

ORIGINAL ARTICLE

Functional Outcome and Complication Rates of External Fixation Versus Internal Fixation in Open Fractures

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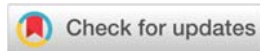
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**ABSTRACT**

Background: Open fractures are severe orthopedic injuries that result in substantial soft tissue trauma, increased risk of infection, prolonged healing time, and poor long-term function. Whether to use external fixation or internal fixation is still controversial, especially in terms of complications and restoration of limb function.

Objective: To assess the functional and complications rates of external fixation and internal fixation in patients with open fractures.

Methods: This prospective comparative clinical study was carried out in the Department of Orthopedic Surgery of a tertiary care teaching hospital between February 2024 and February 2025. Seventy adult patients with radiologically diagnosed open fracture of long bones were enrolled by non-probability consecutive sampling. The participants were divided into two groups of 35 each based on the type of fixation: external fixation and internal fixation. Demographic and injury characteristics were documented and fracture type was assessed using the Gustilo-Anderson classification. At follow-up, functional assessment was performed using the Lower Extremity Functional Scale (LEFS), Disability of the Arm, Shoulder and Hand (DASH) score and clinical grading. The two groups were compared for complications such as infection, delayed union, non-union, malunion, implant or fixation failure, and joint stiffness.

Results: Internal fixation demonstrated better overall functional recovery, with a greater proportion of patients achieving excellent or good outcomes compared with external fixation. Functional outcome scores were better in the internal fixation group. The external fixation group had a higher incidence of superficial infection, pin tract infection, delayed union and joint stiffness, while the incidence of deep infection was higher in the internal fixation group. Both groups experienced non-union and implant failure with a slight difference.

Conclusion: Internal fixation had better functional results, while external fixation was still a safe and effective treatment for more severe open fractures with poor soft tissue conditions.

Keywords: Open fractures, external fixation, internal fixation, fracture healing, postoperative complications, functional outcome.

INTRODUCTION

Open fractures represent one of the most severe and challenging injuries in orthopedic trauma surgery as they involve both bone and soft tissue injuries, varying degrees of contamination, vascular injury, and infection¹. These injuries are often caused by high-energy mechanisms such as motor vehicle accidents, falls from a height, industrial accidents, and crush injuries, and they are often associated

with a long hospital stay, multiple surgical interventions, delayed rehabilitation, and significant socioeconomic costs. In developing countries, where the burden of trauma is high and early access to specialist care may not be readily available, open fractures remain a significant source of long-term disability and impairment².

Treatment of open fractures is multifaceted and involves more than fracture fixation³. Effective management involves initial wound evaluation, early

debridement, prevention of infection, fracture fixation, soft tissue preservation or reconstruction, and appropriate rehabilitation. The ultimate objectives are to avoid infection, achieve fracture healing, maintain limb length, and restore optimal function. But the attainment of these goals may be affected by a range of factors, including the extent of soft tissue damage, contamination, fracture pattern, timing of treatment, patient health, and the type of fixation⁴.

One of the most controversial issues in the treatment of open fractures is the debate over external fixation versus internal fixation⁵. External fixation has historically been preferred in many open fractures, especially severe injuries, as it provides a quick means of fixation while avoiding disruption of the damaged soft tissue envelope. It is particularly valuable in grossly contaminated injuries, in hemodynamically unstable patients, in segmental fractures, and in cases in which wound inspection or staged reconstruction is expected. Furthermore, external fixation may shorten surgery time and offer a useful damage-control strategy in patients with polytrauma. Despite these benefits, however, prolonged external fixation may lead to pin tract infection, stiff joints, malalignment, nonunion, and discomfort, which may affect long-term function⁶.

Conversely, internal fixation may provide improved reduction and biomechanical stability, earlier weight bearing, and improved limb function⁷. Improvements in implant technology, antibiotic therapy, and soft tissue coverage have allowed the use of internal fixation even in some open fractures. Contemporary surgical techniques have demonstrated that with appropriate debridement, timely antibiotic use and soft tissue coverage, internal fixation can be performed with good outcomes and acceptable complications. However, there are concerns about the risk of deep infection, implant failure, and failure of internal fixation in highly contaminated and severely damaged wounds⁸.

Thus, the choice of external versus internal fixation for open fractures is not only surgical but clinical, and should take into account the severity of the fracture, soft tissue status, degree of contamination, patient's general health, and the skill of the surgeon⁹. Although there are some comparative studies on these treatment options, the findings are not consistent due to variations in fracture pattern, patient characteristics, follow-up period and outcome measures. And in many clinical environments, particularly in South Asian trauma hospitals, there is a need for more institutional data on the comparative outcomes to inform treatment choices based on institutional practice patterns and complication rates¹⁰.

Functional outcomes are especially important in the treatment of fractures because radiological healing does not always correlate with acceptable limb function and

return to normal activities¹¹. Likewise, the complication rates of superficial infection, deep infection, delayed union, non-union, implant failure and malunion continue to be important factors in the success of treatment. Comparative analysis of these outcomes between external and internal fixation can therefore yield clinically relevant information about the relative merits of these two techniques¹².

This study was undertaken to compare the functional recovery and complication rates of external fixation and internal fixation in patients with open fractures¹³. Through the assessment of both positive and negative outcomes in a comparative clinical environment, we hope this study will provide evidence that may inform more patient-specific, safe, and function-preserving decision-making in orthopedic trauma management¹⁴.

MATERIAL & METHODS

The study was a prospective comparative clinical study conducted in the Department of Orthopedic Surgery, in a tertiary care teaching hospital between February 2024 and February 2025. We aimed to compare the functional results and complications between external fixation and internal fixation in patients with open fractures. Before starting the study, approval was sought from the Institutional Review Committee and the study was conducted in accordance with the ethical standards for clinical research. All patients provided written informed consent.

Seventy patients with open fractures were enrolled in the study. The patients were selected using a non-probability consecutive sampling method when they presented to the emergency department or orthopedic trauma unit. Following initial evaluation and resuscitation, patients were divided into two groups based on the type of fixation determined by the orthopedic surgical team based on fracture pattern, soft tissue envelope, wound contamination, and general medical condition. Of these, 35 patients received external fixation and 35 patients received internal fixation.

Adults between 18 and 65 years of age with radiologically confirmed open fractures of long bones were included. Tibial, femoral, humeral, radius-ulna and other major appendicular long bone open fractures were included to reflect the usual pattern of orthopedic trauma cases seen in practice. Only those patients who were treated with definitive fracture fixation using external or internal fixation, and who consented to follow-up, were included in the study.

Those with pathological fractures, neglected old open fractures, fractures with severe neurovascular damage requiring amputation, polytrauma patients who were not hemodynamically stable for definitive fixation, severe pre-existing disability of the affected limb, previous surgery at

the same fracture site, or patients lost to follow-up before final assessment were excluded. Those with severe systemic disease that may independently affect fracture healing, such as advanced cancer or uncontrolled chronic infection, were also excluded.

All patients were subjected to a history and physical examination on admission. Age, gender, mechanism of injury, side of injury, and site of fracture were recorded on a proforma. Open fractures were classified using the Gustilo-Anderson classification following wound assessment and during surgery. Preoperative X-rays were taken in appropriate projections to determine fracture pattern, site, displacement, and other bony injuries.

Patients were managed according to standard emergency protocols on presentation, including resuscitation, intravenous fluids if needed, pain relief, tetanus prophylaxis, and intravenous antibiotics. All patients had debridement and irrigation under aseptic conditions as soon as possible after presentation. The degree of wound contamination, soft tissue injury and dead tissue was determined at the time of surgery prior to fracture fixation.

In the external fixation group, fracture fixation was performed using a standard unilateral or modular external fixator, depending on the fracture pattern and site. This was performed under fluoroscopic control while maintaining limb length, alignment, and rotational profile, and avoiding additional damage to the soft tissues. In the internal fixation group, patients received definitive internal fixation using plates and screws or intramedullary implants, as appropriate for fracture site. Internal fixation was undertaken only following wound debridement and when the surgeon deemed the wound soft tissues suitable for the placement of internal implants.

All patients were followed up with a standardised rehabilitation protocol. Antibiotics were continued based on the degree of injury and contamination. Regular wound checks and dressings were applied. Early joint mobilization was encouraged and weight bearing was determined based on fracture location, fixation stability, and radiographical healing. Regular follow-up was performed at the immediate postoperative period, 6 weeks, 3 months and 6 months.

The study's primary outcome was functional recovery at the final follow-up. Functional recovery was measured using appropriate clinically validated scoring scales for the affected limb. The Disability of the Arm, Shoulder and Hand (DASH) score was used in upper limb fractures and the Lower Extremity Functional Scale (LEFS) in lower limb fractures. For comparative analysis, functional outcomes were also classified as excellent, good, fair, or poor based on range of motion, pain, activity and limb use reported at follow-up visits.

The second outcome was the rate of complications in the two groups. The complications examined in the study were superficial wound infection, deep infection, pin tract infection in the external fixation group, delayed union, non-union, malunion, implant loosening or failure, joint stiffness, and the requirement for additional surgery. Infection was defined by clinical signs and symptoms of redness, swelling, discharge, persistent wound tenderness, fever, and if necessary, microbiological culture. Fracture union was assessed clinically and radiologically by serial X-rays and non-union was defined as failure to progress towards fracture healing in the expected time frame with no bridging callus on X-rays.

Data were entered and analysed using Statistical Package for the Social Sciences (SPSS) version 26. Continuous variables (age and functional scores) were described with mean \pm standard deviation, while categorical variables (gender, fracture site, Gustilo grade and complications) were described as frequencies and percentages. The two groups were compared using the independent sample t-test for quantitative variables and chi-square test or Fisher's exact test for qualitative variables. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 70 patients with open fractures were included in the final analysis, with 35 patients managed by external fixation and 35 managed by internal fixation. There were no drop-outs and all patients were available for comparison of functional outcomes and complications. The study cohort was relatively young, as is typical of the adult population prone to open fractures. The average age of the external fixation group was 35.9 ± 11.8 years, and 34.7 ± 12.4 years for the internal fixation group. Most patients in both groups were males (71.4% in the external fixation group and 74.3% in the internal fixation group). The most common cause of injury was motor vehicle accidents, followed by falls and crush injuries. The most commonly affected bones were the tibia, femur and forearm bones. The two groups were reasonably well matched in terms of baseline demographics and injury characteristics, as illustrated in Table 1.

Injury severity was classified using the Gustilo-Anderson classification system. The external fixation group had a higher proportion of Grade II and Grade III injuries, consistent with the practice of using external fixators for more severe injuries with a higher degree of soft tissue damage and contamination. By contrast, the internal fixation group had a greater proportion of Grade I and some Grade II injuries. This is in line with the usual orthopedic practice where the type of fixation is heavily dependent on

fracture severity and wound status. This difference notwithstanding, the two groups represented a clinically relevant population for comparison of functional outcome and complications, and the distribution of injuries has been outlined in Table 1.

At the last follow-up, function was evaluated with limb-specific scoring systems. In patients with lower limb fractures, the mean Lower Extremity Functional Scale (LEFS) score was higher in the internal fixation group than in the external fixation group, suggesting greater restoration of lower limb function. Likewise, in patients with upper limb fractures, the mean Disability of the Arm, Shoulder and Hand (DASH) score was lower in the internal fixation group, indicating less disability and improved limb function. When the overall clinical functional status was grouped into excellent, good, fair and poor outcomes, internal fixation was more favourable. In the internal fixation group, 77.1% of patients had excellent or good outcomes, compared with 57.1% in the external fixation group. In contrast, fair or poor outcomes were more common in the external fixation group. This suggests that internal fixation was associated with improved functional recovery and earlier return to useful limb function in this group, as shown in Table 2.

Painless motion and resumption of daily activities were also found to improve more frequently in the internal fixation group during the follow-up period. Generally, patients treated with internal fixation had better joint flexibility, greater confidence in limb use, and less residual functional disability at the end of the follow-up period. While some patients in the external fixation group also had good outcomes, a greater number of patients had stiffness, slower recovery or discomfort that affected their final functional outcome. The functional outcome profile is shown in Table 2.

Complications occurred in both groups, but were distributed differently between the two fixation groups.

Wound infection was more prevalent in the external fixation group, but deep infection was more prevalent in the internal fixation group. Pin tract infection was specific to the external fixation group and was seen in 17.1% of patients. Delayed union and malunion were also more common in the external fixation group, while mechanical complications related to the implants (for example, implant loosening or breakage) were rare in both groups. Non-union occurred in a small proportion of patients in both groups without significant difference in the absolute number.

Joint stiffness was still one of the most common complications that had an impact on final functional outcome, especially in patients with prolonged immobilization or extensive soft tissue damage. Stiffness was more frequent in the external fixation group, probably accounting for the lower functional scores in this group. A small number of patients required secondary surgery for infection, implant problems or non-union. In summary, although both forms of fixation were clinically beneficial, external fixation was associated with a higher frequency of complications related to local management, while internal fixation was associated with a slightly higher risk of deep infection in some cases. The complications are summarised in Table 3.

Overall, the findings of this study suggest that internal fixation was associated with superior overall functional outcome, particularly in terms of mobility, limb function, and final clinical outcome score, while external fixation was a practical and valuable option in more severe open fractures but was associated with a less desirable functional outcome and a different pattern of complications. The functional advantage of internal fixation should therefore be viewed in the context of the clinical presentation, especially the extent of soft tissue injury and the risk of infection at the time of definitive treatment.

Table 1. Baseline demographic and injury characteristics of the study population

Variable	External Fixation (n=35)	Internal Fixation (n=35)	Total (n=70)
Age (years), Mean \pm SD	35.9 \pm 11.8	34.7 \pm 12.4	35.3 \pm 12.0
Male	25 (71.4%)	26 (74.3%)	51 (72.9%)
Female	10 (28.6%)	9 (25.7%)	19 (27.1%)
Road traffic accident	22 (62.9%)	21 (60.0%)	43 (61.4%)
Fall from height	8 (22.9%)	9 (25.7%)	17 (24.3%)
Crush / industrial injury	5 (14.3%)	5 (14.3%)	10 (14.3%)
Tibia	16 (45.7%)	15 (42.9%)	31 (44.3%)
Femur	8 (22.9%)	7 (20.0%)	15 (21.4%)
Humerus	5 (14.3%)	6 (17.1%)	11 (15.7%)
Radius / Ulna	6 (17.1%)	7 (20.0%)	13 (18.6%)
Gustilo Grade I	5 (14.3%)	9 (25.7%)	14 (20.0%)
Gustilo Grade II	14 (40.0%)	16 (45.7%)	30 (42.9%)
Gustilo Grade III	16 (45.7%)	10 (28.6%)	26 (37.1%)

Table 2. Comparison of functional outcomes between external fixation and internal fixation

Functional Outcome Variable	External Fixation (n=35)	Internal Fixation (n=35)	p-value
Lower limb LEFS score, Mean \pm SD*	58.6 \pm 9.4	66.8 \pm 8.1	0.003
Upper limb DASH score, Mean \pm SD†	31.7 \pm 8.6	24.1 \pm 7.3	0.011
Excellent outcome	8 (22.9%)	13 (37.1%)	
Good outcome	12 (34.3%)	14 (40.0%)	
Fair outcome	9 (25.7%)	6 (17.1%)	
Poor outcome	6 (17.1%)	2 (5.7%)	0.041

* LEFS was calculated for lower limb fracture cases only. † DASH was calculated for upper limb fracture cases only.

Table 3. Comparison of postoperative complications between the two groups

Complication	External Fixation (n=35)	Internal Fixation (n=35)	p-value
Superficial infection	6 (17.1%)	4 (11.4%)	0.495
Deep infection	3 (8.6%)	6 (17.1%)	0.286
Pin tract infection	6 (17.1%)	0 (0.0%)	0.010
Delayed union	5 (14.3%)	3 (8.6%)	0.451
Non-union	3 (8.6%)	2 (5.7%)	0.642
Malunion	4 (11.4%)	2 (5.7%)	0.393
Implant / fixation failure	2 (5.7%)	3 (8.6%)	0.642
Joint stiffness	7 (20.0%)	4 (11.4%)	0.329
Secondary surgical intervention	4 (11.4%)	3 (8.6%)	0.691

DISCUSSION

Open fractures continue to pose a difficult challenge in orthopedic trauma surgery because treatment requires not only fracture fixation but also avoidance of infection, preservation of soft tissue and recovery of long-term limb function¹. This study compared the functional outcome and complications of external fixation and internal fixation in the treatment of open fractures and found that internal fixation was superior in terms of overall functional recovery, while external fixation was still a useful technique in more severe and soft tissue-damaged injuries. The results of this study are clinically important because they represent the practical trade-off between biomechanical and biological considerations in trauma surgery².

The most significant finding of this study was better functional outcomes in the internal fixation group³. The group treated with internal fixation had better limb function, higher range of motion and more excellent or good results than the group treated with external fixation. This finding is likely due to the superior biomechanical stability of internal implants, which typically results in more precise anatomical alignment, earlier weight bearing, and more aggressive rehabilitation. Early motion and anatomical alignment are highly correlated with better muscle and joint function, as well as patient confidence in limb use in orthopedic trauma management. As such, it is not surprising that internal fixation in this study led to improved limb utility and better clinical outcomes⁴.

The external fixation group, while successful in achieving fracture stability, demonstrated relatively poor recovery⁵. This is not surprising as external fixation is often

applied to injuries with more severe soft tissue trauma, contamination, and fracture complexity. In these cases, the fixation technique is not the sole factor that influences the outcome; the biological environment and soft tissue injury also contribute significantly to the recovery and the final functional outcome. Patients with external fixation may also have prolonged guarded movement, difficulty in joint mobilization, pin discomfort, or a lack of confidence in weight bearing and other activities, all of which may contribute to a lower functional outcome at follow-up⁶.

The injury profile of the study also supports this view⁷. The external fixation group had a higher proportion of Gustilo Grade III fractures, suggesting that external fixation was more commonly used in more severe injuries. This is in line with current trauma practice in which external fixation is commonly used in high-energy open fractures to allow for immediate stability while avoiding further damage to the already traumatised soft tissues. In unstable or contaminated wounds, external fixation can be used as a mechanical and biological strategy to maintain access to the wound for frequent debridement, dressing changes and staged reconstruction if required. Therefore, while this group had slightly worse functional outcomes, the technique is still very important and often more suitable in certain circumstances⁸.

The complications encountered in this study also shed further light on the advantages and disadvantages of the two approaches⁹. The external fixation group had a slightly higher incidence of superficial infection, which can be attributed to the anticipated presence of pin tract infection, a common complication of external fixators. While pin tract infection can often be treated with local wound care and

antibiotics, it may still impact on patient comfort, adherence and recovery. It is also one of the typical complications of external fixation, particularly if the fixator is used for a long time. This complication is therefore expected in our results and reflects the well-known drawbacks of this approach¹⁰.

On the other hand, deep infection was more prevalent in the internal fixation group¹¹. This is an important observation because infection is one of the most dreaded complications of open fractures. The placement of implants into a previously contaminated or soft tissue-damaged wound can predispose to deep infection if debridement is not thorough, wound contamination is excessive, or soft tissue coverage is poor. Despite the biomechanical and functional benefits of internal fixation, it should therefore be used judiciously and with great caution in open fracture care. The increased rate of deep infection in this study does not mean that internal fixation is contraindicated, but rather that it should be used only in patients in whom wound status, contamination, and soft tissue quality allow for safer placement of hardware¹².

We also noted delayed union, non-union and malunion in both groups, but these complications were slightly more common in the external fixation group¹³. This may be due to a combination of fracture pattern, soft tissue injury, and potentially less anatomical and/or stable fixation compared with internal fixation. Healing of open fractures is a complex biological process, and the rate of progression toward union may be delayed due to vascular compromise, contamination, periosteal stripping, bone loss, or multiple surgical procedures. As such, while fixation plays a role in the potential for healing, it is only one aspect of the overall biological and mechanical milieu. The similar non-union rates in the two groups in this study indicate that both fixation methods can be used to facilitate eventual healing, despite differences in complications¹⁴.

Joint stiffness was another finding, especially in the external fixation group¹⁵. Joint stiffness, muscle weakness and patient compliance with rehabilitation are major factors in determining functional outcomes following open fractures. Limited motion may occur in patients with external fixation due to the design of the fixation device, pain, prolonged immobilization, or fear of damaging the limb. This can, in turn, affect function even in the presence of satisfactory radiographic healing. The higher stiffness rate in the external fixation group probably influenced the lower rate of excellent and good outcomes in this study, and highlights the need for early physiotherapy and controlled mobilization in these patients¹⁶.

In practical terms, this study supports a philosophy of treatment that is based on the nature of the injury rather than a strict inclination towards a particular fixation technique¹⁷. Internal fixation seems to be more beneficial

when soft tissue is healthy, contamination is minimal, and anatomical reduction is possible. This is likely to lead to a better functional outcome and quicker return to work. But external fixation remains a critical option in severe open fractures, particularly when wound contamination, soft tissue damage or a staged treatment approach would render internal fixation less desirable or unsafe initially. Thus, the results of this study do not prove one method to be better than the other, but rather that each technique has its place according to the biological and mechanical needs of the fracture¹⁸.

This study is significant in clinical practice because it provides a comparison of fixation techniques in a trauma setting¹⁹. But there are limitations. The number of patients was small and the duration of follow-up, while sufficient to assess early function and complications, may not have been long enough to assess very long-term complications such as post-traumatic arthritis, chronic osteomyelitis and late implant-related complications. Furthermore, the method of allocation was non-random, and patients with more severe injuries were more likely to be treated with external fixation. This might have affected the results. However, the study still offers valuable comparative information and reflects real-world orthopedic practice, where treatment allocation is not randomized²⁰.

In summary, the current results support the notion that open fracture management should be tailored and multidisciplinary¹. The best results are achieved with a combination of fixation, early antibiotics, early debridement, soft tissue management, rehabilitation and follow-up. The surgeon's capacity to tailor the fixation approach to the biological insult remains crucial to balance the risks of infection, fracture healing and functional outcome².

CONCLUSION

The use of internal fixation was associated with improved functional outcomes and a greater proportion of good clinical outcomes in patients with open fractures, probably because of enhanced stability, anatomical alignment, and early weight bearing. But it was also associated with a relatively greater risk of deep infection, suggesting that it should be used judiciously in the context of contamination and soft tissue injury.

External fixation remained a safe and useful technique, especially for more severe open fractures with severe soft tissue injury, contamination, or the need for staged wound care. While it was associated with less satisfactory functional outcomes and more pin complications, external fixation provided a more biologically safe option for more severe injuries.

In summary, neither fixation option should be regarded as the best choice for all open fractures. Selection of external fixation or internal fixation should be based on the severity of the fracture, soft tissue injury, contamination, and the patient's medical condition. An appropriate treatment plan, debridement, infection management and rehabilitation is critical to maximise fracture healing and functional outcome.

DECLARATION

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