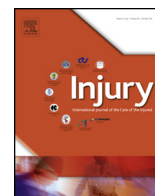




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Soft tissue complications and timing of surgery in patients with a tongue-type displaced intra-articular calcaneal fracture: An international retrospective cohort study

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ABSTRACT

Introduction: Tongue-type displaced intra-articular calcaneal fractures (DIACF) are associated with a specific pattern of fracture displacement in contrast to joint depression fractures. This may result in tension of soft tissue in the posterior part of the heel. Tension-induced ischemia can result in skin necrosis. The objectives of this study were to investigate whether patients with tongue-type calcaneal fractures exert a higher risk of complications, especially of the posterior soft tissues, than joint depression type fractures. Also, late interventions (e.g., antibiotics, debridements, and amputations) and the effect of timing of surgery on the complication rate was assessed.

Methods: In this international retrospective cohort study, data of adult patients with a DIACF in the period January 1, 2005–December 31, 2015 were extracted from patients' medical files. Descriptive, univariate, and multivariable analyses were performed in SPSS.

Results: A total of 560 patients with 632 DIACF were included (295 tongue-type and 337 non-tongue-type fractures). At hospital presentation, 20.3% of the patients with a tongue-type fracture had compromised posterior soft tissue versus 12.8% with non-tongue-type fractures ($p=0.032$). However, corrected for potential confounders the risk was no longer statistically significant (OR 1.497; 95% CI 0.831–2.696). Patients with a TT-DIACF had a 1.2–3.4-fold higher rate of any local wound complication (deep infections, and full thickness lesions, $p<0.03$). In addition they had 2.0–8.0-fold more intravenous antibiotics, debridements, soft tissue coverage procedures and amputations ($p<0.03$). Patients who underwent surgery within two days after trauma had a higher risk to develop any complication, in particular superficial infections, when compared to surgery between 3–7 days, but no significant difference between 3 and 7 and ≥ 8 days could be demonstrated.

Conclusion: Despite the fact that patients with a tongue-type fracture developed posterior skin and soft tissue compromise nearly twice as often, this difference disappeared after correction for confounders. The overall complication risk was increased in patients with tongue-type calcaneal fractures as compared to patients with a non-tongue-type fracture. Whether or not patients with tongue-type fractures require immediate surgery cannot be concluded from the data.

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Introduction

According to Essex-Lopresti displaced intra-articular calcaneal fractures (DIACFs) can be divided, into either tongue-type or joint depression patterns [1]. In a tongue-type DIACF, the fracture line disperses longitudinally from the articular surface and exits

posteriorly through the calcaneal tuberosity. Hereby, the posterior tuberosity fragment is displaced superiorly and dorsally due to traction of the Achilles tendon and plantar fascia. This specific pattern of fracture displacement easily results in significant pressure on and tension to the skin covering the posterior part of the calcaneus. Too much or prolonged tension may aggravate trauma-induced soft tissue injury, due to additional soft tissue ischemia, and finally necrosis, and thus converting a closed fracture into an open one (Fig. 1). Posterior skin compromise is

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described to occur in 21% of the patients with tongue-type calcaneal fractures [2].

Displaced intra-articular calcaneal fractures are often managed operatively [3]. Postoperative wound infections occur frequently, often resulting in delayed wound healing and prolonged length of hospital stay, and sometimes in permanent iatrogenic disability [4,5]. In order to decrease the number of wound complications, it was thought that patients would benefit from delayed operative fixation of calcaneal fractures [6]. However, failure to detect ongoing soft tissue deterioration during the (pre-operative) period may also lead to additional soft tissue morbidity [1,5]. It is the question whether a delayed surgical procedure is suitable for all calcaneal fractures.

Reversible skin ischemia (*i.e.*, compromised skin perfusion due to the specific fracture displacement) may progress into irreversible skin necrosis if patients with tongue-type DIACFs are not operated on immediately [2,7]. To date, little has been reported on posterior soft tissue complications associated with tongue-type calcaneal fractures.

The primary aim, of this study was to compare the rate of posterior soft tissue compromise in adult patients with a tongue-type versus non-tongue-type DIACF. Secondary aims were 1) to compare the rate of other complications; 2) to compare the rate of late interventions; and 3) to examine the effect of timing of surgery on the complication rate.

Methods

Study design

In this international, retrospective cohort study patients were identified from hospital records based upon their ICD-10 (International Coding of Diseases, 10th revision) code S92.0, Diagnosis Related Group (DRG; in Dutch, DBC) code 236, or hospital specific surgical intervention codes. Data were extracted from the patient's medical files in the three participating hospitals.

Adult patients aged 18 years or older who were treated for a unilateral or bilateral DIACF (Essex-Lopresti tongue-type or joint depression type and Sanders type II–IV) between January 1, 2005 and December 31, 2015 were eligible for inclusion if a clinical follow-up of at least three months was documented. Patients suffering from local skin conditions that were not related to the fracture itself, but could influence outcome (*e.g.*, burn or chemical wounds or pre-existing skin conditions in the affected foot region for example resulting from diabetes mellitus or venous insufficiency) and patients with a pathological calcaneal fracture were excluded. Open fractures, not caused by direct external trauma, were not excluded.

Data collection

Patient characteristics (*i.e.*, gender, age at trauma, ASA grade, Body Mass Index (BMI), comorbidities, and medication use), injury characteristics (*i.e.*, date of trauma, affected side, trauma mechanism, fracture classifications [1,8], soft tissue compromise, injury classifications [9], and radiographic measurements [2,10]), treatment characteristics (*i.e.*, admission duration, method of swelling reduction, treatment type: Open Reduction and Internal Fixation (ORIF), Closed Reduction and Internal Fixation (CRIF), primary arthrodesis or non-operative treatment (*i.e.*, plaster cast, a pressure bandage or PTB-Brace), initial soft tissue coverage), complications, and late interventions were obtained from the electronic patient's medical files.

Compromise was defined as the lack of sufficient blood supply for soft tissue to remain viable. Compromise is defined as a reversible condition, but could potentially result in more severe (*e.g.*, infection), or irreversible conditions (*e.g.*, necrosis). Soft tissue compromise is limited to the posterior part of the foot. Compromise at the anterior, lateral, and medial side were not registered as compromise, nor was compromise caused by external trauma. In this study the following conditions are registered as compromise, when occurred within three weeks post trauma (or



Fig. 1. A. Lateral radiograph of a tongue-type DIACF at first hospital presentation, with severe displacement of the posterior tuberosity of the calcaneus. B. Presence and impending posterior soft tissue compromise (*e.g.*, hematoma, blisters, and necrosis) due to the specific fracture displacement resulting in high tension on the skin. C. Status after Open Reduction and Internal Fixation (ORIF), 5 months after trauma. D. Wound healing after ORIF via Sinus Tarsi Approach.

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