International Journal of Orthopaedics Sciences

ISSN: 2395-1958
IJOS 2019; 5(2): 783-786

www.orthopaper.com
Received: 24-02-2019
Accepted: 28-03-2019

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A study on complications of expert tibial intramedullary nailing of tibial fractures

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DOI: https://doi.org/10.22271/ortho.2019.v5.i2k.90

Abstract
The mechanical behaviour of IM nails depends on both material and geometry of the design. Intramedullary nails, such as Lottes and Ender nails, used without reaming, have been employed successfully in the treatment of open tibial fractures and have been associated with low rates of post-operative infection. They are, however, contraindicated for comminuted fractures, as there tends to be shortening or displacement of such fractures around these small nails. Twenty five patients with proximal 1/3rd and distal 1/3rd tibia fractures were selected for the study. In total number of 25 patients admitted, there were 17 males (68%) and 8 females (32%). There were 20 closed fractures (80%) and 5 open fracture (20%) (GA type I-3, GA type II-2). The average range of motion in the knee joint was 135.6 degree, full ankle motion was observed in 20 patients. One patient showed a loss of $>25^0$ of motion at ankle compared to the normal side while 4 patients showed $< 25^0$ of loss of joint motion. One case (4%) of deep infection and implant failure was noted in the present study. Two patients (8%) showed a superficial soft tissue infection. One case (4%) of malunion was found with an anteroposterior angulation of 10 degrees, one case (4%) with a distal 3rd showed a shortening of < 1cm.No cases of significant rotational deformities and varus or valgus angulation deformities was noted.

Keywords: Complications, expert tibial intramedullary nailing, tibial fractures

Introduction
The anatomy of the leg makes tibia susceptible to open fractures. The entire medial border is subcutaneous and is covered only by skin and subcutaneous tissues. It also makes a tempting target for the enthusiastic surgeon, as the surgical approach to the tibia is simple. The anterior tibial border in the diaphyseal region of tibia is very dense and extends from tibial tuberosity proximally to just above the ankle joint distally. The subcutaneous prominence of tibia lends itself very readily to pin fixation due to lack of muscles and tendons traversing the anteromedial portion [1].

The upper end of tibia is markedly expanded from side to side, to form two large condyles which overhang the posterior surface of the shaft. The upper end includes: a medial condyle, a lateral condyle, an intercondylar area and a tuberosity. The tuberosity is divided into an upper smooth area and a lower rough area. The epiphyseal line for the upper end of the tibia passes through the junction of these two parts [2].

The shaft has three borders and three surfaces. The anterior border is sharp and S shaped being convex medially in the upper part and convex laterally in the lower part. It extends from tibial tuberosity above to the anterior border of the medial malleolus below. It is subcutaneous and forms the shin.

The medial border is rounded and the lateral or interosseous border has interosseous membrane attached with it, which in turn is attached to fibula.

The lower end of the tibia is slightly expanded and has five surfaces. The anterior surface has a smooth upper part and grooved lower part. The medial surface is subcutaneous and is continuous with medial surface of medial malleolus. The lateral aspect of the lower end presents a triangular fibular notch to which lower end of fibula is attached. The inferior surface is articular, it articulates with talus and thus forms the ankle joint [3].

Intramedullary fixation offers many advantages in fracture healing when compared to other methods.

Union is usually rapid because unlike rigid plate fixation external callus is seldom completely suppressed. This is due to the fact that a nail can never be completely rigid. Movement at the fracture site along with axial micromotion in dynamically locked nails promotes the external bridging callus. This may also be due to the fact that as the medullary blood supply is lost the periosteal vascular supply increases.

Intramedullary nailing avoids ―stress protection osteopenia‖ and so the risk of late refracture after nail removal is uncommon. Controversy exists regarding the damage to the vascular supply following reamed and non-reamed intramedullary nailing. Intramedullary nailing in any of its forms damages the endosteal blood supply. This blood supply is rapidly reestablished when a loose fitting nail is used. But when a reamed well fitting nail is used, the viability of the bone depends on the alternative periosteal blood supply. If this blood supply is defective following some soft tissue damage, the whole of the diaphysis may get devascularized especially in the tibia [41]. This leads to two problems. First, there may be a delayed union, as revascularization can occur only slowly and secondly, the dead bone is prone to infection. Considerable surgical judgement is required in choosing the type of intramedullary nailing [4].

All the intramedullary nails, regardless of their types, act as flexible internal splints providing stability for the fracture fragments from within.

It is a 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 strain induced is now considered the most important factor in later stage of fracture callus remodeling [5].

Intramedullary locked nails, in addition to 3 point fixation and elastic impingement mainly provide stability by anchorage of the bone both proximal and distal to the fracture site by interlocking screws/bolts.

The mechanical behaviour of IM nails depends on both material and geometry of the design.

Intramedullary nails, such as Lottes and Ender nails, used without reaming, have been employed successfully in the treatment of open tibial fractures and have been associated with low rates of post operative infection. They are, however, contraindicated for comminuted fractures, as there tends to be shortening or displacement of such fractures around these small nails. The locking of intramedullary nails to the major proximal and distal fragments decreases the prevalence of malunion of comminuted fractures. Until recently, however, all interlocking intramedullary nailing involved reaming, which destroys the endosteal blood supply. The rate of infection after treatment of open tibial fractures with intramedullary nailing with reaming has been relatively high, causing most investigators to discourage the use of this technique for grade III open tibial fractures [6].

Methodology

Twenty five patients with proximal 1/3rd and distal 1/3rd tibia fractures were selected for the study.

Inclusion criteria

- Adult patients above age 18 years
- Proximal and distal tibial metaphyseal fractures
- Patients with open fracture tibia- Gustilos-Anderson type I and type II

Exclusion criteria

- Patients aged less than 18 years
- Patients medically unfit for surgery
- Comminuted and segmental fractures
- Diaphyseal tibial fractures
- Type III Compound fractures

In total number of 25 patients admitted, there were 17 males (68%) and 8 females (32%). There were 20 closed fractures (80%) and 5 open fracture (20%) (GA type I-3, GA type II-2).

Postoperative Care

- NBM 4-6 hours postoperatively
- IV fluids/ blood transfusion if necessary
- IV antibiotics: In most of the patients injection cefotoxime and injection gentamycin were used for 5 days.
- IM analgesics
- Tranquilizers HS
- Limb elevation over pillows
- Watch for active bleeding

Results

Table 1: According to the pattern of fracture

Fracture pattern	No. of cases	Percentage
Transverse	8	32
Oblique	12	48
Spiral	5	20

Oblique fractures were more commonly seen in our study.

Table 2: Incidence of closed and open fractures

Closed		Open	
		Type I	Type II
No. of Cases	20	3	2
Percentage	80	12	8

We classified tibial fractures into closed and open. The open fractures were classified according to Gustilos grading. Open fractures of tibia treated definitely with external fixator were excluded from the study.

Table 3: Associated injuries

Nature of Injury	No. of cases	Percentage
Ipsilateral fibula	21	84
Rib fracture	2	8
Ipsilateral femur	1	4
Ipsilateral patella	1	4
Contralateral both bones fracture forearm	1	4
Head injury	3	12

These associated injuries may delay surgery and predispose for many complications, polytrauma head injury and chest injury play important role in outcome.

There were three patients with head injury and were operated immediately after neurosurgical clearance. One patient had ipsilateral femoral fracture which was treated by closed

intramedullary interlocking nailing. One patient had ipsilateral patella fracture which was treated by AO cannulated screws and tension band wiring. One patient with contralateral both bones forearm fracture was treated by open reduction and internal fixation with DCP in same sitting.

The average range of motion in the knee joint was 135.6 degree, full ankle motion was observed in 20 patients. One patient showed a loss of $>25^0$ of motion at ankle compared to the normal side while 4 patients showed $< 25^0$ of loss of joint motion.

One case (4%) of deep infection and implant failure was noted in the present study. Two patients (8%) showed a superficial soft tissue infection.

One case (4%) of malunion was found with an anteroposterior angulation of 10 degrees, one case (4%) with a distal 3rd showed a shortening of < 1cm. No cases of significant rotational deformities and varus or valgus angulation deformities was noted.

One case (4%) of failure of implant was seen due to deep infection. Ilizarov ring fixator was applied subsequently.

Seven cases (28%) complained of pain in the knee joint at final follow up. All were of mild variety and occurred on kneeling down.

Table 4: Complications

Complications	No. of Cases	Percentage
Malunion	1	4
Superficial infection	2	8
Deep infection	1	4
Knee pain	7	28
Implant failure	1	4
Shortening	1	4
Delayed union	2	8

Discussion

Majority of the fractures involved distal third of the tibia (60%). Twenty one of the fractures were associated with ipsilateral fibula fractures. The out come of the isolated fractures of tibia was not different from rest of the fractures. Other associated injuries were rib fracture in 2 patients (8%), ipsilateral femoral shaft fractures in patient (4%), ipsilateral patella fracture in one patient (4%), contralateral both bones forearm fractures in one patient (4%) and head injury in 3 patients (12%).

The average range of knee joint was 141 degrees. (Range 128-161 dedress) and that of ankle movements was 84 degrees (Range 45-109 degree) in tibial fracture treated by reamed nailing in a study reported by Larsen *et al*.

In the study by Mosheiff *et al*. 5 patients had mild loss of ankle motion (<5%) and the range of motion of knee was full in all the 52 cases.

In the study by Robinson *et al*. 5 patients lost ankle motion: 4 had mild (<25%) and one patient who had crush injury to the ipsilateral foot had marked loss of ankle motion.

In the study by Singh *et al.* two patients (11.11%) had a loss of terminal knee flexion (10º and 20º); none had extension lag. Three patients (16.67%) had a loss of ankle dorsiflexion (15º in 2 and 5º in one).

The average range of knee joint motion in present study was 135 degrees and 76% of patients showed full ankle motion compared to the normal limb. One patient showed a loss of more than 25 degree of motion at ankle compared to the normal side while 4 patients showed less than 25 degree of loss of ankle joint motion.

Larsen *et al*. [7] reported a malunion in 2 of 22 patients treated by reamed nailing.

One case (4%) of malunion was found with as anteroposterior angulation of 10 degree had a fracture of upper third of tibia close to the tibial tubercle.

Malalignment is a common problem in proximal third fracture treated with locked nails because of the large discrepancy in size between the tibial nail and the wide tibial metaphysis. Freedman and Johnson [8] found that 58% of proximal fractures were malaligned compared to 7% of middle third and 8% of distal third fractures. Singer *et al*. [9] stated that it is imperative that the fracture be held reduced during nail insertion in case of proximal tibia fracture through use of bone clamps, a small plate or by using blocking screws. In a study of 32 proximal tibial fractures treated with intramedullary nail, Lang GJ *et al.* observed that 27 patients (84%) had angulation >5° in frontal or sagittal plane. In the study by Vidyadhara *et al*. four patients had average valgus angulation of 4.5° (range 3-9°), seven had average apex anterior angulation of 4.5° (range 2-9°), five had average posterior displacement of 4 mm (range 3-5mm), one patient had 3° of varus angulation and one had 4° of internal rotation deformity after nailing. In the study by Nork *et al.* 3 patients (8.1%) showed angulation ≥5° (5° varus in 1 patient, 7° varus in other and 5° valgus in 1 patient).

In the study by Singh *et al*. 3 patients had valgus angulation of <5° (4° valgus in 2 patients and 3° valgus in 1 patient). In a study by Hansen M *et al.* using the Expert tibial nail, they found that the risk for varus, valgus or antecurvation malalignment of more than 5 degrees in any plane on radiologic long leg views was 4.3% for shaft fractures, 1.5% for distal fractures, and 13.6% for proximal fractures. In study by Dogra *et al*. 3 patients had malalignment: One had a recurvatum and varus angulation of 5 and 8°, respectively and another had a recurvatum and varus angulation of 4 and 5°, respectively. One patient had a pure valgus malalignment of 5°.

In the study by Nork *et al*. 3 patients had angular malalignment: 2 patients had recurvatum of 5° and 1 patient had a valgus angulation of 5°.

In the study by Robinson *et al*. 3 patients had mal-alignment: 1 patient had a varus angulation of 10°, 1 patient had a varus angulation of 15° and 1 patient had recurvatum of 20°. Refinements in technique, including more precise placement of the entry portal (a more proximal and posterior entry portal), extending the knee during insertion of the nail, using a nail with more proximally located bend, use of blocking screws, uncoritical plates and two pin medial external fixation have been described to reduce the frequency of this complication.

The current study had one case (4%) of deep infection developed in the region of traumatic wound leading to purulent discharge in patient with a type II fracture 2 weeks after surgery. The wound was debrided and purulent material was sent for culture and sensitivity and appropriate antibiotics were instituted. The infection subsided with regular dressings of the wound. The fracture failed to unite even after dynamization. Implant was removed.

Two cases (8%) developed superficial soft tissue infection, one at proximal nail entry point and one at distal locking screw. One patient among the two was diabetic. They were treated by appropriate antibiotics, pus was sent for culture and sensitivity and appropriate antibiotics were instituted. The infection subsided with regular dressings of the wound and fractures united at 14 and 12 weeks respectively.

Singer *et al*. [9] recommended use of antibiotics for 2 to 6

weeks in cases of infection associated with in intramedullary nailing. Keating *et al.* opined that adequate soft tissue and bony debridement followed by sound soft tissue coverage is the key to minimize deep infection in open fractures of tibia irrespective of the type of fixation used. The use of antibiotic bead pouches reduces the incidence of infection further. If infection occurs, it is not necessarily a catastrophic complication and usually can be eradicated with prompt measures [10].

Functional results according to Klemm and Borner shows excellent result in 18 cases good result in 5 cases, one had fair result and poor result was seen in one case.

Conclusion

The management of metaphyseal tibial fractures remains a significant challenge. Treatment with a modified tibial nail like Expert tibial nail can give excellent functional and clinical results. Complications such as failure of the bone-implant construct or post-operative malalignment are avoidable if careful pre-operative planning is allied with meticulous surgical technique.

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