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Outcome and Evaluation of Distal Tibial Close Fractures with Locking Compression Plate (LCP): A Prospective Study (MIPO) Approach

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Abstract **Original Research Article**

Background: Fractures of the distal tibia have historically proved difficult to treat. The distal tibia is less deeply covered by muscle and has a poorer blood supply. Therefore, problems are possible during the surgical treatment. We hope to evaluate the outcomes of LCP with minimally invasive plate osteosynthesis (MIPO) for the fixation of distal tibial fractures. ***Materials and Methods:*** A Multicentered based quasi-experimental prospective study was performed in 250 Beded District Hospital, Chapainawabganj, Rajshahi, Bangladesh, from January 2020 to December 2022. A Total Twenty-one patients were prospectively analyzed. Included were AO types 43A, 43B, and 43C. There were 21 patients (14 men and 7 women, with a mean age of 51). ***Results:*** The Mean time to union duration was 11 months (range, 3-35). There was a high perceived result for 17 fractures. The union of one patient was delayed. Nonunion, in one case, necessitated revision surgery, but the fracture healed with a satisfactory good functional outcome. Two patients had minor infections at the wound's surface, but their fractures subsequently healed. ***Conclusion:*** The MIPO procedure for the distal tibia has proven effective and offers many benefits over more traditional approaches. Stiffness and contracture can be avoided by early mobility without the potential of subsequent displacement.

Keywords: LCP, MIPO, AO.

INTRODUCTION

Fractures of the distal tibia might be difficult to agree on if they are unstable or if they extend into the joint. Traditional techniques of fixation have been related to the high prevalence of problems [1]. Distal periarticular tibial fractures are typically not candidates for intramedullary nailing. Traditional open reduction and internal fixation of such fractures necessitates substantial soft tissue dissection and periosteal damage, cutting off the bone's blood supply. This can lead to a higher risk of infection, a longer healing time, and even nonunion [2]. Similarly, up to 50% of patients with external fixation of distal tibial fractures may experience pin site infection and loosening, and up to 45% may experience malunion [3].

There may be great advantages to using minimally invasive plate osteosynthesis (MIPO). One of the key benefits of MIPO is that it reduces soft tissue dissection and exposure, resulting in less surgical stress and protecting the blood supply. Osteogenic fracture hematoma evacuation is reduced during biological fixation [4]. Interlocking compression plates ensure stability. They improve the communication between internal and exterior fixation [5]. The distal tibial LCP has contributed to the creation in prominence of minimally invasive plate osteosynthesis (MIPO), which has recently been developed with several purported advantages [6].

This plate has been modified to fit the medial portion of the tibia, making it ideal for use in the indirect reduction of tibial fractures. Through a minor skin incision (2 cm) made along the medial portion of the tibia, the plate is tunneled subcutaneously but extraperiosteally before being secured with locking screws. The plate and the device are designed to interlock, making for a strong fixed-angle device [7]. Displaced distal tibial fractures (43A, 43B, 43C), unstable metaphyseal fractures too distal for safe stabilization using intramedullary nails, and fractures

with intra-articular extensions are all excellent candidates for minimally invasive plate osteosynthesis [8] To evaluate the clinical and functional outcome of the novel LCP plate in treating distal tibia fractures, we prospectively examined our experience treating 21 patients.

METHODS

Distal tibial fractures were sequentially fixed with LCP using the MIPO approach, and their outcomes were evaluated prospectively. was performed in 250 Beded District Hospital, Chapainawabganj, Rajshahi, Bangladesh, from January 2020 to December 2022. Twenty-one patients were included (7 females and 14 males) aged 24 to 92. The fractures included 16 closed and 5 open. Our series comprised both open and closed distal tibia fractures caused by high-velocity forces. Both intra- and extra-articular fractures were found. We preserved a complete set of medical documents and imaging studies for each patient we analyzed. The AO comprehensive classification system was used to describe fractures [9].

The fracture of the bones occurred as follows: fourteen 43A, four 43B, and Three 43C. We used the Gustilo and Anderson classification to classify open fractures [10]. Nine patients were engaged in vehicle accidents, and 12 had experienced some sort of fall from a great height. Four of the nine patients treated for injuries sustained in traffic accidents had multiple injuries. Five of the fractures were open (three type I and two types II, Gustilo and Anderson). An accompanying fibular fracture was present in each patient. Standard debridement, irrigation, and primary fixation were employed initially to treat wounds caused by open fractures, with the addition of plastic surgical intervention if needed. (Figures 1, 2).

Primary and secondary foot and ankle exercises were allowed on the first postoperative day, and patients were allowed to move around without bearing weight on their feet using crutches. Thromboprophylaxis in the form of large amounts of enoxaparin was administered after surgery. At six weeks, patients began partial weight-bearing and, based on further radiological and clinical evaluation, might progress to full weight-bearing.

Patients were seen in the outpatient clinic two weeks after surgery for a wound assessment and imaging verification. Patients were followed up with a clinical and radiological evaluation at six weeks, three months, six months, and a year following surgery. Patients were released once the fracture had healed, and any problems after surgery were handled.

Figure 1: Figure showing small incisions

Surgical Technique

All of the procedures were managed by a single experienced expert trauma surgeon. Antibiotics were administered intravenously prior to the induction. A thigh tourniquet was applied, and the patient was laid out supine on a table. After an acceptable closed indirect reduction was accomplished, the plate was temporarily secured with K-wires via the plate, and then percutaneous plating was conducted. The distal and proximal ends of this plate include purpose-built holes for this. To avoid posterior drooping of the tibia at the fracture site, a kidney dish wrapped in a towel was put beneath the leg during repair.

Anatomical reduction and fixation of the fibula; (2) manual traction and temporary fixation of the bone using K-wires; and (3) anatomical reduction of displaced or rotated intraarticular fractures using thick (2 mm) K-wires or Steinmann pins as a joystick were used to achieve the desired results for 43C fractures in terms of shortening, axis deviation, and quality of reduction. Image intensifier testing confirmed the accuracy of the preliminary decrease. There was no decrease with the help of a femoral distractor. Through a small longitudinal incision (2 cm) made above the medial malleolus, a distal tibial LCP (Synthes) was

tunneled subcutaneously but extraperiosteally to prevent damaging the saphenous nerve and vein. In some situations, a plate-independent lag screw (PILS) or plate-directed compression was used to achieve interfragmentary compression (Figure 1).

In 12 patients, a one-third tubular plate was used to treat the fibular fracture, which allowed the tibia to lengthen and minimize the fracture. Nine patients did not need fixing since their fibula fracture was located in the proximal third. Fracture reduction and fixation were evaluated during surgery with the use of an image intensifier. Absorbable braided suture material was used to close the deep layers of the wound, and a subcuticular monofilament suture was used to close the skin. It was wrapped in a wool and crepe bandage. Six senior, less active patients wore an ankle brace at night to prevent equines deformity.

Table 1: Overview of the consequences

Pt. no.	M/F	AO classification	Open/closed	Delay in fixation (days)	Op. time (min)	Fibula fixation	Union (months)	FWB (weeks)
1	M	43B2	Closed	15 (blisters)	70	No	6	6
2	F	43A3	Closed	2	90	Yes	13	13
3	M	43A3	Type I	2	50	Yes	9	9
4	M	43A2	Closed	6	55	No	6	6
5	M	43A2	Closed	8	65	No	6	6
6	M	43A1	Closed	1	70	No	4	4
7	M	43C2	Closed	2	110	Yes	5	5
8	M	43A2	Closed	9	100	No	5	5
9	F	43A2	Type I	1	65	Yes	6	6
10	F	43A2	Closed	1	90	Yes	12	12
11	M	43B3	Closed	1	120	Yes	5	5
12	M	43B2	Type II	4	90	Yes	6	12
13	M	43A2	Type I	1	60	No	6	6
14	F	43A1	Closed	1	75	Yes	3	3
15	F	43C3	Type II	7	90	Yes		24
16	M	43A2	Closed	4	90	Yes	3	6
17	F	43B1	Closed	2	95	No	6	6
18	M	43A2	Closed	3	90	No	3	12
19	F	43C1	Closed	1	200	Yes	6	6
20	M	43A2	Closed	3	80	Yes	4	4
21	M	43A1	Closed	14	105	No	4	4

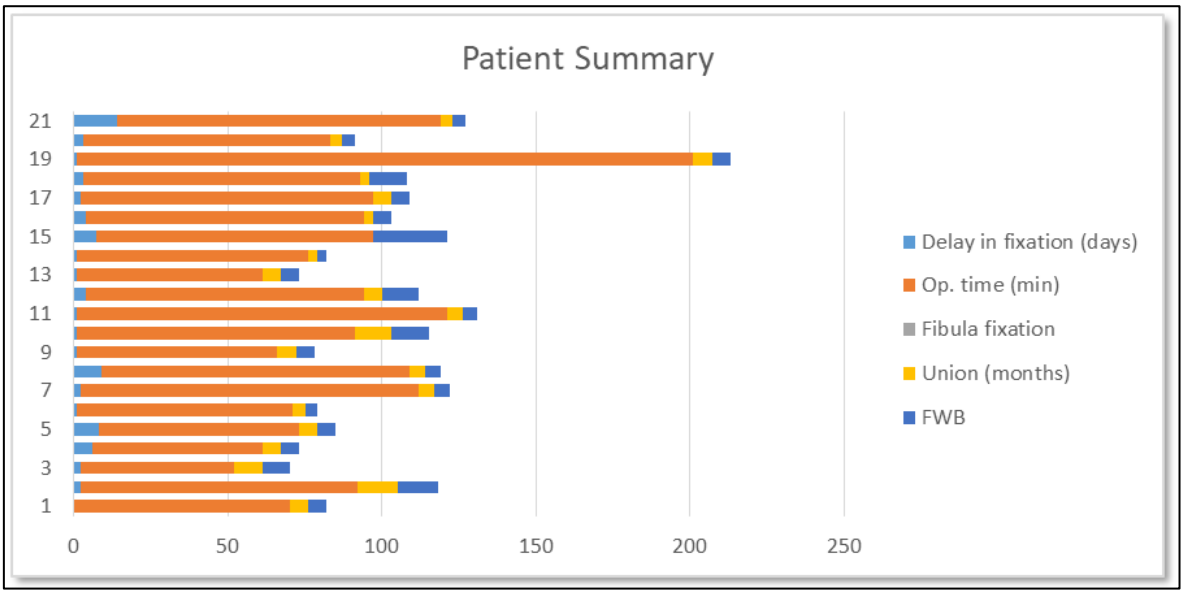

Figure 2: Patient Summary

RESULTS

Clinical and radiological results for these 21 individuals were tracked (Figures 2, 3). There was a two-day median (0- 15 days) between hospitalization and final fracture fixation. A typical procedure took about 88 minutes (50-150). In 12 patients, the fibula

was stabilized. (Table 1). In two patients, iliac crest bone grafting was done following complete fixation (15 and 21). There was a minimum of a year of follow-up. Radiographic confirmation of a mature callus spanning the fracture site, in addition to pain-free, full weight-bearing, was considered diagnostic of complete healing. There was an average of 5.5 months of wedded bliss (range: 3-13). Fourteen closed fractures healed within six months, one healed in the six to twelve months range, and one healed a full year following surgery (Figure 4).

Three of the five patients in the open fracture group had complete fracture healing in six months, one had complete healing in nine months, and one case had aseptic nonunion. Infections of the wounds occurred in two individuals (cases 10 and 12). Two patients had nonunion (case 1) or delayed union (case 2) (Case 15). Patient 10, a 40-year-old woman, had an infection from her wound. She had poorly controlled diabetes, with an HbA1C of 11. It was discovered after surgery that the skin above the fracture site was ischemic. After surgery, the skin began to deteriorate at the site of the ischemia. A transfer performed by plastic surgeons replaced the skin.

After 12 months, the fracture had healed, and the plate could be relocated again. Case 12 had an open 43B2 fracture of type II. The right femoral shaft fracture, diaphragmatic rupture, and damage to the liver and spleen all resulted from this man's RTA accident. Away from the fracture site, on the anterolateral side of his leg, he had a deep laceration that exhibited evidence of superficial infection. After taking antibiotics, the patient got better quickly, and within six months, all of the fractures had healed.

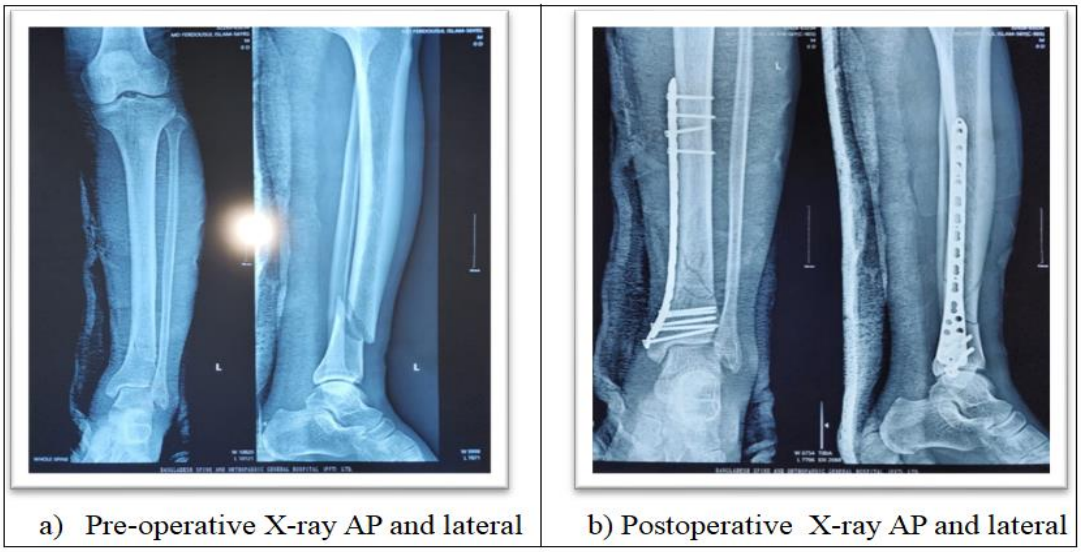

Figure 3: Distal tibial fracture diagnosed before surgery

Union in Case 2 was delayed. This individual was previously identified as having hypothyroidism and multiple sclerosis. The fracture healed 13 months after she had revision surgery with exchange plating and bone grafting. Case 15 was a 75-year-old woman who had a nonunion. The asthma required long-term steroid treatment for this woman. An open type II 43C3 fracture was found in the patient. An external fixator was used to stabilize the fracture while the soft tissue was first managed. After seven days, the external fixator was withdrawn alongside the LCP fixation. She had nonunion; therefore, at 18 months, we did revision surgery with exchange plating (LCP) and bone grafting. Within six months, the bone had healed from the fracture.

Table 2: Result

Score	No. of Cases	Percentage (%)
Excellent (90-100)	17	81
Good (80-90)	3	14.3
Fair (70-80)	1	4.7
Poor (<70)	0	0
Total	21	100

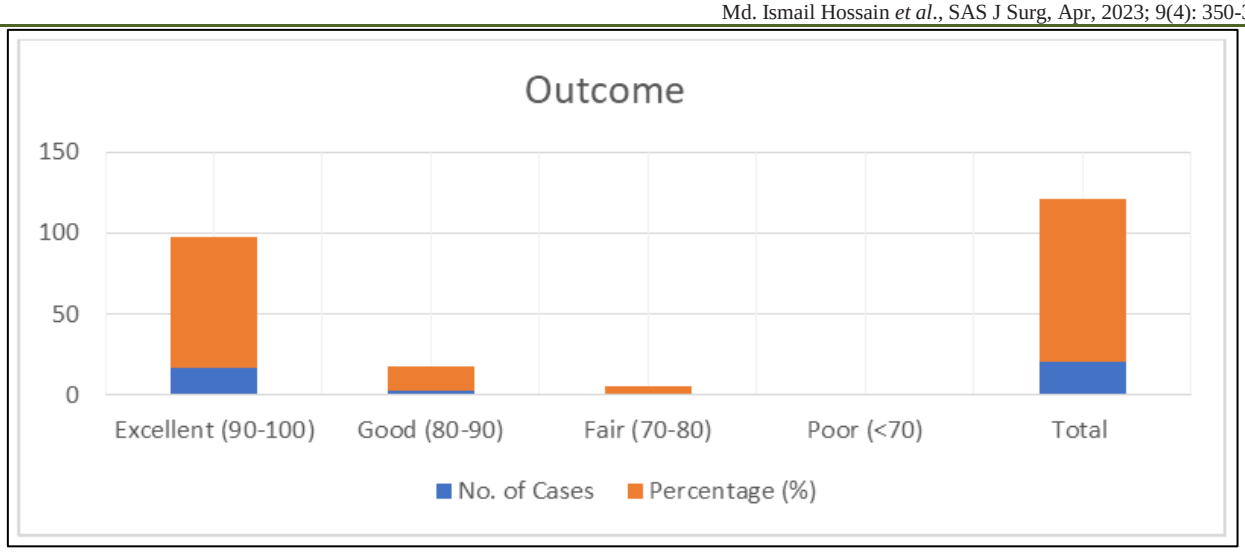

Figure 4: Outcome

Table 3: Complication

Variable	No. of Cases	Percentage (%)
Superficial wound Infections	2	9.5
Nonunion	1	4.8
Underwent revision	1	4.7

DISCUSSION

High rates of consequences such as wound infection, malunion, nonunion, and implant failure have been linked to the conventional techniques of fixing distal tibial fractures. Distal tibial open reduction is associated with an increased risk of vascular disruption, as Borelli *et al.*, showed [11]. LCP plating using MIPO causes minimal soft tissue damage. Therefore, it has a biological advantage over ORIF in that it preserves the periosteal blood supply and increases the chance of healing [12]. Many study described indirect fracture reduction and percutaneous plating techniques as evolutionary steps in biological plating. Redfern *et al.*, [13] reported good results for MIPO using closed, indirect reduction, and contoured dynamic compression plates for distal tibial fractures.

For fractures that are not amenable to intramedullary nailing's, such as those with intra- or periarticular extensions or those that are too complex to be treated through open reduction and internal fixation at the distal tibia, our experience lends credence to recent studies of LCP fixation using MIPO in this regard. Plate osteosynthesis, a less invasive method of fixing distal femur fractures, has been reported to be effective [14]. Recently, Borrelli *et al.*, [11] showed that the tibial distal metaphysis receives substantial extra-osseous blood flow, mostly from the anterior and posterior tibial arteries. With the "internal fixator" design of locking plates, the bone fragments are not drawn to the plate after screw insertion, making precision contouring of the plate less crucial for accomplishing appropriate fracture reduction.

Similarly, the locking plate should have a much smaller footprint than conventional nonlocking plates so that the periosteal blood flow to the fracture is not compromised [15, 16]. In most cases, partial weight-bearing can be safely mobilized on the first postoperative day without the need for external splinting of the limb. Due to this, the knee, ankle, and subtalar joints might also begin moving sooner.

We used the plate to compress the fracture site with dynamic holes or as an evaporation plate after lagging the fracture with cortical screws in cases of simple noncomminuted fractures. The plate was used as a bridge in complex fractures involving comminution. On average, our study found that recovery took 20 weeks. When employing this plate with the MIPO approach, we saw no discernible difference in fracture healing between simple and multifragmentory fractures. We think a range of distal tibial fractures can be effectively treated with distal tibial LCP, allowing for rapid recovery with few problems.

Our studies only have a few instances, but the clinical and radiological findings are highly promising. This method's reduced risk of complications has contributed to its rising popularity worldwide [17].

CONCLUSION

For distal tibia shaft fractures that are not amenable to intramedullary nailing, the MIPO procedure with LCP plates is a reliable treatment. Anatomically reshaped and low-profile, the distal tibial LCP is designed for a certain side of the leg. Standard fixation methods for such injuries, which can cause soft tissue issues, malalignment, and knee discomfort, are

avoided to a large extent. We think that the application technique of these plates to achieve early union in these injuries is mainly determined by the fracture anatomy itself. When treating basic, noncomminuted fractures, the plate should be utilized to neutralize the fracture site after compression has been achieved. However, these plates must be utilized as a bridging device to stabilize complicated comminuted fractures. By using these plates in conjunction with the MIPO approach, early fracture union can be achieved with few side effects if the surgeon uses discretion.

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