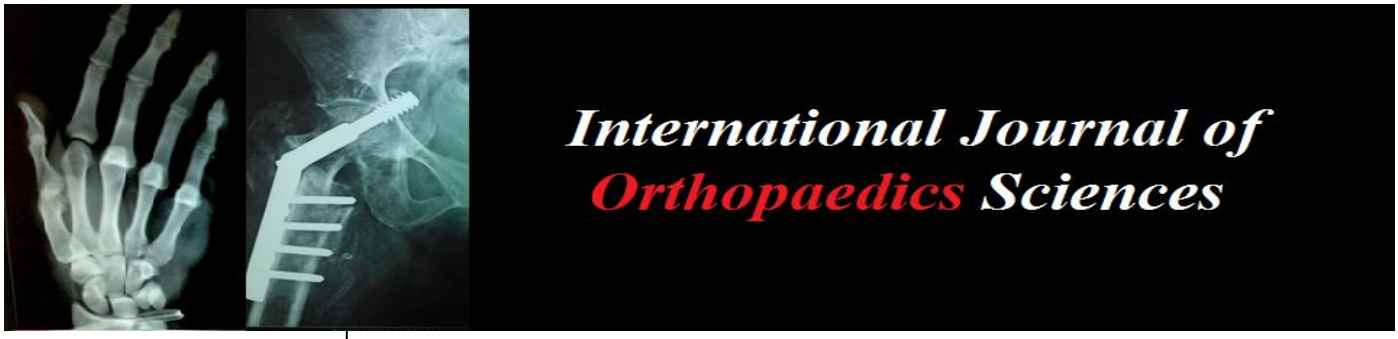

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2021; 7(3): 675-678

www.orthopaper.com
Received: 03-05-2021
Accepted: 19-06-2021

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Evaluation of the management of tibial diaphysial fracture AO Type - 42C with locking compression plate by MIPO technique

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DOI: https://doi.org/10.22271/ortho.2021.v7.i3j.2819

Abstract
Introduction: Fracture involving the diaphysis of the tibia especially due to high energy trauma continues to be a challenging problem in Orthopaedic surgery. Treatment of tibial diaphysial fracture has improved with the evaluation of plate and nailing technologies. Recently locking compression plating have been used with minimally invasive plate osteosynthesis (MIPO) technique with indirect reduction and percutaneous plate insertion, which reported excellent results especially in comminuted tibial shaft fractures (AO Type-42C) where IM nail were contraindicated. The purpose of this study is to analyze and discuss the outcome of comminuted tibial shaft fractures (AO Type-42C) treated with MIPO technique.
Methods: This prospective (interventional) study included 19 adult male and 06 adult female patients who had high-energy closed tibial shaft fractures with varying degrees of displacement and comminution. All cases were assessed by clinical examinations and radiographs before and after surgery. Post-operative follow-up was done for a mean time of 06 months and evaluated radiologically and functionally according to the Association for the Study and Application of the Methods of Ilizarov (ASAMI) scoring system.
Results: Most of the fractures 11(44%) united with a mean union time of 19.6±2.53 weeks. ranging from 19-21weeks. Clinical and radiological outcomes according to the ASAMI scoring system showed satisfactory results (excellent and good) in 23 patients, representing 92% of the studied group. There were no persistent limitation of the knee or ankle motions and deep wound infection. Implant failure didn't occurred in any of the patients until the last follow-up, and none of the patients required a second major open intervention.
Conclusion: The minimally invasive plate fixation with locking compression plate is an effective method of stabilization for closed comminuted tibial shaft fractures, yielding good bone alignment with minimal soft tissues injury, leading to higher union rates with good functional outcome.

Keywords: MIPO, Tibial diaphyseal fracture, locking compression fracture

Introduction
Fracture involving the diaphysis of the tibia especially high energy trauma continues to be a challenging problem in Orthopaedic surgery. Tibial diaphysial fracture comprises approximately 01% of all the fractures and they are difficult to treat. In addition, these fractures are associated with high rate of nonunion and malunion. The tibial diaphysis is the most common site of fracture in the tibia and about 80% of these injuries have associated with fibula fracture [1].
Traditionally, these tibial diaphyseal fractures were treated non-operatively with simple casting. But the treatment of tibial diaphysial fracture has improved with the evaluation of plating and nailing technologies. Closed locking intramedullary nailing (IM) is used for closed and some open tibial shaft fractures. Open reduction with plate was successfully used during 1960s. But soft-tissue complications associated with open plating and complex trauma changed the popularity. Now-a-days, minimally invasive plate osteosynthesis (MIPO) approach with indirect reduction and percutaneous locking compression plate is gaining popularity especially where intramedullary nailing is contraindicated [2].

Biological fixation focuses on soft tissues and vascularity of the bone. This MIPO technique described 'indirect reduction methods' using distracters, traction tables, or manual traction to minimize direct fracture exposure and soft tissue stripping. [3] Fractures fixed by MIPO do not show primary bone healing as found in rigidly fixed fractures with dynamic compression plate. The bone healing in case of MIPO depends on the formation of bridging callus. This technique reduce surgical trauma and keep soft tissue healthy, that promotes fracture union and reduces infection [4].

In MIPO technique, the intervening small fragments of comminuted fracture are left unfixed, that reduces the disturbance in blood supply. As a result, overall healing potential of the bone is increased which leads to union with callus formation. This is known as bridging technique. Emphasis on preservation of osseous vascularity utilizing indirect reduction technique has led to increased union rate without bone grafting [5, 6].

So, considering these facts, we carried out this study to assess the functional outcome of the management of tibial diaphyseal fracture (AO Type- 42C) by MIPO technique with locking compression plate.

Materials and Methods

This prospective interventional study was carried out in National institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh between August 2015 to June 2017. This study included 19 adult male and 06 adult female patients who had high-energy closed tibial shaft fractures with varying degrees of displacement and comminution. Study population were admitted according to inclusion and exclusion criteria (Table 1). All cases were assessed by clinical examinations and radiographs before and after surgery.

In all patients, internal fixation was done by MIPO technique using locking compression plate. During surgery, indirect reduction was done under image intensifier and several small incisions were made for plate and screw insertion. Surgical wounds were closed in layers and short leg back slab was given immediate post operatively. On third post-operative day check dressing was done. Stitches were removed on 14th post-operative day and allowed partial weight bearing walk with the help of axillary crutches.

Post-operative follow-up was done for a mean time of 06 months and evaluated radiologically and functionally according to the Association for the Study and Application of the Methods of Ilizarov (ASAMI) scoring system.

Before Commencing the study ethical Clearance was obtained from the concerned authority. All potential subjects were informed verbally about the underlying objectives of the study, advantages and risks associated with their participation and their rights to withdraw themselves from the study at any time for any reason what so ever.

Data were collected using a structured questionnaire (research instrument) which contained all the variables of interest. All the variables were analyzed according to standard statistical methods using appropriate formula and results were presented in tables.

Table 1: Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion criteria
Patients of both sex	Open Comminuted Tibial shaft fracture
Adult patients of 19 – 65 years	< 19yrs & > 65yrs
All closed comminuted fracture shaft of Tibia (AO Type-42C).	Pathological fracture
Fracture occurred within two weeks	Fracture with neurovascular deficit
	Endocrine comorbid condition e.g.- DM, Hypo parathyroid

Results

Out of 25 patients, 19 (76%) patients were male and 06 (24%) patients were female. The male female ratio was 3.17: 1. Out of 25 tibial diaphyseal fractures, 13 (52%) patients were AO Muller's Type 42C1, then 08(32%) patient were AO Muller's Type 42C2 and 04 (16%) patients were AO Muller's Type 42C3. 15 (60%) patients were operated within 08-12 days of injury. Mean surgical interval time was11.5±5.22 days. Operating time was 51-70 minutes in most of the patients (64%). Mean operative time was 68.0±12minutes.

Most of the fractures (44%) were united between 19-21weeks. Mean duration of radiological union was 19.6±2.53 weeks (Figure 1). Out of 25 patients, 21 (84%) patients had limb length discrepancy of 0.6-1.5cm and 04 (16%) patients had shortening of <0.5 cm. Mean limb length shortening was 06± 0.5 cm. Regarding the activities of the study population, 18 (72%) patients had same level of activity as before, but 07 (28%) had some form of painless limping Out of 25 study population, most of the patients 22(88%) had no complication but rest of the patients 03 (12%) had soft tissue infection & hard ware prominence (Table 2).

a b c

Fig 1: a) Immediate post-operative X-Ray. b) Union of fracture seen at 20th week. c) Squatting without difficulty after union of fracture.

Table 2: Post-operative complications of the study population (n=25)

Post-operative Complication	Number of patients	Percentage (%)
Skin & soft Tissue Infections (SSTI)	2	12%
Hard ware prominence (HWP)	1	4%
Deep Infection	0	0
Implant failure	0	0
No complains	22	88%
Total	25	100%

Radiological results were assessed by ASAMI. Sixteen patients (64%) had good outcome 07 patients (28%) had excellent and 02 patients (8%) had fair outcome (Table-3).

Table 3: Radiological results assessed by ASAMI scoring system

Sl. No	Bone result	Number of patient
1	Excellent	7(28%)
2	Good	16(64%)
3	Fair	2(8%)
4	Poor	0

Radiological results were assessed by ASAMI. Sixteen patients (64%) had good outcome 07 patients (28%) had excellent and 02 patients (8%) had fair outcome (Table-3).
Functional results were assessed by ASAMI scoring system. Out of 25 patients, 18 patients (72%) had good outcome, 05 patients (20%) had excellent and 02 patients (8%) had fair outcome (Table-4).

Table 4: Functional result assessed by ASAMI scoring system

Sl. No	Functional result	Number of patient
1	Excellent	5(20%)
2	Good	18(72%)
3	Fair	2(8%)
4	Poor	no

Functional outcome in majority of the patients (92%) were Satisfactory and only 2 patients showed were unsatisfactory outcome.

Discussion

Diaphyseal tibial fractures remain one of the most substantial therapeutic challenges that confront the orthopedic surgeon. Fractures of the diaphyseal tibia are associated with significant soft tissue injury by direct injury. The key point in the management of this injury is to recognize the importance of the soft tissue component. There are different modalities of treatment for diaphyseal tibial fractures. Previously it was treated both conservatively and operatively. Operative fixation includes nailing, non-locking conventional plating, locking plating and also external fixator including Ilizarov ring fixator. None of these techniques can be considered as specific for the diaphyseal tibial fractures.

Treatment selection is influenced by the proximity of fracture displacement, comminution and injury to soft tissue envelope [7]. MIPO technique for these fractures is technically feasible and advantageous in that it minimizes soft tissue compromise and devascularization of the fracture fragments [8]. In this study functional outcome of the management of tibial diaphyseal fracture (AO Type- 42C) by MIPO technique with locking compression plate was assessed.

Lee SM *et al*. found that the IM is the most stable implant for the use in the treatment of comminuted fractures of the Shaft of tibia [8]. However, when it is difficult to achieve satisfactory reduction by nailing, dual locked plates may be a stronger implant for use in MIPO compared with lateral locked plating, which is currently being used. In our study, it was noticed that once callus appeared in the tibial diaphyseal fracture, nonprotected full weight bearing was found to be safe, with no complications in the form of loss of reduction, varus malalignment and implant failure.

Indirect closed reduction and extra periosteal dissection in MIPO technique with bridging long plate provide anatomic alignment and relative stability, which enables limited motion at the fracture site that creates secondary bone healing with callus formation [9]. *In-vitro* biomechanical studies have made recommendations that the long plates with limited number of screws are essential to achieve a sound, flexible fixation and to reduce implant failure [10]. We also found good callus formation in the fracture site.

In this study, long plates with limited number of screws were used through a medial approach to fix the fracture in tibial shaft fracture and the functional outcomes are similar to other studies [11, 12]. The results were also comparable to preliminary results of other studies where the medial approach was used and complex tibial shaft fractures were fixed with a plate by MIPO technique [5, 12, 13]. The healed fibula which augments, protect the fixation and improve the mechanical properties of the entire construct including the bridging tibial plate [13].

He *et al*. reviewed 11 publications in a meta-analysis comparing the use of intramedullary nails with percutaneous plating in diaphyseal tibial fractures and found no significant difference in the outcomes between these two methods [14].

In this study 25 fractures (AO 42c) were treated by minimally invasive plate osteosynthesis (MIPO) technique using LCP. Overall all final outcome of surgical management of comminuted Tibial diaphyseal fracture was assessed by ASAMI score. Most of the patient's age group was 16yrs -25 years, ranging from 19-65 years of age. Almost similar finding were reported in other studies [11, 12, 13].

The mean fracture healing time in this study was <19.6 ± 2.53 weeks, which is also comparable with the fracture healing time in other patients in whom the same procedure was used and also comparable with other patients treated by interlocking intramedullary nailing; The average period for fracture consolidation in tibial diaphysis treated with bridge plate and IM nail by MIPO technique were similar to that found in other studies, in which the average time of consolidation was 16 weeks in case of bridge plating [15] and 20 weeks in IM nailing [16].

In this study all patients were operated within 14 days and mean operative time was 68.0±12.00 minutes ranging from 31 to 70 minutes and up to 0.5 cm shortening developed in 16% patients. Phisitkul el al, reported deep infections in 8 patients (22%), that required operative debridements, and 5 of them had a hardware removal [17]. However, there was no deep infection in our study. Only 02(8%) patients developed superficial infection, which is treated by antibiotics and dressing of the wounds.

This study's outcome support the management of tibial shaft fracture (42 C) with a bridge plate by MIPO technique. A weakness of this study is the small series of cases that were available for review and short postoperative follow-up period. However, our results support that it is possible to obtain a favorable outcome in diaphyseal tibial fractures using percutaneous insertion of plate and screws as long as careful management of soft tissues is performed. We recommend a comparative randomized controlled multicenter study between intramedullary nailing and bride plating by MIPO

technique, which will aid in the treatment decision for patients with diaphyseal tibial fracture (42 C).

Conclusion

This study demonstrated excellent to good result in majority of cases of tibial diaphysial comminuted fracture (AO type 42C) treated with minimally invasive plate osteosynthesis (MIPO) technique with Locking compression Plates (LCP). Most (92%) of the cases returned to the routine pre-injury activities without limitation. MIPO is an effective method of stabilization that can ensure both a mechanical and a biological environment needed for fracture healing. MIPO technique for the treatment of diaphysial comminuted tibial fractures in adult is an easy, effective, and safe procedure with higher union rates, minimal complications and good functional outcome.

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