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Comparative study between the unreamed intramedullary nailing and the limb reconstruction system (LRS, Orthofix) in type IIIa open tibial shaft fractures

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Abstract
Background: The tibia is exposed to frequent injury; it is the most commonly fractured long bone. Because one third of the tibial surface is subcutaneous throughout most of its length, open fractures are more common in the tibia than in any other major long bone. We evaluated and compared the outcome of the unreamed intramedullary nailing and limb reconstruction system (LRS, Orthofix) in the treatment of type IIIA Gustilo-Anderson open fractures of tibial diaphysis.
Materials and methods: This study involved prospective evaluation of 160 patients of type IIIA open fracture of tibia treated at our institute between August 2008 to December 2015. 80 cases were treated with orthofix were labelled as group A and 80 cases treated with unreamed intramedullary nailing were labelled as group B.
Result: Average time of union in group A was an average 35 weeks (30-40 weeks) in 64 cases (80%) with 16 cases (20%) of non-union which were subsequently treated with bone grafting and showed union at an average 40 weeks (38-44 weeks). Group B showed average time of union at an average 29 weeks (24-38 weeks) in 66 cases (82.5%) with 10 cases(12.5 %) of infective non-union at which subsequently treated with external fixator and showed union at average 36 weeks (34-38 weeks). 4 cases which showed delayed union were dynamised and bone grafted and showed union at an average 32 weeks.
Conclusion: Intramedullary nailing can be used in the management of type IIIA fractures as it allows early union and primary closure with the avoidance of secondary procedures with the risk of higher rate of deep infection. Orthofix gives lower rate of infection with slightly delayed union compared to nailing with the need for secondary procedures.

Keywords: Type IIIA open tibia fracture, unreamed intramedullary nailing, limb reconstruction system, orthofix, LRS

1. Introduction
Fractures of the tibia and fibula are relatively common and have been recognized as serious and debilitating injuries for centuries [1]. Because of its location, the tibia is exposed to frequent injury; it is the most commonly fractured long bone. Because one third of the tibial surface is subcutaneous throughout most of its length, open fractures are more common in the tibia than in any other major long bone [2].
Management of type IIIA Gustilo-Anderson [3, 4] open tibial diaphyseal fractures is a matter of debate. The treatment options range from external fixators, nailing, ring fixators or bone grafting with or without plastic reconstruction. All the procedures have their own set of complications, like acute docking problems, shortening, difficulty in soft tissue management, chronic infection, increased morbidity, multiple surgeries, longer hospital stay, malunion, nonunion and higher patient dissatisfaction [5].
IM nailing is the most common treatment of tibial diaphyseal fractures [1]. The literature supports irrigation and debridement followed by immediate nailing of lower grade (Type I and type II) open tibial fractures [6, 7]. The large prospective SPRINT trial [8] also showed a low infection rate for primary nailing of open tibial fractures [8]. The outcomes of tibial nailing in studies with predominantly higher grade (Type IIIA, IIIB, and IIIC) open fractures have not been as positive.

The large multi-center prospective Lower Extremity Assessment Project (LEAP) study [9] investigated these injuries and found an infection rate of 16% and that complication rates ranged from 33% to 57% [1].

External fixation of tibial diaphyseal fractures has been used for over 100 years particularly for high-grade open fractures. The definitive use of external fixation for fracture fixation is associated with high rates of pin tract infection. These rates can be greater than 100% as some patients have more than one infection. Although most infections can be treated with oral antibiotics, intravenous antibiotics and removal of pins are sometimes necessary. In addition, frames require more intensive postoperative management than is required with internal fixation [1]. Although limb reconstruction system (LRS, uniplanar monotube external fixator, Orthofix) proved to be an effective modality of treatment in cases of open fractures of the tibia, as definite modality of treatment for damage control as well as for achieving union [9].

We evaluated and compared the outcome of the unreamed intramedullary nailing and limb reconstruction system (LRS, Orthofix) in the treatment of type IIIA Gustilo-Anderson open fractures of tibial diaphysis.

1.1 Aim and objectives

1. Compare the rate of fracture union in type IIIA open tibia fractures according to Gustilo-Anderson classification, in skeletally mature patients treated with intramedullary interlocking nail and LRS (Orthofix).
2. Enumerate the complications associated with both the methods.

2. Materials and methods

This study was performed in Mysore medical college from August 2008 to December 2015, and 160 patients eligible for inclusion were selected. All the fractures were post-traumatic fresh fractures.

Inclusion Criteria was Fresh cases of type IIIA open tibia fractures according to Gustilo-Anderson classification in skeletally mature patients.

Exclusion Criteria were type I, type II, type IIIB and type IIIC open tibia fractures according to Gustilo-Anderson classification, pathological fractures, non-union and delayed union, who do not give consent.

After admission into the hospital, general and systemic examination as well as local examination along with thorough assessment of patient to rule out other systemic injuries was done, followed by evaluation of patients in terms of age, sex, mode of trauma and period between injury and arrival. Thereafter patient is stabilized with intravenous fluids, oxygen and blood transfusion as and when required. Careful assessment of injured limb as regards to neuro-vascular status was noted. Primary wound lavage was done in all cases with normal saline and immobilization done with a anterior and posterior above knee slabs and Anterio-posterior and true lateral views of injured limb including ankle joint and Knee joint were done. Analgesics were administered as required.

The time interval between the trauma and the arrival at the hospital was on an average 6 hours. Also the ATLS evaluation and the investigations in the casualty and the starting the surgery took on average another 2 hours. All the patients were operated between 48-72 hours.

Preoperative preparation include prophylactic antibiotics on the arrival at casualty and just before skin incision. The antibiotic coverage included 3rd generation cephalosporin, aminoglycosides for type IIIA fractures.

2.1 Operative procedure

Either Spinal anesthesia or General anesthesia were used. Intra-operatively wound thoroughly debrided and fractures were fixed using the intramedullary nailing and LRS.

The intramedullary nailing done through the split patellar tendon approach. The medullary canal was not reamed. Nail length which was measured pre-op and the nail size depending upon the medullary canal was inserted and two distal and one proximal interlocking was done. Considering the patient's condition partial weight bearing mobilization using a walker was done as soon as possible with the help of supervised physiotherapy.

Schanz pins of LRS were inserted by longitudinal stab incision and separating the soft tissue down to the bone by blunt dissection on the anteromedial surface of tibia hence preventing the risk of neurological, vascular or tendon injuries. The rod and assembly connected over these proximal and distal pins maintaining the leg length and this definitive fixator was used as a guide to pass the rest of the pins, to ensure that the rail is parallel to the long axis of the bone and all the remaining screws will be on the bone, in the same plane, perpendicular to the long axis of the tibia and parallel to the knee and ankle joints and aligning the tibial tuberosity with the second metatarsal. Compression and distraction was started after a week of the surgery. Patients were encouraged to attain knee and ankle range of motion (ROM) after the application of LRS, depending on the patient pain tolerance. This compression and distraction was continued till the signs of callus are visible and then distraction was stopped and dynamization of the LRS system done, which was followed by weight bearing mobilization by the patient as per his tolerance. The dynamized LRS system was left in-situ for further 4-6 weeks for consolidation of the regenerate and fracture union to occur. After the union and consolidation phase that is, till the three cortex union seen on the AP and lateral views, the LRS system was removed and the patellar tendon bearing cast was applied allowing full weight bearing, for further 4 weeks.

In both the groups, post-operatively systemic antibiotic were continued for 5 days and dressing done regularly. In patients whose bone was exposed, as the wound condition improved the patients were planned for flap rotation. In the rest of the patients, the wound was left as such to heal, with secondary intention or if required, split skin grafting was done.

Patients were followed up clinically and radiologically at 4, 8, 12, 24 and 36 weeks and till radiological union.

3. Results

There were 134 males and 46 female patients of mean age 45 years. The choice between nailing and LRS was done alternatively and the resultant clusters of two different treatment modalities were followed. Group A was the patients treated with LRS and group B was the cases treated with intramedullary nailing.

	Orthofix (Group A)	Nailing (Group B)
AGE in years (average)	37-57(44)	34-52 (42)
Males	56 (70%)	48 (60%)
Females	24 (30%)	32 (40%)

Average time of union in group A was 35 weeks (30-40 weeks) in 64 cases (80%) with 16 cases (20%) of non-union which were subsequently treated with bone grafting and showed union at an average 40 weeks (38-44 weeks).

Group B showed average time of union at an average 29 weeks (24-38 weeks) in 66 cases (82.5%) with 10 cases(12.5 %) of

infective non-union, which subsequently treated with external fixator and showed union at average 36 weeks (34-38 weeks). 4 cases which showed delayed union were dynamised and bone grafted and showed union at an average 32 weeks.

	Orthofix (Group A)	Nailing (Group B)
Union average weeks	35 (64 cases, 80%)	29 (66 Cases, 82.5%)
Non-union	16 (20%)	10 (12.5%)
Bone Graft	16 (20%)	14 (17.5 %)

Fig 1 & 2: = Pre-op and Post-op xrays of nailing

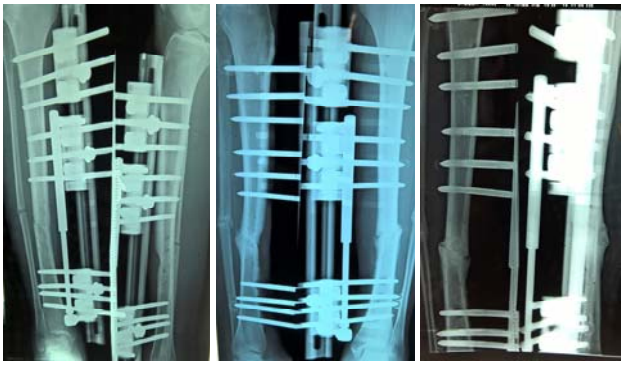

Fig 3, 4, 5: = Immediate post-op, and follow up xrays of orthofix.

Group	Orthofix (Group A)	Nailing (Group B)
Mean	35	29.50
SD	2.97	4.10
SEM	0.37	0.51
N	64	66

The rate of superficial infection in group A was 10% (8 cases) which mostly included pin tract infections which needed regular dressing and oral antibiotics while rate of deep infection was 5% (4 cases) which needed the re-debridement. The rate of superficial infection in group B was 5% (4 cases) from fracture site which needed re-debridement and secondary skin grafting while the deep infection rate was 20% (16 cases) which needed re-debridement and bone grafting with secondary skin graft or flap once infection settled down.

	Orthofix (Group A)	Nailing (Group B)
Primary closure	26 cases (32.5%)	48 cases (60%)
Delayed closure	26 cases (32.5%)	16 cases (20%)
SSG/FLAP	28 cases (35%)	16 cases (20%)
Superficial Infection rate	10%	5%
Deep infection rate	5%	20%

4. Discussion

The management of open tibia fracture has been a challenging task for orthopedic surgeon. Like any of the open fracture, the union of bone is inter-related to soft tissue coverage, which in turn decides the rate of infection. As the tibia is subcutaneous bone, the triad of soft tissue coverage, infection and bone union decides the ultimate outcome. In this study we followed up the patients with Gustilo-Anderson open tibia fractures type IIIA treated with intramedullary nailing and limb reconstruction system.

In this study the nailing has shown better union rates than orthofix, partly due to the stable intra-medullary fixation compared with rigid extra-medullary fixation with orthofix and partly to the fact that it allowed more cases for primary closure of soft tissue. Orthofix allowed the lower rate of infection than nailing, but the secondary procedures like bone graft, SSG and flaps were more.

5. Conclusion

Intramedullary nailing can be used in the management of type IIIA fractures as it allows early union and primary closure with the avoidance if secondary procedures with the risk of higher rate of deep infection. Orthofix can give lower rate of infection with slightly delayed union compared to nailing with the need for secondary procedures.

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