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Post-operative spondylodiscitis

L.A. NASTO, D. COLANGELO, B. ROSSI, M. FANTONI*, E. POLA

Division of Spinal Surgery, Department of Orthopaedics and Traumatology, School of Medicine, Catholic University of the Sacred Heart, Rome (Italy)
**Institute of Infectious Diseases, School of Medicine, Catholic University of the Sacred Heart, Rome (Italy)*

Abstract. – Postoperative spine infections (PSIs) are a frequent and dreaded complication of spine surgery. Although different studies have been published, the prevalence of PSIs is thought to be about 5% for most spine surgical procedures. Different risk factors have been identified for PSIs. Among the others, extensive soft tissue dissection, longer operative time, soft tissue devitalization, and use of surgical instrumentation have been associated with higher risks of infection. Direct inoculation during surgery is the common infection route for PSIs. Gram-positive cocci (such as *Staphylococcus aureus, Staphylococcus epidermidis* and β-hemolytic streptococci) are the most common pathogens. Gram-negative bacteria also play a role in PSIs and may be associated with systemic illness and multisystem organ failure. A high level of suspicion is of paramount importance in early diagnosis of PSIs. Clinical symptoms of PSIs may be subtle and the infection may become apparent only in its late stages. Early diagnosis is the most important prognostic factor for PSIs. Although blood tests (i.e. ESR, CRP, and white blood cell count) and imaging studies (most commonly MRI) can be useful, it must be clear to the clinician that diagnostic modalities, either tissue biopsy or blood cultures, are of the utmost importance for diagnosing PSIs and devising a correct antibiotic therapy. Antibiotic therapy with early bracing (or bed rest) is the most commonly used treatment method for PSIs. Nevertheless, a more aggressive surgical treatment may be required in some patients. The goals of surgical treatment are to help the eradication of the infection, provide an adequate wound closure, and maintain spine column mechanical stability.

Key words:

Post-operative, Spine infections, Surgery.

Introduction

According to the CDCP (Center for Disease Control and Prevention) postoperative superficial and deep infections are differentiated. Superficial infections are located in the skin and subcutaneous tissue, whereas deep infections are located below the muscle fascia. Vertebral osteomyelitis, spondylodiscitis, diskitis, epidural abscesses, and surgical wound infections form a spectrum of infectious processes involving the spine. They can present as separate entities or in conjunction with one another and are commonly referred as postoperative spine infections (PSIs). PSIs result from direct inoculation of pathogenic microorganisms in the intervertebral space, epidural space or soft tissues surrounding the spine. Consequently, PSIs can only occur as a complication of an invasive procedure on the spine, either diagnostic or therapeutic.

Postoperative spine infections are relatively frequent and dreaded complications of spine surgery. Prevalence more than 12% has been reported in literature[1-3]. PSIs result in significant acute and chronic morbidity for patients and significant direct and indirect costs to the health care system[4]. Early diagnosis and prompt treatment are of paramount importance in treating PSIs and to avoid more severe complications. A high index of suspicion, a thorough examination of the patient, and understanding of the factors that place a patient at risk for PSIs are extremely important for diagnosis. Moreover, an understanding of the management principles is extremely important to successfully treat these patients.

The aim of this review is to summarize available literature data about postoperative spine infections. We will analyze epidemiology and risk factors, microbiology, diagnostic modalities, and

Corresponding Author: Enrico Pola, MD, PhD; e-mail: enrico.pola@rm.unicatt.it

treatment strategies for PSIs according to published clinical data and Authors' experience.

Epidemiology

The reported prevalence of PSIs ranges from 0.5% to 18.8%[1-3,5,6]. Such a broad range is most probably due to significant variation in many factors (i.e. case complexity, use of instrumentation, and surgical approach), although more invasive procedures generally correlate with a higher risk of infection. Superficial and deep infections occur in 2-3% of lumbar discectomy/laminectomy cases[7] and in more than 5% of lumbar instrumented fusions[1,8]. Conversely, infection risk for fusion without instrumentation ranges from 0.4% to 4.3%[9]. Extensive soft tissue dissection, longer operative time, soft tissue devitalization, and the creation of dead space are important risk factors for PSIs. Many other risk factors for PSIs have been reported in literature and are summarized in Table I.

Instrumentation increases infection risk[10,11]. Implants may become a nidus for subclinical growth of infectious organisms. The implant provides an avascular surface on which bacteria can assume a biofilm phenotype, which acts as a barrier to the host immune response and antibiotic treatment. Although numbers differ widely in literature, many Authors[12-14] report infection rates with the use of spinal instrumentation between 5% and 6%.

Table I. Reported risk factors for postoperative spine infections (PSIs).

Risk factor	References
Patient age	46
Obesity	47
Diabetes	48
Urinary incontinence	15
Tobacco use	21
Poor nutritional status	49
Complete neurologic deficit	1
Revision surgery	21
Nonsteroidal antinflammatory drug use	50
Posterior surgical approach	15
Tumor resection	15
Increased estimated blood loss	21
Use of blood transfusions	51
Prolonged surgical time	52
Multilevel surgery fusions extending to the sacrum	53
Spinal instrumentation	10
Presence of 3 or more comorbid diseases	15

Anterior spinal procedures are associated with a lower risk of infection than posterior procedures[15]. The lower infection rate of anterior procedures is most probably related to a better vascularity of the anterior spine and less extensive muscle dissection needed for bone exposure. Reported infection rates[16,17] for anterior cervical spine surgery range from 0% to 1%. Similar infection rates have been reported for thoracic and lumbar anterior procedures[15].

Spinal trauma patients are a very high risk population for PSIs. Local hypoxia, muscle tissue necrosis and hematoma formation are very important local predisposing factors for infection[18]. Moreover, the commonly associated neurologic injury significantly increases the risk of postoperative infections. Blam et al[19] reported a 9.4% infection rate in a large surgically treated spine trauma patient cohort. The infection rate of the patients undergoing elective spinal surgery during the same time period at the same hospital was as low as 3.7%[19].

Microbiology

Pathogenic microorganisms can have access to the surgical site through three different sources: direct inoculation during the operative procedure; contamination during the early postoperative period, and hematogenous seeding. Direct inoculation during surgery is by far the most common infection route. Gram-positive cocci are the most common pathogens responsible for acute postoperative infections. *Staphylococcus aureus* is the most commonly reported organism in the literature, having been isolated in almost 50% of cases[13,20,21]. Other common Gram-positive species that cause postsurgical infections include *Staphylococcus epidermidis* and other coagulase-negative *Staphylococcus* species. Common Gram-negative organisms cultured from infected surgical sites include *Escherichia coli, Pseudomonas aeruginosa, Klebsiella pneumoniae, Enterobacter cloacae, Bacteroides,* and *Proteus* species.

Generally, some risk factors can help predicting the microorganisms involved in PSIs. Fecal contaminants are more likely to be involved in surgeries of the low lumbar or sacral regions. Bladder or fecal incontinence may predispose to Gram-negative flora, especially with posterior lumbosacral incisions.

Late infections are more commonly caused by slow-growing and low-virulence bacteria like coagulase-negative *Staphylococcus, Propionibacterium acnes,* and diphteroids[16]. Hematogenous spread can also cause surgical site infections. Blood-borne infections are usually due to highly virulent organisms including Gram negative bacteria. These infections are often associated with systemic illness and sometimes have serious consequences such as multisystem organ failure. Intravenous drug users have a higher incidence of gram-negative infections, as do patients who have prolonged hospital admissions[21].

Diagnostic Modalities

Clinical presentation

The most common presenting complain for postoperative spinal infections is pain. Although majority of infections occurs within 90 days of the initial surgery, patients can present later than 3 months postoperatively after a relatively pain-free period. The pain is classically unremitting and poorly responsive to common pain medications. Moreover pain is frequently associated with constitutional symptoms, namely fever and/or weight loss. Clinicians must have a high index of suspicion for postoperative spine infections and must pay close attention to any change in normal postoperative course (e.g. an unexpected change from pain free to painful).

Pain at the surgical wound site, erythema, warmth, or drainage are signs suggestive of infection. Superficial wound infections generally present within 2 weeks from surgery and although less painful than deep infections they can always hide a deeper, subfascial infection. Constitutional symptoms should raise suspicion of a more serious deep infection that requires more aggressive treatment. Non complicated superficial wound infections in the early postoperative period can frequently be treated with local wound care and oral antibiotics for approximately 2 weeks.

Some physical findings can suggest the presence of a deep infection. Increased erythema, edema, tenderness to palpation, and drainage are clear alarming signs. Clear, serosanguineous drainage might indicate an underlying seroma, whereas more copious purulent discharge indicates infection. Unfortunately, it is hard to distinguish between deep and superficial infection as deep infections frequently have relatively unimpressive superficial findings making diagnosis only presumptive.

Many patients with deep infections have no constitutional symptoms, with fever and weight loss being the most frequent, when present. Other common symptoms are chills, night sweats, lethargy, or malaise. More complex cases with systemic involvement can present with a sepsis syndrome with multiorgan failure and need urgent evaluation and treatment. Patients with late infections have a more insidious onset of symptoms. Frequently surgical incision is already healed and no changes are apparent. The most reliable symptom in these cases is non-remitting pain at the surgical site. Of course, an infection must be suspected and other causes of pain need to be excluded to make the correct diagnosis.

Laboratory testing

The most useful laboratory studies in cases of PSIs are: complete blood count (CBC) with white blood cell counting and differential (WBC), erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP). When used alone, these laboratory markers are of little use. Moreover, these parameters are sensitive but not specific and are more useful in terms of temporal course to follow up the response to treatment.

Both ESR and CRP elevate after surgery and do not normalize until several weeks postoperatively. ESR returns to preoperative values by the third postoperative week, whereas CRP decreases to baseline more rapidly (i.e. within 10 to 14 days)[22]. This rapid normalization makes CRP a more sensitive indicator of infection and a more useful diagnostic tool when determining the presence of infection, especially in the acute and subacute postoperative period[23]. Regardless of inflammatory markers, the isolation of the causative organism is of critical importance for the treatment of PSIs. In superficial infections a wound swab or aspiration are generally enough, although cultures are often contaminated with skin flora. In deep infections CT or fluoroscopic guidance can be used to obtain a deep culture from the affected area. CT guidance is generally preferred by many Authors[24]. Blood cultures can reveal the responsible organism if taken in a septic patient before initiation of antibiotics. The most accurate cultures are those obtained during the surgical debridement before the administration of antibiotics. Diagnostic yield of needle biopsy and blood cultures ranges from 57% to

92% and strongly depends on previous antibiotic treatments[25].

Imaging

Although standard X-rays are often performed during workup of a suspected infection, findings are frequently insidious. Generally up to 4 weeks are required before infection signs can be observed on plain X-rays[26]. Disc space narrowing is the first radiographic finding and usually occurs between 4 to 6 weeks postoperatively. Endplate destruction, osteolysis and deformity take much longer to develop as are late signs of infection[27]. CT has lost some of its importance in diagnosing PSIs since MRI has become a widely available imaging technique. CT still provides a clear assessment of the osseous destruction and is still extremely important in evaluating residual spinal stability and planning the surgical approach and technique.

Nuclear medicine studies are only rarely used when working up PSIs. Bone scans are often nonspecific and may show generalized uptake around the surgical site in a postoperative spinal infection[26]. Although Gallium-67 and Technetium-99m are the two most commonly used isotopes, gallium-67 allows for more specific and sensitive diagnosis[28,29].

MRI is the imaging modality of choice when evaluating postoperative spinal infections. MRI is both highly sensitive (93%) and specific (96%) when evaluating spinal infections[30,31]. Characteristic findings suggestive of spinal infections are: areas of vertebral body and disc space hypointensity on T1-weighted images, increased vertebral endplate intensity on T2-weighted images, loss of endplate definition, and contrast enhancement of the disc and vertebral body[32]. Short tau inversion recovery (STIR) sequences offer an higher signal intensity but with a decreased anatomic detail[32].

Management

The ultimate goals of PSIs treatment are eradication of the infection, adequate wound closure, and maintenance of vertebral column mechanical stability[33]. In this perspective the mainstay of the treatment is antibiotic therapy. It is extremely important to not start any treatment before the causative agent has been isolated. We generally perform a CT of fluoroscopic guided biopsy before proceeding with an open surgical biopsy. Additionally, a minimum of three sets of blood cultures are sent on all patients with a suspected spinal infection. After an organism has been identified, appropriate antibiotic therapy should be initiated. Superficial infections can be treated with 2 weeks of oral antibiotics and close clinical follow-up. Deep infections, however, require a minimum of 6 weeks of IV antibiotics followed by 6 weeks or oral antibiotics. ESR and CRP measurements are used to monitor the response to treatment. Sometimes it is impossible to isolate the causative agent despite many different approaches have been attempted (i.e. fine needle aspiration, blood cultures, open biopsy). In these cases a high dosage broad-spectrum drug therapy is needed.

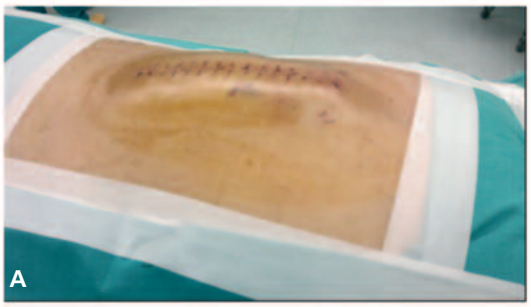
Bed rest is commonly considered part of the treatment. Nevertheless an early mobilization should be attempted to avoid bed rest complications especially in old patients. The use of a spinal orthosis is recommended to speed up recovery and allow for early mobilization. The type of immobilization depends on many factors, including localization of the infection, general conditions and age of the patient.

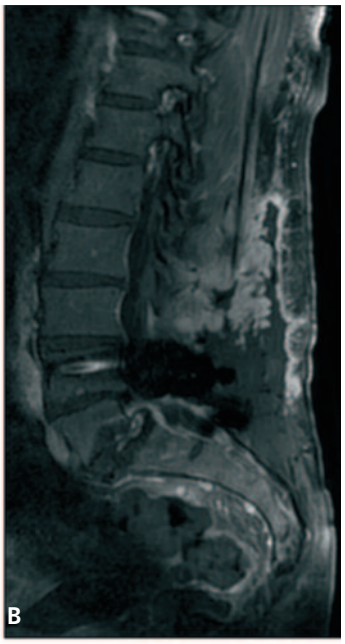
Although the majority of patients with PSIs can be successfully treated conservatively, a more aggressive approach is needed in some patients[34]. In most cases an extensive debridement followed by antibiotic therapy and orthosis immobilization can successfully eradicate the infection. Some cases need an even more extensive surgery. Indications for surgery for these cases include: severe destruction of endplates, abscess formation, chronic osteomyelitis with biomechanical instability, neurologic deficit, local kyphosis, severe pain, septic pseudoarthrosis or resistance to conservative treatment[35-40].

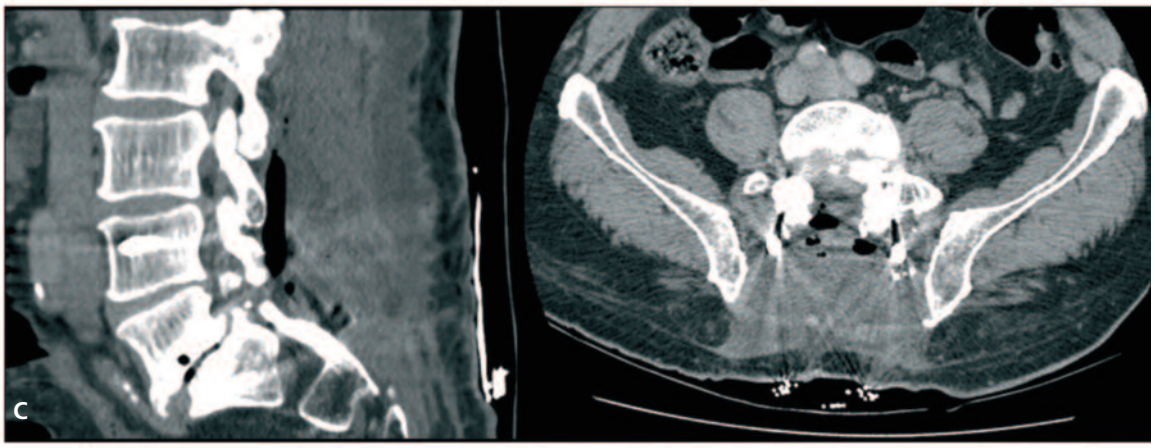
Commonly, deep infections and complicated superficial infections will require surgical debridement in addition to IV antibiotic therapy. Surgical debridement is extremely important in order to completely eradicate the infection; a meticulous approach must be used and the wound must be thoroughly explored to clean up all affected tissue. Each wound layer must be explored. At each layer, assessment of tissue devitalization and possible communication with underlying planes must be assessed. We routinely send all specimens for bacterial studies including aerobic, anaerobic, fungal, and acid-fast studies from each explored layer.

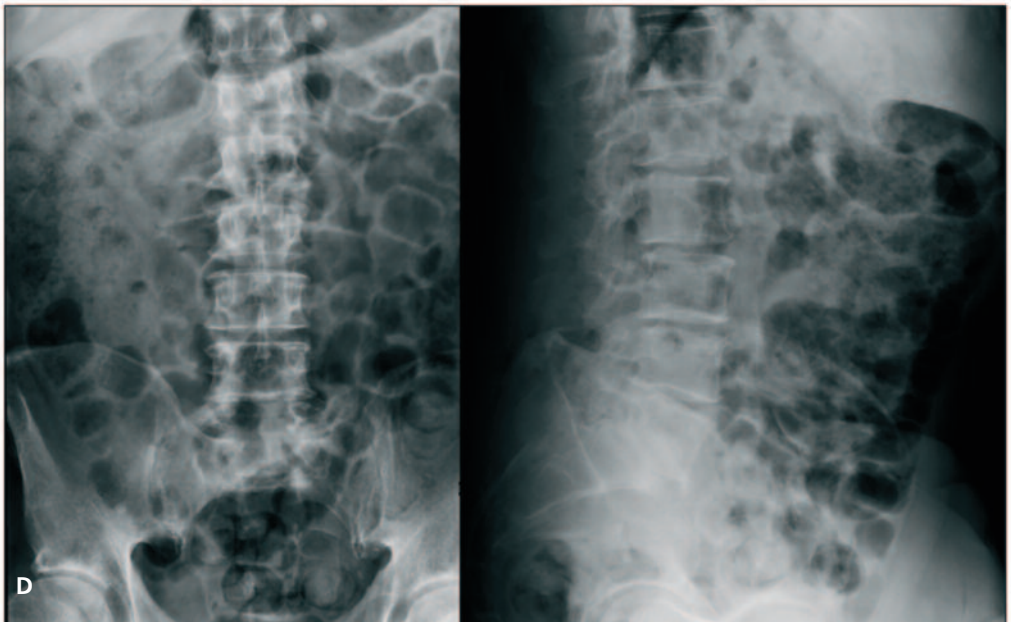
When involved with the infection, the deep fascial layers should be opened and all loose tissue and foreign material should be removed.

Figure 1. *Case illustration 1.* A 60-year-old male patient treated for anterolisthesis L5-S1 with lumbar posterior fixation and fusion was admitted after 4 weeks with fever and severe back pain, locally a fluid mass and surgical lumbar wound erythema were observed (*A*). Fine-needle aspiration of the fluid mass was performed and the purulent material was sent for microbiologic examination. *Staphylococcus aureus* was isolated, thus a specific antibiotic therapy was started. MR (*B*) and CT scans (*C*) at the time of presentation showed the infection at L5-S1 level extending around the implants and through paravertebral lumbar soft tissues with subcutaneous extension. We first performed extensive débridement surgery through posterior approach without removing surgical instrumentation. Subsequently, because of persistence of fever, high levels of ESR and CRP, and recurrent superficial abscess 2 weeks postoperatively, we performed a second débridement surgery with instrumentation removal (*D*). Antibiotic therapy and immobilization with a lumbar bracing allowed full recovery from infection after 6 months.









As for PSIs after fusion surgeries some Authors recommend to inspect and remove bone graft that appears to be significantly infected or is loosened by the debridement[41]. Following sufficient debridement and irrigation of the wound, assessment of the wound and a plan for closure must be devised. We recommend performing a primary layered closure and placing one or two closed suction drains for a few days postoperatively.

During debridement of infections with instrumentation, the implants should be routinely inspected. If the implants show obvious signs of loosening, they should be removed. Removal of infected instrumentation that remains well fixed has long been debated in the literature. Some authors suggest complete removal of instrumentation in all cases of deep infection, independent of fixation and fusion status[42,43]. Although instrumentation can promote bacterial growth and make infection eradication more difficult, an attempt to leave well-fixed instrumentation in place following thorough debridement to prevent possibly catastrophic spinal instability should be made (Figure 1. Case illustration 1). Vertebral column misalignment, spinal cord compression, and paralysis are potential complications associated with instability if fusion is not complete at the time of instrumentation removal. Titanium implants are less adherent to the bacterial glycocalyx and are hence favored over stainless steel implants if instrumentation needs to be reimplanted in an infected site.

In cases with gross bony destruction, deformity or instability of anterior column, a bone grafting is usually needed to give mechanical support to the spine column. Anterior approaches to the spine are usually needed to achieve an extensive anterior debridement. Debate on the timing of the bone grafting is still ongoing. A primary bone graft offers a good and safe mechanical support to the spine and allows for a one-stage procedure. The main risk of primary bone grafting is graft resolution with loss of intervertebral height and sagittal alignment[44]. Secondary bone grafting requires reoperation with theoretically increased morbidity. Instrumentation can be added to the grafting procedure. While the use of spinal instrumentation in the presence of spinal infection has been controversial in the literature, an increasing number of Authors indicate that instrumentation is not contraindicated in cases when radical debridement is achieved[45]. Epidural abscesses need a special mention due to devastating neurologic outcomes if not rapidly treated. Two major prognostic factors for a favorable outcome are early recognition and prompt intervention, particularly surgical decompression and debridement. Urgent surgical decompression is the treatment of choice for a progressive epidural abscess with neurological compromise. Posterior canal epidural abscesses are usually best treated with a posterior decompression such as a laminectomy. Anterior spinal canal epidural abscesses are frequently associated with granulation tissue from discitis or osteomyelitis, and anterior surgery may be needed to eradicate the infection.

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