

Treatment Of Post Traumatic Femoral Bone Loss Using Ilizarov External Fixator; Technical Difficulties and Complications Analysing Approach

Adel Abdel Azim Foda

Adel Abdel Azim Foda, Lecturer Orthopaedic Surgery, Faculty of medicine Zagazig University, Zagazig, Egypt

Correspondence to: Adel Abdel Azim Foda, sharkia governorate, zagazig city, faculty of Medicine Street, new surgery building, 4th floor, Orthopaedic surgery Department, Egypt.

Email: Afoda77@gmail.com

Telephone: +201206007522

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ABSTRACT

BACKGROUND: Internal bone transport using Ilizarov external fixator for management of post traumatic femoral bone loss is a technically demanding procedure that entails many surgical difficulties. Many complications were encountered either intra or post operative. Proper and early management of these complications markedly improves the overall results.

METHODS: In the period from January 2011 to June 2013, 17 cases of post traumatic femoral bone loss were treated with bone transport using Ilizarov external fixator. All fractures were open, 15 cases were grade IIIb and two cases were grade IIIc according to Gustillo – Anderson classification. The cases included in this study had bone defect more than four cm. The defect was diaphyseal in five cases and metaphyseal diaphyseal in 12 cases with distal intra articular extension in two cases. This procedure was lengthy; to reduce the time of the procedure, all cases were managed either by acute collapse at the fracture site and subsequent limb lengthening or partial collapse of the defect and limb lengthening to achieve limb length equality.

RESULTS: In all cases the bone continuity was restored with complete union of the fracture. The complication rate was high but all of them could be dealt with successfully. According to ASAMI scoring system the bone results were higher than functional results in all cases.

CONCLUSION: This method was proved to be effective in restoring the skeletal integrity inspite of many complications recorded.

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Key words: Bone transport; Distraction osteogenesis; Ilizarov external fixator; Ilizarov complications

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INTRODUCTION

Restoration of bone continuity following traumatic bone loss is challenging especially with massive bone loss. Iliac bone graft will not be enough to fill the defect and the process of graft incorporation and corticalization to support body weight will take a long time and may never be complete^[1]. Micro vascular transfer the fibula with its blood supply is proved to be useful in overcoming large skeletal defects, but it is technically demanding^[2]. Internal bone transport with Ilizarov external fixator provides a solution for this difficult problem. Bone transport is based on the concept of induction of new bone formation when the osseous surfaces are gradually pulled apart; this concept is known as distraction osteogenesis^[2]. Internal bone transport is a demanding procedure that has many operative difficulties and post operative complications. Good preoperative preparation to overcome the surgical difficulties and keen follow up of the cases with skilled management of the complications will achieve better final outcome

METHODS

In the period from January 2011 to June 2013, 17 cases of femoral

fractures with post traumatic bone loss (Figure 1) were treated with bone transport with Ilizarov external fixator at Zagazig university hospitals. The age of patients ranged from 18 to 51 years old (Mean age was 39.5). The mean follow up period was 18 months. All cases were males. Ten cases were right side while 7 cases were left side. The aetiology of the trauma was road traffic accidents in 15 cases and gunshot injury in two cases. The cases included in this study had bone defect more than 4 cm, in 13 cases the defect was more than six cm and in four cases the defect was less than six cm. The defect was diaphyseal in five cases and metaphyseal diaphyseal in 12 cases with distal intra articular extension in two cases. Two cases had ipsilateral diaphyseal tibial fractures, one case had stable pelvic fracture, one case had ipsilateral open multiple metatarsal fractures and one case had ipsilateral humeral shaft fracture.

The general conditions of all patients was stable at the time of admission except for two cases which had hypovolaemic shock which were rapidly controlled by the emergency team. All the fractures were open. According to Gustillo – Anderson classification^[3], 15 cases were grade IIIb and two cases were grade IIIc. One case had sciatic nerve injury, two cases had impalpable neither dorsalis pedis nor posterior tibial pulsations. For these cases urgent vascular evaluation and intervention were done.

Radiological evaluation included plain X-ray from hip to knee joints in both antero-posterior and lateral planes, plain X-ray pelvis, dorsolumbar spine, chest and skull for all cases. Additional plain films were done for five cases which had associated skeletal injuries.

All cases were operated on the same day of injury either by application of the Ilizarov external fixator (Figure 2) or temporary spanning external fixator in cases that needed vascular intervention then definitive external fixation was applied later. The frame was prepared pre – operatively. It was composed of two arches proximally, one floating ring and two rings distally. Thorough debridement was performed under anaesthesia before application of the fixator.

Before application of the frame the femoral condyles were fixed with two cannulated screws for the two cases which had intra articular fractures and extension of the frame below the knee joint was performed for these cases.

Acute collapse of the fracture site was done for cases where the bone defect was less than six centimeters. Partial collapse of the bone defect was done for cases in which the bone defect was more than six centimeters.

After frame application corticotomy was done distally in five cases with diaphyseal defect and proximally in the 12 cases where the defect extended to the distal metaphysis. During application of the frame both the proximal and the distal segments should be aligned with each other in all planes to make the intercalary segment to meet the fixed segment properly at the docking site otherwise malalignment will occur.

Vascular intervention was performed for two cases where unilateral external fixator was applied first then vascular repair was done, after 21 days the unilateral fixator was removed and Ilizarov external fixator was applied aiming for bone transport.

Post operatively daily dressing; continue IV antibiotic therapy for 3 days for 14 cases, while 3 cases which showed persistent infection needed to extend IV antibiotic therapy and repeated debridement. Gradual distraction of the corticotomy site started on the 7th postoperative day on a rate of one millimeter per day divided on four times (every six hours). Active and passive range of motion of the knee joint was encouraged from the second postoperative day with the range increased as tolerated except for the cases which had



Figure 1 Pre operative X- ray of one case.

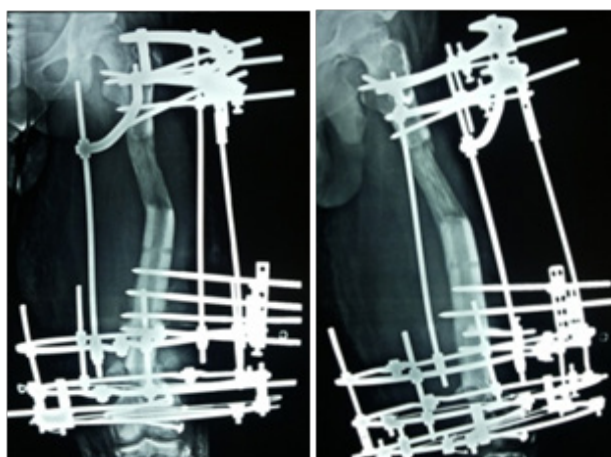


Figure 2 X- ray during the course of treatment.

extended frame below the knee joint.

Secondary surgical procedures were usually needed. In all cases with partial collapse, exposure of the docking site removal of the interposed fibrous tissue, removal of the sclerotic bone edges, and placement of autogenous iliac bone graft were performed. This was followed by compression of the bone ends by approximating the rings connected to both segments. Seven cases required pins and wires exchange for persistent pin tract infection. Adjustment of the frame to correct malalignment in two cases and removal of the tibial frame was performed for the two cases with tibial extension of the frame. This was done eight to ten weeks after application of the frame with union of the intra articular fractures.

Dynamization of the frame was done three weeks before frame removal. This was considered a preparatory step. The aim of this step was to prepare the bone for loss of external support; dynamization was done by loosening of nuts at the ends of the connecting rods. It was done for both the fracture site and the distraction site. The process of dynamization increases callus formation by preventing stress shielding of bone by the external fixator, additionally dynamization increased loads stimulating osteogenesis^[4].

Frame removal was considered when three of four cortices at the distraction site were formed (Figure 3). For the docking site, the presence of enough external callus besides the absence of pain on weight bearing on dynamized frame were taken as parameters

for sufficient union enough for frame removal, also before frame removal we disconnected the ring on each side of the fracture and clinically tested fracture stability, the absence of pain and motions at the fracture site were signs of bone healing.

After frame removal a brace for the whole lower limb extending from the pelvis to the foot was used for all cases and partial weight bearing is allowed till radiographic evidence of bone consolidation.

RESULTS

The mean total time of treatment was 10.55 millimeter/month. This time was taken by bone transport, healing at the docking site and consolidation of the regenerate at the distraction site.

There were three case of delayed consolidation of the regenerate (17.5%) and four cases with delayed union at the fracture site (23.5%) in spite bone grafting and refreshment of the bone ends. Consolidation of the regenerate improved after the use of bisphosphonates. Weight bearing on the dynamized frame improved union progression in cases with delayed union.

There was no significant limb length discrepancy but we had two cases of varus deformity of the femur.



Figure 3 X-ray after removal of the fixator showing varus malalignment.

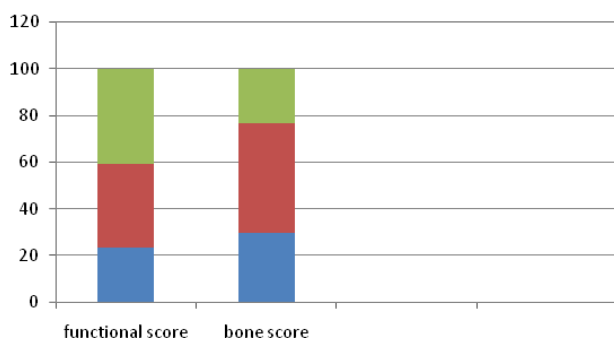


Figure 4 Comparison between functional and bone results. (Good:Blue Fair: Red Poor:Green).

One case had acute ischemia just post operative. This case had acute compression of the defect, immediately the femur was expanded and within few minutes the circulation was restored and the plan was changed to internal bone transport instead of acute collapse and lengthening.

Three cases had 3 persistent infections at the fracture site; they needed repeated debridement under anaesthesia, I.V. antibiotic therapy and daily dressing. Infection subsided in all cases within one month.

Stiffness of the knee joint was present in all cases with variable degrees after removal of the fixator, after adequate rehabilitation program 12 cases regained their functional range of motion however no cases achieved full knee flexion (135°). Five cases had restriction of knee flexion which reached to 90 degrees.

Disuse osteoporosis was present in all cases but completely cured with weight bearing. Three cases had reflex sympathetic dystrophy but cured after mobilization, physical therapy and medical treatment.

All cases had pin tract infection which resolved with repeated dressing and local antibiotics except for seven cases which needed exchange of the infected wires and half pins with new ones in non infected sites

One case had DVT one month after application of the fixator, the condition resolved after medical treatment. Patients were instructed for active mobilization of all lower limb joints as possible for prophylaxis against this complication.

Two cases had septic arthritis of the knee one in the second month and the other in the third month after applications of the fixator, both cases required surgical drainage.

One case had femoral fracture at the transport site three months after removal of the fixator after minor trauma, this case was treated by reapplication of Ilizarov external fixator and bone grafting till healing occurred in four months later.

We used ASAMI scoring system to evaluate our results^[5]. Table 1 shows the results of this study, functional scores are lower than bone scores. There were no excellent results as regard functional or bone results. As regard to functional scoring 23.5% of cases had good score, 35.5% had fair score and 41 % had poor score. As regard to bone score 29.5% of cases had good score, 47% had fair score and 23.5 % had poor score (Figure 4).

DISCUSSION

Restoration of bone integrity after massive bone loss is still a dilemma for orthopaedic surgeons, several methods were tried to overcome this problem as free avascular bone grafts, vascularised bone grafts and bone transport.

Autogenous avascular bone grafts can be used for small bone defects but are not suitable for larger defects even if big quantity is collected from multiple sites, partial resorption of the graft and revascularization by creeping substitution results in weakness of the reconstructed segment predisposing to fractures besides donor sites morbidity^[6].

Vascularised bone grafts are proved to be effective in treatment

	Number of cases according to Bone scoring	Number of cases according to Functional scoring
Excellent	0	0
Good	5	4
Fair	8	6
Poor	4	7
Failure		0

of massive bone defects especially in the upper limb. Various donor sites can be used for vascularised bone grafting, such as iliac crest, ribs or fibula^[7]. The fibula is generally accepted as the most suitable vascularised bone graft for the reconstruction of segmental long-bone defects. The fibula provides up to 25 cm of high-density, straight cortical bone with a good vascular pedicle and minimal donor-site morbidity^[8]. Vascularised graft technique has many advantages including short duration of external fixation and consequently less pin tract infection and less pain, additionally with vascularised fibular graft there is usually no need to secondary operations which is not the case in bone transport, however there are many drawbacks in using this technique including the technical difficulties, vascular failure resulting in necrosis and fracture of the grafted fibula^[9], long time of bone remodelling because of the discrepancy between the graft diameter and the original femoral diameter^[10] and high refracture rate of the fibula especially when the single vascularized fibular graft is applied for a large bone defect of the femur^[11] because difference in size between the donor fibula and the femur which produces stress concentration during weight bearing^[12].

Considerable success has been reported with internal bone transport with Ilizarov technique for treatment of bone defects^[13]. This technique avoids the drawbacks of other techniques, it can restore large bone defects and the bridging bone has the same diameter as the original bone. It causes less soft tissue trauma and no donor site morbidity than vascularised fibular grafts and there is no soft tissue coverage operations needed as the case in vascularised fibular grafts. Bone transport technique can correct bone and soft tissue loss, maintains limb length equality, prevent and correct any skeletal deformities before or during the course of treatment^[10]. With this technique functional loading is allowed during terminal stages of treatment which reduces limb disability from prolonged application of the fixator.

In attempts to shorten the time of application of the external fixator, acute collapse of the bone defect with subsequent lengthening at the corticotomy site is tried by different authors. Acute compression has many advantages as healing process starts from the day of surgery, good bony apposition is achieved from the start, no need for other operations to remove soft tissue from the docking site or refreshing the bone ends or placement of bone graft to stimulate healing process at the docking site and shorter time for application of the external fixator.

The safety margin for the amount of acute compression at the defect site has not been described in the literature^[14]. Some authors consider the absolute size of the defect is the only factor that determines which is suitable to be done, either acute collapse with lengthening or bone transport to restore the bone defect. For defects less than 6 centimeters in the femur or tibia acute collapse with lengthening can be done^[15], for larger defect more than 6 centimeters internal bone transport is used and acute collapse is avoided for fear of limb ischemia due to kink of the vessels at the compression site. Other authors consider the size of the defect suitable for acute collapse is a percent to total length of the femur; they stated that acute collapse can be done when the defect is up to 15% of the femoral length^[16]. In this study acute collapse for bone defects less than six cm was performed but with precautions. Strict follow up of the limb vascularity was routinely done both during and after the operation.

In large femoral bone defect when acute compression of the fractures site is not possible, much time will be taken for the intercalary segment to reach the docking site; this time will be added to the time for bone healing at the docking site. In a trial to improve the situations for bone healing at the docking site partial collapse of

the defect was performed at the time of surgery to approximate the fracture ends to accelerate arrival of the intercalary segment to the docking site. This partial collapse can be safely done without vascular problems. Care should be taken to restore the true limb length by distraction at the corticotomy site. Using this technique the overall time of the procedure is not significantly shortened in comparison to cases done without collapse but this technique affords better circumstances for healing of the intercalary segment at the docking site due to increase the time of contact between the intercalary segment and the fixed segment. The time needed for lengthening and for consolidation of the bone regenerate at the distraction site will increase but usually earlier bone contact and compression at the docking site is preferable. The same vascular precautions done for the limbs treated with acute collapse was followed for patients treated with partial collapse.

The need for reoperations is another problem. The complexity of the procedures makes multiple re-operations mandatory in all cases, in this study all cases need secondary operations the mean number of operations was 3.8 operations per patients. This number is comparable to other authors^[10,17].

Pin tract infection rate was 100% in this study, other series mention that the rate of pin tract infection is also high; this can be explained by long time of application of the external fixator^[11].

Delayed consolidation of the bone regenerate at the corticotomy site is another common problem. We used bisphosphonates to enhance poor consolidation of the bone regenerate. Both, bone formation and bone resorption occur in distraction osteogenesis, blocking bone resorption by anti-resorptive agents, such as bisphosphonates, can lead to increased bone formation^[18].

Stiff knee is more frequent in cases where the external fixator extends distally beyond the knee even if hinges were applied to allow knee motions. 70% of cases had functional range of motion and 30% of cases had limitation of knee flexion. This high percent of knee stiffness is attributed to muscle scarring due to very high percent of pin tract infection and transfixation of vastus lateralis to the femur by the half pins, scarring of the supra patellar pouch and intra articular adhesions; also pain due to pain tract infection and lack of patient co-operation prevents preservation of the normal knee range of motion during application of the fixator.

CONCLUSION

In spite of technical difficulties and many recorded complications, post traumatic femoral defects can be treated successfully using bone transport. Good preoperative preparation and proper management of the complications renders this technique useful for treatment of this problematic issue. Internal bone transport deals with the bone defect, soft-tissue loss, deformity, and leg-length discrepancy simultaneously. Functional results following this technique are not so impressive as bone results.

CONFLICT OF INTERESTS

There are no conflicts of interest with regard to the present study.

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Peer reviewers: Kejian Lian, Professor, Department of Orthopaedic Surgery, The Affiliated Southeast Hospital of Xiamen University, Orthopaedic Center of People's Liberation Army, Zhangzhou, China.