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Research

Functional Outcome Evaluation of Grade III Open Tibial Fracture Treated by External Fixation as Definitive Treatment

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ABSTRACT

Background: Tibial shaft fractures including open tibial fractures grade III are one of the most common fractures of long bones. There are many methods of conservative and operative treatment, one of them is external fixation. External fixation is more common used temporary in polytraumatized patients with tibial shaft fractures. The study was undertaken to see if the patient can be treated with external fixation as the definitive treatment and evaluate the functional outcome after the treatment.

Subjects and Method: A retrospective review of a prospectively-collected database was performed. Data was taken from the Orthopaedic Department of RSUD Dr. Moewardi Hospital patients' database. The study included all patients who underwent grade III open tibial fracture treatment from May 2018 to May 2019. A total of 8 patients who were included in our study were a patient with open tibial fractures grade III planned for external fixaton as definitive treatment. They were evaluated radiographically and clinically to determine the union rate. The data were reported descriptively.

Results: External fixator time ranged in this study around 240 days. In this study, there were a few patients whose progress were remain unknown due to loss of contact. Fractures studied 5 out of 8, no patient were union after 8 months of external fixator used. 4 out of 8 patients were reported non-union after 8 months based on their radiological examination (50%) and 1 out of 8 patients were reported has been performed Removal of External Fixation (ROEF) after 5 months of treatment. The rest of the 3 patients' results were remain unknown.

Conclusion: Open tibial fractures grade III of the leg can be managed with use of external fixator as a definitive treatment. However, the use of external fixation does not provide maximum results in grade III A tibial fractures.

Keywords: open tibial fractures, external fixation, union, malunion

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BACKGROUND

Tibial shaft fractures are one of the most common shaft fractures of long bones. Open, but also many closed tibial shaft fractures can be a very difficult orthopedic problem. There are many methods of conservative and operative treatment. Among operative treatments, the methods of external and internal fixations are applied (Stojković et al., 2006) One possible surgical treatment method is

bridging external fixation. This technique relies on ligamentotaxis to obtain and maintain fracture alignment (Walenkamp et al., 2013).

External fixation was widely used in the early part of the 20th century but fell into disregard later with advent of new internal fixation devices. It became popular again in the 1980s but there were still a number of questions and problems with this device (Beltsios et al., 2009). The external fixation is a method of choice in the treatment of open tibial shaft fractures. Most surgeons prefer intramedullary nail to stabilize tibial shaft fractures. External fixation or plating is also considered as another treatment method, depending on various factors such as surgeon experience, fracture severity, fracture location or the degree of soft tissue injury. Definitive treatment of tibial shaft fractures by external fixation has been reserved for patients with severe open and complex fractures. External fixation is more common used temporary in polytraumatized patients with tibial shaft fractures (Milenkovic et al., 2018). This study aimed to observe if the patient can be treated with external fixation as the definitive treatment and evaluate the functional outcome after the treatment.

SUBJECTS AND METHOD

1. Study Design

A retrospective analysis was carried out. Data was taken from the Orthopaedic Department of RSUD Dr. Moewardi Hospital patients' database. The study included all patients who underwent grade III open tibial fracture treatment from May 2018 to May 2019.

2. Population dan Sample

A total of 8 patients who were included in our study were a patient with open tibial fractures grade III planned for external fixaton as definitive treatment, but 3 of them were loss to follow-up. All 5 fractures were evaluated radiographically and clinically to determine the union rate. The radiographic evaluation was done using antero-posterior and lateral postoperative radiographs taken at the time of healing and at the most recent follow-up.

Acute infected fractures, comminuted diaphyseal, and juxta articular fractures of tibia were also included in the study. Patients with multiple fractures or suffering systemic or bone disease were excluded.

3. Data Analysis

The data were analyzed descriptively in frequency and percentage. Radiology findings were reported in figures.

RESULTS

In the present study, most of the fractures are not union following treatment with external technique. Time from injury to application of frame ranged from 4 days until 2 months. External fixator time ranged in this study around 240 days. In this study, there were a few patients whose progress were remain unknown due to lost of contact. Fractures studied 5 out of 8, no patient found union after 8 months of external fixator used. 4 out of 8 patients were reported non-union after 8 months based on their radiological examination (50%) and 1 out of 8 patient were reported has been performed Removal of External Fixation (ROEF) after 5 months of treatment. Fractures were subsequently diagnosed as non-union and treated by further fixation procedures. The rest of the 3 patients's results were remain unknown.

Table 1: Union status after treatment with external fixation

Union Status in Treatment	Number of Patients	Percentage (%)
Non-Union	4	50%
Union	0	0%
ROEF	1	12.5%
Unknown	3	37.5%

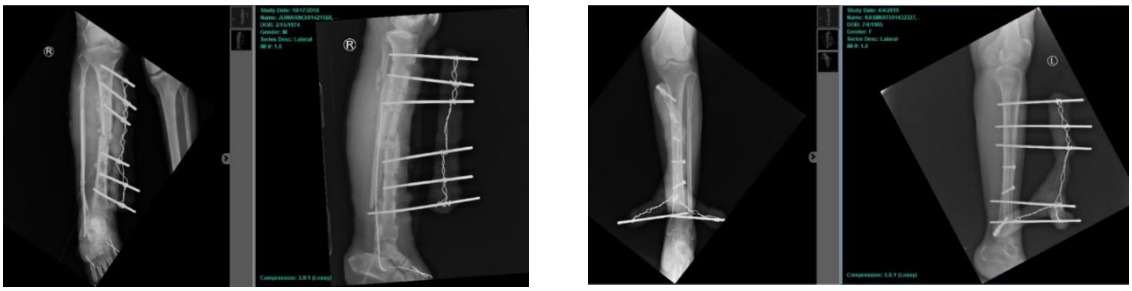
By 8 months, there were no case showed radiological union. 4 out of total 8 cases which were not united at 6 months were diagnosed as non-union at 8 months. The mean time of union in the united cases of fracture in this study was around 240 days.

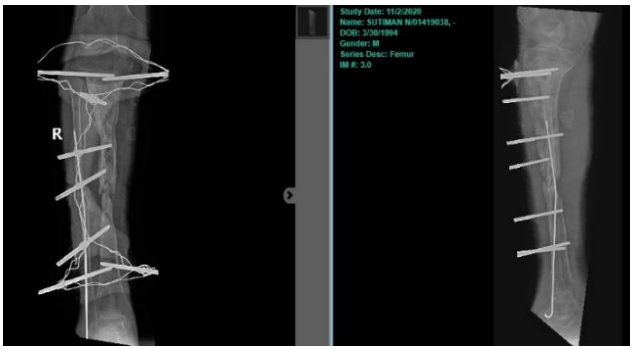
(a)

(b)

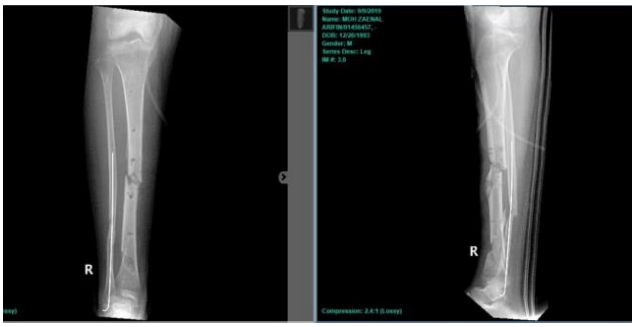
Figure 1. An illustrative union case treated with external fixation. (a) Preoperative radiographs of the injured limb. (b) The initial postoperative radiographs following application of an external fixator is nonunion after 8 months from the initial operation.

(a)





(b)



(c)

Figure 2. An illustrative for result of patients treated with external fixation. (a) union cases.(b) malunion cases (c) ROEF case

DISCUSSION

Physicians have been using external fixation to treat fractures for more than 2000 years after being first described by Hippocrates as a way to immobilize the fracture while preserving soft tissue integrity. The fixator design and biomechanics have changed dramatically over the years, but the principles remain the same. The primary goal of external fixation is to maintain the length, alignment, and rotation of the fracture (Foster et al., 2012). External fixator types divide into several different subcategories, including uniplanar, multiplanar, unilateral, bilateral, and circular fixators. By adding pins in different planes (i.e., placed perpendicular to each other), one can create a multiplanar construct.

Uniplanar fixation devices are fast and easy to apply but are not as sturdy as multiplanar fixation. Bilateral frames are created when the pins are on both sides of the bone and can also add additional stability. Circular fixators have gained popularity with limb lengthening procedures but are especially effective at allowing the patient to weight bear and maintain some joint motion during the treatment (Fragomen, 2007). External fixation plays a vital role in fracture care today. Not only can it temporarily stabilize fractures, but it can provide definitive fixation as well. The use of external fixation in a damage control setting can prevent the so-called "second hit" phenomenon because of the quick application, decreased blood loss, and minimally invasive application.

In Dr. Moewardi Hospital, we often use uniplanar as a treatment for open tibial fractures. Uniplanar devices have side-bars in the same plane as the bone fragments. Uniplanar fixators are called monolateral if one side-bar is connected to the bone fragments using half-pins or bilateral if they employ one side-bar on each side of the limb, attached by pins that transfix the bone. The other device is multiplanar external fixators. These external fixators have connection members that surround the limb. Fixators of this class include circular frames, such as the Ilizarov frame (De Agostinis et al., 2018).

Union was defined as the time when a bridging callus was identified on the radiographs and the fracture site was painless during weight bearing. Delayed union was defined as bone healing that occurred without additional surgery but with a healing time that exceeded double the normal healing time of 3 months. Nonunion was defined as deficient bone healing requiring additional surgical measures such as cancellous bone grafting or revision osteosynthesis. Malunion was defined as bone healing with an axial deviation in any direction exceeding 58 or 1 cm of leg-length discrepancy. Deep infection was defined as infection involving tissue below the muscular fascia (Ma et al., 2013).

The incidence of malunion was investigated and was found to be higher in EF, in accordance with some other meta-analyses. Some published studies have reported that open tibial fracture patients treated with EF may experience malunion, with an incidence of up to 20% (Fang et al., 2012; Xu et al., 2014). Our study showed that the majority of patients given external fixation therapy in Dr.Moewardi Hospital experienced a malunion. Some study found that malunion was associated with suboptimal initial reduction or usually related to secondary displacement following satisfactory initial reduction. Displacements were due to technical

causes, such as inadequate fixation of the palmar medial epiphyseal fragment or the insufficient length of the distal screws (Jeudy et al., 2012).

The main complications associated with external fixation are ankle stiffness, pin site infection and loosening. When external fixation is used for temporary stabilization of tibial shaft fractures, there is an increased risk of subsequent infection of any intramedullary nail used for definitive fixation (Newman et al., 2011). One of the basic goals in the treatment of open tibial fractures is to prevent infection (Newman et al., 2018). Deep infection is an important factor for predicting patient prognosis in terms of limb salvage and preservation of function. Previous studies have indicated that external fixation may increase the risk of infections in the medullary canal and even the risk of amputation. However, in our study, no significant difference in the rates of deep infection was detected.

Advantages of this external fixation system are: more simple application, more simple additional fracture reduction if needed (without additional surgery), safer with regard to intraoperative injuries of neurovascular, tendineae and muscular structures as pins enter through safe areas of subcutaneous surface of tibia, less bulky providing an easy additional plastic procedure (Grubor et al., 2012).

Other study showed that an external fixator is a safe and viable procedure in tibia if it is done by protocol and planned from the onset of treatment. In the tibia, the soft tissue envelope is the determining factor for using an external fixator. To avoid possible serious complications such as deep infection as well as to improve bone mineralization, conversion should be done as soon as the soft tissues allow and in a one stage procedure (Pairon et al., 2014).

We concluded that open tibial fractures grade III of the leg can be managed with use of external fixator as a definitive treatment, although the use of external fixation does not provide maximum results in grade III A tibial fractures. The follow up of this treatment modality is a bit complicated but external fixation treatment has a minimal additional operative trauma and an acceptable complication rate.

AUTHOR CONTRIBUTION

Each author individually made significant contributions to the development of this manuscript.

CONFLICT OF INTEREST

All the authors declare that there was no conflict of interest referring to this manuscript.

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