Injury, Int. J. Care Injured 49 (2018) 376–381

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Full length article

Is external fixation needed for the treatment of tibial fractures with acute compartment syndrome?

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ARTICLE INFO

Article history:
Accepted 15 November 2017

Keywords:
Acute compartment syndrome
Tibial fracture
External fixation
Fasciotomy

ABSTRACT

Acute compartment syndrome (ACS) after tibial fracture carries a risk of various complications, including infection, delayed union, nonunion, nerve damage, and poor prognosis. For the treatment of fractures with ACS, fasciotomy is conducted, and the method to stabilise the fracture has to be considered. Thirty-five patients who underwent surgery for ACS with tibial shaft fractures were evaluated, and the results of initial internal fixation (Group I, 20 patients) and initial external fixation (Group II, 15 patients) were analysed. The mean age was 41 years. Five patients needed additional surgery for bone union. Complications occurred in 4 cases, but no deep infection was reported. The time to bone union, the need for additional surgery, and the incidence of complications in Group I and Group II were not statistically different. For the treatment of ACS with tibial fracture, immediate internal fixation and changing from external fixation to internal fixation did not affect the clinical course.

Introduction

Acute compartment syndrome (ACS) is a limb-threatening condition, which presents a surgical emergency. This syndrome develops in 4.3% of tibial shaft fractures, and 40% of overall acute syndromes occur from tibial shaft fractures [1,2]. If diagnosis and treatment for ACS is delayed, complications such as muscle necrosis, infection, contracture, and the need for amputation can develop, causing significant functional issues [3]. In cases of ACS with tibial fractures, the incidence of complications such as infection and nonunion is higher than that for simple tibial fractures [4].

For the treatment of tibial fractures with ACS, decompression of all 4 compartments using fasciotomy is most important. After 4-compartment fasciotomies, a staged closure of the fasciotomy sites is primary closure, split-thickness skin grafts, or local fascio-cutaneous flaps [5]. Upon fasciotomy, external fixation is carried out to stabilise the fracture or internal fixation is performed immediately following fasciotomy.

The purpose of this study was to compare clinical and radiological outcomes of treating tibial fractures with ACS using external fixation and fasciotomy with immediate internal fixation. Our hypothesis was that these methods do not differ in terms of the incidence of complications such as infection and nonunion.

Institutional review board approval was obtained for this study. This study was performed in accordance with the Declaration of Helsinki.

Patients and methods

Patients were identified through our trauma registry and database over a 4-year period ranging from March 2012 to March 2016. All patients were treated at a single Level I trauma centre by a single orthopaedic trauma surgeon (corresponding author). Patients were skeletally mature (over 18 years old) with an acute tibial shaft fracture surgically treated for acute compartment syndrome requiring fasciotomy. The diagnosis of ACS was made as per the clinical judgement of the attending orthopaedic surgeon (corresponding author). The following were excluded: lower extremity amputation, open fracture of higher than Gustilo-Anderson type II accompanied by bone defect, clear evidence of brain damage (Glasgow Coma Scale <15), polytrauma of greater than ISS 16, pathologic fracture, periprosthetic fracture, and patients without a follow-up longer than 1 year after surgery.

Fasciotomies were performed using a single incision or double incision technique, releasing all 4 compartments of the lower leg. Following 4-compartment fasciotomies, negative pressure wound therapy was conducted on the surgical wounds. A staged closure of

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https://doi.org/10.1016/j.injury.2017.11.018
0020-1383/

the fasciotomy sites was performed using primary closure or split-thickness skin grafts.

Fixation of the fracture was conducted after fasciotomy, by either temporary external fixation or definitive fixation using a plate or intramedullary nail. Depending on the technique used for the stabilisation of the initial fracture, patients were divided into two groups (Group I: definitive fixation; Group II: temporary external fixation). If temporary external fixation was performed and closure of fasciotomy sites was considered possible, then definitive fixation was conducted followed by closure of fasciotomy sites.

The electronic medical records and radiographs of each patient were reviewed. Data collection included the following parameters: age, gender, body mass index (BMI), smoking status, past illness, injury mechanism, AO/OTA fracture classification, Gustilo-Anderson open fracture classification, time (days) to definitive closure of fasciotomy wounds, time (days) to definitive fixation, method of fixation, wound closure method, time to bone union in months, presence or absence of complications, and additional surgery. The time to definitive fixation was defined as the time between the injury and definitive bone fixation. Bone union was confirmed when callus formation was observed in 3 or more of the 4 cortices. Delayed union was defined as cases in which more than 6 months were required to reach bone union without additional surgery, while nonunion was defined as cases where bone union required further surgical treatment. Routine follow-up was conducted at 4-week intervals until solid callus formation. Malalignment (or malunion) was defined as cases with angulation or rational deformity of more than 5° compared to the normal limb. Final clinical outcomes were evaluated using the Lower Extremity Functional Scale [6] (LEFS: 0 = unable to perform any activity to 80 = excellent function) by a physician who was blinded to patient information. Complications were recorded as union-related or soft tissue-related.

The software package, SPSS version 22.0 (SPSS Inc. Chicago, IL, USA), was used for the statistical analyses. The Kruskal-Wallis test, Mann-Whitney test, Chi-square test, Fisher's exact test, and regression analysis were used to determine the relationships between each group. A p value of <0.05 was considered significant for all analyses.

Results

A total of 35 patients were included in the study (Table 1). The average age was 41 (21–61) years, with 25 males and 10 females. The average BMI was 24.5 (19.5–29.4), and 4 patients had a history of diabetes. At the time of the injury, 12 patients were smokers, 5 patients had a prior history of smoking but had quit smoking, and 18 patients had no history of smoking. The injury mechanisms are as follows: 9 pedestrian traffic accidents, 17 motorcyclist accidents, 4 industrial accidents, and 5 vehicle accidents.

Immediately following fasciotomies, definitive fixation was performed in 20 patients (Group I), out of which 4 patients had plates and 16 patients had IM nails for fracture fixation (Fig. 1). Following fasciotomies, temporary external fixation was performed in 15 patients (Group II), out of which plates were used in 3 patients and IM nails were used in 12 patients for definitive fixation (Table 2).

Time to wound closure took on average 10.6 days (range: 5–18 days) and definitive fixation on average 5 days (range: 0–16 days). In terms of wound closure, 20 patients had gradual closure, and 15 patients had split-thickness skin grafts (Fig. 2). Time to bone union took on average 5.8 months (range: 3–12 months). Five patients presented with delayed union and 5 patients with nonunion.

Additional surgery for bone union was conducted in 5 cases, which included 1 case of dynamisation, 2 cases of autoiliac bone graft, and 2 cases of exchange nailing. Complications were observed in 4 cases, including 1 case of superficial infection, 1 case of partial necrosis of the skin graft site, and 2 cases of malalignment. There were no cases of deep infection.

Between Group I, that received definitive fixation immediately for stabilisation of the initial fracture, and Group II, that received temporary external fixation, there were no statistical differences in gender, age, BMI, smoking status, diabetes, injury mechanism, and AO/OTA type. For Group II, who received external fixation, switch to internal fixation took on average 9.3 days. Time to wound closure (days) was on average 10.9 days for Group I and 10.4 days for Group II ($p = 0.831$). Time to bone union (months) was on average 5.6 months for Group I and 6.3 months for Group II ($p = 0.681$). Additional surgery was conducted on 2 patients from Group I and 3 patients from Group II, showing no statistical difference ($p = 0.360$). Complications occurred in 2 patients from both Group I and Group II, showing no statistical difference ($p = 0.581$). The final clinical score of LEFS also showed no statistical difference between the 2 groups.

Discussion

The soft tissue surrounding the tibia is thin, often leading to open fracture of the tibia. Recent trends in fixation methods for tibial shaft fracture indicate immediate intramedullary nailing for

Table 1
Patient demographics.

		No (Group I)	External fixation (Group II)	P-value
Sex	Male (n)	14	11	0.567
	Female (n)	6	4	
Age (years)		41.0 ± 10.5	41.5 ± 13.3	0.714
BMI (kg/m^2)		24.17 ± 2.38	24.47 ± 2.80	0.419
Smoking	No (n)	10	8	0.513
	Quit (n)	4	1	
	Current (n)	6	6	
DM	No	18	13	0.581
	Yes	2	2	
Injury Mechanism	Pedestrian (n)	6	3	0.665
	Motorcycle (n)	9	8	
	Industrial (n)	3	1	
	In car TA (n)	2	3	
Fracture type[a]	A (n)	8	4	0.121
	B (n)	9	4	
	C (n)	3	7	

[a] Fracture type according to AO/OTA classification.