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Assessment of Post-Operative Infection of Acetabular Fracture Fixation: Meta-Analysis

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ABSTRACT

Background: Acetabular fractures is a break in the socket portion of the "ball and socket" hip joint. The operative treatment often necessitates extensive surgical exposure. Surgical site infection (SSI) an unfortunate and troublesome complication after surgery, usually leading to increased morbidity, mortality

Objective: The aim of the current work was to investigate the risk factors of SSI after acetabular fracture surgery and to perform a meta-analysis of all the case-controlled trials (CCTs) to determine whether there were any significant differences in the average operation time, intraoperative blood loss, fracture end reset satisfaction rate, early/late complication rates, and the approach during operation and BMI.

Patients and methods: This Meta-analysis is a quantitative, formal, epidemiological study design used to systematically assess previous research studies to investigate the risk factors of SSI after acetabular fracture surgery and to perform a meta-analysis of all the case-controlled trials (CCTs) in the last ten years to determine whether there were any significant differences in the average operation time, intraoperative blood loss, fracture end and the Harris hip score (HHS) good function rate.

Results: Pooled prevalence of SSI was 6.71% among all studies and it was a significant rate like all studies as they were significant impacted rates in comparison to base (Zero). Majority among all studies were Staphylococcus species including Methicillin Resistant Staphylococcus aureus (MRSA), followed by Enterococcus faecalis. Operation time was significantly higher among cases of SSI at all studies and at pooled analysis. Regard pooled analysis diabetes mellitus (DM) considered as significant risk factor with Pooled OR 2.31 (1.1-8.63).

Conclusion: The collected data from the included studies showed that operative time, injury severity score and DM are all risk factors after operation. Also, most common organism among all studies were Staphylococcus species including Methicillin Resistant Staphylococcus aureus (MRSA), followed by Enterococcus faecalis. Finally, in all studies we founded hypertension and smoking are not risk factors of the post-operative infection.

Keywords: Acetabular Fracture Fixation, Surgical site infection (SSI).

INTRODUCTION

Surgical site infection (SSI) is defined as an infection at the site of operation that occurs within 30 days after the procedure or within 1 year if a foreign body was implanted during the operation [(1)]. The SSI is an unfortunate and troublesome complication after surgery, usually leading to increased morbidity, mortality, length of hospital stays, and health-care costs [(2)].

A great variety of risk factors for SSI after orthopedic surgery are reported, including patient related (e.g., increased age, diabetes mellitus, obesity, previous surgical infection, poor nutrition), injury-related (e.g., open fracture grade) and surgery-related (e.g., operation duration, surgical site classification, excessive blood loss, and antibiotic prophylaxis) factors [(3)].

Acetabular fracture is a break in the socket portion of the "ball and socket" hip joint. Historically, they were treated conservatively, which often involved prolonged immobilization and a high incidence of post-traumatic osteoarthritis (OA). In 1964, **Judet *et al.*** were the first to advocate open anatomical reduction and internal fixation of these fractures. They found that operatively treated displaced acetabular fractures resulted in better preservation of the hip and less posttraumatic OA [(4)].

Since that time, operative treatment of displaced acetabular fractures has been the treatment of choice. However, it is associated with postoperative complications, such as infection and nerve palsy as (sciatic nerve) [(5)].

The treatment of patients with acetabular fractures is challenging. Surgical treatment of acetabular fractures was established. In the last 30 years, open anatomical reduction of the articular surface with a rigid internal fixation became the standard management for these fractures [(6)].

The operative treatment often necessitates extensive surgical exposure, long operative time, and high blood loss. Post-operative SSI after the acetabular fracture surgical procedure is fortunately uncommon. Still, the results from an infection are devastating, limiting the patient's physical performance substantially and dramatically impairing life quality [(7)].

Suzuki *et al.* [(8)] reported 326 patients who underwent acetabular fracture surgery in which SSI developed in 17 patients, including 10 deep infections and seven superficial infections. The univariate analysis showed that the Injury Severity Score (ISS), intensive care unit (ICU) stays, amount of packed red blood cells

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(PRBCs) transfused, operative time, operative blood loss, body mass index (BMI), and frequent performance of combined approach were associated with the development of an infection. The BMI, and the Morel-Lavallee's lesion were independent risk factors in the multivariable analysis.

We aimed in this work to investigate the risk factors of SSI after acetabular fracture surgery and to perform a meta-analysis of all the case-controlled trials (CCTs) to determine whether there were any significant differences in the average operation time, intraoperative blood loss, fracture end, and BMI.

PATIENTS AND METHODS

Our study protocol was registered to institutional review board (IRB) in Zagazig University in February 2021. We searched for the clinical studies that comparing risk factors for infection of acetabular fracture fixation. Computerized research was performed in PubMed, Medline, Elsevier, Scopus, Google scholar and Cochrane Library database to identify the relevant literatures published from January 2010 until 20 May 2021. The search included the single keyword or in combination: a "Surgical Site infection and acetabular fixation" "infection and acetabular fracture fixation". All participants provided written informed consent, and the study was approved by the research ethical committee of Zagazig University's faculty of medicine. (IRB#:6745-21-2-2021) work was done in accordance with the Declaration of Helsinki, the ethical code of the world medical association for human studies.

Study Selection:

In this meta-analysis we included studies which fulfill the following criteria:

1. Studies including ICU stay and BMI.
2. Studies including SSI organisms.
3. Studies including sex, surgical approach and occupation.
4. Studies including hospital stay and morel-lavallee lesion**.**

Data Collection Process:

After duplicates removed, the two researchers (T.E) and (A.G) independently screened the titles and abstracts, any conflicts were discussed with the third researcher (A.H). Then the full text investigated based on inclusion and exclusion criteria for this study.

Flow chart:

According to the search strategy, 460 articles were identified from the PubMed, Embase, and Cochrane databases, and reference lists of the published studies after duplicate articles were removed; 22 articles remained after the titles and abstracts were screened. Only 7 studies were included in the meta-analysis after full texts were reviewed**.**

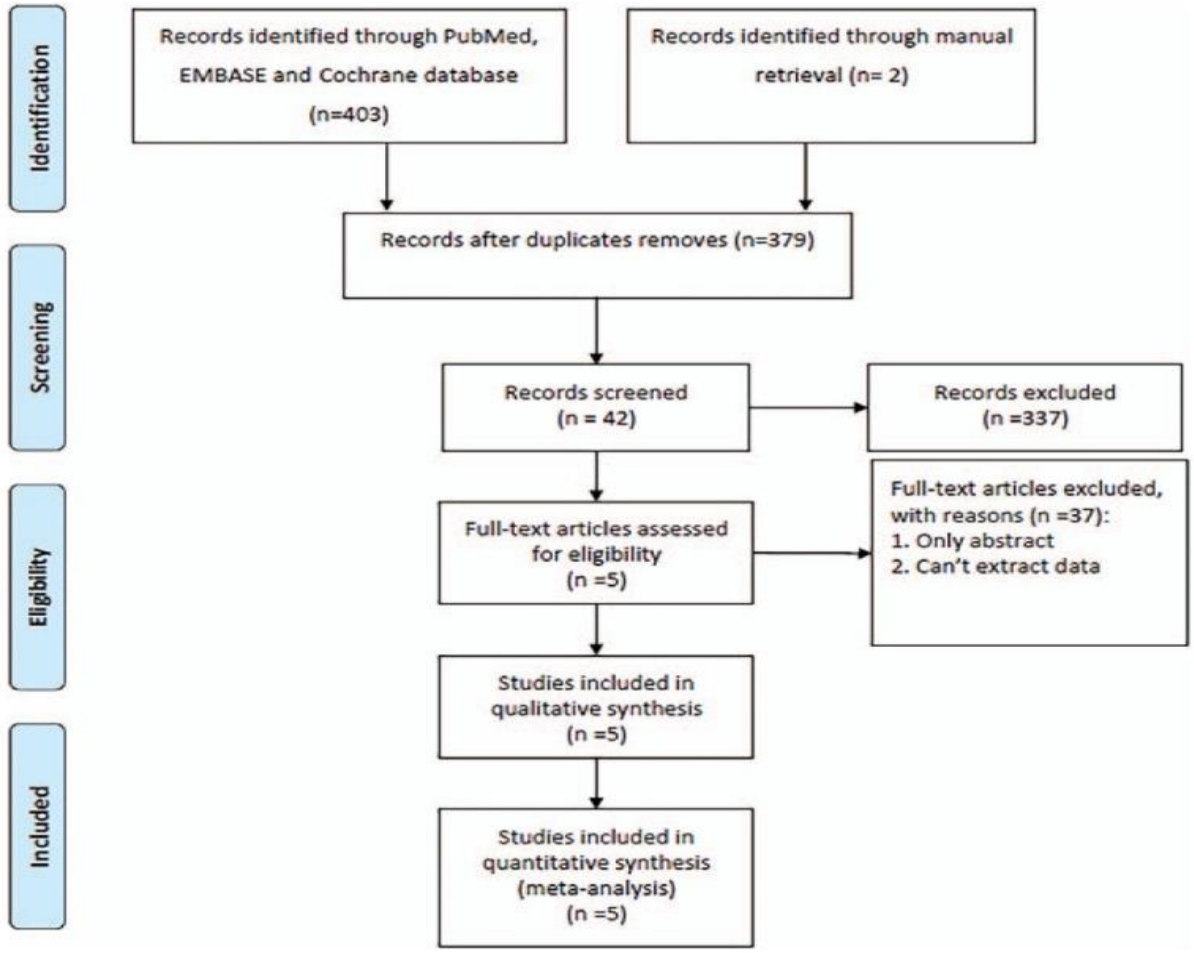

Figure (1): Flow chart of study articles.

Table (1): Summary of studied articles results

Study	N	Age	SEX		BMI		ISS		Operative duration		ICU stay		DM	DM
			Male	Female	N	mean±SD	N	mean±SD	N	mean±SD	N	mean±SD	N	N %
Suzuki *et al.* [8]	**326**	**42.9_18.1**	**76.6%**	**23.4%**	**17**	**33.0±9.2**	**17**	**23.8±14.9**	**17**	**278.1±120.7**	**17**	**13.48±9.63**	**17**	**1 5.8%**
Al-Mulhim *et al.* [11]	**3096**	**38.13 ± 12.1**	**75.3%**	**24.7%**	**79**	**NA**	**79**	**NA**	**79**	**268.2±90.58**	**79**	**9.59±2.53**	**79**	**NA**
Li *et al.* [6]	**338**	**38.23±8.7**	**66.5%**	**34.5%**	**16**	**27.3±2.3**	**16**	**30.9 ±17.4**	**16**	**385.3 ±87.62**	**16**	**3.14 ±1.08**	**16**	**2 12.5%**
Iqbal *et al.* [9]	**250**	**45.4±21.6**	**58.8%**	**41.2%**	**14**	**32.4±8.74**	**14**	**NA**	**14**	**192.7±72.3**	**14**	**11.47±3.58**	**14**	**3 21.4%**
Ding *et al.* [12]	**791**	**41.9±8.78**	**71.5%**	**28.5%**	**56**	**31.2±3.61**	**56**	**25.1±3.58**	**56**	**NA**	**56**	**13.62±4.85**	**56**	**7 12.5%**
Mardanpour *et al.* [13]	**788**	**47.5 ± 15.87**	**69.0%**	**31.0%**	**53**	**NA**	**53**	**NA**	**53**	**NA**	53	NA	**53**	**NA**
Misha *et al.* [14]	**251**	**38 ± 16.30**	**49.8%**	**50.2%**	**53**	**NA**	**53**	**NA**	**53**	**NA**	**53**	**10.25±2.88**	53	NA
Pooled		**42.5 ± 14.69**	**70.25%**	**29.75%**		**31.9±6.39**		**26.89±8.52**		**286.57±70.58**		**10.42±2.85**		

Statistical analysis

Data entered organized in Microsoft excel 2010 then export to comprehensive meta-analysis software version 3. Pooled: for analysis of multiple studies and found adjusted accumulative outcome. Z score method: to test difference in mean. Test for heterogeneity: Cochran's Q test and I2: Under null, it is approximately distributed as a chi-square with k-1 degrees of freedom for test heterogeneity and homogeneity of studies results and finding.

RESULTS

Socio demographic distribution as mean age from all studied was 42.5 ± 14.69 and male were majority with average percentage of 70.25% and female 29.75%, smoking founded in 27.96% and DM in 14.96% in pooled analysis. **(Table 2).**

Pooled Prevalence of SSI was 6.71% among all studies and it was a significant rate like all studies as they were significant impacted rates in comparison to base (Zero) Homogeneity among studies were founded.

No bias account for differences in results among studies, which are not due to chance, after quantifying all factors. We found no significant heterogeneity and we found agreement between studied **(Table 3).**

Majority among all studies were Staphylococcus species including Methicillin Resistant Staphylococcus aureus (MRSA), followed by Enterococcus faecalis **(Table 4).**

Injury Severity Score (ISS) was significantly higher among cases of SSI at all applicable studies and at pooled analysis also Homogeneity among studies were founded. No bias account for differences in results among studies, which are not due to chance, after quantifying all factors. We found no significant heterogeneity and we found agreement between studied **(Table 5).**

Operation duration was significantly higher among cases of SSI at all applicable studies **(Table 6).**

Regard pooled analysis DM considered as significant risk factor with Pooled OR 2.31 (1.1-8.63) **(Table 7).**

Table (2): Distribution of demographic data among studied studies.

Study	N	Age	Sex		Smoking	DM
			Male	Female		
Suzuki *et al.* [8]	**326**	**42.9_18.1**	**76.6%**	**23.4%**	**36.0%**	**18.6%**
Al-Mulhim *et al.* [11]	**3096**	**38.13 ± 12.1**	**75.3%**	**24.7%**	**39.3%**	**17.3%**
Li *et al.* [6]	**338**	**38.23±8.7**	**66.5%**	**34.5%**	**25.3%**	**15.9%**
Iqbal *et al.* [9]	**250**	**45.4±21.6**	**58.8%**	**41.2%**	**22.9%**	**11.3%**
Ding *et al.* [12]	**791**	**41.9±8.78**	**71.5%**	**28.5%**	**26.63%**	**10.55%**
Mardanpour *et al.* [13]	**788**	**47.5 ± 15.87**	**69.0%**	**31.0%**	**23.6%**	**NA**
Misha *et al.* [14]	**251**	**38 ± 16.30**	**49.8%**	**50.2%**	**NA**	**NA**
Pooled		**42.5 ± 14.69**	**70.25%**	**29.75%**	**27.96%**	**14.96%**

Table (3): Prevalence of SSI among studied studies.

Study	N	Prevalence		Z	P
		N	%		
Suzuki *et al.* [8]	326	17	5.2%	11.63	0.00**
Al-Mulhim *et al.* [11]	3096	79	2.6%	31.96	0.00**
Li *et al.* [6]	338	16	4.7%	11.73	0.00**
Iqbal *et al.* [9]	250	14	5.6%	10.29	0.00**
Ding *et al.* [12]	791	56	7.1%	18.57	0.00**
Mardanpour *et al.* [13]	788	53	6.7%	18.48	0.00**
Misha *et al.* [14]	251	53	21.1%	8.52	0.00**
Pooled			6.71%	44.85	0.00**

Table (4): SSI Organisms among studies.

Study	Prevalence	
	N	%
Suzuki *et al.* [8]	**17**	**Staphylococcus aureus 9 Enterococcus faecalis 6 Acinetobacter species 0 Staphylococcus epidermidis 3 Pseudomonas aeruginosa 2 Enterobacter cloacae 2 Escherichia coli 0**
Al-Mulhim *et al.* [11]	**79**	**Staphylococcus aureus 23 Enterococcus faecalis 14 Acinetobacter species 17 Staphylococcus epidermidis 8 Pseudomonas aeruginosa 15 Enterobacter cloacae 2 Escherichia coli 0**
Li *et al.* [6]	**16**	**NA**
Iqbal *et al.* [9]	**14**	**Staphylococcus aureus 10 Enterococcus faecalis 2 Acinetobacter species 0 Staphylococcus epidermidis 0 Pseudomonas aeruginosa 0 Enterobacter cloacae 2 Escherichia coli 0**
Ding *et al.* [12]	**56**	**NA**
Mardanpour *et al.* [13]	**53**	**NA**
Misha *et al.* [14]	**53**	**Staphylococcus aureus 26 Enterococcus faecalis 2 Acinetobacter species 4 Staphylococcus epidermidis 3 Pseudomonas aeruginosa 4 Enterobacter cloacae 2 Escherichia coli 12**

Table (5): ISS distribution between cases with SSI and cases without SSI among all studies.

	SSI		NO SSI		Z	P
Study	**N**	**Mean±SD**	**N**	**Mean±SD**		
Suzuki *et al.* [8]	**17**	**23.8±14.9**	**309**	**15.7±11.7**		**0.004***
Al-Mulhim *et al.* [11]	**79**	**NA**	**3017**	**NA**	**----**	**-----**
Li *et al.* [6]	**16**	**30.9 ±17.4**	**322**	**17.5 ±14.9**	**3.65**	**0.00****
Iqbal *et al.* [9]	**14**	**NA**	**236**	**NA**	**----**	**-----**
Ding *et al.* [12]	**56**	**25.1±3.58**	**735**	**17.52±2.36**	**19.75**	**0.00****
Mardanpour *et al.* [13]	**53**	**NA**	**735**	**NA**	**----**	**-----**
Misha *et al.* [14]	**53**	**NA**	**198**	**NA**	**----**	**-----**
Pooled		**26.89±8.52**		**16.87±8.52**	**17.85**	**0.00****

Table (6): Operation duration distribution between cases with SSI and cases without SSI among all studies.

	SSI		NO SSI		Z	P
Study	**N**	**Mean±SD**	**N**	**Mean±SD**		
Suzuki *et al.* [8]	**17**	**278.1±120.7**	**309**	**194.9±81.3**		**0.00****
Al-Mulhim *et al.* [11]	**79**	**268.2±90.58**	**3017**	**185.5±62.36**	**5.128**	**0.00****
Li *et al.* [6]	**16**	**385.3 ±87.62**	**322**	**208.6 ±52.3**	**10.45**	**0.00****
Iqbal *et al.* [9]	**14**	**192.7±72.3**	**236**	**149.4±47.50**	**6.258**	**0.00****
Ding *et al.* [12]	**56**	**NA**	**735**	**NA**	**----**	**-----**
Mardanpour *et al.* [13]	**53**	**NA**	**735**	**NA**	**----**	**-----**
Misha *et al.* [14]	**53**	**NA**	**198**	**NA**	**----**	**-----**
Pooled		**286.57±70.58**		**182.6±58.96**	**11.51**	

Table (7): DM as a risk factor for SSI.

Study	**SSI**		**NO SSI**		**OR (CI 95%**	**Z**	**P**
	N	**N %**	**N**	**N %**			
Suzuki *et al.* [8]	**17**	**1 5.8%**	**309**	**9 2.9%**	**2.2 (0.88-9.63)**	**0.67**	**0.49**
Al-Mulhim *et al.* [11]	**79**	**NA**	**3017**	**NA**	**----**	**------**	**--------**
Li *et al.* [6]	**16**	**2 12.5%**	**322**	**16 4.9%**	**2.1 (0.95-8.63)**	**1.25**	**0.085**
Iqbal *et al.* [9]	**14**	**3 21.4%**	**236**	**15 6.3%**	**4.3 (1.85-10.52)**	**1.97**	**0.035***
Ding *et al.* [12]	**56**	**7 12.5%**	**735**	**66 8.9%**	**1.2 (0.85-18.6)**	**0.87**	**0.385**
Mardanpour *et al.* [13]	**53**	**NA**	**735**	**NA**	**----**	**-----**	**------**
Misha *et al.* [14]	53	NA	198	NA	----	------	--------
Pooled					**2.31 (1.1-8.63)**	**2.115**	**0.028***

DISCUSSION

The SSI is an unfortunate and troublesome complication after surgery, usually leading to increased morbidity, mortality, length of hospital stays, and health-care costs [2].

A great variety of risk factors for SSI after orthopedic surgery are reported, including patient related (e.g., increased age, diabetes mellitus, obesity, previous surgical infection, poor nutrition), injury-related (e.g., open fracture grade) and surgery-related (e.g., operation duration, surgical site classification, excessive blood loss, and antibiotic prophylaxis) factors [3].

Acetabular fractures are uncommon injuries with a rising trend in the developing countries. This could be due to increase in motor vehicle accident**.** Increase in motor vehicle accident could be due to ignorance of traffic police and poor traffic system, all contribute to the incidence of this dilemma. Acetabular fractures are challenging and complex injuries [9].

We should be afraid from infection after acetabular fracture fixation, because infection after surgery is associated with long-term harm to the patient, including prolonged surgical length of stay, rehospitalization, and decreased quality of life. We believe that any causal pathway between early and late infection or mortality would be most likely indirect. For example, the initial infection could cause absence from work, leading to financial hardship, reduced quality of life, and inability to meet medical needs, leading to poor outcomes [10]. In addition, the infection in some patients need for reoperation and hospitalization, which lead to increase mortality and morbidity due to sepsis and bacteremia, also in delay infection may cause osteomyelitis [10].

This meta-analysis study showed that majority among all studies were Staphylococcus species including Methicillin Resistant Staphylococcus aureus (MRSA), followed by Enterococcus faecalis in the pooled data.

This mete analysis study showed that socio demographic distribution as mean age from all studied was 42.5 ± 14.69 and male were majority with average percentage of 70.25% and female 29.75% in pooled analysis with no significant difference according to age and sex.

Injury severity score correlates with mortality, morbidity and hospitalization time after trauma. This meta-analysis in our study show (mean±SD 26.89±8.52**)** in all study, in addition (Z score 17.85) in pooled analysis indicates that ISS increased risk of SSI in orthopedic surgery. Also (Cochran Q 6.28) and I2 (Inconsistency 5.96) that's means no significant

heterogeneity and we found agreement between studied.

Operative times especially in open fractures are related to an increased overall risk for surgical site infection related to several challenges, as both intrinsic and extrinsic patient, surgeon, and hospital factors. This meta-analysis in our study show (mean±SD 286.57±70.58**)** in all study in addition (Z score 11.51) in pooled analysis indicates operation duration increased risk of SSI in orthopedic surgery. Also (Cochran Q 3.88) and I2 (Inconsistency 3.29) that's means no significant heterogeneity and we found agreement between studied.

High blood sugar levels can weaken a person's immune system defenses. People who have had diabetes for a long time may have peripheral nerve damage and reduced blood flow to their extremities, which increases the chance for infection. The high sugar levels in your blood and tissues allow bacteria to grow and allow infections to develop more quickly. The meta-analysis in our study show (mean±SD 1.1-8.63**)** in all study, in addition (Z score 2.115) in pooled analysis indicates that DM increased risk of SSI in orthopedic surgery. Also (Cochran Q 9.23) and I2 (Inconsistency 10.33) that's means no significant heterogeneity and we found agreement between studied.

Study Limitations:

It is known that meta-analyses require detailed and explained mechanisms for determining which studies to include or exclude. This study showed some limitation, we could not gather many RCTs or studies with appropriate allocation of patients in large sample size studies, and most papers were retrospective. In addition, multiple variables are found to be a risk factor of surgical site infection with no multi variant analysis in between the different variables that can affect the outcome.

CONCLUSION

The collected data from the included studies showed that operative time, injury severity score and DM are all a risk factors after operation. Also, most common organism among all studies were Staphylococcus species including Methicillin Resistant Staphylococcus aureus (MRSA), followed by Enterococcus faecalis. More RCTs with large sample size, about surgical site infection of acetabular fracture fixation is needed, for more assessment and to confirm our findings.

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