**Acute Compartment Syndrome of the Foot After an Ankle Sprain: A Case Report**

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**Abstract**

**Objective:** To present the diagnostic and clinical features including management of acute compartment syndrome of the foot and to create a sense of emergency amongst orthopaedic surgeons of this rare and dangerous condition.

**Clinical features:** A 19-year-old young man presented at the emergency department referring a twisting injury of his left ankle presented with swelling and pain after an acute second-degree lateral ankle sprain. The patient was treated with the RICE protocol (rest, ice, compress, and elevate). Two days later, the patient returned at the emergency department, late at night with severe swelling, paresthesia, referring an excruciating pain at his left foot and inability to walk. A diagnosis of foot compartment syndrome was made.

**Intervention and outcome:** An emergency fasciotomy of the lateral and medial compartment (dual dorsal incision) of the foot was performed and necrotic muscle parts were removed.

**Summary:** Foot compartment syndrome is a rare but existent complication of ankle injuries. Every patient with ankle sprain should be informed about potential complications and advised to be immediately examined in case of suspicious symptoms. This article discusses the key components of presentation, diagnosis, and management of foot compartment syndrome.

**Keywords:** Acute compartment syndrome; Ankle sprain; Foot; Compartment syndrome; Diagnosis; Fasciotomy; Surgical emergency

**Introduction**

Compartment syndrome occurs whenever the pressure within a closed osseofascial anatomic space is greater than its perfusion pressure leading to muscle and nerve ischemia. Untreated, compartment syndrome leads to tissue necrosis, permanent functional impairment, renal failure, limb-threatening, and occasionally life-threatening injury leading to death [1]. Ankle sprains are very common musculoskeletal injuries leading to medical treatment. Initially, a common treatment plan for an acute inversion ankle sprain is RICE protocol (rest, ice, compress, and elevate). Acute compartment syndrome of the foot is extremely rare after an ankle sprain. This article presents a case of acute compartment syndrome of the foot following a grade two lateral ankle sprain in a 19-year-old male. The patient consented to release all information in regard to his case for publication.

**Case Report**

A 19-year-old male presented to emergency department with a primary complaint of left lateral ankle pain and swelling surrounding and up to 4 cm proximal to the lateral malleolus following a low-energy injury into ankle inversion and plantar flexion. Physical evaluation revealed a 2nd degree lateral ankle sprain. The foot was swollen with a normal neurovascular status. Radiographs were interpreted as normal. The patient had no noteworthy medical history or regular medication. The patient was treated with the RICE protocol (rest, ice, compress, and elevate), a below-the-knee posterior plaster splint was applied, along with an antithrombotic prophylaxis (Heparin 4000 I.U. once a day). Two days later, the patient returned at the emergency department, late at night, due to inability to walk, extreme constant sharp, electric like pain out of proportion of injury and rapidly deteriorating neurological signs.
Physical evaluation showed severe swelling of the left foot and decreased range of active and passive motion. Vital signs revealed a temperature of 36.7, pulse rate 115 bpm, respiratory rate 20 bpm, and blood pressure was 130/80. Pain intensity was reported as 10/10. Blood test results were normal or close to reference levels. Further, there was severe edema with ecchymosis on the dorsum of the left foot and the toes, the skin was tense and pale, the dorsalis pedis and posterior tibial pulses were palpable. Capillary refill time was less than 3 seconds bilaterally. The patient was sent for complete Doppler examination of left leg. There was no evidence of deep vein thrombosis in the left leg. Further, Doppler ultrasound showed intact dorsalis pedis and posterior tibial pulses of the left foot.

Another radiological foot and ankle series was performed and read as unremarkable (Figures 1 & 2). CT-scan of the ankle and foot was negative for fractures (Figure 3). Under the potential diagnosis of foot compartment syndrome an emergency fasciotomy of the lateral and medial compartment of the foot was performed, (dual dorsal incision, overlying the second and fourth metatarsals) all the foot web spaces under the incisions were carefully opened and necrotic muscle parts were removed. Within minutes, skin changed colour from pale to pink. As soon as the patient recovered from anesthesia, he reported dramatic relief of pain. Many surgical approaches have been proposed for an acute compartment syndrome involving the whole foot, with a double-incision technique on the dorsum and/or an additional medial approach preferred depending on the location of a specific fracture (Figure 4) [2-4]. In our patient a double-incision technique was sufficient to relieve intramuscular pressure and avoid muscle necrosis and late sequelae (Figures 5-7). Secondary intention of wound healing and non-weight-bearing 90° below knee plaster splint followed for 20 days. Rehabilitation exercises were completed at home for two months duration. Upon one-year follow-up all motor testing was within normal limits. The patient could actively dorsiflex the foot to 18° and plantarflex to 50°, normal ranges are 20° and 50° respectively. No contractures of the toes or deformities of the affected leg or foot were noted. Follow-up at 6 months showed full recovery.
Discussion

In this case acute compartment syndrome was a complication of a second-grade degree ankle sprain. Acute compartment syndrome typically occurs after a [5-9] traumatic event such as a fracture, soft tissue injury, or vascular trauma [1,10]. Although there are various theories of how compartment syndrome develops, the exact mechanism is unclear. The most accepted explanation is that the hypoperfusion occurs to the tissues in response to the increased intercompartmental pressure lead to tissue ischemia and necrosis of muscles and nerves in the compartment [1,4,11]. The result of acute compartment syndrome without surgical intervention includes severe neurological deficits, ischemic contracture, gangrene, and tissue necrosis leading to amputation [1,5,10]. Therefore, early diagnosis is extremely important and requires a high index of suspicion during evaluation of the patient [12-14]. Initial management of foot compartment syndrome is to elevate the foot to the level of the heart, which maintains adequate venous drainage without compromising local arteriolar pressures [3]. Ice is contraindicated in compartment syndrome, as this may impair microcirculation. If compartment syndrome is due to a circumferential cast, the cast should be univalved, bivalved, or completely removed to decrease pressure within the compartments [15-17]. Fasciotomy is the definitive treatment of compartment syndrome. Most myoneural deficits due to ischemia can be prevented if fasciotomy is performed within 12h. If left untreated, the prolonged elevation of intercompartmental pressure will lead to ischemic injury of the nerves and muscles. This ischemic injury can develop within 5–6h and ultimately result in muscle necrosis, ischemic contracture, frequent chronic pain, infection, and delayed healing of fractures [8,18]. Functional neural deficits begin within 30min of ischemic onset and become irreversible after 12–24h of ischemia [1,13]. Muscle dysfunction occurs after 2–4h and becomes irreversible after 4–12h of ischemia [1,13].

There are currently nine specific compartments within the foot that have been described: medial, lateral, superficial, [19,20] adductor, the four interosseus compartments and calcaneal [1,9,10]. The calcaneal compartment contains the quadratus plantae muscle, the posterior tibial nerve, artery, and vein, and the lateral plantar nerve, artery, and vein [21]. The four interosseus compartments contain the interossei muscles, and the adductor compartment contains the adductor muscle. The flexor hallucis and abductor hallucis muscles compose the medial compartment, and the abductor digitii quinti and the flexor digital minimi muscles compose the lateral compartment. The superficial compartment contains the flexor digitorum brevis muscle, the lumbrical muscles, and the flexor digitorum longus tendons [22]. Acute compartment syndrome may present as increased pain out of proportion of original injury, that is particularly accentuated by active and passive range of motion of the ankle joint, forefoot or toes, sensory deficits in the specific compartment, pallor, paresthesia, pallor, paralysis [11,17] and a significant amount of swelling. Pulselessness is uncommon and only seen in the late stages of acute compartment syndrome [1,7,10]. Severe and spontaneous pain has been identified as the earliest and most sensitive clinical sign that
manifests with acute compartment syndrome of the foot [4,12,23]. Muscle necrosis can occur within 4 hours [24]. Irreversible nerve damage, muscle contracture, and anatomic deformities can result after 12 to 24 hours [25]. Most often the clinical diagnosis of acute compartment syndrome is confirmed by measurement of the intercompartmental pressure. Many different methods exist for measuring intra-compartmental pressures, such as the Stryker IC pressure monitoring system, the Ace IC pressure monitor, the needle technique, the wick catheter, and the slit catheter. In our patient the ICP was not measured due to convincing signs and symptoms of acute compartment syndrome. Normal compartment pressure is between 0 and 10mmHg [16]. In patients presenting with acute compartment syndrome, pain and paresthesia first appears at an ICP between 15–30mmHg. Patients with a measured intercompartmental pressure of 30mmHg are recommended to undergo an immediate fasciotomy. [2] A compartment syndrome of the foot typically follows an acute bony or soft-tissue injury, frequently high-energy as might occur with a calcaneal or Lisfranc joint fracture, for example [3]. Even without evidence of major trauma, acute compartment syndrome in the foot has been reported secondary to closed muscle rupture, [26] use of anabolic steroids, [14] oral anticoagulation and bleeding disorders, associated with trauma [27], popliteal vein thrombosis, [28] after thrombolysis for myocardial infarction [29] and after hemilithotomy positioning in the operating room [30]. Open injuries do not necessarily release compartments as it is improbable that all nine compartments will be released with open injury. Compartment syndrome may follow an acute vascular ischemic attack of primary origin or after elective vascular surgery [31].

Summary

Acute foot compartment syndrome typically occurs after trauma, as seen in crush injuries or motor vehicle accidents, surgery, vascular injury and fractures, especially in Chopart and Lisfranc joint dislocations [32-35]. Patients who present with high-energy fractures and severe crush injuries to the foot are at risk of developing acute compartment syndrome and should be monitored serially [1,3]. The foot is a rare location for compartment syndrome, accounting for approximately 5% of all reported cases [2,22]. The goal of surgery in acute compartment syndrome is to open the inelastic osseofascial planes surrounding the edematous muscle allowing venous circulation to recover [21]. The diagnosis of foot compartment syndrome is challenging and requires a high index of clinical suspicion. Compartment syndrome of the foot should be considered early in the evaluation for any foot injury associated with soft tissue swelling [17,19].

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