MANAGEMENT OF

MIDDLE AND LOWER THIRD FRACTURE

TIBIA

BY ENDER'S NAILING

Dr. ABHIJEET MUKHERJI

P.G. HOSPITAL

1933, WRIGHT TOWN

JABLAPUR (M.P.)

INTRODUCTION

The present study was undertaken using ENDERS NAILS for fracture lower and middle third of Tibia. This nail is stronger than V. Nails, cheaper than other interlock nails, easily available does not need any special instrumentation and can be done with simple technique.

AIMS AND OBJECTIVES

1. To assess the results of dynamic interlocking nailing by ENDERS NAIL in unstable and compound fractures of tibia.

2. To review available literature on the treatment of fracture shaft of tibia with modified interlocking nail and elastic nails.

3. To discuss merits and demerits of procedure.

REVIEW OF LITERATURE

A number of treatment of fractures, particularly for those of leg have been devised from time to time. The common treatments are :

1. Conservative methods :
   Closed reduction and plaster immobilization
   Cast bracing
   Pins & plaster.

2. Operative - Open reduction & internal fixation :
   Encirclage wiring
   Screw fixation
   Plate and screw fixation.

Intramedullary nailing.

3. External Fixation :
External Fixators.

The conservative treatment is still the treatment of choice for stable type of fracture.

The principle of medullary fixation in fractures of long bones was evolved during the present era. It's earliest use appears to have been in 1897 by Nicolaysen, in 1906 by Delbet, and in 1913 by Lambotte. Delbet practised the internal fixation of the fractures of the femoral neck by screws introduced under X-ray control.

Lambotte's work was mainly concerned with the fixation of small bone fragments with thin nails. He also practised with the axial method of Oastosynthesis of Clavicle.

In America in the year 1939, Rush L.V. and Rush H.L. Presented a entirely new technique of longitudinal fixation of the fragments by means of a Steinmann Pin, In their method, the pin projected from the skin. This prosthesis was temporary and after few weeks it was extracted.

In England, Lambrinudi C in 1940 presented as a discovery the intramedullary use of kirschner wires. He lets the wire protrude through the skin and removes it between the fourth and fifth weeks.

It was Kuntscher of Germany who showed convincingly the Osteosynthesis could be secured along the medullary cavity of the long bones. His first paper was presented in March 1940 to the " Deutsche Kongress Fur Chirurgie". He described longitudinal fixation by means of metallic material occupying the full length of the medullary space. The material was strong, a rod, as large size as the bone canal permitted. The material was introduced by a extra-articular route, as far from the fracture site as possible, and without exposure of the fracture. The material was completely burried. The end of the prosthesis which extruded beyond the bone was covered by the soft parts and the skin. The reduction has been attained by external manoeuvres before the intramedullary fixation. After consolidation of the bone the prosthesis was extracted. Thanks to the adaptability of the material and to the technical skill, which Kuntscher displayed at the outset, one of the most difficult problems of Osteo-synthesis was solved.

Merianos, Pazaridis, Serenes, Orfanidis & Smyrnis (1982) reported 31 fractures of tibial shaft treated with closed ender nailing and early weight bearing. Twenty five of these fractures were closed and six open. All fractures united between 6 and 16 weeks, No case of deep infection was encountered. Comminuted fractures of the proximal and distal and were prone to angular deformities and needed cast protection post operatively. Nail re-insertion was done in two patients. Delay of the operation renders closed reduction very difficult. The authors mentioned that this method is advantageous as Normal knee and ankle movements were possible during healing and Rapid restoration of bone continuity was possible.

THE LOCKING NAIL

In 1968 Kuntscher described the application of nail which was attached to the femoral shaft with screw proximally and distally he called this technique " Detensionsnagelung" and gave the name of nail as " Detensor". In 1970 Klemm and Schellman with permission from Kuntscher developed the nail further initially bolts without thread were used but as these become loose screw with terminal self tapping threads were used.

In 1972-1977 Grosse and Kempf perfected the osteosynthesis system. In 1977 Grosse and Lafforging designed a target device for distal locking which could be attached to the image intensifier's C arm enabling distal locking to be carried out under X-ray control. All these techniques contributed materially to the routine application of " Locking Nail" according to a specific protocol.

Vecsei and Heinz (1990) studied the results of the interlocing nail for long comminuted and compound fracture of femur and tibia, and described interlocking nail as an optimal method. The cases treated were 208 fractures of femur and 158 fractures of the tibia. There was a low complication rater as it was done by a closed method. In the femur the nail fractured in 8 cases (3.9%), infection is seven cases (3.5%) and in three cases pseudoarthrosis. Following tibial interlocking authors found deviation of the axis by greater than degrees in eight cases (5%), fracture of nail occurred in one case (0.6%), infection in six cases (3.8%) and one case of pseudoarthrosis (0.6%).

Reynders, Schonken and Hoogmartens (1990) made a simple selfbuilt target device which allows easy placement of the distal transverse screws.

Reudi T. (1990) stated that in Gustilo I and II degree of open fractures of the tibia, the unreamed locked nail may perhaps become the preferred implant.

Kempf, Grosse, Taglang, Bernhard and Moin (1991) conducted a study with 837 cases of fresh fractures of the femur (385) and the tibia (397) treated by locked intramedullary nailing. In two third of the cases the procedure was static and in one-third it was dynamic. Full weight bearing was allowed in a mean period of 60 days. Of the femur (371 closed and 65 open fractures) authors noted 8 infection out of which 2 deep infections (0.45%), 5 non-union, 25 moderate mal-unions in varus and 18 in valgus. Of the tibia (267 closed and 132 open fractures) authors had observed 15 deep infections (3.7%) out of which 9 (2.2%) after open fractures, 15 non-union (3.7%), 22 compartment syndromes, 6 malunion in varus and 54 malunions in valgus greater than 5 degrees out oof which 15 greater than 10 degrees.

Court-Brown, Keating, McQueen (1991) treated 459 tibial fractures by primary reamed nailing with the Grosse-Kampf locking nail. Of these 391, were closed or Gustilo type I in severity, 26 were type II, 18 were type IIIa and 24 were type IIIb. All the closed fracture were treated by the nailing technique described by Court-Brown (1991) with antibiotic cover by a three dose regime cefuroxime 1.5g was given at the induction of anaesthesia and

750 mg 6 and 12 hours after operation. The average infection rate for nailing of closed and type I open fractures was 4.1%.

The incidence of infection rate in type II and type III was 3.8% and 9.5% respectively.

S. Weller (1993) reviewed internal fixation of fractures by intramedullary nailing and gave indications, contra-indications and mentioned about the advantages and dis-advantages of intramedullary nailing.

INDICATIONS

Good Indications :	Extended Indications :
Transverse Fractures	Transitional fractures
Short oblique fractures	Segmental fractures
Delayed Union	Multifragmentary fractures
Pseudoarthrosis	

The author concluded that internal fixation of the long bones (femur, and tibia) by intramedullary nailing is an extremely efficient and elegant therapeutic technique.

Riemer B.L., Miranda M.A., Butterfield S.L., Burke C.J. (1995) did retrospective study comparing dynamic and static undreamed nailing in 88 cases which included closed, Grade I and II Gusited open fractures. They found that tibia treated with dynamic nails united in an average of 20 weeks with 3 reparations, tibia treated with static locked nails united in and average of 30 weeks with 21 re-operations. They concluded that static locking mode appeared to delay union.

BIOMECHANICS OF INTERLOCKING & FLEXIBLE NAILING

All intramedullary nails, regardless of their types act as flexible internal splints which provide stability for the fracture fragments from within it is load sharing device in which stress shielding is minimal due to the fact that it is situated close to the neutral axis of the bone where strain is minimal. The nail allows considerable load from the muscle action and weight bearing to be transmitted across the fracture site. The strain induced is now considered the most important factor in the later stage of fracture callus remodeling.

A. basics understanding of the bio-mechanical principles of intramedullary nailing is important to understand the bio-mechanics of interlocking nails.

In all operative treatment of fractures, there is a race between bony union and implant failure. Mechanical failure of nail may occur in one of the two ways.

1. plastic deformation.

2 Fatigue failure.

if a nail is overloaded it will deform after the yield point is palled. This is called as plastic deformation. Fatigue failure may result after cyclical loading of the nail as such load is concentrated where there is a hole through the nail or at any point where the nail is damaged.

Bending strength:

The bending strength of an intramedullary nail is proportional to the cube of the diameter of a cylinder of constant wall thickness.

Rigidity :

The rigidity of an intramedullary nail is inversely proportional to cube of the working length. For an oblique or transverse fracture stabilized by a well fitting, reamed intramedullary nail, the working length is short and the rigidity of the construct high. Construct high. Conversely in a comminuted fracture fixed with an interlocking nail, the working length is long and rigidity of the construct is low.

Torsional Rigidity :

The torsional rigidity of an intramedullary nail increases with the fourth power of its radius. Therefore if the radius of a cylindrical nail is doubled, the torsional rigidity of nail increases by a factor of 16.

Working length :

Working length is defined as the length of a nail spanning the fracture site from its distal point of fixation in the proximal fragment to its proximal point of fixation in the distal fragment. A less technical definition states that it is the distance between the two points on either side of the fracture where the bone firmly grips the metal. Thus working length is the unsupported portion of the nail between the two major bone fragments and reflects the length of nail carrying the majority of the load across the fracture site.

The bending stiffness of a nail is inversely proportional to the square of its working length, while the torsional stiffness is inversely proportional to its working length. Shorter working length means stronger fixation.

two techniques which modify the working length are medullary reaming and interlocking. Medullary reaming prepares a uniform canal and improves nail bone fixation towards the fracture, thus reducing the working length. Interlocking screws also modify the working length in torsion by fixing the nail to the bone at specific points. The torsional stability is substantially improved by this technique and is directly related to the distance between the two fixation points. Weight bearing with an interlocked bail further improves the nail bone contact as the bail bends under axial load reducing the working length and adding to the overall stiffness of the fixation

Cross section of the nail :

Cross section of the nail determines it's bending and torsional strength. A circular nail has an area and polar moment of Inertia proportional to its diameter. Similarly a square cross-sectional nail has an area and polar moment of inertia proportional to its edge length. Complicated cross sectional shapes need calculations to assess their moments of inertia. In simple terms the further the material is distributed from the principal axis the greater the moments of inertia.

Shape plays an important role in the mechanics of the nail bone interface. A nail with sharp corners or fluted edges resists torsional forces to a greater degree than a smooth walled nail.

Slotted and Non-slotted nails :

A Slotted nail is flexible. This flexibility is observed more in torsion than in anteroposterior bending. A flexible nail also tolerates variation in the point of insertion.

The non-slotted nail bone construct is more stable than the partially slotted nail bone fixation in torsion and thus prevents shear stress generation at the fracture site. Absence of shear stress improves fracture healing. A non-slotted nail, being less flexible, must be introduced risk of bone splitting.

Comparison of slotted and non-slotted nails

parameters	Slotted nail	Non-slotted nail
Diameter	Larger	Smaller
Wall thickness	Thicker	Thinner
insertion point	Variation tolerated	Precision mandatory
Stability	Less stable	More stable
Shear stress	More	less
Stiffness in torsion	Flexible	Rigid 40x (slotted nail)
Distal targeting device	Cannot be used	Can be used

The standard non-locked nail is useful in the treatment of simple and minimally comminuted mid shaft fractures of femur and tibia. In unstable and comminuted fractures interlocking nailing is treatment of choice.

Static locking and bridging fixation :

Screw insertion at the two ends of a nail interlock it with the proximal and the distal fracture fragments. This technique prevents sliding of these fragments along the nail and is called static locking. interlocking controls both the bone length and the rotation of the fragments but mainly improves the rotational stability of the nail-bone construct. Static locking achieves bridging fixation. In the presence of severe comminution it is undesirable to open the fracture site and handle individual fragments to achieve alignment as further devascularization occur and the risk of infection increases. In bridging fixation the implant extends across the zone of soft tissue injury and fracture but is fixed to the major bone fragments proximal and distal to the injury site. Although the fracture appears to be held in distraction by bridging fixation, a favorable environment for periosteal callus formation exists and healing rather than non union is the rule. This occurs because the tissue remain viable and the fixation permits limited motion. Static locking is used in fixation of segmental, comminuted long oblique or spiral fractures and in stabilization of fracture with bone loss or in pseudoarthrosis.

Dynamic Locking :

When the screws are inserted only at one end of the nail, the fixation is called dynamic locking. Dynamic locking is effective only when the contact area between the two major fragments is at least 50% of the cortical circumference. Dynamic fixation will fail in the presence of unstable bone contact between the main fragments.

In an interlocking nail the working length in bending and torsion is reduced with axial loading, as the nail bends and abuts against the cortex near the fracture, improving the nail-bone contact.

The holes for locking screws in the intramedullary nail are stress risers, also the perimeter of the hole may be inadvertently nicked during screw insertion. An increased possibility of fatigue failure of nail through these holes exists because of these factors. The stresses in an interlocked nail increase in a distally located fracture because in this situation the nail is loaded like a cantilever beam. When the fracture site is within 5 cm of the most proximal of the distal locking screws, the peak stresses around that hole may exceed the stress level above which fatigue fracture of the nail may occur. Such a fixation should be additionally protected.

Dynamization :

It is no longer a standard practice to dynamize weaken the interlocking nail assembly by removing the locking screws. if healing is progressing normally than there is no need to dynamize. if consolidation is continuing well the removal of the distal screw will not improve the quality of the callus.

Dynamization is indicated when there is risk of development of non-union as in established pseudoarthrosis. The screws are then removed from the longer fragment, maintaining adequate control of shorter fragment. Premature removal of locking screw may cause shortening instability and non-union.

Dynamization does potentially increase the fatigue life of the nail by decreasing its load bearing however if adequate cortical stability or bone regeneration has not occurred before bynamization, shortening will result**.**

MATERIAL AND METHODS

Twenty five fractures of shaft of tibia were treated and followed at P.G. HOSPITAL, JABALPUR using ENDERS NAILING system between Jan.. 2012 to July 2012. Mode of trauma included both high energy and low energy trauma. 20 of 25 cases were injured in road traffic accidents and other had sustained injury due to direct blow, fall of weight over leg. The age of patient ranged between 18 to 45 years. All cases were male.

Criteria for selection of cases :

Closed but unstable fresh fractures of middle third or distal third tibia.

Fresh open fractures (Gustilo's grade I)

INSTRUMENTS

The basic instrumentation set is very simple and economical.

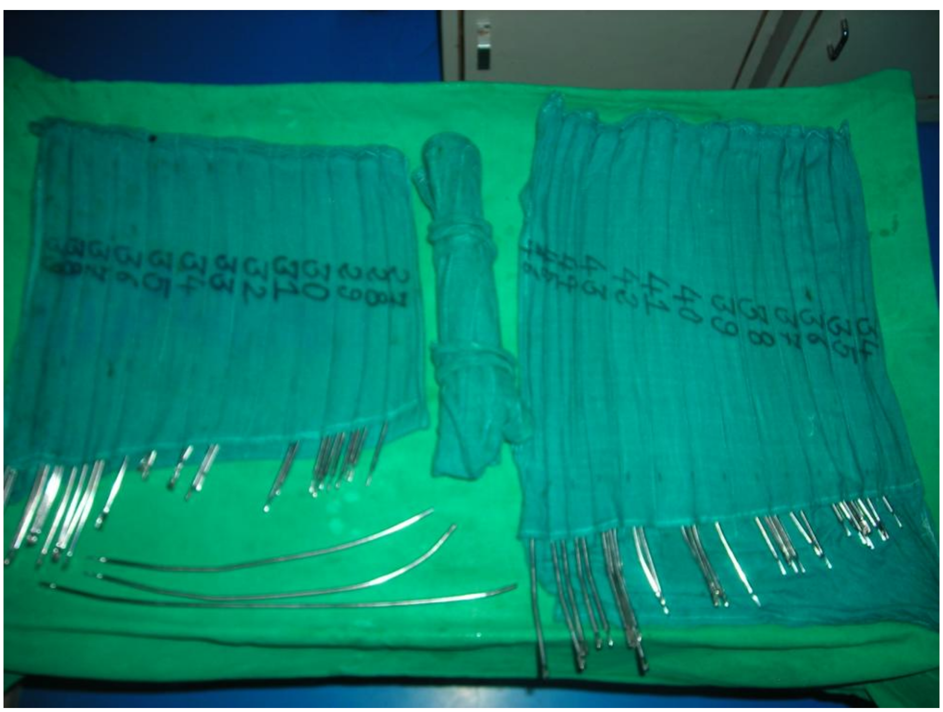
It comprises of :

1. Set of awls for perforating the cortex for making an entry for the nail.
2. An introducer to impact as well as change the direction of nail.
3. Punch for final impaction of nail end.
4. Extractor for nail removal.
5. Nail Bender.
6. Nail Straightner.
7. Drill
8. Screw driver and screw Box for locking screws into nail eye.
9. Measuring scale.

IMPLANTS

The Endres nails are flexible elastic nails made of 316 L stainless steel with a bevel at one end and an eyelet of the introducing end. The nails come in diameters of 3 mm 3.5 mm and 4 mm. The eyelets of the 3.5 mm and 4 mm nails are large enough to allow locking of this end of the nail with a 3.5 mm cortical screw, when the nail is desired to be used as a locked nail.

The nails are generally pre contoured to allow easy introduction and they accommodate according to the medullary canal once hammered inside. For narrow medullary canal, two 3 mm or 3.5 mm nails are used in scissoring fashion. (one from medial and the other from lateral said)
For wide medullary canals, 4 mm nails are used and more than 2 nails can also be used (stack nailing).



PRE OPERATIVE MANAGEMENT

Preoperative management was done till the patient was investigated for surgical intervention.

In closed fractures of tibia above knee plaster of paris slab was applied, limb was elevated, active toe movements, analgesics, anti-inflammatory drugs was started.

In case of open fractures anti-tetanus globulin, tetanus toxoid, broad spectrum antibiotics were started and debridement if needed was done at the earliest followed by application of above knee plaster of paris posterior splint.

Measurement of nail size :

Correct length of nail is measured form opposite leg, length is taken from tip of tibial tuberosity to tip of medial malleolus substract 2.5 cm, or from tip of tibial tuberosity to ankle joint line, substract 1 cm from it.

OPERATIVE MANAGEMENT.

POSITION OF PATENT–SUPINE ON C-ARM COMPETABLE TABLE.

ANAESHTHIESIA – SPINAL MOSTLY OR EPIDURAL

OPERAVTIVE STEPS -

a) For middle third fracture

   Both nails are introduced prograde (from proximal to distal). A hole is made in the medial tibial condyle 2.5 cm distal to the articular surface.

Entry point is confirmed with IITV. The awl is advanced into the proximal medullary canal. The nail is then introduced into the proximal tibia, reduction checked under IITV and then the nail is introduced across the fracture into the distal fragment. At this sage the reduction may not be perfect but it gets corrected by rotating the nail at times, and at other times by introducing the second nail.

The second nail is similarly introduced from the lateral aspect. After final introduction, if the nails are of 3.5 or 4 mm, the eye of the nail is locked with a 3.5mm screw to prevent proximal migration of the nail when weight bearing is started. This allows early dynamization with the advantage of flexible nailing.

The distal ends of the nails must be at least 2.5 to 3 mm short of the ankle joint to allow sliding compression effect. The distal ends of the nail must also abut the opposite cortices to given rotational stability to the fracture.

b) For lower third fractures.

The process of nailing is the same only the nails are introduced from distal to proximal and are locked only at the medial malleolus. Proximally the nails are left short of the knee joint by 2.5 to 5cms. Excessive length of the nail may cause distraction of the fracture site.

c) For comminuted fractures or difficult reduction rarely open reduction is done through a mini open (1” to 2”) exposure of the fracture and negative suction drain is put before closure.

POST OPERATIVE MANAGEMENT :

Antibiotics, analgesics and anti inflammatory drugs are given. Limb is elevated, active toe movements, Quadriceps exercises, active knee movements, active ankle movements are started as soon as pain permits.

Drain is pulled out after 48 hours, check dressings are done on 3^{rd} post operative and 7^{th} post operative days. Stitches are removed on 10^{th} day. Touch down weight bearing is started on 3^{rd} – 5^{th} post operative day if no contraindication such as associated injuries or per-operative complication are present. All patients are given a PTB type of Brace, removable at rest and at night.

Follow up :

All patient were advised to attends orthopaedic out patients department on a fixed date at regular intervals. On each occasion status of union, functional evaluation and complication, if any were assessed in the following manner.

1. Patients were asked about any subjective complaints like pain, swelling, range of movements, loss of function, weight bearing etc.
2. Movements of knee, ankle and foot were checked.
3. Standard anteroposterior and lateral X-ray were taken to assess the radiological union.

4. Any complication like infection, implant failure in any form were checked.

RESULTS WERE ASSESSED AS FOLLOWS :

a. Clinically

No tenderness at fracture site.

No abnormal movements at fracture site.

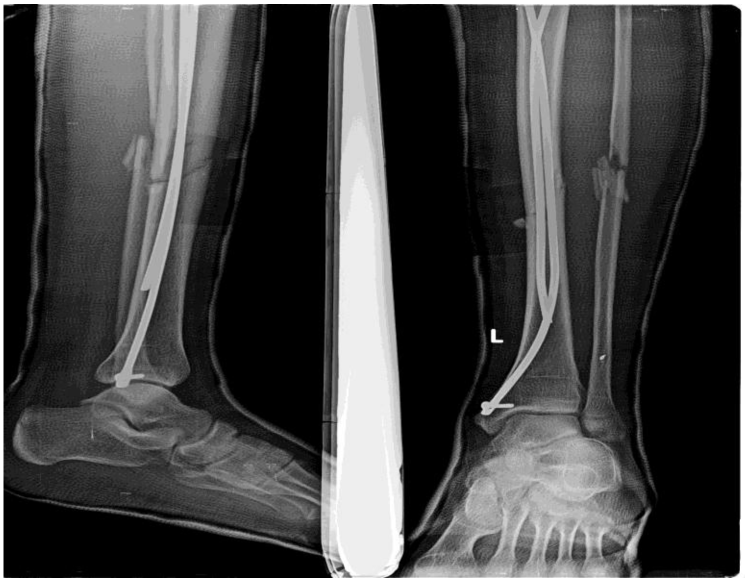
b. Roentgenographically :

Obliteration of fracture line.

Evidence of bridging callus.

Restoraion of trabecular pattern.

S.No.	Functional	Excellent	Good	Fair	Poor
1	Malalignment of tibia (degrees) Valgus or Varus Antecurvatum or Internal Rotation recurvatum External Rotation	5 5 5 10	5 10 10 15	10 15 15 20	>10 >15 >15 >20
2	Shortening of the tibia (cm)	1	2	3	>3
3	Rang of movement of the knee Degrees) Flexion Extension deficit	120 5	120 10	90 15	<90 >15
4	Pain or Swelling	None Minor	Sporadic	Significant	Severe
5	Range of Ankle Motion (degrees) Dorsiflexion Planter Flexion	20 30	20 30	10 20	<10 <20
6	Foot Motion as Fraction of Normal Range of Motion	5/6	2/3	1/3	<1/3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OBSERVATIONS :

The present study consisted of 25 diaphyseal fractures of tibia who were treated at Department of ortholpedics and Traumatology, P.G. Hospital, Jabalpur by ENDERS NAILING TIBIA. system. These cases were managed from Jan. 2012 to July 2012. The observations made in this study are presented only here :

AGE INCIDENCE

TABLE NO.1 : AGE DISTRIBUTION

S.NO.	Age Group	No. of Cases	Percentage
1	16-25	7	28
2	26-35	14	56
3	36-45	4	16
Total		**25**	**100**

The age of patient varied from 18 years- 40 years. The average age was 29 years. Majority of cases were young adults in their active period of life. All the cases incidentally were male probably because males are more involved in out door activities.

MODE OF INJURY

TABLE NO.2

S.NO.	Mode of injury	No. of Cases	Percentage
1	R.T.A.	20	80
2	Assault by hard and blunt object	4	16
3	Fall of weight over limb	25	4
	Total	25	100

Road traffic accident accounted for 80%of the cases. In 4 cases mode of injury was assault by hard and blunt object over the limb. Rest one case sustained injury by fall weight over the limb (mine collapse)

In 20 cases (80%)fracture of tibia was caused by high energy trauma and in 4 cases (16%) low energy trauma.

TABLE NO.3
SIDE INJURED

Side of Injured leg	No. of Cases	Percentage
Right	16	64
Left	09	36
Total	25	100

In majority of cases right tibia was fractured.

CLINICAL TYPE OF FRACTURE
TABLE NO.4

Open Vs Closed injuries	No. of Cases	Percentage
Closed	13	52
open Grade I Gustilo	12	48
Total	25	100

Both closed and open fractures were included in present series and they were approximately equal in number. Closed being 52% (13 cases) and open grade I Gustilo 48% (12 cases).

RADIOLOGICAL TYPES OF FRACTURE

TABLE NO.5

S.NO.	Type of fracture	Closed	%	open	%	Total	%
1	Oblique	8	57.14	6	42.85	14	56
2	Transverse	4	50	4	50	8	32
3	Comminuted	1	33.3	2	66.66	3	12
	Total	13	52	12	48	25	100

Oblique, transverse and comminuted fractures were included in this series. Most of them were oblique 56% followed by transverse fracture which were 32% of these 14 cases of oblique fracture 57.14% were closed and 42.85% open. Similarly of 32% of transverse fractures 50% were Closed and 50% open.

LAVEL OF FRACTURE

TABLE NO.6

S.NO.	Level of Fracture	No. of Cases	Percentage
1	lower third/Middle third Junction	11	44
2	Middle third	9	36
3	Lower third	5	20
	Total	25	100

Lower tibial diaphyseal fracture lower middle third junction and lower third which are known to be more prone to delayed union constituted Majority of cases. Lower third and middle third junction fractures were 44% and lower third fracture 20% which together accounted for 64% of cases and middle third fractures constituted rest 36% of cases.

TABLE NO.7

CAUSE OF INJURY AND FURTHER CLASSIFICATION OF FRACTURES

S.NO.	mode of injury	Oblique	Transverse	Comminuted
1	RTA	10	7	3
2	Assault by hard & blunt object	3	1	0
3	Fall of weight	1	0	0
	Total	14	8	3

TABLE NO.8

ASSOCIATED INJURIES

S.NO.	Associated Fracture	No. of Cases	Contralateral/ lpsilateral	%
	Fracture shaft femur	2 lpsilateal	25	2
2	Fracture both bone leg Upper third	2	Contralateral	25
3	Fracture medial Malleolus	1	lpsilateral	12.5
4	Fracture 2nd &3rd MT	1	lpsilateal	12.5
5	Fracture both bone forearm	1	lpsilateral	12.5
6	Fracture clavicle	1	lpsilateral	12.5

Out of 25 cases of our series 6 cases had associated lower limb injuries because of which weight bearing after operation had to be delayed in 5 cases which included 2 cases of fracture shaft femur on ipsilateral side and 2 cases of fracture both bone seg upper 3rd on contralateral side, one case had fracture medial malleolus of the same side.

TABLE NO.9

PERIOD BETWEEN INJURY AND HOSPITALIZATION

S.NO.	Duration Days	Closed	%	open	%	Total	%
1	0-1	9	52.94	8	47.05	17	68
2	2-3	3	60	2	40	5	20
3	4-5	1	33.33	2	66.66	3	12
	Total	13	52	12	48	25	100

Fresh cases were included in the series as is seen in chart out of 25 cases 17 cases (68%) were admitted within 24 hours of injury.5 cases (20%) were admitted within 3 days of injury and rest (12%) in 4-5 days of injury

TABLE NO.10

INJURY OPERATION INTERWAL

S.NO.	Injury operation Interval days	No. of Cases	Percentage
1	3-5	13	52
2	6-8	10	40
3	9-12	2	8
	Total	25	100

Early operation was attempted in this series and the cases had the cases had to wait till routine investigations and pre anaesthetic fitness.52%of cases were operated within 5 days of injury of which 40% were operated within 8 days of injury, one case on 10th day and one on 12th day after injury.

TABLE NO.11

INTRA OPERATIVE COMPLICATIONS

S.NO.	Complications	No.of Cases	Percentage
1	Sphintening of cortex around window	4	80
2	Broken drill bit	1	20
	Total	5	100

In this series there were 6 cases of intraoperative complication of which 4 cases 66.66% had splintering of anteromedial cortex at the base of window,1 case 16.67% of splintering of cortex at fracture site was their as tip of nail was stuck up at posterior cortex of nail There was one case of broken drill bit as bit was on the nail border rather than being in hole.

TABLE NO.12

PARTIAL WEIGHT BEARING WITH/WITHOUT CAST WAS STARTED EARLY

S.No.	Partial weight bearing started in post operative days	No.of Cases		Total	Percentage
		with cast	With cast		
1	5th-10th	*5	8	13	52
2	11th-15th	1	1	2	8
3	16th-20th	1	4	5	20
4	21st and above	0	5	5	20
	Total	7	18	25	100

* PTB cast was applied after removal of stitches.

Partial weight bearing was promoted during early post operative period cases were allowed partial weight bearing with the help of standard walking frame or crutches. 13cases 52% out of 25 case started partial weight bearing within 10 days of operation of operation of which 5 were given a PTB cast after stitches removal. These 5 cases were allowed touch down weight bearing initially with the help of crutches before removal of stitches without PTB cast. These five cases either had communition at fracture site or the D nail used was of 8 mm. In 7 cases weight bearing was started after 2 weeks which was mainly done because of superficial infection either at fracture of at window site,2 cases of these were given PTB after superficial infection had healed as 8 mm nail was used in these 2 cases. 5 cases had associated injuries of the lower limbs and these weight bearing was started after 6 week of operation. No cast was given in these, as patients were confined to bed due to other associated injuries of the lower limb. In these cases physiotherapy was promoted as soon as pain permitted.

TABLE NO. 13

RELATION BETWEEN ONSET OF PARTIAL WEIGHT BEARING AND UNION TIME

S.no	Partial weight bearing started post operatively	No.of Cases	12-14	weeks	15-17 weeks	18-20 weeks		
			N0.	%	No.	%	No.	%
1	5th-10th	13	10	76.92	3	23.08	-	-
2	11th-15th	2	1	50	1	50	-	-
3	16th-20th day	5	1	20	1	20	2	40
4	21days &above	5	2	40	2	40	1	20
	Total	25	14		7		3	

Partial weight bearing was started within 10 days of operation in 13 cases 52% out of these 13 cases 10 cases 76.92% united within 14 weeks and rest 3 cases 23.08% in 17 weeks. In 2 cases the partial weight bearing was started in around 15 days of operation, one case united within 14 weeks, and one in 17 weeks, showing that union percentage within 14 weeks fell down from 76.92% to 50%. In five cases weight bearing was delayed till around 20 days out of these one cases (20%) only united within 14 weeks and one case of these five cases united within 17 weeks, 2 cases had union after 18 weeks, whereas one case went into non union. In other five cases weight bearing was delayed till around 6 weeks because of associated lower limb injuries. In these five 40% had union in 14 weeks, 40% in 17 weeks and 20% in 20 weeks. The case in which non-union occurred was one of the cases which had deep seated infection finally landing into osteomyelitis. In this case of non union nail had to be removed and canal was reamed. Thus we found that as we delayed the initial partial weight bearing in patients union percentage within 14 weeks gradually fell down. Union time raises between 12-20 weeks averaged being 14.08 weeks.

Table No. 14
USE OF DRAIN AND RELATION TO INFECTIONS

S.NO.	Drain	No of Cases		Early Superficial infection		Late deep infection	
		No.	%	No.	%	No.	%
1	Not used	7	28	4	57.1	2	28.57
2	Used	18	72	3	16.67	-	-
	Total	25	100	7		2	

When procedure was started negative suction drain was not used in 7 cases (28%) and out of these 7 cases, there was superficial infection in 4 cases (57.1%) and of these 4, finally deep infection and osteomyelitis occurred in 2(28.57%). Later negative suction was used at site of anteromedial window in 18 cases of which superficial infection occurred in 3 (16.67%) and deep infection in none. Thus use of negative suction drain at window site decreases the number of infection.

TABLE NO. 15

SHOWING TIME TAKEN FOR UNION

S.NO.	Union time in weeks	No. of Cases	Percentage
1	12-14	14	56%
2	15-17	7	28
3	18-20	3	12

Union time ranged from 13 weeks to 20 weeks in 24 cases out of 25 cases included in this series. 14 cases (56%) of these united in 12-14 weeks. Union time on an average was 14.08 weeks. One case had non- union.

TABLE NO. 16

POST OPERATIVE COMPLICATIONS

S.NO.	Complication	No. of Cases
1	Superficial infection	7
2	Deep infection	2
3	Gaping of wound	1
4	Pain in ankle	4
5	Pain at fracture site	2
6	Knee stiffness	1
7	Ankle stiffness	2
8	Shortening	4
9	Recurvatum 5o	1
10	Compartmental syndrome	Nil
11	Nail breakage	Nil
12	Screw breakage	Nil
13	Torniquet palsy	Nil
14	Non Union	1
15	Proximal migration of nil	1

TABLE NO. 17

RESULTS

Results	No. of Cases	Percentage
Excellent	17	68
Good	6	24
Fair	1	4
Poor	1	4
Total	25	100

DISCUSSION

POST OPERATIVE HOSPITAL STAY :

Post operative hospital say varied from 5-10 days, average being 7 days.

Pintore Maffuli et al. (1992) in their series the average hospital say was 9 days regardless of the fracture.

We routinely keep the patient till removal of sutures because most of the patients were from distant places were adequate health facilities were not available.

Closed Vs open nailing :

In our series of 25 cases closed nailing could be done in 13 cases (52%) and open nailing had to be resorted in 12 cases (48%) it was observed that where injury operation interval was around 1 week or more opening up fracture site for nailing was done more commonly as compare to those which were operated within 5 days of injury.

In Arne Ekeland, Thoresen et al. (1988) series of 45 cases 41 were closed nailing and only 4 were open nailing.

The significant difference between our series and Thoresen et al. series is due to the fact that we used manual traction and manipulation without X-ray control where as Thoresen et al. used calcaneal traction, fracture table and radiological control for their procedure.

PARTIAL WEIGHT BEARING :

Partial weight bearing with or without cast was promoted early. In 80% it was started within 21 days of operation 52% (13) cases it was started within 10 days of operation. In 7 cases (28%) weight bearing was delayed for around 2 weeks mainly because of superficial infection and rest 5 cases (20%) weight bearing was delayed till 6 weeks because of associated injuries in lower limb. In 7 cases out of 25 weight bearing was supported with PTB cast mainly because there was either communition at fracture site or the nail used was of 8 mm.

In Arne Ekeland, Thoresen et al. (1992) in their series median time for full weight bearing was 30 days. In Michael Alms series (1962) average period of weight bearing was just under 19 days.

TIME TAKEN FOR UNION :

Clinically union was assessed on the basis of absence of tenderness and abnormal movements at fracture site. Radiological union was mainly judged on basis of presence of bridging callus, other radiological criteria used were absence of visibility of fracture line or continuation or trabecular pattern. In our series of 25 cases 14 cases (56%) united within 14 weeks, 7 cases (28%) within 17 weeks and 3 cases (12%) took more than 18 weeks to unite. One case (4%) went into non union, this case was Gustilo grade I compound, open rainlin had to be done in this case. Partial weight had to be delayed for 2 weeks as patient had superficial infection and finally osteomyelitis, probably all these factors in combination resuled in non union in this case. Overall union time varied form 12 to 20 weeks averaged being 14.08 weeks.

Arne Ekeland, Thoresen et al. (1988) in their series the median time for roentgenographic fracture healing was 16 weeks (8-40 weeks). Pintore Maffuli et al. (1992) in their series consolidation was achieved approximately in 3 months.

The median time for fracture healing in our present study is comparable to that of Arne, Thoresen et al. (1988) and Pintore Maffuli et at. (1992) series.

POST OPERATIVE COMPLICATIONS :

In our series there were 7 cases of superficial infection, 2 cases of deep infection, 1 case of gaping of wound, 4 cases of pain in ankle, 2 cases of ankle stiffness, 2 cases of pain at fracture site, 1 case of recurvtum (10 degree), 4 cases of shortening, one case of non union, and no case of compartment sysndrome, tourniquet palsy. There was one case of proximal migration of nail.

RESULTS :

In our present study all the 25 cases were followed for a period of 4 to 14 months (the average being 6.96 months). The average age of those injured was 29 years. There was a predominance of young adults. All cases incidentally were male. Predominant aetiology was road traffic accident (80%). There were 52% closed and 48% Grade I Gustilo fractures. 56% were oblique, 32% transverse and 12% comminuted fractures. Cases selected were mainly of lower and middle third shaft tibia.

Preoperative antibiotics was administered in all patients 6 hours before surgery, intraoperatively before the inflation of tourniquet. In this series 13 cases were operated within 5 days of injury, 10 cases were 6 to 8 days of injury and 2 cases in 10 days. Partial weight bearing was started with P.T.B. cast in 7 cases and without cast in 18 cases, 52% of cases started partial weight bearing within 10 days of operation. Knee and ankle movements were started as soon as pain permitted. Average hospital stay was 21 day, 60% cases united within 14 weeks with an overall average union period being 14.08 weeks. Final functional results were assessed on the basis of criteria given by Thoresen. Superficial infection in 9 cases, deep infection in 10 cases, revurvatum of 10 degree in 1 case, shortening in 4 cases, pain in ankle in 4 cases, pain at fracture site in 1 case of non union, one case of proximal migrations of nail were the post operative complication seen.

Based on Thoresen's criteria results were 68% excellent 24% good and 4% fair and 4% poor.

Arne Ekeland, Thoresen et al. (1988) treated 45 tibial shaft fracture with Gross Kempf nailing. The Final evaluation was made using Thoresen's criteria. The results were 64.44% excellent, 28.88 good, 4.44 fair and 2.22% poor.

Riquelme Rodriguez et al. (1992) treated 50 tibial shaft fractures with Grosse Kempf interlocking nail. The final evaluation were made as per Thorensen's criteria the results were 92% excellent, 4% good and 4% poor.

The results of our present study are comparable with he results of the studies conducted by Arne Ekeland, Thoresen et al (1988).

In this series of ours we did not use negative suction drain in initial 7 cases and we found a direct relation of it with superficial infection. After we started using negative suction drain infection rate went down to almost nil. Therefore we recommend use of negative suction drain at window site.

SUMMARY AND CONSLUSION

The study of MANAGEMENT OF LOWER AND MIDDLE THIRD TIBIA FRACTURE BY ENDERS INTERLOCKING NAIL was carried out in he Department of Orthopaedics and Traumatology, P.G. Hospital, Jabalpur consisting of 25 cases of fracture shaft of Tibia.

In the light of results obtained it can be summarized and concluded that :

1. It is an effective modality which allows early ambulation and weight bearing, and decreased dependency.
2. Infection rate is low provided negative suction drain is used ate window site.
3. It reduces hospital stay of patients and later patient can return early to work, thus minimizes psychological trauma and financial burden to the patient.
4. It given good results in terms of union and functional recovery.
5. It is economical.
6. It is done by a simple technique can be mastered easily and does not require costly instrumentation of IITV thus can be done in remote areas.

Fracture of tibia arises controversies regarding any standardized method of treatment, but with encouraging and convincing results here is a better future for fracture of tibia leading to good solution to controversial problem of fractures of tibia by ENDERS interlocking Nailing System.