MANAGEMENT OF TIBIAL BONE DEFECTS DUE TO HIGH ENERGY TRAUMA USING THE LOCALLY MANUFACTURED EXTERNAL FIXATOR BY SEGMENTAL BONE TRANSPORT

Ahmad Sohail Sahibzada, Muhammd Ayaz Khan, Muhammad Shoaib Khan
Department of Orthopaedic and Trauma, Ayub Medical College & Hospital Complex Abbottabad, & PGMI Lady Reading Hospital Peshawar

Background: Bone defect in long bones is a problem in orthopaedic which needs proper treatment to restore limb length and function of the limb. There are various treatment modalities available to fill the defect like bone grafting, vascularised bone graft, allograft and bone transport through fixators (Ring or Uniplanner). This study was done to determine the outcome of locally manufactured External Fixator (Naseer and Awais) in the management of tibial bone defect due to trauma. **Methods**: This descriptive study was conducted on 20 patients in orthopedic department in Lady Reading Hospital Peshawar and Ayub Teaching Hospital Abbottabad, from Nov 1997 to Nov 2002. Patients from either gender aged between 20 to 50 years, having tibial bone defect of more than five centimeter due to trauma were included in the study. Follow up was done for two years. Outcome measures were adopted according to the classification of the Association for the Study and Application of the Method of llizarov (ASAMI) based on clinical (functional) and radiological findings (defect filling). **Results:** Out of 20 patients 14 (70%)were males and 6 (30%)were female patients. Right tibia was involved in 12 patients (60%)and left tibia in 8 patients (40%). Bony defects due to firearm injury were in 14 patients (70%) and road traffic accidents were in 6 patients (30%). Radiological (bony) results were excellent in 12 patients (60%), good in 2 patients (10%), fair in 3 patients (15%) and poor in 3 patients (15%). Clinical (functional) results were excellent in 7 patients (35%), good in 8 patients (40%), fair in 4 patients (20%) and poor in 1 patients (5%). Post operative complications after distraction osteogenesis were pin tract infections in 8 patients (40%), Axial deviations in 6 patients (30%), foot equinus in 4 patients (20%) and refracture in 1 patient (5%). **Conclusion**: Uniplanner locally manufactured (NASEER & AWAIS) External Fixator for distraction osteogenesis is cheap, easy to apply and gives excellent and comparable results in tibial bone defects.

Key words: Tibial bone defects , distraction osteogenesis, uniplanner local version external fixator.

INTRODUCTION

Management of bony defects in limbs is a challenge which orthopaedic surgeons have been facing for centuries. Treatment is difficult since cancellous bone grafts, which have normally been used can only cover small defects.[1,2] Other techniques such as vascularized fibular graft, transplantation of the allograft bone and Papineau techniques have also been described.[3] Filling bony defect with segmental bone transport by regenerate is innovative, an alternative to the classic bone grafting techniques and a revolutionary concept confronting the long held belief that bone could not be regenerated.

Due to increase in population and changing human habitats the number of accidents and high energy trauma is on the increase. Because of better understanding and soft tissue management of these defects, a lot of limbs are being saved which would normally be amputated.[4]

Segmental bone transport is a slow, gradual and controlled stretching of the bony callus after a low energy, subperiosteal corticotomy to fill the bony defects. The basic principles of this procedure is to create an environment of a combination of conditions based on maximum preservations of blood supply, osteogenic elements and stable fixation coupled with appropriate rate and rhythm of distractions. With this procedure soft tissue defect can be bridged and segmental transport can be performed leaving the wound open in the entire procedure.

Different types of external fixators can be used for segmental bone transport by the llizarovs distraction osteogenesis technique. This technique is useful to manage complicated fractures and deformities. We have used the local version fixator (Naseer Awais) which is a modification of the AO, Hoffman fixator and other unilateral fixators used for this purpose.

This fixator is less cumbersome, technically easy to apply and more comfortable for the patients than the ring fixators being the first prototype used by llizarov. The purpose of the study was to evaluate the results of Naseer and Awais (NA) fixator (Fig-1) in the management of tibial bone defects.

MATERIAL AND METHODS

This study is an analysis carried out on twenty patients at orthopaedic department of Lady Reading Hospital, Peshawar and Ayub Teaching Hospital, Abbottabad from Nov. 1997 to Nov. 2002. Patients from either gender were included with age range from 20-50 years having tibial bone defect of more than 5cm due to high energy trauma.

All the patients were admitted through the casually department, where they were evaluated for life threatening conditions as per ATLS protocol. After initial resuscitation, history and physical examination, the open wounds were covered with sterile dressings and the fractures were splinted to relieve pain and prevent further soft tissue trauma. Patients were prepared for general anesthesia and emergency surgery.

Analgesics, intravenous antibiotics and prophylaxis against tetanus were administered after taking swab for culture and sensitivity. Patients were X-rayed in AP and lateral views with joint above and joint below. Under General or Spinal Anesthesia and tourniquet control, the wounds were debrided and thoroughly washed with normal saline to remove the dirt, debri and dead tissue.

Twelve fractures were initially stabilized with simple AO external fixator while the remaining 8 were stabilized primarily with Naseer Awais (NA) fixator. The AO fixator used initially as emergency salvage procedure were later converted to Naseer Awais (NA) fixator .

After thorough debridement the Schanz screws of NA fixators were inserted according to the site chosen after making holes with 3.2 drill bit using a pneumatic drill, followed by application of longitudinal bars with Schanz screws of the unilateral fixator.

Figure-1: Naseer Awais (NA) fixator

An osteotomy was performed to create a segment of bone which was gradually transported within the surrounding soft tissue envelope to the other side of the defect called docking site. Distraction was started after 10 days of osteotomy at the rate of one millimeter per day in four equal increments. The patients were educated regarding the importance of distraction at a proper rate and care of the frame and pin site. The patients were referred to physiotherapy for exercises of the joint above and below.

First radiograph of the involved extremity was made on the seventh day after the date of distraction to document the site and adequacy of osteotomy.

Follow up was done for two years according to outcome measures of the classification of the association for the study and application of the method of llizarov (ASAMI) while looking for clinical (functional) and radiological findings (defect filling). The clinical results were based on five criteria i.e significant limp, stiffness of knee and ankle joints, dystrophy, pain that reduced the acitvites or disturb sleep or inactivity i.e inability to return to daily activity because of the injury.

The functional results were considered excellent if the patient was active but three or four of the other criteria were applicable, fair if the patient was active but three or four of the other criteria were applicable and poor if the patient was inactive regardless of other criteria .

The radiological findings were evaluated according to four criteria: union, infection, deformity and leg length discrepancy.

According to the protocol of the ASAMI a bone result could not be graded excellent unless union was achieved without the use of bone graft. An excellent bone result was defined as union, no infection , deformity of less then seven degrees and a leg length inequality of less then 2.5 cm. A good result was union and any two of the other three criteria; a fair result was union and one of the other criteria and poor results was nonunion or refracture or union but none of the remaining three criteria that are required for an excellent result.

First follow up visit was after two weeks to assess the condition of wound, joint moment, pin tract infection and radiological finding of transport process. The subsequent follow up visits were done on monthly interval for assessing clinical and radiological findings.

On each follow up visit the patients were evaluated both clinically and radiologically while covering the following points:

- Distance moved on the credit rod as compared to the previous visit
- The range of active and passive motion at the knee and ankle joint were recorded at each follow up visit. A decrease in the range of motion from the previous visit was considered the first sign of muscular contracture and physiotherapy was

intensified to decrease the development of contracture.

- In addition splints were applied where indicated.
- Patients were evaluated for neurological complications at each visit. If the patients showed signs of nerve injury distraction was slowed .
- The Pin sites were examined for signs of inflammation or infection and were treated according to the standard treatment protocol. (Table 1)[5]
- Stability of the frame and components was checked.
- On each follow up visit the limb was radiologically evaluated for the regenerate and progression of the moving segment.

After completion of the distraction phase the fixator was locked and the patients were encouraged to increase their activities and weight bearing on the limb.

The fixator was removed after corticalization and consolidation of the regenerate bone. The consolidation criteria followed were the disappearing of the radiolucent area and appearance of the radiodense bony column bridging the gap and ossification and cortilization of the bone. The patients were followed for an average period of 2 years after removal of the fixator frame.

Protective Sarmiento bracing was used after removal of fixator.

Table-1: Protocol for pin tracts infection treatment

Type	Characteristics	Treatment
I	Serous Discharge	Local Care
II	Superficial Infections	Local Care +Oral antibiotics
III	Deep Infections	Local Care +I/V antibiotics
IV	Sequestrum	Removal of Pin & Sequestrum

RESULTS

Out of 20 patients 14 (70%) were males and 6 (30%) were females. Right tibia was involved in 12 patient (60%) and left tibia in 8 patients (40%). Bony defects due to firearm injury were in 14 patients (70%) and road traffic accidents were in 6 patients (30%).

Results were divided according to radiological (bony) and clinical (functional) findings based on ASAMI criteria. According to this criteria bony result achieved were excellent in 12 patients (60%), good in 2 patients (10%), fair in 3 patients (15%) and poor in 3 patients (15%) initially.

Good results were eventually achieved after bone grafting at the docking sites.

The functional results were excellent in seven (35%), these patients were able to return to work and daily activates without any other problem. Good results were in eight (40%) patients who were active but four of them had a limp, four had more then 15 degree loss of dorsiflexion at the ankle, Four (20%) were active but they had limp and stiffness at the ankle joint and the results were graded fair in them. The remaining one (5%) patient was unable to return to his previous employment and the results were graded poor.

The radiological (bone) and clinical (functional) are compared and shown in table 2.

Table-2: Results according to the ASAMI criteria

Result	Excellent	Good	Fair	Poor
Bone	12(60)	2(10%)	3(15%)	3(15%)
Functional	7(35)	8(40%)	4(20%)	1(5%)

Post operative complications during distractions osteogenesis were pin tract infections in 8 patients (40%) which were treated according to the standard protocol. Axial deviation in 6 patients (30%) but with full function of the limb and no further treatment was needed, foot equines was observed in 4 patients (20%) who were treated successfully conservatively with exercises and splints. Refracture occurred in 1 patient (5%) which was undisplaced and treated in protective cast which united eventually.

DISCUSSION

Management of open tibial fractures continues to be controversial in the orthopedic trauma. Studies evaluating open tibial fractures with bone loss due to high energy trauma especially firearm injuries are limited .

The llizarov method of segmental bone transport has been shown to be an alternative to the more conventional treatment of post traumatic bony defects such as cancellous bone grafting, transplantation of free fibular bone grafts and vascularized bone grafts.[6]

Different types of fixator are used for segmental bone transport to fill bony defects. The most commonly used is the Ilizarov's ring fixator. This fixator is commonly used for more complex fractures and multi directional and multi planar deformity correction . We used the local version mono lateral and mono planar external fixator based on the same philosophy various versions being in use.

This unilateral configuration of the fixator greatly reduced the risk of neurovascular injuries and is more comfortable for the patients than the ring fixators.

Segmental bone transport are found to be effective in the treatment of compound fractures with bone loss. This technique addresses bone loss, infection, non-union and deformity simultaneously. It also assists in bridging the soft tissue gap.

The only disadvantage of this technically demanding procedure is the long period of external fixator application.

This relatively simple local version of external fixator is easily applicable with a hand drill , allows the patient a good range of movement of the joint above and below and has a better patient tolerance and easy in handling the distraction process.

The fixator is cheap, locally available and has a short learning curve for trainees in its use. However, full weight bearing on limb is limited with this fixator as compared to the llizarov ring fixator.

The main advantages of the procedure are however the definitive treatment of bone loss, eradication of infection and good quality new bone formation along with soft tissue bridging.

This method is an impressive approach to all aspects of the traumatic bone loss in long bones that simultaneously addresses all the problems associated with these complex injuries.[7]

The present series of patient have an average bone defect of 7 cm either primarily due to the original trauma or after resection of the infected and necrotic bone ends. Majority of our patient had firearm injuries because of our local traditions and direct impact from the Afghan War.

The only disadvantage of this method is the prolonged use of external fixtor. In our study the mean external fixation time was 6.8 months (4-8 months).

This external fixation time is comparable with those mentioned in the literatures.[8] We achieved union at the docking sites in 17 (85%) patients at an average of 4.8 months after the completion of the distraction phase. In the remaining three (15%) cases good union was achieved after bone grafting at the docking sites.

Most series of tibial bone defects in the literatures have reported only on the presence or absence of bone union. Union rate reported from these series are 93%[9] 87.80%[10] and 85% for bone grafting procedure and 98% for internal fixation.[11]

In our study we had a residual shortening of more than 2.5cm in five patients and angular deformity of less than seven degree in five cases, yet they all had adequate function not needing any further corrective surgery.

Most of the authors in the literatures did not report on residual shortening and angulations. Those who have reported on this issue have comparable results.[12]

Pin track infection was the most common complication. Patients were educated regarding the pin site care and were encouraged to do dressings at home because of non availability of trained health care personal in the remote areas they came from.

A pin track infection of 40% which be attributed to the ignorance of the patient to take care of the pin sites and failure to attend the review clinics regularly.

There was no incidence of sequestrum formation for which pin removal was necessary .The late complications included axial deviation during the distraction phase: refracture through the regenerate during the consolidation phase and joint stiffness.

Our complications rate is well comparable with the results mentioned in the literature.[9]

Our functional results are inferior to the bone results because the functional results were affected by the condition of the nerves, muscles, vessels, and joints and to a lesser degree the bone. Although our series represents our learning curve in the method of segmental bone transport with the llizarov distraction technique using locally made eternal fixator, still we have got comparable results to those reported in the literature.[8,10,11,13]

In our study we concluded that segmental bone transport with llizarov's distraction technique to fill a bony defects, especially in the tibia, is a useful and definitive method with the only disadvantage of lengthy external fixation time and complications.

CONCLUSION

We concluded that distraction osteogenesis to fill a bony defect in tibia with local version Naseer Awais external fixator could be used to obtain impressive results.

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Address for Correspondence:
Dr. Ahmad Sohail Sahibzada, Department of Orthopaedic and Trauma, Ayub Medical College & Hospital Complex Abbottabad.
Email: sohailsahibzada@hotmail.com