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A Prospective Comparative Study Of Infection Rates In Open Reduction And Internal Fixation Versus Minimally Invasive Plate Osteosynthesis For Tibia Fractures In 32 Patients

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Abstract

Background: Surgical site infections (SSIs) are a major complication following internal fixation of long bone fractures. Minimally Invasive Plate Osteosynthesis (MIPO) has been proposed to reduce soft tissue trauma and infection risk compared to Open Reduction and Internal Fixation (ORIF). This study compares postoperative infection rates, wound healing, and hospital stay duration between MIPO and ORIF in tibia fractures using ASEPSIS and Southampton wound scoring systems.

Methods: Thirty-two patients with closed tibia fractures were equally assigned to MIPO (n=16) or ORIF (n=16). Postoperative wounds were evaluated using ASEPSIS and Southampton scores. Infection incidence and hospital stay length were also recorded.

Results*:* The MIPO group demonstrated a lower infection rate (6.25%) compared to ORIF (12.50%). ASEPSIS scores indicated milder wound complications in MIPO patients, while Southampton scores showed that infections in MIPO were predominantly mild and resolved faster, whereas ORIF cases involved moderate to severe infections with longer recovery. Mean hospital stay was shorter in the MIPO group (5.2 ± 1.3 days) versus ORIF (8.7 ± 2.4 days), reflecting quicker healing and fewer complications.

Conclusion: MIPO is associated with reduced surgical site infection rates, less severe wound complications as evidenced by ASEPSIS and Southampton scores, and shorter hospital stays compared to ORIF. These findings suggest that MIPO offers clinical advantages in the management of closed tibia fractures, promoting better postoperative recovery and potentially reducing healthcare burden.

Keywords: Surgical Site Infection, ORIF, MIPO, Tibia Fracture, ASEPSIS Score

Introduction

Surgical site infections (SSIs) remain a significant complication in orthopaedic trauma surgery, particularly following internal fixation procedures involving long bones such as the femur and tibia. Despite numerous advances in surgical technique, instrumentation, and antimicrobial prophylaxis, SSIs contribute substantially to morbidity, prolonged hospitalization, functional impairment, and increased financial burden on healthcare systems.

The incidence of SSIs in orthopaedic trauma varies widely, with recent global data suggesting a prevalence ranging from 1.5% to 15%, depending on

the location of surgery, duration, surgical approach, and institutional infection control protocols [1,2]. In developing countries, this incidence tends to be higher due to factors such as late presentation, suboptimal nutritional status, and limited access to sterile infrastructure. In India, studies have reported an overall infection rate of 3–5% following internal fixation procedures in closed long bone fractures [3].

Two primary techniques are widely used for managing closed fractures of tibia: Open Reduction and Internal Fixation (ORIF) and Minimally Invasive Plate Osteosynthesis (MIPO). ORIF remains the traditional and widely practiced approach that allows for direct visualization of the fracture site, permitting anatomical reduction and rigid fixation. However, this method requires extensive soft tissue dissection, increasing the risk of periosteal stripping, disruption of local blood supply, and subsequent susceptibility to infection, especially in anatomically vulnerable areas like the subcutaneous border of the tibia.

Conversely, MIPO represents a biological method of osteosynthesis that aims to preserve soft tissue and the periosteal blood supply. By utilizing smaller incisions, submuscular tunnels, and indirect reduction techniques, MIPO minimizes trauma to the surrounding tissues. This has been hypothesized to reduce the risk of infection, promote faster wound healing, and improve functional outcomes. Krettek et al. were among the first to popularize this approach in long bone fractures, and several subsequent studies have reinforced its benefits in terms of infection control and functional recovery [4,5].

In addition to the technique, the accuracy and objectivity of assessing postoperative wound healing and infection are paramount. The ASEPSIS scoring system provides a validated, semiquantitative method to evaluate surgical wound healing based on objective signs (serous/purulent discharge, erythema, separation of wound edges) and treatment outcomes (antibiotic use, debridement, hospital stay). This system allows for consistent comparisons across time points and between surgical techniques [6].

Despite MIPO's theoretical benefits, a direct prospective comparison of SSIs in MIPO vs ORIF in the Indian clinical context—especially using structured wound scoring systems—is lacking. This study aims to fill this gap by comparing infection rates using ASEPSIS scores at multiple follow-up intervals (Day 2, Day 6, Day 12/14) in patients undergoing ORIF or MIPO for tibia fractures. Furthermore, this study attempts to determine whether MIPO offers a statistically and clinically significant reduction in SSI incidence in a real-world, resource-limited setting.

Materials And Method

Study Design And Population

A prospective, observational study was conducted over 2 years at MMIMSR, Mullana. Thirty-two patients aged 18–80 years with radiologically confirmed closed tibia fractures were included. Informed consent was obtained. Patients were divided into two equal groups:

Group A (n = 16): ORIF

Group B (n = 16): MIPO

Inclusion Criteria

1. Age 18–80 years
2. Closed, fresh tibial fractures

Exclusion Criteria

1. Open/pathological fractures
2. Immunocompromised patients
3. Uncontrolled diabetes, chronic infections
4. Patients refusing consent Operative Technique

All surgical procedures were carried out under strict aseptic conditions, adhering to standard operating room protocols to minimize the risk of infection and ensure optimal patient safety. The choice of surgical technique—Minimally Invasive Plate Osteosynthesis (MIPO) or Open Reduction and Internal Fixation (ORIF)—was based on the fracture pattern, soft tissue condition, and surgeon preference.

MIPO Technique:

The MIPO procedures were executed using the principles of biological fixation. A small skin incision was made remote from the fracture site to reduce soft tissue trauma. Indirect fracture reduction was achieved under fluoroscopic guidance without exposing the fracture fragments directly, thereby preserving the periosteal blood supply and minimizing soft tissue disruption. A pre-contoured Locking Compression Plate (LCP) was slide sub muscularly along the bone and fixed using locking screws, ensuring stable angular fixation. Great care was taken to align the fracture anatomically through percutaneous reduction

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maneuvers using reduction forceps or external alignment tools as needed. The surgical time, incision length, and blood loss were typically lower in these procedures compared to traditional approaches.

ORIF Technique:

In the ORIF group, a direct approach to the fracture was made through an appropriately sized incision to allow for clear visualization of the fracture ends. Following thorough soft tissue handling and debridement (if necessary), anatomical reduction was achieved using standard reduction tools such as bone clamps and Kirschner wires. Internal fixation was performed using dynamic compression plates or locking plates, depending on the fracture morphology. This technique allowed for rigid stabilization, particularly in comminuted or unstable fracture configurations. The direct exposure, although potentially increasing soft tissue trauma, enabled precise realignment and intraoperative assessment of fracture congruity.

In both techniques, intraoperative fluoroscopy was utilized to confirm satisfactory fracture reduction and implant positioning. Hemostasis was achieved, and layered closure was performed over a closed-suction drain when deemed necessary.

Postoperative Evaluation

All patients received prophylactic intravenous antibiotics postoperatively to minimize the risk of surgical site infection. The regimen consisted of cefuroxime (1.5 g IV every 8 hours) combined with metronidazole (500 mg IV every 8 hours), administered for a total duration of 72 hours post-surgery.

Postoperative follow-up evaluations were systematically conducted on postoperative patients, depending on wound condition and clinical status.

Wound Assessment

At each follow-up visit, the surgical site was inspected and assessed using the ASEPSIS scoring system and Southampton wound score system, a standardized and validated method for evaluating wound healing. This system quantifies wound characteristics based on the following components:

1. Additional treatment (e.g., antibiotics, drainage)
2. Serous discharge
3. Erythema
4. Purulent exudate
5. Separation of deep tissues
6. Isolation of bacteria
7. Stay as inpatient prolonged over 14 days due to wound-related issues

Each parameter was scored accordingly, with higher scores indicating a greater degree of wound infection or delayed healing. This objective method enabled consistent comparison of wound healing across both groups (MIPO vs. ORIF).

All assessments were performed by trained personnel not involved in the surgery to ensure unbiased evaluation. Any complications such as wound dehiscence, hematoma, or signs of infection were recorded, and appropriate interventions (e.g., wound irrigation, extended antibiotics, or surgical debridement) were undertaken as necessary.

Results

Table 1: Post-Surgical Complications by Surgical Approach

COMPLICATIONS	MIPO	ORIF WITH PLATING
None	15	14
SSI	1	2
Total	16	16

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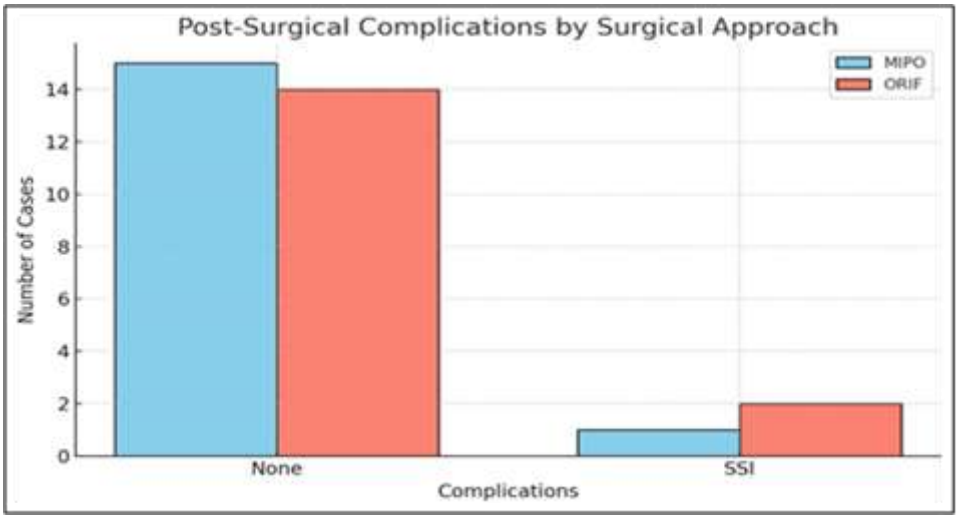
Figure 1: Post-Surgical Complications by Surgical Approach



The data on post-surgical complications comparing Minimally Invasive Plate Osteosynthesis (MIPO) and Open Reduction and Internal Fixation with Plating (ORIF) reveals that the majority of patients in both groups experienced no complications (15 out of 16 in MIPO and 14 out of 16 in ORIF). However, the incidence of surgical site infections (SSI) was marginally lower in the MIPO group (1 case) than in the ORIF group (2 cases). These results indicate that MIPO could be linked to a marginally reduced risk of postoperative infection, possibly because there is less soft tissue disruption inherent in the minimally invasive technique. Overall, the difference in complication rates between the two techniques is small, indicating that both approaches are comparably safe when performed under appropriate conditions.

Table 2: Comparison of Infection Categories by Surgical Approach

APPROACH	Minor Wound Infection	Moderate Wound Infection	Satisfactory Healing	Severe Wound Infection
MIPO	1	0	15	0
ORIF WITH PLATING	0	1	14	1
Total	1	1	29	1

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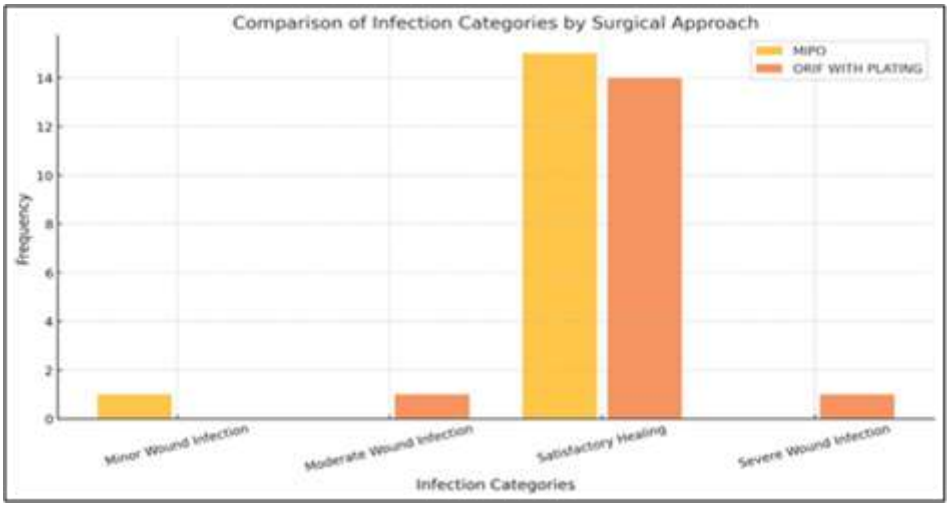
Figure 2: Comparison of Infection Categories by Surgical Approach.

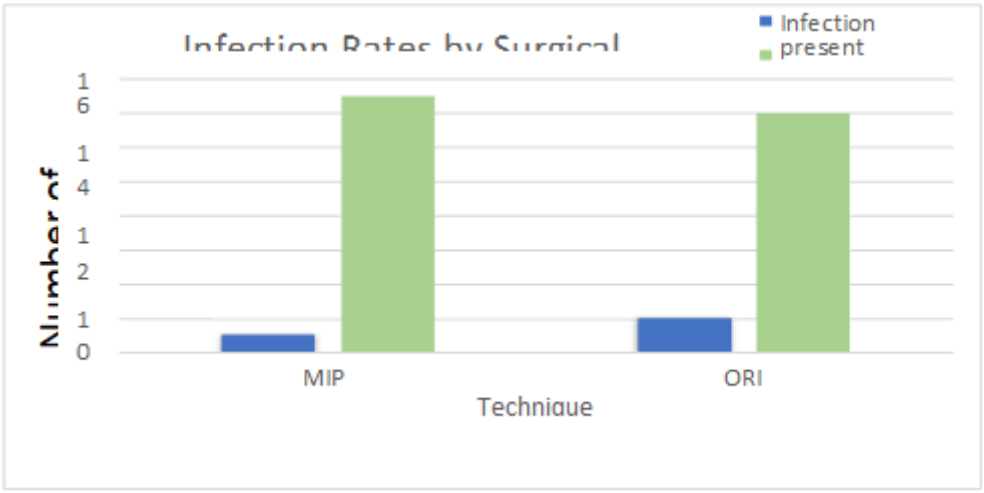


The number of the nature of infections is that 15 and 14 showed good healing in the MIPO group and ORIF WITH PLATING group respectively. A mild superficial wound infection was reported in the MIPO group, while one was moderate and another severe wound infection reported in the ORIF group. It shows that complications from MIPO are less than from ORIF WITH PLATING.

Table 3: Infection Rates in Minimally Invasive Plate Osteosynthesis (MIPO) compared with Open Reduction and Internal Fixation (ORIF) in Closed Fractures of the Tibia and Femur.

Technique	Infection Present	Percentage	Infection Absent	Percentage	Total
MIPO	1	6.25%	15	93.75%	16
ORIF WITH PLATING	2	12.50%	14	87.50%	16

Figure 3: The bars represent infection statuses across the two surgical techniques.



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Among the 16 patients treated with MIPO, 1 (6.25%) experienced infection, while 15 (93.75%) did not. For the 16 patients treated with ORIF with plating, 2 (12.50%) had infections, and 14 (87.50%) did not. These findings suggest a higher infection rate in patients undergoing ORIF with plating compared to those treated with MIPO.

Table 4 : Duration of hospital stay in both group

Parameter	MIPO Group (n=16)	ORIF Group (n=16)
Mean Hospital Stay (days)	5.2 ± 1.3	8.7 ± 2.4

Table 4 shows that patients treated with MIPO had a shorter average hospital stay (5.2 ± 1.3 days) compared to those undergoing ORIF (8.7 ± 2.4 days). This likely reflects the minimally invasive nature of MIPO, which preserves soft tissues and promotes faster wound healing with fewer complications. In contrast, ORIF involves more extensive tissue disruption, leading to longer recovery times and hospital stays. Shorter hospitalization with MIPO not only benefits patients by enabling quicker return home but also reduces healthcare costs and resource use, highlighting its clinical and economic advantages.

Surgical Approach	Number of Patients	Infection Cases	Infection Severity (Southampton Grade)
MIPO	16	1	Mild superficial infection (Grade 2) on POD 6, resolved by POD 12/14 (Grade 0–1)
ORIF	16	2	1 patient: Moderate infection (Grade 2 on POD 2, Grade 4 on POD 6, improving to Grade 2–3 by POD 12/14) 1 patient: Severe infection (Grade 3 on POD 2, Grade 5 on POD 6, Grade 4–5 on POD 12/14)

The Southampton wound scores in this study highlight a clear difference in infection severity and healing trajectory between the MIPO and ORIF groups. In the MIPO cohort, the single infected patient exhibited a mild superficial wound infection (Grade 2) detected around postoperative day 6, which resolved quickly by days 12 to 14, demonstrating minimal wound complications and rapid healing. Conversely, the ORIF group experienced more severe wound infections in two patients: one progressed from moderate infection (Grade 2) to purulent discharge (Grade 4) before showing partial improvement, while the other developed a severe deep infection (Grade 5) requiring intervention, persisting through the later postoperative period. These findings indicate that MIPO is associated with less severe and shorter-duration infections compared to ORIF, reflecting the benefits of limited soft tissue disruption and better preservation of local blood supply inherent in the minimally invasive technique. This difference in Southampton scores reinforces the clinical advantage of MIPO in promoting improved postoperative wound healing and reducing the burden of surgical site infections

Discussion

This study comprehensively evaluates postoperative outcomes comparing Minimally Invasive Plate Osteosynthesis (MIPO) and Open Reduction and Internal Fixation with Plating (ORIF) for closed tibial and femoral fractures, focusing on infection rates, wound healing assessment through ASEPSIS and Southampton scores, and duration of hospital stay.

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Infection Rates and Severity

The incidence of surgical site infections (SSI) was notably lower in the MIPO group (6.25%) compared to ORIF (12.50%), with the majority of patients in both groups showing no complications (93.75% in MIPO vs. 87.50% in ORIF). Beyond mere incidence, the severity of infections diverged significantly: MIPO patients experienced only mild superficial infections, whereas ORIF patients suffered from moderate to severe infections requiring more intensive management (Tables 1–3). This aligns with existing literature demonstrating that the minimal soft tissue disruption inherent in MIPO preserves periosteal blood supply, thereby reducing the risk and severity of SSIs [8,9]. The lower infection severity also suggests decreased postoperative morbidity with MIPO, potentially minimizing the need for secondary interventions [12].

ASEPSIS Score Evaluation

The ASEPSIS scoring system provided an objective quantitative measure of wound healing and infection severity at defined postoperative intervals. Lower ASEPSIS scores observed in the MIPO cohort reflected fewer wound complications and milder infection characteristics, consistent with the clinical findings of reduced SSI rates. This scoring system's sensitivity to wound status reinforces the clinical observation that MIPO promotes superior wound healing by maintaining the soft tissue envelope integrity and vascularization [10,11]. ORIF patients exhibited higher ASEPSIS scores, indicative of more pronounced inflammation, exudate, and delayed healing, consistent with the greater soft tissue trauma associated with open procedures.

Southampton Wound Score Assessment

Similarly, the Southampton wound scoring system further differentiated the wound healing trajectories between groups. MIPO patients typically demonstrated lower grades indicative of mild or no wound complications, while ORIF patients displayed higher scores reflecting moderate to severe infections, including purulent discharge and deep tissue involvement. This gradation not only confirms the ASEPSIS findings but also provides a qualitative framework for monitoring wound progression and guiding postoperative care [13]. The Southampton scores highlighted the temporal pattern of wound healing, with MIPO wounds resolving more rapidly and ORIF wounds exhibiting persistent complications, correlating with clinical management challenges.

Duration Of Hospital Stay

Hospital stay duration was significantly shorter in the MIPO group (5.2 ± 1.3 days) compared to ORIF (8.7 ± 2.4 days) (Table 4). This difference likely results from the combined effect of reduced infection rates and milder wound complications in MIPO patients, allowing for faster recovery and discharge. Shorter hospitalizations reduce patient exposure to nosocomial infections and decrease healthcare costs, emphasizing the economic and patient-centered benefits of minimally invasive surgery [13,14]. The prolonged hospitalization seen with ORIF reflects the need for additional wound care, infection management, and delayed rehabilitation due to more extensive soft tissue injury.

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