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ORIGINAL RESEARCH

A retrospective, observational study to evaluate different bone fixation techniques and skin coverage methods in the treatment of open leg fractures in high-risk environments

[1]Dr. Aditya, [2]Dr. Pradeep Kamboj, [3]Dr. Mohit Khanna, [4]Dr. Sahil Arora

[1]Junior Resident, Department of orthopaedics, PGIMS, Rohtak, Haryana, India
[2]Sr. Professor and Unit Head, Department of orthopaedics, PGIMS, Rohtak, Haryana, India
[3]Professor, Department of orthopaedics, PGIMS, Rohtak, Haryana, India
[4]Associate Professor, Department of orthopaedics, PGIMS, Rohtak, Haryana, India

Corresponding Author
Dr. Aditya
Junior Resident, Department of orthopaedics, PGIMS, Rohtak, Haryana, India

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ABSTRACT

Aim: The objective of this study was to evaluate different bone fixation techniques and skin coverage methods in the treatment of open leg fractures in high-risk environments.**Methods:** This retrospective, observational study was conducted over a four-year period, involving patients aged 15 years and older who underwent osteosynthesis and plastic surgical procedures for fracture site coverage. A total of 50 patients were included in the study.**Results:** The study cohort comprised 40 men and 10 women. The leading cause of injury was road traffic accidents (90%, n=40), followed by workplace accidents involving heavy objects falling on the leg (10%, n=5). Based on the Gustilo and Anderson classification, wounds were classified as Type II (40%, n=20) and Type IIIB (60%, n=30).**Conclusion:** Open leg fractures are common and severe injuries, with a rising incidence primarily due to the increase in road traffic accidents. These fractures have a significant socioeconomic impact, particularly affecting young, active males. Their management poses a considerable challenge in daily clinical practice.Following meticulous debridement and tissue trimming, external fixation is the most frequently used bone stabilization technique, while muscle flaps are preferred for covering extensive soft tissue defects. The study's results were satisfactory and comparable to findings from similar research conducted under analogous conditions.
Based on the AO classification, the tibial fracture was categorized as simple in 54% of cases and complex in 46%.

Key words: Leg, type II and IIIB open fractures, external fixator, centromedullary nail, fasciocutaneous flap, muscle flap

INTRODUCTION

An open fracture occurs when a broken bone and/or surrounding hematoma are exposed to the external environment due to a traumatic disruption of the soft tissue and skin[1].The severity of open fractures varies, ranging from cases that can be sutured primarily after debridement to more complicated injuries requiring advanced reconstructive techniques. These injuries often result from high-impact trauma and can present a dramatic clinical picture, sometimes diverting focus from more critical, life-threatening conditions. Therefore, it is imperative to follow the Advanced Trauma Life Support (ATLS) protocol to identify and manage any potentially fatal injuries first. The initial evaluation should always take precedence, with necessary life-saving interventions implemented immediately.1 Timely and effective resuscitation is a key determinant in reducing fatality rates, minimizing infection risks, and promoting optimal wound healing. Once the patient is stable, open fractures must be promptly examined and treated. Standard radiographs are typically sufficient to evaluate the extent and complexity of the fracture, while a computed tomography (CT) scan may be required for a more detailed assessment if the patient is hemodynamically stable. In cases where peripheral pulses are absent, a

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CT angiogram can help detect vascular compromise[2].Thorough documentation of neurovascular injuries, along with capturing wound photographs, is an essential aspect of routine clinical assessment. Several factors-including patient demographics, injury characteristics, systemic response, pre-existing conditions, and functional demands-play a role in determining the most appropriate treatment plan. While the National Institute for Health and Care Excellence (NICE) discourages wound irrigation in emergency settings[3], the International Consensus Meeting (ICM) on Musculoskeletal Infection supports its application to remove visible contaminants before dressing the wound[4].

Proper wound cleansing and sterile dressing can help minimize contamination and allow time for comprehensive debridement[5].The initial phase of open fracture management plays a pivotal role in determining overall prognosis. In addition to antimicrobial therapy, treatment typically involves wound excision, fracture immobilization, and coverage of the injury site[6, 7].Bone stabilization techniques include external fixation devices and internal stabilization methods such as intramedullary nailing and bone plating.8 In cases of soft tissue loss, coverage is achieved using fasciocutaneous flaps or musculocutaneous grafts.

This study aims to analyze various bone fixation methods and skin reconstruction techniques used in the management of open leg fractures in resource-constrained settings.

MATERIALS AND METHODS

This study was a retrospective, descriptive analysis conducted over a four-year period. It included patients aged 15 years and older who had undergone osteosynthesis and surgical coverage for open leg fractures. A total of 50 patients were enrolled in the study.

EXCLUSION CRITERIA

The following cases were excluded:

- Leg crush injuries.
- Type I and Type II open fractures that healed successfully after suturing in the emergency department.
- Open leg fractures with delayed presentation after the onset of infection.
- Study Parameters.

THE STUDY EXAMINED

- Age and sex of the patients
- Type of injury
- Method of osteosynthesis
- Fracture site coverage techniques
- Clinical and anatomical outcomes at the final follow-up

Skin injuries were classified based on the Gustilo-Anderson system[9], while bone fractures werecategorized using the AO classification.

INITIAL EMERGENCY MANAGEMENT

- Upon arrival at the emergency department, wounds were medically treated using the following protocol:
- Minimal irrigation with a saline solution.
- Application of an antiseptic solution.
- Sterile dressing.
- Temporary fracture immobilization using a splint.

Antibiotic therapy included an initial loading dose of 2g amoxicillin-clavulanic acid administered intravenously, followed by 1 g every 8 hours. For highly contaminated wounds, ceftriaxone (2 g daily) was preferred, combined with metronidazole (500 mg three times daily). Tetanus prophylaxis was systematically provided through tetanus toxoid and human tetanus immunoglobulin.

SURGICAL MANAGEMENT

In the operating room, under anesthesia, the patient underwent:

Extensive wound irrigation, often using tap water, followed by physiological saline.

Meticulous debridement and tissue trimming.

Bone stabilization was achieved using either an external fixator or a centromedullary nail, depending on implant availability and the surgeon’s preference. The fracture site was covered either immediately or in a subsequent procedure, depending on wound condition and the patient’s socio-economic status.

For soft tissue coverage, a fasciocutaneous flap or a muscle flap was used, selected based on the extent of skin loss and the surgeon’s expertise. Anatomical and functional outcomes were evaluated using modified Ketenjian criteria after an average follow-up period of 28 months.

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RESULTS

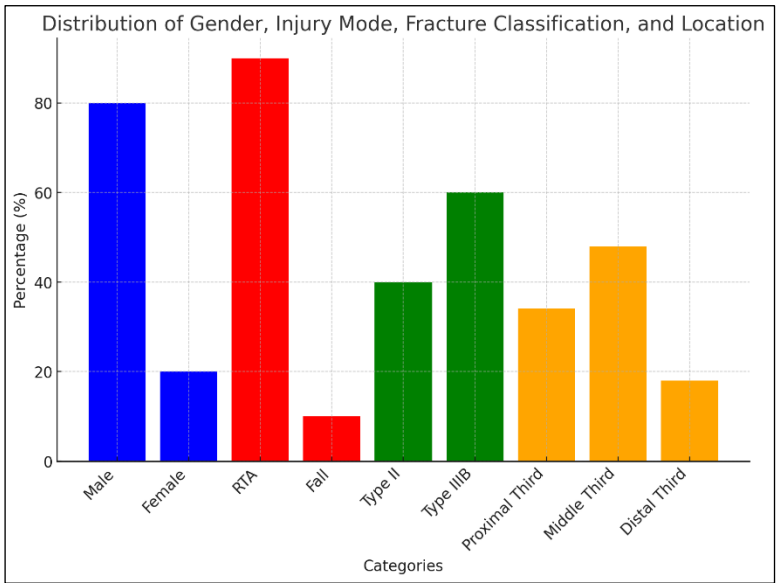

Figure 1: Baseline characteristics

The study included 40 males (80%) and 10 females (20%). The majority of injuries were attributed to road traffic collisions (RTC) (90%, n=45), whereas workplace mishaps involving a heavy object striking the leg accounted for 10% (n=5).

Based on the Gustilo-Anderson classification, 40% (n=20) of cases were categorized as Type II wounds, while 60% (n=30) were designated as Type IIIB injuries.

The fractures were distributed as follows:

UPPER (PROXIMAL) THIRD OF THE LEG:34% (n=17).

CENTRAL (MIDDLE) THIRD:48% (n=24).

LOWER (DISTAL) THIRD:18% (n=9).

Table 2: AO Classification

	AO classification	Number	Percentage
Oblique	A2	16	32
Transverse	A3	11	22
With 3rd fragment	B2	15	30
Partial comminution	B3	8	16
Total		50	100

According to the AO classification, the fracture line on the tibia was simple in 54% and complex in 46% of cases.

Table 3: Flap types

Types	Fracture site	Number
Muscle flap		
Soleus with distal hinge	Middle third, distal third	14
Soleus with proximal hinge	Middle third, proximal third	8
Gastrocnemius	Proximal third	6
Fasciocutaneous flaps		
Sural with distal hinge	Middle third, distal third	15
Cross leg	Proximal third	5
Gliging flap	Distal third	2
Total		50

The fracture site was covered by a fasciocutaneous flap (44%; n=22) and a muscle flap (56%; n=28).

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Table 4: Ketenjian evaluation criteria

Ketenjian evaluation criteria	N	%
Excellent	20	40
Very good	10	20
Good	15	30
Poor	5	10

According to the Ketenjian evaluation criteria, results were judged to be excellent and very good (60%, n=30); good (30%, n=15) and poor (10%, n=5).

DISCUSSION

Open leg fractures are prevalent due to the tibia's subcutaneous position, accounting for 8-10% of musculoskeletal traumatic injuries. In developing countries, they are primarily caused by road accidents, especially those involving two-wheeled vehicles, and frequently affect young adults[13, 14].These fractures result from high-energy trauma, often leading to multi-tissue damage that can impair limb function[15].They are serious injuries, with infection rates ranging from 2% to 40% and a nonunion rate of approximately 23%[16, 17].

Among the cases studied, 40 were men and 10 were women. The majority of fractures were caused by road traffic accidents (90%, n=40), while the remaining cases were due to workplace incidents involving heavy objects falling on the leg (10%, n=5). Studies indicate that road accidents are the leading cause of open leg fractures[18-20]. The leg is particularly vulnerable due to the tibia's subcutaneous location[21].Based on the Gustilo and Anderson classification, the fractures were categorized as Type II (40%, n=20) and Type IIIB (60%, n=30). Their anatomical distribution was as follows: proximal third (34%; n=17), middle third (48%; n=24), and distal third (18%; n=9).

According to the AO classification, 54% of the fractures had a simple pattern, while 46% were complex. Soft tissue coverage of the fracture site was achieved using fasciocutaneous flaps in 44% (n=22) of cases and muscle flaps in 56% (n=28). Based on the Ketenjian evaluation criteria, outcomes were classified as excellent and very good in 60% (n=30), good in 30% (n=15), and poor in 10% (n=5).

Historically, external fixation has been the preferred method of bone stabilization for open fractures due to its effectiveness in infection control[15, 19].Other benefits include the speed of the procedure, management of associated injuries, and the ability to facilitate soft tissue reconstruction. However, since the 1990s, complications such as pin tract infections, the necessity for repeat surgeries before bone consolidation, and patient discomfort have led to a shift toward internal endomedullary osteosynthesis[8, 13].

External fixators play a critical role in damage control orthopedics and are commonly used in staged fracture management when the GHOISS score is above 9[22].This approach is minimally invasive, reduces additional soft tissue damage and ensures stable skeletal stabilization. Proper pin placement is crucial to allow for subsequent soft tissue reconstruction, which should be assessed during debridement. Pins must be inserted through intact skin, avoiding the wound, to facilitate tissue healing.

Previously, internal fixation was often avoided due to concerns about infection, biofilm formation, and potential compromise of blood supply. However, advancements in debridement techniques have improved infection control, making internal fixation a more widely accepted option. When applied correctly, internal fixation can enhance healing and functional recovery. Primary internal fixation is suitable for open fractures with a GHOISS score below 9, minimal contamination, limited soft tissue involvement, and patient stability[23]. Proper debridement and careful handling of bone fragments to prevent devascularization are essential. Definitive fixation of upper limb fractures can be performed unless there is significant organic contamination (Grade C recommendation)[24].

A study by Rajasekaran*et al*.[25] reported excellent results, with only a 3% incidence of deep infection following immediate primary skin closure in Type III fractures when strict inclusion and exclusion criteria were applied.

CONCLUSION

Open leg fractures are prevalent and severe injuries, with their incidence rising due to the growing number of road traffic accidents. These injuries have a notable social impact, primarily affecting young, active men. Managing such cases presents a significant challenge in daily medical practice. Following meticulous debridement and wound preparation, external fixation is commonly employed for bone stabilization, while muscle flaps are frequently utilized for skin coverage. Our findings demonstrate promising outcomes, aligning with results observed in similar studies conducted under comparable conditions.

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