Effect of dynamization in delayed union tibia shaft fracture

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Abstract

Introduction: Tibial shaft fracture is among the most common long bone fracture encountered, open fractures are more common in the tibia because one third of the Tibial surface is subcutaneous throughout most of its length, and the blood supply to the tibia is more precarious than that of bones enclosed by heavy muscles. Whenever open fractures occur in the tibia they are more commonly type IIIB.

Objective: To study delayed union, non-union and infection are relatively common complications of tibial shaft fracture functional outcome & effect of dynamization in closed Intra-medullary Interlocking nailing for closed and open (Gustilo & Anderson Type I to Type IIIb) Tibial diaphyseal fractures.

Material and Methods: Total of 56 skeletally mature patients diagnosed as Tibial diaphyseal fracture included closed & open (Gustilo type I to IIIb). Treated with intramedullary interlocking nail.

Observation & Results: The age distribution was 42.9% in 21-40 years age group & 41.1% in 41-60 years age group with mean age 39.32 ± 14.85. Majority of fractures occurred in male i.e. 76.8%. Road traffic Accidents were found to be the main culprit as it contributed to 83.9% of total cases, other includes the fall from height (12.5%) & slip at home (3.6%). Among 56 tibia fractures 51.8 % were the lower 1/3rd shaft of tibia. 31.5% were middle 1/3rd shaft of tibia fracture. 1.8% upper 1/3rd shaft of tibia fracture. 8.9% are segmental fracture. In 33 cases which is more commonly i.e. 58.9% & Right side was involved in only 23 cases i.e. 41.1% of total cases. 80.4% of total cases (45) were closed tibia fractures. Dynamization increases the rate of callus formation with mean time to union post dynamization is 6.86 weeks. We evaluated patient using Lysholm score at 3 months and we found that mean Lysholm score was 75.54, which has increased in 6 months to 87.84. At the end of the study we found score further increased to 95.39. Final result in 56 case of tibia shaft fractures treated with intramedullary interlocking nail, 39 case (69.6%) result was "Good to excellent", in 13 patient (23.2%) results were "Excellent". 3 patients (5.4%) had "fair to good "result. 1 patient had "fair" result. We found no case with poor results.

Conclusion: Dynamization increases the pace of fracture healing in delayed uniting fracture. Intramedullary interlocking nails shows good to excellent results in the treatment of diaphyseal fractures. Distal tibia shaft fracture are more common followed by middle 1/3rd.

Keywords: Tibia Shaft Fracture, Diaphysis Fracture, Intramedullary Nail, Dynamization.

Introduction

In this fast growing world the distance has reduced with the use of automobiles, on the other hand this has also contributes to high energy trauma. Tibial shaft fracture is among the most common long bone fracture encountered, open fractures are more common in the tibia because one third of the Tibial surface is subcutaneous throughout most of its length, and the blood supply to the tibia is more precarious than that of bones enclosed by heavy muscles. Tibial fractures may be associated with compartment syndrome or neural or vascular injury. The presence of hinge joints at the knee and the ankle allows no adjustment for rotary deformity after fracture, and special care is necessary during reduction to correct such deformity. Delayed union, non-union, and infection are relatively common complications of Tibial shaft fracture.(1)

Tibial fractures have a bimodal distribution with low-energy spiral patterns being more common in patients over 50 years of age and high-energy transverse and comminuted fractures being more common in patients under 30 years of age.(2)

However, high-energy tibial fractures in younger patients are approximately twice as common in males than females.(3)

5% of the fracture involve fracture at two distinct sites in Tibia.

When open fractures occur in the tibia they are more commonly type IIIB requiring flap coverage than for other sites of injury.(4)

During the 1890s, Gluck recorded the first description of an interlocked intramedullary device. The device consisted of an ivory intramedullary nail that contained holes at the end, through which ivory interlocking pins could be passed. In the 1970s, Grosse and Kempf and Klemm and Schellmann developed nails with interlocking screws, which expanded the indications for nailing to include more proximal, distal, and unstable fractures.(5)

Tibial shaft fracture can be treated conservatively or operatively depending upon type of fracture, comminution, and soft tissue injury. For conservative management casting, function cast brace etc. are the options. Fractures in which closed treatment is inappropriate can be treated with plate and screw fixation, intramedullary fixation (interlocking intramedullary nails), and external fixation. Locked intramedullary nailing currently is the preferred

treatment for most tibial shaft fractures requiring operative fixation. Plating is used primarily for fractures at or proximal to the metaphyseal-diphyseal junction. External fixation is useful for fractures with periarticular extension and for severe open fractures.
The important factors in prognosis are:[6]

1. The amount of initial displacement.
2. The degree of comminution.
3. Whether infection has developed.
4. The severity of the soft tissue injury excluding infection.

Intramedullary interlocking nailing currently is considered the treatment of choice for most type I, type II, and type IIIA open and closed tibial shaft fractures. Soft tissue concerns with open plating techniques resulted in the increased use of either percutaneous plating methods or intramedullary nail (IMN) fixation, which has the added benefit of being a load-sharing device to allow early weight bearing.[7]

Both open and closed fractures of the tibia and fibula can be associated with skin complication, any areas of skin tenting or puckering should be relieved by restoration of the normal anatomic alignment and splinting once the initial limb assessment is completed. Irreversible full thickness skin necrosis can occur within hours and in severe cases this may result in subsequent soft tissue reconstruction procedures.[8]

Some patients with significantly displaced tibial and fibular fractures will have diminished or absent pulses distal to the injury because of kinking of the arteries of the leg. In most of these cases, palpable pulses will return once normal anatomic alignment is restored.

Classification of the Tibial shaft fracture:

1. OTA classification[9,10]
2. Gustilo Anderson classification for open fracture[11]
3. Tscherne classification of closed fractures[12]

Associated injuries includes compartment syndrome,[13] ankle fractures,[14-15] floating knees,[16] Knee ligament injuries.

Treatment

Treatment option includes casting, functional cast bracing, patella tendon bearing cast, operative etc.
Common Indications for operative treatment includes:

- Failure to obtain adequate closed reduction:
- Open fractures.
- Vascular injury.
- A soft tissue envelope which precludes cast application.
- A patient who is too unreliable for closed treatment.
- Patient preference to not have a cast.

Operative treatment include External Fixator, Interlocking Nail, and plating.
In intradullary interlocking nailing three Surgical approaches can be used:

- Parapatellar
- Patellar Tendon Split
- Suprapatellar

The Suprapatellar technique is currently gaining popularity because of the ease of obtaining a starting point for proximal fractures, starting points beginning midline at the superior pole of the patella and proceeding 5cm proximally. The quadriceps tendon is split longitudinally and the knee joint is entered from above. Specialized trocar is used that protect the patellofemoral joint from guidewire, reamers, and nail insertion.[17-18]

Material and Methods

56 skeletally mature patients diagnosed as Tibial diaphyseal fracture included in the study. Retrospective cohort Study design was used for assessment.

Inclusion Criteria

1. All skeletally matured patients with Tibial diaphyseal fractures.
2. Tibial diaphyseal fracture confirmed with appropriate radiographs.
3. Patients who are medically fit for surgery.
4. Patients and/or his/her legally acceptable representatives willing to provide voluntary written informed consent for participation in the study.

Exclusion Criteria:

1. Tibial diaphyseal fracture with associated tibial plateau fracture.
2. Medically unfit for surgery.
3. Patient who are not willing for surgical intervention.
4. Patients and/or his/her legally acceptable representatives not willing to provide voluntary written informed consent for participation in the study.

We used Intramedullary interlocking nail for tibia with a bend at proximal 1/3rd junction with 11^0 posteriorly angled, with one dynamic & one static slot for interlocking screw at proximal end and 3 static slot, two lateral and one anterior-posterior.

Pre–operative assessment in the form routine blood, urine & radiological investigation were done, additional investigation as per patients requirements were done.

Procedure

Prophylactic intravenous antibiotics is administered 30 min prior to skin incision.
The patient then given spinal anaesthesia under aseptic condition.
All cases were operated on a standard fracture table under spinal anesthesia using standard operating technique of the implant chosen. The fracture table is essential to achieve reduction and as it allows free access for the C-arm in both views.

Patient positioned in supine with roller rest for knee of affected side and thigh rest for contralateral thigh. Tourniquet applied on affected side. Assessed under C-Arm in AP & lateral views & also clinically by aligning iliac crest, patella and 2nd ray of foot in a line.
Skin preparation & draping was done under strict aseptic conditions.
Midline incision over knee extending from distal pole of patella to 3 cm distally. Patellar tendon splitting approach is used. Care taken not to violate knee joint only limited to anterior fat pad.
With a curved awl entry point is made under the guidance of C-arm. Which is just medial to lateral tibial spine in A.P. view, and just anterior to the articular margin on lateral imaging.
Ball tip guide-wire was passed through fracture site till distal metaphysis up to 1 cm from joint line, Centre in Antero-posterior and lateral views.
Starting with a reamer smaller than the measured diameter of the tibial canal, ream the canal in 0.5-mm increments.
Nail diameter that is 1.0 to 1.5 mm smaller than the last reamer used & length is determined using a separate guide wire under C-Arm. With the help of exchange tube ball tip guide wire is changed to Non ball tip guide wire.
Nail is attached to the jig and inserted in the canal. Guide wire is removed. Nail proximal end is checked under C-Arm which is kept within 0.5 to 2.0 cm from the subchondral bone. With the help of jig proximal screw are placed after drilling through drill bit & calculating length using depth gauze. 2 screws, one dynamic & one static.
Distal locking by using a freehand technique after "perfect circles" are obtained by fluoroscopy. Screws are placed after drilling through drill bit & calculating length using depth gauze. 3 screws-2 lateral & 1 Anterior-posterior. Proximal end, fracture site & distal end was checked in C-Arm.
The same combination of antibiotics which is used prophylactically before surgery is used for 48 hours postoperatively in standard doses.
All patients in our study is been treated with physical methods such as early mobilization, manual compression of the calf and elastic stockings. Patients had been encourage to do ankle, calf & Knee Range of motion exercises from day one and mobilized weight bearing from the second postoperative day depending upon the physical condition of the patient. Drains, if any had been remove by 48 h. The wounds will be inspected on the 2nd and 6th post-operative day. Stitches were removed on the 15th day.
Patients were followed up at one monthly interval till fracture union and then at 6 monthly interval for 1 year and then at yearly interval.
No sign or minimal sign of union at end of 12th week was considered criteria for dynamization. Which was done by removing the proximal dynamic screw.
At every 3rd month, 6th month, 9th month functional outcome will be analyzed using **Lysholm Score**. The data collected will be evaluated using appropriate statistical tests.
To describe the data minimum, maximum, mean, range & standard deviation or medians has been reported for continuous variables. For categorized variable, percentage has been used. To determine the statistical significance of categorical data (non-numerical data) paired "t" test statistic has been used to investigate whether distributions of categorical variables differ from one another. Level of significance is set at $p<0.05$.

Observation & results

Observation and analysis of result were done in relationship to the Age, Sex, Occupation, residence, Mode of trauma, Side affected, type of fracture, level of fracture, associated co-morbidity, associated any injury, union time, functional outcome & complication.

Site of Injury:

Table 1: Distribution of patients according to site of injury (N=56)

Site of Injury	Number	Percentage
Lower 1/3rd	29	51.8
Middle 1/3rd	21	37.5
Upper 1/3rd	1	1.8
Segmental	5	8.9
Total	56	100.0

Gustilo-Anderson Classification:

Table 2: Distribution of patients according to Gustilo-Anderson Classification (N=56)

Gustilo-Anderson Classification	Number	Percentage
None	45	80.4
G-I	1	1.8
G-II	6	10.7
G-IIIA	1	1.8
G-IIIB	3	5.4
Total	56	100.0

Side involved:

Table 3: Distribution of patients according to side involved (N=56)

Side involved	Number	Percentage
Left side	33	58.9
Right side	23	41.1
Total	56	100.0

Dynamization:

Table 4

Dynamization	Number	Percentage
No	33	58.9
Yes	23	41.1
Total	56	100.0

Lysholm Score:

Table 5: Mean Lysholm Score at 3 months, 6 months and 9 months (N=56)

Lysholm Score	Number	Mean ± SD
At 3 months	56	75.54 ± 6.16
At 6 months	56	87.84 ± 4.47
At 9 months	56	95.39 ± 3.09

Results

Table 6: Distribution of patients according to results at 9 month (N=56)

Result at 9 month	Number	Percentage
Fair	1	1.8
Fair to Good	3	5.4
Good to Excellent	39	69.6
Excellent	13	23.2
Total	56	100.0

Discussion

The Tibial anterior surface is subcutaneous most of its length, thus open fractures are more common in the tibia. The blood supply to the tibia is more precarious than that of bones enclosed by heavy muscles thus incidence of delayed union and non-union is higher as compared to other long bones. The tibia bone during injury not only suffers the insult of bending force but also the rotation injury. The knee and ankle joints are hinge joints thus they do not allow rotational compensation, so during correction care should be taken, to correct the rotational alignment as much close to normal anatomy.

In Our study we studied 56 patient with tibia shaft fracture including closed & open fracture occurred between year 2011 to 2015.

Mode of injury: On analysing the mode of injury road traffic accidents were found to be the main culprit as it contributed to 83.9% of total cases, other includes the fall from height (12.5%) & slip at home (3.6%).

Occupation wise distribution: In our study we found that 57.2 % were working class population which includes shopkeeper, businessman, farmer, painter, service man. 19.6% were students. 21.4 % were house wives. 3.6 % people were those who belongs to non-working class.

Site of injury: Among 56 tibia fractures 51.8 % were the lower 1/3rd shaft of tibia. 31.5% were middle 1/3rd shaft of tibia fracture. 1.8 % upper 1/3rd shaft of tibia fracture. 8.9 % are segmental fracture.

Limb involved: In our study the left side was involved in 33 cases which is more commonly i.e. 58.9 % & right side was involved in only 23 cases i.e. 41.1 % of total cases.

Distribution according to classification

In 56 tibia shaft fractures according to AO classification 19 (33.9%) were spiral fractures of Tibia shaft i.e. AO type 42.A1, followed by 13 (23.2%) oblique fracture >30^0 angulation i.e. AO type 42.A2. There were 6 (10.7%) transverse fracture. 4 cases with spiral wedge (AO type 42.B1) & 4 were bending wedge AO type 42. B2 which contributes to 7.1% each. There were 4 cases (7.1%) with segmental tibia fracture i.e. AO type 42.C2. We found 4 cases (7.1%) with Irregular i.e. comminuted fractures. In 2 cases we found fragmented wedge fracture of tibia shaft fracture.

In our study 45 cases were closed tibia fractures which includes 80.4 % of total cases. Open tibia fractures were present in 13 cases only contributed to 19.6% of total cases.

Among closed fractures majority (62.5% cases) suffered grade II soft tissue injury & 17.9% suffered grade I injury. According to Tscherne classification.

Open tibia fractures were present in only 13 cases contributed to 19.6% of total cases. 6 cases suffered Grade II injury i.e. 10.7% of total cases. 3 suffered Grade III B injury. 1 case had Grade I & 1 case had Grade III A Injury according to Gustilo-Anderson classification. Alho et al.[21] studied 93 cases, and found 19 with open grade I to II. Karladani et al[24] in their study of 104 tibial fractures found 22 open fractures.

Dynamization: 23 patients out of 56 were treated with dynamization. The mean time of union post-dynamization was 6.86 weeks with one nonunion.

Reaming: Bhandari M et al[30] in 2008 did a randomised controlled trial of 1319 patients for reaming versus nonreaming and found no significant difference between the same at end of one year. YuGuangshu et al[31] did a meta analysis of 985 patients (475 in the unreamed group and 510 in the reamed group) and he also found no clinical difference between the same although he found significant higher fixation failure rate in nonreamed cases**.** Thus in all our cases we used reaming.

Functional outcome using Lysholm score: We evaluated patient using lysholm score at 3 months we found that mean lysholm score was 75.54, which has increased in 6 months to 87.84. At the end of the study we found score further increased to 95.39. All data were statistically analysed using paired 't' test.

Final Result

In study of 56 case of tibia shaft fractures treated with intramedullary interlocking nail, 39 case (69.6%) result was "Good to excellent", In 13 patient (23.2%) results were "Excellent". 3 patients (5.4%) had "fair to good "result. 1 patient had "fair" result. We found no case with poor results.

Bone et al[5,6] used Medical Outcomes Study Short

Form-36 Health Survey to the twenty-five matched pairs of patients yielded scores that were significantly better after nailing than after treatment with a cast, a mean of 85 points compared with a mean of 74 points.
Klemm et al[4,7] 97% of femur and 94.3 % of tibia had excellent or good results after treatment with intramedullary nailing.
Govender et al[63] used Bone Morphogenetic Protein-2 (rhBMP-2) & found rhBMP-2 group notonly had a 44% reduction in the risk of failure but also significantly faster fracture-healing (p = 0.0022) than did the control patients.

Fig. 1: Pre Operation

Fig. 2: 3 months after nailing

Fig. 3: 8 weeks post-dynamization

Distribution according to time for union

In our study mean time for fracture to unite is 18.02 ± 3.64 weeks.
Sarmiento et al[20] studied 780 tibia fracture treated with functional cast brace closed fractures healed in an average of 17.4 weeks and open fractures in an average of 21.7 weeks
Karladani et al[24] in 61 fractures the mean healing time was 17 weeks, & in 27 cases delayed union was seen with a mean of 35 weeks.
Im et al[2,6] studied distal metaphysis fracture treated with closed intramedullary nail in group 1 & plating in group 2, they found mean period of union was 18 weeks in group 1 & 20 weeks in group 2.

Conclusion

Dynamization increases the pace of fracture healing in delayed uniting fracture. Intramedullary interlocking nails shows good to excellent results in the treatment of diaphyseal fractures. Distal tibia shaft fracture are more common followed by middle 1/3rd.

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