

## Deep spinal infection in instrumented spinal surgery: diagnostic factors and therapy

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**SUMMARY: Deep spinal infection in instrumented spinal surgery: diagnostic factors and therapy.**

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*Aim. Postoperative surgical site infections (SSI) are complication of spinal surgery. These complications may lead to a poor outcome with neurological deficits, spinal deformity and chronic pain. The purpose of this study is to explore the statistical value of diagnostic parameters and the proper therapy.*

*Method. We retrospectively reviewed 550 patients who underwent spinal instrumentation at our department from January 2011 to December 2015. The SSI was present in 16 patients out of 550 operated. Diagnostic criteria of SSI were the positivity of the surgical wound swab or blood culture, the clinical findings, positivity of labo-*

*ratory tests and radiological elements. All patients had peri-operative antibiotic prophylaxis. Diagnostic laboratory findings were compared with a homogeneous control group of 16 patients and analyzed by univariate statistical analysis with Chi-square test for the discrete variables.  $P < 0,05$  was considered statistically significant.*

*Results. Matching the SSI patients with a group of control, fever was not statistically significant for diagnosis as number of leukocytes, neutrophils and lymphocytes. On the contrary values of ESR and CRP were statistically significant with  $p < 0,01$ . The hardware was removed only in 3 patients (18%) out of 16 SSI patients.*

*Conclusion. In this study the statistically significant parameters to diagnose SSI are ESR and CRP values. The leukocytes count, number of lymphocytes and presence of fever integrates the data of ESR and CRP with no statistical significance. Most patients with SSI reach clinical healing with favorable outcome by means of target antibiotic therapy without hardware removal.*

KEY WORDS: Spinal infections - Spine surgery - Surgical site infections - Instrumented spinal surgery - Spinal fusion surgery.

### Introduction

Postoperative surgical site infections (SSI) are a serious complication following spinal fusion surgery for trauma or tumors with an incidence ranging from 2 to 20% (1, 2). Nowadays the increasing prevalence of antibiotic-resistant organism such as methicillin-resistant *Staphylococcus aureus* (MRSA) presents new challenges for the treatment of SSI. These infections are associated with increased morbidity and, if not properly treated, patient's death. In case of infection persistence a revision surgery is required and the hardware removal is

associated with severe complications such as pseudoarthrosis and poor prognosis. Nowadays, thanks to new antibiotic therapies, hardware can be left in place in most cases (2, 3). An early diagnosis with laboratory test, MRI imaging and tissue culture remains the gold standard to start the proper treatment of the disease. For this goal the knowledge and the real value of diagnostic factors are essential. When the diagnosis has been made the antibiotic therapy must be target on the cultural exams. A revision surgery must be performed only in patients with persistent infections.

### Patients and methods

We reviewed retrospectively 550 patient who underwent spinal fusion from January 2011 to December 2015 at the Neurosurgery Department of University Politecnica delle Marche of Ancona; 16 patients (9 male and 7 female) out of 550 showed a postoperative surgical site infection (SSI). The mean age at the time of surgery was 60,2 years (range 37-82 years).

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All procedure were performed using a standard surgical scrub and draping of patients after administering general anesthesia. In all patients cephazolin sodium 1 one gram was administered 30 minutes before skin incision and went on twice a day for 48 hours after surgery. Surgical drainages were placed and removed after 48 hours from surgery. The choice of hardware for instrumented fusion was based on the characteristics of the pathology and in all cases was titanium screws with rods or cervical plates. In all patients CT scan were performed 48-72 hours after surgery and MRI with inflammatory laboratory tests only in infected patients.

Diagnostics criteria of SSI were the presence of local clinical findings of infected wound (redness, dehiscence, secretions, tenderness to palpation), increasing back pain, the positivity of the surgical wound swab or blood culture, fever, positivity to laboratory tests (increase of C-reactive protein CRP and erythrocyte sedimentation rate ESR, count of white blood cell, neutrophils and lymphocytes) and radiological inflammation findings (collected abscess, abnormal uptake of contrast medium on CT and/or MRI) (Figure 1).

Diagnostic laboratory findings were compared with a homogeneous control group of 16 patients and analy-

zed by univariate statistical analysis with Chi-square test for the discrete variables.  $P < 0,05$  was considered statistically significant. The software used for the analyses was SPSS (Version 20).

## Results

In this study 16 patients (2.9%) out of 550 operated with spinal instrumentation had a surgical site infections. The minimum follow-up was 1 year with a maximum of 5 years. The median latency before the diagnosis of infected wound after surgery was 8 days, 31-day average with a minimum value of 2 and a maximum of 210 days after surgery.

In 9 patients out of 16 the onset of symptoms was within 10 days from surgery, from 10 to 30 days in 3 patients, from 30 to 90 days in 2 patients and after 90 days in 2 patients. Fever was present in 5 pts out of 16.

In this series 12 out of 16 patients presented swelling and erythema of the wound with serous-hematic secretions; leukocyte count was  $< 10,000$  cells/mm<sup>3</sup> in 7 patients out of 16, between 10 to 12,000 cells/mm<sup>3</sup> in 5 patients and  $> 12,000$  cells/mm<sup>3</sup> in 4 pts. The neutrophil

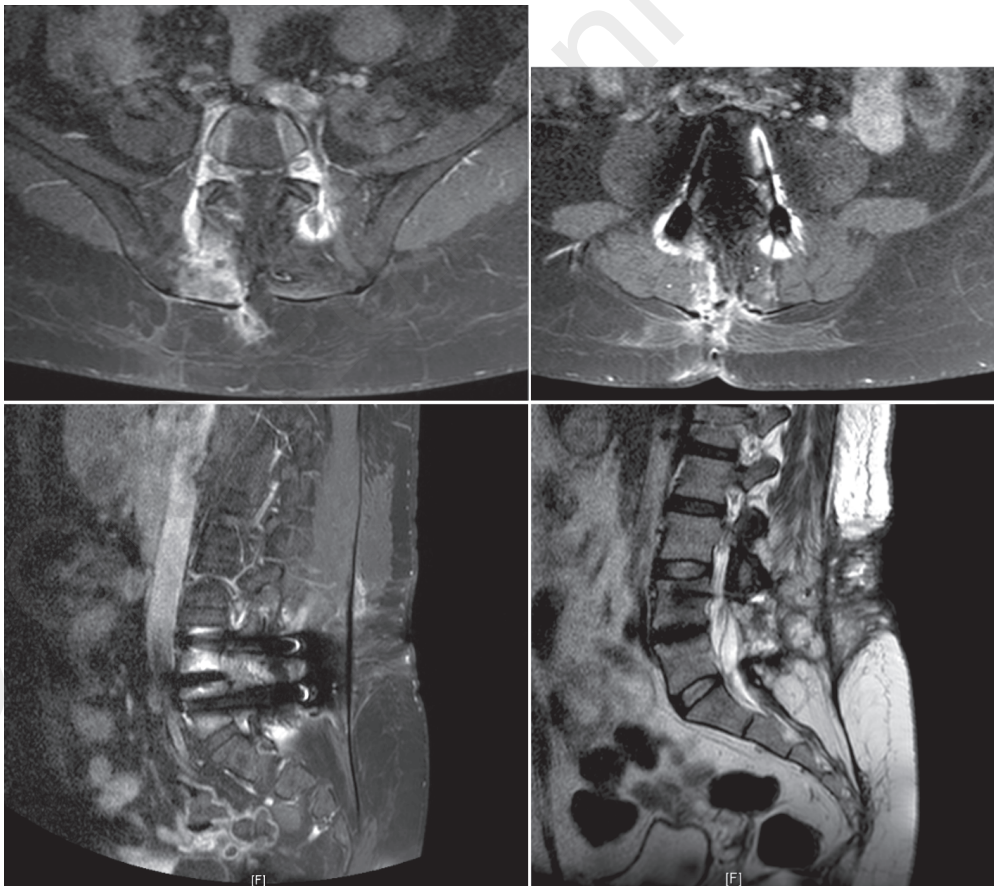


Figure 1 - MRI with contrast enhancement in patient with SSI and spinal hardware.

TABLE 1 - SUMMARIZING TABLE.

PTS	SEX	AGE	WBC (x10 <sup>3</sup> /mmc)	NEUTROPHILS (x10 <sup>3</sup> /mmc)	LYMPHOCYTES (x10 <sup>3</sup> /mmc)	ESR (mm/h)	CRP (mg/dl)
1	M	79	>12	<12	<1	>40	>0,6
2	F	73	10-12	<12	<1	<27	>0,6
3	F	77	10-12	<12	>1,1	>40	<0,6
4	F	54	<10	<12	<1	>40	<0,6
5	M	66	<10	<12	<1	28-40	>0,6
6	M	68	>12	<12	<1	28-40	<0,6
7	M	37	>12	12-14	<1	>40	>0,6
8	M	37	10-12	<12	<1	>40	>0,6
9	F	63	<10	<12	<1	>40	>0,6
10	M	52	<10	<12	<1	28-40	>0,6
11	M	66	<10	<12	<1	>40	>0,6
12	F	72	10-12	<12	<1	>40	>0,6
13	M	82	>12	<12	<1	>40	>0,6
14	F	44	<10	<12	<1	28-40	>0,6
15	F	45	<10	<12	<1	>40	>0,6
16	M	50	10-12	<12	>1,1	28-40	>0,6

count was < 12,000 cells/mm<sup>3</sup> in 15 patients out of 16, lymphocytes count was <1 in 15 pts out of 16. The erythrocyte sedimentation rate (ESR) value was <27 mm/hour in 1 patient out of 16, between 28 to 40 mm/hour in 5 patients and > 41 mm/hour in 10 patients. The C-reactive protein (CRP) value was superior to normal range in 13 patients out of 16 (Table 1). The CT study with contrast was performed in all patients, MRI has been performed in 13 patients out of 16; paravertebral abscesses were present in 13 patients out of 16, 3 patients were negative for CT scan/MRI findings of inflammation but showed a dehiscence of the surgical wound with swab culture positive. The etiological agents were Gram-positive in 9 patients out of 16 and Gram-negative in 7 patients. The surgical wound swabs were positives in 12 patients out of 16: 7 pts Gram-positive bacteria (Staphylococcus Aureus methicillin sensitive in 2 patients, Staphylococcus Epidermidis in 1 patient, Staphylococcus Aureus methicillin resistant in 2 patients, Constellatus Streptococcus in 1 patient and Mycobacterium in 1 patient). The positive culture for Gram-negative organisms was obtained in 5 patients: Enterococcus Faecalis, Serratia Marcescens, Enterobacter Aerogenes, Citrobacter Koseri, Morganii Morganella, Pseudomonas Aeruginosa, Klebsiella Pneumoniae. Blood cultures were positive in 4 patients out of 16: Gram-positive organisms in 2 cases (coagulase-negative Staphylococcus) and Gram-negative microorganisms in 2 patients (Escherichia coli and Klebsiella Pneumonia).

In this study 10 pts out of 16 healed with antibiotic therapy specific for the isolated microorganisms of the wound or blood culture, 6 pts with persistent infection underwent a second surgical procedure with debridement of the wound. Finally in 3 patients out of 6 the persistence of the infection made it necessary to remove the hardware (Figure 2). In these patients the microorganisms were staphylococci MRSA in 2 cases and Morganella

Morganii in the last one.

Matching the SSI patients with a group of control, fever was not statistically significant for diagnosis as number of leukocytes, neutrophils and lymphocytes.

However, the values of ESR and CRP were statistically significant with a value of p <0, 01 (Table 2).

## Discussion

Deep spinal infection following instrumentation remains a challenging pathology to diagnose and treat (1, 4, 5). Today its incidence is increasing due to the high number of elderly patients with chronic diseases (6). Another cause of spine spread infections is the elevated number of surgical procedures for spinal trauma and tumors thanks to the evolution of materials and techniques (7-9). Although the adoption of preoperative antibiotic prophylaxis decreases SSI rate, still today it has not been completely eliminated causing poor outcome in infected patients (9). Staphylococcus aureus is the most common organism isolated in SSI but recently MRSA has become more diffuse and very challenging to treat (2). At present no single test or clinical finding are sufficient to make the correct diagnosis and often the onset of symptoms is insidious and long standing. Pain is the most frequent symptom with local wound abnormalities such as tenderness, dehiscence or redness but they may appear very late from surgery. In our study one patient developed the clinical signs of wound infection after 210 days from spinal surgery. Laboratory studies are unreliable indicator of spine infection, high value of ESR remain for up to six weeks after surgery, CRP normalize within two weeks and fever is frequent in the postoperative period (2). However in our series the increase of inflammation indices such as CRP and ESR was statistically significant

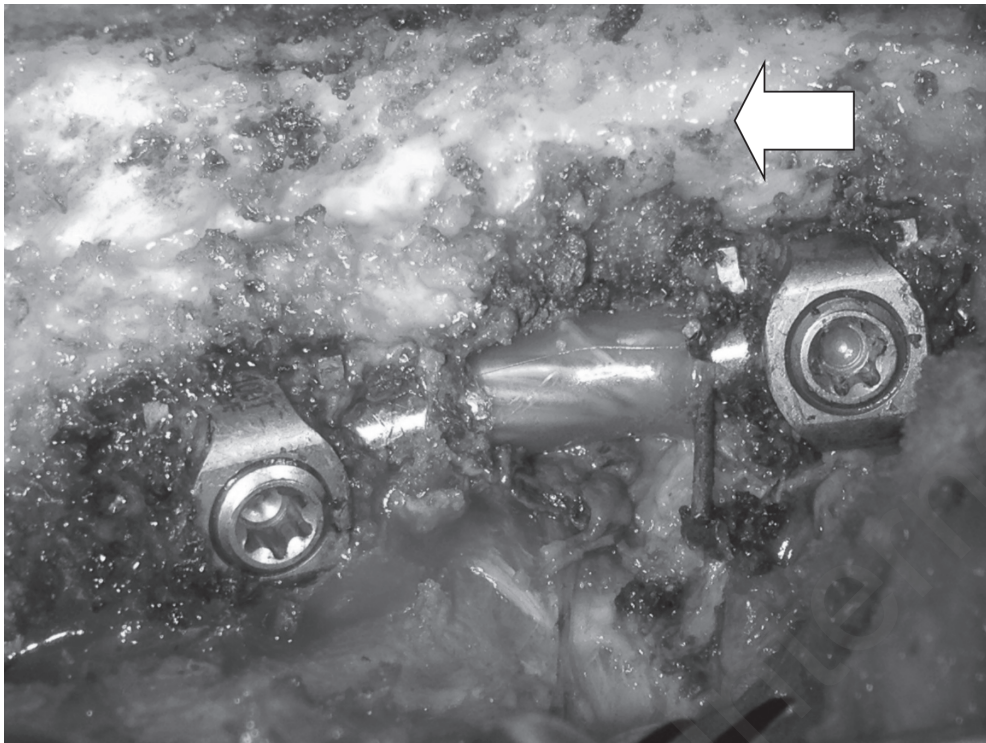


Figure 2 - Infection of screws and rod with abscessual collection (arrow).

TABLE 2 - STATISTICAL SIGNIFICANCE.

<b>Significance value: Leukocytosis</b>	Value	dF	Asymp. Sig.(2 sided)
Pearson's Chi-square	,410	2	,814
Likelihood Ratio	,409	2	,815
Linear-by-Linear Association	,033	2	,856
N° of Valid Cases	38		
<hr/>			
<b>Significance value: ESR</b>	Value	dF	Asymp. Sig.(2 sided)
Pearson's Chi-square	18,756	2	,000
Likelihood Ratio	22,951	2	,000
Linear-by-Linear Association	10,752	1	,002
N° of Valid Cases	38		
<hr/>			
<b>Significance value: CRP</b>	Value	dF	Asymp. Sig.(2 sided)
Pearson's Chi-square	22,342	1	,000
Likelihood Ratio	26,438	1	,000
Linear-by-Linear Association	22,806	1	,000
N° of Valid Cases	38		

and this is in accord with literature (10-15). The increase of leucocytes, neutrophils and lymphocytes count was not statistically significant as well as the presence of fever (16). Superficial cultures in many cases do not reliably assist to identify the causative organism so intraoperative tissue culture remains the gold standard for diagnosis of the SSI (2). In this series all patients were positive at wound swab and 6 patients out of 16 at blood culture too. As reported in literature in our study the polymicrobial infections are rare and more frequent as a re-

sult of traumatic events (17, 18). Besides many studies have shown that there is no difference in organisms between superficial or deep spinal infections. In our study the Gram-negative organism were isolated in 7 patients out of 16 and Gram-positive in 9 patients out of 16. The use of magnetic resonance imaging (MRI) help for diagnosis; the MRI is the most useful study to diagnose SSI, gadolinium enhancement improves the diagnostic accuracy (19). Nevertheless MRI lack accuracy to distinguish between recently treated and ongoing active in-

fections or presence of fibrotic tissue. Finally metallic implants limit the diagnostic performance of MRI. Previous studies suggested that FDG PET/CT may be useful to diagnose postoperative spine infection with a good sensitivity (20). The use of both diagnostic tools may be useful in patients with suspected diagnosis or uncertain healing of spinal infection. In our series 6 patients out of 16 underwent a second surgical procedure with drainage and irrigation of the spinal abscesses. The aim of the surgical procedure was the cleaning and debridement of the infected tissue, spinal decompression and the isolation of the microorganism. Intra-operative tissue cultures remain the gold standard to identify the causative organism in SSI (21). In 3 cases out of 6 the implant was removed with a third surgical procedure cause the persistence of the infection. In 2 out of 3 cases the infection was caused by MRSA which are generally reported as highly virulent and resistant to therapy (22); in the third patient the infection was sustained by the *Morganella Morganii*. In 13 patients out of 16 the antibiotic therapy had a favorable outcome with spinal infection healing. In infected patients antibiotic therapy was continued for at least six weeks postoperatively and in case of MRSA recent recommendations suggest to extend intravenous antibiotic therapy for eight weeks (20). In all patients the hardware was titanium screws, rods or cer-

vical plate known as safe also in patients with ongoing active infections (23, 24). This characteristic is due to the difficulty of organisms to colonize the titanium material biofilm (3). In all patients the healing of the spinal infection was documented by clinical improvement, normalization of laboratory tests and disappearance of contrast enhancement on CT/MRI study. The presence of fever was not statistically significant with resolution after a few days of antibiotic therapy targeted on wound or blood cultures.

## Conclusions

Our analysis shows that the statistically significant parameters to diagnose SSI after spinal implant are ESR and CRP values. The leukocyte count, number of lymphocytes and presence of fever integrates the data of ESR and CRP with no statistical significance. MRI with contrast is the exam of choice but FDG PET/CT may be useful in patients with a suspicion of SSI. Some pathogens have proved to be particularly hard to treat conservatively such as staphylococcus-MRSA. However most patients with SSI reach clinical healing with favorable outcome by means of target antibiotic therapy without no hardware removal.

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