



# Surgical Site Infection Following Fixation of Acetabular Fractures

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**Purpose:** Acetabular fractures are mainly caused by high energy trauma. Surgical fixation of these fractures requires extensive surgical exposure which increases the length of operation and blood loss as well. This may increase the risk of surgical site infection. Our aim is to evaluate the prevalence of surgical site infections and the risk factors associated with it so as to minimize its chances.

**Materials and Methods:** A total of 261 patients who underwent acetabular fracture surgery were retrospectively reviewed. Patients were divided into 2 groups, with or without surgical site infection. Factors examined include patients' gender, age, body mass index (BMI), time between injury and surgery, operative time, estimated blood loss, number of packed red blood cell transfused, length of total intensive care unit (ICU) stay, fracture type, surgical approach, smoking status, patients' comorbidities and associated injuries.

**Results:** Fourteen patients (5.4%) developed surgical site infection. Out of 14 infections, 4 were superficial and 10 were deep. The factors that were found to be associated with surgical site infection following acetabular fracture fixation were prolonged operation time, increased BMI, prolonged ICU stay, larger amount of packed red blood cell transfused and associated genitourinary and abdominal trauma.

**Conclusion:** In our study, we conclude that measures should be undertaken to attenuate the chances of surgical site infection in this major surgery by considering the risk factors significantly associated with it.

**Key Words:** Acetabular fractures, Surgical site infection, Risk factors

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## INTRODUCTION

Acetabular fracture, mainly caused by high velocity trauma, is becoming a commoner injury due to rise in the incidence of road traffic accidents<sup>1</sup>. Although postoperative surgical site infection (SSI) is uncommon in orthopedic surgery but if infection occurs it may cause devastating complications and may affect the functional outcome of the surgery<sup>2</sup>. SSI itself prolongs the patient's hospital stay and increase in health care cost which increases financial burden on the patient<sup>3</sup>. Acetabular fractures are complex and challenging injuries. These injuries require trained and expert orthopedic surgeons for management. Open reduction and internal fixation of acetabular fractures involves extensive surgical exposure which increases the length of operation and blood loss as well. As these fractures are mainly caused by high

energy trauma and patients also sustain other associated injuries, therefore these patients may require prolonged intensive care unit (ICU) stay. With the prevalence of high energy trauma cases in our society, acetabular fracture surgeries are becoming more common in our trauma centres. There is a need to evaluate the prevalence of infection of these cases and the risk factors associated with it so to minimize the chances of SSI.

In our study, we analyzed the relationship of SSI after acetabular fracture fixation with certain possible risk factors: body mass index (BMI), operative time, estimated blood loss (EBL) and blood transfusions, ICU stay, smoking status, associated injuries and comorbidities such as diabetes mellitus, hypertension and others.

## MATERIALS AND METHODS

This was a retrospective study conducted at Department of Orthopaedic Surgery, Liaquat National Hospital and Medical College Karachi, Pakistan. The study was approved by the hospital ethical review committee (IRB approval no. 0121-2017). Patients enrolled for the study were those who were operated for acetabular fractures between January 1, 2010 and December 31, 2014. Data was taken from trauma registry. Factors examined include patients' gender, age, BMI, time between injury and surgery, operative time, EBL, number of packed red blood cell (PRBC) transfused, length of total ICU stay, fracture type, surgical approach, patients' comorbidities (diabetes mellitus, hypertension, ischemic heart disease, chronic obstructive pulmonary disease, and cirrhosis), smoking status and associated injuries. The risk factors which were found to be significantly associated with SSI as per significant  $P$ -value ( $<0.05$ ) were analyzed through logistic regression using multivariate analysis to identify the factors independently associated with infection. Open fractures were not included in the study. Fracture patterns were classified according to Letourne<sup>4</sup>.

All surgeries were performed by a single surgeon who had 15 years' experience in pelvis and acetabulum surgeries. Operative fixation was performed in all 261 patients using reconstruction plates. Prophylactic antibiotics were given 30 minutes before the start of the procedure. We used chlorhexidine solution for skin sterilization and disposable surgical gowns in both groups. Conditions of operating room were similar in both groups with laminar flow system in all cases. The 1st generation cephalosporin (cefazolin) at a dose of 3 mg/kg was used for prophylaxis. Prophylactic antibiotics were discontinued within 24 hours of the end of

surgery. After discharge, patients were followed at regular intervals in outpatient department at 2 weeks, 6 weeks, 3 months, 6 months and 12 months for wound assessment and bony union. Eleven patients were lost to follow up.

The definition of SSI was based on the Centres for Disease Control and Prevention/National Nosocomial Infections Surveillance system<sup>5</sup>. We considered infection as superficial when infection occurred just in the area of skin where the incision was made and deep when it occurred beneath the incision area in muscles and the tissues surrounding the muscles. In patients with SSI, causative organism, date of diagnosis and its treatment were retrieved from the registry.

The data was analyzed statistically using IBM SPSS Statistics version 20.0 (IBM Co., Armonk, NY, USA). Categorical variables were compared through chi-square test and Fisher exact test and continuous variables were compared using Mann-Whitney test. Multivariable analysis was done to identify the factors independently associated with infection. The level of significance was set at  $P$ -value less than 0.05.

## RESULTS

Out of 250 patients, 147 were males and 103 were females with a mean age of 45.4 years. Patient demographics are shown in Tables 1 and 2. The mean BMI was 28.6 kg/m<sup>2</sup>; the mean time between injury and surgery, 4.7 days; the average operative time, 157.3 minutes; the mean EBL during surgery, 637.2 mL; the mean PRBC transfused, 2.8 units; the average length of stay in ICU, 4.1 days. The most frequent fracture type was posterior wall in 70 patients followed by both column fractures in 54 patients. All surgeries were performed in a single stage using various approaches and decision of approach was mainly based upon fracture pattern and surgeon preference as well. Kocher-Langenbeck approach was the most common surgical approach ( $n=170$ ), followed by ilioinguinal ( $n=45$ ) and tri-radiate ( $n=35$ ). Sixty-three patients were smoker and 18 patients were also associated with diabetes. Most common associated injury was extremities ( $n=22$ ) followed by genitourinary ( $n=18$ ), head and neck ( $n=15$ ), pelvic ring ( $n=14$ ), abdomen ( $n=9$ ), and chest ( $n=7$ ).

Out of 250 patients who underwent open reduction and internal fixation of acetabular fractures using reconstruction plates, 14 (5.6%) developed SSI. Out of 14 SSIs, 4 were superficial and 10 were deep. *Staphylococcus aureus* was the most common causative organism in 7 patients and was methicillin resistant in 2 patients. *Staphylococcus epidermidis*

**Table 1.** Descriptive Statistics of Quantitative Variables

Parameter	Total (n=250)	SSI (n=14)	Non-SSI (n=236)	P-value
Age (yr)	45.4±21.6	45.2±20.8	45.5±19.2	0.065
Body mass index (kg/m <sup>2</sup> )	28.6±6.9	32.4±8.7	27.9±6.7	0.004*
Time between injury and surgery	4.7±2.3	4.9±2.5	4.4±2.2	0.126
Operative time	157.3±48.8	192.7±72.3	149.4±47.5	0.024*
Estimated blood loss	637.2±200.8	1,255.9±823.7	598.7±255.6	0.001*
PRBC transfused	2.8±3.6	5.4±2.9	2.5±3.1	0.002*
ICU stay	4.1±7.8	11.4±9.1	4.9±7.6	0.006*

Values are presented as mean ± standard deviation.

SSI: surgical site infection, ICU: intensive care unit, PRBC: packed red blood cell.

\* P-value<0.05 considered significant.

**Table 2.** Descriptive Statistics of Qualitative Variables

Parameter	Total (n=250)	SSI (n=14)	Non-SSI (n=236)	P-value
Gender				
Male	147	8 (57.1)	139 (58.9)	0.233
Female	103	6 (42.9)	97 (41.1)	0.217
Surgical approach				
Kocher-lengenbeck	170	5 (35.7)	105 (44.5)	0.067
Ilio-inguinal	45	3 (21.4)	42 (17.8)	0.155
Tri-radiate	35	6 (42.9)	89 (37.7)	0.097
Fracture type				
Simple				
Anterior wall	8	0 (0)	8 (3.4)	0.151
Posterior wall	70	4 (28.6)	57 (24.2)	0.097
Posterior column	32	1 (7.1)	25 (10.6)	0.072
transverse	20	1 (7.1)	19 (8.1)	0.264
Anterior column	18	1 (7.1)	17 (7.2)	0.564
Associated				
Posterior column+wall	23	3 (21.4)	35 (14.8)	0.068
Transverse+ posterior wall	7	0 (0)	7 (3)	0.182
T-type	13	1 (7.1)	12 (5.1)	0.094
Anterior column+posterior hemi-transverse	5	0 (0)	5 (2.1)	0.091
Both column	54	3 (21.4)	51 (21.6)	0.542
Smokers	63	2 (14.3)	61 (25.8)	0.314
Diabetes mellitus	18	3 (21.4)	15 (6.4)	0.299
Hypertension	12	1 (7.1)	11 (4.7)	0.877
Ischemic heart disease	4	0 (0)	4 (1.7)	0.854
COPD	13	1 (7.1)	12 (5.1)	0.998
Cirrhosis	5	0 (0)	5 (2.1)	0.511
Associated injury				
None	165	6 (42.9)	159 (67.4)	
Extremities	22	2 (14.3)	20 (8.5)	0.311
Head and neck	15	0 (0)	15 (6.4)	0.441
Genitourinary	18	4 (28.6)	14 (5.9)	0.009*
Chest	7	0 (0)	7 (3.0)	0.339
Abdomen	9	1 (7.1)	8 (3.4)	0.041*
Pelvic ring	14	1 (7.1)	13 (5.5)	0.078

Values are presented as number only or number (%).

SSI: surgical site infection, COPD: chronic obstructive pulmonary disease.

\* P-value<0.05 considered significant.

was found in 3 patients followed by pseudomonas in 2 patients as shown in Table 3. Deep tissue cultures were taken in patients suffering from deep infection while swabs were taken for superficial infection. All deep cultures were positive while in 2 cases of superficial infection, swabs showed no growth. There was a chance of contamination while taking cultures in superficial infection; therefore, antibiotics were started on clinical basis in two cases in which cultures were negative (erythema, redness, and induration at the surgical site). The mean time from surgery to diagnosis of infection was 39.4 days.

All the patients were followed at least till 12 months. Complete bony union was achieved in all patients who underwent open reduction and internal fixation till 6 months. Infections were controlled in all patients. Superficial infections were treated by removal of sutures with drainage of pus, debridement and open wound care by daily dressings followed by delayed primary or secondary suturing of the wound. Culture specific antibiotics were given for one week in case of superficial infections and 6 weeks in case of deep infections. Antibiotic beads were placed temporarily in 10 cases where the infection was deep. Antibiotic beads were removed at 6 weeks when there were no signs of infection and inflammatory markers were also within normal limits. After 6 weeks, antibiotics were stopped. Implant was not removed in superficial infections but was removed in all deep infections after 6 months once

**Table 3.** Frequency of Infective Organism

Pathogen	Frequency
MSSA	5
MRSA	2
<i>Staphylococcus epidermidis</i>	3
<i>Pseudomonas aeruginosa</i>	2

MSSA: methicillin-sensitive *Staphylococcus aureus*,  
MRSA: methicillin-resistant *S. aureus*.

**Table 4.** Multivariable Analysis

Variable	Odds ratio	95% CI	P-value
Body mass index	14.211	0.911-1.324	0.003*
Operative time	9.451	1.121-1.564	0.008*
Estimated blood loss	1.288	1.288-1.772	0.068
PRBC transfused	2.157	1.112-1.554	0.034*
ICU stay	18.238	0.875-1.217	0.002*
Genitourinary trauma	4.249	1.087-1.442	0.014*
Abdominal injury	19.237	0.833-1.317	0.002*

\* P-value<0.05 considered significant.

CI: confidence interval, PRBC: packed red blood cells, ICU: intensive care unit.

complete union occurs.

The factors that were found to be associated with SSI following acetabular fracture fixation were prolonged operation time, increased BMI, prolonged ICU stay, larger amount of PRBC transfused, large amount of EBL, and associated genitourinary and abdominal trauma as shown in Tables 1 and 2. These factors were then evaluated through multivariable logistic regression analysis. Multivariate analysis showed that BMI, operative time, blood transfusion, ICU stay, associated abdominal injury and genitourinary trauma were independent risk factors as shown in Table 4.

## DISCUSSION

In our study, the prevalence of SSI following fixation of acetabular fractures is 5.6% which is comparable to other studies<sup>6</sup>. Suzuki et al.<sup>7</sup> reported the SSI rate of 5.2% after acetabulum fracture surgery, both superficial and deep. Mayo<sup>8</sup> founded the infection rate after acetabular fracture fixation of 4%.

The limitation of this study is that it was a single centre retrospective study, hence true prevalence of SSI following surgical management of acetabular fractures in our country was not evaluated because there are large differences in ICU care setting and regional policies for infectious disease management among different hospitals in our country.

We found many factors associated with SSI after acetabular fracture surgery such as the prolonged operative time<sup>9</sup>, high BMI<sup>10</sup>, prolonged ICU stay<sup>11</sup>, high rate of PRBC<sup>12</sup>, and associated abdominal and genitourinary trauma<sup>13</sup>.

Many authors have found that obesity is one of the important risk factor for SSI. In our study, we found that there was an increased incidence of SSI in patients with obesity. Falagas and Kompoti<sup>14</sup> in his study concluded that obese patients are more prone to develop SSI than non-obese individuals. Numerous studies have investigated the

relationship between infection and obesity<sup>15</sup>). Obesity will increase the local tissue trauma related to retraction, lengthen operation time and disturbance of body homeostatic balance<sup>16</sup>. Olsen et al.<sup>17</sup> reported in his study that morbidly obese patients are more prone to develop wound complications.

In agreement with previous studies<sup>18</sup>, length of operation of more than 3 hours is a risk factor for SSI. Our study also showed that patients who required more than 3 hours of surgery had high risk of SSI. Increasing the length of procedure increases the susceptibility of wound infection by increasing bacterial exposure and extent of tissue trauma<sup>10</sup>.

Transfusion of PRBC was also larger in SSI group in our study. Previous studies also indicated that blood transfusion is considered to be a significant risk factor for infection<sup>19</sup>. There are multiple mechanisms responsible for SSI while receiving blood products<sup>20</sup>.

Although previous studies found that diabetes mellitus is an independent risk factor for infection<sup>2</sup>, diabetes mellitus was not demonstrated statistically significant in our study. Out of 250 patients, 18 patients were diabetic but it was well well-controlled prior to surgery,

Patients with prolonged stay in ICU are at high risk of nosocomial infection because of frequent exposure of invasive procedures in ICU setting<sup>11</sup>. Prolonged ICU stay itself increases the financial burden to the patient<sup>21</sup>. Deep SSI tends to raise cost more than superficial surgical site group<sup>22</sup>. The most common organism found in our study was *S. aureus* which was consistent with prior findings<sup>5</sup> followed by *S. epidermidis*. There is an increasing trend of gram-positive organisms rather than gram-negative causative organisms in the recent years<sup>23,24</sup>. This will vary across countries due to different antibiotic protocols, resistance pattern and infection control practice. Some studies report that more than half of the nosocomial infections are due to gram negative bacteria<sup>25</sup>. Thus patients with prolonged stay in ICU are more prone to develop SSI.

Smoking was not demonstrated statistically significant in our study. Although previous studies shows that cigarette smoking delays wound healing<sup>26</sup>, in our study cigarette smoking is not statistically significant as a risk factor of SSI due to our failure of not obtaining the duration of smoking (the number of packs per day the patient used and the length of time since patients had quit smoking) in our patients while taking history.

In our study associated injury such as abdominal injury (splenic injury) and genitourinary trauma (bladder injury) also had positive influence on SSI. Li et al.<sup>13</sup> reported in his study that abdominal trauma and urinary tract trauma are

commonly associated with SSI following acetabular fracture fixation. Hence, special attention must be made while treating associated injuries to reduce the incidence of SSI.

## CONCLUSION

In our study, we conclude that the length of operation, BMI, prolonged ICU stay and increased blood transfusions are the risk factors associated with SSI following acetabular fractures fixation. So, special attention must be paid to control the modifiable risk factors like unnecessary prolonged ICU stay, duration of surgery, and unnecessary blood transfusions while managing acetabular fractures to reduce the incidence of infection.

## CONFLICT OF INTEREST

The authors declare that there is no potential conflict of interest relevant to this article.

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