EVALUATION OF CALCANEAL FRACTURES BY MULTI DETECTOR CT AND ITS SIGNIFICANT EFFECT ON THE SURGICAL MANAGEMENT PLANNING

THESIS

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By

Mohamed Doleib Mohamed Elmahdi Doleib
M.B.B.Ch.
Faculty of medicine
Upper Nile University

Under Supervision of

Dr. Mohamed Abd Elfattah Hassaan
Professor of radio-diagnosis
Faculty of medicine
Cairo University

Dr. Ashraf Nehad Moharram
Professor of orthopedic surgery
Faculty of medicine
Cairo University

Dr. Kareem Mohsen Moussa
Lecturer of radio-diagnosis
Faculty of medicine
Cairo University

Cairo University 2013

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Mohamed Doleib Mohamed Elmahdi Doleib

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Dedication

I would like to dedicate this study to spirit of my father Prof. Doleib Mohamed Elmahdi Doleib, and to spirit of my mother…

Also I would like to dedicate it to my family for their great help; continuous support and encouragement which were essential for the completeness of this work

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ABBREVIATIONS

CT	Computed tomography.
L2	Lumber vertebra number 2.
MDCT	Multi detector computed tomography.
T12	Thoracic vertebra number 12.

ABSTRACT

This study aimed to look at the role played by the multi detector computed tomography (MDCT) in decision making in the management of extra and intra articular fractures of the calcaneum. A total of twenty eight cases with calcaneal fracture were included. Their initial radiographs and MDCT films were performed. Sanders classification for intraarticular fractures was used. The study showed that MDCT is the best method of assessing calcaneus fractures, delineate the fracture fragment and help in making the pre-operative planning.

Key words: Computed Tomography, Calcaneal Fracture, Sanders classification, Musculoskeletal

INTRODUCTION

The calcaneus is the largest and most commonly fractured of the tarsal bones. Calcaneal fractures represent only about **2%** of all fractures but **60%** of fractures involving the tarsal bones ***(Stoller et al., 2004)***. Familiarity with the normal calcaneal anatomy is important for understanding fracture mechanisms and classification schemes. Clinical presentation at the time of evaluation generally includes *(a)* a history of a fall from a height, and *(b)* certain signs that aid the physician in identifying possible calcaneal fractures ***(Kenneth et al., 2011).***

Modern calcaneal fracture classification systems rely heavily on computed tomography (CT) because of its three-dimensional approach, rather than on two-dimensional conventional radiography as was used in the past. Use of multidetector CT has allowed the development of classification systems that correlate with management ***(Kenneth et al., 2011).***

The Sanders classification system is the most commonly used system for describing intra articular fractures of the calcaneus, which account for the majority of calcaneal fractures. Extra articular fractures are classified according to a tripartite anatomic division of the calcaneal surface. Treatment can be either surgical or conservative depending on the radiologic classification of the fracture ***(Kenneth et al., 2011).***

AIM OF WORK

The purpose of this study is to explore the anatomy and patho-physiology of intra and extra articular calcaneal fractures, with emphasis on their appearances at CT and to discuss the impact of these CT findings on the management of these fractures.

Anatomy of the calcaneus

The calcaneus is designed to withstand the daily stresses of weight bearing. Understanding of the anatomy of the calcaneus is essential in determining the patterns of injury and treatment goals and options ***(Moore et al., 2007).***

The calcaneus has four articulatoin surfaces, three superior and one anterior **(Figure 1).** The superior surfaces, the posterior, middle, and anterior facets articulate with the talus. The posterior facet is separated from the middle and anterior facets by a groove that runs posteromedially, known as the *calcaneal sulcus*. The canal formed

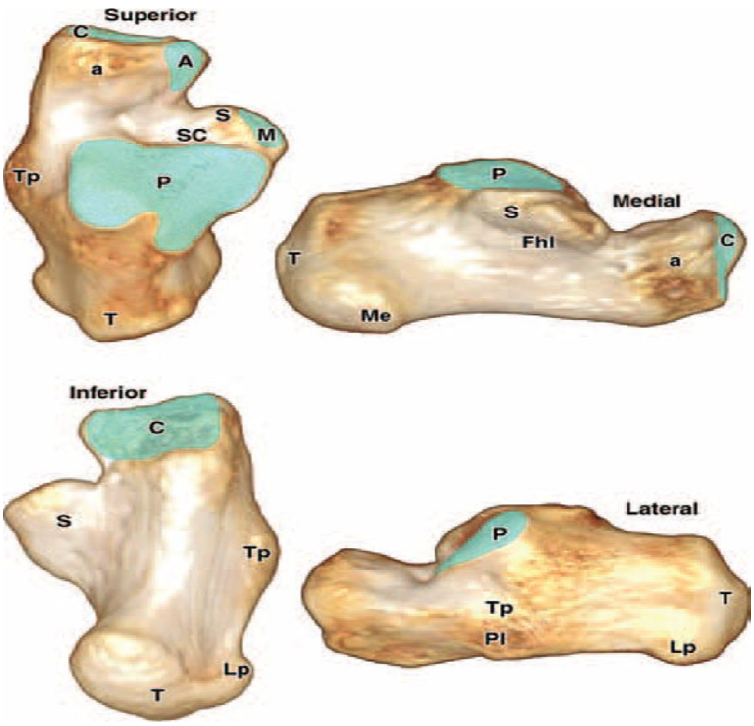

Figure 1. Drawings illustrate the anatomy of the calcaneus, including the anterior process of the calcaneus *(a)*, anterior facet of the talus *(A)*, anterior facet of the cuboid bone *(C)*, groove for the flexor hallucis longus tendon *(Fhl)*, lateral process *(Lp)*, middle facet of the talus *(M)*, medial process *(Me)*, posterior facet *(P)*, peroneus longus groove *(Pl)*, sustentaculum tali *(S)*, sulcus calcanei *(SC)*, posterior tuberosity *(T)*, and trochlear process *(Tp)* ***(Kenneth et al., 2011).***

between the calcaneal sulcus and the talus is called the *sinus tarsi*. The middle calcaneal facet is supported by the sustentaculum tali and articulates with the middle facet of the talus. The anterior calcaneal facet articulates with the anterior talar facet and is supported by the calcaneal beak. The triangular anterior surface of the calcaneus articulates with the cuboid ***(Fitzgibbons et al., 2009).***

The lateral surface is extremely important because it is the area exposed during the most common surgical approach used for fracture fixation. The most posterior aspect of the calcaneus is called the tuberosity. Just lateral to the tuberosity is what is considered the body of the calcaneus. A small process in the plantar lateral portion of the calcaneus is called the lateral process of the tuberosity. Also, laterally is the groove for the peroneus longus tendon, just under the peroneal trochlea. In the midportion of the calcaneus on the lateral side, the lateral margin of the posterior facet can be seen. Distally on the lateral side, the articular surface of the calcaneocubid joint is seen. The middle and anterior articular surfaces are not visible at the time of surgery from the lateral side ***(Fitzgibbons et al., 2009).***

Medially, the talus is held to the calcaneus firmly by the interosseous ligament and the thick medial talocalcaneal ligaments. The sustentaculum tali is seen at the anterior aspect of the medial surface. The groove inferior to it transmits the flexor hallucis longus tendon. The neurovascular bundle runs adjacent to the medial border of the calcaneus. The neurovascular bundle may be injured during trauma or during surgery for the reduction of the sustentacular fragment, which is a key element in the surgical management of calcaneal fractures ***(Gray, 2009).***

The inferior surface is triangular with the apex anterior and the base posterior. The posterior base or the tuberosity is composed of a lateral and a medial process. The medial process is larger and broader and is the main weight bearing structure ***(Desouze et al., 1993).***

The posterior surface can be divided into three areas: a smooth proximal area separated from the Achilles tendon by a bursa and adipose tissue, a middle area for the insertion of Achilles tendon; and a distal area inclining downwards and forwards which is the subcutaneous weight bearing area ***(Churchill, 1995).***

The calcaneus has a relatively thin cortex. The cortical bone just inferior to the posterior articular facet is condensed to approximately 1 cm and is called the *thalamic portion* . Thickening of the cortex is also seen in the regions of the sustentaculum tali, medial wall, and critical angle of Gissane **(Figure 2)** ***(Fitzgibbons et al., 2009).***

Figure 2. Lateral radiograph shows the lateral process *(L)* of the talus *(T)* above the angle of Gissane and the thalamic bone (arrowheads) just below it. *C* = calcaneus ***(Kenneth et al., 2011).***

There are compression and traction trabeculae present within the calcaneus to withstand axial and sheer stresses. The neutral triangle is an area with sparse trabeculae that is located under the subtalar joint thalamic bone directly under the lateral process of the talus. Fractures generally occur through this weakest portion of the calcaneal bone **(Figure 3)** ***(Kenneth et al., 2011).***

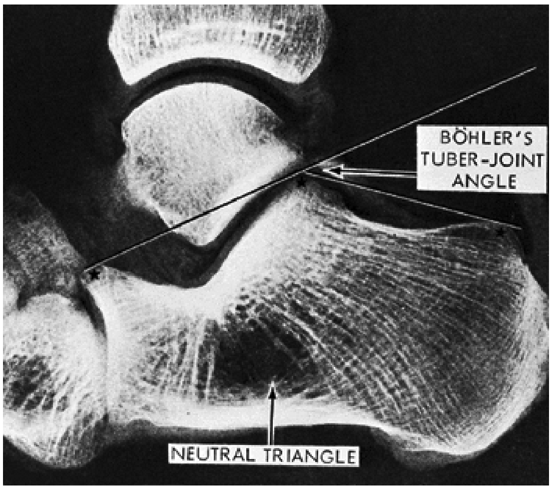

Figure 3. Lateral radiograph shows the neutral triangle ***(John et al., 2009).***

Cross-sectional anatomy of the tarsal bones by MDCT

Figure 4 is a series of straight axial images through the ankle and hind foot, from proximal to distal. The straight axial plane is well suited to examine the syndesmosis (see *arrow*). The two joints that make up the Chopart joint, the talonavicular joint and the calcaneocuboid joint , are also well profiled in the axial plane. However, the ankle and subtalar joints are not well profiled in the axial plane, and because examination of these two joints is usually the primary indication for requesting a CT of the ankle or hindfoot, other reformatted planes are required ***(John et al., 2009).***

Figure 5 is a series of straight sagittal images through the hindfoot, from lateral to medial . Nearly all of the joints are profiled in the sagittal plane, including the ankle joint, the calcaneocuboid and talonavicular joints, and the posterior and middle facets of the subtalar joint. The only joint not well seen in the sagittal plane is the syndesmosis, but this is easily seen in the axial plane. The lateral sagittal images are also useful for visualizing the lateral process of the talus and the anterior process of the calcaneus. Fractures through these pointed bony projections are often difficult to see on radiographs and are typically worked up with CT ***(John et al., 2009).***