Annals of R.S.C.B., ISSN:1583-6258, Vol. 26, Issue 1, 2022, Pages. 492 - 500
Received 08 November 2021; Accepted 15 December 2021.

Functional Outcome of Open Reduction and Internal Fixation (ORIF) versus Minimally Invasive Plate Osteosynthesis (MIPO) in Distal Third Tibia Fractures: A longitudinal study

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Abstract

Aim: The aim of this study was to compare the outcome of open reduction and internal fixation (ORIF) of the tibia and minimally invasive plate osteosynthesis (MIPO) of the tibia in distal third tibia fractures.

Study design: A longitudinal study

Place and Duration: This study was conducted at Saidu Teaching Hospital Saidu Sharif, Swat Pakistan from June 2020 to June 2021.

Methodology: A total of 60 patients with distal tibial fractures were included in this study. Out of these 60 patients, 30 were treated with open reduction and internal fixation (ORIF) and the remaining 30 with minimally invasive plate osteosynthesis (MIPO). Duration of the surgery, duration of stay at the hospital, length of incision, blood loss during the procedure, AOFAS grading, and mobilization post-surgery with partial weight-bearing and full weight-bearing were considered to evaluate the outcome of both procedures.

Results: Mobilization with full weight-bearing, length of the incision, and blood loss during the surgery were higher in patients treated with open reduction and internal fixation (ORIF) as compared to patients treated with minimally invasive plate osteosynthesis (MIPO).

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Conclusion: Minimally invasive plate osteosynthesis (MIPO) results in less surgical trauma, more stable construction of the bone, lesser clearing of fracture hematoma, and less damage to the blood supply. Thus, MIPO was more biologically favorable than ORIF.

Keywords: open reduction and internal fixation (ORIF), minimally invasive plate osteosynthesis (MIPO), distal tibial fracture

Introduction:

Distal tibial fractures are the most common tibial fractures to occur. They are a result of direct trauma during situations like high energy falls, road traffic accidents, or sports injuries [1]. Soft tissue injury is often accompanied by tibial fracture [2]. Without proper treatment, such fractures can lead to disability. Distal tibial fractures are difficult to treat due to the bone being very superficial without much muscle covering it. Also, the proximity of the tibial bone with the ankle joint and its poor blood supply makes its fracture difficult to treat [3]. These factors lead to the high incidence of nonunion, malunion, and delayed union of the fractured bone irrespective of the advances in its treatment technique [2, 4].

Surgical treatment of tibial fracture includes external fixators, implantation of plates, and nails [5]. Minimally invasive plate osteosynthesis of the tibia has started to be frequently practiced recently due to minimum soft tissue and periosteal partition during the procedure. During this procedure, fracture hematoma is not dilapidated and bone healing is achieved by micromotion of the fracture. Soft tissue blood supply is also preserved [6].

The current study was planned to compare the outcome of open reduction and internal fixation (ORIF) of the tibia and minimally invasive plate osteosynthesis (MIPO) of the tibia in distal third tibia fractures.

Methodology

It was a longitudinal study. This study was conducted at Saidu Teaching Hospital Saidu Sharif, Swat Pakistan from June 2020 to June 2021. All the patients included in this study had a distal tibial fracture. The inclusion criteria for the participants of this study was patient being older than 18 years, patients with an open fracture of type 1 and type 2 according to Gustilo Anderson classification, and patients with closed fractures. Patients with neurovascular problems and additional ankle fractures with distal tibial fractures were excluded from this study. A total of 60 patients were included in this study. Out of these 60 patients, 30 were treated with open reduction and internal fixation (ORIF) and the remaining 30 with minimally invasive plate osteosynthesis (MIPO). Proper consent was taken from all the participants. Also, they have explained the process and the aim of this study. Permission was taken from the ethical review committee of the institute.

Data related to the history, clinical investigation, and radiological investigation of all patients were collected. History, radiological records, examinational records, wound check follow-up, immobilization for six weeks, removal of suture, six weeks to three months of ankle active extension and more than 3 months of partial weight-bearing were the basis of patient evaluation.

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In open reduction and internal fixation, the anteromedial cut was made from the medial malleolus to the proximal fracture site. Skin and subcutaneous tissue were dissected and reduction was accomplished. Fluoroscopic equipment was utilized for this procedure. On the medial surface of the distal tibia, the pre-contoured locking plate was fixed. At the end of the procedure, 4 proximal and 4 distal screws were used to secure the reduction. Lag screws were used in the case of spiral fractures. Tourniquet was deflated for stopping the bleeding. At last, the wound was cleaned and closed.

In minimally invasive plate osteosynthesis, firstly fracture was manipulated. The minimally invasive reduction was done under the guidance of fluoroscopy. A longitudinal incision was made at the center of the medial malleolus, locking plate was then pushed inside subcutaneously on the medial surface of the leg. During this, it was considered that the periosteum should not be damaged. K wires were used to momentarily fix the locking plate, one proximally and one distally. Four proximal and four distal screws were fixed at the line of traction. During the operation, the need for fibula fixation was evaluated. The distal tibiofibular joint was assessed for this evaluation. In case of the need to fix the fibula, an intramedullary plate was used.

After 2 days of operation, patients treated with both techniques were inspected and, ankle and knee rom was started. Sutures were removed on the 12^{th} day after the operation. Till the radiological examination showed union of the fracture, weight-bearing was not allowed to the patients. Every six weeks radiological imaging was done. Once the imaging showed the beginning of the union of fracture, the first part and gradually full weight-bearing were allowed. AOFAS grading system was used to assess all the patients. A score of more than 90 was considered excellent, 80 to 89 was considered good, 70 to 79 was fair, and less than 70 was considered poor.

Follow-up of each case was continued for 6 months. Follow-up checkups included AP and lateral view radiographs of the fracture site. When pain and tenderness of the fractured bone were relieved and radiographs showed callus formation with four or five cortices, it was considered as a bone union. Follow-ups were ended with AOFAS grades being assigned to every case to evaluate the clinical outcomes. A score of more than 90 was considered excellent, 80 to 89 was considered good, 70 to 79 was fair, and less than 70 was considered poor.

Duration of the surgery, duration of stay at the hospital, length of incision, blood loss during the procedure, AOFAS grading, and mobilization post-surgery with partial weight-bearing and full weight-bearing were considered to evaluate the outcome of both procedures.

Results:

A total of 60 patients were included in this study. The highest percentage (33 %) of the patients belonged to the age group of 51 to 60 years. The percentage of this age group was dominant in both groups of the patients, one treated with ORIF and the other with MIPO. 51 to 60-year-old patients were 32 % in ORIF and 35 % in the MIPO group. 71 to 80-year-old patients were 29 percent in ORIF and 30 % in the MIPO group. 61 to 70-year-old patients were 16 % in ORIF and 19 % in the MIPO group. Patients belonging to the age group 18 to

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50 years old were 23 % in ORIF and 16 % in the MIPO group. This is shown in Table 1. The difference was insignificant with the p-value being equal to 0.09. The male population was dominant in this study. In the ORIF group, 33 % of patients were female and 67 % were male. In the same way in the MIPO group, 41 % of patients were female and 59 % were male. The difference was insignificant with the p-value being equal to 0.882. This is shown in Table 2.

Most of the patients, almost 68 %, had fractures of the right leg. ORIF group had 65 % right side involvement and MIPO had 70 %. ORIF had 35 % left side involvement and MIPO had 30 %. The difference was statically insignificant with the p-value being equal to 0.821. This is shown in Table 3. Unstable fractures were more prevalent in both groups. ORIF had 80 % unstable fractures and MIPO 76 %. Stable fractures were 20 % in the ORIF group and 24 % in MIPO. This difference was statically insignificant with the p-value being equal to 0.672. Table 4 shows the prevalence of co-morbidities in both groups of patients. Hypertension was the most common (23 %) co-morbidity in both groups, 34 % in ORIF and 15 % in MIPO. The least common co-morbidity was chronic kidney disease, 0 % in the ORIF group and 4 % in MIPO. The difference was statically insignificant with the p-value being equal to 0.432. The results showed that the incision length and blood loss during surgery were significantly higher during ORIF than during MIPO. The incision length of ORIF was 13 cm while of MIPO was 8 cm. This difference was statically significant with a p-value being equal to 0.0002. Blood loss during ORIF was 116 ml while during MIPO was 79 ml. This difference was also statically significant with a p-value being equal to 0.001. The duration of ORIF was 76 minutes and of MIPO was 70 minutes. This difference was statically insignificant with the p-value being equal to 0.49. These results are shown in Table 5.

Mobilization with full weight-bearing was allowed after 17 weeks to ORIF patients while to MIPO patients after 12 weeks. This difference was statically significant with a p-value being equal to 0.0002. On the other hand, mobilization with partial weight-bearing and duration of the stay at the hospital were more in ORIF patients. Their difference was also statically insignificant with the p-value being equal to 0.283 for hospitalization duration and 0.51 for partial weight-bearing. These results are shown in Table 6. As shown in Table 7, the most common outcome of both surgery techniques was excellent. ORIF patients had 57 % excellent outcomes while MIPO patients had 70 %. ORIF patients had 39 % good outcomes while MIPO patients had 24 %. ORIF patients had a 4 % fair outcome while MIPO patients had a 6 %. Patients of both the groups had 0 % poor output. This difference was statically significant with a p-value being equal to 0.002.

Table 1 Age distribution of the study participants

Age (Years)	Open Reduction and Internal Fixation (ORIF)	Minimally Invasive Plate Osteosynthesis (MIPO)	Total
18 to 50	23 %	16 %	20 %
51 to 60	32 %	35 %	33 %

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61 to 70	16 %	19 %	17 %
71 to 80	29 %	30 %	30 %
Total	100 %	100 %	100 %

Table 2: Gender distribution of study participants

Gender	Open Reduction and Internal Fixation (ORIF)	Minimally Invasive Plate Osteosynthesis (MIPO)	Total
Female	33 %	41 %	36 %
Male	67 %	59 %	64 %
Total	100 %	100 %	100 %

Table 3: Side involvement of the patients

Side	Open Reduction and Internal Fixation (ORIF)	Minimally Invasive Plate Osteosynthesis (MIPO)	Total
Right	65 %	70 %	68 %
Left	35 %	30 %	32 %
Total	100 %	100 %	100 %

Table 4: Co-morbidities distribution in study participants

Co-morbidities	Open Reduction and Internal Fixation (ORIF)	Minimally Invasive Plate Osteosynthesis (MIPO)	Total
Hypertension	34 %	15 %	23 %
Asthma	2 %	4 %	4 %
Diabetes mellitus	30 %	11 %	19 %
Chronic kidney disease	0 %	4 %	3 %
None	34 %	66 %	51 %
Total	100 %	100 %	100 %

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Table 5: Intraoperative factors

Intraoperative factors	Open Reduction and Internal Fixation (ORIF)	Minimally Invasive Plate Osteosynthesis (MIPO)	P-value
Duration of the surgery	76 minutes	70 minutes	0.49
Incision length	13 cm	8 cm	0.0002
Blood loss during the surgery	116 ml	79 ml	0.001

Table 6: Postoperative factors

Postoperative factors	Open Reduction and Internal Fixation (ORIF)	Minimally Invasive Plate Osteosynthesis (MIPO)	P-value
Duration of stay at the hospital	6 days	5 days	0.283
Mobilization with partial weight-bearing	7 weeks	6 weeks	0.51
Mobilization with full weight-bearing	17 weeks	12 weeks	0.0002

Table 7: AOFAS grading

AOFAS score	Open Reduction and Internal Fixation (ORIF)	Minimally Invasive Plate Osteosynthesis (MIPO)	Total
Excellent (more than 90)	57 %	70 %	62 %
Good (80 to 89)	39 %	24 %	32 %
Fair (70 to 79)	4 %	6 %	6 %
Poor (less than 70)	0 %	0 %	0 %
Total	100 %	100 %	100 %

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Discussion:

Distal tibial fractures are the most common type of fractures. There are various treatment options available for this fracture including closed reduction, intramedullary plate or nail insertion, open reduction and internal fixation, minimally invasive plate osteosynthesis [3]. Every procedure has its own drawbacks and its own benefits.

Being superficial due to less muscular and soft tissue covering and its blood supply being at risk, the tibia's fracture is difficult to treat. And if the periosteum is also damaged then the blood supply also gets impaired, further delaying the healing process and union of the bone [7].

Minimally invasive plate osteosynthesis of the tibial fracture preserves the fracture hematoma and the destruction of soft tissue surrounding the fracture site is minimum [8]. The clinical and imaging outcomes of this procedure have shown successful results. Internal fixation uses an open plating technique to achieve stability of the fractured bone [9].

Delayed union and non-union of the distal tibial fracture are some of its common complications. In the study of Cheng W, Li Y, Manyi W, minimally invasive plate osteosynthesis was used. Its results reported no case of delayed union or non-union [10]. The results of our study also did not show any such type of cases. The study o Guo JJ, Tang N, Yang HL, Tang TS, also showed the same results [11].

The most common complication in the healing of distal tibial fracture was malunion. It was prevalent in almost 2 to 35 % of the cases [3]. In the study of McCann PA, Jackson M, Mitchell ST, Atkins RM, almost 3.4 % of the cases reported malunion, via open plating technique [12]. On the other hand, in the study of Zou J, Zhang W, Zhang CQ, no cases of malunion were reported in the open reduction technique [13]. It also reported 9.6 percent malunion in minimally invasive plate osteosynthesis patients [13]. Another study reported 9.5 percent malunion cases. Our study reported only one case of malunion using minimally invasive plate osteosynthesis. Malunion occurs in patients treated with minimally invasive plate osteosynthesis because closed manipulation of the fracture is done for bone reduction using fluoroscopy. This technique indirectly aligns the fractured bone hence, misalignment is possible.

During open reduction and internal fixation, more blood is lost because the procedure is open. In the same way, complication during the procedure and postoperative infection incidence is also predicted to be higher. But in our study, no such case of infection was reported in open reduction and internal fixation patients. In this procedure, precise reduction, alignment, and rigid fixation of the fracture are possible. The incision length and blood loss during surgery were significantly higher during ORIF than during MIPO in our study. Also, the duration of ORIF surgery was more as compared to minimally invasive plate osteosynthesis and this difference was statically insignificant. Another study also showed similar results [3]. In the study of Gawali SR, Kukale SB, Nirvane PV, Toshniwal RO, in open reduction and internal fixation, the time for mobilization with full weight-bearing was higher than minimally invasive plate osteosynthesis. This difference was statically significant. On the other hand time for mobilization with partial weight-bearing was also more in open reduction and

internal fixation than in minimally invasive plate osteosynthesis. But this difference was not statically significant. [15]

Conclusion:

Minimally invasive plate osteosynthesis (MIPO) results in less surgical trauma, more stable construction of the bone, lesser clearing of fracture trauma, and less damage to the blood supply. Thus, MIPO was more biologically favorable than ORIF.

Conflict of interest

None

Funding source:

None

Permission:

It was taken from the ethical review committee of the institute

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