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Outcomes of Primary Versus Delayed Primary Stump Closure in Post-Traumatic Below-Knee Amputations: A Surgical Perspective

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ABSTRACT

Objective: To compare the outcomes of primary and delayed primary closure of stump after traumatic below-knee amputation (BKA).

Study Design: Quasi-experimental study.

Place and Duration of Study: Orthopedic Surgery Department of Ali Medical Centre Islamabad, Pakistan, from Jan 2022 to Jun 2023.

Methodology: Eighty (n=80) patients who underwent traumatic below-knee amputation (BKA) were included, and divided into two groups. Group-A patients underwent primary stump closure and Group-B patients underwent delayed primary stump closure. Patients underwent surveillance after the procedure, and variables including length of hospital stay, reoperation and wound infection were noted in both groups.

Results: The mean age of patients was 38.65±0.65 years. 71(88.8%) patients were males while 9(11.3%) were females. The mean length of hospital stay in Group-A was 6.17±2.74 days and in Group-B group was 8.42±1.48 days (p<0.001). Wound infection was observed in 7(17.5%) patients in Group-A and in 3(7.5%) patients in Group-B (p=0.17). Reoperation for above-knee amputation was performed in 2(5%) patients in Group-A and in 1(2.5%) patient in Group-B (p=0.55).

Conclusion: Primary closure of stump after traumatic below-knee amputation (BKA) is associated with reduced length of stay in the hospital without any significant increase in the incidence of wound infection and reoperation.

Keywords: Below-Knee Amputation, Closure, Delayed Primary, Infection, Stump

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INTRODUCTION

Lower limb amputations are carried out when doctors come upon a non-viable limb. The nonviability of the limb may be because of infection, ischemia, trauma, or malignancy. More than 50% of the lower extremity amputations performed worldwide are caused by diabetic foot and peripheral artery disease.[1] The next commonest cause is the trauma. In 2017, 57.7 million people worldwide were living with a traumatic limb amputation.[2] These amputations are most commonly caused by falls, auto accidents, gunshot wounds, and mine explosion injuries, and can lead to significant soft tissue injuries that can also cause systemic life-threatening sepsis.[3-6]

The road to recovery after a traumatic lower limb amputation is also fairly challenging. A multicenter prospective study was conducted in the United States that concluded that wound infection encountered in 34.2% of the patients after traumatic lower limb amputation was the most common complication.[7] Ciufo *et al.*, documented that after below-knee amputation (BKA), 9.63% of patients underwent unplanned re-operations.[8] Some surgeons prefer delayed primary closure (DPC) of the BKA stump to reduce the incidence of wound infection and re-operation while others think that it only increases the length of stay in hospital. A study conducted in Turkey concluded that primary closure (PC) after traumatic lower limb amputation does not enhance the risk of wound infection.[9] However another study conducted in a level-I trauma center, in the United States documented that DPC resulted in reduced incidence of wound infection.[10]

Due to this disparity existing in the available literature, no standard guidelines are followed about the timing of the closure of the stump after traumatic lower limb amputation. In our country, surgeons follow different approaches depending on their personal preferences or departmental guidelines. A study hence needed to be conducted to evaluate the outcomes associated with primary closure versus delayed primary closure of BKA stump.

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METHODOLOGY

This Quasi-experimental study was conducted at the Orthopedic Surgery Department of Ali Medical Centre Islamabad, Pakistan after obtaining approval from the Ethical Review Committee (ERC serial no#:121).

Inclusion Criteria: Adult patients aged between 16-60 years, of either gender, who presented to the trauma bay with an unsalvageable limb after trauma, and below-knee amputation (BKA) was performed within 06 hours.

Exclusion Criteria: Patients with non-traumatic lower extremity amputations, those with chronic liver disease, chronic kidney disease, malignancy, congestive cardiac failure, and those with multiple traumatic injuries requiring multiple surgeries were excluded.

To calculate sample size, we used OpenEpi calculator, with anticipated wound complications attributable to surgical technique after primary closure (PC) 21% and after delayed primary closure (DPC) 10%, which came to 86.[11] Initially, 43 patients were included in each group, with Group-A having patients who underwent primary Closure, and Group-B having patients with delayed primary closure. However, out of these, 06 patients were lost to follow-up, which led to analysis of 80 patients (40 in each group). This data is shown in the patient flow diagram in Figure-1.

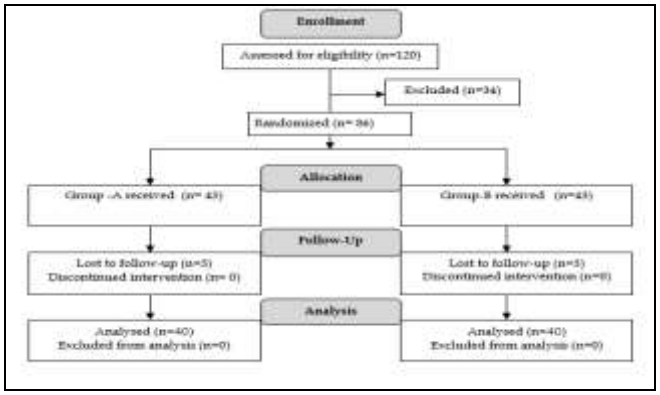

Figure-1: Patient Flow Diagram (n = 80)

Patients reported to the Trauma Bay and were managed initially as per ATLS guidelines.[12] Successful resuscitation was completed and intravenous broad-spectrum antibiotic coverage was provided. Necessary diagnostic investigations were carried out. Nonviability of the lower limb was established and the level of amputation was decided. After planning BKA, the closure timing of the stump and possible outcomes were discussed with the patients. Informed written consent was obtained from the patient or attendants for inclusion in the research study. The demographic profiles of patients were recorded in a predesigned proforma and patients were divided into two groups via paper lottery method. Patients were shifted to the operation theatre (OT) and all surgeries were performed under general or spinal anesthesia. A broad-spectrum intravenous antibiotic was administered at the time of induction of anesthesia. The skin incision was made to create a long posterior flap.[13] During surgery, meticulous debridement of all dead and unhealthy tissues was done, and the wound cavity was washed with copious amounts of normal saline. In Group-A, a closed suction drain was placed in the wound cavity and stump closure was done using a polypropylene suture. In Group-B, no drain was placed and skin closure was not done, however, the muscle was carefully approximated to provide adequate bone coverage to prevent exposure of the cut end of the bone to the external environment. All patients were shifted to the surgical high-dependency unit (HDU) and post-operative recovery was carefully monitored by the surgeon and nursing staff. DPC of the BKA stump was performed after 72 hours under anesthesia. After discharge from the hospital, follow-up visits were planned on the 7th, 14th, and 30th day post-surgery. Length of stay, incidence of wound infection within 30 days post-surgery, and the incidence of reoperation done for one joint above amputation / above-knee amputation (AKA) were compared between the two groups. Mortality rates within 30 days post-surgery were also compared. Wound Asepsis Score was used to classify wound infection with special emphasis on the following parameters: skin erythema/bruising, hematoma, seroma, purulent discharge, separation of deep tissues, isolation of bacteria, and length of stay in the hospital for more than 14 days. A total score > 20 was classified as wound infection.[14]

Statistical Package for Social Sciences (SPSS) version 22 software was utilized for data analysis. Quantitative variables (age, length of stay in hospital) were represented using mean ± standard deviation (SD). Categorical variables (gender, mechanism of injury, wound infection, amputation revision, mortality) were expressed as frequency and percentages. Categorical variables were compared between groups by using the Chi-square test. Quantitative variables were compared between

groups using independent sample t-test. A *p*-value of ≤ 0.05 was considered significant.

RESULTS

A total of eighty patients (n=80) were analyzed, with 40 patients in the Group-A and 40 patients in the Group-B. The mean age was 38.65±0.65 years. Seventy-one (88.8%) patients were males while 9(11.3%) were females. A comparison of these baseline characteristics between the two groups is shown in Table-I

Table-I: Comparison of Baseline Characteristics between Study Groups (n = 80)

Characteristic	Group-A (n = 40)		Group-B (n = 40)	*p*-value
Age (years) Mean ± SD	38.85 ± 6.03		38.45 ± 5.65	0.76
Gender	Male	36(90.0%)	35(87.5%)	0.72
	Female	4(10.0%)	5(12.5%)	

The mechanism of injury was a road traffic accident (RTA) in 52(65%) patients, a fall from height in 23(28.8%) patients, gun-shot wound (GSW) in 3(3.8%) patients, and blast injury in 2(2.5%) patients. This comparison between the two groups is tabulated below in Table-II

Table-II: Comparison of Mechanism of Injury between Study Groups (n = 80)

Characteristic		Group-A (n=40) n (%)	Group-B (n=40) n (%)
Mechanism of Injury	RTA	26(65.0%)	26(65.0%)
	Fall from height	11(27.5%)	12(30.0%)
	GSW	1(2.5%)	2(5.0%)
	Blast	2(5.0%)	0
	Total	40(100.0%)	40(100.0%)

**RTA: Road Traffic Accident, GSW: Gunshot Wound*

While comparing the outcomes between groups, it was observed that the mean length of hospital stay in Group-A was 6.17±2.74 days, while in Group-B, it was 8.42 ± 1.48 days (*p*=0.000). Wound infection was observed in 7(17.5%) patients in Group-A and in 3(7.5%) patients in Group-B (*p*=0.17). Reoperation for above-knee amputation (AKA) was performed in 2(5%) patients in Group-A and in 1(2.5%) patient in Group-B (*p*=0.55). Post-surgery, 30 days mortality occurred in 1(2.5%) patient form Group-A and in none from Group-B (*p*=0.31). This comparison is demonstrated below in Table-III

Table-III: Comparison of Outcome between Groups (n = 80)

Outcome	Group-A (n=40)	Group-B (n=40)	*p*-value
Length of hospital stay mean±SD (days)	6.17±2.74	8.42±1.48	<0.001
Wound infection	7(17.5%)	3(7.5%)	0.17
Reoperation (AKA)	2(5.0%)	1(2.5%)	0.55
Mortality	1(2.5%)	0(0%)	0.31

**AKA: Above-knee Amputation*

DISCUSSION

Traumatic injury of the limbs is one of the commonest causes of limb amputation performed by orthopedic surgeons. Wound infection is the most common complication after traumatic below-knee amputation (BKA). Moreover, some patients have to undergo repeated revisional surgeries which significantly increases morbidity and financial burden. To prevent complications and enhance the recovery and rehabilitation process surgeons adopt various techniques and follow different protocols. Some surgeons believe that while performing traumatic BKA, PC of the stump should be avoided as it may increase the risks of complications. However, the other school of thought is that if meticulous debridement and copious irrigation of the wound are done at the time of surgery, PC can be done.

In our study, majority of the patients were between the ages of 30 and 40 years. Dhillon *et al.* conducted a study and documented that maximum traumatic limb amputations were performed in patients of age between 30-40 years, which aligns with the results of our study.[15] Most of our patients were males because of increased occupational hazards and more engagement in high-risk recreational activities. Sadoma *et al.* mentioned similar findings in their study documenting that traumatic amputations were far more common in the male population as compared to the female gender.[16] In our study, we included patients who underwent BKA, as it was performed frequently in our hospital. Saini et al. documented that BKA was the most common level of amputation in patients who suffered from lower extremity trauma.[17] The most common cause of trauma in our study was RTA. McDonald et al. conducted a secondary database descriptive study and mentioned falling from a height to be the commonest cause, which contradicts the findings of our study.[18] The reason for this

discrepancy may be that our study was conducted in Pakistan, and the incidence of RTAs is far more common in our country because of the rapidly growing population, poor road infrastructure, and lack of strict enforcement of traffic laws. We found out in our study that, length of stay in the hospital was significantly higher in patients who underwent DPC of amputation stump. However, we found no significant difference in terms of wound infection, reoperation, and 30-day mortality post-surgery. Katiyar et al. in a similar study concluded that no statistically significant difference was there in terms of length of stay in hospital, wound infection, and conversion to AKA, which aligns with our study's results.19 Maricevic et al. conducted a similar study and found that if traumatic lower limb amputation is performed within 06 hours of injury, primary wound closure can be done without any significant increase in infection rate.[20] Ali *et al.*, in their study, concluded that even after adequate debridement is performed, PC causes an increased risk of infection and more incidence of higher amputation levels. These findings don't align with the results of our study.[10]

LIMITATION OF STUDY

Single center study, limited follow up period and limited sample size were few limitations of this study. Variations in patient characteristics (e.g., age, gender) and severity of trauma could have impacted the outcomes. The results may not be generalizable to other populations, settings, or types of amputation.

CONCLUSION

In conclusion, if traumatic blow-knee amputation is performed within 06 hours of injury and adequate debridement is done during the surgery, primary closure of the wound can be performed with no significant increase in risk of wound infection and higher-level re-amputation. Moreover, primary closure is also associated with reduced length of stay in the hospital.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

YU & SJI: Data acquisition, data analysis, critical review, approval of the final version to be published.

AN & NJ: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

WU: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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