Original Article

# Surgical site infection in posterior spine surgery

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## Abstract

**Background:** Surgical site infections (SSIs) in spine surgery remain a significant cause of morbidity and prolonged hospitalization. Factors affecting SSI includes patient's comorbidities, duration of surgery, type and indication for surgery among others. We intend to document our experience in our center and highlight possible factors influencing SSI in posterior spine surgery.

**Methodology:** All consecutive patients who had posterior spine surgeries between January 2012 and July 2014 were recruited into the study. All patients who had wound infection were noted and culture sensitivities were documented as well. Results were analysed to get the infection rate, reasons for prolonged stay on admission as well as possible contributing factors to wound infections.

**Results:** A total of 62 patients' records were reviewed with 34 males and 28 females (male:female = 1.2:1). SSI was classified as deep or superficial to the fascia. Ten (16.1%) patients were found to have an SSI with 7 (11.3%) patients having deep infections and 3 (4.8%) had superficial infection. Vertebral level operated, etiology, and diagnosis were not statistically significant for SSI. However, spinal instrumentation, surgery on cervical region and wound inspection on or before postoperative day 5 were associated with an increase in the rate of SSI. Comorbidities such as diabetes mellitus, obesity, and anemia were significant risk factors. The organisms cultured were *Pseudomonas* and *Staphylococcus* species.

**Conclusions:** Wound infection is a significant complication of posterior spine surgery. This causes distress for both patient and surgeons alike. Uncontrolled diabetes, spine instrumentation and long duration of surgery are significant risk factors for SSI. Practices of early wound inspection, frequent wound dressing changes and not keeping to nontouch technique for changing and removing dressings are important risk factors for SSI in posterior spine surgeries that need to be changed to reduce the burden of SSI.

**Key words:** Delayed wound exposure, diabetes, posterior spine surgery, spine instrumentation, surgical site infection

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## Introduction

The rate of surgical site infection (SSI) in the literature ranges from 0.2% to 16.7%.[1,2] The type of surgery is perhaps the most notable variable affecting the incidence of SSIs in spinal surgery. Posterior surgical approach is associated with higher infection rates. In contrast, anterior spinal exposures are associated with a reduced risk of infection.[3]

While advances have been made in infection control practices, including improved operating room ventilation, sterilization methods, barriers, surgical technique, and

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availability of antimicrobial prophylaxis, SSI remains a substantial cause of morbidity, prolonged hospitalization, increased health cost and death. The main additional costs are related to re-operation, extra nursing care and interventions, as well as drug treatment costs. The indirect costs, due to loss of productivity, patient dissatisfaction and litigation, and reduced quality of life, have been studied less extensively.[4,5]

There are variations in the definitions of SSI.[6] Defining an SSI requires the use of International Classification of Diseases-10 criteria, but we used evidence of clinical signs and symptoms of infection, which includes fever, pain and tenderness on palpation of operation site, examination findings of separation of the edges of incision site, redness or swelling at operation site, discharge of pus or serosaguinous fluid at the surgical site, and microbiological evidence. Erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) values are also considered useful in the detection and monitoring of spinal infection.[6,7]

The majority of SSIs become apparent within 30 days of an operative procedure and longer in instrumented surgeries.[8] The aims of this study are to determine the incidence of SSI, highlight the factors responsible for SSI, and to compare the incidence of SSI in early wound inspection and delayed wound inspection.

## Methodology

This study was a retrospective cross-sectional study. It involved a review of all patients who had posterior spine surgery within a 2-year period. A total of 62 patients were included in the study based on the selection criteria. Patients who had primary infective process such as Potts' disease were excluded from the study. The only exception was a patient who had kyphosis from previous tuberculosis spine which had been treated with appropriate anti-Kocks medications for over 3 months.

Ethical approval was obtained from the appropriate authority. Confidentiality of the patient's information in the medical records was ensured, as names were not required for this study.

Information gathered included demographic details, etiology, diagnosis, radiological, and laboratory investigations. Pre-, intra- as well as post-operative findings were recorded as well. Patients with suspected SSI had wound swab done for microscopy, culture, and sensitivity pattern. Infection was categorized as superficial when it involved only the skin edges and subcutaneous layer. SSI was said to be deep when it extended beyond the fascia and required irrigation and debridement to treat. Other details such as presence of comorbidity (hypertension, diabetes, and obesity), body mass index, day of wound inspection, and duration of surgery were also recorded. Patients were followed up for a minimum of 12 months after the surgery.

All the data obtained were divided into pre-, intra-, and post-operative patient details. Mean and standard deviation were computed for continuous variables while frequency was generated for categorical variables. Analysis was carried out to confirm significant relationship between variables of interest, the fisher's exact test was utilized to assess the infection rates in the duration of surgery in hours and uncontrolled diabetic patients, association between variables was determined using a $P < 0.05$.

## Results

A total of 62 patients' records were eligible for inclusion in the study. There were 34 males and 28 females (male: female ratio 1.2:1). The mean age was 44.2 years [Table 1]. Within the study group, 10 (16.1%) patients had SSI. Seven (11.3%) patients had deep SSI whereas 3 (4.8%) had superficial SSI. Presence of co-morbid conditions such as poorly controlled diabetes mellitus and obesity were noted to be associated with increased rate of infections [Table 2] whereas hypertension was not associated with wound infection. Another patient with anemia who declined blood transfusion on religious basis had wound infection. Univariate analysis of the preoperative characteristics showed that poorly controlled diabetes mellitus ($P = 0.003$) significantly increased the risk of SSI.

Indications for posterior spine surgery were diverse and cut across all possible spine pathologies such as trauma, spondylosis, spine tumor, and in some cases a combination of these. The commonest in this study was trauma (35.5%), and this was followed closely by degenerative causes of spine pathology (33.9%) [Table 1]. Most interventions were done in the cervical vertebrae (38.7%). The incidence of SSI was higher in the cervical vertebra interventions as compared to lumbar and thoracic. There was no incidence of SSI in thoracic spine surgery.

Patients were about equal in instrumented and noninstrumented categories. Laminectomy either as a single procedure (19.4%) or in association with tumor excision (16.1%) was the single most performed noninstrumented case [Table 1]. A total of 32 patients (51.2%) had spinal fixation of different types.

In all, 48 patients (77.4%) had their surgery completed within 4 h while it took more than 4 h in the remaining 14 (22.6%) patients. This was statistically significant. $P = 0.038$ [Table 3].

A total of 45 patients had their surgical wound exposed within 5 days after surgery. Eight (17.4%) had SSI. The incidence was not as high in patients who had there

**Table 1: Patient characteristics and associated wound infection rates**

| | Frequency (%) (*n*=62) |
|---|---|
| Preoperative characteristics | |
| Gender | |
| Male | 34 (54.8) |
| Female | 28 (45.2) |
| Mean age (±SD) | 44.2 (±16.0) |
| Co-morbidities | |
| Diabetes | 3 (4.8) |
| Obesity | 1 (1.6) |
| Anemia | 1 (1.6) |
| Tuberculosis | 1 (1.6) |
| Hypertensive | 1 (1.6) |
| Etiology | |
| Spine degenerative | 21 (33.9) |
| Spine trauma | 22 (35.5) |
| Spine tumor | 10 (16.1) |
| Spine trauma and spine degenerative | 1 (1.6) |
| Postinfective | 3 (4.8) |
| Spine others | 4 (8.1) |
| Intraoperative characteristics | |
| Surgical level | |
| Cervical | 24 (38.7) |
| Thoracic | 15 (24.2) |
| Lumbar | 20 (32.3) |
| Cervical and lumbar | 2 (3.2) |
| Cervical and sacral | 1 (1.6) |
| Procedure | |
| Not instrumented | |
| Laminectomy | 12 (19.4) |
| Discectomy | 7 (11.3) |
| Kyphoplasty | 1 (1.6) |
| Laminectomy and tumor excision | 10 (16.1) |
| Instrumented | |
| Fixation | 1 (1.6) |
| Decompression and fixation | 11 (17.7) |
| Laminectomy and fixation | 17 (27.4) |
| Others | 3 (4.8) |
| Length of surgery | |
| 0-4 | 48 (77.4) |
| >4 | 14 (22.6) |
| Postoperative characteristics | |
| Wound inspection | |
| Opened within 5 days | 45 (72.6) |
| At day 10 | 17 (27.4) |
| Wound MCS | |
| *Pseudomonas aeruginosa* | 4 (6.5) |
| *Staphylococcus* species | 6 (9.7) |

MCS=Microscopy, culture, and sensitivity; SD=Standard deviation

wound exposed much later at 10 days after surgery (11.8%) [Figures 1, 2 and Table 4]. There was no statistical significance on the day of wound exposure. The organisms cultured on the wound culture and sensitivity test were *Pseudomonas* and *Staphylococcus* species.

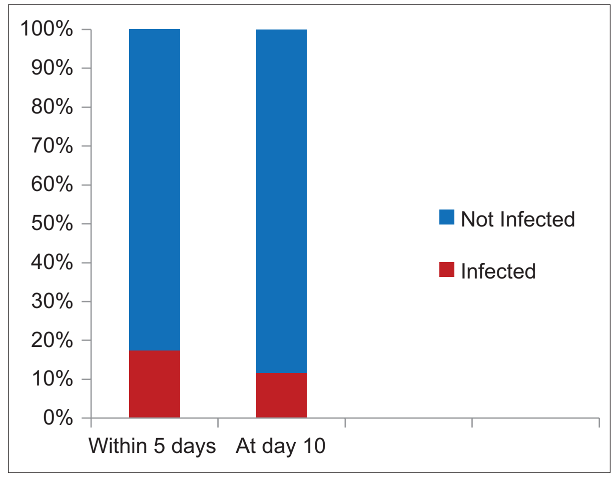


**Figure 1:** Wound inspection/infection characteristics

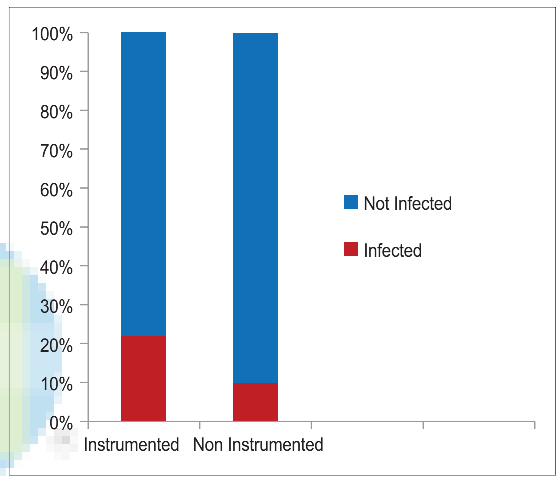


**Figure 2:** Incidence of infection at instrumentation

## Discussion

SSI places a significant burden on the patient and health system, especially in Africa where resources are limited. The overall rate of SSI for patients with posterior spinal surgery in this study is 16.1%. Though the incidence for deep SSI of 11.3% is within the acceptable range, the total SSI rate is at the upper end of documented range in the literature.[1,2,9] We do not have any similar study of such in our region to compare. The incidence is relatively high when compared to the range of infection in clean neurosurgical operations in randomized controlled trials which is 4.0–12% without prophylactic antibiotics and 0.3–3.0% with prophylactic antibiotics.[9] All our patients were given prophylactic antibiotic.

Patients with SSI present commonly with back pain and associated wound discharge. Discharge could be serosaguinous at the early stages but could become frank pus if not treated appropriately. In deep SSI, presentation may be only back pain without wound dehiscent. The accumulated

**Table 2: Univariate comparison of individual risk factors in patients with superficial or deep surgical site infection after spinal surgery**

| Preoperative characteristics | *n* with surgical site infection | | | | | |
|---|---|---|---|---|---|---|
| | Clinical infection | | Superficial | | Deep | |
| | *n* (rate) (%) | *P* | *n* (rate) (%) | *P* | *n* (rate) (%) | *P* |
| Co-morbidities | | | | | | |
| Diabetes | 3 (100.0) | **0.003** | 1 (33.3) | 0.140 | 2 (66.7) | **0.032** |
| Obesity | 1 (100.0) | 0.161 | 0 (0.0) | 1.000 | 1 (100) | 0.113 |
| Tuberculosis | 1 (100.0) | 0.161 | 0 (0.0) | 1.000 | 1 (100.0) | 0.113 |
| Anemia | 1 (100.0) | 0.161 | 0 (0.0) | 1.000 | 1 (100.0) | 0.113 |
| Etiology | | | | | | |
| Spine trauma | 5 (22.7) | 0.306 | 2 (9.1) | 0.285 | 3 (13.6) | 0.691 |
| Spine degenerative | 4 (19.1) | 0.722 | 0 (0.0) | 0.545 | 4 (19.1) | 0.214 |
| Spine tumor | 1 (9.1) | 0.674 | 1 (9.1) | 0.449 | 0 (0.0) | 0.335 |

Bold values indicate $P<0.05$

**Table 3: Univariate comparisons of intraoperative risk factors in patients with superficial or deep surgical site infection after spinal surgery**

| Intraoperative characteristics | *n* with surgical site infection | | | | | |
|---|---|---|---|---|---|---|
| | Clinical infection | | Superficial | | Deep | |
| | *n* (rate) (%) | *P* | *n* (rate) (%) | *P* | *n* (rate) (%) | *P* |
| Surgical location | | | | | | |
| Cervical | 7 (29.2) | **0.037** | 3 (12.5) | 0.054 | 3 (16.7) | 0.415 |
| Lumbar | 3 (15.0) | 1.000 | 0 (0.0) | 0.545 | 4 (15.0) | 0.671 |
| Procedure | | | | | | |
| Laminectomy | 2 (16.7) | 1.000 | 0 (0.0) | 1.000 | 2 (16.7) | 0.612 |
| Decompression and fixation | 1 (10.0) | 1.000 | 0 (0.0) | 1.000 | 1 (10.0) | 1.000 |
| Laminectomy and fixation | 6 (35.3) | **0.020** | 2 (0.0) | 0.180 | 4 (23.5) | 0.082 |
| Laminectomy and tumor excision | 1 (9.1) | 0.674 | 1 (9.1) | 0.449 | 0 (0.0) | 0.335 |
| Instrumentation | | 0.304 | | 1.000 | | 0.427 |
| Instrumented | 7 (21.9) | | 2 (6.3) | | 5 (15.6) | |
| Not instrumented | 3 (10.0) | | 1 (3.3) | | 2 (6.7) | |
| Length of surgery | | **0.038** | | 0.125 | | 0.184 |
| 0-4 | 5 (10.4) | | 1 (2.1) | | 4 (8.3) | |
| >4 | 5 (35.7) | | 2 (14.3) | | 3 (21.4) | |

Bold values indicate $P<0.05$

**Table 4: Univariate comparisons of postoperative risk factor and wound microscopy, culture, and sensitivity in patients with superficial or deep surgical site infection after spinal surgery**

| Postoperative characteristics | *n* with surgical site infection | | | | | |
|---|---|---|---|---|---|---|
| | Clinical infection | | Superficial | | Deep | |
| | *n* (rate) (%) | *P* | *n* (rate) (%) | *P* | *n* (rate) (%) | *P* |
| Wound inspection | | | | | | |
| Within 5 days | 8 (17.4) | 0.712 | 3 (6.52) | 0.555 | 5 (10.9) | 1.000 |
| At day 10 | 2 (11.8) | | 0 (0.0) | | 2 (11.8) | |
| Wound MCS | | | | | | |
| *Pseudomonas aeruginosa* | 4 (100.0) | **<0.001** | 0 (0.0) | 1.000 | 4 (100.0) | **<0.001** |
| *Staphylococcus* species | 6 (100.0) | **<0.001** | 3 (50.0) | **0.001** | 3 (50.0) | **0.016** |

Bold values indicate $P<0.05$. MCS=Microscopy, culture, and sensitivity

infected fluid or pus is usually responsible for the back pain from the pressure effect. It is, therefore, important for patients to be followed up for at least 3 months as in our study and for the surgeon to have a very high index of suspicion, especially in developing countries where appropriate diagnostic tools may be too expensive for routine use.

The diagnosis is essentially clinical with back pain, wound discharge, and fever being common to many cases of SSI. Inflammatory markers such as white blood cells count, ESR, and CRP value will help in confirming the infective process. The image of choice for deep SSI is magnetic resonance imaging but not all patient in resource-poor region will be able to afford this.[10]

A case specific breakdown of the SSI in this study showed that the incidence of SSI dropped by 30% if wounds were inspected on day 10-postoperation as compared to wound inspection with change of dressing on day 5. Christodoulou *et al*. had included the dressing changing condition as part of their protocols to reduce postoperative infection.[9] Many surgeons are unable to guarantee the sterile dressing changing process except the dressing done by the surgeon in the theater after closing the wound.

The National Institute for Health and Clinical Excellence guideline of 2008 recommends wound inspection on day 3–5. This led to development of a high impact intervention care bundle for postoperative wound care, which comprises three clinical actions to be implemented for best practice:[11]

1. Preoperative phase: Involving screening and decolonization, preoperative showering, hair removal
2. Intraoperative phase: Prophylactic antibiotics, normothermia, incise drapes, supplemented oxygen, glucose control
3. Postoperative phase: Surgical dressing, hand hygiene.

If all elements are performed every time and for every patient, the risk of infection will be reduced. The material and manpower to enforce this are not readily available in our center and possibly in other developing countries. We, therefore, advise the dressings to remain unchanged until the sutures are to be removed except dressing is soaked with blood or dirty to merit the wound exposure.

Various factors were associated with SSI in posterior spinal surgeries in this study, this including the duration of surgery (in hours), which was a significant risk factor for SSI ($P = 0.038$). This is consistent with other similar studies associating the surgery duration with the occurrence of SSI.[12] The increase duration of surgery for posterior spine surgery compared to anterior approaches involves the time for dissection and retraction of the posterior spinal musculature. The extent of muscle trauma and devascularization of the paraspinal muscles increases the potential for blood loss, and results in larger dead spaces, which also contribute to the risk of SSI. Other risk factors identified in a study done by Watanabe *et al*. are trauma and uncontrolled diabetes. It is therefore advised that diabetes should be well controlled before elective surgery and patients to be encouraged to lose weight if possible prior to spine surgeries. Copious irrigation of wound at the surgeries with the aim of reducing contamination is also helpful.[12,13]

The use of Philadelphia collar both pre and post has been suggested as reasons for high incidence of SSI in cervical spine surgery.[2] The use of postoperative cervical collar needs to be weighed against the possibility of increasing the chances of postoperative infection. If the cervical construct is stable, there is no need for the use of collar after the surgery, and it should be discouraged.

Olsen *et al*. also identified posterior approach, procedures for tumor resection, dural tear, and morbid obesity as risk factors for SSI after spinal surgery.[14] Surgery in the cervical region was associated with significant risk factor for SSI ($P = 0.037$), this may not be unconnected with increase skin flora as a result of inefficient skin bath and application of cervical collar both pre- and post-operation.

The organisms which most workers have implicated in SSI infections include *Staphylococcus* species and *Pseudomonas aeruginosa*.[15] This is true in over 50% of patients with SSI in this study.[16]

Instrumentation was associated with increased rate of infection as compared with the noninstrumented cases [Figure 2]. This study is in agreement with studies which have noted an increased rate of SSI with instrumentation.[8] Lumbar laminectomy with fixation procedure was particularly noted to be a significant risk factor in the occurrence of SSI ($P = 0.020$). Several reasons have been attributed to this that includes increase surgical time and operative complexity. This is quite appreciable because it takes a longer time to instrument compared to cases that were not instrumented. Therefore, longer operation time increases the chances of infection.

It is important for surgeons to take the factors associated with incidence of SSI into consideration while planning for surgery. Copious irrigation with normal saline during surgery, intraoperative, vancomycin powder use in instrumented spine and prolonged prophylactic antibiotics had been found useful in reducing incidence of SSI.[12,17] Infected instrumented spine surgery may not necessarily requires the removal of the implants but aggressive irrigation and debridement.[1]

Mortality of SSI ranges from 0% to about 1.4% though there was no mortality in this series.

## Conclusions

Practices to prevent SSI are to be done at multi levels; pre-, intra-, and post-operative phases of patient care to alter both the modifiable and nonmodifiable risk factors of SSI. Traditional risk factors for SSI such as obesity, uncontrolled diabetes mellitus, anemia, duration of surgery, location of surgery (cervical), and complexity of procedure are important in the prevention of infection. However, practices of early wound inspection, frequent wound dressing changes, and not keeping to nontouch technique for changing and removing dressings need to be subjected to further studies to substantiate their association with SSI. Adequate management of the risk factors will help to reduce surgical patients' morbidity, mortality, and length of stay, and save cost for the healthcare institutions. Perhaps with more spine surgeons in sub-Saharan Africa, we may get the SSI rate for the temperate region.


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## Conflicts of interest

There are no conflicts of interest.


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