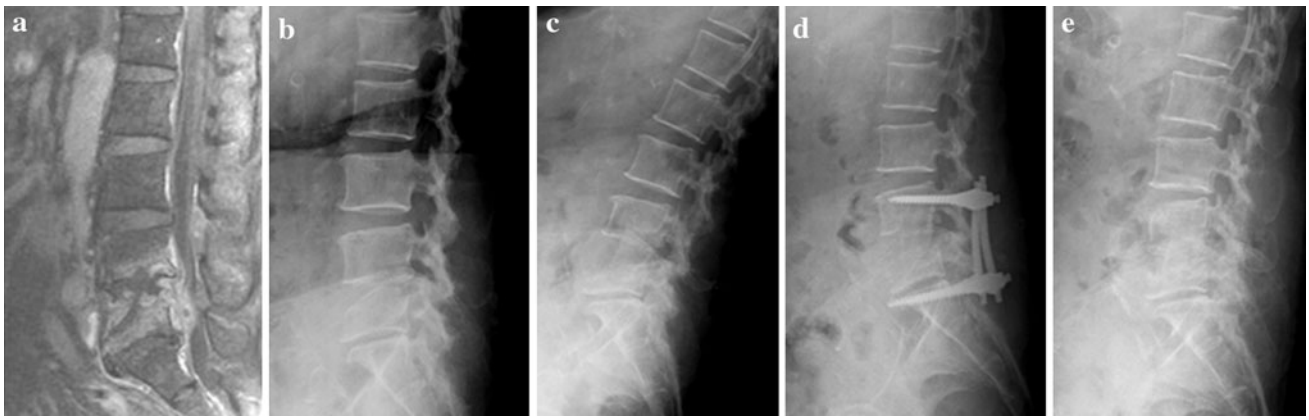


**Fig. 1** A case of L4–5 infection. **a**, **b** Preoperative magnetic resonance imaging (MRI) and lateral plain radiograph. **c** Immediate plain radiograph after autogenous tricortical iliac bone graft for spinal reconstruction. **d** A two-stage operation with posterior instrumentation and fusion was performed to maintain the correction of kyphosis and to stabilize the unstable segment. **e** Removal of the loosening pedicle screws 6 months after initial surgery was performed. At the final follow-up, the interbody fusion was good

mean of 7.7 (range, 6–9); postoperatively, the mean VAS was 3.4 (range, 2–5). In the five patients who had neurological compromise before the operation, no neurological function worsened postoperatively. Following postoperative rehabilitation, the neurological improvement was obtained by at least one grade during follow-up in four Frankel C category patients. Among them, one patient improved to category D and three to category E. Otherwise, the neurologic status remained unchanged in the patient who was graded as Frankel A preoperatively.

Causative bacteria from the biopsy samples were identified in 11 patients. *Staphylococcus aureus* was the most common organism: MSSA (methicillin-sensitive *Staphylococcus aureus*) in three patients and MRSA (methicillin-resistant *Staphylococcus aureus*) in four patients. Other organisms included *Enterococcus faecalis* in three patients and tuberculous bacteria in one patient. Systemic antibiotics and anti-tuberculous therapy were administered according to sensitivity studies for identified pathogens. In five patients showing negative culture results, cefazoline combined with gentamicin was prescribed empirically. In two patients, the antibiotics were changed to vancomycin due to the persistent elevation of CRP. Parenteral antibiotics were administrated for at least 6 weeks in all patients until clinical improvement was noted, except for two who died during hospitalization. Six weeks after surgery and antibiotic treatment, the mean CRP level declined to 19.7 mg/dl (range, 10.3–38.8 mg/dl). If the CRP levels were still not in the normal range, the patients had follow-up as outpatients on oral antibiotics. In general, patients were discharged with improved clinical symptoms and laboratory findings.

Postoperative complications included dislodgement of the iliac bone graft within 4 weeks after single anterior surgery in two patients who required revision surgeries. In the one patient who underwent staged anterior and posterior surgeries, persistent infection with a dislodgement of the bone graft and retroperitoneal wound dehiscence occurred 3 weeks after the initial anterior surgery. The infection subsided after repeated debridement. This patient also had removal of the loosening posterior implants 6 months after surgery, although anterior fusion was completely consolidated (Fig. 1). Three patients had been admitted to the intensive care unit for postoperative care due to difficult weaning after operation. Mortality was observed in two patients, who were excluded from the postoperative clinical outcome evaluation. One patient died within 1 month after a single anterior procedure and another died after a staged posterior procedure, due to persistent sepsis and complications of pneumonia and respiratory failure.

On plain radiographs before the surgery, all patients showed local kyphotic deformities due to destruction of the disc and endplates of the involved vertebral segment. At the final follow-up, radiographs revealed a good interbody fusion in 12 of 14 surviving cases, although with a variable anterior bone graft subsidence (Fig. 2). However, this did not cause clinical symptoms. The mean lordotic angles of the involved segments before and after surgery, and at the last follow-up were −6.7° (−14° to 0°), 5.7° (0°–20°), and −0.86 (−13° to 15°), respectively. We did not observe any progressive destruction of the infected area or an increase in kyphosis in comparison with the preoperative kyphosis.

## Discussion

The incidence of hemodialysis catheter-related infection varies among different series of patients, ranging from 5.3 to 37% [2]. Theoretically, long-term hemodialysis has a


**Fig. 2** A case of L4–5 infection, with an anterior interbody fusion with tricortical iliac strut bone graft. **a**, **b** Preoperative magnetic resonance imaging (MRI) and lateral plain radiograph. **c** Immediate plain radiograph after autogenous tricortical iliac bone graft for spinal reconstruction. **d** At the final follow-up, the interbody fusion was good, although there were bone graft subsidence and a decrease in lordotic angle. However, this did not cause clinical symptoms

cumulative effect on increasing the likelihood of bacteremia and is a risk factor for spine infection. In the current study, only six patients had concurrent bacteremia related to an infection of the hemodialysis access site. This suggests that long-term hemodialysis may not be the sole critical factor for spine infection. Additional risk factors for spine infection include uremia, malnutrition, iron overload, anemia, old age, and the presence of diabetes mellitus (DM) [15]; however, a detailed discussion of these risk factors is beyond the scope of this study.

Hemodialysis patients commonly have amyloidosis along with its nonspecific symptoms, such as back pain, malaise, and low-grade stiffness [3, 8]. These nonspecific symptoms can also mimic the symptoms of bacterial spondylodiscitis [12, 19]. However, neurological problems occur only in the late stages of spondylodiscitis, due to either complete collapse or destruction of the involved vertebral bodies, or due to epidural abscess formation. Most patients in this study were afebrile or had temperatures of <38.5°C, classifying the disease as subacute or latent onset. Only two patients had an acute onset with high-grade fever. The percentage of hemodialysis patients with acute onset of bacterial spondylodiscitis in this study was lower than that reported in other studies (range, 30–60%) [14, 17]. This clinical finding was similar to the findings of Tsuchiya et al. [21]. This latent onset bacterial spondylodiscitis without remarkable fever may obscure inflammation-induced pain and complicate the diagnosis of hemodialysis patients, which can result in the delay of treatment.

In the current study, all patients presented with intractable back pain. A history of increased body temperature was observed in only six patients. Hemodialysis patients with spine infection present with unobvious clinical symptoms, except for back pain at the infection site. Spine infection should be suspected for an unexplained back pain presented in hemodialysis patients, even without fever. The ESR level often increases with uremic state without an infection [5, 16]. The serum CRP level is the most reliable marker of an infectious condition in dialysis patients [13]. A CRP level of >50 mg/l proved highly suggestive of a significant inflammatory process, and a value of <10 mg/l always excluded inflammation [9]. In the current study, all patients had elevated CRP levels preoperatively (range, 20–465.2 mg/dl). Thus, CRP level is useful in diagnosing bacterial spondylodiscitis and as a baseline measurement to compare and monitor the response to antibiotic therapy.

Plain radiographs are of little diagnostic value in early stage bacterial spondylodiscitis. Plain radiographs of some hemodialysis patients identify disc space narrowing and endplate erosion due to destructive spondylarthropathy (DSA), a condition similar to bacterial spondylodiscitis. It is difficult to distinguish between these two entities with plain radiographs, especially in afebrile patients. MRI is an effective tool for the early diagnosis of bacterial spondylodiscitis, especially in differentiating it from DSA [9, 17, 20]. The high sensitivity of non-invasive MRI is also important in making an effective early diagnosis. Typically, bacterial spondylodiscitis has increased signal intensity on T2-weighted images and low signal intensity on T1-weighted images. However, the increased signal intensity on T2-weighted images of DSA is uncommonly presented. Additionally, lesions on T1-weighted images are more clearly localized and seldom enhanced by contrast in DSA than in bacterial spondylodiscitis. These characteristics can be used to distinguish DSA from bacterial spondylodiscitis in an MRI study.

The surgical goals for treating bacterial spondylodiscitis include debridement of necrotic bone and surrounding tissue, drainage of associated paraspinal abscesses, and

correction of kyphotic deformity with spinal fusion. There is a controversy regarding the most appropriate surgical approach for treating bacterial spondylodiscitis. In the current study, most patients underwent an anterior procedure only and achieved good control of the infection. Although the final follow-up radiographs revealed variable bone graft subsidence and a decrease in the corrective lordotic angle, it did not cause related clinical symptoms. Circumferential fusion was performed in four cases to improve the spinal stability and to maintain the bone graft position; one patient had a dislodgement of the anterior bone graft and loosening of the pedicle screws. ESRD can cause renal osteodystrophy, with patients having continuous bone loss due to chronically elevated parathyroid hormone [7]. Osteoporosis can cause loosening of the pedicle screws. This should be considered before conducting posterior instrumentation in ESRD patients. The decision to use additional posterior instrumentation requires careful assessment. Since ESRD patients have medical comorbidities, it is not always necessary when the posterior spinal structures are intact. For ESRD patients with single-level spondylodiscitis, we recommended anterior debridement and interbody fusion with a postoperative rigid brace protection.

Treatment of bacterial spondylodiscitis must be preceded by correct bacteriological diagnosis, even after a successful debridement. If the causative bacteria are identified, antibiotics are normally chosen based on culture and sensitivity test results. However, if the causative bacteria are not identified, empirical antibiotic therapy should still be administered without bacteriological study results. We preferred to prescribe a first-generation cephalosporin such as cefazolin to cover the Gram-positive aerobic organisms and gentamicin to cover the Gram-negative aerobic organisms. Intravenous antibiotics are typically administered for 6 weeks based on the clinical symptoms and laboratory findings [4, 18].

Although the results of spinal reconstruction surgery in the treatment of spinal infection have been satisfactory, significant complications can occur especially in immunocompromised patients, including instrumentation failure, wound dehiscence, cardiac arrest, or inability of weaning ventilator [10]. In addition, there were reports of patient mortality during the early postoperative period [11]. In the current study, three patients were admitted into the intensive care unit for postoperative care due to difficulty in weaning after operation. Mortality was also observed in two patients. They died within 1 month after the surgical procedures due to persistent sepsis and complications of postoperative pneumonia and respiratory failure. Although the surgical results are promising, postoperative care requires careful consideration.

In conclusion, diagnosis and treatment of hemodialysis patients with bacterial spondylodiscitis is difficult. In addition, fever is not always present in hemodialysis patient with vertebral osteomyelitis. This latent form of presentation complicates early diagnosis. A spine infection should be suspected in hemodialysis patients with severe back pain, even when they are afebrile. An MRI study should be undertaken expeditiously, not only for the early diagnosis of bacterial spondylodiscitis, but also to differentiate between destructive spondylarthropathy and infectious condition. Surgical intervention should be considered when the infections are refractory to nonoperative treatment or a neurological deficit occurs even in ESRD patients. The surgical outcomes are acceptable; however, the approach of surgery should be carefully adjusted according to the individual case since the complication and mortality rates are relative high during the perioperative period.

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