A CLINICAL STUDY OF SURGICAL MANAGEMENT OF DIAPHYSEAL FRACTURES OF TIBIA WITH INTRAMEDULLARY INTERLOCKING NAIL
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ABSTRACT: BACKGROUND: Intramedullary interlocking is currently considered the treatment of choice for tibial shaft fractures, with high rates of fracture union, advantage of early stabilization which decreases the morbidity and mortality rate in patients, allows early mobilization, reduces the incidence of infection, malunion, non-union or implant failure. OBJECTIVES: To assess and study diaphyseal fractures of tibia and to evaluate the functional outcome of patients with tibial shaft fracture treated with locked intramedullary nailing. MATERIALS & METHODS: Patients of both sexes belonging to adult age group presenting with fracture shaft tibia to orthopaedic department of Kempegowda institute of medical sciences, Bangalore are admitted from November 2011 to November 2013 and evaluated. Those satisfying our inclusion criteria and are surgically fit are included in this study. All enrolled patients were treated with locked intramedullary nailing of their tibia. A total of 30 cases studied. Final assessment of functional outcome is done using johner and wruh’s criteria. RESULTS: The results of interlocking fracture shaft tibia were excellent in 23 patients (76.67%), good in 5 patients (30%) and fair in 2 patients (6.67%). The average healing time was 20.13 weeks. In our study valgus deformity of 3 degrees (3 patients) and varus deformity of 3 degrees (1 patient) and anteversion of 5 degrees (1 patient) is seen. There were 1 superficial infection (3.33%), 3 patients with anterior knee pain (10%), 2 patients with delayed union (6.67%) and 2 patients with shortening of 1 cm seen (6.67%). CONCLUSION: The method of treatment employing closed intramedullary interlocking nailing to stabilize diaphyseal fractures of tibia is ideal because of its excellent and good results. The method has a long learning curve but with the excellent results. The advantage of rapid rehabilitation and relatively few complications serve to recommend it for wider use.

KEYWORDS: Diaphyseal fractures of tibia; Interlocking; Closed nailing.

INTRODUCTION: With the increasing number of vehicles on roads in India, complex trauma cases caused by road traffic accidents have increased progressively. Being subcutaneous in location, the tibia is the commonest bone to be fractured and seen commonly in orthopaedic practice.

Open fractures are more common, because one third of its surface is subcutaneous throughout most of its length. Furthermore, the blood supply to the tibia is more precarious than that of bones enclosed by heavy muscles. The presence of hinge joints at the knee and ankle allows no adjustment for rotatory deformity after a fracture. Delayed union, non-union and infection are relatively frequent complications especially after open fractures of the shaft of tibia.

Due to its frequency, topography and mode of injury it has become a major source of temporary disability and morbidity.

Hence special care and expertise is necessary when treating such fractures. It requires the widest experience, the greatest wisdom and the nicest of the clinical judgement in order to choose the most appropriate treatment for a particular pattern of injury.
The major goal in the treatment of fracture tibia is achieving functionally useful and stable extremity. Yet the spectrum of injuries to tibia is so great that no single method of treatment is applicable to all fractures. But the drawbacks of prolonged healing time, fracture disease, malalignment and non-compliance of the patient has led to the thought of other modalities of treatment, finally resulting in the use of closed interlocking intramedullary nailing which has given excellent results.

Now-a-days the well laid principle of biological osteosynthesis is rightly applied in long bone fracture healing and hence the selection of closed intramedullary interlocking nailing in this study.

The following study highlights the role of closed interlocking nailing used for treating the fractures of the shaft of tibia.

MATERIALS AND METHODS: Patients of both sexes belonging to adult age group presenting with fracture tibia to Orthopaedic Department of KIMS, Bangalore are admitted from November 2011 to November 2013 and evaluated. Those satisfying our inclusion criteria and are surgically fit are included in the study. This includes a prospective study of 30 cases.

INCLUSION AD EXCLUSION CRITERIA:

Inclusion criteria:
1. >18 years of age
2. Acute fractures of diaphysis of tibia.
3. Closed fractures and gustillo Anderson type 1 and 2 compound fracture
4. Segmental fractures.
5. Communited fractures.

Exclusion criteria:
1. Age <18 yrs.
2. Grade 3 and above gustillo Anderson compound fractures.
3. Associated with head injury.
4. Associated with fractures in any of 4 limbs.
5. Pathological fractures, fracture non-union and delayed union.
6. Patients not willing and medically unfit for surgery.

METHODOLOGY: Patients admitted with fractures of shaft of tibia after meeting inclusion and exclusion criteria are selected for study. After clinical assessment of signs and symptoms, clinical examination and x rays, pre-operative investigations are done. After prior informed consent, a pre-operative anesthetic evaluation is done. Pre-op planning of fixation is made and nail length is measured. Under anesthesia, closed reduction and internal fixation with intramedullary interlocking nails done using c-arm. Post-operatively mobilized without weight bearing on 2nd to 4th day, patients are advised active quadriceps exercises, knee bending exercises, ankle exercises. Partial weight bearing started at 6 weeks. Full weight bearing was possible by 8-12 weeks depending on the fracture configuration, callus response.

Assessment was done at regular intervals of 6 weeks, 12 weeks and 6 months. At each follow-up visit, patient is evaluated clinically, radiologically and complications are noted.

Based on these data the final outcome is assessed according to johner and wruh’s criteria.1
ETHICS: Since closed intramedullary interlocking nailing of tibia is worldwide accepted procedure so there are no ethical issues associated with the procedure. A prior informed written consent is taken for surgery and anesthesia.

RESULTS:

| Age   | Male | Female |
|-------|------|--------|
| 18-29 | 11   | 4      |
| 30-39 | 5    | 1      |
| 40-49 | 4    | 2      |
| 50-59 | 1    | 1      |
| 60-69 | 0    | 1      |
| Total | 21   | 9      |

AGE DISTRIBUTION ACCORDING TO SEX

| Sex    | Cases | Percentage |
|--------|-------|------------|
| Male   | 21    | 70.00      |
| Female | 9     | 30.00      |

SEX DISTRIBUTION

| Mode of injury | Number of patients | Percentage |
|----------------|--------------------|------------|
| RTA            | 26                 | 86.67      |
| Fall           | 4                  | 13.33      |

MODE OF INJURY

| Side incidence | Cases | Percentage |
|----------------|-------|------------|
| Right          | 16    | 53.33      |
| Left           | 14    | 46.67      |

SIDE INCIDENCE

| Type of injury       | Number of patients | Percentage |
|----------------------|--------------------|------------|
| Simple               | 21                 | 70.00      |
| Compound type 1      | 1                  | 3.33       |
| Compound type 2      | 8                  | 26.67      |

TYPE OF INJURY

| Anatomical location of fracture | Number of patients | Percentage |
|---------------------------------|--------------------|------------|
| Upper third                     | 4                  | 13.33      |
| Upper and middle third junction | 1                  | 3.33       |
| Middle third                    | 15                 | 50.00      |
| Middle and lower third          | 3                  | 10.00      |
| Lower third                     | 7                  | 23.33      |

ANATOMICAL LOCATION OF FRACTURE
### Type of Fracture

| Type of Fracture   | Number of Patients | Percentage |
|--------------------|--------------------|------------|
| Transverse         | 7                  | 23.33%     |
| Oblique            | 2                  | 6.67%      |
| Wedge (butterfly)  | 6                  | 20.00%     |
| Spiral             | 2                  | 6.67%      |
| Commuted           | 13                 | 43.33%     |

### Nail Diameter (Mm)

| Nail Diameter (Mm) | Number Of Cases | Percentage | Sex   | Number Of Cases | Percentage |
|--------------------|-----------------|------------|-------|-----------------|------------|
| 8                  | 1               | 6.67%      | Male  | 0               | 0          |
|                    |                 |            | Female| 1               | 100%       |
| 9                  | 7               | 23.33%     | Male  | 0               | 0          |
|                    |                 |            | Female| 7               | 100%       |
| 10                 | 19              | 63.33%     | Male  | 18              | 94.4%      |
|                    |                 |            | Female| 1               | 5.6%       |
| 11                 | 3               | 10.00%     | Male  | 3               | 100%       |
|                    |                 |            | Female| 0               | 0          |

### Nail Length (Mm)

| Nail Length (Mm)  | Number Of Cases | Percentage | Sex   | Number Of Cases | Percentage |
|-------------------|-----------------|------------|-------|-----------------|------------|
| 300               | 2               | 6.67%      | Male  | 0               | ----       |
|                   |                 |            | Female| 2               | 100%       |
| 320               | 7               | 23.33%     | Male  | 0               | ----       |
|                   |                 |            | Female| 7               | 100%       |
| 330               | 5               | 16.67%     | Male  | 5               | 100%       |
|                   |                 |            | Female| 0               | 0          |
| 340               | 11              | 36.67%     | Male  | 11              | 100%       |
|                   |                 |            | Female| 0               | 0          |
| 360               | 5               | 16.67%     | Male  | 5               | 100%       |
|                   |                 |            | Female| 0               | 0          |

### Weight Bearing

| Weeks | Partial wt. bearing No of patients | Full wt. bearing No of patients |
|-------|-----------------------------------|---------------------------------|
| 4 – 8 | 24                                | 0                               |
| 8-12  | 6                                 | 7                               |
| 12-16 | 0                                 | 5                               |
| 16-20 | 0                                 | 14                              |
| 20-24 | 0                                 | 2                               |
| >24   | 0                                 | 2                               |
| Fracture union | Number of patients | Percentage |
|---------------|-------------------|------------|
| 8-12          | 2                 | 6.67%      |
| 12-16         | 5                 | 16.67%     |
| 16-20         | 18                | 60.00%     |
| 20-24         | 3                 | 10.00%     |
| 24-32         | 2                 | 6.67%      |

**RADIOLOGICAL FRACTURE UNION**

| Complications       | Number of patients | Percentage |
|---------------------|--------------------|------------|
| Superficial infection | 1                  | 3.33%      |
| Delayed union       | 2                  | 6.67%      |
| Anterior knee pain  | 3                  | 10.00%     |
| Fat embolism        | 1                  | 3.33%      |
| Shortening          | 2                  | 6.67%      |

**COMPLICATIONS**

| Deformity (in degrees) | Number of patients | Percentage |
|------------------------|--------------------|------------|
| Valgus                 | None               | 26         | 86.67%    |
| Valgus                 | 2-5                | 3          | 10.00%    |
| Varus                  | None               | 26         | 86.67%    |
| Varus                  | 2-5                | 1          | 3.37%     |

**DEFORMITY ASSESMENT**

| Anteversion | Number of patients | Percentage |
|-------------|--------------------|------------|
| None        | 29                 | 97.67%     |
| 0-5         | 1                  | 3.33%      |

| Recurvation | Number of patients | Percentage |
|-------------|--------------------|------------|
| None        | 30                 | 100%       |

**MOVEMENTS**

| Joint | Normal | >80% | >75% | 50-75% | <50% |
|-------|--------|------|------|--------|------|
| Knee  | 24     | 4    | 2    | 0      | 0    |
| Ankle | 25     | 1    | 5    | 0      | 0    |
| Subtalar | 26 | 1    | 3    | 0      | 0    |
**DISCUSSION:** This study includes 30 patients who were admitted to the Orthopedics Wards of Kempegowda Institute of Medical Sciences Hospital, Bengaluru.

This study includes various patterns of fractures, closed as well as open injuries treated by closed method.

**Age Distribution:** In our study, the majority of the patients were in the age group of 18-29 years. There were 15 patients in this age group in our study. The average of the patient in our study was 32.9 years. Diaphyseal fractures of tibia were seen in the younger age group as they are the persons who are physically active, were engaged in increased various outdoor activities and as a result most of the injuries sustained were high-velocity injuries.

Arne Ekeland et al in a study series of 45 patients noted the average age of patients to be around 35 years.2

Court Brown et al noted the average age to be 32.4 years. Average age was seen to be around 37 years in a study by Court Brown et al in 1995 in a study titled “The Epidemiology of Tibial Fractures”.3

Our study with an average age of 32.9 years is comparable to the study, with respect to the average age of the patient in fractures of the tibial diaphysis.

**Sex Distribution:** In our study, males predominated the females. There were 21 male patients (70%) and 9 female patients (30%). The incidence of males is higher because of their more outdoor activities, while women confined themselves to the domestic activities.

Court Brown et al in their study noted the male incidence to be around 81.3%, while the female incidence to be around 18.7%.3

Hooper et al noted male incidence at 82% and female incidence at 18%.4

Gaston et al, also noted the percentage of males to be around 81%, while females around 19%.5

Our study had incidence of 70% males which is lower when compared to above studies, whereas 30% in females which is higher when compared to other studies.

**Mode of Injury:** In our series, we have found that majority of the tibial diaphyseal fractures occurred due to road traffic accidents (26 patients). In the majority of cases, they involved the patients who were the motorists, while the remaining patients tended to be pedestrians or motor vehicle occupants.

The incidence of fracture shaft of tibia due to road traffic accidents (86.67%) seemed to be higher in our study compared to Court Brown et al in whose study, the incidence was around 37.5%.3
But in this study, also the commonest mode of injury was road traffic accidents followed by fall. This can be attributed to the poor road traffic sense and poor quality of roads, leading to a higher incidence of road traffic accidents in our country.

Lawrence B Bone et al reported in an earlier study a 90% incidence of Road Traffic Accidents in tibial shaft fractures.⁶

Hooper et al reported a 59% incidence in his study.⁴

Anatomical Location of the Fracture: In our study, the anatomical location of the fracture was in the middle-third of the shaft of tibia in 15 (50%) patients, followed by the lower third in 23.33% of the cases.

This is comparable to Lawrence B Bone et al series, where 53.5% were middle-third fractures.⁶ Hooper et al where 48% were middle-third fractures⁴ and Court Brown et al where 44% were middle-third fractures.⁷

The middle-third fractures are common because of anatomical features of more rigidity of the bone and its subcutaneous nature make it more vulnerable to the injuring force.

Type of Fracture: Our series had a higher incidence of comminuted in 43% of cases, transverse fractures made up 23% cases. Oblique and transverse fractures made 30% fractures (09 patients).

This is comparable to Court Brown et al reported 37.2% of transverse and oblique fractures⁷ and Arne Ekeland et al reported 42% of transverse and oblique fractures.²

The fibula was fractured along with the shaft of tibia in our series in 80% of cases; this is comparable to the study of Court Brown et al, where the fibula was also fractured in 77.7% of the cases. The associated fracture of the fibula, in most of the cases reflects on the high-velocity injury pattern in our study, as most of the injuries are due to road traffic accidents.⁸

Preoperative, Operative and Nailing Procedure: In our series, we have used intramedullary nails ranging from 8 to 11 mm in diameter and from 300 to 360 mm in length.

Reamed closed intramedullary nailing was done in all the cases in our studies. Static locking was done in all the cases.

Schemitsh et al noted no difference in bone formation between reamed and unreamed nailing.⁸

Postoperatively, in our studies, one patient had fat embolism and it was treated.

No other complications like compartment syndrome, neurological or vascular injury occurred.

Superficial infections occurred in one patient at the site of surgical incision over knee and both the superficial infections healed by dressings and antibiotics.

In majority of our patients, active hip, knee, ankle movements and quadriceps exercises were started on the first postoperative day in all the 30 patients. Majority of the patients were mobilized with the walker from the third postoperative day, without bearing weight on the operated leg. Suture removal was done in all patients on 14th day. Complete relief of pain was seen in majority of patients in two weeks. Follow up was done at, 6th, 10th, 12th, 16th, 20th week and 6th month. At follow-ups, clinical and radiological assessment was done regularly with suitable follow-up advice.

Depending upon the type of fracture and stable fixation of fracture, partial weight bearing was started between 4 – 8 weeks when there is evidence of early callus. In our study, partial weight
bearing was started in the majority of patients (24) by the 4-8 weeks. Weight bearing encouraged and increased depending on the progression of healing as evidenced by tolerance, clinical and radiological assessment.

**Full Weight Bearing:** Full weight bearing was started at 8-12 weeks in 7 patients (23.33%), 12-16th week in 5 patients (16.67%), 16-20 week in 14 patients (53.33%) and 20-24 weeks in 2 patients (6.67%), >24 weeks in 2 patients (6.67%).

The appearance of bridging callus was used to assess and allow the patient full weight bearing. The average time of full weight bearing was 18 weeks.

Full weight bearing has been delayed in few patients in comminuted fractures.

This is comparable to Lawrence B. Bone et al where in his study weight bearing has been delayed in unstable fractures.6

Twenty four patients in our study recovered and got normal knee, ankle and subtalar joint movements.

In six patients restriction of movements seen in those six patients restriction of knee movements is seen in 6 patients out of those 6 patients’ four patients had restriction of subtalar and ankle movements.

**Fracture Union:** Fracture union was considered when patient was full weight bearing without pain, fracture site was not tender on palpation and radiograph showed osseous union.

In our series, majority of fractures united within 20 weeks (16 patients). The average time of union was 20.13 weeks.

Court Brown et al reported average union time of 16.7 weeks.7
Arne Ekeland et al reported average union time at 16 weeks.2
In our study, average time of union was 20.13 weeks.

**Complications:** Lawrence B. Bone et al noted an infection rate of 6.25%.6
Arne Ekeland et al noted infection rate of 4.4%.2
Blachut PA et al noted an infection rate of 1%.9

In our study, which is comparable to the above workers study, superficial infection rate was 3% and it healed with dressings and antibiotics.

Anterior knee pain was seen in three patients 10%. In these patients the nail was abutting the patellar tendon and tibial tuberosity and menisci damage causing anterior knee pain and this can be relieved after removal of the nail.

Anterior knee pain can be compared to Hernigou P et al, who noted improper entry of nail into medullary canal, may cause anterior knee pain.10
Jarmo AK Toivannen et al noted anterior knee pain to be common in tibial intramedullary nailing.11

Shortening is seen in 2 patients (6.67%) in our study one patient had comminuted fracture and in one patient comminuted fracture with delayed union and fibulectomy done for it. Shortening was seen in two patients. These were managed by heel raise of the footwear.
Deformity Assessment: In our study valgus deformity of 2 – 5 degrees is seen in 3 patients and varus deformity of 2-5 degrees is seen 1 patients.

In Arne Ekeland et al study valgus deformity of 6-10 degrees is seen in 6 patients and varus deformity is seen in 4 patients.2

In Blachut PA et al study valgus deformity of 6 – 10 degrees is seen in 3 patients and varus deformity of 6 – 10 degrees is seen in 2 patients.10

In Hooper et al study deformities is not seen.4

In our study anteversion of 0- 5 degrees is seen in 1 patient.

In Arne Ekeland et al study anteversion of 6 – 10 degrees is seen in 3 patients.2

In Blachut et al study anteversion of 6 – 10 degrees is seen in 1 patient and recurvation of 6 – 10 degrees is seen in 3 patients.9

In Hooper et al study anteversion and recurvation is not seen in any patients.4

Out of all the cases which showed deformity in coronal plane (4) and in sagittal plane (1) two were at the proximal third, due to wide proximal tibial metaphysis.

And in two cases due to fracture at the junction of middle and distal third and comminuted. Since the distal fragment is short and has a wide medullary cavity, deformity resulted due to poor nail bone construct.

Functional Outcome: Final assessment in our series was done at 6 months using the Johner and Wruh’s criteria, taking into account the following objective and subjective symptoms of gait, pain, deformity, range of motion of knee, ankle and subtalar joints, shortening, neurovascular disturbances, ability to do strenuous activities, radiological union and presence or absence of non-union. Functional outcome was graded into excellent, good, fair and poor.1

In our series, 76.67% (23 patients) have got excellent, 16.67% (5 patients) have good, 6.67% (2 patients) have fair functional outcome.

| STUDY                  | EXCELLENT | GOOD | FAIR | POOR |
|-----------------------|-----------|------|------|------|
| Arne Ekeland et al2   | 64.4      | 28.8 | 4.4  | -----|
| Klemm et al12         | 62.50     | 31.8 | 4.5  | 1.2  |
| Present study         | 76.67     | 16.67| 6.67 | -----|

We have achieved excellent outcome in 2/3rd of the cases and fair to good in another 1/3rd of cases with least complications and early return of function.
CONCLUSION: Tibial diaphyseal fractures are commonly seen in physically active young people and are commonly seen as a result of road traffic accidents.

- The interlocking nailing combines control of length, alignment and rotation, preserves periosteal blood supply, some amount of endosteal blood supply and with biological osteosynthesis, lowers the infection and malunion.
- Closed intramedullary interlocking nailing under c arm guidance is a well-established standard procedure for treatment of tibial shaft fractures.
- Patients operated with this technique can be ambulated early without external immobilization in majority of cases, patients are allowed to resume work early as tolerated and this procedure also reduces the hospital stay and boosts up the morale of the patient.

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