IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 15, Issue 8 Ver. X (August. 2016), PP 12-19
www.iosrjournals.org

Functional Outcome of Various Modalities of Management of Distal Tibial Fractures

Dr. E S Arivazhagan M.S Ortho

I. Introduction

Distal tibial fractures remain a challenge to orthopedic surgeons. They usually occur as a result of high energy trauma in young patients, but in the elderly they can result from a simple fall. In the elderly, the problem is compounded by poor bone-stock, their limited ability to partially weight bear in co-morbid conditions.

The main challenges.[2]

1. The compromised skin and soft tissue envelope as in open fractures lead to a high incidence of complications following open reduction and internal fixation.

2. In the mataphysis, fixation is less rigid and early loosening is a frequent as the cancellous is open and 'cell-like' and therefore ill equipped to support as screw thread.

3. Comminuted fracture patterns, which create difficulty in achieving rigid fixation since the purchase in trabecular bone is less than optimal to permit weight bearing or even start early joint mobilization. These conditions that restrict mobility lead to decubitus ulcers, deep vein thrombosis, joint stiffness and secondary osteoarthritis.

4. These high energy fractures may be associated with extremely damaged soft tissue envelope, as well as comminuted metaphyseal region and articular surface making anatomical reduction difficult.

Following are various classical and conventional methods available to address such injuries, but each has its own set of advantages and disadvantages.

1) Non-operative management:

Closed, simple fractures in patients those are having associated Co-morbid diseases rendering them unfit for anesthesia, leaving them to be managed conservatively.

2) Intramedullary nailing:

Simple fractures, those without associated soft tissue envelope damage and less comminution, can be managed with intramedullary nailing.

3) AO External fixators:

These fixations have been successful in reducing the fractures temporarily and attending the soft tissue injuries.

4) Plating devices:

Fractures not associated with significant soft tissue damage can be treated with open reduction and plating. This may be done with conventional, bridge plating technique or locking plating.

5) Hybrid External fixation:

In periarticular fractures wires are placed into the metaphyseal region and schanz pins into the diaphyseal region after reducing the fractures.

Aim Of The Study

To analyze and individualize the choice of fixation in the management of distal tibial fractures.

Clinical Features

In conscious patient's pain, swellin and deformity are conspicuous. Physical examination should include the assessmentof neurovascular status of the patient's injured limb, since compartment syndrome may be apparent within few hours. It is extremely important to examine the skin thoroughly and any open wound should be assessed.

Radiological Assessment

Anteroposterior and lateral radiographs of the leg including knee and ankle joints must be taken.

Computed tomography is useful in cases of fractures extending into the distal particular surfaces.

1. Location and pattern of he fractures,
2. Secondary fracture lines, if any, which might get iatrogenically displaced if unnoticed.
3. The presence of comminution signifying high energy trauma and association soft tissue damage.
4. Bone loss
5. Articular extension of fractures
6. Status of the bone
7. Gas in the soft tissue region
8. Osteoarthritis and presence of knee arthroplasty

Treatment

Even though the treatment of distal tibial fractures remains controversial, the following principles should be significantly adhered to in order to achieve the goal of good functional out come. Careful assessment and treatment of the entire patient and the injured limb leads in priority than the treatment of fracture alone.

The Basic principles in the management are

1. Assurance of adequate blood flow
2. Provisional reduction of marked deformity or dislocation
3. Care of the open wound
4. Precise reduction of the skeletal deformity
5. Maintenance of reduction till the healing is complete
6. Rehabilitation

Conservative Management

The results of non operative management of these injuries have historically been unsatisfactory with high rates of malunion, joint stiffness, deep vein thrombosis and early osteoarthritis. But conservative management is to be considered when the patient is unwilling for surgery and where there are associated co-morbid conditions which render them unfit for anaesthesia.

We generally accept the following Trafton's recommendations:

- 5 degrees' valgus / varus
- <10 degress anterior / posterior anulation
- <10 degrees' rotation
- < 15mm of shortening

The techniques are

- ❖ Cast immobilization
- ❖ Pin traction

Cast immobilization:

Fractures with minimal displacement or severe comminution are reduced and above knee cast is applied.

Pin Traction:

This is done by means of calcaneal pin traction with weight of 1/5th of the total body weight which allows early ankle mobilization and ligamentotaxis in cases of pilon fractures. This method is done for highly comminuted fractures or for fractures with open wounds or as a temporary measure before definitive treatment, but is seldom used for definitive treatment.

The results of operative treatment have been found to be more superior to that of non operative methods.

Intramedullary Nailing

This is the standard method for stabilizing diaphyseal tibial fractures. This method spares extra – osseous blood supply, allows load sharing and avoids soft tissue dissection.

Additional techniques for obtaining and maintaining the distal metaphyseal fracture reduction during all aspects of the nailing included such as the use of femoral distractor, temporary fixation with a percutaneous clamp, percutaneous manipulation with schanz pins and open reduction and temporary fixation with a unicortical tibial plate.

Plate Osteosynthesis

Fractures with less degree of soft tissue damage can be treated with open reduction and plate osteosynthesis. The methods were popularized by Reudi & Allgower for open reduction and internal fixation.

The technique follows AO principles of anatomical reduction, stable internal fixation, preservation of blood supply and early active mobilization. A 4.5mm Dynamic compression plate, limited contact compression plate (LC – DCP) or locking plate could be used.

The fracture should be exposed with minimum soft tissue and periosteal stripping. When there is comminution, bridging the fragments by Bridge plating technique helps in not disturbing the fracture hematoma and also by damaging the periosteum or soft tissue envelope minimally.

Then plate should be avoided in the subcutaneous anteromedial surface of the tibia.

Plates should be controured in order to negotiate with the distal tibial flare and torsion.

Hybrid External Fixation

The specific definition of hybrid external fixation is quite ambiguous. The term hybrid denotes no single or universally accepted treatment strategy or device. It is called hybrid fixation because it combines wire fixation technique with pin fixation technique

In periarticular fractures the advantages of using a circular frame, tensioned small wires and external fixator are numerous. The articular wires a Rotational or Translational deformities also can be corrected as a consolidation progresses.

In addition, small tensioned wire fixation allows for early partial weight bearing and mobilization of adjoining joints. It also promotes callus formation by continuous axial movements in the fixation frame.

In this method wires are placed percutaneously in such a way so as not to injure the neurovascular bundles according to Ilizarov's principle. External fixators applied in both sides of tibia are connected with circular frame holding the wires.

II. Materials And Methods

Materials:

The present study deals with the analysis of out come of various modalities of treatment of distal tibial fractures depending on the type of fracture, location of the fracture and the status of the soft tissue envelope.

The study was conducted in Government Royapettah Hospital, Kilpauk Medical College between 2004-2006.

Patients admitted with distal tibial fractures with or without intra articular extension and those having closed or open injuries were considered for this study.

Age / Sex Distribution:

Age Group	Male	Female
21-30	2	1
31-40	5	3
41-50	2	-
51-60	4	1
61-70	4	1

The total number of patients in this study is 23 with their ages ranging from 21-70 years with an average of 46.91 years. 3 patients were lost to follow up. Hence, the total number of patients were 20. There were 17 males and 6 females.

Mode of Injury:

RTA	13	56.5%
Fall	6	26%
Fall of Heavy Object	2	8%
Wall Collapse	1	4.3%
Assault	1	4.3%

Associated Injuries:

1. Bimalleolar fracture 2
2. Hand Injuries 4

Incidence of Open Injuries according to The Gustilo - Anderson System:

1.	Grade I	6
2.	Grade II	3
3.	Grade III	
A	1	
B		
C		

The patients with symptoms suggestive of distal third tibial fractures are examined both clinically and radiologically after initial resuscitation.

Antero - Posterior radiographs of the affected leg with knee and ankle joints taken. All fractures were classified according to AO system. There were totally 13 patients in type A, 3 patients in type B and 7 patients in type C.

The open fractures were classified according to GUSTILO - ANDERSON System. Out of which 6 patients were grade 1, 3 were grade 2 and 1 was grade 3A.

Initially patients were immobilized in POP Splints.

In open injuries, thorough wound wash and debridement was done and calcaneal pin traction was applied.

Patients with open injuries, being received in the causalty was given intravenous antibiotics.

In five patients with open injuries and severe comminution, Hybrid external fixation was done, whereas, in another five patients with closed, simple fractures interlocking nailing[5] was done.

Patients with closed injuries with severe comminution away from the tibial plafond were treated with Bridge plating technique.

Patients associated with medical diseases (not fit for anesthesia) and those not willing to undergo surgical procedures were treated conservatively either by POP immobilization or pin traction technique according to the soft tissue status of their lower legs.

The range of follow up varies from 6 months to 16 months.

Associated Injuries:

Ankle injuries were commonly associated. 2 patients had bimalleolar fractures and 2 had closed hand injuries.

Case incidence according to AO Classification.

A1	.1 .2 .3	3	B1	.1 .2 .3	1	C1	.1 .2 .3	3
A2	.1 .2 .3	3 1	B2	.1 .2 .3	2	C2	.1 .2 .3	3
A3	.1 .2 .3	6	B3	.1 .2 .3		C3	.1 .2 .3	1

Methods:

All patients having distal third tibial fractures were admitted and evaluated for co-morbid conditions. Routine investigations are done for anesthetic fitness and also to rule out systemic illness. Associated medical conditions were treated by corresponding specialists. The patients were maintained in POP and calcaneal pin traction in the case compound fractures. Patients with compound fractures were treated with broad spectrum antibiotics. The time of surgery varied from 5 days to 25 days.

There were 10 open injuries, of which there were 6 – Grade; 3- Grade 2 and 1 - grade 3 open injuries.

Those 5 patients who were not willing to undergo surgical procedures were treated conservatively by applying POP after 3 weeks of pin traction and check x-ray.

6 patients with comminution (OA type A3.1/A2.2) in their diaphysco metaphyseal region were treated with Bridge plating after their swelling subsided and wound healed The range of period for taking the patient fo surgery was 5 to 10 days.This was effectively done by means of limb elevation, ice packing in the immediate period after injury, good wound management and immobilization. I patient who was treated with conventional plate osteosynthesis lost to follow up.

6 patients with fractures of OA type A1.1 / A2.1 were treated with interlocking nailing. The range of preoperative period was 5 to 10 days. 1 patient not turned for follow up.

5 patients with OA type B.3.3 / C1.1 / C2.1 / C3.2 were treated with Hybrid external fixation.

III. Analysis Of Results

The outcome of treatment of distal tibial fractures, is most affected by the severity of injury, management of the fracture and occurrence of certain complications.

There are no uniformly accepted criteria for rating results. A number of factors are important for assessing results of tibial shaft fractures. Most reports omit one (or) more of them.

For example, Anderson et al., used only shortening and angulation to classify results of treatment into categories of excellent, good, fair, and poor. He rejected range of motion of the ankle joint as criteria.

However, Horne and Colleagues with Hutching found ankle motion was a major determinant of functions.

Various Criteria's

Bauer and Colleagues

They classified the outcome into two grades:

Good ⟶ Minimal (or) no complaints, full (or) slightly limited function Fair Major complaints: nonunion, wound discharge, amputation (or) poor function of knee or ankle.

⟶ EDWARDS expanded on this scheme and used eight different parameters plus non-union, osteomyelitis and amputation to classify results. His system considers pain, ability to work, gait, sports activity, motion of knee, foot and ankle. Notable absence is any reference to deformity.

Criteria which was proposed by JOHNER and WRUH (1983) has now become widely accepted. It includes the various criteria proposed by Edwards along with the reference to various deformities.

This criterion considers nonunion, osteitis, amputations, neuro vascular disturbances, deformity – varus / valgus, anteversion / recurvation, rotation, shortening, mobility of knee, ankle, subtalar joints, pain, gait and strenuous activity.

We have also followed this classification in our study.

		Excellent	**Good**	**Fair**	**Poor**
1.	Non unon, Osteitis, amputations	None	None	None	Yes
2.	Neurovasclar Disturbances	None	Minimal	Moderate	Severe
3.	Deformity - Varus / valgus	None	2^0-5^0	6^0-10^0	$>10^0$
	Anteversion / Recurvation	0^0-5^0	6^0-10^0	11^0-20^0	>20
	Rotation	0^0-5^0	6^0-10^0	11^0-20^0	>20
	Shortening	0-5mm	6-10mm	11-20mm	>20mm
4.	Mobility – Knee	Normal	>80%	>75%	>75%
	Ankle	Normal	$>75^0$	$<50^0$	$<50^0$
	Subtalar Joint	>75%	>50%	<50%	
5.	Pain	None	Occasional	Moderate	Svere
6.	Gait	Normal	Normal	Insignificant Limp	Insignificant Limp
7.	Strenuous Activities	Possible	Limited	Severely Limited	Impossible

Non union, Osteitis, Amputation:

Non patient in our study had non-union or amputation However to patient had ostitis and deep infection In one patient infection settled after nail removal and antibiotics. Another patient is on treatment at present.

Neuro Vascular Disturbances:

No patient had developed neurovascular complication in our study.

Deformity:

- **5** Patients had varus / valgus deformity ranging 2^0-5^0.
- **4** Patients has varus / valgus deformity ranging 6^0-10^0.
- No anteversion or recurvation deformity noted. '
- Shortening measuring 0.5cm found in 3 patients and 1 cm shortening was noted in two patients.

Mobility:

Knee:

- 13 patients had full range of movements.
- 8 Patients it was > 80%.
- I patient $<75^0$ of knee mobility.

Ankle:

- 8 patients had > 75% of normal movements
- 3 patients has < 50% of Ankle movement.

Subtalar Joint:

- All patients has regained almost normal range of subtalar movement except for 3 patients who had <50% of normal.

Pain:

- Five patients with interlocking nailing had anterior knee pain.
- 10 patients had occasional pain at the fracture site for 2 months.
- 4 patients had moderate amount of pain at the fracture site for 1 month.
- 3 patients has severe pain at the fracture site, which disturbed their sleep and activities of daily life for 15 days.

Gait:

Gait was near normal in almost all patients except 3 patients who complained of significant Limp. 2 of them had been treated conservatively.

Strenuous Activities:

16 patients were able to do strenuous activity and it was severely limited in 4 patients. In comparing our result we have used general features like time to uion and infection rate. The incidence of deep infection rate in our study may be due to more numbers of open reduction performed and increased exposure of fracture site to the environment. The mean time of union in many literatures is around 5 months (2-8 months) which is the same in our study.

WU cc, Shih C in their article in

J. Trauma 1993 June: 34 (6) 72-796 reported union rate at 85.7% 14.3% non union and 7.2% deep infection which is 70%, %, 8.2% in our study.

The variation in the result of functional out come in various modalities reflects the difficulties in distal third fractures management.

In our study we observed 69.55% (16) excellent or good results, 17.39%(4) showed fair results and 1304%(3) of poor results.

The poor out comes were associated with either technical difficulties or the presence of other injuries (or) associated co-morbid conditions.

IV. Discussion

In between August 2004 and November 2006, 23 fractures of distal tibia were treated. In all cases, treatment was individualized depending on the type, nature of the wound, time of presentation, associated injury and the available facilities of treatment.[2] The different modalities of treatment were interlocking nailing[3] plating; Hybrid external fixation and conservative method. In our study 25% of patients were in the age group between 31 – 40 years. There was also a higher percentage of involvement of males most probably due to their increased involvement in out door activities and also road traffic accidents. The incidence of type a was found to be high and there was a higher incidence of open fracture associated with type C fractures which exposes the high velocity nature of this injury and this adds to the difficulty in the management of type C fractures. This is also shown by the higher incidence of type A3 fractures. In most of the patients the initial management is closed reduction and POP slab application and few others were initially managed by calcaneal pin traction or by external fixation.

About fifty percent of the patients had open injuries which delayed the definitive surgical procedures. Conservative treatment included either closed manipulative reduction or POP application. POP was used for patients who were not willing to undergo surgical procedures or with associated co-morbid conditions which deferred them for anesthetic fitness. Conservative management is associated with high incidence of valgus / varus deformities due to incomplete reduction and to joint stiffness due to prolonged immobilization in above knee cast.

Calcaneal pin traction had been advocated by Robert E. Leach. We have found this procedure to be very useful in our set up in cases of gross displacement and overlapping of fragments. It is also useful in holding the fracture which awaits soft tissue healing prior to bony surgery. We have found this useful in fractures of the tibial plafond and we have not seen any increase in the incidence of infection in any surgeries after calcaneal pin traction.

Regional anesthesia was preferred in all cases due to the decreased incidence of complications and extended post operative analgesia.

In our study we have found that surgical treatment considering soft tissue status and fracture pattern & location give better results than conservative management especially where the artcular fragments cannot be well controlled.

We found that inter locking nailing gives better results in the presence of minimal soft tissue injury, minimal comminution and without articular involvement.

In the presence of minimal soft tissue injury, severe comminution and without articular involvement we preferred plate osteosynthesis especially Bridge plating technique, when the fracture location was well above the articular surface.

In the presence of extended articular comminution and severe soft tissue injury we had better results with application with Hybrid external fixation.

There were certain advantages and disadvantages when comparing others:

1. Less tissue damage during interlocking nailing and better stability was achieved. But, technical difficulty was encountered when there was comminution of fragments.

2. Bridge plating gives relative lesser stability, but the fracture hematoma was not disturbed. But this technique needed relatively prolonged immobilization than others, which might have resulted ankle joint stiffness in certain cases[5].

Hybrid external fixation technique was unopposedly used in cases with severe soft tissue damage where plating is ruled out and cases with articular comminution. Here the fragments were held together by tensioned 'K' wires and stability was achieved by external fixation in the proximal tibial fragment. '

In this method it was difficult to manage open injuries which needed split skin grafting or rotation flap covers which was impeded by the crisscross wires. However, we had to resort to this method in the presence of open injuries.

In all cases sutures were removed by 10th post operative day.

Patients were allowed to weight bear once callus appeared and then was progressed as tolerated.

Average time for partial weight bearing was 8 (6-10) weeks except in cases with plating where it is delayed by 14 (12-16) weeks and average time for clinical and radiological union was 5 (3-8) months.

Post operative infection noticed in 6 patients out of which 5 had superficial infection which settled after local dressing and appropriate antibiotics.

One patient had deep infection involving bone. Average duration of hospital stay was 45 days (2 weeks - 6 weeks) Overall 60% patients had regained full range of movements of knee and ankle. 18% patients had varus / valgus deformity 6-10 degrees - Treated with interlocking nailing. 11 patients had excellent or good outcome whereas 7 patients had fair outcome and 2 showed poor results.

V. Conclusion

A short series of results of various modalities of management of distal tibial fractures were analyzed and the overall results including quality of reduction, functional recovery and the presence or absence of complications have led to us to individualise the option of treatment according to the status of the soft tissue, fracture location; fracture pattern and articular involvement.

We are aware of the fact that the number of patients and duration of study may not give us the liberty to conclusively arrive at a protocol and might need a more elaborate study for standardization of the different methods available for the management of fractures of distal tibia.

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