Basrah Journal of Surgery

Bas J Surg, September, 11, 2005

TREATMENT OF CLOSED UNSTABLE TIBIAL SHAFT FRACTURE BY A UNILATERAL UNIPLANER EXTERNAL FIXATION. IS A SECOND OPERATIVE STEP NECESSARY?

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Abstract

This is a prospective study was conducted in Basrah University Hospital from January 1996–January 2001.

Thirty patients with thirty closed tibial shaft fractures were treated until healing with a unilateral uniplaner external fixation device that permits fracture site compression with weight bearing, after failure to maintain adequate closed reduction in plaster. There were twenty-five men and five women, age range from ten to fifty-five years with an average 29.9. Fractures were classified depending on the anatomic location, fracture configuration and extent of concomitant soft tissue injuries. Immediate bone graft was needed for two cases and delayed bone graft for two cases. All patients were permitted early partial weight bearing when their fractures showed early signs of union which took an average of eight to ten weeks and progressed to full weight bearing, with fixator dynamization in seventeen cases. Cast immobilization after removal of external fixation device was needed for all cases. Twenty-four cases showed complete healing. The time to fracture union ranged from twenty-six to thirty weeks average of twenty-eight weeks. The main complications were; four delayed union, two non-union, and twelve cases screw site infection four of which require screw changes with the other eight require antibiotic therapy and local cleaning and ten had stiffness of the ankle joint.

The study highly recommends the use of external fixation as a good alternative to internal fixation for treatment of closed unstable tibial shaft fracture in a compliant, tolerant patient. It provides easy techniques to apply without the need of second surgery to remove it. Most of the complications can be managed without removing the device.

Introduction

Fractures of the tibial diaphysis are considered to be the most common long bone injuries[1]. The standard treatment for the majority of closed tibial shaft fractures consists of closed reduction and cast immobilization, if an acceptable alignment is maintained and weight bearing is initiated early[2-6].

Most authors agreed that criteria for acceptable reduction include less than 12 mm of shortening with angulations less than 5° and rotational deformity less than 5°[3,6,7]. However certain closed tibial shaft fractures are at great risk for non union or mal-union and merit consideration for early operative stabilization, such as fracture with excessive comminution, excessive initial displacement and fractures of proximal and distal third which are difficult to immobilize[2,6,7]. Regardless of the treatment method chosen, the restoration of structural stability and maintenance of an acceptable mechanical axis for the tibial shaft are the criteria of successful treatment. Once the decision has been made to operate there are many options for treatment; Plate osteosynthesis[3]. Closed intramedullary nailing, reamed or un reamed with interlocking[8-10], External fixation[7,11] and Ilizarov method[12,13]. Maintenance of an acceptable reduction while minimizing morbidity determines the treatment options for the patient. Maximum functional restoration is also dependent on the extent of associated soft tissue injury and the possibility of further damage from the proposed treatment which must be weighted when considering treatment options. External skeletal fixation has been applied primarily for open fractures but there are advocates for its application to closed tibial fractures[11,13,14]. External fixation is indicated in unstable closed fractures and closed fractures complicated by compartment syndrome, head injury, burns or impaired sensation[14,15]. The history of external skeletal fixation had began in the middle of the 19th century with Malgaigne[15] who developed straps on metal points and claws to stabilize displaced fractures. The external fixation was used in clinical practice to treat fractures and pseudoarthrosis as well as arthrodesis of the ankle and knee joints. The Association for the study of problems of internal fixation (AO) has also devoted itself to the problems of external skeletal fixation. The introduction of the AO tubular system had brought with it considerable improvements in external fixation device both in design stability and strength[15]. The purpose of this study is to present the results of the use of external fixation as a definite method of treatment for unstable closed tibial shaft fractures.

Patients and method

This is a prospective study undertaken between Jan. 1996–Jan. 2001. Thirty patients with thirty tibial shaft fractures were treated in Basrah University Hospital with unilateral uniplanar external fixation. All patients were admitted to the orthopaedic wards after transport from the causality unit. The mean time of admission after trauma was one hour ranging from (1/2-3hour). The patients were five women and twenty-five men. Their mean age was 24.9 ranging from 10-55years. Eighteen patients were injuired in road traffic accidents; nine were fall from a height and three cases in blunt trauma. The fractures were classified according to the anatomical location, fracture configuration and the extent of the soft tissue injuries (table I). There were nineteen right tibial fractures and eleven left tibial fractures. Associated fibular fracture was seen in all cases. Poly traumatic patients were excluded from the study. All patients were subjected initially to manipulation under anesthesia and their legs were immobilized in above knee back slab plaster. The patients included in this study were those in whom closed reduction failed to be maintained in plaster, those with more than one centimeter shortening, angulation and /or rotation more than five degrees.

The operations were performed three to eight days after admission: except in one case in whom, fixation was done at time of fasciotomy on the same day of accident.

Prophylactic antibiotics were given at the time of induction of anesthesia and for the following three days in form of third generation cephalosporin (cefatoxime). Immediate bone graft was needed in two cases with comminution and delayed bone graft two weeks after application of external fixation when swelling subsided, in two cases. The donor site was the upper tibia, homolateral in two cases and controlateral in two**.**

Procedure:

The fractures were reduced and stabilized by external fixation using AO tubular external fixation. The technique recommended by Hierholzer et al[16] was followed. A unilateral frame with a single longitudinal support and half pins in one plane constitute the unilateral one plane configuration. Three schanz screws of 4.5 mm diameter were placed in each major fragment in the sagittal plane. The safe corridor described by Behrens and Searls was used[17]. Its advantages are that the anterolateral muscles comportment is not penetrated by multiple pins and that is well suited to neutralizing most of the bending forces which tend to cause displacement of the fragment. Drill sheath were used with drilling and pin insertion. Predrilling reduces bone temperature and pins were inserted by hand. The distance between the screws in each fragment was at least 3.5cm. The pin length, the distance between the clamp and the bone, was ideally 5.5cm. Intra fragment preloading was achieved by hand pressure. The wound was dressed in the standard fashion. Pin sponges were applied to minimize soft motion at the pin skin interface. ***Post operative care***: In the early post operative period. The injuired limb segment is often supported by pillows. As soon as the patient is reasonably comfortable active exercise for the ankle, knee and muscle strengthening exercise are permitted .To avoid rapidly developing equines contracture, the ankle joint is splinted in about 5-10 degree of dorsiflexion[17]. Early post operative the patients were allowed to amboulate with crutches, but practically it took 7-10 days. The stitches were removed after 12-14 days. Partial weight bearing was allowed when the fracture showed early signs of healing both clinically and radiologically and then gradually proceeded to full weight bearing as tolerated. At the first radiographic indication of periosteal callus formation with appearance of a gap, the external fixation was dynamized to allow further force transmission through the fracture site. The patient was taught schanz screw and frame care. The pin sites were cleaned daily using an applicator that has been soaked in chlorhexidine solution. The pin site sponge were changed daily until the wound was sealed or without drainage. A visual inspection was made every 2-3 weeks until the fixator was removed to check for pin loosening or infection. When complete healing was determined, the external fixator device was removed. The limb was placed in a protective cast and the patient was allowed to ambulate with weight bearing to toleration with crutches until full weight bearing is possible.

Results

All patients started partial weight bearing from the eighth to tenth weeks post operative. The mean time to full weight bearing was sixteen weeks. The time to fracture union averaged 28 weeks with range from 26-30 weeks. The mean time spent in a frame varied with fracture pattern and was 18 weeks ranging from 16-20 weeks. There was not a single mal-union in this series. Minor pin tract infection presented with discharge and cellulites was seen in eight cases treated by drainage and antibiotics. Major pin tract sepsis warranting removal and reinsertion of the pin at another site with the use of short course of antibiotics occurred in four cases. No cases of chronic osteomyelitis at screw site were recorded. Fracture union within the expected period had occurred in 60% of patients, 24 of 30 patients. Six patients had failed to show signs of union in the expected time, four of them healed spontaneously after prolonged immobilization in 30 weeks .while two cases were labeled as non union. Stiffness of the ankle joint was observed in 10 cases, with persistence of edema of the ankle and foot in two cases.

Discussion

Closed tibial shaft fractures are common injuries that remain challenging to treatment because of the wide spectrum of fracture patterns and soft tissue injuries.

Regarding the type of fracture, several classification schemes have been developed. The goal of AO/ASIF classification is to identify the fracture that have a poor prognosis for healing and leg function (generally the higher energy fracture)[18]. Tsecherne classification of soft tissue injury associated with closed fracture is useful and can aid in the decision making process in the management[18]. Grade 0 and 1 injuries are generally caused by indirect or moderate direct trauma have simpler fracture pattern and have soft tissue suitable for direct incision. Grade 2 and 3 injuries have, more fracture comminution. These injuries generally are caused by high energy direct traum or crush injury, the skin is less suitable for surgical incision. The classification of fracture in this series is shown in Table I. By studying the personality of the fracture as recognized by Nicoll in[2], the tibial shaft fractures that are associated with; complete initial displacement of the fracture, comminution more than half of the circumference of the bone, transverse orientation of the fracture in addition to presence of fibular fracture are indicator of unstable fracture as well as a high energy mechanism of injury[4]. In diaphyseal fracture of the tibia there are different well-established surgical stabilization modalities (plate fixation, intramedullary nailing or external fixation). Each one has its special indication, advantages and disadvantages. No more than ever, the state of the soft tissue cover governs which fixation device should be used. One third of the tibia has no muscle cover and lay directly beneath the skin, so the extent and location of swelling and bruises should be assessed first. The fracture blisters are also a sign of massive soft tissue swelling. Plate fixation of the tibia offers the ability to achieve and maintain anatomic alignment giving it a certain appeal. Plates continue to be associated with increased soft tissue morbidity and early weight bearing is not always feasible[4]. It require a second procedure for hardware removal and the rate of refracture after plate removal has been reported to be as high as 11%[3]. Recently it was shown that the implant with the greatest appeal in the management of closed tibial shaft fracture warranting fixation is the intra medullary nailing[11]. The complications associated with intramedullary tibial nailing include infection, the incidence of infection reported in various studies ranges from 0.9% to as high as 6%[8,9,10,19], the other major risk is compartment syndrome[20,21]. External fixation is a less invasive mode of stabilization. It is the most respectful, amongst fixation devices in cases complicated by soft tissue swelling.

In the philosophy of AO, group regarding fracture healing they stated that external fixation seems to be too rigid to exert a physiological stimulus for normal callus formation. Externally fixed diaphyseal bone heals only slowly or not at all, if no other surgical procedures are applied such as screw fixation of the fracture plus neutralization by the existent fixation or bone grafting or even change to internal fixation. However it was shown experimentally that the combination of a semirigid external fixation constructed with a lag screw resulted in increased tortional stiffness but healing equal to that seen with external fixation alone[22]. With improved components and a better understanding of the principles that governs its safe and effective use, external fixation has become an indispensable tools in the hands of the experienced trauma surgeon and is now becoming used successfully as both primary and definitive stabilization tool in a considerable number of cases[15]. AO tubular fixator is of a simple design is easy to apply and has proved to be highly versatile. Clinical and experimental evidence[15,17,23] emphasises the importance of local mechanical environment on the process of fracture healing to increase the stiffness of an applied frame and to diminish motion at the fracture site which include: placement of the principal frame in the sagittal plane, increasing the schanz screw spread within each main bony fragment, preloading of schanz screw automatically done by slight oversizing (+0.2 mm) of the core, increasing the number of schanz screw in each bony fragment, and reducing the distance between the bone and the tube (significant reduction in the rate of the healing caused by reducing the offset distance of the fixator bar by 10mm)[24]. In vast majority of cases, simple unilateral fixator configurations are sufficient thus avoiding the patient discomfort and functional impairment characteristics of bilateral or circular assemblies. The time to fracture union was averaged 28 weeks and this coincides with other studies[11]. Where the average time to union was thirty weeks. In this series the incidence of delayed union is 13.3% and 6.1 % non union compared to 11% delayed union of tibial shaft fracture treated with reamed and 5% with un reamed inter looking nail. While cases of non-union was 2% with reamed and 8% with non reamed nailing (8.9). The author agree with Hamdan[25] that there was acceleration of fracture healing with gradual build down of the fixator frame and after removal of the external fixator. Progressive force transmission across the healing fracture site appears to stimulate bone formation. Once the patient has progressed to full, unsupported weight bearing, a further increase in force transmission can be achieved though dynamization. It was shown that cyclic movement is produce by early weight bearing with the fixator column closed, while progressive closure of the gap occurs after unlocking the column[26]. Also, a comparative study showed that axial compression with early weight bearing[27] using dynamic ASIF BM tubular external fixation gave a high rate of union and shorter healing times decrease need for bone grafting and also decreased incidence of pin tract infection, less than the delta ASIF static frame. Many studies showed a significant reduction in time to healing when micro movement was imposed[28-31]. Unfortunately, the incidence of pin tract infection was very high 40%. Minor pin tract infection was observed 26.6% while major pin tract sepsis was seen in 13.3%. Pin loosening and infection are notorious complications and are reasons why external fixation has some time fallen into disrepute. The other complication is localized osteoporosis and algodystrophy which was 70% and 40% respectively in one study[32]. In this series, there were two cases (6.6%) with persistent odema of the ankle and foot that responded well to exercise and aggressive physiotherapy.

Ankle stiffness is another complication occurred in 33% of cases in this series. The surgeon should guard against this from the start by proper pin insertion and proper patient education and physiotherapy. The author agrees with Hamdan[25] that all cases need protection in plaster after removal of the external fixator, even when good callus formation was apparent on radiographs.

In conclusion: due to problematic soft tissue situation and poor vascularization of the bone, the external fixation is preferred in the treatment of tibial shaft fractures. With the use of AO tubular component many of tibial shaft fracture cases can be stabilized with a uni planar-unilateral frame.

Table (I): Classification of fractures regarding site, pattern of fracture and state of soft tissue

Site of fracture		*₁Pattern of fracture AO/ASIF classification			*₂ State of soft tissue Tscherne classification			
		A	B	C	0	1	2	3
Upper third	8	4	3	1	2	4	2	0
Middle third	14	7	2	5	6	4	3	1
Lower third	8	5	1	2	2	6	0	0
Total	30	16	6	8	10	14	5	1

$*_1$ AO/ASIF classification:

type A (simple, caused by low force or tortional indirect trauma. Spiral or long oblique).
Type B (bending wedge by intermediate force, transverse or short oblique).
Type C (complex, direct high energy trauma, comminuted).

$*_2$ Tscherne classification system of soft tissue injury associated with closed fractures.

Grade 0: minimal soft tissue damage and swelling.
Grade 1: some abrasions/ contusion with moderate soft tissue swelling.
Grade 2: deep abrasions/ contusion with significant soft tissue swelling.
Grade 3: decompensated compartment syndrome requiring fasciotomy.

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