Efficacy of Klemm and Borner Criteria in Evaluating the End Results of Management of Closed Diaphyseal Fracture of Tibia Treated by Closed Interlocking Nailing

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Research Article

Abstract: **Background.** The tibia is the most common fractured long bone, because of its exposed anatomical location and inadequate muscular envelope. **Objectives**: Evaluate fracture healing and union time with closed Interlocking nailing with reaming in regards to its functional outcome (klemm and borner criteria) with respect to knee and ankle joint movements, deformity, muscle atrophy and radiological union aiming at early mobility of patients. We report a randomized analysis of 30 patients treated in one center in rural area. **Methods:** Study done at Orthopaedic Department of NIMS Medical College, Jaipur (Rajasthan) between May 2011and May 2013. The patients included were more than 18 years, only closed diaphyseal fractures considered. Fractures of tibia other than diaphysis and unfit patients were excluded. Mean age was 32.4 years.29 patients had road traffic accident,1patient had history of fall:16 had ipsilateral fibula fracture,6 had contralateral tibia shaft fracture ,3 had head injury,3 had metacarpal fracture,2 had fracture clavicle and one had floating knee. **Results:** Average union time 4.7 months Complications encountered were 3 delayed union,1 malunion,1superficial infection,1 deep infection and 15 developed anterior knee pain. **Conclusion:** 90%of the total cases had excellent results,6.66% had good results and 3.33% had fair results.

Keywords: deformity, klemm and borner, tibia.

Introduction

The tibia being the most common fractured long bone, because the exposed anatomical location of the tibia makes it vulnerable to the direct blow and high energy trauma . Tibia has precarious blood supply due to inadequate muscular envelope. The presence of hinge joints at knee and ankle, allows no adjustment for rotatory deformity after fracture. Among the various modalities of treatment such as Immobilization in plaster cast has been used most commonly in the past, but it does not always maintain the length of the tibia and leaves the wound relatively inaccessible.[1]Open reduction and internal fixation with PlateandScrews has yielded unacceptably high rates of infection.[2,3,4] This method may be selected with more severe injuries associated with displaced intra-articular fractures of knee and ankle. External fixation considered the treatment of choice by many traumatologists, has disadvantage of bulky frames and frequent pin tract infections, non-unions and malunion.[5] The intramedullary nailing, locked or unlocked has became an attractive option since image intensifires has made closed intramedullary nailing possible. Advantages of closed interlocking nailing are: Fracture haematoma is preserve. Proved method of treatment in delayed and non-union. Effective in open fracture, Type I and II with clean wound. Vascular damage is minimal. Stability and length is well maintained. Rotational instability will be checked by locking screws. The objective is to study fracture healing and union time with intramedullary interlocking nailing with regards to functional outcome in respect to knee and ankle joint Movements,deformity(varus-valgus/antero-post angulation),muscle atrophy and radiological bone union,aming at early mobilization and reduce hospital stay in a rural setting. The biomechanical principles of intramedullary splinting were established by intramedullary nailing technique introduced by Kunstscher in 1940. In 1950, he developed the technique of medullary reaming and closed insertion of intramedullary nail without exposing the fracture. Lotte was one of the earliest proponents of non-reamed intramedullary nailing. Using triflanged nail, he developed a technique called “Blind nailing technique” without the use of fracture table, image intensifier and radiographic equipment[6]. The technique of closed interlocking was popularized by AO-ASIF during the period 1970-1975 for the middle third for the femur and tibia.

Nazri MY *et al.*(2004)[7] : A retrospective study was done in 30 patients with infected closed fractures, showed that 77% of infected fractures with a stable implant united even in the presence of infection.

Methods

Patients with Road Traffic Accidents, and also with other modes of injury resulting in fractures tibia and fibula were admitted to the hospital in NIMS university jaipur from may 2011 to may 2013.A randomized sampling of 30 patients were done which were included to evaluate the end results of Management of closed Diaphyseal Fracture of Tibia treated by Closed Interlocking Nailing .The patients included were more than 18 years, only Closed diaphyseal fractures were considered. Fractures of tibia other than diaphysis and unfit patients were excluded. A detailed history with complete systemic and musculoskeletal examination and meticulous radiological examination was done. The surgical procedure is done under spinal or general anaesthesia. Standard Operating table was used in tibial nailing. Postoperatively the limb is elevated on a pillow..Parenteral antibiotics are given for5days, and continued in the form of oral antibiotics till suture removal, which is done between 1 to 2 weeks. Active quadriceps exercises are restarted on the 1st postoperative day with active ankle and toe movements with knee mobilization, as far as the patient Is comfortable and free of pain. Radiograph of the leg is taken to assess the fracture alignment, nail placement and locking screws.The patient is made to ambulate from the 3rd postoperative day without bearing weight on the operated leg with crutches or walker. Suture removal is done between 1 to 2 weeks, usually after the 10th day if the wound has healed.

Follow Up (fig 1)

It was done using on the basis of following criteria by Klemm and Borner (1986)[8].

I. Excellent
- Full knee and ankle motion
- No muscle atrophy
- Normal radiographic alignment

II. Good
- Slight loss of knee and ankle motion (<25°)
- Less than 20 mm of muscle atrophy
- Angular deformities (<5°)

III. Fair
- Moderate loss of knee or ankle motion (25°).
- More than 20 mm of muscle atrophy.
- Angular deformities (5-10°)

IV. Poor
- Marked loss of knee or ankle motion (>25°).
- Marked muscle atrophy
- Angular deformities (>10°)

Patients were followed up periodically on an outpatient basis at 4th, 6th, 10th, 12th, 16th, 20th week and 6thto 8thmonthand in between if required.

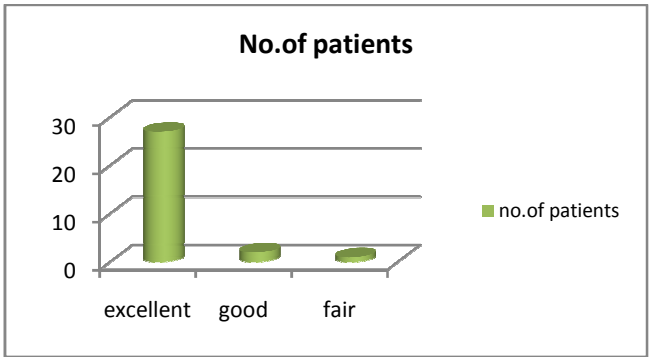
The complaints were noted and the clinical and radiological assessment of the patients was done for pain, deformity, range of motion of knee and ankle joints, muscle atrophy and radiological Union. Deformity was noted as None, Anteversion-recurvatum, Varus-Valgus and Rotation deformity in Degrees. Range of motion of knee and ankle joints was noted in degrees.Radiological union is noted as consolidated for excellent results, Angular deformity <5^{o} for good results and Angular deformity 5-10^{o} for fair results , Angular deformity >10^{o}for poor results at 6 month. Angular alignment (varus-valgus, anterior and posterior angulation) was assessed radiologically(fig 1) Varus-valgus was determined by measuring the angle between the line drawn perpendicular to bisecting the tibial plateau and proximal medullary canal with the line bisecting the distal medullary canal and tibial plafond. Antero-posterior alignment was determined by measuring the angle between the lines parallel to the proximal fragment and distal fragment on lateral radiographs. Rotations were assessed clinically. Malunion was considered when varus-valgus angulation was more than 5°,anterior-posterior was more than 10^{0} , internal and external rotations of more than 10°and shortening of more than 10 mm.Weightbearing was done, initially partial weight bearing at the 1 week depending on type of fracture and rigidity of fixation. Full weightbearing is allowed after bridging callus is seen and there is solid union, usually at 8th to 10th week. Late delayed complications like screw breakage, nail bending, mal-union, nonunion, limp, anterior knee pain and infection was noted and any secondary procedure done was noted. Dynamization was not needed. Gait was assessed whether normal or associated with a limp. In this study fracture union was considered when patient was weight bearing without pain, fracture site was not tender on palpation, radiograph showed osseous union in antero-posterior and lateral views. Gait and ability to do strenuous activities was also assessed.

Results

In this study, olique fractures were seen in 53.33% of cases, followed bytransverse fractures in 20% of cases, spiral fractures in about16.66 % of cases. wedge fracture were seen in about 6.66% of cases and communited fracture in 3.33% case (one patient with single tibia fracture). We encountered, Ipsilateral fibula fracture was the common associated injury and it was 53.33%. Three patients had head injury.One patient had same side shaft femur fracture that is floating knee. Nailing was done for both fractures. Six patient had bilateral fracture tibia. They were also treated with nailing. Two patient had fracture clavicle, treated conservatively with figure of 8 bandage.Three patients had metacarpal fracture treated with K wiring. Proper evaluation and treatment of head injury was done. Patients were posted for surgery after head injury treatment and once they are fit for operation. In our study most of the cases are mobilized (non weight bearing crutchwalking) on next day after operation. The average

time for partial weightbearing in our study was 3.7weeks(25.9 days). The average time for full weightbearing in our study was11.9 weeks.Half of the cases (15, 50 %) in our study commenced protectiveFWB between 8 and 10 weeks. 15 cases (50 %) commenced FWB after 14 weeks. 30 out of 30 fractures united (100 %). The time for union ranged from Three and a half to Eight months with an average of 4.7 months. 27 fractures healed before 5 months (20 weeks), 3 fractures healed between 5 and 8 months (20 to 32 weeks). In 27 cases (Taking each limb as a single case)(90 %) full range of knee motion gained at 12 weeks. In 2 cases(6.66%)<25° loss of Knee motion was noted at 12 weeks .In 1 case (3.33%) 25° loss of knee motion was noted at 12 weeks Amonst the 27 cases (Taking each limb as a single case) (90 %) full range of ankle motion was gained at 12 weeks. In 2 cases(6.66%)<25° loss of ankle motion was noted at 12 weeks .In 1 case (3.33%)25° loss of ankle motion was noted at 12 weeks.ONE case out of 30 cases had malunion.that is anterior angulation of 7.5^0.This case also had deep infection.

No.of patients	Functional outcome
27	Excellent
2	Good
1	Fair



Discussion

The end results of all 30 cases are summarised here. All the cases had a follow-up between 6 and 8 months. Results were evaluated at every 4-6 weeks from the date of discharge.

1. Union

30 out of 30 fractures united (100 %). The time for union ranged from Three and a half to Eight months with an average of 4.7 months. 27 fractures healed before 5 months (20 weeks), 3 fractures healed between 5 and 8 months (20 to 32 weeks). In our series, majority of fractures united within 20 weeks (27 patients). The average time of union 18.8 weeks. This is comparable to **Lawrence B. Bone *et al.*** (1986)[9],and **Court Brown *et al.*** (1990)[10] where the average union time was 19 weeks and 16.7 weeks respectively.

2. Range of motion

One of the essential aspects of closed reduction and internal fixation with interlocking intramedullary nailing is the ability to mobilize the joints early.

No of cases	Range of movement at knee at 12 weeks	Range of motion at ankle at 12 weeks
27	Full	Full
2	$<25^0$ loss	$<25^0$loss
1	25^0loss	25^0loss

The major causes for restricted range of motion in this series were;

a) Upper diaphyseal fracture- restricted knee movements.

b) Deep Infection.

c) Delayed union, requiring long period of immobilization.

3. Malunion

ONE case out of 30 cases had malunion.that is anterior angulation of 7.5^0.This case also had deep infection .

4. Delayed union

3 cases out of 30 cases had delayed union

Probable causes for delayed union in this series were;

a) Deep Infection

b) Prolong immobilization.

c) Old age

d) Poor nutrition

5. Non-union

In the present study none of the case out of 30 cases had non-union.

6. Infection

One patient developed superficial infection. This healed with oral antibiotics as per culture sensitivity and,fracture united.

One patient developed deep infection and treated for 6 weeks with antibiotics administered intravenously after pus culture sensitivity. In this case fracture unitedin more than 5 months time . In this study, 1 case developed superficial infection 3.33% which is comparable with **Lawrence B. Bone *et al.*** (1986)[9],who noted an infection rate of 6.25% and **Arne Ekeland *et al.*** (1988)[11],who noted infection rate of 4.4%.

Blachut P. A. *et al.*(1997)[12], noted an infection rate of 1%.

One patient developed deep infection.

The causes of infection in this series was probably poor nutrition and low socio-economic status due to which patient did not maintain proper hygine.

7. Knee pain

In our study, 15 patients (50%) developed anterior knee pain. Anterior kneepain is the most commonly reported complication after intramedullary nailing of tibia.56% of patients have some degree of chronic knee pain and more have difficultykneeling according to Campbell. The mean incidence of anterior knee pain after tibial nailing is close to 50% but rates up to 86% have been also described in the literature [13]. The transtendinous approach has been reported to increase the incidence of anterior knee pain[14] but other studies have not shown a difference between transtendinous and paratendinous approaches[13] The causeof this knee pain is still unclear. Thigh muscle weakness from reflex inhibition of quadriceps and injuries to collateral ligaments, cruciate ligaments, menisci or the articular cartilage can predispose to knee pain after IM nailing[15]. In our study also cause for knee pain was unclear. But the probable causes were nailprominence above the proximal tibial cortex and meniscal tear. Anterior knee pain can be compared to **Hernigou P. *et al.*** (2000)[16], whonoted improper entry of nail into medullary canal, may cause anterior knee pain.

Jarmo A. K. Toivannen *et al.* (2002)[17], noted anterior knee pain to becommon in tibial intramedullary nailing

Conclusion

Active young individuals were the main sufferers in tibia diaphyseal fractures (with average age group of 32.4years and maximum patients were in the age group of 20-39 years) Bread winning working men with outdoor activities are majority in tibial Fractures. High velocity road traffic accidents are the major cause of these fractures. Mid diaphyseal fractures are common site as it is subcutaneous in nature. Common type of fracture was oblique followed by transverse

All fractures were closed type and mostly right sided. Patients operated with this technique can be ambulated early without external immobilization in majority of cases, patients are allowed to resume work early as tolerated and this procedure also reduces the hospital stay and boost up the morale of the patient. All the patients were mobilized post operatively as early as possible depending upon fracture stability, general condition, associated injuries and tolerance of patient. Twenty seven fractures (90%)had united within 5 months of injury. The method of intramedullary interlocking nailing is ideal because of excellent results (90%)which is comparable to other workers series mentioned earlier.

Table 1: Type of fracture

Type	No. of cases	Percentage
Oblique	16	53.33%
Transverse	6	20%
Spiral	5	16.66%
Wedge(Butterfly)	2	6.66%
Communited	1	3.33%
Segmental	0	0%
Total	30	100%

8. Failure of implant

Such as proximal and distal screw brakage or nail brakage. In current study no failure of implant was observed.

9. Functional Results

It was done on the basis of criteria by Klemm and Borner. 27 (90%) of cases had excellent results, 2 (6.66%)of cases have good results, 1(3.33 %)of case have fair results.

Type of Fracture

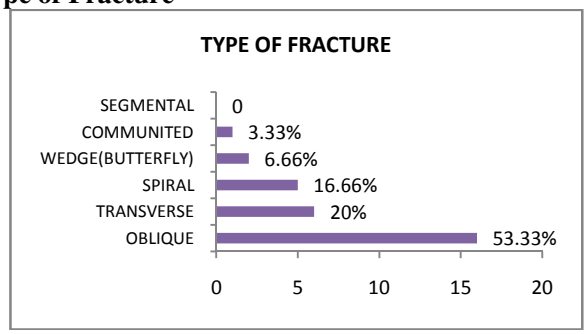


Table 2: Commencement of PWB

PWB (days)	No. of cases	Percentage
0 to 10	14	46.66%
10 to 20	1	3.33%
20 to 30	0	0
> 30	15	50%
Total	30	100%

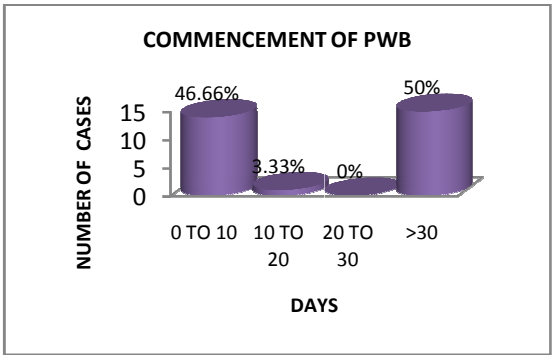


Table 3: Commencement of full weight bearing

FWB (weeks)	No. of cases	Percentage
8 to 10	15	50%
10 to 12	0	0%
12 to 14	0	0%
>14	15	50%
Total	30	100%

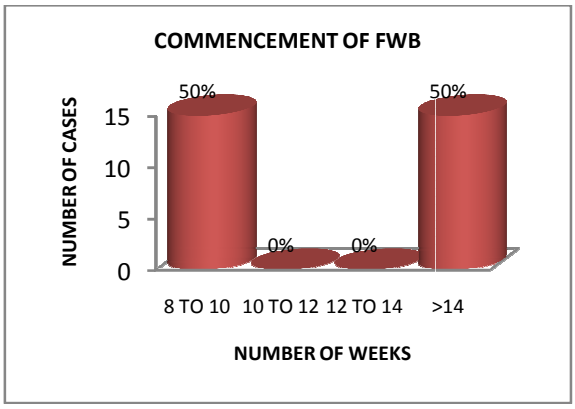
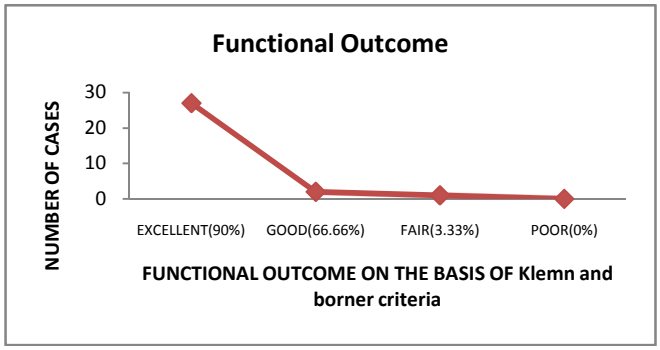


Table 4: Functional results in the present study

Results	No. of cases	Percentage
Excellent	27	90%
Good	2	6.66%%
Fair	1	3.33%
Poor	0	0%
Total	30	100%



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S.NO.	FRACTURE UNION (IN WEEKS)	FOLLOW UP AT 6 MONTHS						FUNCTIONAL OUTCOME
		PAIN	DEFORMITY	RANGE OF MOTION(%)		MUSCLE ATROPHY	RADIOLOGICAL UNION	
				KNEE	ANKLE			
1	17 WEEKS	ANT KNEE PAIN	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
2	18 WEEKS	A	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
3	18WEEKS	ANT KNEE PAIN	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
4	19WEEKS	A	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
5	18 WEEKS	A	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
6	17 WEEKS	ANT KNEE PAIN	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
7	18WEEKS	ANT KNEE PAIN	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
8	19WEEKS	A	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
9	29 WEEKS	ANT KNEE PAIN	deg varus de	<25 deg loss	<25 deg loss	14mm	CONSOLIDATED	GOOD
10	18WEEKS	ANT KNEE PAIN	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
11	18WEEKS	A	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
12	18 WEEKS	ANT KNEE PAIN	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
13	19 WEEKS	A	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
14	32 WEEKS	ANT KNEE PAIN	deg anterior	25 deg loss	25 deg loss	26mm	CONSOLIDATED	FAIR
15	30 WEEKS	ANT KNEE PAIN	deg varus de	<25 deg loss	<25 deg loss	17mm	CONSOLIDATED	GOOD
16	18 WEEKS	ANT KNEE PAIN	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
17	18WEEKS	A	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
18	16WEEKS	A	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
19	19 WEEKS	A	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
20	18WEEKS	A	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
21	19WEEKS	A	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
22	20WEEKS	ANT KNEE PAIN	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
23	18WEEKS	A	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
24	17 WEEKS	ANT KNEE PAIN	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
25	18 WEEKS	A	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
26	19WEEKS	ANT KNEE PAIN	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
27	17 WEEKS	A	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
28	14WEEKS	A	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
29	18WEEKS	ANT KNEE PAIN	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT
30	14WEEKS	ANT KNEE PAIN	NIL	N	N	NIL	CONSOLIDATED	EXCELLENT