DISTRACTION OSTEOGENESIS IN SEGMENTAL BONE DEFECTS IN TIBIA BY MONOAXIAL EXTERNAL FIXATOR

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ABSTRACT

Objective: *To evaluate the results of segmental bone transport using monoaxial external fixator in patients with non union of the tibia with segmental bone loss.*

Material and Methods: *This descriptive study was carried out at orthopedic unit of Hayatabad Medical complex Peshawar from July 2004 to January 2007 with 32 patients of tibial non union with segmental bone loss. Locally made "Naseer-Awais" uniplanner external fixator was applied and osteotomy performed. Distraction started at tenth post operative day. Patients were followed fortnightly. Check radiographs were taken on every visit. At the end of consolidation phase fixtor was removed. Results were assessed using Association for the Study and Application of the Method of ILIZAROV (ASAMI) scoring system.*

Results: *Out of 32 patients 29 were male and 3 were female. Eighteen patients had road traffic accidents, 10 fire arm injuries and 4 bomb blast injuries. Average length of bone transport was 7cm. Average duration of fixator was 8 months and average follow up was 25 months. Eight(25%) patients had some additional procedure in form of fibular osteotomy, fasciocutaneous flap and bone grafting. Twenty-eight(87.5%) patients had pin tract infection. Repositioning of pins was done in 18(56.25%) patients. External fixator was changed in 10(31.25%) patients. Four patients developed mal-alignment which required fixator resetting. Four(12.5%) patients had re-osteotomy. Five(15.62%) patients developed persistent equinus deformity. Nine(28.12%) patients had to modify their profession.*

Conclusion: *Distraction osteogenesis can be achieved with locally made Naseer Awais fixator in non union of tibia with segmental bone loss.*

Key words: *Distraction osteogenesis, Bone transport, Monoaxial external fixator, ASAMI*

INTRODUCTION

Non-union of long bones with segmental defect is a major problem[1]. It usually follow high energy trauma leading to open fractures with soft tissue damage and may be further complicated by infection.[2] Segmental bone loss may be due to initial injury, secondary to debridement or produced by post-traumatic osteomyelitis needs resection of necrotic bone segment for treatment. The treatment of non-union with segmental bone loss is challenging, time consuming and costly. A number of options are available to bridge a bone defect. Autogenous bone graft can be used for defects up to 7-8 cm.[3] Similarly vascularized bone graft, transplantation of allograft and synthetic bone substitute are also used.[4] Large tibial defects can be treated with dual on lay bone graft, fibula-pro-tibia procedures and microsurgical transfer of vascularized fibula or iliac crest[5].

Distraction osteogenesis is a mechanotransduction process capable of generating viable osseous tissue by gradual separation of osteotomized bone edges[6]. It is the treatment of choice for limb length discrepancies due to any cause[7,8]. This technique was originally described by Ilizarov in Russia[9]. In his method, a circular frame is used to which bone fragments are fixed with the help of trans-osseous wires. Threaded rods connected the rings to each other. Corticotomy low energy or osteotomy was made in one of the major fragment. Slow gradual transport of the middle fragment at a rate of 1 mm per day was started after 7 days. This slow distraction causes formation of a regenerate due to recruitment of progenitor cells from the endosteum at the osteotomy site. After the defect was bridged the bone transfer is stopped and the fixator remaind till bone consolidation. Consolidation phase was usually twice of the distraction phase.

The Ilizarov method is an established method of distraction osteogenesis[10] which along with bone transport promotes soft tissue regeneration. It can be used in infection that provides excellent stability and early weight bearing is possible [11]. It allows the use of distraction, compression, bone lengthening and correction of deformity in any plane, but it is technically demanding, time consuming and expensive [11, 12].

Various studies have been conducted on the use of monoaxial external fixator for bone transport using Ilizarov principles of distraction osteogenesis[13]. Uniplanner external fixators do not provide much stability and can not correct deformity in all the planes. However all results are comparable to Ilizarov technique. They are technically less demanding and cost effective.[14,15] Good results have been claimed with the use of uniplanner orthofix fixator, Arbeitsgemeinschaft fuer Osteosynthesefragen - Association for the Study of Internal Fixation (AO/ASIF) tubular external fixator and similarly with locally made "Naseer-Awais"(NA) unilateral fixator[4,16].

One of the major drawback common to all types of external fixators for distraction osteogenesis is prolong treatment time.[17] To overcome this problem intramedullary nail with external fixator can be used. In this external fixator is removed at the completion of bone transport and stability is provided by intramedullary nail in the consolidation phase of the regenerate.[18] The earlier removal of the external fixator is associated with increased patient comfort, convenient to the patient, rapid rehabilitation and decreased complication rate[18].

Intramedullary nail alone can be used for distraction osteogenesis in the treatment of non-traumatic disorders.[19] Similarly low intensity ultrasound reduces external fixation time in segmental bone transport[20].

This study was conducted to describe the results of locally made "Naseer-Awais" external fixator in the treatment of non-union with bone loss using distraction osteogenesis principals.

MATERIAL AND METHODS

This descriptive study was conducted from July 2004 to January 2007 in orthopedic unit, Hayatabad Medical Complex Peshawar Pakistan. A total number of 32 patients were included in study after taking informed written consent. After preoperative preparation these patients were operated under general or spinal anesthesia. In all patients debridement, resection of sclerotic and infected bone was performed. Locally made "Naseer-Awais" fixator was applied for segmental bone transport. This is a monoaxil external fixator consists of Schanz screws 5 mm which fix bone fragment. These screws are held together by clamps and clamps are interconnected by two rods, one threaded and the other smooth. The pitch of the thread on the rod is one mm.

First the most proximal and distal Schanz screws were passed. After aligning the tibia and maintaining the length clamps and rods were applied to the pins. Rests of screws were passed in the proximal and distal clamps and the rods tightened. The transporting segment fixed with two or three Schanz screws. After this open subperiostel osteotomy was performed with osteotome.

Postoperatively all the patients were treated by bifocal distraction compression method. Distraction was started after 10 days of osteotomy at the rate of 0.5 mm twice a day. Patients with infected nonunion had a prolong use of antibiotic according to culture sensitivity. Screws sites were cleaned with pyodine solution twice a day and patients were instructed to continue pin site care. Ankle and knee joint physiotherapy was started on the first post operative day. They were discharged home on the third post operative day and were called to outpatients department after a week and distraction was started. Then patients were followed fortnightly, radiographs were taken to see regenerate quality and malalignment in the distraction phase. In the consolidation phase patients were followed up monthly. Full weight bearing was allowed after eight weeks. After successful segment transport fixator was removed under general sedation. The results were evaluated using Association for the Study and Application of the Methods of Ilizarov (ASAMI) scoring system[21].

RESULTS

In our study 29 patients were male and 3 were female. Average age of the patients was 29 years range from 16 to 49 years. Eighteen patients developed tibial segmental defect after road traffic accident, 10 after fire arm injuries and 4 after bomb blast injuries. The right limb was involved in 14 cases while the left in 18.

Average bone resection was 3.5cm (range 2 to 5cm) at the time of fixator application. Average length of bone transport was 7cm; ranges from 3 to 17 cm. Average duration of fixator that remained in patients were 8 months (range 3^{1}_{2} to 22 months). Average follow up of patients was 25 months (range 10-42months).

Using ASAMI[21] criteria (Table 1), bone results were Excellent in 18(56.25%), Good in 7(21.87%), Fair in 2(6.25%) and Poor in

5(15.62%) cases in while Functional results were Excellent in 20(60%), Good in 6(18.75%), Fair in 3(9.37%) and Poor in 3(9.37%) cases as shown in table 2.

In this study we had a 100% union. Eight patients (25%) in our study required some additional procedures. In this series 2(6.25%) patients had fibular osteotomy, 2(6.25%) had a fasciocutaneous flap and 4(12.5 %) patients had bone grafting at fracture site. In this study there were no comportment syndrome and no peroneal nerve paralysis. Twenty-eight (87.5%) patients had pin tract infection. Eighteen patients (56.25%) had required pin resiting and 10 (31.25 %) patients needed fixator resiting due to pin loosening. Four patients (12.5%) developed malalignment (25-40^0 angulation) which required fixator resiting. Four (12.5 %) patients had re-osteotomy. Five (15.62 %) patients developed persistent equinus deformity not responding to physiotherapy and underwent tendo-Achilles lengthening. Twenty-three (71.87 %) patients continued their former profession while 9 (28.12 %) had to modify it.

Table 1: ASSOCIATION FOR THE STUDY AND APPLICATION OF THE METHODS OF ILIZAROV (ASAMI) SCORING SYSTEM[21]

Bone results	
Excellent	Union, no infecti on, deformity<7°,limb length discrepancy<2.5 cm
Good	Union + any two of the following: no infection, deformity<7°,limb length discrepancy<2.5 cm
Fair	Union +only one of the following: no infection, deformity<7°,limb length discrepancy<2.5 cm
Poor	Non union / refracture / union + infection + deformity>7° + limb length discrepancy>2.5 cm
Functional results	
Excellent	Active, no limp, minimum stiffness(loss of <15°knee extension/<15°dorsiflexion of ankle),no reflex sympathetic
Good	dystrophy, insignificant pain Active with one or two of the following: Limp, stiffness, RSD, significant pain.
Fair	Active with three or all of the following: Limp, stiffness, RSD, significant pain
Poor	Inactive(unemployment or inability to return to daily activities because of injury)
Failure	amputation

Table 2: BONE AND FUNCTIONAL RESULTS USING ASAMI SCORING SYSTEM (n=32)

Results	Excellent	Good	Fair	Poor	Failure
Bone	18(56.25%)	7(21.87%)	2(6.25%)	5(15.62%)	-
Functional	20(60%)	6(18.75%)	3(9.37%)	3(9.37%)	None

Table 3: COMPARISON OF DIFFERENT STUDIES

Study	Sample Size	Bone Results (%)				Functional Results (%)				Returning to work (%)
		Excellent	good	fair	poor	Excellent	good	fair	poor	
Sanders et al[26]	15	48	21	5	26					62.5
Dendrinos et el[24]	27	50	28	4	18	26	41	15	18	82
Sangkaew C[14]	21	81	14.3	-	4.7	85.7	14.3	-	-	
Sahibzada AS et al[16]	20	60	10	15	15	35	40	20	5	
Our study	32	56	22	6	16	63	19	9	9	72

DISCUSSION

Management of segmental bone loss is challenging task. Much research work has been done for its management like distraction osteogenesis with the use of both multiplaner Ilizarov external fixator and uniplanner monofixators but none has been proven to be free of complication. A study done by Sangkaew C showed average bone transport of 5.6 cm and average fixator time was 8 months in 70 patients[15]. He used conventional external fixator in his study. Pasha et al studied eleven patients and reported average 6.7 cm bone transport in fourteen months by using "Naseer and Awais" fixator.[22] Iqbal A et al average bone transport of 6.4cm in 9.4 months fixator time using "Naseer and Awais" fixator.[23] Using Ilizarov fixator Dendrinoset al achieved healing in 9.6 months with 6 cm bone transport in 28 patients.[24] Similarly in the study of Paley D et al healing took 10.6 months with 6.2 cm bone transport in 25 patients.[25] In our study average fixator time was 8 months for average bone transport of 7 cm. So the result are comparable to both conventional and Ilizarov fixator.

The complications can be divided in to two groups; one related to frame and fracture site and the other related to the distraction process. Majority of complications were related to the former. Pin tract infection was the most common complication in our study and was observed in 89.6% of patients. 57.65% requiring pin resiting while 32% underwent fixator resiting. Pasha et al[22] and Iqbal A[23] reported 40.2% and 38% pin tract infection respectively. Four (12.8%) patients in our study developed malalignment which were treated by reapplication of the fixator. Sangkaew C[15] reported malalignment in 5.7% of patient using monolateral conventional external fixator. With the use of multi planar Ilizarov fixator malalignment was reported in 4(16%) of patients by Dendrinos et al.[24] Another major complication at fracture site which required surgical intervention was delayed union. In our study 12.8% of patient required bone grafting for delayed union. Pasha et al had bone grafting in 53% of cases using "Naseer and Awais" fixator.[22] This problem is less common with the use of Ilizarov frame. Dendrinos et al [24]and Paley D[25]reported use of bone grafting at fracture site in 11% and 0% of patients in there series. Soft tissue related complications due to distraction are mainly nerve traction injuries and joint contractures. In our study there was no case of peroneal nerve paresis. Five (16%) of our patients had developed equinus deformity of the foot and was treated by tendo- Achilles lengthening. Pasha et al[22] and Iqbal A et al [23] reported 13.3% and 7.7% equinus deformity of foot respectively. A total of 71 complications occurred in 28 patients, which makes a ratio of 2.2 complications per patient. This is comparable to those reported in other studies for example by Dendrinos et al[24] reported 2.5 and Iqbal et al[23] 2.38 complications per patient.

Comparison of results in different studies is given in table 3 by using ASAMI[21] criteria.

CONCLUSION

Distraction osteogenesis can be managed with locally made Naseer Awais fixator in non union of tibia with segmental bone loss. It yields excellent results in 56-60% and no failure in this study.

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