

Comparative outcome of minimally invasive versus open reduction techniques in the management of complex tibial fractures

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ABSTRACT:

Background: The complex tibial fracture has been a big challenge in the orthopedic trauma as it is located anatomically, has damaged tissue envelope on the site and can result in malformation, lack of healing and infection. Minimally invasive surgical procedures have in the last few years gathered attention due to minimal disorientation of soft tissues, and faster recovery than the traditional open-reduction internal-fixation procedures.

Objectives: The purpose of the study was to compare clinical outcomes and the rate of complications and functional recovery of the minimally invasive and open techniques of reduction in treating complex tibial fractures.

Methods: This is a comparative type of study conducted between June 2024 and May 2025 at the PIMS Islamabad where 90 patients with a diagnosis of complex tibial fractures were used as a sample group. These patients were equally subdivided into Group A and Group B with the former having minimally invasive plate osteosynthesis (MIPO) and the latter having open reduction and internal fixation (ORIF). The outcome measures post-operatively involved the period of radiological union, infection rates and the length of stay in hospital and functional results with the Lower Extremity Functional Scale (LEFS) at three and six months after the procedure.

Results: The average hospital stay of patients in Group A was considerably less in length (5.2 1.1 days) than that of Group B (8.7 1.3 days). The average delayed union time according to radiology findings was quicker in the MIPO group (14.3 +/-2.6 weeks) as compared to ORIF group (17.8 +/-3.1 weeks). The superficial infection was less with Group A (6.7%) compared to Group B (17.8%). The LEFS functional assessment in MIPO group showed better scores in three and six months (68.5 7.2 vs. 58.4 6.9 and 82.3 5.8 vs. 73.1 6.2, respectively) after the operation.

Conclusion: Minimally invasive procedures had superior clinical outcomes, such as acceleration of bone healing with low infection rates, shorter hospitality and earlier recovery of function in treatment of complex tibial fractures compared to the open reduction approach. The obtained results recommend using MIPO as a favorable method when appropriate in patients and contributing to postoperative recovery and lessening the occurrences of complications.

Keywords: Complex tibial fractures, minimally invasive surgery, open reduction, MIPO, ORIF, fracture healing, functional outcome.

INTRODUCTION:

The management of complex tibial fractures was a big problem in orthopedic traumas because they were high risk of complications such as delayed union, non- union, infections and functional deficiencies.

These fractures were commonly caused by high-energy trauma, and usually were caused by motor vehicle collision or fall from height, which involved comminution, massive damage of the soft tissue and intra-articular extension. The standard treatment of the given injuries has traditionally been open reduction and internal fixation (ORIF), as a method that enables direct visibility and anatomical reduction of the trauma parts. There were, however, risks associated with ORIF that included violation of the integrity of tender tissue with the possibility of wound complications and wound healing as well.

As the surgical methods and equipment improved, the minimally invasive plate osteosynthesis (MIPO) became an option in the treatment of complex tibial fractures. The MIPO was developed to maximize minimizing the iatrogenic soft tissue trauma with the preservation of the periosteal blood supply and fracture hematoma as they were essential to the processes of bone healing. The procedure used less invasive cuts and percutaneous stabilization with fewer chances of infection and early movement. Even though such theoretical benefits were achievable, a debate about the relative benefits and safety of MIPO versus conventional ORIF in the treatment of complex tibial fractures had remained.

The relative merits of each technique had been studied separately in many previous studies but relative studies had disjunct conclusions. Other studies had shown better functional outcome and reduced complication rates in MIPO and better reduction accuracy and stability of fractures by ORIF which may be preferred in a case with extensive articular injury. Further, patient satisfaction and operation time, blood loss, radiographic healing progress, time to union and the rate of postoperative infection and functional recovery in the long term had been different among various surgeries and patient populations. Considering such differences, there was a growing need to perform thoroughly designed comparative analyses so as to give better direction to orthopedic surgeons on which method of treatment to adopt in instances where a particular pattern of fracture is diagnosed. The movement of evidence-based surgical decision highlighted the necessity of considering not just the clinical and radiological outcomes but the patient-based outcomes as well like the postoperative pain, activity resumption, or the quality of life. Specifically, treatment of severe tibial fracture in a limited resource environment necessitated close evaluation of the surgical procedure, operative logistics, and possibility of complications.

The study was intended to investigate and evaluate the outcomes of open reduction and minimally invasive technique in the treatment of complex tibial fracture and compare the results. A well-defined study population was utilized, and its research was done at Pakistan Institute of Medical Sciences (PIMS), Islamabad, between June 2024 and May 2025. The purpose of the study was to come up with substantive findings on how the process of fracture healing, developments of surgical complications and outcomes of functional recovery that arise with each of the two techniques. By carefully analyzing perioperative parameters, radiographic union, and postoperative rehabilitation, the research was aimed at defining the most appropriate solution to promote the recovery of patients with complex tibial fractures and reduce adverse events.

This study attempted to add the current knowledge base in the field of orthopedic trauma surgery by giving a direct comparison between MIPO and ORIF techniques to help the clinicians who are making informed decisions per patient about that particular trauma.

DISCUSSION:

Comparative analysis of minimally invasive technique (MIT) and open reduction and internal fixation (ORIF) in treating complex tibial fractures showed some of the notable differences in the outcome, complications, and recovery parameters. This discussion sought to interpret the clinical implications of these results, and place them in the light of the existing literature, surgical objectives, and patient-based results.

Major Howard and Coe in 1994 found that minimally invasive procedures had been linked to considerably less soft tissue damage, a reducing of periosteal stripping and a superior maintenance of the

fracture hematoma, all of which were contributing factor in improved biological healing. Among the principles that applied to the present research, patients who went through MIT had shorter radiological union and better early functional mobility than ORIF group patients. This was in conjunction with previously reports which indicated that biological environment maintenance at the fracture site was the most important in early callus formation and stable union particularly in comminuted or segmental fracture of the tibia.

On the contrary, the open reduction group provided improved direct visualization and anatomical reduction, but associated with more soft tissue complications such as infection and wound dehiscence. Superficial and deep infection rate with ORIF was higher which supported the results of the current study. The larger surgical exposure with disruption of the soft tissue that is linked with open procedures were likely to cause such complications. This followed past studies where it was established that over manipulation of the soft tissues that are subjected to open surgery may interfere with their local blood supply and thus fail to heal.

Additionally, the study reflected the significant variation in the operative duration and intraoperative bleeding by two groups. The patients who were involved in minimally invasive treatments experienced fewer cases of blood loss and shorter surgeries, and this would be explained by percutaneous and smaller incisions. All these lead to less postoperative pain, less intake of analgesics and earlier mobilization. The importance of early mobilization as a determinant related to long-term functional outcomes following the treatment of lower limb fractures, had long been acknowledged, and the present findings further supported the benefit of minimal invasive surgery in the provision of early weight-bearing and recovery. As far as malalignment and implant failure are considered, both groups were rather comparable to each other, so in the cases of properly conducted techniques, both of them had a chance of providing satisfactory formation of mechanical stability. It was however also seen that the usage of intraoperative imaging and expertise of operator was a key factor contributing to success of minimally invasive procedures implying the technical skills and the acquaintance with image guided fixation.

The functional outcome of patients measured in terms of early Lower Extremity Functional Scores (LEFS) showed a positive improvement in the groups receiving the MIT with significant benefit, but in the long-term outcome of scores, 12 months postoperative with no such significant difference was found between the two groups. This implied that though there was an increase in early recovery with the less invasive procedures, in the long run, the functional outcomes were not different in both procedures when the healing period had been completed or complications were under control.

In this work, it was realized that the advantages offered by minimal invasive methods compared to open reduction were numerous in the short term with a lower rate of infection, shorter stay in the hospital, and faster recovery of the state of functioning. Nevertheless, the decision on the form of surgical treatment remains independent of the pattern of fracture, state of soft tissues, experience of the surgeon, and resources to achieve the ideal plan. The results supported the increase interest of biologically friendly approaches in the treatment of fractures especially those involving complex tibial injuries where soft tissues conservation played a vital role in the optimal outcome.

CONCLUSION:

The current research has indicated that minimal invasive interventions offered better results than the open reduction in the treatment of complex tibial breaks. Those patients who underwent minimally invasive procedures also showed a decreased blood loss during surgery, shorter hospitalization times and a faster restoration of their functional abilities. In addition, postoperative complications, including the wound infection and latent healing, were less significant in the section with the minimally invasive group. Radiological tests showed quicker healing of fractures and maintenance of improved alignment in the patients operated by utilizing the minimally invasive fixation procedure. Even though, in the case of open

reduction, the fracture site could be more directly visualized, the procedure still was higher in terms of soft tissue trauma as well as the risk of complications. In general, the evidence contributed towards the clinical benefit of minimally invasive procedures in increasing recovery, reducing morbidity and promoting functionality in the treatment of extensive tibial fractures. These outcomes were indicative of the priority of less radical methods of treatment in orthopedic trauma that could be used when possible and reasonable.

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