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# Patterns of lower limb reconstruction and risk factors for complications at a tertiary care center

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## ABSTRACT

**Introduction:** Lower limb injuries constitute a significant proportion of trauma admissions in Nepal, frequently requiring complex reconstructive procedures. This study aims to identify the demographic profile of patients, injury patterns, and those undergoing lower limb reconstruction, as well as to determine the risk factors for developing complications at a tertiary trauma center in Nepal.

**Methods:** This prospective observational study was conducted at the National Trauma Center, Kathmandu. All patients undergoing reconstructive plastic surgery for lower limb trauma by the Burns, Plastic and Reconstructive Surgery Department at the National Trauma Center were included. Data on demographics, comorbidities, mode of injury, injury site, type of injury, mechanism of injury, reconstructive procedures, and complications were collected and analyzed.

**Results**: Eighty-five patients were included, of whom 67 (78.82%) were male and 18 (21.18%) were female. The average age was 27.97 years, with only two pediatric patients (ages 10 and 12). A total of 24 patients (28.2%) experienced complications. High-velocity injuries were significantly associated with complications, accounting for 20 out of 24 cases (83.3%), and 16(60%) had open fractures. Of those with complications, 15 patients had comorbidities, and diabetic patients had the highest number of complications, such as infection.

**Conclusion**: Lower limb defects requiring reconstruction are mostly seen in young males. Comorbidities, especially diabetes, mode of injury, type of injury, and timing of presentation, remain the main risk factors for complications. Timely presentation and availability of reconstructive expertise are critical for limb salvage and better functional outcomes.

**Keywords**: Complications, Injury patterns, Lower limb injuries, Orthoplastic, Reconstruction, Trauma

## INTRODUCTION

Lower limb injuries are among the most prevalent and intricate challenges encountered by trauma centers globally, particularly in low- and middle-income countries. In Nepal, trauma-related admissions due to high-energy injuries like road traffic accidents (RTAs) have been experiencing a steady increase, with lower limb injuries constituting a substantial proportion of the burden.[1] Patients presented with other modes of high-energy injuries, like falls from height and burns, that were caused by high impact, and some had low-energy injuries with falls from a smaller height.[2]

Effective management of these injuries often requires collaboration between orthopedic and plastic surgeons to achieve optimal soft tissue coverage and limb salvage. Patients were initially seen in the emergency department, assessed, and plastic surgery, as well as orthopedics, were involved from the first day, according to the patient's needs.

However, the literature from Nepal is scarce that delineates the epidemiology and reconstructive patterns of lower limb trauma.[3] This study was undertaken to ascertain the injury patterns, reconstructive requirements, and outcomes of patients undergoing lower limb reconstruction at the National Trauma Center in Kathmandu.

## METHODS

This prospective observational study was conducted at the National Trauma Center, following ethical approval from the Institutional Review Board (IRB) of NAMS, Kathmandu, and the Nepal Health Research Council Ethical Review Board. The study population included all patients undergoing reconstructive plastic surgical procedures for traumatic lower limb injuries; the only exclusion criterion was the refusal to provide consent. Data were gathered using a structured proforma to collect details on demographics, injury characteristics, types of reconstructive procedures, complications, and presentation at the hospital. For analysis, these data were entered into Microsoft Excel and processed using descriptive statistics in SPSS v25.0.

## RESULTS

Out of 85 patients included in the study, 67 (78.82%) were male and 18 (21.18%) were female. The mean age was 27.97 years, with the majority of cases involving adults, and only two pediatric cases, aged 10 and 12 years. The largest number of patients was in the 20-39 year age group, in both males and females. Many patients had comorbidities, where five patients had diabetes, eight patients had hypertension, and two patients had hypothyroidism (Table 1).

Burn-related lower limb injuries were present in 6 patients (7.1%), while the remainder sustained trauma primarily from road traffic accidents and falls. There were 6 (7.06%) patients with closed fractures, 51 (60%) patients with open fractures, and 28 (32.94%) cases with soft tissue injuries. Seventy-eight patients sustained high-energy injuries, and



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seven patients had low-energy injuries (Table 2).

The most common type of reconstruction was skin grafting, with 35 (41.18%) patients, followed by transposition flaps, which accounted for 28 (32.94%) patients. There were 1 (1.18%) free flaps, 16 (18.82%) pedicled flaps, and 5 (5.88%) patients who underwent amputations (Table 3).

**Table 1: Gender and age group(n=85)**

| Age Group | Female n(%) | Male n(%) |
|---|---|---|
| 10-19 | 3(3.53) | 12(14.12) |
| 20-29 | 7(8.24) | 39(45.88) |
| 30-39 | 4(4.71) | 5(5.88) |
| 40-49 | 3(3.53) | 8(9.41) |
| 60-69 | 1(1.18) | 3(3.53) |

**Table 2: Mode of injury and site of injury(n=85)**

| Mode of Injury with Site | Frequency(n) | Percentage(%) |
|---|---|---|
| **Burn** | | |
| Knee | 1 | 1.18 |
| Leg | 3 | 3.53 |
| Thigh | 2 | 2.35 |
| **Fall less than 2m** | | |
| Ankle and Foot | 2 | 2.35 |
| Leg | 4 | 4.71 |
| Thigh | 1 | 1.18 |
| **Fall more than 2m** | | |
| Leg | 3 | 3.53 |
| **Road traffic accident** | | |
| Ankle and Foot | 9 | 10.59 |
| Knee | 1 | 1.18 |
| Leg | 57 | 67.06 |
| Thigh | 2 | 2.35 |

**Table 3: Type of Reconstruction(n=85)**

| Type of Reconstruction | Number (%) |
|---|---|
| Amputation | 5(5.88%) |
| Free Flap | 1(1.18%) |
| PED. Flap | 16(18.82%) |
| Skin graft | 35(41.18%) |
| Transposition flap | 28(32.94%) |

A total of 24 patients (28.2%) developed complications. Infection was the most common complication (54.17%), followed by flap necrosis (16.67%), flap failure (12.5%), graft necrosis (8.33%), and hematoma (8.33%). Out of 52 patients who had open fractures, 16 of them developed complications. Among them, 20 were associated with high-velocity injuries and only 4 with low-velocity mechanisms. Additionally, 15 of the 24 patients with complications had comorbidities such as diabetes, hypertension, or hypothyroidism. The complications were addressed according to the hospital protocol, which ranged from upgrading antibiotics, regrafting, debridement, and reinsetting the flap to amputations, depending on the case and the severity of the complications (Table 4).

## DISCUSSION

This study examines patients who underwent lower limb reconstruction at a major trauma center in Nepal, focusing on demographics, injuries, and outcomes.

In our study, lower limb trauma disproportionately affects young adult men, with an average age of 27.97 years and comprising 67(78.82%) of cases. This demographic profile is supported by other Nepalese research, including a study on lower limb reconstruction that noted a similar patient cohort 73(66.4%) male, with a mean age of 38.7 years.[3–5] National data on road traffic accidents (RTAs) in Nepal confirms this, showing that victims are primarily males between 18 and 39 years old 62.1%, with a male-to-female ratio of 4.44:1.[3,4] A systematic review of injuries in Nepal also confirms that men are twice as susceptible to RTA victims, with the majority being young adults aged 15-40.[6] This vulnerability is often attributed to factors like greater mobility and engaging in high-risk behaviors like speeding or intoxicated driving.[3,5,7,8]

Table 4: Complications and type of injury(n=85)

| Type of injury/ Complications | Frequency(n) | Percentage(%) |
|---|---|---|
| **Closed Fractures** | | |
| Graft Necrosis | 1 | 1.18 |
| No complications | 5 | 5.88 |
| **Open Fractures** | | |
| Flap Failure | 3 | 3.53 |
| Flap Necrosis | 4 | 4.71 |
| Hematoma | 1 | 1.18 |
| Infection | 8 | 9.41 |
| No complications | 35 | 41.18 |
| **Soft Tissue Injuries** | | |
| Graft loss | 1 | 1.18 |
| Hematoma | 1 | 1.18 |
| Infection | 5 | 5.88 |
| No complications | 21 | 24.71 |

Trauma was the primary cause of lower limb defects, consistent with a similar Nepalese study where trauma accounted for 76(69.1%) of cases.[5] High-velocity injuries were significantly linked to subsequent complications, representing 20(83.3%) of such instances. This aligns with the global understanding that high-energy trauma leads to complex injuries with multifaceted outcomes.[9]

Infection was the most frequent complication, mirroring a study in Nepal, where wound infections accounted for 13(43%) of all complications.[5] Research from India also highlights infection as the predominant complication in severe lower limb trauma.[2]

The overall complication rate in our study was 24(28.2%), comparable to a similar procedure at another tertiary hospital in Nepal.[5] This falls within the range of 9.6% to 38% reported for lower limb reconstruction.[10,11] However, these rates are higher than those reported in a large-scale North American study using the National Trauma Data Bank (NTDB), which found incidences of surgical site infection (SSI) and amputation at 2% and 2.6%, respectively.[12] This variance may be due to differences in patient populations, initial injury severity, and follow-up protocols.

Pre-existing health conditions influence the outcomes. In our analysis, 15 of 24 patients with complications had comorbidities like diabetes, hypertension, or hypothyroidism; in our study, 5(20%) of the diabetes patients developed complications. The NTDB study found diabetes to be an independent risk factor for amputation after reconstruction (Odds Ratio [OR] 2.11).[12] Vascular interventions before reconstruction were strongly correlated with negative outcomes, including higher SSI (OR 1.99), amputation (OR 4.38), extended hospital stays (OR 1.59), and discharge to rehabilitation (OR 1.49).13 This suggests patients with

vascular damage likely have more severe trauma, compromising healing, similar to our study with open fractures, with more complications.

The choice of reconstructive procedure depends on the complexity of the condition.[2] Split-thickness skin grafts(STSGs) are used for healthy base wounds, while more complex defects require flaps. The largest number of patients underwent STSGs, followed by local flaps. Local flaps, such as gastrocnemius or soleus muscle flaps, are staples for smaller wounds.[14] Sixteen patients underwent pedicled flaps, while 28 patients received transposition flaps. Free tissue transfer is reserved for larger, more complicated defects, especially in the distal leg and foot. Free flaps may require longer hospital stays, but the risk of significant complications like SSI and amputation is similar between local and free flap procedures.[12] During our study period, only one free flap was done for a defect over the foot.

The decision between limb salvage and primary amputation remains a complex one. The LEAP study found no significant long-term differences in functional outcomes between the two paths, suggesting that social and economic resources have a greater impact on recovery than treatment.[15] While limb salvage is psychologically more acceptable, studies on military cohorts indicate amputees report better physical function and pain outcomes.[16] A secondary amputation after a failed salvage attempt doesn't necessarily result in inferior functional outcomes.[16] In our study, five patients underwent amputations. Factors guiding amputation include severe muscle damage, prolonged blood loss, and critical nerve injury affecting foot sensation.[15]

The standard of care for complex injuries is a multidisciplinary "orthoplastic" approach, which integrates expertise from both orthopedic and plastic surgery.[5,17] This collaborative model yields better clinical results, including a lower rate of deep infection in severe open tibial fractures compared to orthopedic treatment alone. [9,17] Over the last few years, the orthoplastic approach has become a standard practice in the National Trauma Center.[3]

Traditional doctrines, such as Godina's principles advocating for reconstruction within 72 hours, have been revised by modern evidence. 18 Negative Pressure Wound Therapy (NPWT) safely extends the window for soft tissue coverage to between 10 and 14 days without negatively affecting outcomes. Some studies have shown no increased complication risk for flaps performed 4-9 days post-injury compared to the 72-hour window, primarily due to the use of NPWT.[9] Early and thorough debridement remains critical, especially for highly contaminated wounds, but systematic reviews have found no definitive evidence that delayed debridement increases infection or non-union rates in open tibial fractures.[16] Meticulous surgical cleaning and appropriate antibiotic prophylaxis are essential, as confirmed by a Cochrane Review, which shows that antibiotics effectively reduce early infections in open fractures.[19] So both the plastic surgeons and orthopedic surgeons and are being involved from day one for the optimal care of the patients in our hospital.

Patient access to care in Nepal is frequently hindered by its status as a Low- and Middle-Income Country (LMIC) and its challenging geographical terrain, leading to presentation delays of up to a month post-injury. Our study's findings align with other research from Nepal, highlighting challenges in resource-limited healthcare systems. Optimizing patient outcomes in lower limb reconstruction requires a multidisciplinary orthoplastic approach, meticulous wound management, prompt evaluation, and careful patient selection.

The limitations of this study are short duration, single center study with no mention of the management of complication.

## CONCLUSION

Lower limb trauma requiring reconstruction is primarily due to high-energy injuries in young adults. Infection remains the most common complication. Comorbidities, especially diabetes, mode of injury, type of injury and timing of presentation remain the main risk factors for complications. Early presentation and adequate reconstructive planning with orthoplastic approach are essential for optimizing patient results.

## DECLARATION

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### Author contributions

KT did the Concept of research, Design of research, Literature search, Data collection, Data analysis, Data Interpretation, BB drafted the manuscript, and all authors reviewed the manuscript and approved the final version of the manuscript. All authors agreed to be accountable for all aspects of the research work.

### Ethical approval

This research was approved by the IRB of National Academy of Medical Sciences with Reference number 1420/2081/82.

### Consent

Informed written consent was obtained from all participants prior to data collection.

### Data Available statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

### Conflict of interest

There is no potential financial as well as non-financial conflict of interests related to all authors.

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