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Treatment of Compound Tibial Diaphyseal Fractures by Ilizarov Method: A Retrospective Study

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Abstract: ***Background: This study was done to evaluate the results obtained by treatment of open tibial shaft fracture grade IIIA and IIIB by Ilizarov external fixator in terms of radiological bone healing and functional results, and to study treatment associated complications. Methods: Study was carried out in Pt. B. D. Sharma postgraduate institute of medical sciences, Rohtak, Haryana between April 2017 till Jan 2020. After satisfying the criteria, selected 34 patients subjected to thorough history, followed by a clinical examination. Proper counselling and thorough radiological and laboratory investigation were done. Patient was operated as early as possible and serial follow up was done and at minimum follow up of 1 year, the patients were assessed clinically using the Tucker's criteria and Johner and Wruh's criteria. Post-operatively patients were assessed both radiologically and clinically to determine the effect of treatment. Radiological union was graded on the basis of Fernandez-Estev grading. Data analysis was done using statistical packages for social sciences (SPSS) 22.0. Results: Age of cases ranged from 19-54 years. With average being 37.74 years. 70.6%of the cases were male in the study group. Equal proportion of both sides (Right and left) was involved. In 31 (91.18%) patients fracture united whereas in remaining 3 (8.82%) patients non-union occurred. Mean fixator removal time was 22.76 weeks. 31(91.18%) cases showed excellent to good results after the intervention and only 3(8.82%) of the cases showed poor result according to Tucker's criteria and 30 (88.23%) cases had excellent to good results and 4 (11.77%) cases had poor results using Johner and Wruh's criteria. Conclusions: It is recommended to use llizarov external ring fixator apparatus to provide primary definitive fixation for high energy long bone fractures. Early weight bearing even in severely comminuted fractures is the key factor that separates it from other methods of fixation. It promotes early functional recovery, eliminating fracture disease. Further studies with larger sample sizes and longer follow ups are recommended.***

Keywords: Open tibia fracture, Ilizarov method

1. Introduction

Open tibial fractures are the most common open fractures involving the long bones with an annual incidence of 5.6 per 10,000 persons in the United States[1]. These fractures continue to pose a challenge to orthopaedic surgeons worldwide. The precarious blood supply and lack of soft-tissue cover of the shaft of the tibia make these fractures vulnerable to non-union and infection[2].

The acceptable goals for open tibial diaphyseal fractures remain the prevention of infection; maintenance of normal length, alignment and rotation of the extremity; minimising additional damage to soft tissue and bone; preserving the remaining circulation and providing a mechanical environment which stimulates periosteal and endosteal responses which favour bone healing. The complications in open injuries during the course of fracture treatment dictate the use of methods believed to reduce the risk of complications, including urgent or emergent treatment and thorough debridement of wound, consisting of removal of all foreign materials, removal of devascularised tissues and reduction of the bacterial load introduced by disruption of the soft tissue envelope[3].

The options offered for the treatment of fractures of tibia range from Charnley's close reduction, external fixator to the AO principles of internal fixation and Gavril ilizarov external ring fixator. External fixation has been popular because of the relative ease of application and the limited effect on the blood supply of the tibia, but these advantages have been outweighed by the high incidence of non-union and pin-track infection, difficulties relating to soft-tissue management and the potential for malunion.

Ilizarov defined Distraction Osteogenesis as the mechanical induction of new bone between bony surfaces that are gradually pulled apart. He pioneered the biology of bone and soft tissue regeneration and relies on the consolidation of regenerated new bone which is an intramembranous type[4]. It is said that one patient accidentally turned the connecting rods between rings in distraction rather than compression. llizarov observed new bone formation radiographically following this distraction.

Hence, this study was carried out retrospectively to analyse the management of open tibial fractures with Ilizarov external fixator.

2. Aims and Objective

This study was done

1) To evaluate the results obtained by treatment of open tibial shaft fracture grade IIIA and IIIB by Ilizarov external fixator in terms of radiological bone healing and functional results, and
2) To study treatment associated complications.

3. Materials and Methods

Study was carried out in Pt. B. D. Sharma postgraduate institute of medical sciences, Rohtak, Haryana between April 2017 till Jan 2020. After satisfying the criteria, 34 patients with open tibial fracture Gustilo Anderson type

IIIA and IIIB subjected to thorough history, followed by a clinical examination.

Modified Gustilo Anderson Classification System:

1) Gustilo type I: Fractures of this type have a clean wound of less than 1 cm in size with little or no contamination.
2) Gustilo type II injuries have a skin laceration larger than 1 cm, but the surrounding tissues have minor or no signs of contusion.
3) Gustilo type III is divided into subtypes III A, III B, and III C. Gustilo type III A usually results from high energy trauma, but there is still adequate soft tissue coverage of the fractured bone, despite extensive soft-tissue laceration or flaps. Gustilo type III B in contrast to the type III A has an extensive soft-tissue loss with periosteal stripping and bone exposure. Gustilo type III C includes any open fracture associated with arterial injury requiring repair, independent of the fracture type.

Proper counselling and thorough radiological and laboratory investigation were done. Patient was operated as early as possible and serial follow up was done and at minimum follow up of 1 year, the patients were assessed clinically using the Tucker's criteria and Johner and Wruh's criteria.

Tucker's Criteria

An excellent result is defined as fracture union with full knee extension and more than 125° flexion, ankle range of motion >75% of normal, limb length discrepancy <1 cm, no angulation >7° in any plane, no rotation >7° and absence of infection.
A good result is indicated by fracture union with one criterion missing.
A fair result was fracture union with two criteria missing.
A poor result indicated fracture union with three missing criteria or non-union.

Johner and Wruh's Criteria:

It consists of 4 parameters 1. Non union/infection, 2.neurovascular injury, 3. Deformity, 4. Mobility of joints and gait. Depending upon these 4 parameters score given as excellent, good, fair and poor.

Post-operatively patients were assessed both radiologically and clinically to determine the effect of treatment. Radiological union was graded on the basis of Fernandez-Estev grading.

Fernandez-Estev Grading (Radiological Union)[5]:

Grade I- empty space between two fragments without radiopacity.
Grade II- presence of cloud of bony callus.
Grade III- presence of periosteal bridge in at least one diaphyseal wall in every X-ray projection.
Grade IV- presence of periosteal bridge in both diaphyseal walls in every X-ray projection.
Grade V- structural callus is seen.

Checketts-Otterburn Classification For Pin Tract Infection [6] :

In this pin tract infection classified as minor and major.

Minor infection

Grade1. Slight redness and little discharge is treated with improved pin site care ,
Grade2. Redness of the skin, discharge, pain and tenderness in the soft tissue is treated with improved pin site care and oral antibiotics
Grade3. Is Grade 2 but no improvement with oral antibiotics. In this affected pin or pins are resited with external fixation continuation.

Major infection

Grade 4. Severe soft tissue infection involving several pins, sometimes with associated loosening of the pin in which External fixation must be abandoned
Grade 5. Grade 4 but with radiographic changes then external fixation must be abandoned
Grade 6. Infection after fixator removal. Pin track heals initially, but will subsequently break down and discharge in intervals. Radiographs show new bone formation and sometimes sequestra. This is treated with Curettage of the pin tract.

Data analysis was done using statistical packages for social sciences (SPSS) 22.0.

4. Results

Age of cases ranged from **19-54 years**. With average being **37.74 years**. **70.6%** of the cases were male in the study group. Equal proportion of both sides (Right and left) was involved.

Majority of patients **44.12%** were labourer by occupation followed by student and housewife who were about **14.71%** each.

Most common type of fracture pattern seen in our study was communited type **(35.29 %)** and most common fracture type was GA type IIIB **(55.88%)**

Average weight bearing was done in 3.27 days in our study.

In **31 (91.18%) patients** fracture united whereas in remaining **3 (8.82%) patients** non-union occurred.

Mean fixator removal time was **22.76 weeks**.

31(91.18%) cases showed excellent to good results after the intervention and only **3(8.82%)** of the cases showed poor result according to Tucker's criteria and **30 (88.23%)** cases had excellent to good results and **4 (11.77%)** cases had poor results using Johner and Wruh's criteria.

The mean follow up in our study was around **18.17 months**.

5. Discussion

In this study, all the patients were from the active age group. Maximum age was 54 years and minimum age was 19 with a mean age of 37.74. Out of these 34 patients, 24 (70.6%) were males and 10 (29.6%) were females. In R.

Jan et al[7], 50 patients were studied out of which 43(86%) males and 7(14%) females. This study shows higher incidence of open injuries in male population in comparison of females suggesting a relationship between incidence and activity of the affected population. Since male population are more involved in outdoor activities, they are exposed to open fractures. Also in Court Brown et al[1], there were 230 patients and 76% of them occur in male population.

In this study, patients with only type IIIA and IIIB open tibial diaphyseal fracture (modified Gustilo Anderson classification) were included. Among 34 patients, 15(44.1%) were type b and 19(55.9%) were type a.

In this study, distal 1/3 fractures (n=13) were commonest followed by middle 1/3(n=11) and proximal 1/3 fractures(n=10). Subcutaneous location of distal and middle 1/3 diaphysis tibia predisposes it to open injury. Also precarious blood supply to distal 1/3 tibia increases the chances of nonunion. Hence these factors favour the use of ilizarov method to decrease the chance of non union, thereby reduces the morbidity of the patient.

In the study, 22 patients had no bone loss whereas 12 patient patients had upto 6 cms of bone loss. 6 patients had 2 cms of bone loss whereas 4 had 3 cms and 3 patients had 1 cm, 5 cms and 6 cms of bone loss each.

In this study, split skin grafting was done in 25(73.5%) patients whereas local rotation flap was used in 5(14.8%) patients, 2(5.9%) patients secondary healing was achieved and in remaining 2(5.9%) patients, primary closure was done. Local rotation flaps of medial gastrocnemius and soleus were used with excellent results.

In this study, 16 patients required a second procedure, 6 patients required secondary debridement for infective compound wound and 4 needed wire tensioning. 3 patients needed realignment with frame adjustments. Loss of reduction was due to full weight bearing in immediate postoperative period. Secondary bone grafting was done in 1 patient. Recorticotomy was done in 2 patients.

In this study, 32 patients had immediate post operative limb edema which was treated by limb elevation and physiotherapy. 11 cases had pain had fracture site, 2 patients had pain at pin skin interface, 2 cases had pain at corticotomy site which was managed by painkillers and reassurance. 4 patients had ankle stiffness and 3 case had knee stiffness which was managed by active and passive physiotherapy. 1 patient had varus deformity due to frame loosening and it was treated by recorticotomy. 1 patient had LLD of 2 cms for which shoe raise was given. We had 3 cases of grade I pin tract infection and 5 cases of grade II pin tract infection. They were treated with daily dressing and oral antibiotics. Total case of pin tract infection in our study is 8/34 cases as against 14/32 cases in Alemdaroglu et al[8].

In this study, Maximum fixator time was 40 weeks and minimum fixator time was 17 weeks with a mean fixator time of 22.76 weeks. This is comparable with Nesari et al[9], Tucker et al[10], Kumar et al[11].

At the final follow up, results of tibial shaft fractures were assessed by Tucker's and Johner and Wruh's criteria. According to the Tucker's criteria, 28 cases had excellent results, 3 patients had good results and 3 had poor result. According to Johner and Wruh's criteria, 28 patients had an excellent result, 2 patients had a good result, 3 had poor and 1 had fair result.

6. Conclusions

It is recommended to use llizarov external ring fixator apparatus to provide primary definitive fixation for high energy long bone fractures. Early weight bearing even in severely comminuted fractures is the key factor that separates it from other methods of fixation. It promotes early functional recovery, eliminating fracture disease. Dynamization and correction of deformities in any plane is easily accomplished. Frame constructs can be modified to facilitate wound cover and access. Therefore it gives the much needed flexibility in complex fractures. Corticotomy, acute docking and lengthening allows removing the dead necrotic bone ends and correction of limb length discrepancy by distraction at corticotomy site. Further studies with larger sample sizes and longer follow ups are recommended.

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