

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

THESIS

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radio-diagnosis

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CONTENTS

	Page
▪Introduction & aim of work.....	1
▪Anatomy of the calcaneus	6
▪Mechanism of injuries &Classification of calcaneal fractures.....	17
▪ Radiographic evaluation.....	34
▪ Treatment	49
▪Subjects & methods.....	54
▪Results.....	59
▪Case Presentation	67
▪Discussion.....	95
▪Summary and conclusion.....	102
▪References.....	104
▪Arabic summary.	

LIST OF FIGURES

No.	Title	Page
1	Drawings illustrate the anatomy of the calcareous.	7
2	Lateral radiograph of calcaneus.	10
3	Lateral radiograph shows the neural triangle.	11
4	Straight axial images through the ankle and hindfoot.	14
5	Straight sagittal images through the ankle and hind foot.	15
6	Oblique coronal images through the hind foot.	17
7	Diagram of the calcareous shows basic fracture mechanism.	19
8	Lateral radiograph shows a joint depression type fracture and Tongue type fracture.	22
9	Coronal multidetector CT scan of the right foot shows Sanders type I fracture.	25
10	Coronal (a) and axial (b) multidetector CT scan of the left hindfoot shows Sanders type IIA fracture.	25
11	Coronal (a) and axial (b) multidetector CT scan of the left foot shows Sanders type IIB fracture.	26
12	Coronal (a) and axial (b) multidetector CT scan of the right foot shows Sanders type IIC fracture.	27
13	Coronal (a) and axial (b) multidetector CT scans of the right foot shows Sanders type IIIAB fracture.	27
14	Coronal (a) and axial (b) multidetector CT scan of the right foot shows Sanders type IIIAC fracture	28
15	Coronal (a) and axial (b) multidetector CT scan of the left foot shows Sanders type IIIBC fracture.	29
16	Coronal (a) and axial (b) multidetector CT scan of the right foot shows Sanders type IIIBC fracture.	29
17	Superior, medial, and lateral views of the calcaneus illustrate the anatomic limits of types A, B, and C extraarticular calcaneal fractures.	31
18	Sagittal MPR image shows Type A extraarticular calcaneal fracture.	31
19	Sagittal MPR image shows Type B extraarticular calcaneal fracture.	32
20	MPR image shows a fracture Type C extraarticular calcaneal	32

	fracture.	
21	Lateral radiograph shows double density sign.	35
22	Calcaneus diagram shows (a) Gissane's and (b) Bohler's angles.	36
23	Anteroposterior X-ray view of the left foot shows calcaneocuboid joint.	37
24	Radiographic view shows Harris view.	38
25	Photograph (a) and Corresponding radiograph (b) shows the technique to obtain Broden's view.	40
26	Optimal CT reformation planes for evaluation of calcaneal fracture.	43
27	Axial view of the calcaneus on CT scan shows minimally displaced fracture of the medial process of the calcaneus.	44
28	Coronal view of the calcaneus on CT scan.	45
29	Sagittal CT image shows decrease in Boehler's angle.	46
30	Three-dimensional CT scan view of a calcaneus fracture.	48
31	Clinical photographs show Ilizarov(Calcaneal external-Fixator).	51
32	Lateral radiograph shows percutaneous screw fixation of a Sanders type IIA fracture.	53
33	Sanders classification percentage.	62
34	Case presentation No. (1) shows (a) lateral X-ray (b) sagittal CT scan (c) coronal CT scan.	67
35	Case presentation No. (2) shows (a) lateral X-ray (b) sagittal CT scan (c) coronal CT scan (d) axial CT scan (e)3D CT scan .	71
36	Case presentation No. (3) shows (a) lateral X-ray (b) sagittal CT scan (c) coronal CT scan (d) axial CT scan. (e)3D CT scan .	75
37	Case presentation No. (4) shows (a) lateral X-ray (b) sagittal CT scan (c) coronal CT scan (d) axial CT scan.. (e)3D CT scan .	79
38	Case presentation No. (5) shows (a) lateral X-ray (b) sagittal CT scan (c) coronal CT scan (d) axial CT scan. (e)3D CT scan .	83
39	Case presentation No. (6) shows (a) lateral X-ray (b) sagittal CT scan (c) coronal CT scan (d) axial CT scan.. (e)3D CT scan .	87
40	Case presentation No. (7) shows (a) lateral X-ray (b) sagittal CT scan (c) coronal CT scan (d) axial CT scan. (e)3D CT scan .	91

LIST OF TABLES

No.	Title	Page
1	Frequency and percentage of different sex.	59
2	Frequency and percentage of unilateral and bilateral fracture.	60
3	Frequency and percentage of the risk factors.	60
4	Frequency and percentage of clinical presentation.	61
5	Intraarticular fracture types frequency and percentage according to sanders classification.	62
6	Frequency and percentage of accuracy of Xray to detect calcaneus fractures.	63
7	Relation between Sanders types and Bohler's angle.	64
8	frequency and percentage of the calcaneocuboid joint involvement according to the different Sanders types.	65
9	Frequency and percentage of types of management.	66

ABBREVIATIONS

CT	Computed tomography.
L2	Second lumbar vertebra .
MDCT	Multi detector computed tomography.
T12	Twelvth thoracic vertebra.

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***).

Classification of the intra articular calcaneal fractures has been believed to be difficult because of the complexity and comminution of these fractures and, to some extent, because of the problems with understanding their pathoanatomy (***Rockwood et al., 2006***).

The classification of extra articular fractures has been less controversial, perhaps because they have been the subject of fewer studies than have intra articular fractures. Generally, extra articular calcaneal fractures fall into one of three categories depending on whether the involvement of the calcaneus is anterior, middle, or posterior (***Kenneth et al., 2011***).

In 1996, the orthopedic Trauma Association, in cooperation with the International Society for Fracture Repair and as part of their general system of fracture classification, compiled a system for fractures of the calcaneus (*Chapman et al., 2000*).

This system benefits from both plain radiographs and CT scanning. It divides calcaneus fractures into three main types. This system is complex and has not been used extensively by most orthopedic surgeons (*Charles et al., 2006*).

AIM OF WORK

The purpose of this study is to discuss the CT appearance of intra

And extra articular calcaneal fractures with special emphasis on their

Impact on the manegment 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 articulation 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

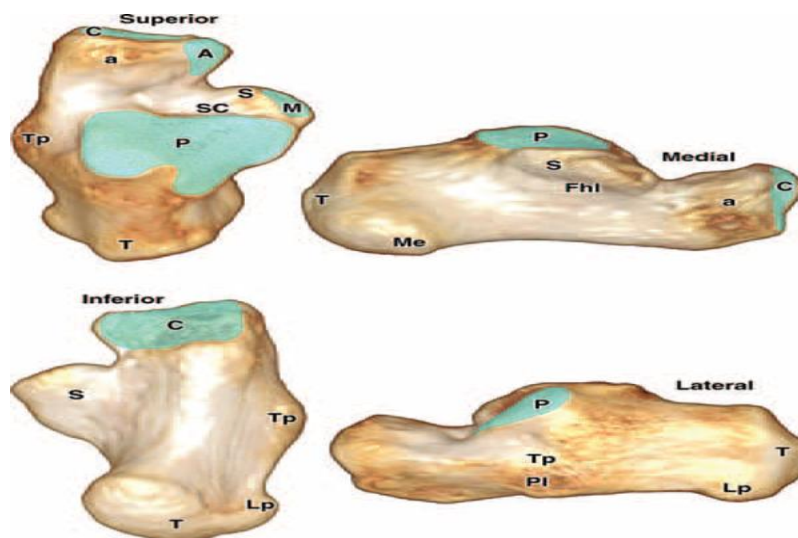


Figure 1. Drawings illustrate the anatomy of the calcaneus, including the anterior process of the calcaneus (*a*), anterior facet of the talus (*A*), anterior facet of the cuboid bone (*C*), groove for the flexor hallucis longus tendon (*Fhl*), lateral process (*Lp*), middle facet of the talus (*M*), 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 calcaneocuboid 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**).

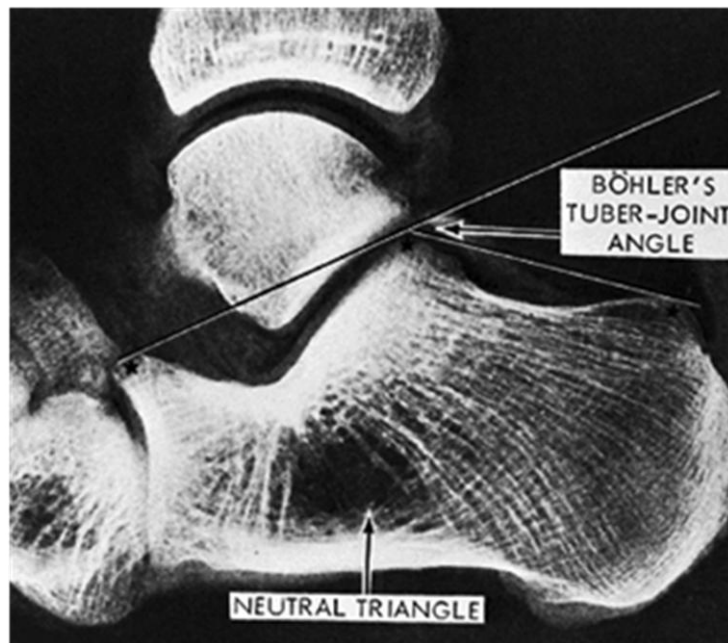


Figure 3. Lateral radiograph shows the neutral triangle (**John et al., 2009**).

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*).

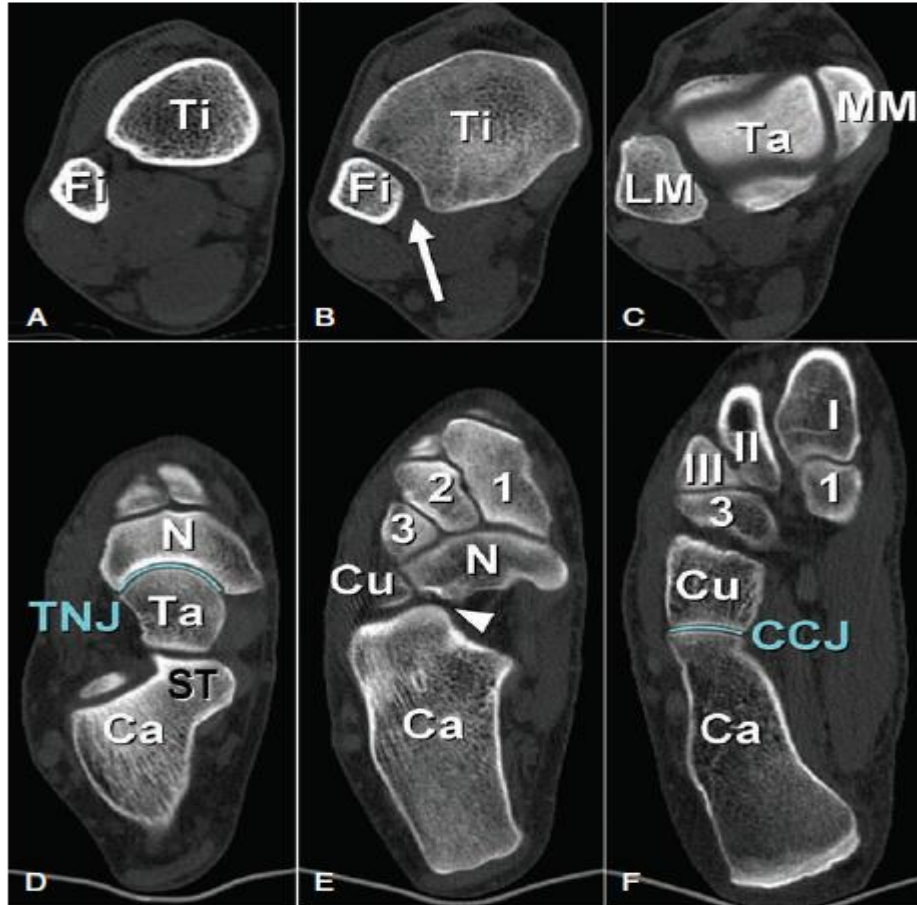


Figure 4. Straight axial images through the ankle and hind foot, proximal (**A**) to distal (**F**). **A**, Proximal to syndesmosis. Fi, fibula; Ti, tibia. **B**, Through the syndesmosis (arrow). Fi, fibula; Ti, tibia. **C**, Through the top of the mortise. LM, lateral malleolus; MM, medial malleolus; Ta, talus. **D**, Through the sustentaculum tali (ST). Ca, calcaneus; N, navicular; Ta, talus; TNJ, talonavicular joint. **E**, Through the level where the calcaneus gets close to the navicular (arrowhead) but does not normally form a joint. If there were an articulation here, or osseous bridging, that would be tarsal coalition. Ca, calcaneus; Cu, cuboid. Numerals indicate cuneiforms. **F**, Through the calcaneocuboid joint (CCJ). Ca, calcaneus; Cu, cuboid. Roman numerals indicate metatarsals (*John et al., 2009*).