Postoperative surgical site infection following acetabular fracture fixation

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Introduction

Postoperative surgical site infection (SSI) in orthopaedic trauma surgery is uncommon,4,5,8,9,19,21,25,28 however, if infection occurs, patient outcome is significantly affected with potentially devastating sequelae. SSI complications lead to an increased number of operations, poorer healing rates, and decreased functional and psychological outcomes. SSI also results in prolongation of the total hospital stay by a median of 2 weeks, doubling of re-hospitalisation rates, and an increase in health-care costs by more than 300%.5,27 A wide variety of risk factors for SSI after orthopaedic surgery have been reported. Patient-related risk factors for SSI in orthopaedic surgery include diabetes, obesity, smoking, older age, steroid-use, and other specific disease relevant to immunocompromised status.4,8,10,21,22,25 Surgery-related risk factors for SSI include extended preoperative hospitalisation, massive intraoperative blood loss, and prolonged operative time.28

Internal fixation of a displaced acetabular fracture is one of the more complex orthopaedic procedures. Operative treatment often requires extensive surgical exposure, long operative time, and high blood loss. These patients often sustain multiple other traumatic injuries and require prolonged intensive care unit (ICU) stay. Some authors have proposed acetabular fracture specific risk factors for infection including associated Morel-Lavallée lesions, associated pelvic ring fractures, urinary tract injuries, antegrade femoral nailing, and embolisation of pelvic arterial injuries.7,11,13,15,23,26

The purpose of this study was to assess the prevalence of patients with SSI who underwent acetabular fracture fixation, to delineate the clinical characteristics of the infection and its treatment, and to identify the risk factors for SSI.

Patients and methods

The study was approved by the institutional review board. We performed a retrospective review of trauma registries at a Level I Trauma Center. All consecutive patients who underwent fixation of acetabular fracture between January 2001 and December 2007 were identified. The definition of SSI was based on the Centers for Disease Control and Prevention/National Nosocomial Infections Surveillance system.14 This definition includes deep SSI with an onset within 1 year and superficial infection with an onset within 30 days after the operation. Patients who did not require surgical intervention of irrigation and debridement were excluded from
classified according to the criteria of Letournel and Judet. The pathogens, and its treatment were collected. The fractures were operative record. In patients with SSI, date of diagnosis, causative operative time, and estimated blood loss were retrieved from the operative record. Of these, 15 patients (17 fractures) were treated by antegrade nailing for femoral shaft fractures were also recorded. The treatment procedures of exploratory laparotomy and/or pelvic packing, embolisation of internal iliac arteries, were posterior approach by Kocher–Langenbeck in 157 patients, anterior approach including ilioinguinal, modified Stoppa, and anterior (not extended) iliofemoral approach described by Letournel and Judet in 113 patients, combined approach of both anterior and posterior in 55 patients, and extended iliofemoral approach in 1 patient. The mean ISS was 16.1 points. The mean amount of PRBCs transfused was 3.2 units. One hundred sixty one patients (49.4%) stayed in the ICU during the initial admission. The mean length of ICU stay of all the patients was 4.8 days. The mean operative time was 199.2 min and the mean estimated blood loss during operation was 783.9 ml. Diabetes mellitus was associated with 10 patients. No patients with known HIV disease, steroid-use, or malignancy were identified. Morel-Lavallée lesion was noted in 9 cases. All of the Morel-Lavallée lesions were debrided and irrigated copiously either before or at the time of fracture fixation. Embolisation of internal iliac arteries was performed in 9 cases.

Of the 326 patients who underwent open reduction and internal fixation of acetabular fractures, 17 (5.2%) developed SSI. Ten infections were defined as deep and seven were defined as superficial. Nine patients had polymicrobial infection and one patient had no positive culture regardless of apparent clinical signs of infection. Staphylococcus aureus was the most common causative pathogens in 9 patients, and was Methicillin-resistant in 3 patients. Enterococcus faecalis was found in 6 patients followed by Staphylococcus epidermidis in 3 patients, and Pseudomonas aeruginosa and Enterobacter cloacae in 2 patients respectively. Other organisms were identified in the remaining 4 patients (Table 3). The mean time from internal fixation to diagnosis of infection was 41.4 days; however most were diagnosed within the first 4 weeks (14 of 17 patients).

Bony union of acetabular fractures was obtained in all patients and infections were eventually controlled except one. A mean of 1.1 surgical procedures were necessary for the eradication of superficial infection (range, 1–2) and a mean of 3.3 surgical procedures for deep infection (range, 1–13). During this time, culture-specific antibiotic therapy was administered at least 1 week for superficial infection and 4 weeks for deep infection. No implant removal was required in the superficial infections, while 4 patients underwent removal in the deep infection group. Three patients had temporary use of antibiotic beads and two had vacuum assisted closure system. Significant heterotopic ossification (Brooker III and IV) was observed following deep infection in 3 cases. One patient presented with chronic osteomyelitis, underwent irrigation and debridement 13 times and resection of the femoral head, and ended up with a recalcitrant draining sinus.

The factors that were found to be associated with a significantly increased risk of SSI in the univariate analysis were increased ISS, prolonged ICU stays, larger amount of PRBCs transfused, prolonged...
operative time, larger amount of estimated blood loss during operation, increased BMI, associated urinary tract injury, Morel-Lavallée lesion, and performance of embolisation of internal iliac arteries and combined approach. There were no differences in the risk of SSI between presence of pre-existing diabetes, active smoker, age, fracture types, or time to fixation (Tables 1 and 2).

Multivariate analysis using these 10 parameters showed that BMI, ICU stay, and Morel-Lavallée lesion were independently significant risk factors for SSI following open reduction and internal fixation of acetabular fractures (Table 4). The odds ratio analysis revealed that the risk of infection was 1.1 times for each increase in BMI of 1 kg/m², 1.1 times for each increase of ICU stay of 1 day, and 8.4 times for the presence of a Morel-Lavallée lesion.

Discussion

In our study, the overall prevalence of SSI was 5.2%, which was comparable to the previous studies where the infection rates of acetabular fracture fixation have been reported to be 3.5–5.0. In univariate analysis, we identified that patients who developed SSI were more severely injured in terms of ISS and ICU stays. The operation was longer and estimated blood loss was larger in the SSI group. Performance of combined approach and embolisation of pelvic arteries were more commonly seen in the SSI group. These factors may serve as markers of increased risk of SSI. Furthermore, in multivariate analysis, we found that ICU stay, BMI, and Morel-Lavallée lesion were independent risk factors for SSI.

In our study population, half of patients with acetabular fractures required ICU care. The ICU is an environment in which patients with implanted metal devices are at high risk of nosocomial infection because of injury severity and the frequent exposure to therapeutic procedures. Patients hospitalised in the ICU present with multi-system derangements that place them into an even more pronounced catabolic and immunocompromised state leading to decreased infection resistance. Thus, patients requiring an ICU stay have been considered to have an increased risk for SSI.

Several authors have reported an increased risk of perioperative complications following acetabular fracture fixation in obese patients. Russell et al. reported that four of five obese patients

<table>
<thead>
<tr>
<th>Pathogens</th>
<th>Number of infections</th>
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<tbody>
<tr>
<td>Staphylococcus aureus</td>
<td>9</td>
</tr>
<tr>
<td>Enterococcus faecalis</td>
<td>6</td>
</tr>
<tr>
<td>Staphylococcus epidermidis</td>
<td>3</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>2</td>
</tr>
<tr>
<td>Enterobacter cloacae</td>
<td>2</td>
</tr>
<tr>
<td>Others</td>
<td>4</td>
</tr>
</tbody>
</table>

Values are total number (percentage). SSI: surgical site infection.

p < 0.05 denotes significance.
developed SSI. Karunakar et al. reported that BMI had a statistically significant relation with the prevalence of wound infection. Porter et al. showed that morbidly obese patients with BMI ≥ 40 were more likely to develop wound complications including infection, drainage, and dehiscence. The acetabulum is located deep within the pelvis and theoretically obese patients require larger incisions, more extensive exposure, and prolonged operative time, which may increase the risk of SSI. This information should be explained to obese patients when decision to perform an open reduction and internal fixation is made.

A Morel-Lavallée lesion is a closed internal degloving injury which results from a shear injury of the soft tissues surrounding the pelvis. This lesion is often overlooked and undertreated, permitting bacterial colonisation and subsequent infection of the surrounding soft tissues. The Morel-Lavallée lesion was reported to be a potential risk for SSI in case series studies. However, our study showed statistically for the first time that its relative risk was significantly high and more than 8 times the risk of cases with no Morel-Lavallée lesion. Careful evaluation and thorough debridement of the closed cavity either via open or percutaneous techniques are required to reduce infection risk. If possible, avoidance of direct incision through the Morel-Lavallée lesion and/or percutaneous fixation may be beneficial due to the higher probability of infection.

There are several limitations in our study. One of the major weaknesses is its relatively small sample size. Therefore, there is the possibility of a type II error with some true differences not being detected. The small sample size also restricts the ability to adequately perform multivariate analyses to identify independent risk factors for infection. Especially, there may be a relationship between the type of acetabular fractures and SSI, but the small number of certain types of acetabular fractures in our study did not permit us to identify a significant difference. We think it is remarkable that the infection rate was higher in T-shaped (4 of 35, 11.4%) compared to posterior wall (1 of 78, 1.3%). Next, this is a retrospective study and the quality of the data depends on the accuracy and completeness of the medical records. Finally, numerous factors other than those studied here may influence the development of SSI such as presence of urinary tract infection, malnutrition, nasal carriage of causative organisms, admission from health-care facilities, and perioperative hyperglycemia. Many of these factors have been analysed, and a full analysis of these was beyond the scope of this article due to insufficient numbers of subsets of patients or lack of full records to draw a conclusion.

In conclusion, we have identified that BMI, ICU stay, and Morel-Lavallée lesion were independent risk factors for SSI following internal fixation of acetabular fractures. Consideration of these factors may increase suspicion for SSI and lead to alternative methods of treatment. Further study with larger numbers should be performed to justify this study and identify methods for reducing the prevalence of SSI following open reduction and internal fixation of acetabular fractures.

Conflict of interest

All authors confirm that they have no financial and personal relationships with other people, or organisations, that could inappropriately influence (bias) this work.

References