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Original Research Article

FUNCTIONAL OUTCOME OF TIBIAL SHAFT FRACTURES TREATED WITH REAMED AND LOCKED INTERLOCKING NAILING - A RETROSPECTIVE STUDY

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ABSTRACT

Background: Tibial fractures are among the most frequently seen injuries that an orthopaedic surgeon comes across day to day in their practice. Throughout the years, various treatment methods have been employed to treat tibial fractures. Currently, the principles of biological osteosynthesis supports the choice of closed intramedullary interlocking nailing. While arguments for and against reaming the canal are persuasive, evidence of the impacts of these biologic alterations on outcomes that are important to patients would be a more compelling data in guiding clinical practice. The objective is analyse the functional outcome of reamed and interlocked intramedullary nails in the management of tibial diaphyseal fractures.

Materials and Methods: Study Design: A Retrospective hospital based Observational study. Study area: The study was conducted in the Department of Orthopaedics, KMCH. Study Period: 2 years (May 2022 to April 2024). Study population: Tibial shaft fractures between 5cm from knee and ankle joint treated with reamed and interlocked nails. Sample size: Total of 30 subjects. Sampling Technique: Convenient sampling.

Results: In our series of 30 subjects with tibial fractures, average age was 36 years, 80% were closed fractures and majority (97.7%) were from RTA. Nails used were stainless steel (50%) and titanium (50%) of diameter 8-10 mm and length of nail ranged between 280-360 mm. All nails were locked in static mode and all fractures, both closed and open, were reamed. 20 cases were operated on within the first 48 hrs post injury while 10 cases were operated on within 2 weeks. Mean operating time was 60 min. 66.6% patients were fully weight bearing between 12-16 weeks and average fracture healing time was 14 weeks. 2 patients needed dynamisation due to delayed healing. Functional outcome was Excellent/Good in 93.4% and Fair in 6.6% with no poor result.

Conclusion: The reamed and interlocked nailing system has emerged as a highly effective and reliable method for the management of tibial diaphyseal fractures offering superior stability through bigger diameter nails and transverse locking screws. It ensures control over limb length, alignment and rotation, thereby addressing the critical need for early bone healing and better overall functional outcome to the patient. The system's ability to facilitate early weight-bearing and joint movement significantly decreases patient morbidity and dependency, while also minimizing complications such as infection, non-union, malalignment and refracture.

Keywords: Tibial fractures, Reamed and interlocked, Intramedullary Nail, Functional outcome.

INTRODUCTION

Tibial fractures are among the most frequently seen injuries that an orthopaedic surgeon comes across day to day in their practice. Tibial fractures often presents as open fractures, primarily because it is close to the skin with annual fracture incidence of 2 per 1000 people.[1] The tibia has a relatively inadequate blood

supply, making complications and significant disabilities common repercussions.[2,3] The techniques employed for achieving skeletal stabilization differ markedly based on the fracture line configuration and the geographical location of the surgeon's practice.[4]

As this bone is located just below the skin and has minimal protection from surrounding muscles. Throughout the years, various treatment methods have been employed. The internal fixation devices employed included rush nails, Kuntshner nails, dynamic compression plates/screws fixation and intramedullary nailing. Intramedullary interlocking tibial nailing (IMIL) offers biological and biomechanical benefits compared to plate osteosynthesis and is typically carried out with the aid of an image intensifier.[5] Surgeons agree on the benefits of operative treatment of tibial fractures with an intramedullary nail. Rates of re-operation remain high between 23% and 60% in prior trials and the two alternative nailing approaches, reamed or non-reamed, each have a compelling biological rationale and strong proponents, resulting in ongoing controversy regarding which is better.[6]

Interlocking intramedullary nailing of the tibia significantly enhances rotational stability and is applicable for axially unstable fractures found between 7cm below the knee joint and 4cm above the ankle joint.[7,8] Intramedullary nails designed with interlocking features were introduced to ensure a more stable fracture fixation and to broaden the range of fractures that could be treated with nailing while minimizing the risks of malunion.[9] Experimental data suggest that reamed nails offer greater biomechanical stability and increased soft tissue blood flow, while non-reamed nails preserve blood flow to the bone. While both arguments are persuasive, evidence of the impacts of these biologic alterations on outcomes that are important to patients would be more compelling data in guiding clinical practice.

Objectives: Analyse the functional outcome of reamed and interlocked intramedullary nails in the management of tibial diaphyseal fractures.

MATERIALS AND METHODS

Study Design: A Retrospective hospital based Observational study.

Study area: The study was conducted in the Department of Orthopaedics, KMCH.

Study Period: 2 years (May 2022 to April 2024)

Study population: Tibial shaft fractures between 5cm from knee and ankle joint treated with reamed and interlocked intramedullary nail.

Sample size: The study consisted of a total of 30 subjects.

Sampling Technique: Convenient sampling

Inclusion Criteria

1. Fracture at least 5 cm away from knee and ankle joints.
2. Closed and open tibial shaft fracture (grade I, II).

Exclusion criteria

1. Patients with grade III a,b,c open fracture and those with a fracture <=5cm from knee and ankle joint.
2. Patients with limited pre-fracture level of activity.
3. Patients with manifested local infection.

Ethical consideration: Institutional Ethical Committee permission was obtained before the commencement of the study.

Study tools and Data collection procedure: Evaluation of all case notes were done and documentation collected for age, sex, mode of injury, smoking, diabetic status, side of injured limb, open/closed fracture, location and type of fracture, associated fracture, days to surgery from injury, make of nail, length and diameter, duration of surgery, duration of admission, peri-operative complications, non weight bearing and full weight bearing status, secondary surgical procedures, bone healing time and functional outcome by Johner-Wruh's criteria based on pain, gait, activity level, joint (knee, ankle, subtalar) ROM, malunion (varus/valgus, recurvatum/procurvatum, rotation, shortening) and any neurological complication.

Statistical analysis: The data obtained was coded and entered into a Microsoft Excel spreadsheet. The categorical data was expressed as rate, ratio and percentage. The continuous data was expressed as mean ± S.D. Fisher's exact test was used to find the association between categorical data. A 'p' value of less than or equal to 0.05 was considered statistically significant.

RESULTS

In our series 66.66% were males and the rest were females and the average age was 36 years involving the right more than the left. 5 patients (17.7%) were smokers and 3 patients (10%) were diabetic, of which one patient was pre-diabetic.

Table 1: Demography Distribution.

Sex	Numbers	Percentage
Male	20	66.66%
Female	10	33.33%
Total	30	100%

Table 2: Type of Fractures

Type	Numbers	Percentage
Closed	24	80%

Open (Gustile et. al)		
Grade-I	4	13.3%
Grade-II	2	6.6%
Grade-III	-	-
Total	30	100%

In our series closed (24) and open (6) fractures were studied. The soft tissue injuries were classified according to Gustilo Anderson classification. There were 80% closed fractures and 20% of open fractures. About 97.66% of the fractures in our series were due to road traffic accidents and most of the fractures were caused by high-energy trauma.

For description the tibia was divided into three zones of equal length, proximal 1/3rd, middle 1/3rd and distal 1/3rd. Middle 1/3rd fractures were 17 (56.6%) cases, which were most common, followed by lower 1/3rd 10 (33.3%) cases and upper 1/3rd 3 (10%) cases. Most tibial fractures (90%) in our series were associated with fibula fractures, except 3 cases. Thirteen fractures were transverse, eleven were oblique, three were comminuted, two were spiral and one segmental fracture. The time from admission to the surgery ranged from 24 hours to 2 weeks. 20 cases were operated on within the first 48 hrs post injury while 10 cases were operated on within 2 weeks.

Table 3: Nail length and Size

Length	Numbers	Percentage
28	1	3.3%
30	4	13.3%
32	13	43.3%
34	11	36.6%
36	1	3.3%
Total	30	100%

In our series we used both Stainless steel (15 cases) and titanium (15 cases) interlocking nails of diameter 8-10 mm and length ranged from 280-360 mm. The site and fracture geometry dictated the choice of the locking mode proximally or distally. All nails were locked in static mode. No fracture was left unlocked. All closed fractures and open fractures were reamed. The mean operating time was 60 minutes (range 45-90 min).

Duration of hospitalization: The duration of hospitalization ranges from 1-3 weeks and the maximum number of patients (20 patients, 66.6%) were discharged within 1 week.

Table 4a: Non weight bearing walking

Duration	Numbers	Percentage
< 1 week	13	43.3%
1-3 weeks	16	53.3%
After 3 weeks	1	3.3%
Total	30	100%

Table 4b: Full weight bearing walking

Duration (Weeks)	Numbers	Percentage
12-16	20	66.7%
17-21	8	26.7%
22-30	2	6.6%
Total	30	100%

Weight-bearing was dictated by the fracture pattern, size of the nail and associated injuries. Full weight-bearing mobilisation was dependent upon clinical and radiological evidence of healing. Fracture healing time of the patients in our series between 8-12 weeks were 10 cases (33.3%), between 12-16 weeks were 13 cases (43.3%), and 16-20 weeks were 6 cases (20%) and 1 case (3.3%) took 30 wks. Average healing time was around 14 weeks. Patients who had shown delayed healing at 16 weeks were dynamised (2 patients, 6.6%).

Table 5: Functional Result
Johner-Wruh's (1983) Evaluation Criteria[10]

		Excellent	Good	Fair	Poor
1	Non union, osteitis, amputation	None	None	None	Yes
2	Neurovascular disturbances	None	Minimal	Moderate	Severe
3	Deformity – varus / valgus in degrees	None	2-5	6-10	>10
	Anteversion/recurvation in degree	0-5	6-10	11-20	>20
	Rotation – internal/external in degrees	0-5	6-10	11-20	>20
	Shortening (in mm)	0-5	6-10	11-20	>20
4	Knee ROM (in %) Ankle ROM (in %)	Normal Normal	>80% >75%	>75% >50%	<75% <50%

	Subtalar joint ROM (in %)	Normal	>75%	>50%	<50%
5	Pain	None	Occasional	Moderate	Severe
6	Gait	Normal	Normal	Insignificant Limp	Significant Limp
7	Strenuous activity	Possible	Limited	Severely limited	Impossible
	In our cases	20	8	2	0
	%	66.6%	26.6%	6.6%	0%

In our study, the functional results were excellent in 20 cases (66.6%), good in 8 cases (26.6%), fair in 2 cases (6.6%).

Objective evaluation:

a) Peri-operative complications: No peroneal nerve palsy encountered in this study group.

b) Wound healing: - Almost all wounds healed within 2 weeks except for two patients with diabetes who had superficial infection which took 3-4 weeks.

c) Union: - Union was defined as the presence of a bridging callus on two radiographic views and the ability of the patient to bear full weight on the injured extremity if other injuries allowed.
   - All 30 fractures united
   - The time to union ranged from 10-30 weeks with an average time of 14 weeks.

d) Range of motion: - Data on the range of motion of the knee flexion averaged 130 degrees. The motion of the ankle averaged 20 degree of dorsiflexion and 30 degree of plantar flexion.

e) Infection: - There were 2 cases of superficial infection, which were resolved with dressing and antibiotics. Culture and sensitivity showed Staph.aureus and was sensitive to third-generation Cephalosporins.

f) Malunion:- Malunion was defined as a varus or valgus angulation of >5 degree, anterioposterior angulation of more than 10 degrees and shortening of >1 cm. Malrotation was evaluated by comparing the amounts of internal and external rotation of the injured extremity with those of the uninjured extremity, provided the other extremity is not affected by any fracture or disease. There were no rotational deformities.

g) Implant failure: - Implant failure in the form of breakage of locking screw or nail. There were no evidence of any breakage of a screw or nail in the study period.

DISCUSSION

Our current research involved 30 reamed and locked intramedullary nailing procedures performed on unstable tibial diaphyseal fractures. The most prevalent treatment method for tibial fractures has been the application of plaster casts; however, this approach comes with several drawbacks such as shortening, angulation, malunion and extended immobilization. Immobilization of of one joint above and below the fracture using a plaster cast should be limited to stable fractures with minimal soft tissue damage.

Using a plate can offer rigid fixation for unstable fractures, which can mitigate issues related to malunion and nonunion. Nonetheless, the soft tissue stripping required for plate application has resulted in an unacceptably high incidence of infection and delayed healing of wounds. The comparatively increased risk of infection makes plate usage an undesirable treatment option. Open tibial shaft fractures have historically faced challenges associated with nonunion and infection. Presently, external fixation is the most widely approved technique for stabilizing grade II and grade III open fractures of the tibial shaft. While an external fixator stabilizes the fracture fragments, it carries disadvantages such as pin tract infections, nonunions, shortening, potential loss of reduction after the fixator removal, and poor patient compliance. Interlocking intramedullary nailing addresses these issues effectively as it allows for control over length, angulation, and rotation.

Our present study included 30 fresh fractures in 30 cases. 24 closed and 6 open fractures. Halil BURC et al.[11] Studied 73 patients with fresh fractures, 28 (38.4%) closed, open 45 (61.6%) Grade I 30 (41.1%). Grade II 10 (13.7%), Grade IIIA 5 (6.9%). Court-Brown study,[12] included 50 fresh fractures and closed C1 group tibial fractures. Finkemeier study included 94 fresh fractures in 90 patients, 49 (52.1%) closed fractures, and 45 (47.9%) open fractures.

In our present study, 14 (46.6%) were Motor Vehicle Accidents, 9 (30%) for Motor Cycle Accidents, 6 (20%) were pedestrian accidents, and 1 (3.3%) was due to fall from height. 66.6% of the cases were in males and the rest in females (33.3%), highlighting the fact that males being mobile in society are more prone to traffic accidents. The median age was approximately 36 yrs in our study correlates to the fact that the younger population is at increased risk of sustaining tibial fractures thereby causing a loss of livelihood from the breadwinner being injured. Halil BURC study,[11] included RTA 47 (64.38%) cases, fall from height 11 (15%), and direct trauma 15(20,5%) patients. 68 males (93.2%), females 5 (6.8%). Median age 31 years (range 17-68yrs). In the Court Brown study,12 5 pts RTA in each group, remaining were low energy injuries. The average age was 35 years in reamed and 36.1 years in unreamed. Males 78% in reamed and 68% males in undreamed. Finkemeier study,[13] included 21 patients with motor vehicle accidents, 15 patients with pedestrians, 10 patients with motorcycle accidents, 26 patients falling from height, 10 patients with assault injuries, 3 patients with low-velocity gunshot wounds, 2 pts industrial accidents, 2 pts riding a slow mobile/jet sky. 74 males, 16 females. Average age 33.8 years

(range 16-88 years). In our present study, 8 cases had significant associated injuries. In Halil BURC study,[11] 24 cases (32.8%) were associated with other injuries. In the Court brown study12, 1 patient in each group had associated injuries.

In our present study closed nailing was done in 25 cases (83.3%) and open nailing was done in 5 cases (16.6%). Open nailing was done in 3 cases due to difficulty in closed reduction (wedge fragment obstructing the guide wire), and in two grade II open fracture cases. In all fractures, the reaming and static locking was done. In Halil BURC study11 56 cases (75.5%) had closed nailing, 17 cases (24.5%) had open reduction. In the Court Brown study12 25 pts were treated with reamed intramedullary, and 25 pts were treated with unreamed nailing. All were statistically locked.

In our present study, there were 2 cases of delayed union, which were united after dynamization. We did not encounter any non-union in our study. The rate of nonunion is negligible in locked intramedullary nailing as compared to functional bracing or plate osteosynthesis. In Halil BURC the average time for union was 18.2 weeks(8-52 weeks). No nonunions. In 4 of 73 cases, dynamization was performed at an average of 18 weeks (range 16-24 weeks) due to delayed union.

In our study 93.3% of fractures united without shortening. We had 2 cases of shortening of about 1-1.5 cms, one case had a communicated fracture and another case had ipsilateral supracondylar fracture of the femur on the same side. The axial and rotational malalignment were minimal in our study. In our study, the median time for full weight bearing was 14 weeks, which was the same as the mean fracture healing time. In our study results were according to Johner-wruh's (1983) Evaluation Criteria, 20 cases (66.6%), were excellent, 8 cases (20.6%), were good, and 2 cases (6.6%) were fair.

Results were comparable with that of the previous such studies. In the study of Halil BURC11 results are very good in 45 patients (61.6%), and good in 28 patients (38.4%), according to Johner-Wrush evaluation criteria. Reamed and Interlocked nails provide the ability to control length angulation and rotation and thus have advantages of early mobilization of the patient, reduced morbidity and decreased time for union with extremely low rates of complications. Due to the above advantages, the indications are being widened for reamed, locked interamedullary nail and has become the treatment of choice for unstable tibial diaphyseal fractures. In our study we had equal split of titanium and stainless steel nails and this did not affect the outcome. However one should keep in mind the affordability of the patient, expertise, familiarity of the procedure and the availability of facilities.

CONCLUSION

The reamed and interlocked nailing system has emerged as a highly effective and reliable method for the management of tibial diaphyseal fractures offering superior stability through bigger diameter nails and transverse locking screws. It ensures control over limb length, alignment and rotation, thereby addressing the critical need for early bone healing and better overall functional outcome to the patient. The system's ability to facilitate early weight-bearing and joint movement significantly decreases patient morbidity and dependency, while also minimizing complications such as infection, non-union, malalignment and refracture.

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