The Incidence, Etiological Profile And Treatment of Surgical Site Infections In Patients of Gunshot Injuries And Bomb Blast Injuries In Pakistan

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Abstract

Purpose: There are few reports on surgical site infections (SSI) following blast injuries. Those occurring in developing nations are a particular source of interest given the recent war in the Middle East. The purpose of this study was to report the incidence, etiological causative agents and treatment of SSI in patients of gunshot and blast injuries.

Methods: A prospective study was performed between January 2008 and December 2008. One thousand, four hundred and sixteen (1416) patients of gunshot injuries and bomb blast injuries were identified. Three hundred and eighty-two patients (27%) were loss to follow-up. Data was collected from bacteriology reports of all surgical site samples and presentation of patients at follow-up.

Results: One hundred and forty-seven (14.2%) patients developed SSI. Culture reports were positive in one hundred and twenty-four (84.4%) patients. Only one etiological agent was isolated in 146 (99.3%) patients. The most common pathogen was Staphylococcus aureus (44.3%), followed by Escherichia coli (25.7%) and Pseudomonas aeruginosa (16.9%). Methicillin resistant staph aureus (MRSA) was found in 2.7%. The most prescribed antibiotic was Ceftriaxone. One hundred and thirty-five (91.8%) patients were cured only with the use of antibiotics. There was a statistically significant increase in infection by BBI compared with SSI (p-value: <0.0001) while no significant correlation was present between SSI and type of fracture, extremity involvement, gender or surgical procedure.

Conclusion: The incidence of surgical site infection is high in gunshot injuries and bomb blast injuries. Staphylococcus aureus was found to be the most common etiological agent, whereas MRSA comprised a very low percentage of infections. Polymicrobial infections were rare. Initial thorough debridement and antibiotics are the mainstay of treatment.

Study Level: Prospective cohort (Level II)

Key Words:Surgical site infection (SSI), gunshot injury, blast injury, wound culture
INTRODUCTION:

The aim of this study is to document the incidence, etiological agent and the treatment of surgical site infection in patients sustaining injuries by gunshot and in bomb blasts in Pakistan in 2008. There are several studies documenting the incidence and pathogens in all surgeries, but there are very limited studies documenting these parameters in gunshot and bomb blast injuries, particularly in this region of the world. The authors hypothesized that there would be a low incidence of MRSA in this patient population, but Methicillin-sensitive staph aureus would be the most common pathogen encountered.

MATERIAL AND METHODS:

A prospective study was performed in all patients of gunshot injuries and bomb blast injuries who were admitted to a single hospital from 1st January 2008 to 31st December 2008.

All patients who sustained injuries with either a gunshot or in a bomb blast, aged above 15 years from both genders were included in this study.

All patients with trauma due to other causes, e.g. road traffic accident, history of fall, crush injuries, industrial injuries, younger than 15 years, patients who were taking antibiotics prior to trauma and those who were lost to follow-up were excluded from this study.

A total of 1416 patients were included in the study. Three hundred and eighty two patients (27%) were lost to follow-up. Out of one thousand and thirty-four patients, 793 patients were injured due to gunshots and 241 patients by bomb blast. Male patients predominated with 80.2% (830). All patients were admitted through Emergency and Accident Department. On admission, thorough history and examination were performed.

Surgical site infection was defined to occur within 30 days of surgery with atleast one of two main conditions was met (i.e. purulent discharge from superficial infection and/or organisms
isolated from aseptically obtained wound cultures). In addition to above, atleast one of clinical signs should also be present, like pain/tenderness, localized swelling, redness/heat, etc.

Surgical site infections were identified by bedside surveillance and post-discharge follow-up. Wound cultures/aspirates were taken from suspected patients. Patients were examined on their first follow-up visit for any infection that took place after discharge from hospital. Antibiotics were given to all patients as per the following regimen.

Thorough debridement was done on admission for all patients. They were given 1g ceftriaxone, IV, OD since day of their admission in the ward. Perioperatively, 1g cefazolin, IV, 30 minutes before the incision and the dose was repeated if a case lasted for more than one-hour. Post-operative antibiotics were specifically tailored as per patients needs’, culture sensitivity results but mostly included IV ceftriaxone, oral 2\textsuperscript{nd} generation flouroquinolones or IV aminoglycosides (mostly amikacin).

In all patients suspected of SSI, pus was collected steriley and was properly preserved, labeled and sent to our hospitals’ pathology department for analysis.

The data was recorded on Microsoft Excel Worksheet. Data was analyzed using Statistical Package for Social Sciences 14.0 (SPSS, Inc., Chicago, IL, USA). \textit{Chi-square Test} was applied to test the association. Results were recorded as frequencies, means, p-values. A p-value of <0.05 was considered statistically.

\textbf{RESULTS:}

There were a total of one thousand and thirty-four patients, in which 793 patients were injured due to gunshots and 241 patients’ sustained injuries in bomb blast. There were 830 male patients (80.2\%) and 204 female patients (19.8\%). Table I shows the various treatment options which were performed during the study.
Surgical site infection occurred in 147 patients (14.2%). Wound cultures were taken from all patients. Positive results for presence of a microbial pathogen were obtained in one hundred and twenty-four (84.35%) patients. A single pathogen was isolated in 123 (99.1%) patients, more than one pathogen was isolated in only one patient. Wound cultures obtained from 23 patients (15.65%) reported a negative result for presence of a microbial pathogen.

One hundred and eighteen male patients (118/830) developed surgical site infection while 29 female patients developed infection (14%). The pathogens noted are described in Table 1. Table 2 describes the procedures associated with each pathogen. Tibia fractures were the most common injury and had the highest prevalence of infection. *Staphylococcus aureus* was the most common pathogen in tibia fractures. *Pseudomonas aeruginosa* was the most common pathogen noted in femur fractures. Table II shows the list of pathogens and sites of infection.

There was no statistically significant difference between the incidence of surgical site infection in male and female patients (p-value > 0.05). Surgical site infection developed in 84 patients (10.6%) out of 793 patients sustaining gun-shot injuries and infection developed in 63 patients (26.1%) out of 241 patients sustaining bomb-blast injuries. A statistically significant difference was present in incidence of surgical site infection in patients sustaining gunshot injuries and bomb blast injuries, higher in the latter (p-value < 0.0001). There was no statistically significant correlation between the SSI and severity of injury, type of fracture, extremity involvement and surgical procedure.

Antibiotics were used for all patients, most frequently used was *Ceftriaxone*, and followed by *Ofloxacin* and *Amikacin*. The most prescribed combination was of *Ceftriaxone* and *Ofloxacin*. One hundred and thirty-five (91.8%) patients were cured only with antibiotics while twelve (8.2%) required further surgical intervention. In these 12 patients, infected implant was removed in 6 (50%) patients, wounds were debrided and cleaned in 4 (33.3%) patients and sequestrum was removed in 2 (16.7) patients.

**DISCUSSION:**
Surgical site infection rates were found to be high in the current study. The rate was higher in BBI compared with GSW. It was observed in the study that wound samples of 23 patients (15.6%) yielded negative results. This negative finding can be due to several reasons and can be attributed to, improper sampling technique, improper site selection, improper laboratory techniques or presence of certain microorganisms, which require special media to grow or may have longer doubling-time. Etiological agents of surgical site infection were documented in 124 patients (84.4%). It was observed that, SSI’s were mostly caused by Gram-positive bacteria. Several studies also concluded that the major causative agent was a Gram-positive bacterium. Thanni et al. reported in their series of SSIs the major pathogen was a Gram-negative rod, however in orthopaedics patients, Gram-positive cocci were the major pathogen. In the current study, the major causative agent was *Staphylococcus aureus*, as seen in other studies. Few studies have reported infections in combat injuries and found *Acinetobacter baumanii* to be the most common pathogen isolated. These studies have reported SSI rates of 26-77%. Our hospital laboratory did not have facilities to detect this organism at the time of study and it could be a major reason for not isolating this organism as causative agent. Murray et al in their study on infection in combat injuries in Iraq reported *Staphylococcus aureus* as the major causative agent and SSI rate of 49%. Bajec et al reported an overall infection rate of 6.6% following blast injuries in Kuwait after the Gulf War. These patients all required additional surgical site would treatment and coverage as well as antibiotic treatment.

In this study, it was observed that infection rate due to bomb blast injuries was higher in comparison with GSW (26% vs 10%). The exact reason is unknown. One explanation is that generally the GSW are relatively clean compared with BBI. The shrapnel’s, ball bearings and other hardware which constitute a bomb (or suicide jacket) are mostly rusted and have higher propensity to cause infection. In addition, BBI’s are more severe injuries with multiple organ involvement and have higher rates of infection. It was also observed that tibial fractures had higher gram positive infection compared with femur fractures (high gram negative infection). Tibia has minimal soft-tissue cover, therefore it is more likely to be infected by skin pathogens (*S. aureus*). The femur has a more extensive soft tissue cover, and is thus less likely to be infected with skin pathogens and was observed in our study that it was infected more with gram negative rods.
It was observed in this study that four (3.2%) patients were infected with *Methicillin-resistant-Staphylococcus aureus* (MRSA). MRSA is emerging as a major clinical problem especially in developed countries\(^6,^7\). There are very few studies which have investigated the prevalence of MRSA in hospitals in Pakistan. A recent study from the same hospital reported MRSA rates of 30%, but this study was limited by significant selection bias as it was a laboratory based study and only included cases which were reported to the lab, and did not include all patients admitted to hospital\(^8\). A common practice followed is that once a patient is diagnosed with MRSA, he is discharged immediately on antibiotics; as there are no proper isolation facilities in majority of hospitals to prevent nosocomial infection to other patients. Nixon et al. concluded from his study that there was an increase of 2.6% MRSA carriers per week of inpatient stay\(^9\). The low incidence of MRSA in our patient population may have been impacted by the shorter hospital stay of the patients in this study, or could be explained by the low prevalence of MRSA carriers in the hospital population.

In the current study, thirty-four (23.13%) patients were noted to present with SSI after discharge from hospital. Patients presented with surgical site infection on their follow-up visits. Delayed development of SSI after discharge has been reported in other studies and may be due to co-morbid factors already described. One study noted an incidence rate of upto 66% of presentation with SSI on follow-up after being discharged without any signs of infection\(^10\).

All patients had initial debridement and then treated with antibiotics. These were initially prescribed for a minimum of one month and later extended in case of SSI. The most commonly used antibiotics for all surgical site infections, including caused by all Gram-negative rods and *Methicillin-Sensitive-Staphylococcus aureus* included cefazolin (1\(^{st}\) generation cephalosportin), ceftriaxone (3\(^{rd}\) generation cephalosporins), ofloxacin (2\(^{nd}\) generation flouroquinolones), amikacin (aminoglycoside), fusidic acid, vancomycin and linezolid. The antibiotics were mostly prescribed in combinations depending on the patients’ compliance, antibiotic availability in hospital, culture sensitivity report, affordability, drug allergies and contraindication (if any). Patient compliance was better with oral antibiotics compared with intravenous due to lack of health providers in home settings. While the hospital has adequate supply of antibiotics which
are provided free of cost to patients, availability of patient sensitive antibiotics may vary. Patients with co-morbid conditions and/or multiple injuries were evaluated for renal and hepatic function before starting with nephrotoxic or hepatotoxic drugs.

The most common combination therapy was ceftriaxone & ofloxacin (in 86 patients (58.5%)) followed by ceftriaxone & amikacin [in 44 patients (29.9%)]. The latter combination was prescribed in patients with persistent infection with gram negative organisms but the former had better patient compliance. The combination of a cephalosporin with an aminoglycoside had a better coverage against gram-negative bacteria, including Pseudomonas aeruginosa, Enterobacter spp., Klebsiella spp. and Escherichia coli. This synergistic action can be attributed to enhancement of antimicrobial uptake in susceptible bacteria when both drugs are given concomitantly11.

In order to treat, MRSA strains of Staphylococcus aureus, fusidic acid was used in two (50%) patients, vancomycin in one (25%) patient and linezolid in 1 (25%) patient. The choice of antibiotic was mostly dependent upon patient’s affordability. Vancomycin is considered to be the drug of first choice for treating MRSA12. In the authors institution the patient has to bear the cost of medicines by themselves. The hospital has supply of common antibiotics, but has limited or no supply of linezolid, vancomycin and other uncommonly used antibiotics. Vancomycin was not freely prescribed because of its high cost and its intravenous route of administration. Linezolid has similar price but it has advantage of oral intake and can be used in home. Fusidic acid is cheap compared to both and works well in our patient population.

There were several limitations in this study. The co-morbid conditions of the patients were not taken into consideration. There was a large percentage of patients lost to follow-up, and patients all underwent external fixation for initial management. Additionally, no long-term follow-up was performed for these patients. Whether the results of this study can be extrapolated to other populations is unknown. However, based on the findings of this study, the incidence of SSI is high in patients with gun-shot and blast injuries and can be adequately treated with thorough debridement and antibiotics in this patient population.
CONCLUSION

The incidence of surgical site infection is high in patients of gunshot injuries and bomb blast injuries, significantly higher in bomb blast injuries. Staphylococcus aureus was found to be the most common pathogen. Initial thorough debridement and antibiotics are the mainstay of treatment.
REFERENCES:


### Table I: Surgical Procedures

<table>
<thead>
<tr>
<th>Surgical Procedure</th>
<th>Number of Infections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex-Fix Tibia</td>
<td>68</td>
</tr>
<tr>
<td>Ex-Fix Femur</td>
<td>29</td>
</tr>
<tr>
<td>Ex-Fix Humerus</td>
<td>16</td>
</tr>
<tr>
<td>Conservative</td>
<td>15</td>
</tr>
<tr>
<td>Ex-Fix Forearm</td>
<td>10</td>
</tr>
<tr>
<td>Ex-Fix Pelvis</td>
<td>9</td>
</tr>
</tbody>
</table>

### Table II: Summary of pathogens and sites of infection

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Ex-fix Tibia</th>
<th>Ex-Fix Femur</th>
<th>Ex-Fix Humerus</th>
<th>Ex-Fix Forearm</th>
<th>Ex-Fix Pelvis</th>
<th>Conservative</th>
<th>Total</th>
<th>Percentage of total infections</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>43</td>
<td>8</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>55</td>
<td>44.35%</td>
</tr>
<tr>
<td><em>Escherichia coli</em></td>
<td>7</td>
<td>7</td>
<td>9</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>32</td>
<td>25.80%</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td>2</td>
<td>9</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>6</td>
<td>21</td>
<td>16.93%</td>
</tr>
<tr>
<td><em>Proteus vulgaris</em></td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>6</td>
<td>4.83%</td>
</tr>
<tr>
<td><em>Klebsiella spp.</em></td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>3.22%</td>
</tr>
<tr>
<td>MRSA</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>3.22%</td>
</tr>
<tr>
<td><em>Enterobacter spp.</em></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>1.61%</td>
</tr>
<tr>
<td>Negative Culture</td>
<td>14</td>
<td>3</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>68</td>
<td>29</td>
<td>16</td>
<td>10</td>
<td>9</td>
<td>15</td>
<td>147</td>
<td></td>
</tr>
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