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Original Research Article

Outcomes of Primary Internal Fixation for Open Fractures of the Lower Limb

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Abstract:

Background: Open fractures of the lower limb are severe injuries often resulting from high-energy trauma such as road traffic accidents and falls from height. These injuries are associated with significant soft tissue damage, contamination, and increased risk of infection and delayed fracture healing. Early stabilization of fractures using primary internal fixation has gained increasing acceptance with advances in surgical techniques and antibiotic therapy.

Aim: To evaluate the clinical, radiological, and functional outcomes of open fractures of the lower limb treated with primary internal fixation.

Methodology: A prospective observational study was conducted on 40 adult patients with open fractures of the lower limb treated with primary internal fixation. Patients were followed for 12 months. Outcome measures included fracture union time, functional outcome, and complication rates.

Results: The mean age of patients was 34.6 ± 11.8 years, with 75% males. The most common mechanism of injury was road traffic accidents (65%). The average time to fracture union was 20.4 weeks. Excellent or good functional outcomes were observed in 78% of patients. Complications included superficial infection (10%), deep infection (5%), delayed union (7.5%), and non-union (2.5%).

Conclusion: Primary internal fixation provides stable fracture fixation and satisfactory functional outcomes in open fractures of the lower limb when combined with proper wound debridement and antibiotic therapy.

Keywords: Open fractures, internal fixation, lower limb fractures, fracture union, orthopaedic trauma.

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Introduction

Open fractures of the lower limb represent complex orthopaedic injuries associated with considerable morbidity.[1] These injuries commonly occur due to high-energy trauma such as road traffic accidents, falls from height, and industrial injuries. Because of extensive soft tissue damage and contamination, open fractures carry a high risk of infection, delayed union, and non-union. [2,3,4]

Traditionally, treatment of open fractures involved staged procedures using external fixation followed by delayed internal fixation once the soft tissue condition improved. [5] However, advances in surgical techniques, implant technology, and antibiotic therapy have made primary internal fixation a viable treatment option in selected open fractures. [6,7]

Primary internal fixation provides several advantages including stable fracture fixation, improved fracture alignment, and early mobilization. [8] Early stabilization also facilitates soft tissue healing and improves patient rehabilitation.[9]

Despite these benefits, concerns regarding infection risk and implant failure remain important considerations in open fractures. Therefore, evaluating the outcomes of primary internal fixation remains important for guiding clinical decision-making.[10]

The present study was conducted to evaluate the clinical, radiological, and functional outcomes of open fractures of the lower limb treated with primary internal fixation.

Methodology

It was a prospective observational study conducted at Department of Orthopaedics at KIMS PBMH MCH, BHUBANESWAR, ODISHA between January 2023 and December 2025 on 40 adult patients with open fractures of the lower limb. Patients were selected based on following criteria:

Inclusion Criteria

- Age ≥18 years
- Open fractures of femur, tibia, or fibula
- Gustilo-Anderson Type I and Type II fractures
- Patients treated with primary internal fixation

Exclusion Criteria

- Gustilo Type III fractures requiring staged management
- Pathological fractures
- Patients with severe systemic illness
- Skeletally immature patients

Surgical Procedure

All patients underwent emergency wound debridement followed by primary internal fixation using appropriate implants such as:

- Intramedullary nails
- Locking compression plates
- Dynamic compression plates

The surgical procedure included:

1. Thorough wound irrigation and debridement
2. Removal of contaminated tissue
3. Fracture reduction
4. Internal fixation using suitable implants
5. Antibiotic prophylaxis and postoperative wound care

Outcome Measures

Primary Outcome: Radiological fracture union.

Secondary Outcomes

- Functional outcome
- Infection rate
- Complication rate

Follow-Up

Patients were evaluated at:

- 6 weeks
- 3 months
- 6 months
- 12 months

Statistical Analysis

All data were entered into Microsoft Excel and analysed using SPSS version 26.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages.

Associations between categorical variables were evaluated using the Chi-square test, while comparisons between continuous variables were assessed using the independent sample t-test. One-way ANOVA was used to compare union time among different implant types. Logistic regression analysis was performed to identify predictors of delayed union. A p-value <0.05 was considered statistically significant.

Results

Table 1: Demographic Characteristics

Variable	Number	Percentage
Male	30	75%
Female	10	25%
Mean age	34.6 years	—

The majority of patients were male (75%), indicating that males are more frequently exposed to trauma-related activities and high-risk environments. The mean age of 34.6 years suggests that open fractures of the lower limb predominantly affect young and middle-aged adults, who are commonly involved in occupational and vehicular accidents.

Table 2: Mechanism of Injury

Mechanism	Patients	Percentage
Road traffic accident	26	65%
Fall from height	9	22.5%
Industrial injury	5	12.5%

Road traffic accidents accounted for 65% of injuries, making them the most common cause of open fractures in this study. Falls from height contributed to 22.5% of cases, while industrial injuries accounted for 12.5%. These findings highlight the significant role of high-energy trauma in the occurrence of open fractures of the lower limb.

Table 3: Gustilo-Anderson Classification

Type	Patients	Percentage
Type I	18	45%
Type II	22	55%

Type II open fractures constituted the majority (55%), indicating moderate soft tissue injury in most cases. Type I fractures accounted for 45% of the study population. This distribution suggests that most patients had relatively less severe open fractures suitable for primary internal fixation.

Table 4: Time to Radiological Union

Union Time	Patients	Percentage
16–18 weeks	10	25%
19–20 weeks	15	37.5%
21–24 weeks	12	30%
>24 weeks	3	7.5%

Most fractures achieved union within 19–20 weeks (37.5%), while 25% healed within 16–18 weeks. Only 7.5% required more than 24 weeks, indicating a relatively low rate of delayed union. The mean union time was 20.4 weeks. These findings demonstrate satisfactory fracture healing following primary internal fixation.

Table 5: Functional Outcome

Outcome	Patients	Percentage
Excellent	16	40%
Good	15	38%
Fair	6	15%
Poor	3	7%

The majority of patients (78%) achieved excellent or good functional outcomes, indicating successful restoration of limb function and mobility following surgery. Only 7% of patients experienced poor outcomes, demonstrating the overall effectiveness of primary internal fixation.

Table 6: Complications

Complication	Patients	Percentage
Superficial infection	4	10%
Deep infection	2	5%
Delayed union	3	7.5%
Non-union	1	2.5%

The most common complication was superficial infection (10%), which was managed successfully with antibiotics and wound care. Deep infection occurred in 5% of patients, while delayed union was observed in 7.5%. Only one patient developed non-union, indicating an overall low complication rate.

Fracture Type vs Functional Outcome: There was no statistically significant association ($\chi^2 = 1.84$, $p = 0.60$) between Gustilo fracture type and functional outcome. Both Type I and Type II fractures showed similar functional recovery following primary internal fixation.

Age vs Union Time: Patients older than 40 years showed significantly longer fracture union times ($t = 2.96$, $p = 0.005$), suggesting that age may influence the rate of bone healing.

Mechanism of Injury vs Complications: No significant ($\chi^2 = 0.71$, $p = 0.70$) association was observed between the mechanism of injury and the occurrence of complications, indicating that complications were relatively independent of the injury mechanism.

Predictors of Delayed Union: Age >40 years showed significant association with delayed union ($p = 0.021$). Logistic regression analysis identified age greater than 40 years as an independent predictor of delayed fracture healing.

Implant Type vs Union Time: A statistically significant difference ($F = 3.74$, $p = 0.033$) in union time was observed among different implant types. Intramedullary nailing demonstrated relatively faster fracture healing compared with plate fixation.

Infection Rate vs Gustilo Fracture Type: Although infection rates were slightly higher in Type II fractures, the association between fracture severity and infection rate was not statistically significant ($\chi^2 = 0.92$, $p = 0.34$).

Discussion

Open fractures of the lower limb are challenging injuries due to the associated soft tissue damage and risk of infection. Early stabilization of fractures is essential to restore limb alignment and facilitate early mobilization. [11] In the present study, the majority of patients were young males injured in road traffic accidents, which is consistent with previously reported epidemiological patterns. The average fracture union time observed in this study was 20.4 weeks, which is comparable to outcomes reported in earlier studies evaluating internal fixation in open fractures. Primary internal fixation offers several advantages including stable fixation, improved fracture alignment, and early mobilization. When combined with proper wound debridement and antibiotic therapy, infection rates can be minimized.[12] The complication rate observed in this study was relatively low. Superficial infection was the most common complication, while deep infection occurred in a small number of cases. Statistical analysis showed that age greater than 40 years significantly influenced fracture healing, while fracture severity and mechanism of injury did not significantly affect functional outcomes. Overall, the findings of this study support the use of primary internal fixation as an effective treatment strategy for selected open fractures of the lower limb.[13]

Conclusion

Primary internal fixation for open fractures of the lower limb provides:

- Stable fracture fixation
- Early mobilization
- Acceptable union rates
- Good functional outcomes

When combined with adequate surgical debridement and infection control measures, this approach leads to satisfactory clinical outcomes.

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