Лечение обширных огнестрельных ран конечности наружным фиксатором Илизарова с тонкими спицами

Treatment of high-energy gunshot wounds to the extremity with the Ilizarov small wire external fixator

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В настоящее время тактика лечения раздробленных переломов конечностей при обширных огнестрельных ранах, вызванных снарядами высокой энергии сосредоточивается на наружных фиксаторах. Чаще всего сегодня используются односторонние наружные фиксаторы. Целью данного исследования является изучение применения наружного фиксатора Илизарова с тонкими спицами в качестве альтернативного метода лечения этих сложных переломов.

Было пролечено восемь пациентов с тяжелыми раздробленными переломами длинных трубчатых костей, вызванных огнестрельным оружием с высокой энергией ранящего снаряда; использован наружный фиксатор Илизарова с тонкими спицами. Локализация переломов: три перелома дистального отдела плечевой кости, один - средней части лучевой кости, два перелома проксимальной части голени, один -дистального отдела голени и один - дистального отдела бедра. Эффективность лечения определялась функциональными (возвращение к работе, амплитуда движений) и рентгенологическими результатами, наличием осложнений, длительность функционального восстановления, а также необходимостью дополнительных процедур. Период наблюдения за пациентами после лечения в среднем составил 25 месяцев. Один пациент с переломом средней части лучевой кости на контроль не явился.

Случаев остеомиелита не наблюдалось, и все переломы срослись. Рентгенологически все конечности имели нормальную длину и анатомическую ось. У одного пациента с положительным ВИЧ образовался целлюлит, что потребовало снятия аппарата Илизарова. Проводилась одна повторная операция для перепроведения спицы из-за случайного ее выдергивания пациентом. Средняя длительность периода фиксации составила 16 недель. Все больные вернулись на работу до снятия аппарата Илизарова и ни у одного из них не наблюдалось нестабильности.

Результаты данного исследования позволяют сделать вывод, что наружный фиксатор Илизарова с тонкими спицами, возможно, имеет преимущество перед традиционными односторонними фиксаторами в связи с более низким уровнем осложнений.

Ключевые слова: огнестрельная травма, длинные кости, аппарат Илизарова.

Current treatment of comminuted fractures of the extremities caused by high-energy gunshot wounds centers around external fixation. Monolateral external fixators are most commonly used today. The purpose of this study is to examine the use of the Ilizarov small wire external fixator as an alternative method for the treatment of these difficult fractures.

Eight patients who suffered severely comminuted long bone fractures caused by high-energy gunshot injury were treated with the Ilizarov small wire external fixator. The fracture sites were as follows: three distal humerus, one mid-radius, two proximal tibia, one distal tibia, and one distal femur fracture. Efficacy of treatment was determined by functional results (return to work, range of motion), radiologic results, complications, time course of functional return and additional procedures required. The average time of follow up was 25 months. One patient (mid-radius fracture) was lost to follow-up.

There were no cases ofosteomyelitis and all fractures went onto union. All of the limbs were salvaged with good length and alignment as seen on radiograph. There was one case of cellulitis that occurred in an HIV positive patient that resolved following Ilizarov removal. There was one reoperation for a pin reinsertion following incidental removal by the patient. The average length of fixation of all fractures was 16 weeks. All patients returned to work prior to Ilizarov removal and none had instability.

The results of this study suggest that the Ilizarov small wire external fixator may be superior to traditional monolateral frames with lower complication rates.

Keywords: gunshot injury, long bones, the Ilizarov apparatus.

INTRODUCTION

Treatment of comminuted fractures caused by high-energy gunshot injury of the extremities has long been a difficult orthopaedic problem. These fractures carry with them significant risk of infection, non-union, limb-length discrepancy, deformity and often require additional procedures. The use of Ilizarov external fixation in the treatment of these fractures has not been well documented, especially

in the United States. Because of the properties associated with Ilizarov external fixation, we proposed that it would be an excellent treatment choice for these fractures.

Monolateral external fixators are most commonly used today and can provide adequate fixation. They are limited, however, by an increased risk ofangulation deformity since they place an eccentric load on the fracture site [1]. In addition, they often do not allow for early mobilization of the patient [2]. The Ilizarov external fixator, on the other hand, can transmit forces in all planes and directions; thus providing a more concentric force on the bone and more exact direction of healing [1]. The stability provided the apparatus allows the patient to be mobilized out of bed on post-operative day one; with weight bearing as tolerated. The Ilizarov external fixator provides high shear stiffliess and allows for more axial dynamic elasticity. Both of these properties have been shown to promote bone healing [3].

In addition to those mentioned above, the Ilizarov external fixator provides several other advantages in treating high-energy gunshot fractures. Bone healing and infection fighting is directly related to the blood supply at the fracture site. In severely comminuted fractures, blood supply from the soft tissues may remain adequate for bone viability and healing [4]. The small wires used in Ilizarov external fixation cause minimal trauma to soft tissues surrounding the fracture site and thus allow for minimal disruption of this blood supply to the bone via these soft tissues. Unlike unreamed and reamed intramedullary nails which disrupt the endosteal and cortical blood supply (by 30% and 70% respectively), Ilizarov external fixation causes significantly less disruption of these blood supplies and thus creates a more optimal environment for healing [5, 6]. Also, with an Ilizarov external fixator in place, limb-lengthening and realignment procedures can be performed as needed.

This investigation was done to help determine the efficacy of treating comminuted fractures caused by high-energy gunshot injury of the extremities with acute Ilizarov external fixation by an experienced surgeon

MATERIALS AND METHODS

Eight consecutive patients who sustained severely comminuted fractures of the extremities caused by gunshots underwent closed reduction and Ilizarov external fixation. There were seven men and one woman. The sites of injury were as follows; three patients sustained distal humerus fractures, three patients had tibia fractures (two proximal, one distal), one patient had a distal femur fracture and another had a mid-radius fracture (Table I). Several patients sustained multiple injuries, the most serious being a gunshot wound to the abdomen causing a cecal perforation. One patient had a partially transected brachial artery that required a primary repair.

All Ilizarov external fixators were placed in the operating room on traditional operating tables using fluoroscopic guidance. A surgeon familiar with the Ilizarov technique was present for all of the procedures. Standard Ilizarov techniques of closed reduction and small wire circular external fixation were followed.

Efficacy of Ilizarov external fixation was determined by functional outcomes (return to work, pain, range of motion), radiological results, complications, time course of functional return, and additional procedures required. The average time of follow up was 13 months.

Each patient was treated surgically with exploration and debridement of the gunshot wound initially and received intravenous broad-spectrum antibiotics. All of the Ilizarov fixators were applied at the initial operation. One patient required repair of a partially transected brachial artery prior to Ilizarov placement and another had the Ilizarov placed following an exploratory laparotomy. Post-operatively, patients were instructed to clean the pin sites four times per day with 95% alcohol. The external fixators were removed when callous density approached that of surrounding bone and the fracture site was clinically stable. The extremity was placed in a fracture brace until healing was adequate to allow for unprotected use.

RESULTS

The patient with the mid-radius fracture and abdominal wounds was lost to follow-up. Of the remaining seven patients, all exhibited aseptic healing and none developed osteomyelitis. (Table II). There were no non-unions and no bone grafting was required.

All of the limbs were salvaged with good length and alignment as seen on x-ray. The distal femur fracture healed with a slight varus deformity (<5%). The only complication was infected hardware in a distal tibia and fibula fracture in an HIV positive patient during the fourth month of fixation. This resolved following Ilizarov removal. The only reoperation was the reinsertion of a pin following inadvertent removal by the patient. All of the patients who were neurovascularly intact during their initial presentation remained so after Ilizarov placement.

The length of fixation ranged from 2.5 to 6

months (Table II). Both patients with proximal tibia fractures were in the Ilizarov apparatus for 6 months. The patient with distal tibia and fibula fractures was in the external fixator for 4 months. The three patients with distal humerus fractures were in the external fixator for 3 months, 2.5, and 4 months respectively. The distal femur fracture was in the external fixator for 4 months and the distal radius fracture was lost to follow up.

Functional results following treatment were uniformly good (Table II). Both of the patients with proximal tibia fractures were able to ambulate with a normal gait and were pain-free. Each also had good range of motion around the knee and were neurovasucularly intact without disability. The patient with the distal tibia-fibula fracture also was able to ambulate without pain. She did, however, have some decreased strength with dorsiflexion (4/5 strength) of the affected foot as a result ofneurologic injury from the initial trauma. The patient with the distal femur fracture was able to ambulate pain-free, however, he suffered a severe direct injury of his quadriceps and was receiving rehabilitation for this weakness. All three patients with distal humerus achieved functional range-of-motion at the elbow and returned to good function of the affected limb. None had instability, and all returned to pre-injury level-of-function well before the Ilizarov external fixator was removed.

DISCUSSION

Treatment of high-energy gunshot injuries has become an increasingly encountered problem in many urban centers. The treatment of these comminuted fractures is a complicated orthopaedic problem. Ilizarov external fixation is a method not often chosen for treatment of these fractures due to many surgeons' unfamiliarity with the technique.

With the acute placement of the Ilizarov external fixator and the subsequent mobilization of the patient on postoperative day one, good outcomes were seen in all of the patients. All patients healed with satisfactory alignment and length; there were no non-unions or malunions and none developed osteomyelitis. All patients regained use of their injured extremity. Cellulitis was a complication in 14.3% (1/7) of the cases and was successfully treated with P.O. antibiotics. There was only one, short, reoperation.

The Ilizarov external fixator with its ability to transmit forces in all planes and directions has inherent advantages over other external fixators. The small wires used in the Ilizarov system causes minimal trauma to the soft tissues surrounding the fracture and thus allows for minimal disruption of the blood supply to the injury. This reduces the risk of infection and aids in healing. Limb elevation is also provided by the ring configuration.

Conservative treatment of these fractures caused by gunshots is not an acceptable option, as demonstrated by the reported high number of infected nonunions and malunions [8]. A previous study treated 25 grade III extremity fractures caused by gunshots with acute placement of the Ilizarov external fixator. They obtained good results with 88% aseptic healing [9].

Definitive indications for external fixation are not well established for many extremity fractures caused by gunshots. For high energy gunshot wounds to the tibia, external fixation is indicated in severe type II or III open fractures, when there is significant bone loss and/or insufficient soft-tissue coverage, vascular injury, severe contamination or infection, or comminution too proximal or distal for an intramedullary rod [10]. Indications for external fixation for fractures of the humerus caused by gunshots are not as well established. Treatment is often left to the discretion of the surgeon. It has been suggested, however, that definitive indications for application of an external fixator to these fractures include injuries with large soft tissue loss or any injury requiring neurovascular repair [11]. External fixation is a viable option for unstable radius type III fractures and fractures with severe comminution or bone loss [13].

In addition to these indications for external fixation, we believe that acute placement of an Ilizarov external fixator is a viable option in most unstable, severely comminuted fracture caused by gunshots. It allows for immediate mobilization of the patient and has shown excellent functional results in our study. The complication rate with this treatment has also been very low despite many concerns of pin tract infections.

This review hopes to demonstrate that using the Ilizarov external fixator acutely in these patients with comminuted fractures caused by high-energy gunshots is a very effective treatment for this complex problem. Excellent functional results as well as the excellent alignment and length were achieved in our patient sample. We hope to gain more knowledge on this treatment, as more patients are being treated currently with this method. While there may be other effective methods to treat these fractures, the use of Ilizarov external fixation by an experienced surgeon is an excellent and often underutilized option.

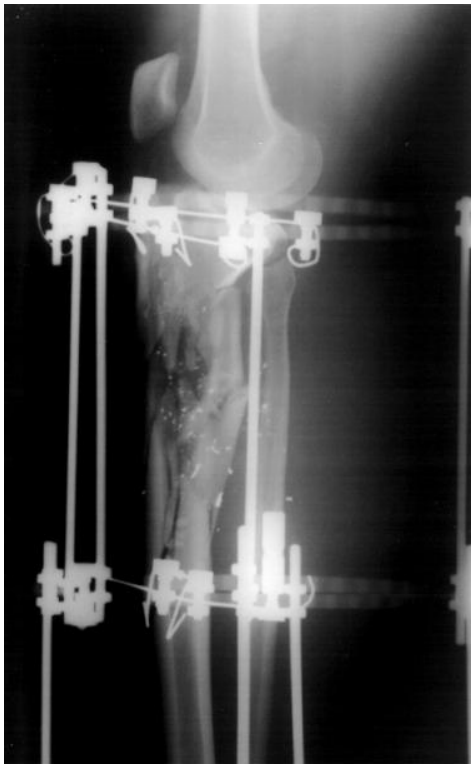

Figure 1. Anterior-posterior radiograph of severely comminuted gun-shot wound to the proximal tibia with Ilizarov external fixator in-place. Radiograph reveals good length and alignment.

Figure 2. Lateral radiograph of the same fracture with Ilizarov fixator.

Figure 3. Anterior-posterior radiograph of the above fracture following Ilizarov removal. Radiograph reveals healed wound with good alignment and length.

Figure 4. Lateral radiograph of the same fracture.

TABLE I

PATIENT NUMBER	PATIENT SEX	FRACTURE SITE/TYPE	ASSOCIATED INJURIES	HOSPIIAL STAY (DAYS)
1	MALE	SEVERELY COMMINUTED PROXIMAL TIBIA	HAND WOUND REQUIRING INCISION & DRAINAGE	5
2	MALE	COMMINUTED PROXIMAL TIBIA	NONE	3
3	FEMALE	COMMINUTED DISTAL 1/3 TIBIA-FIBULA	NONE (HIV POSITIVE)	7
4	MALE	SEVERELY COMMINUTED DISTAL HUMERUS/OLECRANON	FIRST METATARSAL FRACTURE, SEIZURE	9
5	MALE	SEVERELY COMMINUTED INTRA-ARTICULAR DISTAL HUMERUS	NONE	4
6	MALE	COMMINUTED DISTAL 1/3 HUMERUS	TRAUMATIC AMPUTATION LEFT 4TH & RIGHT 5TH DIGITS, PARTIAL BRACHIAL ARTERY TRANSECTION, SEVERE SOFT TISSUE INJURY	8
7	MALE	COMMINUTED MID-RADIUS	CECAL PERFORATION, BUTTOCK WOUND	5
8	MALE	COMMINUTED Distal femur	OUADRICEPS MUSCLE INJURY	5

TABLE II

PATIENT NUMBER	INJURY	RADIOLOGIC OUTCOME	FIXATION TIME (MONTHS)	POST-OPERATIVE COMPLICATIONS	FUNCTIONAL OUTCOMES
1	PROXIMAL TIBIA	GOOD ALIGNMENT & LENGTH	6	NONE	FULL ROM @ KNEE, NO INSTABILITY, NO PAIN
2	PROXIMAL TIBIA	GOOD ALIGNMENT & LENGTH	6	NONE	FULL ROM @ KNEE, NO INSTABILITY.MINIMAL LEG PAIN
3	DISTAL 1/3 TIBIA	GOOD ALIGNMENT & LENGTH	4	CELLULITIS FROM PIN SITE INFECTION	DECREASED DOSIFLEXION, AMBULATES PAIN-FREE
4	DISTAL HUMERUS /OLECRA NON	GOOD ALIGNMENT & LENGTH	2.5	NONE	FUNCTIONAL ROM @ ELBOW,NO INSTABILITY, PAIN-FREE
5	INTRA-ARTICULA R DISTAL	GOOD ALIGNMENT & LENGTH	3	NONE	FUNCTIONAL ROM @ ELBOW, NO INSTABILITY, PAIN-FREE
6	DISTAL 1/3 HUMERUS	GOOD ALIGNMENT & LENGTH	4	FULL-THICKNESS SKIN LOSS	FUNCTIONAL ROM @ ELBOW, NO INSTABILITY, PAIN-FREE •
7	MID-SHAFT RADIUS	GOOD FIXATION	LOST TO F/U	NONE	LOST TO FOLLOW-UP
8	DISTAL FEMUR	GOOD ALIGNMENT(SLIGH T VARUS), GOOD LENGTH	4	QUADRICEPS ATROPHY/WEAKNESS	KNEE ROM (-)5 TO 70-DEGREES, NO INSTABILITY, PAIN-FREE

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Рукопись поступила 08.06.98.