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Comparison between plating by MIPPO and IMLN in proximal tibia extra-articular fractures: Our experience at a tertiary care hospital

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Abstract
Objective: To assess the effectiveness of the two techniques (MIPPO & IMILN) & Compare outcome.
Methods: This is a Prospective, Randomized control trial involving 52 cases of extra-articular proximal tibial fractures treated either with MIPPO or IMILN in the Department of Orthopaedics, IMS and SUM Hospital, Bhubaneswar during September 2017 to September 2019. Functional outcome was calculated with Lower extremity functional scale and Knee society score and final outcome with Johner Wruhs criteria.
Results: Each group had 26 cases in them, cases were followed-up for an average duration of 11.9 months. 2 cases from MIPPO group and 4 from IMILN group lost follow up. The average time to radiological union in MIPPO group was 16.1 weeks and that in IMILN group was 16.9 weeks. IMILN group had a higher rate of mal-reduction (19.1%) than MIPPO (15.4%). anterior angulation of the proximal fragment was commonest. Superficial infection occurred in 8.3% cases of MIPPO group and 4.5% in IMILN group. Non-union occurred in 1 (4.2%) and 1 delayed union (4.2%) in MIPPO group. Non- union developed in 1 case in IMILN group (4.5%) and 2 cases of delayed union (9.1%). Implant irritation was seen in 2 of our cases (8.3%) in MIPPO group. Anterior knee pain was observed in 2 patients in IMILN group (9.1%). LEFS in MIPPO was 45.8% and IMILN was 40.9%. Final outcome showed excellent result in 50% and 45.4% in MIPPO and IMILN respectively.
Conclusions: If principles of treatment are correctly followed, most of cases will have excellent result with either modality of treatment.

Keywords: Osteosynthesis, orthopaedic fracture, MIPPO and IMLN

Introduction
Fractures of proximal third tibia have been a problem to treat because of the subcutaneous location of the antero-medial surface of the tibia. They often result from high energy trauma and are associated with significant comminution, soft tissue damage, compartment syndrome and vascular injuries. Closed management often leads to Varus, especially when the fibula is not fractured. Therefore, it should be considered for undisplaced or minimally displaced fractures. The goals of surgical management include correction and maintenance of sagittal and coronal alignment, restoration of length and rotation and early functional knee and ankle range of motion".

Earlier techniques emphasized precise anatomical reduction and absolute rigid fixation with extensive surgical exposure and soft tissue stripping which often resulted in devitalisation of fracture fragment and soft tissue complications.

For these reasons various modalities of treatment have been described by many surgeons with their own view, of which the commonly used plating technique is Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) using locking plates and Intramedullary Interlocking Nailing.

Minimal soft tissue dissection is required in MIPPO which preserves vascular integrity of fracture as well as the osteogenic fracture haematoma. They also provide semi rigid fixation allowing micro motion at fracture site and thereby fracture healing by secondary intention.

Intramedullary interlocking nailing of proximal one third tibia fractures is advocated because it avoids extensive soft tissue dissection as well as acts as a load sharing device.

However, it was associated with significantly high rates of malalignment, non-union, implant failure and need for revision fixation.

Materials and Methods

This prospective study was carried out in the Department of Orthopaedics, IMS and SUM Hospital from September 2017 to September 2019. A total number of 52 cases were subjected to treatment in our present study, managed surgically, either by Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) Technique or Intramedullary Interlocking Nailing (IMILN). The cases were allotted alternatively in either group.

Inclusion criteria

1. Patients between 20 to 60 years.
2. Closed fractures.
3. 41A2 fractures of AO classification.
4. Segmental fractures with at least one fracture line in the above-mentioned zone.

Exclusion criteria

1. Those having established compartment syndrome.
2. Intra articular fractures of proximal tibia.
3. Comminuted extra-articular fractures (41A3 according to AO system).
4. Compound fractures.
5. Those associated with distal neurovascular deficit

The patients were stabilised and after proper pre-operative planning surgery was performed. They were discharged approximately after 5 days with certain advices and medications. First follow-up was usually done after 4 weeks. Patient was followed up clinically and radiologically at 3-4 weeks' interval till union and at 3 months' interval thereafter. Data was collected by verbal communication, clinical examination and radiographic features.

Patients were evaluated on the basis of union, alignment, complications. Functional outcome was calculated with Lower extremity functional scale and Knee society score and final outcome with Johner Wruhs criteria.

The patient was allowed to bear full weight when the X-Ray showed bridging callus in 3 cortices out of 4 and an absence of mobility and tenderness at the fracture site. This is normally by 8-12 weeks' post-surgery.

Fig 1: Procedure during surgery

Operative procedure: Plating by mippo technique

Indirect reduction was achieved using manual traction and Image intensifier support. An incision of appropriate size was given over the anterolateral surface of the proximal tibia proximal to the fracture site. Then a submuscular tunnel made with periosteal elevator extended across the fracture to the other side. The plate was inserted through the incision, held in place by pointed reduction clamps and K-wires. Then fixed with screws. Wound closure was done in standard fashion, sterile dressing done and slab given.

Fig 2: Operative Procedure: Intramedullary Nailing

Operative Procedure: Intramedullary Nailing

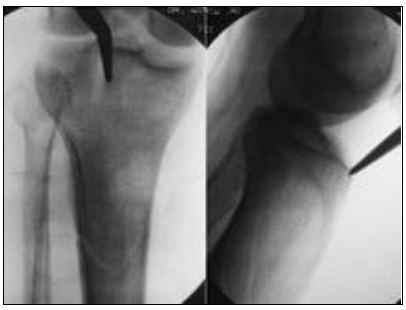

Fig 3: Radiological image

The incision starts at the joint line and extends proximally. Patellar tendon splitting approach was used in all our cases. The starting point was placed more laterally, in line with the lateral intercondylar eminence and long axis of tibia, and more proximally without damaging the articular structures. The starting point location was confirmed in AP and lateral radiographs. Entry point was made, guide wire passed. Manipulation of the fracture site was done if the alignment was not in center. In some of our cases femoral distractor or blocking screws were used to maintain reduction. The fracture was reduced before reaming. Nail of appropriate length then inserted. Distal and proximal locking done.

Results

In the present study, 52 cases of Extra-articular Proximal Tibial Fractures were treated in the Department of Orthopaedics, IMS and SUM Hospital, Bhubaneswar. During the period of September 2017 to September 2019. Total of 26 cases were in either groups. 2 cases from MIPPO group and 4 cases from IMILN group lost follow-up after discharge from hospital hence they were excluded from certain parameters.

Out of the 52 cases 69.24 patients were in 30-50 years age group and the men being 40.2 years. Male female ratio being 4.7:1, most common mode of injury was Road traffic accident.

Radiological union time

Radiological union was defined as bridging callus in 3 out of 4 cortices (Table 1).

Table 1: Duration of post-surgery

Sr. No.	Weeks	MIPPO	%Age	IMILN	%Age
1	12-15	15	62.5	12	54.5
2	16-20	4	16.6	6	27.3
3	21-24	3	12.5	2	9.1
4	>24	2	8.4	2	9.1

Post-operative alignment

Acceptable alignment was defined as less than 5° anterior/posterior angulation, less than 5° Varus/valgus deformity or less than 10° rotation difference. We didn't have any case of rotational mal-alignment. (Table 2)

Table 2: Alignment for both MIPPO and LMN

Sr. No.	Alignment	MIPPO(n=26)		IMN(n=26)	
		No. of Cases	%age	No. of Cases	%age
1	Acceptable Reduction	22	84.6	21	80.8
2	Varus	1	3.8	1	3.8
3	Valgus	0	0	1	3.8
4	Anterior angulation	2	7.7	3	11.5
5	Apex Posterior	1	3.8	0	0
6	Total Malreduction	4	15.4	5	19.1

Complications

Table 3: Complication of participated patients of both MIPPO and LMN

Sr. No.	Complication	MIPPO (n=24)		IMN (n=22)	
		No. of Cases	% Age	No. of Cases	% Age
1	Superficial Infection	2	8.3	1	4.5
2	Common Peroneal Nerve Palsy	1	4.16	0	0
3	Implant Irritation	2	8.3	0	0
4	Anterior Knee Pain	0	0	2	9.1
5	Delayed/Non-Union	2	8.3	3	13.63
6	Malreduction	4 (n=26)	15.4	5 (n=26)	19.1

Functional Outcome: It was calculated using the Knee Society Score and Lower Extremity Functional Scale.

Table 4: (Knee society score)

Knee Society Score (Knee Score)	MIPPO	IMILN
Excellent (85-100)	11	11
Good (70-84)	6	6
Fair (60-69)	5	4
Poor (<60)	2	1
Total	24	22

Table 5: LEFS score in MIPPO and IMILN

LEFS Score	MIPPO		IMILN	
	No.	% Age	No.	% Age
71-80	11	45.8%	9	40.9
61-70	7	29.1%	9	40.9
51-60	4	16.6%	3	13.7
<50	2	8.3%	1	4.5

Result Analysis: The "Johner & Wruhs' Criteria" was used for final result analysis after 1 year as excellent, good, fair and poor.

Table 6: Johner & Wruhs' Criteria

Johner & Wruhs' Criteria	MIPPO		IMILN	
	No.	% Age	No.	% Age
Excellent	12	50	10	45.4
Good	6	25	8	36.4
Fair	4	16.6	3	13.6

Fig 4: Radiological image of post-surgery

Discussion

In our study we had overall malreduction of 15.4% in MIPPO group and 19.1% in IMN group. In both the fixation methods, anterior angulation of the proximal fragment was the commonest deformity due to the pull of the patellar tendon. Coronal plate deformity due to the spaciousness of the canal.

Lang *et al* [1] reported 84% of significant malalignment (more than 5 degrees). They observed that valgus and apex anterior angulation were the commonest.

"Ricci *et al.* [2] described the use of blocking/poller screws to prevent malreduction and increase the stability while nailing these fractures. Clinical follow-up of 11 patients revealed only 1 case of malreduction >5 degrees (9%). Krettek *et al* [12] reported a similar malreduction rate of 10% on 10 proximal and 11 distal tibial shaft fractures treated with intramedullary nails and blocking screws.

Dunbar *et al.* [3] in their study of 33 extraarticular fracture of proximal 1/3rd tibia treated accompanying an unicortical plate had only 3 cases of angulation with >5 degrees in any plane.

Lindvall *et al.* [4] reported significant malreduction rate of 20.58% in their study (5 apex anterior, 1 Varus and 2 apex posterior). Peter A. Cole *et al* [5] in their series of 77 patients reported 8 cases of significant malreduction (10.38%). Stannard *et al* [7] series reported 11.4% malreduction rates.

In different plating studies – Cole *et al.* [5] reported 3% non-union/ delayed union, Schutz *et al.* [6] had non-union rate of 5%. Ricci *et al.* [2] had no case of non-union. Eric lindvall *et al.* [4] reported 6% non-union rate in their percutaneous locking plate series. In intramedullary nailing studies – Lang *et al.* [1] had 2 cases of non-union out of 32(6.25%). Bleuler *et al* [8] had 1 case of non-union out of 14 (7.14%). Lindvall *et al.* [4]. In their series of 22 cases reported union rate of 77% after index (primary) procedure, 95.4% after secondary procedure.

Meena, R.C *et al.* [14] reported a malunion rate of 21.1% in IMILN and 16% in plating group.

Incidence of non-union in our series was very much similar to earlier published studies. In MIPPO group we had 1 case of non-union out of 24 cases (4.16%) and 1 case had delayed union (4.16%).

The mean time for union in MIPPO group was 16.1 weeks and that for nailing was 16.9 weeks. Comparing the union rates in the two groups we found the p value = 0.6196. From the above calculated value, it is concluded that the difference between union times in two groups is not statistically significant.

In Stannard *et al*. [7] series the average time to radiological union was 15.6 weeks. In OH-Jong *et al*. [9] series all fractures united at an average time of 16.5 weeks.

Meena, R.C *et al*. [14] in their randomized prospective clinical study union time (p = 0.004) were significantly less in the IMN group than in the PTP group

In our study 2 patients in IMILN group had anterior knee pain. Implant irritation was observed in 2 of our patients; both in MIPPO group but neither of them had implant removal before union. 1 patient had peroneal nerve neuropraxia post-operatively. Hardware irritation in different study series – Ricci *et al*. [2] -5%, Cole *et al*. [5] -5% Stannard *et al*. [7] – 18%, Boldin *et al*[4]-8%, Peroneal nerve neuropraxia as shown in studies – Cole *et al*. [5]. -1%.

The infection rate in our study was 8.3% in MIPPO and 4.5% in IMILN. Meena, R.C *et al*[14] found infection rate IMILN – 5.3% and MIPPO - 8% which is quite similar. Bhandari *et al*. [13] studied both plating and IMILN and said that there was low evidence of less infection with IMILN but the study did not include MIPPO.

Xi Liu and Shiqiang cen *et al* [2017] [15] in current study found similar union rate, mal-union rate and infection rate for IMN and plate. IMN was more patient satisfactory, but at the same time, more technically requiring and concluded that both the methods are equally satisfactory only secondary to proper techniques.

Functional outcome was evaluated at each follow-up using the following. Knee score was evaluated each visit using the "Knee Society Scoring System (Knee Score)" by Insall *et al*. Mean score in MIPPO group was 80.208 and that in nailing group was 80.818, p-value = 0.8479 (statistically non-significant).

Functional status of the affected limb was compared to that of the normal limb at each visit and at final visit using the Lower Extremity Functional Scale (LEFS) by Binkley JM, Stratford PW, Lott SA, Riddle DL. The maximum score is 80. The average LEFS score at final follow up was 65.25 for MIPPO group and 67.25 for nailing group. Comparing the two did not reveal any statistically significant difference (p-value =0.3523).

"Johner & Wruhs' Criteria" was used for final result after one year as excellent, good, fair and poor. Our study –in MIPPO group we had- 12 excellent (50%), 6 good (25%), 4 fair (16.6%) and 2 (8.4%) poor results out of 24 cases. In intramedullary nailing group we had 10 excellent (45.4%), 8 good (36.4%), 3 fair (13.6%) and 1 (4.6%) poor results.

In Weiner LS *et al*. [10] series they had 34% excellent, 48% good, 12% fair and 6% poor results. James J. Hutson [11] series 85% were excellent or good results.

Conclusion

IMILN is a good method. In spite of small upper fragment reduction can be kept. The need for changing of the routine method and additional method are mostly needed for reduction. MIPPO is relatively easy technique and do not need use of additional instrumentation. It improves the fracture union rate with reduced rates of infection than conventional plating. Closed fractures progress to predictable healing regardless of the surgical procedure employed. If principles of treatment are correctly followed, most of cases will have good final outcome with either modality of treatment for these fractures

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