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Case Report

Brake Pedal Injuries to the Foot: Not Always Too Obvious

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Received: August 03, 2016; **Published:** August 05, 2016

Abstract

Injury statistics show that lower extremity injuries follow second to head trauma in motor vehicle crashes. Fractures to the ankle/foot make up approximately 35% of all lower extremity injuries in motor vehicle crashes [1].

Keywords: *Pedal injuries; Foot fractures; Ankle and Foot; Foot fractures*

Introduction

Despite achievements in vehicle construction safety, the proportion of foot and ankle injuries sustained by drivers in frontal crashes has not decreased over the past two decades. It appears that despite recent advancement of vehicle performance in crash tests, efforts to reduce axial forces sustained in lower extremity remain uninfluenced [2,3]. Not always is the injury obvious. In polytraumatised patients, it can be missed - in others underestimated.

The Case

A 27-year-old female was involved in a road traffic accident as restrained driver of a Vauxhall Corsa. According to her estimate, she travelled with 40 km/h on a country road when another small car approached at approximal 60 km/h. It collided head-on into the patient's car in an 11 O'clock position. The airbags deployed. The patient was able to anticipate the events and to slam her foot on the brake making an emergency stop. The deformity of the car was not significant. The patient was able to exit the car but found it difficult to bear weight on her right foot. She was taken to hospital by the ambulance.

On arrival, she was immobilized on the stretcher with a neck brace. The right foot and ankle was kept in a pneumatic splint. After the first body check, the splint could be removed for an examination of the foot. It revealed only minor swelling over the lateral aspect of the ankle and did not show a significant deformity. She was neuro vascularly intact with closed soft tissues.

On palpation, she indicated tenderness over lateral distal fibula. Frick Test was positive. Plantarflexion, pro- and supination were painfully impaired. The metatarsal bones, especially the base of the 5th metatarsal were not tender. Achilles tendon appeared intact. Anterior-Drawer-Test was painful and could not be tested.

Figure 1: *X-rays revealed a shell-like lesion over the distal and lateral aspect of the fibula. For further differentiation, a CT scan was conducted.*

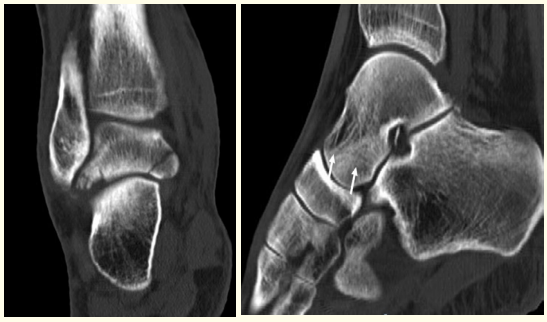

Figure 2: *The CT scan raised the suspicion of a fracture through the talar neck with distinct fracture lines that extended into the bilateral processes.*

Discussion

In a frontal car crash, the driver's foot and ankle may be injured due to loading by the brake pedal. The driver of a vehicle often has time to initiate emergency braking before an impending collision, which places the forefoot or midfoot over the brake pedal. During the crash, the pedal may induce dorsiflexion and axial loading of the ankle due to forward motion of the occupant and rearward intrusion of the pedal relative to the vehicle.

In a review of more than 15000 accidents [2], found that injuries to the ankle and foot affected in 41 percent the ankle, 29 percent the forefoot, 20 percent the midfoot, and in 10 percent the hind foot. Fifty percent of their fractures occurred in head-on collisions and 34 percent occurred in accidents with multiple collisions.

Parenteau [4] found 805 foot-ankle injuries out of 57,949 car occupant injuries. Ankle fractures and sprains both occurred at an incidence of 3.7 per 1000 injuries, followed by malleolus fractures at 2.7 and mid tarsal fractures at 2.4. The foot-ankle injury incidence and rate were significantly greater in near oblique-frontal crashes than for 12 O'clock frontals. For drivers in 11 O'clock and front passengers in 12 O'clock, the incidence was 27.8 per 1000 injuries as compared to 17.5 for drivers and front passengers in 12 O'clock crashes.

Richter [2] found that 82 percent of injuries occurred between fifteen and sixty kilometers per hour. Contributing factors for the severity of the injury can be a BMI > 25, an intrusion of the toe pan of more than 2 cm [5] and a high Delta V [1]. For occupants with malleolar fractures, the average delta V is 44.1 kph (27.4 mph) and the average intrusion is 9.6 cm. In contrast, drivers sustaining lower leg fractures other than malleolar fractures had an average BMI of 30 kg/m^2, an average delta V of 39.6 kph (24.6 mph), and average toe pan intrusion of 12.0 cm.

The position of the car occupant can play a role too. As car occupant, the front seated driver or passenger have the highest but an equal risk of sustaining injuries. The foot pedals, steering wheel, or the asymmetric design of the dashboard do not influence the injury incidence, mechanism or severity. Foot fractures are mainly caused by the foot compartment deformation in head-on collisions.

Cadaveric studies [6] suggest that pedal loading in frontal crashes can cause fractures of the medial malleolus and talar neck. While axial compression is the predominant loading mechanism for causing the majority of injuries, the pattern changes with each position in which the impact occurs to the foot. Thus, a multitude of possible injuries can be observed.

Most talus fractures occur in the neck, usually as a result of a high-energy trauma. They account for more than 2/3 to the talar fractures. This prevalence can also result from the fact that a proportion of peripheral fractures of the talus (including those of the posterior and lateral processes) often go unnoticed [7,8]. Posterior process fractures may involve the lateral tubercle, the medial tubercle, or both. Lateral tubercle fractures may be inversion injuries resulting in avulsion by the posterior talo-fibular ligament, or may result from forced plantarflexion, in which the lateral tubercle is compressed between the calcaneus and tibia. Medial tubercle fractures may occur in pronation of a dorsiflexed foot, resulting in avulsion by the posterior fiber of the deltoid ligament.

Lateral tubercle fractures should be treated initially in a below-knee cast and protected weight bearing for 4 - 6 weeks, and may require excision of the fragment. Medial tubercle fractures may be treated closed or may require ORIF as the fragment is often large and interposition of the flexor hallicus longus may block closed reduction.

Relevance

The evaluation of 6,378 car accidents with 8,931 injured persons [9] concluded that the foot fractures especially in combination with other injuries can remain unrecognized within the primary examination and therefore underestimated. The long-term outcome resulted to a high degree in impairment due to foot fractures.

A contributing factor can be the osteonecrosis rate in talar neck fractures that ranges from 21 to 58% [10,11] while in the talar body, 88% of the patient's present evidence of osteonecrosis and/or post-traumatic arthritis [7].

An outcome assessment tool can be questionnaires. The FAOS and the FFI - 5pt show the strongest evidence for having good measurement characteristics. Currently, the FAOS is regarded as the most appropriate foot- and ankle-PROM for general foot and ankle problems [12].

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Volume 3 Issue 5 August 2016