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Surgical management of compound fracture tibia using an unreamed interlocking intramedullary nail

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Abstract
Background and Objectives: Tibial fractures are one of the most common long bone fractures with increasing number of motor vehicle accidents. Complications like compartment syndrome, neurovascular injuries, malunion are common. Reaming before insertion of nail disrupts the medullary blood supply. Infection rate with reaming is high because the foreign bodies, dust, etc are pushed deeper into the tissues with reaming. Thus considering all these factors, the unreamed intramedullary nail can be used for the management of compound fractures of tibia.
Materials and methods: The present study was conducted at the Department of Orthopedics, Adichunchangiri Institute of Medical Sciences, B G Nagara, Mandya district after obtaining ethical clearance. This study was conducted on 20 patients involving both male and female. Study was conducted for a period of 18 months from December 2018 to June 2020. Cases were followed up with 4 visits.
Results: Compound fractures of the tibia treated by unreamed interlocking intra medullary nail gave excellent results measured by surgical outcome and patient satisfaction. This technique boasts lower rates of complications in comparison with other treatment modalities.
Interpretation & Conclusion: Unreamed interlocking nailing is a lucrative option in management of compound and segmental tibial fractures. It promotes early union. Also it has low risk of infection. Early mobilisation can be advocated. It helps early return to activities.

Keywords: Unreamed, interlocking intramedullary nailing, dynamisation, reaming

Introduction
"The primary objective in the management of an open fracture is union with prevention or eradication of wound sepsis." - Gustillo *et al*. It is a well known fact that tibia is the most commonly fractured long bone. There are 26 cases of tibia fractures per lakh population. Because of its very location: compound fractures in tibia are common because two third of tibia is subcutaneous distal tibia has less muscle coverage because of which there is less protection and poor blood supply which may even result in non union later. Complications like compartment syndrome, infection, non union are common. Knee joint and ankle joint give very less freedom of movement for leg. Usually tibia gets fractured in five ways; direct blow, assaults, sports falls and injuries, falls, road traffic accidents and bullet injuries [1]. With use of C-arm, use of intramedullary nail is favourable and an attractive option. Nail is a load sharing device. It shows resistance to both axial and torsional forces. Locking of the nail proximally and distally gives rotational and axial stability. Reaming before insertion of nail disrupts the medullary blood supply. Nailing with reaming provides a double insult to the nutrient artery distribution [2]. Infection rate with reaming is high because the foreign bodies, dust, etc are pushed deeper into the tissues with reaming.

Materials and Methods
The present study was conducted at the department of Orthopedics, Adichunchangiri institute of medical science, B G Nagara, Bellur, Mandya district after obtaining ethical clearance. This study was conducted on 20 patients involving both male and female. Study was conducted for a period of 18 months from December 2018 to June 2020.

All cases were traumatic and were fresh cases. Most cases were admitted from casualty. Few were admitted from out-patient department.

Study design: Cohort study

Inclusion Criteria
1. Compound Fracture of the tibia
2. segmental fractures of tibia
3. Age Limit: 18 years to 70 years
4. Gustillo Anderson open fracture Grade I, II, IIIA, IIIB fractures

Exclusion Criteria
1. Pathological fractures.
2. Fractures within 5cm of distal articular surface of tibia.
3. Intraarticular extension of fractures.
4. Patients with Gr IIIC fractures

The duration of follow-up ranged 18 months with 4 visits (6 weeks, 3 months, 6 months and 12 months). There were 16 men and 4 women in the study. 14 cases had right tibia fracture while 6 had left tibia fracture. Most of the fractures were outcome of high –velocity trauma.12 of the fractures were caused by motor cycle accidents, four by motor vehicle accidents, four pedestrian accidents. Fractures and wounds were classified according to the system of Gustilo et.al, number of cases accordingly were
Type I - 2 cases, Type II- 10 cases, Type IIIA – 4 cases, Type IIIB – 4 cases
Location of the fracture - Proximal third -5cases Middle third – 8 cases, Distal third– 7 cases.
Fracture patterns - Communited fractures -9cases Transverse fractures – 3 cases, Oblique fractures - 6 cases, Spiral fractures - 2 cases. Patients, on admission, were looked for other system injuries, shock and morbidities. Patients on presentation to casualty or OPD were given intramuscular analgesics and intravenous antibiotics. Detailed clinical examination was done and proper history was documented. Patients were taken to the minor procedures OT for wound care. Culture sensitivity of the swabs taken from the wounds was done. Saline irrigation was done till all the wound contaminants flushed out. Primary closure was done to clean wounds which had adequate soft tissue coverage and when patients presented within 6 hours. Sterile dressing was done. Limb was immobilised in above knee slab and was kept elevated over pillows or BB splint. X-rays photographs were taken in A-P and lateral views. Patients were operated as early as possible, once the patients were deemed fit for surgery.
Preoperatively, tibia length was assessed by measuring from highest point of tibial tuberosity to highest point of medial malleolus. Diameter if the tibia was measured at level of isthmus from x rays of the sound leg. Patient is placed in Supine position on the operating table. C arm is placed in position. Knee is flexed 90 degrees and is hanged by the side of the table. A sterile blob is kept under the thigh distally. This allows hyperflexion of knee if needed. In this position gastrocnemius and soleus relax. This also allows reduction of fracture by gravity. The uninjured leg is rested on the operating table undisturbed. Then limb is painted with betadine solution from mid thigh to foot. Sterile drapes are used to cover rest of the body. Foot is covered in receiving drape or in sterile gloves. Nail length and nail diameter is measured with radiographic ruler. Skin Incision is taken over patellar tendon. It extends from inferior pole of patella to the tibial tuberosity. It is approximately 4 cm long. Incise the patellar tendon vertically in the middle and retract it on either sides. Determine the point of insertion on tibial tuberosity. It is medial and in line with the medullary canal.

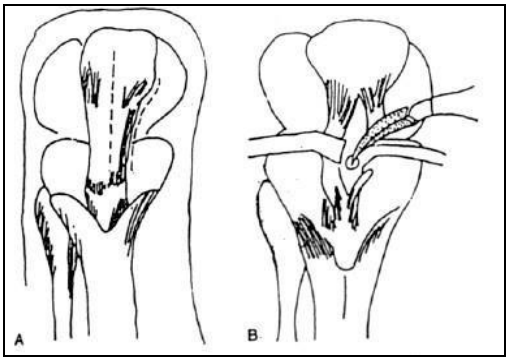

Image 1: incision and tendon spliting

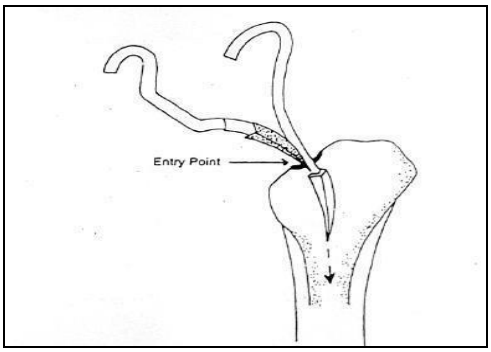

Image 2: Point of entry

A curved bone awl is used to make entry into canal. Point of entry is widened with a proximal reamer. A guide wire of 3mm diameter x 95 cm length is passed into the canal. Now the fracture is reduced using c-arm guidance mostly by longitudinal traction in line with the tibia. It is passed till 0.5-1cm just above distal end of tibia. Now an assembled tubular nail is passed across guide wire. However when solid nails were used, no guide wire was inserted and directly nail was negotiated into the canal. Leg is flexed at knee joint. Ankle joint supported by a kidney tray as a counter support. Medio-lateral screws are inserted in order under image intensifier guidance. Limb position is adjusted until a clear circular hole is seen. Adjust it until a K wire appears as solid circle in the center of the outer ring. Hammer the K wire in to the bone. Remove the k-wire. Measure the size of screw using screw gauge. Add 2mm to this reading so that the locking bolt perfectly engages the far cortex. Make sure the screw completely obliterates the circular hole seen on image intensifier. Similarly anteroposterior distal locking is done. If fracture gap is present, docking is done either by backslapping the mallet attached to the jig or by thumping the foot. The jig has holes which guides proximal locking. Incised wound is washed with betadine and normal saline. Patellar tendon is sutured with absorbable sutures and skin is sutured. Sterile dressings were applied over the wound, Compression bandage is applied, capillary filling and peripheral arterial pulsations checked. Limb elevation given I.V antibiotics given for 5 days post-operatively, Active knee, ankle and toe mobilization was started next day if all parameters were normal. Patient was allowed non weight bearing crutch walking on postoperative day one. From day 4 or 5, partial weight bearing was advised with crutches, depending on the type of fracture and rigidity of the fixation. Sutures or staples

were removed on 10th postoperative day. Every 6th weekly follow up was done. Efforts were made to obtain good coverage of the wound within 7 days. Split skin grafting was done in one patient same time after operating tibia. Another patient was done with grafting after 10 days of injury

Results

Patients were mostly from age group 20-30 (35%) and age group 41-50 (25%), the youngest patient was 20 years old and the oldest patient was of 65 years.Majority of the patients were male (80%) and only 20% were females. The major cause of fracture in our study was motor cycle accidents, (60%), 25% were motor vehicle accidents and 15% were pedestrian accidents. Left tibial fracture constituted majority of the patients. 14 patients (70%) had left tibial fractures

Table 1: Fracture classification

Gustilo Type	No. of patients	%
I	2	10.0%
II	10	50.0
IIIA	4	20.0
IIIB	4	20.0
Total	20	100.0

Fractures were mostly located middle and distal third of tibia (80% together)

Table 2: Fracture location

Level Fracture	No. of patients	%
Proximal	4	20.0
Middle	8	40.0
Distal	8	40.0
Total	20	100.0

Table 3: Fracture pattern of patients studied

Fracture pattern	No. of patients	%
Comminuted	9	45.0
Oblique	6	30.0
Spiral	2	10.0
Transverse	3	15.0
Total	20	100.0

Most of the patients in our study were operated within 6 hours of the trauma (60%), 4 cases which were medically comorbid or other such reasons were operated after 24 hours. All cases were operated under spinal anesthesia. Our mean operation time was 90 minutes. (Range 60 min. to 120 min). 15 cases (75%) of them were operating in time range of 60 to 120 minutes. Blood loss was approximately 200-300 ml in most cases in our series. All cases were mobilized with non weight bearing (NWB) crutch walking /walker on next day. For 8 patients partial weight bearing was started before 8 weeks. for half the number of patients PWB was started 2 weeks postoperatively (50%). In 2 cases PWB was delayed for more than 30 days (10%). Full weight bearing was started in less than 8 weeks in 4 patients (20%), in 65% of patients it took 8 to 16 weeks.7 cases out of 20 needed secondary procedure. 2 out of those 7 required split skin grafting, while 5 needed dynamisation.95% of the fractures united. 15 of those 19 cases united in normal time while 4 went for delayed union. 1 case(5%) didn't unite.19 of the 20 fractures united (95%). 5 fractures united before 4 months, 1o fractures took 4 to 8 months for union, 4 fractures united after 34 weeks.In our study 15 patients fracture united in the normal duration(70%), 4 patients had delayed union(20%) and 1 case of non union (5%). In 12 patients (60%) full range of knee motion was achieved. In 6 cases (30%) more than 80% of knee motion was achieved. In 1 case knee motion was less than 75%.16 patients (80%) had normal range of ankle motion.2 patients achieved more than 75% of ankle motion, 1 patient had his ankle movements restricted to less than 50%. 18 out of 20 patients had over 75% of subtalar range of motion. 2 patients achieved just oiver 50% of range of movements. 4 patients (20%) out of 20 developed infection. 2(10%) patients developed superficial infections. One in gustilo type II, and one in type IIIB. All the 2 infections were healed with oral antibiotics. 2(10%) patients developed deep infection in gustilo type II fracture and gustilo type IIIA. they were treated for 6 weeks with antibiotics administered I.V.

Table 4: Infection of no. patients

Infection	No. of patients	%
No	16	80.0
Deep	2	10.0
Superficial	2	10.0
Total	20	100.0

In our study only 1 patient (5%) noticed pain at the left knee joint.

Results as excellent, good, fair, poor were derived as per Johner and wruh's criteria.

Table 5: Results and No. of patients

Results	No. of patients	%
Excellent	12	60.0
Good	6	30.0
Fair	1	5.0
Poor	1	5.0
Total	20	100.0

Case 1

Pre op wound

Preoperative X ray

Immediate postop X ray

Knee flexion

Post op xray 6 months

CASE-2

Wound

Pre op x ray

Immediate post op x ray

Knee flexion

Post Op x ray 6 months

Discussion

Treatment of open fractures of tibia have always been a challenge since the risk of infection is high. More severe the fracture, more the rate of complications and delayed healing. Also need to preserve endosteal and periosteal blood supply is of utmost importance for fracture healing. Johner R *et al.* [3] reported that plating as compared to nailing results in infection five times more in incidence and non-union twice as common. Holbrook *et al.* [4] compared ender's nails with external fixators in twenty eight open tibial fractures. They found 14 percent rate of deep infection in patients treated with external fixators and 36 percent rate of malunion. For enders nails they reported 7% rate of infection and 21% rate of malunion, enders nails never gave fractures the axial control.Reaming the canal leads to higher rate of infection and bone necrosis and non union, in series of 18 open tibial fractures with severe soft tissue injuries treated with intramedullary nail with reaming, Smith JE [5], found rate of infection of 33 percent. Klemm KW *et al.* [6] in series of 93 grade I open tibia fractures, found rate of infection to be 6.5% after intramedullary nailing with reaming. Unreamed nailing has advantages compared to reamed nailing that it doesn't damage the endosteal blood supply. Klien MP *et al.* [7] ,evaluated the cortical blood supply of canine tibiae after nailing with and without reaming. They found that reaming disrupts an average of 70 percent of the cortical blood supply ,while insertion of a nail without reaming disrupts the blood supply in only the inner third of the cortex. There was bimodal distribution with respect to age group. 35% of cases were in the age group 20 to 30 years while 25% belonged to 4 to 50 years age group. Singer RW *et al*[8] showed average to be 36 years in their study of 43 patients. Bonatus T *et al.* [9] studied 72 such cases where he determined the average age to be 30.3 years. There were 16 male and 4 female patients, indicating male patients to be more than female patients. Singer RW *et al.* [8] study included 30 males and 11females, while Bonatus T *et al.* [9] study had 52 men and 19 women. High velocity trauma is the main cause of open tibial fractures. Motor cycle accidents (two wheelers) constituted 60% of the cases, 25 were motor vehicle accidents (four wheelers), while 15% were pedestrian accidents Majority of the cases sustained fractures from road traffic accidents. Singer RW *et al* [8] reported 54.16% fractures to be out of motor vehicle accidents. Whittle AP *et al.* [10] in their study found out that the most common mode of injury was pedestrian –automobile accident- 23 cases (46%). In our study, we obtained excellent results for management of compound tibial fractures using unreamed techniques. In our series fifteen fractures (75%) united within 6 months of injury, In series published by author Jain V *et al.* [11] union occurred after 18.09 and 26.5 weeks after immediate and delayed nailing group respectively while in IIIB union was achieved at 24.7week and 47.2weeks respectively. They got excellent results in 73.07% patients after immediate nailing and 53.84% after delayed nailing. This is comparable to our studies. Singer *et al.* [8] reported union at average of 6.1 months. In our study, the delay in union was noticed in 4 patients, mainly due to deep infection in a case and extensive injuries and comminution in other cases. Union occurred in all fractures after a mean time of 24.3 weeks. In our study, there were two cases with deep infection (10%) and 2 cases with superficial infection (10%). Jain V *et al.* [11] found out that superficial infection rate was 8.33% while 4 cases had deep infection (28.2%) in their observation. Malunion was defined as > 5 degrees angulation in a coronal plane,>10 degrees angulation in sagittal plane or > 1cm of shortening. In our series, 3 cases of malunion occurred Swanson TV *et al*[12] suggested that malunion is possible even if the fractures are axially stable. Dynamisation can be done in cases where callus is not seen after 10-12 weeks. It gave good results in our current study. In a study by D Joshi *et al.* [13] of the 56 fractures, 44 healed within 32 weeks; 6 (4 in type II and 2 in type IIIA) had delayed union and were dynamised by removing the proximal screw (4 cases) and distal screw (2 cases) after a mean of 20 weeks.12 patients had (60%) full range of knee motion, in 16 patients. These results are comparable with other series of studies. In our study one patient (5%) complained of pain in the operated side knee joint. Patzakis MJ *et al.* [14] recommend removal of nail after fracture heals to avoid complications. In our series, no patient developed complications like iatrogenic neurovascular injuries, fat embolism, acute respiratory distress syndrome, compartment syndrome.

Conclusion

Unreamed interlocking nailing is a lucrative option in management of compound and segmental tibial fractures. Since the vascularity is not damaged, fractures tend to unite

early. There is minimal blood loss intra- operatively and is associated with low risk of infection. Early mobilisation can be advocated. It minimizes hospital stay and early return to day-to-day activities. Even complication rate is low

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