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Risk factors of superficial surgical site infection post debridement and internal fixation of open fractures in long bones at Sanglah General Hospital, Bali, Indonesia

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ABSTRACT

Background: The fracture condition exposed to the environment can damage muscle, vascular, and nerve tissue due to infection. This study aims to determine whether age, Hb, OF grade II, duration and surgery time are risk factors of superficial surgical site infection for post-debridement and internal fixation in long bone fractures.

Methods: This study used cohort retrospective. Samples of patients with open long bone fractures at Sanglah Denpasar from February to July 2020 were assessed for their risk factors for infection based on secondary data from medical records, physical and laboratory examinations. Monitoring for infection incidence was performed 1-4 weeks postoperatively, based on clinical and infection markers (Procalcitonin). After that, descriptive and inferential statistical analysis was performed using the Chi-square test and Logistic Regression using SPSS version 24 for Windows.

Results: Hb level < 10 g/dLwas proven to be a risk factor (p=0.027). There was a significant difference in patients with grade II (p=0.049; RR=10.00). There was a significant difference in the risk with patients with surgery duration ≥ 2 hours (p=0.011; RR=15). There was a significant difference in the patients with time to operation ≥ 12 hours (p=0.005; RR=8). Logistic Regression Test proves that the most influencing factor for superficial surgical site infection is operation duration (RR=9.328).

Conclusion: Hb, OF grade II, duration, and time to operation are risk factors of superficial surgical site infection for post-debridement and internal fixation in open fractures of the long bone. The most important risk factor for superficial surgical site infection is the duration of surgery.

Keywords: Long Bone Fracture, Open Fracture, Surgery Duration, Infection.
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INTRODUCTION

Surgical Wound Infection (SWI) after Open Reduction Internal Fixation (ORIF) is defined as microbial contamination from surgical wounds within 30 days of surgery or within one year after surgery if there is implantation in the patient.[1] Risk factors that affect the incidence of SWI are therapy or action given to the patient as well as the time of treatment of wounds in the patient.[2] Surgical wound infections are clinically enforced, i.e., by the discovery of purulent fluid around the wound or drain scar or the spread of cellulitis from surgical wounds.[1,2]

Infections such as surgical wounds can be affected by age, wherein several previous studies that examined the relationship of age with the incidence of surgical wound infections, it was found that the older it would increase the risk of various types of surgical wound infections as well as other harmful complications such as lifelong disability.[3] While the risk of infection to surgical wounds can occur when hemoglobin levels in the blood are reduced.[4] This plays an important role in the process of the body's defense mechanism against infection.

Surgical wound infections were also found that getting an elongated surgery duration would increase the risk of superficial infection. According to Cheng H et al., the longer the operation, the risk of infection increases to double every subsequent 15 minutes, and the duration of the operation is more than 2 hours considered as a risk factor for infection.[5]

Infection rates are also affected by the waiting time of the patient's operation. The longer the waiting time for surgery, the higher the infection rate can occur, and the rate of surgical wound infection in open fractures can reach 11.1% if the treatment is more than 12 hours but less than 24 hours.[6]

RSUP Sanglah is a referral hospital for all of Bali, so many cases of open fractures are treated in the hospital. Until now, the

cases are diverse in other multi centers. The information that can be obtained from this research can be useful, especially for RSUP Sanglah or other hospitals, in terms of setting protocols or SOP (standard operational procedures) of open fracture handling and preparing in terms of both energy and tools. To solve the infection problem, please be aware of the risk factors for the occurrence of the infection. This study aims to determine whether age, Hb, OF grade II, duration and surgery time are risk factors of superficial surgical site infection for post-debridement and internal fixation in long bone fractures.

METHODS

The study used a retrospective cohort study design. Of the patient population suffering from open fractures of long bone performed consecutively, the samples' selection was performed. Assessment of postoperative complications seen from the medical records of samples that included inclusion and exclusion criteria.

The scope of the study area is at Sanglah Hospital Denpasar from February 2020 to July 2020. In this study, the variables studied were each patient with an open long bone fracture who had undergone debridement surgery and open reduction and internal fixation.

The inclusion criteria for this study sample were all patients with open fractures of long bone who underwent open debridement and reduction surgery and internal fixation at Sanglah Hospital or other multi centers.

The exclusion criteria for this study sample were patients who died during treatment, patients aged <13 years and> 80 years, were taking routine corticosteroid drugs, suffer from malaria, fungal diseases, autoimmune diseases, cardiac surgery, pancreatitis, burns, Kawasaki disease, and cardiogenic shock, the patient refused to be the subject of the study, suffer from other infections elsewhere, such as pneumonia, decubitus ulcers, UTI.

Using the formula calculation, a sample of 21 patients was obtained for each study group. The sampling technique is by consecutive sampling. The descriptive statistical analysis assesses the standard distribution and deviation of each study variable. Characteristics of the study subjects described are Hb levels, fracture grading, duration of surgery, time to operation as risk factors for post-debridement infection, and internal fixation in fractures. Chi-square test with Yates correction was used for the statistical analysis. For categorical comparative data, which were not paired with 2xK tabulation, the chi-square test was used if the x^2 requirement was met. This study's significance level (α) was set at a probability value (p) of less than 0.05. All statistical analyzes were performed using the SPSS version 24 for Windows. Multivariate analysis was performed using the Logistic Regression Test to assess each factor's effect on infection after controlling for analytically confounding variables. This analysis aims to evaluate the main factors that have the most substantial influence on patients' risk of infection after debridement and internal fixation of long bone fractures. The association size obtained from the Logistic Regression Test is Adjusted Relative Risk (ARR).

RESULTS

From a total of 42 samples, 30 were male (71.4%) and 12 samples were female (28.6%), with an average age 42.64±16.42 (range 13-80 years) (Table 1). Grade 2 open fractures are more common (76.20%) rather than grade 1 (23.80%). Hb levels < 10 g/dL are 14.3% and ≥ 10g/dL are 85.7%. The duration of surgery < 2 hours is 23.8% and ≥ 2 hours is 76.2% and the waiting time of doing operations in time brackets <12 hours is 52.38% and ≥12 hours is 47.62% (Table 1).

From the total 42 samples of postoperative patients, patients aged 41-80 years infected were 12 patients (46.15%), while those who were not infected were 14 patients (53.85%). In patients aged <40 years, 9 patients (56.25%) were infected, while 7 patients (43.75%) were not infected (Table 2).

In addition, there was no significant difference in the risk of infection between patients aged 41-80 years compared with ages 13-40 in post-debridement patients and internal fixation of long bone fractures (p=0.751) (Table 2).

From a total of 42 postoperative patient samples, 6 infected patients (100%) had hemoglobin levels <10 g/dL, while those without infection were 0 patients (0%). In patients with Hb level ≥10 g/dL, the infection was 15 patients (41.67%), while those without infection were 21 patients (58.83%) (Table 2). There was a significant difference in the risk of infection between patients with Hb levels <10 g/dL compared with Hb levels ≥10 g/dL in post-debridement patients and internal fixation of long bone fractures (p=0.027) (Table 2). The relationship strength parameter used is RR, where anemia has a RR value of 2.40 (1.631-3.532), which means that patients with anemia have a 2.4 (probability) of occurrence of infection compared with patients without anemia in patients post-

Table 1. Characteristics of Research Subjects in general

Variable	Total (N=42)	Percentage (%)
Gender		
Male	30	71.40
Female	12	28.60
Age (Years) (mean±SD)	42.64±16.42	
Hb Levels (g/dL)		
< 10	6	14.30
≥ 10	36	85.70
Grading Fractures		
I	8	19.00
II	34	81.00
Duration of Operation (Hours)		
< 2	10	23.80
≥ 2	32	76.20
Operation Waiting Time (Hours)		
< 12	22	52.38
≥ 12	20	47.62

Table 2. Risk of infection among several parameters

Variable	Groups (N=42)		p	95% CI
	Infection (N=21)	No Infection (N=21)		
Age (Years), n (%)				
≥ 40	12 (46.15)	14 (53.85)	0.751	-
< 40	9 (56.25)	7 (43.75)		
Hemoglobin (g/dL), n (%)				
< 10	6 (100.00)	0 (0.00)	0.027	2.40 (1.631-3.532)
≥ 10	15 (41.67)	21 (58.83)		
Grading, n (%)				
II	20 (58.80)	14 (41.20)	0.049	10.00 (1.104-90.593)
I	1 (12.50)	7 (87.50)		
Duration of Operation (Hours), n (%)				
≥ 2	20 (62.50)	12 (37.50)	0.011	15.00 (1.685-133.551)
< 2	1 (10.00)	9 (90.00)		
Operation Waiting Time (Hours), n (%)				
≥ 12	15 (75.00)	5 (25.00)	0.005	8.00 (2.012-31.803)
< 12	6 (27.30)	16 (72.70)		

Table 3. Logistic regression test for infection risk factors

Risk Factors	Exp(B)	95% CI (B)	
		Lower	Upper
Hemoglobin (Hb) < 10 g/dl	4.896	0.097	6.450
Open Fracture (*Grade* II)	1.143	0.077	16.947
Duration of Operation (≥ 2 hours)	9.328	0.187	13.446
Operation Waiting Time (≥ 12 hours)	5.833	0.982	34.643

debridement and internal fixation of long bone fractures (Table 2).

From a total of 42 samples of postoperative patients, patients with grade II open fractures, 20 patients were infected (58.80%), while those without infection were 14 patients (41.20%). In patients with grade I open fractures, the infection was 1 patient (12.50%), while those without infection were 7 patients (87.50%) (Table 2). There is a significant difference in the risk of infection between patients with grade I open fractures than grade II in post-debridement patients and internal fixation of long bone fractures (p=0.049) (Table 2). The relationship strength parameter used is RR, where fracture grading has a RR value of 10.00 (1.104-90.593), which means patients with grade II open fractures have a probability (probability) of 10 times the occurrence of infection compared with grade I open fractures in post-debridement patients and internal fixation of long bone fractures (Table 2).

From a total of 42 samples of postoperative patients, patients with a duration of surgery ≥ 2 hours, the infection was 20 patients (62.50%), while 12 patients (37.50%) were not infected. In patients with a duration of surgery < 2 hours, the infection was 1 patient (10.00%), while those without infection were 9 patients (90.00%) (Table 2). There is a significant difference in the risk of infection between patients with duration of surgery < 2 hours compared with the duration of surgery ≥ 2 hours in patients after debridement and internal fixation of long bone fractures (p=0.011) (Table 2). The relationship strength parameter used is the RR, where the duration of the operation has a RR value of 15.00 (1.685-133.551), which means patients with a duration of surgery ≥2 hours have a probability (probability) of 15 times the occurrence of infection compared with the duration of surgery <2 hours in post-debridement patients and internal fixation of long bones fractures (Table 2).

From a total of 42 samples of postoperative patients, patients with a surgery waiting time of ≥12 hours, the infection was 15 patients (75%), while those without infection were 5 patients (25.00%). In patients with a surgery waiting time <12 hours, the infection was 6 patients (27.30%), while those without infection were 16 patients (72.70%) (Table 2). There is a significant difference in infection risk between patients with surgery waiting time <12 hours compared with ≥12 hours in patients after debridement and internal fixation of grade I and II long bone fractures (Table 2). The relationship strength parameter used is RR, where the golden period has a RR value of 8.00 (2.012-31.803) which means that patients with surgery waiting time of ≥12 hours have a probability of 8 times the occurrence of infection compared with surgery waiting time <12 hours at post-debridement patients and internal fixation of grade I and II long bone fractures (Table 2).

Variables that influence infection risk are anemia, fracture grading, duration of surgery, and golden period. The strength of the relationship can be seen from the RR value (EXPB). The most significant relationship strength is Operating Duration (RR=9.328), while the smallest relationship strength is fracture grading (RR = 1.143) (Table 3).

DISCUSSION

Research successfully showed that age is the risk of infection in the organ system that varies.[3] Elderly patients with exposure to the infection suffer from bacteremia that

develops towards worsening (SIRS). As a hematogenous infection, pneumococcal infection is the main complication due to exposure to the environment.[7] This is supported by research in 2018 that proves younger patients have a higher risk of surgical site infections.[8] One possible explanation is that younger patients are more often involved in high-energy trauma leading to more complex fractures with more significant soft tissue damage. This requires more surgery and as a result this group has a greater risk of infection.[8] Nevertheless, research by Borgohain M et al., instead reports that old age is the leading risk factor for postoperative infection, caused by several factors such as malnutrition, poor absorption, low healing rate, decreased immunity, increased catabolism, and others.[9]

On the other hand, another study by Kortram K et al., proves no significant difference between age and incidence of infection.[10] Findings in this study concluded that age is not a risk of infection in grade I and II open fractures.[10] Although these findings differ from the results of other studies and studies, the number of samples and debridement techniques likely played a role in the incidence of infection.

Studies related to the relationship between Hb levels and the risk of infection show a complicated relationship. The non-involvement of red blood cells in the fight against infection, and given the general condition, plays a role in immune function. There is still no conclusive theory that suggests a clear causal relationship. One of the studies found that anemia can be caused by infection and inflammation, but there has not been a link that anemia causes infection.[11] This study tried to find a link between Hb levels and the risk of infection, which showed no significant association between the two.

Looking at the difference in morphological appearance at 1st and 2nd degree followed by the difference in port d'entree between the two, the risk of infection between them is also different. This is supported by studies showing a difference in infection at 1st degree, which was 2.4%, as for 2nd degree was 44%.[12] So, the study's findings are in line with the results of the previous studies, confirming that a higher degree of fracture will increase the risk of infection. However, this may also be due to the number of samples with more grade 2 open fractures than grade 1, so further studies are still needed to prove this.

On the other hand, the long duration of surgery has been proven from various studies as a risk factor for infection. The longer the risk of infection increases to double every subsequent 15 minutes.[13] The findings of this study are in line with the theory that surgery duration is a risk factor for infection in fractures of grade I and II.

Scientific reasoning states that immediate debridement action is expected to lower the risk of infection in open fractures. This study leads to similar conclusions. There is now a growing investigation into the significance of the golden period in open fractures. The study by Fernandes Mde et al., which evaluated 142 patients with open fractures, showed no significant difference in infection risk between surgery under and above six hours.[14] The authors suggest internal fixation debridement is performed as early as possible as the best therapeutic option with optimal Hb levels. Regardless of the uniformity of the operator's competence, the reduced risk of infection can be implemented concerning the duration of operation. Anticipation of bleeding should be well prepared.

Observation and determination of infection status should concern every patient with an open fracture, with periodic and complete monitoring of physical and laboratory status. It is beneficial for patients to receive appropriate treatment and a source of information for similar research. Follow-up cohort studies are needed to evaluate risk factors shown to increase the risk of infection in this study.

CONCLUSION

Age over 40 years is not proven to be a risk factor for infection after post-debridement and internal fixation in long bone fractures. Hb, fracture grading, duration of operation, and operation waiting time are proven risk factors for post-debridement infection and internal fixation for long bone fractures. The most influential risk factor for the risk of infection in patients after debridement and internal fixation of long bone fractures is surgery duration≥ 2 hours.

CONFLICTS OF INTEREST

The author states that there is no conflict of interest related to the material discussed in the manuscript.

RESEARCH ETHICS

The research protocol for Ethical Clearance from the Research Research Ethics Commission at the Faculty of Medicine, Universitas Udayana, Sanglah Hospital Denpasar, will be submitted before the research is carried out. Subjects who met the study criteria have explained the study's purpose and were asked to fill out written informed consent. Researchers have also attached a secondary data collection permit in the form of a medical record at Sanglah Hospital Denpasar.

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AUTHOR CONTRIBUTION

Stedy Adnyana Christian is responsible for finding research samples, implementing actions, analyzing data, and reporting on research results. Putu Astawa and I Ketut Suyasa were responsible for designing the research concept and the supervisor in this study.

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