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Pyogenic spondylitis caused by *Escherichia coli*: A case report and literature review

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Abstract

BACKGROUND

Pyogenic spondylitis is often manifested as atypical low back pain and fever, which makes it easy to be confused with other diseases. Here we report a case of pyogenic spondylitis and describe the diagnosis and treatment based on the related literature.

CASE SUMMARY

The reported case suffered from pyogenic spondylitis caused by *Escherichia coli* and complicated with bacteremia and psoas abscess. Acute pyelonephritis was initially diagnosed due to atypical symptoms. Symptoms were improved from antibiotic treatment while developing progressive lower limb dysfunction. One month post the admission, the patient underwent anterior lumbar debridement + autogenous iliac bone graft fusion + posterior percutaneous screw-rod internal fixation, and received 6 wk of antibiotic treatment after the operation. Reexamination 4 mo post the operation showed that the patient had no evident pain in the waist, and walked well with no evident dysfunction of lower limbs.

CONCLUSION

Here we describe the application value of several imaging examinations, such as X-ray, computed tomography and magnetic resonance imaging, and certain tests like erythrocyte sedimentation rate and C-reactive protein in the clinical treatment of

pyogenic spondylitis. This disease requires early diagnosis and treatment. Sensitive antibiotics should be used in early stages and surgical intervention should be taken if necessary, which may help for a speedy recovery and prevent the occurrence of severe complications.

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INTRODUCTION

Pyogenic spondylitis (PS) is a type of non-specific spondylitis caused by bacterial infection mainly involving vertebral body and/or intervertebral disc, and can be clinically classified as discitis, vertebral osteomyelitis and epidural abscess^[1,2]. Antibiotic treatment of septic spondylitis is a long-term process, and identification of the pathogenic microorganism by blood culture, tissue culture and nucleic acid amplification test is crucial^[3]. *Staphylococcus aureus* is the most pathogenic, while Gram-negative bacilli cannot be negated, with the disease caused by relevant infections on the rise annually^[4]. Due to the fact that the clinical symptoms of PS are lack of specificity, early diagnosis turns out a tough issue, which results in failure of timely and effective treatment. Besides, PS after recovery often comes with nerve injury and spinal deformity attributed to the long disease course and poor prognosis^[5,6].

Escherichia coli (*E. coli*) is an opportunistic pathogen that is mainly responsible for cystitis and even pyelonephritis secondary to transurethral infection of the urinary system. Currently, there have been few case reports for the PS caused by *E. coli*^[7]. We here report a 61-year-old male case of PS caused by *E. coli* infection, whose main manifestations are acute urethral syndrome and low back pain. We also review the relevant literature to elucidate related treatment strategies and experience for this rare disease.

CASE PRESENTATION

Chief complaints

Had bilateral low back pain (mainly manifested on the left) with prominent dysuria, urgency, and frequency.

History of present illness

While with no significant fever, the low back pain was gradually exacerbated in following days. One day prior to the admission, the patient suffered from chills and fever with a body temperature up to 39.5 °C, and accompanied with gross hematuria.

History of past illness

The patient had pulmonary tuberculosis 30 years ago.

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Personal and family history

No special personal history, no familial genetic disease.

Physical examination

Physical examination showed bilateral lumbar tenderness prominent on the left, bilateral renal percussion pain manifested as positive and no signs of neurological disorders.

Laboratory examinations

Laboratory examination revealed no increase in white blood cell (WBC) count ($7.9 \times 10^3/\mu\text{L}$) at admission, including neutrophil count of $6.4 \times 10^3/\mu\text{L}$ and lymphocyte count of $0.6 \times 10^3/\mu\text{L}$, as described in reported literature^[8], while an increase of C-reactive protein (CRP) content (260 mg/L) and procalcitonin (5.34 ng/L). On the 1st day of the admission, flow urine sediment inspection presented red blood cell (2683/ul) and WBC (142/uL), with no WBC or pyocyte in stool routine. On the 4th day of the admission, *E. coli* were detected from blood by bacteria culture (piperacillin/tazobactam S: < 4), *Acinetobacter baumannii* and *Aeromonas caviae* were seen in urine with no bacilli detected, and no pathogens like *Salmonella* and *Vibrio parahaemolyticus* were detected in feces. On the 7th day of the admission, no acid-fast bacilli were detected from sputum smear.

Imaging examinations

Figure 1 Preoperative lumbar CT

Figures 1A and 1B show uneven density of L2-3 vertebral bodies, local bone defects at opposite margin, mass-like soft tissue density shadow around, left psoas enlargement with uneven density, and infection is suspected; Figure 1C shows local bone destruction of anterior and middle L2-3 vertebral bodies, and uneven density around.

Figure 2 Preoperative lumbar MRI plain and enhanced scans

Figures 2A and 2B show the vertebral signal changes, with no evident changes observed in the intervertebral disc. T1 and T2 weighted images show patchy hypo-intense signal in the L2-L3 vertebral bodies; Figures 2C and 2D with fat suppression show that the cortical bone of spine is incomplete, hyper-intense signals are seen in the L2-3 vertebral bodies, and no obvious enhancement is seen after enhanced scan; Figure 2E shows long T1 and T2 signal shadows in the left psoas major muscle, and annular enhancement is seen from enhanced scan, suspected of abscess formation; Figure 2F shows coronal patchy changes in the L2-3 vertebral bodies.

FINAL DIAGNOSIS

PS.

TREATMENT

The patient was diagnosed with acute pyelonephritis at admission. He initially went to the Department of Nephrology and received intravenous piperacillin/tazobactam (4.5 g) once every 8 h combined with intravenous moxifloxacin (0.4 g) once daily for anti-infection treatment. Intravenous aztreonam (2 g) once every 8 h was then taken according to the results of blood culture and drug test. Urinary irritation symptoms and fever were improved after treatment. The patient still had persistent pain in the waist, which gradually extended to the left thigh. Physical examination showed Grade 3 muscle strength of the left iliopsoas, Grade 4 muscle strength of the quadriceps, and

weakened left knee and ankle reflexes. Lumbar computed tomography (CT) and magnetic resonance imaging (MRI) examinations showed abnormal L2-3 vertebral bodies, and formation of paravertebral and left psoas abscess, and infection was suspected. Conservative treatment with intravenous antibiotics was continued, and no resolution of symptoms was observed. On the 34th day of admission, the patient received anterior lumbar debridement + autogenous iliac bone graft fusion + posterior percutaneous pedicle screw-rod internal fixation. During the operation, the abscesses around the psoas major muscle were removed, and the large amount of necrotic tissue in the L2-3 intervertebral space was cleaned and kept for culture. Autologous iliac bone of the patient was taken for structural bone grafting after trimming. Piperacillin/tazobactam (4.5 g) once every 8 h was given by intravenous drip for anti-infection treatment after the operation.

OUTCOME AND FOLLOW-UP

Fever, low back pain and radiating pain of the left lower limb were significantly alleviated, and the infection indexes in blood routine significantly recovered. Postoperative lumbar X-ray showed good L2-3 internal fixation and well positioned bone graft, and no paravertebral soft tissue swelling was found. The muscle strength of the left lower limb recovered significantly after 1 mo of the operation. Four months after the operation, imaging findings showed good lumbar internal fixation of the bone graft, and the patient had no prominent low back pain or dysfunction of lower limbs, and walked well by himself.

DISCUSSION

PS caused by *E. coli* infection is a rare disease that is commonly seen secondary to genitourinary diseases, such as urinary tract infection and pyelonephritis^[9]. Common predisposing factors include diabetes, and complications from a history of spinal surgery or trauma^[10-13]. Recent studies have shown that patients with PS caused by Gram-negative bacilli infection may have potential malignant tumors or are under

immunosuppression^[14]. PS caused by Gram-negative bacilli infection is a blood-borne disease. Microorganisms reach the spine through the vertebral nutrient arterioles or the paraspinal Baston venous plexus, which is similar to the metastasis of malignant tumors to the spine and is the main cause for the occurrence of PS^[15,16].

The patient in this report had no diarrhea, and no WBCs or pyocyte in stool routine. Intestinal infection was excluded. The patient had no previous spinal trauma. Among the tumor indicators, prostate specific antigen was slightly increased to 4.436 ug/L. B-mode ultrasound of urinary system showed peri-renal abscesses, urine culture grew *Acinetobacter baumannii* and *Aeromonas caviae*. *E. Coli* was tested negative in urine culture, but detected positive in blood and intervertebral pus culture. *E. Coli* infection from the urinary system, therefore, cannot be ruled out as a cause of spinal involvement.

The diagnosis of PS requires a combination of clinical manifestations, imaging examination, laboratory examinations, etiologic examinations and drug sensitivity tests^[17].

PS is characterized by atypical symptoms. For patients suffering from PS caused by Gram-negative bacilli infection, pain in the affected part is the most common symptom, though up to 15% of patients may feel no pain^[4,13,18]. Persistent pain is a dangerous sign of PS and worsens at night^[13,18]. Only 16.4% of the patients present with motor weakness. Lumbar spine involvement is the most common, and paravertebral abscesses develop in about half of the patients which is easy to be confused with peri-renal one^[19]. Despite the low mortality, this disease often comes with sequelae like neurological deficits, which makes early diagnosis particularly important^[10].

In this reported case, a delayed diagnosis was made, since the initial diagnosis by physicians in the Department of Nephrology was only based on the B-mode ultrasound for urinary system and blood culture, combining a difficulty in distinguishing lumbar percussion pain from bilateral renal percussion pain. High fever was relieved by taking sensitive antibiotics according to drug sensitivity test, but the body temperature still fluctuated repeatedly, finally resulting in the occurrence of symptoms of nerve

dysfunction of lower limbs. Lumbar infection was then evidenced by lumbar CT scan and MRI examination.

Early PS shows few symptoms in early X-rays, and the normal appearance can usually be maintained for 2-8 wk^[18]. Disc space narrowing, irregularity, or unclear vertebral endplates are the initial and most common manifestations^[20]. Osteopetrosis may develop within 10-12 wk if no treatment is managed^[18]. For the PS in early stages, radionuclide examination is more sensitive compared to X-ray examination with a diagnosis rate of at least 90%^[21]. However, it has low specificity, which is especially seen in patients having tumor metastasis or degenerative spinal disease^[21,22]. CT findings are similar to those in conventional X-rays but potentially more sensitive to early changes, including swelling of surrounding soft tissue, effusion and epidural abscess, which is suitable for patients with contraindications to MRI^[22]. Currently, CT-guided needle biopsy is identified a helpful tool for early pathological and bacteriological diagnosis.

In 2015, Infectious Diseases Association recommended MRI as the first choice for PS inspection due to its sensitivity and specificity as high as 98% and 93%, respectively, and it was regarded as the most sensitive and specific detection method for PS^[13,18,23]. In most cases, spinal osteomyelitis manifests as destructive and expansive lesions in MRI findings. Bone marrow edema may lead to increased fluid signals, manifested as hyper-intense signal on T2-weighted images, hypo-intense signal on T1-weighted images, and positive gadolinium enhancement^[22]. MRI is superior in distinguishing tumors from degenerative diseases to other imaging examinations^[6]. On T2-weighted images, the highest signal intensity for infectious lesions of PS is seen equal to or higher than that of cerebrospinal fluid, while the signal intensity of malignant lesions is lower^[20]. Besides, epidural and soft tissue abscesses are also readily seen on T2-weighted images and contrast sequences^[18]. Nevertheless, inflammatory repair and bone healing can be seen earlier in CT images, compared to MRI findings, which makes CT scan superior in curative effect monitoring and long-term follow-up^[24].

More than 90% of patients with spinal infection have changes in certain inflammatory indicators, such as erythrocyte sedimentation rate (ESR) and CRP^[25]. Rosahl *et al*^[26] suggested that CRP and ESR should be used as monitoring indicators for the diagnosis and treatment of spinal infection. WBC count may not increase in patients with PS, and such increase is reported to occur in no more than 50% of cases^[18]. It is recognized that WBC count is a routine examination indicator for the diagnosis of infection, but its specificity for spinal infection is relatively low.

Blood culture is the simplest method for identification of microorganisms, and with this way responsible pathogen can be identified in about half of patients with PS^[27]. This method is recommended to complete in the peak period of fever or the period of the severe degree of chills, which helps improve the microbial positive rate^[18]. In cases of negative results, percutaneous bone biopsy should be considered. Besides, open biopsy sampling is required if two or more cultures from CT-guided biopsy samples or blood fail to identify pathogens^[28].

Treatment approaches for PS include antibiotic treatment, external fixation (cervical spine) or use of braces (thoracic and lumbar spine), and surgery^[18,29], while the optimal treatment has not yet been determined.

The intervertebral disc is the largest structure devoid of blood vessels in the human body, and the penetration into tissues by antibiotics must be carefully considered when choosing the appropriate antibiotic regimen^[4]. Fluoroquinolones, clindamycin, and rifampine are recommended by some specialists for the PS caused by *E. coli*^[30-32]. Some studies found that patients receiving a combination of multiple antibiotics have shorter treatment duration compared to patients with a single antibiotic^[4]. Antibacterial agents should be delayed, unless disease progresses, until a microbiological diagnosis is established^[18]. CT-guided biopsy is required in cases of the initial blood culture is negative. If the pathogen cannot be determined, empirical broad-spectrum antibiotics (e.g. third-generation cephalosporins) is recommended, which may cover most bacterial infections.

As for the duration of medication, a 6-wk antibiotic treatment has efficacy not inferior to a 12-wk antibiotic treatment, suggesting that standard antibiotic treatment for patients with the disease can be shortened to 6 wk^[33]. Moreover, most studies suggest a medication time of 6-8 wk with intravenous injection of antibiotics, followed by a further treatment time of around 6 wk with oral antibiotics. Antibiotic discontinuation can be managed while following symptoms occur^[34]: (1) Alleviation of spinal pain and disappearance of inflammation; (2) Normal body temperature; (3) Normal CRP and/or ESR; and (4) Stable and improved X-rays. For patients with severe sepsis, regular monitoring of liver and kidney function should be considered when antibiotics are used.

At the initial diagnosis, bed rest is recommended for about 3-4 mo until the pain is significantly relieved^[13]. External fixation helps stabilize the spine, relieve pain, prevent deformity, and allow a small range of spinal movement^[2]. The duration of fixation depends on the severity of bone destruction and deformity until bony ankylosis occurs^[35,36].

Percutaneous drainage, which is a minimally invasive treatment combining etiological and histopathological diagnosis, has become the only effective treatment option for patients who cannot tolerate surgery and respond to long-term anti-infection treatment^[37]. CT-guided percutaneous puncture or surgical treatment should be considered for abscess drainage and infection control in the presence of uncontrollable sepsis. Soft tissue is the best action site for microbiological diagnosis in PS patients with needle biopsy^[38].

Surgical treatment is committed to removing infected foci to reduce the compression on the nerve as far as possible, which facilitates to alleviate symptoms, reconstruct the stability of spine and correct spinal deformity^[36,39].

The surgical indications for PS are described as follows: (1) No clinical improvement after 2-3 wk of intravenous antibiotics, or the persistently increased inflammatory indicators, ESR and CRP^[40]; (2) Spinal cord compression, no more than 36 h of paralysis time, or progressive neurological dysfunction^[41]; and (3) Spinal instability

and/or deformity^[16]. When the disease progresses to chronic osteomyelitis, surgical removal of necrotic tissue also needs to be considered, which may result in reduction of bacterial biofilm formation and development of antibiotic resistance^[42].

The surgery time for patients with PS should be scheduled comprehensively from two aspects: the effect of anti-infection treatment and the symptoms of spinal nerves^[35]. Segreto *et al*^[43] conducted a retrospective analysis covering the clinical information of PS cases, and found that patients who underwent surgery within 24 h of admission received better outcome than those who underwent conservative treatment or delayed surgery.

The surgical approaches for PS fall into posterior approach, anterior approach, combined anterior and posterior approach and lateral approach^[44,45]. Among them, anterior approach is classic^[36]. Since intervertebral infection is mostly seen in the anterior and middle column of spine, the anterior approach can make the infected site fully exposed, which directly and clearly displays the diseased tissue to help thoroughly remove the necrotic and infected tissue. In addition, full drainage of the complicated psoas or epidural abscesses can be achieved to avoid residual infectious foci and bacteria^[46]. However, anterior internal fixation often results in surgical failure due to the insufficient fixation strength^[44]. Besides, anterior approach is also associated with higher postoperative morbidity and mortality^[45]. Simple posterior approach for focal debridement and bone grafting has a relatively narrowed operation field, which is prone to result in incomplete focal clearance, insufficient treatment of bone grafting surface of the upper and lower endplates, not fully recovered intervertebral height and other conditions, leading to uncontrollable foci and failed bone graft fusion^[44]. Given these considerations, a combination of anterior focal debridement with posterior internal fixation has been widely recommended in the treatment of lumbar PS.

Minimally invasive techniques, such as percutaneous endoscopic debridement combined with percutaneous pedicle screw fixation, provide a better alternative to the treatment of PS. Percutaneous endoscopic-assisted surgery can keep the posterior

structure intact, while minimally invasive pedicle screw rod system can achieve strong internal fixation^[40].

Since most patients requiring a surgery are in severe disease conditions, which may lead to obvious bone loss of anterior column, bone graft fusion is required aiming to stabilize the anterior spine and prevent the posterior spinal kyphosis to further reduce the relevant damage of nervous system, while autologous bone grafting is the most traditional way. Bone graft fusion is generally performed with the iliac, rib, or fibula which is of a high fusion rate^[16]. In recent years, the application of interbody fusion cages and titanium mesh cages also provides more options for intervertebral fusion^[47,48].

Following bone fusion, nutritional support and bed rest are recommended, and ground activities are allowed under protection of braces. Broad-spectrum antibiotics should be taken one week after the operation, and sensitive antibiotics are used and adjusted according to the results of bacteria culture and drug sensitivity test for 6 wk. In following 6-8 wk, oral antibiotics are taken as alternative until the symptoms disappear, and ESR and CRP decrease to normal range^[34].

In short, for patients suspected of PS, early diagnosis is essential. Once the results of bacteria culture have been identified, the corresponding antibiotics should be initiated for the treatment. ¹ It should be noted that active surgery for PS may improve the prognosis. On the basis of rational surgical indications, anterior focal debridement and bone graft fusion + posterior pedicle screw internal fixation + sensitive antibiotics for spinal infection is an effective treatment for PS, which can achieve reliable fixation and good therapeutic effect.

CONCLUSION

There are some deficiencies in the diagnosis and treatment of this case. For example, the patient was admitted to our hospital for non-specific symptoms, such as high fever and back pain, with a diagnosis of acute pyelonephritis, and treated with conservative treatment, while PS was delayed diagnosed in 2 wk. Atypical symptoms often lead to

delay in diagnosis, which highlights the significance of early clinical detection and diagnosis. It is noteworthy that for patients with more high risk factors, such as non-mechanical new or aggravated low back pain, fever, elevated ESR and/or CRP, diabetes, or complicated genitourinary infections, necessary MRI examination can achieve early diagnosis and distinguish PS from malignant tumors, epidural or other abscesses. Blood, urine, sputum and throat swab culture should be managed at the same time to identify the source of infection. Bacterial culture result can guide the treatment. Although there is a lack of randomized controlled trial, the drug treatment time is generally recommended to be 6 wk, and patients with surgical indications still need to consider surgical treatment.

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