Art. 7307 – P.M. # 10596

European Review for Medical and Pharmacological Sciences 2019; 23(2 Suppl.): 173-178

# Infection after spinal surgery and procedures

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**Abstract.** **Postoperative infections after spinal surgery are a challenging issue, difficult to diagnose and treat, that requires prolonged medical therapy and even surgery. In this paper, we aim to review the current standards in the diagnosis and treatment of post-procedural Spondylodiscitis (SD). We performed a review of the available literature focusing on diagnostic and therapeutic standards of post-procedural SD, both after minimally invasive procedures and open surgery. Spinal infections can occur in less invasive procedures with an incidence ranging from 0.26% to 2.75%. Post-surgical spinal infections range from 2.1% to 8.5% for instrumented surgery, whereas these are less than 1% in open surgery without instrumentation. MRI is currently the most sensitive and specific technique to diagnose postoperative SD. CT guided aspiration culture should be performed in all patients with deep-seated infections with negative blood cultures. Early infections start with wound healing problems within a few weeks from surgery, and the occurrence of fever and an increase in serum markers of inflammation. Late infections often cause chronic pain, implant failure, non-union or wound dehiscence even a long time after surgery. The onset of the infection differentiates the specific treatment. Indeed, in the early postoperative period spinal fusion is not appropriate yet, and the stability of the fusion site only relies on the instrumentation. Therefore, even when suitable, implant removal may lead to undesirable consequences. In chronic infections, on the other hand, implant removal is unlikely to determine instability since the fusion has already been accomplished.**

Key Words
Fibromyalgia, Ozone Therapy, Fatigue, Pain.

## Introduction

Infection is an infrequent complication after spinal surgery and procedures, and it can be a challenge for both the patient and the clinician[1,2]. Postoperative infections also represent a relevant issue for the healthcare system starting from the prolonged hospitalization, and considering that readmission for wound infection following a spinal surgery increases the costs of care significantly[3].

Infection can occur after any spinal intervention; the absolute number of cases is difficult to determine, with a reported incidence varying from 0.5 to 18.8%[4-6]. This wide range can be explained by different factors, such as the clinical presentation: in some patients, the infection may show indistinct back pain and can be self-limiting, even reported to the clinician. In other cases, a devastating sepsis with abscess formation can occur[5,7]. However, a typical clinical presentation includes fever, back pain, and local signs of infection[8]. Wound secretions are present in up to 68% of deep infections and in up to 64.6% of superficial ones[9].

Known risk factors for SD are male gender, smoking, advanced age, obesity (BMI>30), diabetes mellitus, rheumatoid arthritis, use of immunosuppressant, alcohol abuse, long-term steroid use. Previous invasive procedures, such as discography or chemonucleolysis, surgical procedures adjacent to the intervertebral disc space, number of levels, and surgical time above 3 hours, and use of instrumentation represent a severe risk of infection[10-12].

In terms of anatomic classification, superficial infections involve skin and subcutaneous layers. Deep spine infections spread beyond the lumbodorsal fascia or the abdominal fascia, in the posterior and anterior aspects of the spine respectively, or below the deep cervical fascia and ligamentum nuchae or the platysma layer, in the posterior and anterior approaches to the cervical spine respectively[4,13]. The most common microorganisms detected in deep infections are *Staphylococcus aureus* (18% of which are methicillin-resistant) and coagulase-negative staphylococci, such as *Staphylococcus epidermidis*, followed by *Escherichia coli* and *Enterococcus faecalis*, probably due to urinary or fecal wound contamination. Conversely, in superficial infections, *Staphylococcus aureus* is detected in 85.7% of cases. However, culture from the secretion of the wound is positive in only 50% of cases[14].

In this paper, we aim to review the current standards in the diagnosis and treatment of iatrogenic SD. We performed a review of the available literature searching in the electronic database of Medline (http://www.ncbi.nlm.nih.gov/pubmed), Cochrane

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(http://www.thecochranelibrary.com/view/0/index.html) and Google Scholar (http://scholar.google.it/) from inception to February 2018. Isolated keywords were searched and successively combinations of those such as [spondylodiscitis AND instrumented fusion], [discitis AND spine surgery], [minimally invasive spine surgery AND infection], [spondylodiscitis management]. The literature search located more than 500 publications indexed, including clinical and radiological studies and reviews. The attention was focused on diagnostic and therapeutic standards of post-surgical spondylodiscitis, both after minimally invasive procedures and open surgery.

### Approach to the Patient with Suspected Post-Procedural Spondylodiscitis

The first step to investigate a suspected spinal infection is to perform laboratory tests. ESR and CRP elevation are highly sensitive tools in the detection of a postoperative SD. ESR peaks 5 days postoperatively, remaining elevated for weeks or months after surgery. CRP peaks at day 1 to 3 postoperatively and tends to decrease at day 3-5, making this latter a better indicator[5]. Indeed, a postoperative SD should be suspected if ESR is higher than 45 mm/hour and CRP is higher than 2.5 mg/dL at day 15 postoperatively[15].

If clinical signs and ESR and CRP elevations are present, 2 to 4 sets of blood cultures must be collected, preferably during fever spikes. However, these are positive and useful for diagnosis in only 50% of cases[16,17].

Magnetic Resonance Imaging (MRI) is currently the most sensitive (93%) and specific (96%) technique to diagnose postoperative SD, reaching an accuracy of 90%[18,19], and should be the first tool used. Characteristic signs are a high-intensity signal within the disk and the adjacent vertebral bodies, on T2-weighted sequences[20]. However, there are some limitations: implants may generate artifacts that may interfere with signals generating doubtful interpretations, and false positives are possible due to non-infectious conditions which may have similar MRI features[21]. The use of 18F-fluorodeoxyglucose-positron emission tomography (FDG-PET) has gained popularity in this context in the last few years. The 18FDG-PET signal is not affected by metallic implants, and allows to distinguish between SD and degenerative changes, using relatively low doses of radiation[22]. Important limitations are high cost and limited availability, making the use of this technique indicated only in complex cases or when MRI is contraindicated. However, it is most useful in the setting of late infections.

CT guided aspiration culture should be performed in all patients with deep-seated infections with negative blood cultures. It is a relatively safe and minimally invasive technique with a diagnostic accuracy rate ranging from 70% to 100%[23,24] and leads to better results than empirical antibiotic therapy[25].

### Classification of Postprocedural Spondylodiscitis

Several characteristics may help to classify the post-procedural spinal infections. In particular, it is appropriate to differentiate between infections after percutaneous procedures and standard surgery, between instrumented and non-instrumented surgeries, and between early and late infections (Figure 1). On the basis of the interval between surgery and diagnosis of infection, these can be classified in early, including acute ($\leq$ 2 weeks), subacute (2-4 weeks), and late ($>$ 4 weeks)[26]. However, from a practical point of view, we suggest the cutoff of three months to differentiate between early and late spinal procedures, on the basis of the average time necessary to achieve fusion in the case of instrumentations[27].

### Infection After Minimally Invasive Procedures

Spine infections can occur in less invasive procedures, such as discography, biopsy, percutaneous discectomy[28,29] and myelography[30]. The incidence ranges from 0.26% to 2.75%[5] and the absolute number of cases seems to be increasing over the years, probably due to the increasing number of procedures. It results from the direct inoculation of a micro-organism into the avascular disc space or vertebral body[28]. The clinical presentation, as in postoperative SD, is characterized by a period of relief, followed by a re-onset of neck or back pain that might be strongly suggestive in postoperative patients[31].

The initial treatment for post-procedural SD is based on immobilization by bracing or a body cast, and antibiotic therapy (Figure 2).

Laboratory exams and clinical symptoms are followed up for at least 6 weeks[5]. If CRP and ERS still increase, as well as in the occurrence of worsening pain or neurologic deficits, or if MRI detects progression of the infection with abscess of disruption of the vertebral body, an open surgical procedure consisting of debridement and removal of implants, should be considered[32].

### Postoperative Spinal Infections

The incidence of postoperative spinal infections ranges from 2.1% to 8.5%[33] for instrumented surgery, whereas it is less than 1% in open surgery

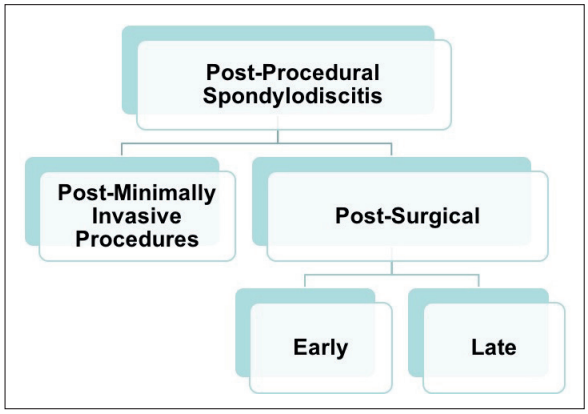


**Figure 1.** Classification of post- procedural spinal infections on the basis of the performed procedure and the interval between surgery and diagnosis of infection.

without instrumentation[34]. In fact, spinal instrumented fusion surgery has some procedure-related risk factors, including longer operative time, higher intraoperative blood loss, and risk of bacterial adherence to metal implants; these add to those related to any spinal surgery, such as hematoma formation or ischemia and necrosis of the back muscles and subcutaneous fat layers after subperiosteal dissection and use of retractors[35,36].

The risk of surgical site infections is higher with a posterior surgical approach than with the anterior or combined approaches (4.4% *vs.* 1.7%). As proper management of postoperative infections requires a thorough study of site and depth of the infectious process, MRI is the best tool for diagnosis also in patients with spinal instrumentation thanks to specialized protocols for the suppression of metal artifacts. The most common MRI findings are abscess or phlegmons in the back muscles (93.0%), at the laminectomy site (67.4%) and at the subcutaneous fat layer (62.8%). With the progression of the infectious process, these MRI patterns also extend to the anterior aspect of the spinal column[36].

Generally, early infections start with wound healing problems within a few weeks from surgery, and the occurrence of fever and an increase in serum markers of inflammation. Late infections often cause chronic pain, implant failure, non-union or wound dehiscence even a long time after surgery.

The onset of the infection differentiates the specific treatment. Indeed, in the early postoperative period spinal fusion is not appropriate yet, and the stability of the fusion site only relies on the instrumentation. Therefore, even when suitable, implant removal may lead to undesirable consequences. On the other hand, in chronic infections implant removal is unlikely to determine any local complication since the fusion has already been accomplished.

Moreover, pathogenic aspects differ between early and late infections. While the first has most often positive cultures, in patients affected by delayed infections we are less able to isolate low virulence germs.

### *Early Infections*

Approximately 86% of patients show signs and symptoms of spine infection within the first four weeks following surgery. This represents a window period in which a high level of suspicion should be maintained[9,36]. Patients often complain of pain, purulent drainage, and partial wound dehiscence.

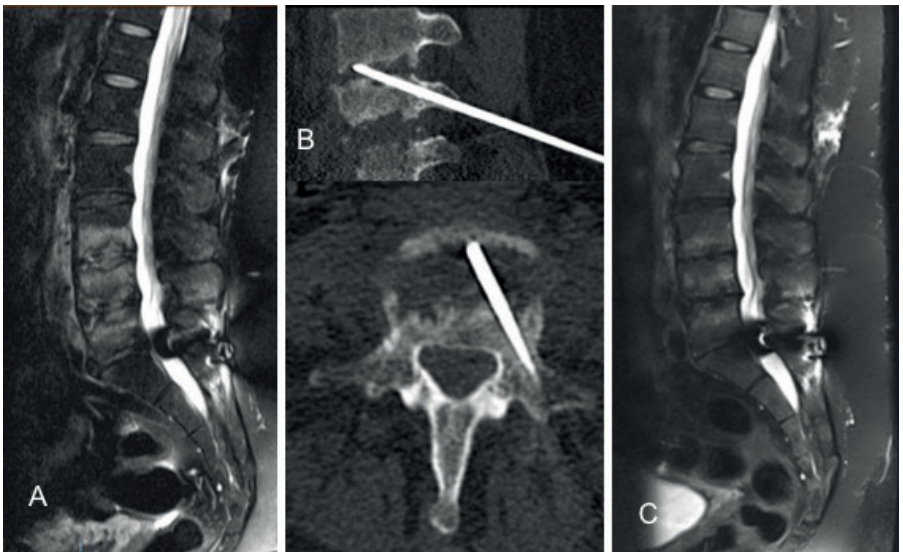


**Figure 2.** Iatrogenic spondylodiscitis after percutaneous laser discectomy at multiple levels and interspinous spacer insertion showed by sagittal MRI (**A**); the patient presented with persistent elevated fever, severe pain, and elevation of CPR and ESR; a CT-guided biopsy was performed for microbiology samples (**B**). The management included broad spectrum antibiotics for 12 weeks and the continuous use of a Cheneau brace. After six months, the patient eventually improved, and presented with resolution of the symptoms and decrease in the bone marrow edema and vertebral involvement at control MRI (**C**).

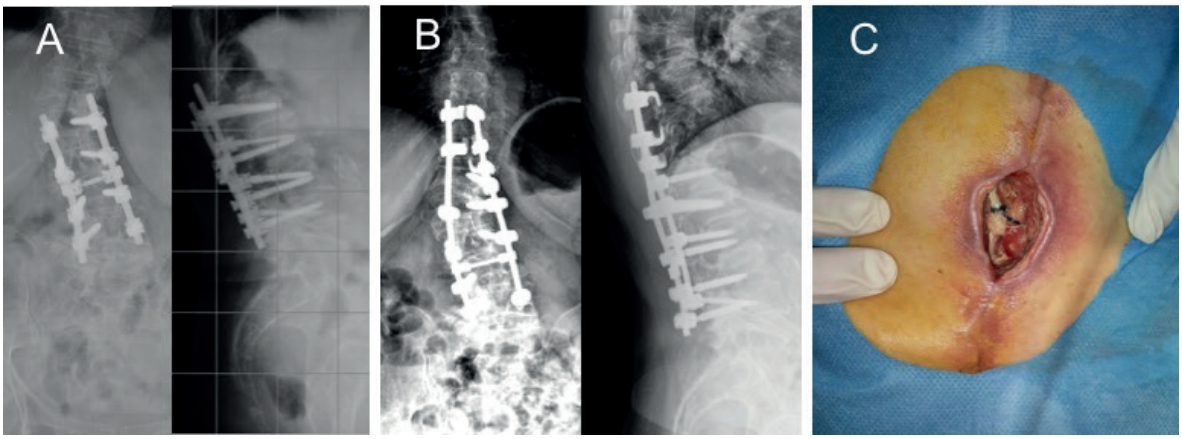


**Figure 3.** Postoperative early deep infection in a patient operated for adjacent segment failure after a spinal fusion (**A**), operated for revision of the instrumentation and its extension proximally to achieve deformity correction (**B**). Three weeks after surgery, the patient developed an infection sustained by a Staphylococcus epidermidis, with wound dehiscence and exposure of the muscular and fascial layers (**C**), which was managed by long course antibiotic therapy, and surgical debridement by leaving the instrumentation in place. She eventually recovered in 3 months.

Superficial surgical site infections, such as subcutaneous abscesses or cellulitis, are usually managed by antibiotic therapy, and only rarely require a surgical drainage. On the contrary, treatment of subfascial infections requires meticulous debridement and antibiotic therapy, especially if the patient has spinal instrumentation. The implants, even if made of titanium alloys, are potential surfaces for adhesion of bacteria which may develop a biofilm, resistant to both antibiotics and host immune factors[37].

The most appropriate management of early deep wound infection in the presence of spinal instrumentation is of note. The central role of intravenous antibiotic therapy is well founded. For early deep infections, several authors report high success rates after wound debridement and irrigation with implant preservation (Figure 3)[38]. It is important to drain the abscess, and to remove all the necrotic tissue and non-viable bone graft, while inserting a closed irrigation-suction system, and keeping the spinal instrumentation if possible[39].

### *Late Infections*

Generally, when the onset of symptoms is delayed, the infection is caused by low virulence pathogens migrated from a distant site of infection, intraoperatively inoculated or stimulated to fester by metal fretting[26]. The most commonly detected microorganisms are *Staphylococcus aureus*, *Staphylococcus epidermidis,* and *Propionibacterium acnes.*

Delayed spine infection is difficult to diagnose because of the absence of common clinical signs and symptoms of infection. Fever is often absent, and white blood cell count can also be normal. However, the patient reports a progressive increase of back pain after a period of well-being during postoperative recovery[38]; contextually, a persistent elevation of serum markers of inflammation, such as CRP and ESR, after two weeks from the surgery is encountered[27,40].

Non-union has a high incidence rate in subjects with a spinal infection, suggesting a correlation between this complication and delayed infections.

For patients affected by delayed deep infections (after 12 to 36 weeks), the fusion mass is often solid and the instrumentation, if present, can be removed safely as part of the debridement procedure (Figure 4)[41]. After metal-ware removal and surgical debridement, the antibiotic therapy is administered up to normalization of the serum markers of inflammation. Patients with loose fixation of spinal implants can require delayed revision surgery to stabilize the progressive deformity secondary to multilevel non-union[38].

## Conclusions

Postoperative spondylodiscitis is an infrequent but threatening complication of spinal surgery and procedures. The most important factor to prevent it according to the literature is preoperative and intraoperative antibiotic prophylaxis. The patients' risk factors, which include immunosuppression, obesity, alcohol, smoking, diabetes, and malnutrition, should all be considered when a patient with a spinal disease is managed surgically. Time from the index surgery,

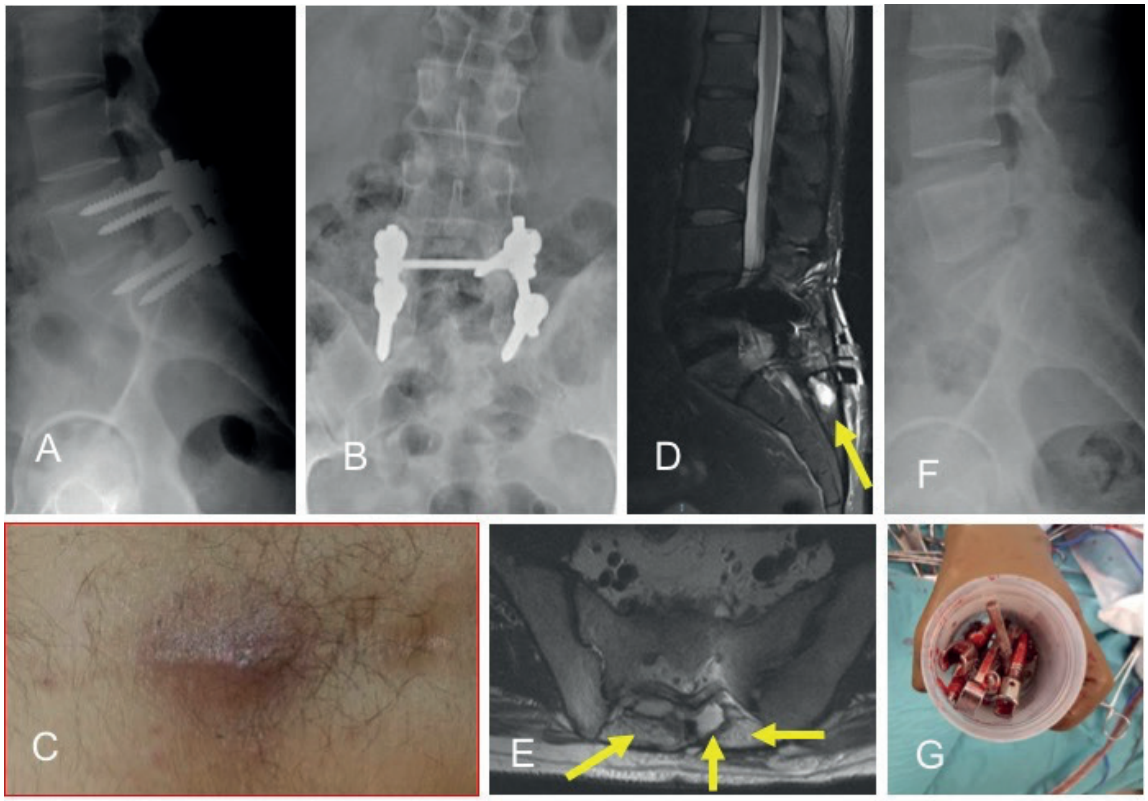


**Figure 4.** Postoperative deep infection sustained by Staphylococcus aureus in a patient operated ten years before lumbosacral fusion (**A**-**B**). The patient suddenly developed fever and a bump on the site of the skin incision (**C**). MRI showed a deep abscess (arrows) adjacent to the bone and instrumentation (**D**-**E**). Surgery consisted of surgical debridement, and instrumentation removal (**F**-**G**), followed by a short course antibiotic therapy targeted to the pathogen.

use of instrumentation, and achievement of a solid fusion are the main pieces of information to guide the clinical process. Early diagnosis and a standardized approach can decrease the morbidity for the patient and lower the incidence of complications.

### Conflict of Interests

The Authors declare that they have no conflict of interests.

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