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ORIGINAL ARTICLE

Retrospective Analysis of Risk Factors and Management of Infection After Lumbar Spine Implantation

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Abstract

Background: **Wound infection still has a negative impact on patient outcomes after spine surgery, despite the discovery of preventative medicines as well as improvements in surgical approach and postoperative care. The risk of intraoperative/postoperative infection is increased by utilizing a posterior surgical approach, applying instrumentation, using an allograft, requiring a blood transfusion, and longer operations.**

Aim: **To determine the prevalence and risk factors for postoperative instrumental lumbar spinal infection and evaluate functional outcomes after the management of the infections.**

Patients and methods: **This study was conducted on diseased persons who had an infection after lumbar spine instrumentation surgery and attended Al-Azhar University Hospitals during the time of the study.**

Results: **The results revealed that ~4% of patients had postspinal implantation infections. The risk factors for postoperative infection included older patients, female sex, obesity, smoking, hyperglycemia, diabetes mellitus, chronic obstructive disease, postoperative urinary incontinence, increasing the duration of surgery, blood loss during operation, blood transfusion, postoperative hospital stay, and posterior approach. 65% of included patients underwent surgical debridement. 35% of the patients that were included had implants removed. The improvement in ASIA score was observed in 87.5% of included patients. After infection management, 65% of patients had a minimal disability.**

Conclusion: **There were various risk factors for infection including patient-related and surgery-related. Therefore, special attention should be paid to reducing the influence of risk factors on the occurrence of infection. The infection treatment using antibiotics, debridement, or implant improved functional outcomes and reduced disability in about 88% of included patients.**

Keywords: Disability, Infection, Mortality, Risk factors, Spinal implant

1. Introduction

Spinal instrumentations have been classified as rigid fixation, total disc replacement, and dynamic stabilization systems for the treatment of various spinal disorders.[1]

Although instrumentation is now a crucial part of treating many spinal diseases, there is a 2–20% infection risk associated with it.[2,3]

Since they are positively linked to longer hospital stays, higher morbidity and healthcare costs, worse long-term findings, long-term intravenous (IV) antibiotic therapy, reoperations, and increased dissatisfaction with the initial surgical procedure, the management of postoperative wound infections has become more important and challenging.[4]

Within weeks after implantation, early infection often manifests as issues with wound healing, and late infection may show up years later, frequently with persistent pain, implant failure, or inadequate spinal fixation. The ideal outcome for treating spinal implant infections is a patient who is pain-free, has a stable spine, and has had the infection treated.[5]

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Early-onset wound infections and late-onset implant infections appear differently and need different treatment plans based on their microbial nature.[6]

Spinal implants provide the necessary stability in the early postoperative phase prior to vertebral body fixation. Adhering to the generally accepted notion that eliminating infected foreign bodies can maximize the resolution of infection may have unfavorable effects in this situation.[7]

The aseptic inflammation caused by metal corrosion may be the cause of many instances of late-onset drainage from spinal implants, and cultures positive for low-virulence microbes from such drainage may not be pathogenic in nature.[8]

At the time of diagnosis, patients with late-onset infections are more likely to have a fused, stable spine. Patients may thus get systemic antibacterial treatment as well as implant removal. In especially for early postoperative infections, there is little agreement on optimum medicinal and surgical treatment methods.[9]

Successful patient outcomes depend greatly on an adequate antibiotic course and surgical therapy, but the most important component is still early identification.[10]

This study aimed to determine the prevalence and risk factors for postoperative instrumental lumbar spinal infection and evaluate functional outcomes after the management of the infections.

2. Patients and methods

This retrospective cohort study was conducted between 2016 and 2020, on Patients whom had an infection within 2 years after lumbar spine instrumentation surgery at Al-Azhar University Hospitals in Cairo throughout the course of the previous, Al Azhar University during the time of the study.

The inclusion criteria were adult patients whom developed signs of acute inflammation as pyrexia 38.5 °C, elevated ESR above 20 mm/h, elevated C-reactive protein (CRP) above 5 mg/d, or had radiological evidence of infection detected by computed tomography (CT), radiography, or MRI of the lumbar spine.

The exclusion criteria were: patients with degenerative spine disease, spinal tumors, vascular disorders, and noninstrumental spine fixation.

The Institutional Review Board (IRB) at Al-Azhar University granted approval. All patients who were involved provided written informed consent.

The following data were collected socio-demographic parameters, date of implant, microbiological, clinical results, infection detection, period of staying in hospital, antibiotic injection, neurological deficits, metal failure, and mortality.

The functional outcome was assessed according to American Spinal Injury Association (ASIA scoring system)[11] for assessing the lumbar spine and the obtained results were tabulated and statistically analyzed. The Oswestry disability index (ODI) was utilized to evaluate the patients' level of impairment.[12]

2.1. Statistical analysis

Utilizing SPSS, version 25. Mean and SD was utilized for the representation of continuous data. Moreover, dichotomous data were represented as frequency and percentage. Independent-test was used for comparing continuous data, Moreover $\chi^2$was used for comparing categorical data. Logistic regression was used for the assessment of risk factors for postspinal implant infection.

3. Results

Form 1006 patients underwent lumber spine instrumentation surgeries (2016:2020), and 40 (3.97%) patients had a postoperative infection and were then included in this trial. The median age was

Table 1. Baseline characters of infected patients.

	Mean	SD	Minimum	Maximum
Age	58.98	15.68	28	89
BMI	27.05	1.69	24	30
	Frequency		Percent	
Sex				
female	18		45%	
male	22		55%	
BMI				
<25	8		20.0	
25:35	32		80.0	
smokers	7		17	
Infected patients using epidural corticosteroid injections within 3 months before surgery	10		25.0	
Non-infected patients using epidural corticosteroid injections within 3 months before surgery	12		1.24	

Table 2. Properties of postoperative infection.

Properties of postoperative infection		
The time between implantation and infection (mean ± SD)	31.3 ± 25.6	
Pathogen	Frequency	Percent
Staphylococcus aureus	16	40.0
Coagulase-negative staphylococci	3	7.5
Enterococci	2	5.0
Cutibacterium spp	1	2.5
Corynebacterium spp	1	2.5
MRSA	6	15.0
Propionibacterium acnes	6	15
E. faecalis	2	5
E. coli	3	7.5
Type of cultures		
Monomicrobial	34	85
Polymicrobial infection	6	15.0
Onset of infection		
Early (within 90 days)	25	62.5
Late (after 90 days)	15	37.5
Clinical findings		
Fever >38 °C	8	20.0
Neck or back pain	32	80.0
Local inflammatory signs	32	80.0
Presence of sinus tract	4	10.0
Focal neurological impairment	2	5.0

58.9 ± 15.68.45% of included patients were female and 55% were male. The BMI was 25 : 35 in 80% of included patients. Only 17% of included patients were smokers. The baseline characters of included patients were further illustrated in Table 1.

The median time from implantation to infection was 31.3 days with SD of 25.6 days. The majority of included patients were monomicrobial infections (85%). However, polymicrobial infections were found in only 15% of included postoperative infected patients. *Staphylococcus aureus* was the associated micro-organism in 40% of infected patients followed by Methicillin-resistant *S. aureus* (MRSA) (15%) and Propionibacterium acnes (15%). Early-onset infection occurred in approximately 62% of included patients, while late-onset infection occurred in 37.5% of included patients. Regarding clinical findings after postoperative infection, 80% of included patients suffered from local inflammatory signs and neck or back pain. Moreover, 20% had a fever greater than 38 °C (Table 2).

Patient-related risk factors for infection included older patients, female gender, obesity, smoking, hyperglycemia, diabetes mellitus, chronic obstructive disease, and postoperative urinary incontinence. Operation-related risk factors for infection include an increase in the duration of surgery, blood loss during operation, blood transfusion, postoperative hospital stay, and posterior approach (Table 3).

All included patients were administrated oral antibiotics for treatment of postoperative infection. Parental antibiotics were used in 40% of included patients. 65% of included patients underwent surgical debridement. The majority of them require one debridement surgery (50%) and additional surgeries were required in only (15%) of included patients. While surgical debridement is not required for 35% of included patients. Implants were removed in 35% of included patients. The improvement in ASIA score was observed in 87.5% of included patients (Tables 4 and 5).

Before infection management, 20 patients had a severe disability, 18 had a moderate disability and 2 had a minimal disability. After infection management, 14 had a moderate disability and 26 had a minimal disability (Fig. 1).

4. Discussion

Wound infection still has a negative impact on patient outcomes after spine surgery, despite the discovery of preventative medicines as well as improvements in surgical approach and postoperative care Ishii and colleagues.[13]

Table 3. Risk factors for infection after spinal implant.

	Infected	Noninfected	Odds ratio (95%CI)	*P* value
Age	58.98 ± 15.68	52.43 ± 2.72	1.19 (1.12,1.26)	0.00
Female	20 (50%)	646 (66.9)	2.018 (1.1–3.81)	0.04
Obese	32 (80%)	272 (28.2%)	10.2 (4.6–22.43)	0.007
Smoking	7 (17%)	29 (3%)	6.85 (2.7–16.7)	0.000
Hyperglycemia	10 (25%)	139 (14.4%)	1.98 (0.95–4.15)	<0.0001
Diabetes	12 (30%)	64 (6.6%)	6.04 (2.93–12.4)	0.00
Post-operative urinary incontinence	11 (27%)	113 (11.7%)	2.86 (1.39–5.89)	0.008
Chronic obstructive pulmonary disease	4 (10%)	29 (3%)	3.5 (1.198–10.7)	0.022
Duration of surgery (hr)	2.83 ± 0.44	1.98 ± 0.22	223,475 (5135.9–9723783.5)	0.01
Estimated blood loss (mL)	1797.60 ± 108.28	1083.27 ± 153.54	–	0.98
Postanesthesia care unit time (hr)	40.78 ± 2.36	21.56 ± 1.88	–	0.98
Hospital stay	8.90 ± 2.35	5.18 ± 1.11	16.7 (7.37–38.1)	0.00
Blood transfusion	22 (55%)	289 (29.9%)	2.86 (1.5–5.419)	0.001
Posterior approach	36 (90%)	721 (74%)	3.05 (1.07–8.67)	0.02

Table 4. Management of postoperative infection.

	Frequency	Percent
Oral antibiotics	40	100
Parental antibiotics	16	40.0
Debridement	26	65.0
One surgery	20	50.0
Two surgeries	4	10.0
Three surgeries	2	5.0
Management with Implant removal	14	35.0

Table 5. Improvement in functional outcome.

	Frequency	Percent
Improvement in ASIA score	35	87.5

Our results revealed that ~4% of patients had postspinal implantation infection, *S. aureus* was responsible for infection in the majority of patients, and early-onset infection was observed in 62% of included patients. The risk factors for postoperative infections included older patients, female sex, obesity, smoking, hyperglycemia, diabetes mellitus, chronic obstructive disease, postoperative urinary incontinence, increasing in the duration of surgery, blood loss during operation, blood transfusion, postoperative hospital stay, and posterior approach. 65% of included patients underwent surgical debridement. 35% of the patients that were included had implants removed. The improvement in ASIA score was observed in 87.5% of included patients. After infection management, 65% of patients had a minimal disability.

Rates of infections after instrumented surgery range from 1% to 4%, and they are rare Ishii and colleagues.[13] In 33%–75% of patients with a microbiologic diagnosis of spinal implant infections, *S. aureus* is the most frequent causative agent. Due to the pathogen's biofilm deposition on the osteosynthesis device's surface, antimicrobial resistance, and slow-growing variations, these infections are challenging to cure Cho and colleagues.[14]

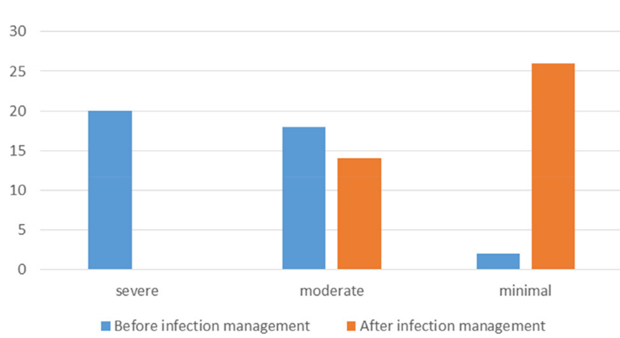

Fig. 1. Disability of infected patients.

In accordance with our study (Kalfas and colleagues)[4] found that 42 patients had an early-onset infection (range, 3–30 days), while the remaining nine had a late-onset illness (range, 3–12 months). Patients presenting with an early-onset illness were substantially more likely to have gram-positive bacilli and monomicrobial infection. Three instances included coagulase-negative Staphylococcus, three involved *Escherichia coli*, one involved *Pseudomonas aeruginosa*, and two involved sterile organisms. The most prevalent clinical symptoms were localized inflammation at the incision site and neck or back discomfort (75% and 74%, respectively). In less than 10% of infections linked to spinal implants, fever, sinusitis, or localized neurologic impairments were noted.

There are several factors that might affect the development of a postoperative infection that can be categorized as either permanent, solely patient-related, or transient, or procedure-related Christodoulou and colleagues.[15]

The patient's age (greater than 70 years) and medical conditions, the most significant of which are diabetes mellitus, cardiovascular disorder, obesity, smoking, malignancy, steroid use, prior lumbar surgery, nutritional status, chronic obstructive respiratory illness, and immunologic competency, are considered to be the so-called unchangeable risk factors Koutsoumbelis and colleagues.[16]

The surgical corridor needed to reach the spine is reduced by minimally invasive spine surgery (MISS) procedures, which also result in decreased tissue damage, blood loss, hospitalization, and postoperative morbidity. Minimally invasive spine surgery may significantly lower the risk of surgical site infections (SSI) and be a useful strategy for lowering hospital expenses Kulkarni and colleagues.[17]

Veeravagu and colleagues[18] showed that Patients with surgical wound infections had longer hospital stays, increased death rates, and greater operating room rates of return than patients without postoperative wound infections.

Whether an SSI is isolated superficial to the muscle fascia or involves the spine deep to the fascia may affect how it is treated after spinal surgery. There have been several therapies mentioned. The first is vigorous surgical intervention along with antimicrobial therapy, the second is tool removal followed by delayed reimplantation, and the third is keeping the stable implant in place Tsiodras and Falagas.[19]

The management of spinal implant infections is critical, especially if the device cannot be withdrawn. Rifampin has strong effectiveness against adherent and stationary-phase staphylococci and excellent bone and biofilm penetrating capabilities. Patients with orthopedic implant-related infections are advised to use combination therapies based on rifampin, especially if the implant cannot be withdrawn Zimmerli and Sendi.[20]

Most infections were caused by one kind of bacteria. *S. aureus* was the most often found bacterium when the wounds were cultured. Surgery irrigation, debridement, and the proper antibiotics to manage the cultured organism were administered to all patients Fang and colleagues.[21]

The retention of instrumentation and successful fusion were made possible in the majority of instances by an aggressive response to deep wound infection that prioritized early irrigation and debridement Fang and colleagues.[21]

In terms of the wound, some writers indicate that it be principally closed after debridement, while others advise either a second-look surgery or keeping the wound open and closing it in two stages Schairer and colleagues.[7]

Pull ter Gunne and colleagues[22] vigorous wound and soft tissue debridement (89.3%), stable hardware retention (73.3%), and primary replacement of instrumentation (14.7%) as therapeutic options in the event of fixation failure. Primary closure over several drains came afterwards. 76% of deep SSIs may be treated with this technique with only one surgical debridement. If the clinical signs of an ongoing infection were not managed, further debridement was done. The average duration of antibiotic treatment for all patients was 40.8 days. In 90% of instances, intravenous antibiotics were utilized, often followed by a brief course of oral antibiotics. The period of diagnosis is used to distinguish between late and early infections; some writers use a cutoff of 90 days, with early infections defined as occurring before 90 days and late infections as occurring after 90 days.

In Zhao and colleagues[23] study, 19 (19/23, 82.61%) of the 23 (37.70%) patients with neurological impairments made a full recovery, whereas 4 (4/23, 17.39%) showed only partial improvement at the final follow-up following debridement.

In the study operated by Kim and colleagues,[24] Mean final and preoperative ODIs were respectively 39.4 (range: 18 to 56) and 20.3 (range: 12 to 36). At the last follow-up, the ODI reported that 7 patients had a moderate impairment and persistent leg pain, whereas 13 patients had a minimum disability with full cure of the leg pain. They came to the conclusion that one treatment approach, implant removal and broad debridement for postoperative infections after posterior instrumented spine fusion, may provide positive outcomes.

4.1. Conclusion

It is concluded that the incidence of postlumbar spinal implantation infection was 3.97% with staphylococcus aureus responsible for the majority of them. There were various risk factors for infection including patient-related and surgery-related. Therefore, special attention should be paid to reducing the influence of risk factors on the occurrence of infection. The infection treatment using antibiotic, debridement, or implant removal improves functional outcome and reduce disability in about 88% of included patients.

Our results should be interpreted with caution as it is a retrospective study conducted according to the data available in the patient database of Al-Azhar University Hospitals in Cairo in the past 5 years only (2016–2020). Therefore, we recommended conducting more prospective, multicenter studies of longer duration to monitor in depth the expected risk factors and optimal treatment modalities.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

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Conflicts of interest

The authors declared that there were No conflicts of Interest.

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