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A case control study to compare the effect of dynamisation of tibia nail in union of tibia shaft fracture versus non-dynamisation

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ABSTRACT

Background: Tibial shaft fractures are commonly treated with intramedullary nails (IMN), with union rates of 90-100%, but complications such as delayed union occur in up to 40%. The rise of technology and urbanization has led to an increase in road traffic injuries and deaths. The treatment of distal tibia fractures has undergone various modifications over the years, with emphasis on preserving local biology and soft tissue handling.
Methods: A retrospective case-control study involving 132 patients with closed or open grade 1 tibia shaft fractures was conducted from September 2021 to May 2022. Patients received tibia IMN with either dynamic locking (group A) or static (group B). Patients were evaluated for fracture healing and clinical condition, with variables including presence or absence of union and time to union. Follow-up clinical evaluations were conducted monthly for six months.
Results: The association between union of bones seen at 1.5 and 3 months between group A and group B was extremely statistically significant (p<0.0001).
Conclusions: Intramedullary nailing with dynamic nailing assemblies is safe and effective for closed or type I open tibial fractures with limited comminution. This approach may reduce complications and re-operations and allow for early weight-bearing. Proper management of tibial fractures requires an interprofessional team.

Keywords: Tibial fractures, Intramedullary nailing, Dynamisation, Union, Complications

INTRODUCTION

Tibial shaft fractures are the most common long-bone fractures. The extramedullary blood supply of tibia, especially of the mid one third and distal one third is of particular importance in fracture healing. The anterior and posterior tibial arteries supplies the exterior 1/10th to 1/3 of the tibial cortex whereas the interosseous blood vessels supply the remaining inner 1/3 cortex.[1]

Since its introduction, intramedullary nailing (IMN) has become the treatment of choice for most of them. The reported union rates achieved with IMN are 90-100%. Typically involve high-energy mechanisms such as road traffic accidents (incidence 43%) or sports.[2] The rate of complications like delayed union (a complication attributed to fracture morphology, soft tissue damage, and the surgical technique used) goes up to 40%. Nailing exchange, fibular osteotomy and dynamization (either as single or combined procedures) are some of the available treatment options to deal with these complications. Dynamization consists in the removal of a statically locked screw to allow controlled transmission of axial loads to the fracture site. This enhances bone contact between bone fragments, stimulating osteogenesis. The reported union rate of nail dynamization varies from 19% to 100%.[3] Under developed and developing countries account for 91.8% of DALY’s lost to road traffic injuries worldwide.[4] It was in 1969 the treatment of distal tibia fractures got revolutionized by the study done by Reudi and Allgower where 74% of patients after surgery were pain free with good functional outcome at 4 years follow-up. Therefore, in 1970's and 80's widespread use of internal fixation for distal tibia fractures became popular. The new techniques used were intra medullary nailing (IM nailing), hybrid fixators and biological minimally invasive plate osteosynthesis (MIPO).[3] The special triflanged nails for treating fractures of femur and tibia were invented by Lottes, in 1950.[4] Modification of the straight Kuntschners nail to a nail with proximal bend was done by Herzog, in mid-1950 to accommodate the eccentric proximal portal. Grosse et al in 1970, developed nails with interlocking nails which expanded the indications for nailing to include more proximal fractures, distal fractures and unstable fractures. The invention of locked IM nailing, which was based on the development of the Kuntschner 'detensor' nail and described by Kempf et al, was a major breakthrough. Closed nailing preserved the soft tissue attachment of fracture fragments, which in turn preserved their blood supply. Fracture union after closed nailing was rapid with abundant callus formation.[5] A study by Duygun et al aimed to investigate the effects of different amounts of compression used in IMN on the stress values of the fracture surface and time of the union process in tibia diaphysis fractures treated with IMN.[6] A study by Somani et al compared static vs dynamic intramedullary nailing of tibia. The mean time to union was 21 weeks in the dynamic group and 26 weeks in the static group.[7] A strong trend was seen in favour of the dynamic nailing group ($p<0.01$) statistically significant difference was observed. The union is caused by periosteal callus and takes a slightly shorter time to be accomplished. In experiments in which periosteal blood flow was suppressed and endosteal circulation remained intact, endosteal callus formed but the union was delayed. This correlated with the findings of Tonna et al study of the cellular response to fracture.[8] They noted that maximum proliferation was seen in periosteum 32 hours after fracture. The contributionof the peripheral vessels to the organization of the callus is much earlier and much greater than that of endosteal vessels. Moreover the suppression or severe decrease of the bone marrow blood flow seems to activate the periosteal circulation, thus paradoxically, the rate of consolidation is higher than it otherwise would be.[9] Another study by Kumar et al has confirmed that fibular fixation in the setting of IM nailing reduces malunion and angular displacement.[10] Selection of appropriate nail length can be done preoperatively by measuring the medial joint line to tip of medial malleolus in the uninjured limb.[11] Distal metaphyseal tibia fractures are not so common. In a series of analysis of 5953 fractures, Court-Brown et al reported 0.7% of fractures only of the distal tibia.[12] Totally, they accounted for 13% of all tibia fractures. Fan et al also evaluated fractures of distal tibia and found it to be only 10% of all tibia fractures.[13] Multiple techniques exist to add stability to these constructs like fibular fixation, blocking or Poller screws, multiplane distal locking screws.[14] Angle stable locking screws when compared to conventional screws have a larger diameter near the head of the screw. These angle stable screwshave a sleeve that expand to fit the interlock of the nail, creating an angle stable interface between the nail and the cortical screw. Biomechanical studies have demonstrated improved structural stability of the construct with the use of angle stable screws.[15]

Objectives

Objective of the research was to study the effect of dynamisation on the rate of fracture healing by evaluating whether union of the fracture occurred and comparing time to union between dynamisation and non dynamisation.

METHODS

Study design, duration and location

The study is a retrospective type of case control study which included 132 patients where cases are the patients who have undergone dynamisation of tibia nail at the onset of surgery and controls are patients who have not undergone any dynamization conducted from September 2021 to May 2022 at Topiwala National Medical College and B.Y.L. Nair Charitable Hospital, Mumbai, Maharashtra, India.

Inclusion criteria

Patients with age more than 18 years, all skeletally matured patients with tibial diaphyseal fractures (fracture at any level of diaphysis), closed tibia fractures and open Gustilo-Anderson type 1 fracture, tibial diaphyseal fracture confirmed with appropriate radiographs, patients who are medically fit for surgery, and patients and/or his/her legally acceptable representatives willing to provide voluntary written informed consent for participation in the study were included.

Exclusion criteria

Patients with associated intra-articular fractures of proximal/distal tibia, open tibia fractures (Gustilo Anderson type 2 and type 3), tibial diaphyseal fracture with associated tibial plateau fracture, patients not willing for surgical intervention, and patients not willing to provide voluntary written informed consent for participation in the study were excluded.

Procedure

This study was conducted during the period of September 2021 to May 2022. This is a retrospective case control study where patients will be enrolled as per eligibility criteria. Data of 132 patients suffering from closed and open grade 1 tibia shaft fractures operated for tibia intramedullary interlocking nailing (static/dynamic) from September 2021 to May 2022 will be selected. This will be divided into 66 cases operated with dynamic mode of tibia nail locking and 66 controls with static mode of tibia nailing. These patients will be requested to come for study visit to evaluate their fracture healing and clinical condition. These patients will be evaluated at the visit for their healing of the fracture with help of following variables: whether union is present or absent, and the rate of union by comparing time to union between 2 groups. Follow up clinical evaluation will be made at 6 weeks,12 weeks and 24 weeks which will be noted and data at the end of 24 weeks will be analysed for the study.

Statistical analysis

The collected data was coded and entered in Microsoft excel sheet. The data was analyzed using statistical package for social sciences (SPSS) version 20.0 software. The results were presented in tabular and graphical format. For qualitative data various rates, ratios and percentage (%) was calculated. For quantitative data, mean, standard deviation (SD), and median was calculated.

RESULTS

Age and sex distribution - overall

We had 94 males and 38 females in our study. There were 40 males and 20 females in the 30-39 years age group, making it the most common age group in the study population (Table 1).

Table 1: Age and sex distribution.

Count of age (row labels)	Column labels (female)	Male	Grand total
10-19		4	4
20-29	12	27	39
30-39	20	40	60
40-49	5	15	20
50-59		5	5
60-70	1	3	4
Grand total	38	94	132

Groupwise age distribution

We have separately displayed the distribution of patients in the dynamization and the non-dynamisation group to show that the distribution of patients with group and age is comparable.Thus, age will not be a confounding factor in our analyses (Table 2).

Table 2: Groupwise age distribution.

Count of age (row labels)	Column labels (dynamisation)	Non-dynam -isation	Grand total
10-19	1	3	4
20-29	24	15	39
30-39	27	33	60
40-49	10	10	20
50-59	2	3	5
60-70	2	2	4
Grand total	66	66	132

Group-wise sex distribution

The dynamization arm had 20 females and 46 males. This ratio was almost equal in the non-dynamisation arm as well with 18 females and 48 males. Thus, even sex was not a confounding variable (Table 3 and Figure 1).

Table 3: Groupwise sex distribution.

Count of sex (row labels)	Column labels (dynamisation)	Non-dynam -isation	Grand total
Female	20	18	38
Male	46	48	94
Grand total	66	66	132

Nature of injury

RTA was the most common mode of injury having 84 cases out of 132 (64%) (Table 4 and Figures 2 and 3).

Table 4: Nature of injury.

Count of nature of injury (row labels)	Column labels (dyna-misation)	Non-dynam -isation	Grand total
Assault	6	5	11
Fall	3	6	9
Fall of an object	2	4	6
Farming injury	5	6	11
Industrial injury	4	2	6
RTA	44	40	84
Sports injury	2	3	5
Grand total	66	66	132

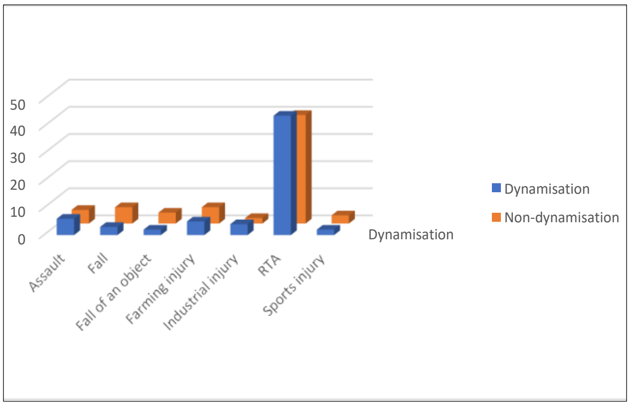

Figure 1: Proportion of type of injury.

Type of fracture

Most of the fractures were of closed type i.e. 129 patients which constituted 93% cases. Remaining 7% were open type 1 fractures. Type 2 and 3 open fractures were not in the inclusion criteria of our study.

Table 5: Type of fracture.

Count of type of fracture (row labels)	Column labels (dyna-misation)	Non-dynam -isation	Grand total
Closed	58	65	123
Open type 1	8	1	9
Grand total	66	66	132

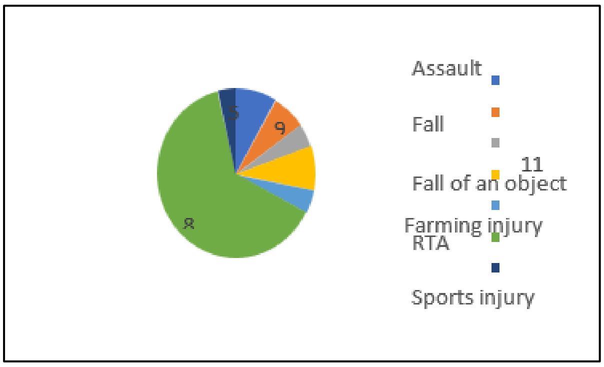

Figure 2: Proportion of nature of injury.

Figure 4 (a and b): Preoperative radiograph of a 38-year-old male presenting with left closed distal tibia with segmental fibula fracture.

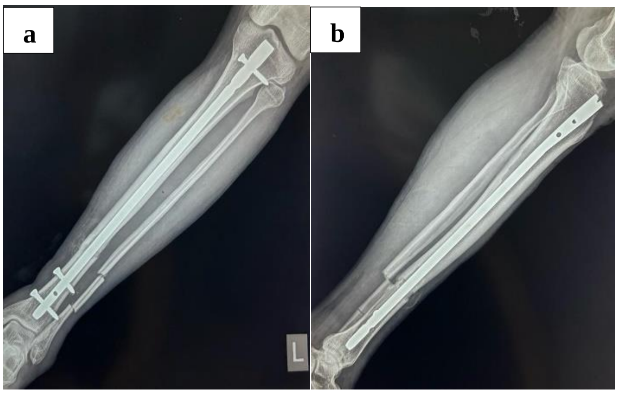

Figure 5 (a and b): Immediate post-operative radiograph of the patient operated with left tibia intramedullary nailing with dynamic locking.

Figure 6 (a and b): 6 months follow-up X-ray showing substantial callus formation with fracture union in distal tibia and fibula.

DISCUSSION

During the past 3 decades, the incidence of colorectal cancer was at a low level in urban and rural populations in India, in comparison with figures observed in developed countries of North America and Europe.[6] Significant advances have been made in the study of colorectal cancer during the last few years. A more thorough understanding of the molecular basis for this disease, coupled with the development of new therapeutic approaches, has dramatically altered the way in which patients are managed.[7] We are in a unique electronic age with access to a plethora of sources of medical information, so the vehicles we use to keep up-to-date must change as well, and this text is no different.[8]

Sex

Predominant male involvement was seen in this study which can be attributed to more outdoor activities and heavier labor undertaken by males as compared to females in the Indian set up. Similar male involvement has been seen in study conducted by Hernandez-Vaquero et al.[16]

Age

Most patients belonged to the 30-39 years age group, with the two adjoining classes also having 2nd and 3rd highest number. Most trauma cases are seen in this age group.

Mode of injury

Road traffic accidents constituted the most common causes of trauma leading to tibia fracture which is similar to all the published studies in literature.

Type of injury

Most of the fractures of tibia (more than three quarters) were of the closed type, in line with data present in literature.[17]

Site of injury

Tibia shaft fractures are the most common site of fractures, as seen in our study as well wherethe middle+lower third was the most common site of fracture.[18]

Union

In present study, the dynamic group exhibited a faster time to union and showed a smaller number of biological complications, and the results were statistically significant, compared to thestatic group. Similar results of better union with dynamization have also been observed by in various studies which have been effectively summarized in the systematic review and meta- analysis by Loh et al.[19]

Weight-bearing as tolerated length stable, extra-articular, transverse shaft fractures, and non- weight bearing for unstable, oblique, or comminuted fractures for 6 weeks in the extra-articular setting and 12 weeks when the joint surface is involved, is the recommendation.

Limitations

This study has certain limitations, notably its retrospective design, which limits control over all variables. To mitigate this, we confined the study to a single center. Also, this study excludes open tibial fractures (Gustilo grade 2 and above).

CONCLUSION

Dynamic nailing assembly in IMN in closed or type I open tibial diaphyseal fractures with limited comminution (types A and B according to the AO classification) is safe when used for these fracture types. It is possible that dynamic assemblies may reduce time to union, complications, and re-operations, and can facilitate early full weight bearing. Accordingly, our findings support the view that the dynamic mode configuration should be used with the new designs of IMN available. The outcomes are good for simple tibial fractures but complex fractures can result in residual pain, prolonged wound healing and difficulty with gait

The management of tibial fractures requires an interprofessional team that includes an orthopedic surgeon, emergency department physician, radiologist, nurse, and a physical therapist.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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