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Evaluation of Functional Outcome Following Minimal Invasive Surgery in Treatment of Distal Tibial Fractures-A Prospective Clinical Study

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ABSTRACT

BACKGROUND: Distal diametaphyseal tibia fracture though requires operative treatment is difficult to manage. Conventional osteosynthesis is not suitable because distal tibia is subcutaneous bone with poor vascularity. Closed reduction and minimally invasive surgery has emerged as an alternative treatment option because it respects biology by minimising damage to soft tissues and the vascular integrity of bony fragments also provides biomechanicaly stable construct.

METHODS: 26 patients (mean age 37.84+_10.15 years) of distal diametaphyseal tibia fracture with or without intra articular extension associated with distal third fibula fracture treated with MIPO with LCP were evaluated prospectively using Teeny and Wiss clinical assessment criteria which is based on 100 points system.We made multiple small (1-2 cm) release incisions over anterior aspect of lower third of leg in between suture lines to decompress the compartment. These patients were followed for average duration of 6 months with maximum followup of 52 wks.

RESULTS: In our study we encountered good ankle ROM (average dorsi-flexion 16.23+_ 2.57 degree ranging from 10 to 20 degree and average planter-flexion 37.23+_ 4.53 degree ranging from 30 to 45 degree), complete bone union was achieved in an average time of 12.46 wks ranging from 10 to 16 wks., one superficial infection over medial aspect , cured with oral antibiotics. No case of rotational malalignment observed in our study.We observed that callus started to appear at 7 wks radiologically in an average time of 10.65+_1.85 wks. And full weight bearing was started only after appearing solid callus (complete fracture union) in an average time of 12.46 wks ranging from 10 to 16 wks.

CONCLUSION:

The present case series shows that MIPO with LCP is an effective treatment method in terms of union time and complications rate for distal diametaphyseal tibia fracture. Malleolar skin irritation is common problem because of prominent hardware. Decompression of anterior compartment of leg definitely reduces post-operative swelling and pain, and adds extra benefits in terms of early treatment and cost effective to MIPO approach

KEYWORDS Distal tibia fracture, MIPO , Decompression , Teeny and Wiss criteria

Introduction

The management of distal tibial fractures (intra-articular & extra-articular) remains challenging(1). Conservative management may be complicated by loss of reduction and subsequent malunion(2). Open reduction and internal fixation requires extensive soft tissue dissection with consequent periosteal injury even in expert hands. High rates of complications including infection, delayed union and non-union have been reported. External fixation, Ilizarov frames, ankle spanning and hybrid constructs have been proposed either as a sole treatment or, more frequently in conjunction with limited internal fixation can be used as a preliminary reduction and fixation tool. Complication of external fixation include the development of pin tract infection, mal-union or non-union.

In order to improve fracture healing, more biological methods have been developed over the last decades trying to lessen the surgical dissection, preserving the blood supply to the bony fragments and containing at least partially the fracture hematoma.

Over the years however, open reduction and plate and screw fixation has remained the preferred treatment for peri-articular fractures. The first attempts at which is called as biological plating gained popularity in the 1980's(Boitzy and Weber).

The development of the wave plate (Brunner and Weber1981) and the bridging plate (Heitmeyer et al 1985) and indirect reduction techniques (Mast et al 1989), brought about a basic change to fracture treatment using plates.

More and more new insights in reduction techniques and fracture healing are leading to the development of a "minimally invasive osteosynthesis" promoted by AO group and others lies on indirect reduction, axial alignment and stable fixation without disturbing the fracture environment and thus preserving most of the vascularisation and fracture hematoma, containing all necessary growth factors for bony healing.

Biological bridge plating uses the plate as an extramedullary splint fixed to the two main fragments. The complex fracture zone is virtually left untouched; however, it is bridged by the plate. Length, alignment, and rotation are restored, but anatomical reduction of each fragment is not attempted.

Material and Methods

This study was carried out prospectively on the patients having fracture of distal leg bones, admitted in the Department of Orthopaedics, SMS Medical College and Hospitals, Jaipur Rajasthan, India during the year 2010-2012 after taking clearance from the institutional ethics committee and informed consent of the subjects.total no of case was 26(n=26). Inclusion Criteria: Closed/open fractures of distal leg bones, Intra-articular/extra-articular fracture of distal tibia,Skeletally mature Exclusion Criteria:With vascular injuries,Isolated distal tibia fractures ,elderly with co-morbidities.

Out of 26 patients (mean age male 37.83+_10.78 years and Females 38.00+_1.41 years), 23 patients(88.46%) were injured by Road Traffic Accident, 2 patients(7.6%) were injured by fall from stairs and 1 patient(3.85%) got injured by fall of stone were classified according to OTA/AO classification: 43-A extraarticular fractures, 43-B partial articular fractures, and 43-C complete articular fractures(3) (Table1). Right limb was involved more than(57.85%) left side.

Table-1:Distribution according to AO Classification of the patients

AO	No.	%
43A1	8	30.77
43A2	7	26.92
43A3	9	34.61
43C1	1	3.85
43C2	1	3.85
Total	26	100.00

Soft tissue Injury categorized as open fractures according to Gustilo and Anderson classification(4) and closed fractures further classified according to Tscherne classification(5) as table-2

Table-2 Soft tissue classification

Soft-tissue injury	No			%
Closed	20	Tc grade	No	%
		Tc0	7	35
		Tc1	10	50
		Tc2	3	15
		Total	20	100
Open	6			23.07
Total	26			100

In our series we operated almost all cases within 48-72 hours in single stage surgery without using any external fixator and resolving swelling using a new innovative idea giving multiple release incisons(1-2cm) over anterior aspect of lower third led to decompress the compartment as depicted in table-3.

Table-3: Multiple Release Incision Distribution

Tscherne Grade CLOSED	Multiple Release Incisions		Total
	yes	NO	
Tc0	2 (10.00)	5 (25.00)	7 (35.00)
Tc1	5 (25.00)	5 (25.00)	10 (50.00)
Tc2	1 (5.00)	2 (10.00)	3 (15.00)
Total	8 (40.00)	12 (60.00)	20 (100.00)
OPEN	5 (83.33)	1 (13.88)	6(100.00)

All cases were followed up for a minimum period of six months as per Teeny and Wiss clinical assessment criteria(7) which is based on 100 points system.

Surgical Technique

The patient was positioned supine on a radiolucent operating table with padding under the leg to assist lateral imaging. The leg was disinfected and prepared circumferentially from the toes to the midthigh and draped free. A support (a single rolled blanket) under the ipsilateral buttock prevents the leg rotating externally. A pneumatic tourniquet was applied to the proximal thigh.The image intensifier is placed on the opposite side and rotated for AP and lateral views.

This MIPO approach is used for extraarticular type A fractures, or for intraarticular simple type C fractures. In the latter, the articular fracture component is not (or only minimally) exposed; and is reduced either by indirect maneuvers using ligamentotaxis and directly applying percutaneous reduction forceps, or with percutaneously inserted lag screws.

After exsanguinating the limb, the tourniquet is inflated to 300 mmHg. Initial attention is directed to the fracture lines which extend into the tibia plafond. These articular fragments are anatomically reduced either by percutaneous means, utilizing fluoroscopy and pointed reduction forceps or via a small anterior incision, arthrotomy, and direct open reduction. Once an articular reduction has been achieved, the articular fragments were stabilized with 3.5 mm lag screws or temporary K- wires.

The medial approach is commonly used for the MIPO technique.However, in selected cases with soft-tissue lesions on the medial side an anterolateral approach may be indicated.

The appropriate length of the distal tibia locking plate was determined by placing a plate along the anterior aspect of the leg and adjusting it so that under fluoroscopy the distal end of the plate is at the level of the tibial plafond and the proximal end extends at least three screw holes beyond the proximal limit of the tibia shaft fracture.

With MIPO plate constructs it is preferable to choose as long an implant as possible for the widest distribution of load at the fracture site(6).

A 2-3 cm straight, or slightly curved skin incision was made along the anteromedial aspect of the tibia, proximal distal to the fracture and distally at the level of the medial malleolus.

After performing the anteromedial approach, the plate is inserted above the epiperiosteal space from distal to proximal on the anteromedial aspect of the tibia. The locking drill sleeves are attached to proximal and distal end holes of the LCP to serve as joysticks for proper positioning under fluoroscopic control.

The position of the plate is adjusted under fluoroscopy in both the coronal and sagittal planes so that it lies along the medial aspect of the tibia. It is important that the plate is in the correct position in relation to the joint space and an intra-articular K-wire can be used as a guide under image intensifier control.

The first 3.5 mm cortex screw was inserted in one of the most distal plate holes just above the ankle joint thus approximating the plate to the bone.

4.5 mm cortex screw was placed at proximal end of the plate and in the mid-portion via small percutaneous stab incisions. Finally distal 3.5 mm screw was tightened. The distal metaphyseal articular fragment can be indirectly reduced to the proximal shaft in this way.

The number and position of the screws inserted is dependent on the individual fracture pattern and bone quality. Ideally the concept of "balanced" fixation should try to be achieved. Usually, the metaphysis requires more screws (3-5) than the diaphysis (3-4). In osteoporotic bone, the number of screws must be increased on both sides of the fracture.

The fibula was fixed in the standard fashion using open reduction techniques and one third tubular plates that bridge the comminuted section

Fig. 1(a-d)

Preoperative skin condition

MIPPO Incisions

Fibula ORIF

Decompression anterior compartment

The surgical incisions were irrigated and closed. After atraumatic closure of skin incisions, we made multiple small (1-2 cm) release incisions over anterior aspect of lower third of leg in between suture lines to decompress the compartment.

Sterile dressings were applied and the limb was immobilized in a well padded posterior Below Knee slab with the ankle maintained in the neutral position and elevated on BB splint. All patients received 72 hrs of perioperative prophylactic intravenous antibiotics (Inj. Ceftazidime 500 mg and Inj Amikacin 500 mg twice daily).

Fig. 2(a-d): X-ray documentation (AO 43A1): a. Preoperative AP and Lateral View b. Postoperative tibia and fibula fixation; c. Radiological union in AP (coronal) and; d. Lateral view (sagittal view) at 6 months

Post-operatively, the limb was maintained in the elevated position and active toe, hip ,knee and ROM exercises were started as soon as pain subsided within a week.

Rehabilitation

All patients were non-weight bearing for at least 6 weeks. Patents were reviewed in outpatient department at 10-14 days post-op for stitch removal and wound inspection. They were then reviewed at 4-8 weeks intervals until they were weight bearing fully with fracture united radiographically and clinically and postoperative complications had been identified and treated properly. Final evaluation was done at 6 months for distal tibial fractures using Teeny and Wiss Scoring System(7)

Results

19 cases operated with MIPPO technique in an average of 2.21+_1.93 days had excellent results; four cases in an average of 4.25+_2.16 days had good results and cases operated in an average time of 5.33+_3.40 days had fair results favours early fixation with minimally invasive technique.

In our series we operated almost all cases within 48-72 hours in single stage surgery without using any external fixator and resolving swelling using a new innovative idea giving multiple release incisons(1-2cm) over anterior aspect of lower third led to decompress the compartment as depicted in table-3,although further study is required.

Average time taken for partial weight bearing was 6.5 weeks ranging from 6 to 8 weeks. In our study full weight bearing was started only after appearing solid callus (complete fracture union) in an average time of 12.46 wks ranging from 10 to 16 wks. Callus started to appear at 7 wks radiologically in an average time of 10.65+_1.85 wks. Union was defined clinically as ability to walk without any support and pain and radiologically as solid callus bridging the fracture segments. Delayed union was defined as healing of fracture between 5 to 9 months and non-union was considered when no evidence of healing was detected after 9 months from the operation *(8)*. **In our series all fractures completely united in 12.46+_1.69 wks**.

Table-4 Distribution according outcome of the surgery of the patients

Outcome (TEENY & WISS Score)	**No.**	**%**
Excellent (>92 points)	**19**	**73.08**
Good. (87-92points)	**4**	15.38
Fair (65-86 points)	**3**	**11.54**
Total (< 65 points)	**26**	**100.00**

Table-5: Mean + Sd of Ankle of ROM DF & PF according to outcome of the surgery of the patients

	Excellent (n=19)	Good.(n=4)	Fair (n=3)
Ankle ROM DF	17.31 ± 1.86	13.75 ± 2.16	12.67 ± 0.94
Ankle ROM PF	38.47 ± 4.58	33.50 ± 2.06	34.33 ± 1.70

Excellent v/s Good	P < .001	HS	Excellent v/s Good	P < .05	Sig
Excellent v/s Fair	P < .001	HS	Excellent v/s Fair	P < .05	Sig
Good v/s Fair	P > .05	NS	Good v/s Fair	P > .05	NS

Complications(Table-6)
All cases showed minimal angulation in any plane(<5degree) and no clinical and rotational malalignment was noted.

SNO.	COMPLICATION	NO OF PATIENTS
1	Implant prominence	5
2	Wound dehiscence	1
3	Infection	2
4	Implant Failure	1

Table-7:Distribution according complications & Multiple release Incisions of the patients

Complications	Multiple release Incisions		Total
	Yes	No	
Implant Failure	0 (0.00)	1 (3.85)	1 (3.85)
Palpable Screw	2 (7.69)	3 (11.54)	5 (19.23)
Sup. Infection	0 (0.00)	2 (7.69)	2 (7.69)
Wound Dehiscence	0 (0.00)	1 (3.85)	1 (3.85)

DISCUSSION
MIPO technique has become widely practised in the operative management of articular, metaphyseal and transitional zone fractures over the last few years (8). It has the advantages of respecting soft tissue via small skin incisions, minimal surgical dissection, indirect facture reduction and minimal hardware application. As a result healing time is accelerated, and complication rates are low .

Teeny and Wiss have encountered 37% infection rate in fractures treated by ORIF and 26% required ankle arthrodesis. They reported poor results in 67% of fractures treated with ORIF(9).

In the study done by **Stefano Ghera et al. (8)** Eighteen patients were treated using the minimally invasive plate osteosynthesis technique. Patient distribution according to AO classification was: 2 patients, type 43 C1; 6 patients, type 43 C2; 3 patients, type 43 C3; and 7 patients, type 42 A1 and 42 A2. No infection or pseudoarthrosis was reported. One patient had radiographic malalignment (8° on AP view). In two patients (C2 and C3 fracture, respectively), _15° of limited range of motion was observed. On radiographs, complete healing time was observed within 16 weeks in C1, C2, and C3 fractures, and within 14 weeks in 41 A1 and A2 fractures. Average consolidation time was 105 days (range: 90-120 days).

In our study we encountered good ankle ROM (average dorsi-flexion 16.23+_ 2.57 wks ranging from 10 to 20 degree and average planter-flexion 37.23+_ 4.53 wks ranging from 30 to 45 degree), complete bone union was achieved in an average time of 12.46 wks ranging from 10 to 16 wks., one superficial infection over medial aspect , cured with oral antibiotics.

Jens Grancois, Geoffroy vandeputte et al.(2004) described that treatment of fracture of distal fibula is quite straightforward and is very important to restore the original length and rotation of distal tibia, although there is no general agreement in the literature(10). **Dogra et al** reported that, three patients of the 15 cases of their series presented angle in varus or valgus >5 degree, without fibular fixation(11). Poor contouring of the plate in study done by **Chang Wug et al.** resulted in malalignment in rotation(12).In our series minimal angulation (<5degree) in any plane was observed and no rotational malalignment resulted as we fixed all associated distal third fibular fractures with one third tubular plate and distal tibia fractures with precontoured distal metaphyseal LCP in MIPO fashion.

We observed in all patients that callus started to appear at 7 wks radiologically in an average time of 10.65+_1.85 wks. And full weight bearing was started only after appearing solid callus (complete fracture union) in an average time of 12.46 wks ranging from 10 to 16 wks. in accordance to previous study(14).

CONCLUSION:
The present case series shows that MIPO with LCP is an effective treatment method in terms of union time and complications rate for distal diametaphyseal tibia fracture. Malleolar skin irritation is common problem because of prominent hardware. Decompression of anterior compartment of leg definitely reduces post-operative swelling and pain, and adds extra benefits to MIPO approach.

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