NEAR EAST UNIVERSITY
INSTITUTE OF GRADUATE STUDIES
DEPARTMENT OF ANATOMY

FREQUENCY OF SESAMOID AND ACCESSORY BONES IN THE FOOT: A RADIOGRAPHIC STUDY OF THE TURKISH REPUBLIC OF NORTHERN CYPRUS POPULATION

MSc. THESIS

Temitope Ayomikun OYENEKAN

Nicosia
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Approval

We certify that we have read the thesis submitted by Temitope Ayomikun Oyenekan titled **"Frequency of Sesamoid and Accessory Bones in the Foot: A Radiographic Study on the TRNC Population"** and that in our combined opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Educational Sciences.

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Declaration

I hereby declare that all information, documents, analysis and results in this thesis have been collected and presented according to the academic rules and ethical guidelines of Institute of Graduate Studies, Near East University. I also declare that as required by these rules and conduct, I have fully cited and referenced information and data that are not original to this study.

Temitope Ayomikun Oyenekan

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Temitope Ayomikun Oyenekan

Abstract

Frequency of Sesamoid and Accessory Bones in the Foot: A Radiographic Study in the TRNC Population

Oyenekan, Temitope Ayomikun

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The amount of sesamoid and accessory bones in the adult human skeleton varies a lot from person to person. The sesamoid and accessory bones can be symptomatic; in most cases, they do not cause any symptoms and are only discovered by radiologic evaluation. The aim of this study was to clarify how often the sesamoid and accessory bones are seen in the population of the Turkish Republic of Northern Cyprus.

A retrospective study was carried out to determine the frequency of accessory and sesamoid bones in the foot. Accessory bones were detected in the 118 (15.0%) patients of the 788 radiographs. The most common accessory bone of the foot was found to be the os trigonum. The observed frequency was (6.5%) followed by the os peroneum (4.3%), accessory navicular (2.8%), os intermetatarseum (0.4%), os vesalinum (0.8%), os calcaneus secundarius (0.1%) and os talotibiale (0.1%).

Bipartite hallucal sesamoid was observed in 2.5% of radiographs. In 2.9% of radiographs the medial hallucal sesamoid and in 0.1% of radiographs the lateral hallucal sesamoid were found to be bipartite. Interphalangal sesamoid of the hallux was found in 0.6% of radiographs. The most common sesamoid bone in the foot asides the hallucal sesamoid was the fifth metatarsal sesamoid bone found in 7.6% of radiographs. The fourth metatarsal sesamoid was found in 1.3% of radiographs, second metatarsal sesamoid was found 2.2% of radiographs and third metatarsal sesamoid was found in 0.8% of radiographs.

We also found the coexistence of two different sesamoid bones in 9.1% of radiographs, coexistence of two different accessory bones in 0.6% of radiographs and coexistence of sesamoid and accessory bones in 14.5% of radiographs.

Key Words: sesamoid bones, accessory bones, foot bones, fracture

Öz

Ayakta Sesamoid ve Aksesuar Kemiklerin Sıklığı: KKTC Popülasyonunda Radyografik Bir Çalışma

Oyenekan, Temitope Ayomikun

Yüksek Lisans, Anatomi Bölümü

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Yetişkin insan iskeletindeki sesamoid ve aksesuar kemiklerin miktarı kişiden kişiye büyük farklılıklar gösterir. Sesamoid ve aksesuar kemikler semptomatik olabilir; çoğu durumda herhangi bir belirtiye neden olmazlar ve sadece radyolojik değerlendirme ile fark edilirler. Bu çalışmanın amacı, sesamoid ve aksesuar kemiklerin Kuzey Kıbrıs Türk Cumhuriyeti popülasyonunda ne sıklıkla görüldüğünü ortaya koymaktır.

Ayaktaki aksesuar ve sesamoid kemiklerin sıklığını belirlemek için geriye dönük bir çalışma yapıldı. 788 radyografinin 118'inde (%15,0) aksesuar kemik tespit edildi. Ayağın en sık görülen aksesuar kemiğinin os trigonum olduğu bulundu. Gözlenen sıklık (%6.5) olup, bunu os peroneum (%4,3), aksesuar naviküler (%2,8), os intermetatarseum (%0,4), os vesalinum (%0,8), os calcaneus secundarius (%0,1) ve os talotibiale (%0.1).

Radyografilerin %2,5'inde bipartit halükal sesamoid izlendi. Radyografilerin %2.9'unda medial halükal sesamoid ve radyografilerin %0.1'inde lateral halükal sesamoid bipartit bulundu. Halluksun interfalangal sesamoidi radyografilerin %0.6'sında bulundu. Ayakta halükal sesamoid dışında en sık görülen sesamoid kemiği, radyografilerin %7,6'sında bulunan beşinci metatarsal sesamoid kemiğiydi. Dördüncü metatarsal sesamoid radyografilerin %1.3'ünde, ikinci metatarsal sesamoid radyografilerin %2.2'sinde ve üçüncü metatarsal sesamoid radyografilerin %0.8'inde bulundu. Ayrıca radyografilerin %9.1'inde iki farklı sesamoid kemiğin bir arada, radyografilerin %0.6'sında iki farklı aksesuar kemiğin bir arada bulunduğunu ve radyografilerin %14,5'inde sesamoid ve aksesuar kemiklerin bir arada bulunduğunu saptadık.

Anahtar Kelimeler: sesamoid kemikler, yardımcı kemikler, ayak kemikleri, kırık

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List of Abbreviations

TRNC:	Turkish Republic of North Cyprus
MNE:	Ministry of National Education
SPSS:	Statistical Package for Social Sciences
PACS:	Picture Archiving Communication System
MTP:	Metatarsophalangeal Joint
IP:	Interphalangeal Joint

CHAPTER I

Introduction

The amount of sesamoid bones in the adult human skeleton varies a lot from person to person (Gray, 1878). Sesamoid bones are tiny osseous structures found within tendons that span joints in the upper and lower limbs, particularly within the hands, wrists, knees, and feet (Drake et al., 2005). The sesamoid bones include: hallucal sesamoids (which are mostly bipartite), metatarsophalangeal sesamoids (MTP), and interphalangeal joint sesamoids (IP) (Gray, 1878). Sesamoid bone fractures can be misdiagnosed as bipartite or multipartite sesamoid bones, resulting in physical and financial loss for patients (Li et al., 2012).

Tendons have sesamoid bones that protect them from friction as they pass over joints (Helal, 1981). Unlike sesamoids, the accessory ossicles are unidentified structures that develop from ossification centers that have failed to fuse with the primary bone. Despite their differences, the imaging properties of sesamoid bones and accessory ossicles are comparable: They are small, well-corticated, ovoid or nodular, bipartite or multipartite, and located near a bone or joint. These osseous formations are frequently discovered by chance (SarraWan, 1993).
Sesamoids and accessory ossicles can be unilateral or bilateral, and morphological differences can be considerable. As a result, identifying pathological conditions may be difficult. Although the symptomatic nature of these bones is difficult to determine, imaging gives significant diagnostic information that should be addressed in the clinical workup (SarraWan, 1993).

Partition of the hallux sesamoid bones is a developmental abnormality that can coexist with sesamoids at other MTP joints and is almost twice as frequent in feet without extra MTP sesamoids as it is in feet with extra MTP sesamoids. They protect the tendons from damage by friction (Turner, 1869)

Although earlier studies had demonstrated the coexistence of bipartite sesamoid bones and sesamoids in the adult foot (Coskun et al., 2009), those earlier studies had primarily focused on the radiographic appearance of the partite hallux sesamoid rather than its relationship with other sesamoids. This synchronicity may be the result of a pattern and underlying interaction between the hallux and sesamoids at the other four metatarsophalangeal (MTP) joints (Hatoff, 1950).

When secondary ossification centers fail to fuse with the main bone, accessory ossicles form. Accessory ossicles come in a wide range of shapes and sizes, as well as morphologic variants (O'Rahilly, 1957).

The accessory ossicles are: the os trigonum, os navicularis, os peroneum, os intermetatarseum, os calcaneus secundarius, os supratalare, os vesalianum, os subfibulare, os supranaviculare, os infranaviculare, os talotibiale, ossubfibulare, and os subtibiale (Drake et al., 2005).

The sesamoid and accessory bones can be symptomatic; in most cases, they do not cause any symptoms and are only discovered by radiologic evaluation, although if symptomatic, they can become very painful due to overuse and trauma (O'Rahilly, 1957). The accessory ossicles and sesamoid bones are prone to leading to an incorrect avulsion fracture diagnosis in the event of trauma; however, the fracture does occur in the sesamoid bones and accessory ossicles on occasion (Helal, 1981). Misdiagnosis of fractures is especially common in the accessory bones of the fibula (os subfibulare) and the accessory bones between the talus and the fibula, with rates of 13.3% and 16.7%, respectively (SarraWan, 1993).

1.2. Statement of the Problem

In the foot, sesamoids and accessory ossicles can be visible, and they differ greatly from person to person in terms of their prevalence and appearance (Nwawka et al., 2013).

One of the most prevalent reasons for a radiographic assessment of the foot is foot and ankle damage. Emergency physicians should therefore be familiar with both abnormal and typical foot and ankle variations, as well as their skeletal development and radiographic appearance (Kose, 2012).

The sesamoid and accessory bones show wide variations in routine radiological examinations (Arslan et al., 2018). All the pathologic diseases that affect the rest of the human skeleton can affect the sesamoids. It is well recognized that their radiographic appearance is crucial for the identification and management of their disorders (Uygur et al., 2016).

The findings of this study may offer anatomical information to clinicians to aid in the diagnosis and treatment of disorders that manifest as foot pain and discomfort. Understanding these variations is crucial to avoiding mistaking them for fractures.

1.3. Purpose of the Study

This study is aimed at clarifying how often the sesamoid and accessory bones are seen in the population of the Turkish Republic of Northern Cyprus.

1.4. Objectives of Study

1. To evaluate the most frequent sesamoid bone of the foot in the population of TRNC.
2. To evaluate the most frequent accessory bone of the foot in the population of TRNC.
3. To evaluate the less frequent sesamoid and accessory bones of the foot in the population of TRNC.
4. To evaluate the frequency of sesamoid bones in males and females in the population of TRNC.
5. To evaluate the frequency of accessory bones in males and females in the population of TRNC.
6. To evaluate the frequency of partition and establish the bones that partition occurs in in the population of TRNC.

1.5. Research Questions/Hypotheses

1. Which sesamoid bone of the foot is frequently seen in the population of TRNC?
2. Which accessory bone of the foot is seen frequently in the population of TRNC?
3. Which sesamoid and accessory bones of the foot are less frequent in the population of TRNC?
4. In which gender do accessory bones occur frequently?
5. In which gender do sesamoid bones occur frequently?
6. Does partition occur only in sesamoid bones of the foot or both (accessory and sesamoid bones) in the population of TRNC?

1.6. Significance of the Study

The significance of this study is that the population of TRNC is made up of several races; therefore, the analysis of this study would be able to show the frequency of each sesamoid and accessory bone present in both genders and also prevent misdiagnosis of these bones as fractures.

1.7. Limitations

- Radiographs of foot that had defects were not included.
- Limited access to patient's clinical information.

CHAPTER II

Literature Review

Sesamoid bones of the foot and ankle are round or oval in shape, grow from their own ossification center (Sarin et al., 1999). Particularly in the distal joints on the palmar and plantar surfaces of the hands and feet, respectively, they develop within tendons in regions where tendons wrap around bony prominences or where tendons are tightly linked to the articular surfaces of joints (Sarin et al., 1999). Sesamoid bones are mostly largely osseous and comprise various proportions of thick fibrous tissue, cartilage, and bone (Dharap et al., 2007). Sesamoid bones improve the efficiency of the gliding process between adjacent tissues by reducing friction between the tendon and other rigid structures (Dharap et al., 2007).

The hallucal sesamoids, 2^{nd} -5^{th} metatarsal sesamoids, and interphalangeal joint sesamoids of the toes are examples of sesamoids found in the foot (Bizarro, 1921).

Accessory bones are skeletal variants that arise from secondary ossification c enters and stayseparate from the parent bone during development (Coughlin, 2006). Although these bones are normally asymptomatic, they may occasionally cause local discomfort or separation, which could be misconstrued as an avulsion fracture. These bones can potentially induce infections or connective tissue problems (Helal, 1981).
The os trigonum, os peroneum, and os naviculare are the most commonly reported ac cessory bones in the foot (Cilli et al., 2005).

The os intermetatarseum, os vesalianum, os supranaviculare, os infranaviculare, os subtibiale, os subcalcis, os supratalare, os talotibiale, os subfibulare, os subtibiale, and os
calcaneus secundarium are among the other structures present in the foot (Trolle, 1948).

Sesamoids and accessory ossicles in the foot can appear or be present in varying numbers. Both accessory ossicles and sesamoids are typically incidental, with different imaging results (Bizarro, 1921). These bones may occasionally be linked to painful syndromes because of a number of diseases, including trauma,

infection, inflammation, degeneration, and others. They are typically found near a bone or joint and can be bipartite or multipartite (Trolle, 1948). As a result, a thorough understanding of these bones and their clinical characteristics is required to avoid incorrect diagnosis and unnecessary interventions (Helal, 1981).

Development of Sesamoid Bones

It is believed that a combination of mechanical and biological process lead to the formation of sesamoid bones. In humans, the sesamoids start as cartilaginous nodules and endochondral ossify between the ages of 3 and 12. (Sarin et al., 1999). The following stages in sesamoid maturation at the first metatarsophalangeal joint are chondrification and incorporation into the joint capsule (12 weeks) and ossification (eighth year) (Sarin et al., 1999). The largest and most well-known sesamoid is the patella, which is found in the quadriceps tendon as it crosses the knee joint (Gray, 1918). Two are always present at the great toe's metatarsophalangeal joint with the medial being the larger. One is occasionally present at the metatarsophalangeal joints of the second and fifth toes, one at the corresponding joint of the third and fourth toes, and one at the interphalangeal joint of the great toe on the plantar aspect of the foot (Gray, 1918).

2.1. Types of Sesamoid bones

2.1.1. *Hallucal Sesamoids*

On the plantar aspect of the first metatarsal head in humans, the hallucal sesamoids are always present. The flexor hallucis brevis tendon's medial and lateral slips include the hallux sesamoids. The hallux sesamoids and the metatarsal head's plantar aspect articulate (Richardson, 1987). They are stabilized within the plantar plate by the medial and lateral capsular ligaments, phalangiosesamoid ligaments, and the intersesamoid ligament. The fibers of the adductor hallucis tendon stabilize the lateral sesamoid, whereas the fibers of the abductor hallucis tendon stabilize the medial sesamoid (Gomez et al., 2019).

The anteroposterior and axial views of a radiograph of the foot are the best for displaying the hallucal sesamoids.

It is extremely rare for a hallucal sesamoid to be absent at birth. Helal (1981) cited Inge's case report of a patient with congenital absence of the tibial sesamoid in his account of a patient with congenital absence of both sesamoids in one foot.

The medial sesamoid frequently exhibits bipartite variation (Munuera et al., 2007).

A hallux sesamoid bone that develops from two ossification centers that do not fuse at maturity is referred to as a bipartite hallux sesamoid bone (Dharap et al., 2007).

Sesamoids with multiple parts are found in 2.7 to 33.5% of the population. Less common than lateral sesamoids are medial bipartite sesamoids. Bilateral medial bipartite sesamoids can occur up to 85% of the time (Richardson, 1987).

2.7 to 33.5% of people are multipartite sesamoids. Sesamoids with a medial bipartite structure are more frequent than those with a lateral structure. Between 22 and 85% of the time, bilateral medial bipartite sesamoids can be found (Richardson, 1987).

Bipartite sesamoid fragments can be distinguished from fractures by the fact that they do not fit together completely. Along with fracture, the hallucal sesamoids are frequently affected by infection, arthritis, and osteonecrosis (Helal, 1981).

Partition of the hallux sesamoid bones is a developmental abnormality that can coexist with sesamoids at other MTP joints and is almost twice as frequent in feet without extra MTP sesamoids as it is in feet with extra MTP sesamoid (Sun et al., 2018).

2.1.2. *2nd -5th Metatarsophalangeal Sesamoids*

Sesamoids appear to be embedded in the plantar aspect of the joint capsule in the second through fifth metatarsals and may be multiple or multipartite anatomically. The one adjacent to the fifth metatarsal head is the most common, with a frequency of up to 4.3%, followed by 0.4% at the second, 0.2% at the third, and 0.1% at the fourth (Bizarro, 1921). Anteroposterior and oblique radiographs of the foot are the best ways to see if these sesamoids are present. Pathology is extremely uncommon. A direct infection spread from nearby soft tissue is a possibility (Coskun et al., 2009).

2.1.3. *Interphalangeal Joint Sesamoids*

They are located on the interphalangeal side of the interphalangeal joint of the great toe (McCarthy et al., 1986). An ossified sesamoid, which is implanted within the joint capsule, can alter biomechanics and restrict joint motion (SarraWan, 1993). According to Coskun et al. (2009), the prevalence in its ossified form is 2-13%, although in a cadaver series, 73% of the joints had nodules (Davies et al., 2005). The most accurate approach to see these bones is on an AP radiograph of the foot or toes. This sesamoid's interposition into a dislocated IP joint, which renders it irreducible, is a potentially dangerous pathology connected to it (Woon, 2010).

2.2. Common Types of Accessory bones

2.2.1. *Os Peroneum*

The os peroneum is a round or oval auxiliary ossicle located in the peroneus longus tendon's tissue at the level of the calcaneocuboid joint (Kohler and Zimmer, 1968).

The os peroneum is best seen on radiographs with the foot viewed in an oblique manner, according to Nwawka et al., 2013. Either an oval or a circle could be the shape. Bipartite situations occur in about 30% of cases, and bilateral ones in about 60%. This can easily be mistaken for an avulsion fracture (Kose, 2012).

Os peroneum syndrome can cause lateral foot pain with restricted plantar flexion, as well as tenderness and swelling along the peroneus longus tendon. The os peroneum may become dislocated or fractured due to a peroneus longus tendon injury (Jones, 1949).

2.2.2. *Os Trigonum*

One of the accessory ossicles around the ankle that is most frequently observed on radiographs is the os trigonum (Kose, 2006).

The os trigonum, which is posterior to the talus and can be triangular or ovoid in shape, is best observed on lateral foot and ankle radiographs (SarraWan, 1993).

According to numerous studies from Turkey and Japan, there is a synchondrosis between the ossicle and the talus, and the prevalence of the os trigonum varies between 1 and 25% of the population (Coskun et al., 2009; Cilli and Akcaoglu, 2005).

According to Kose et al., 2006, it is normally asymptomatic, but it can become symptomatic during or after severe physical activities or an acute ankle injury. It might be mistaken for fractures of the talus's posterior process on radiographs. It is more symptomatic in men than in women (Coskun et al., 2009).

2.2.3. *Accessory Naviculare*

According to reports, the frequency of the accessory navicular bone, also known as the prehallux, os tibiale externum, and os scaphoideum accessorium, varies between 4% and 11% depending on the ethnic group (Trolle, 1948).

Next to the posteromedial tuberosity of the navicular bone, it is situated on the posteromedial side of the foot. The accessory navicular bone comes in three varieties:

In the region where the posterior tibialis tendon inserts, there is a type I sesamoid bone. Type II is caused by a secondary ossification center that is close to the navicular bone and synchondrosed to the navicular tuberosity. It is the location where the posterior tibialis tendon inserts. It is sometimes referred to as cornuate navicular bone when the secondary ossification center combines with the navicular bone to generate Type III accessory navicular bone (Trolle, 1948).

In about half of all cases, the accessory navicular is bilateral, and it is more common in women (Nwawka et al., 2013). It is easily viewed on the anteroposterior radiograph of the foot.

The most symptomatic of the three types of accessory navicular is type 2, which causes medial foot pain. This condition is also known as Os naviculare syndrome (Vora and Wong, 2018).

Patients with tibialis posterior loss of function will have foot pain over the medial aspect of the midfoot, as well as flat-foot deformity and inability to single-heel lift (Summers, 2015).

2.2.4. *Os Intermetatarseum*

Os intermetatarseum is found in the intermetatarsal space between the first and second metatarsals (Dwilight, 1907). On an anteroposterior foot radiograph, it is usually oval or round, but it can also be spindle-shaped and attached to a metatarsal. Although this ossicle is rarely associated with pathology, its location, as in Lisfranc injuries, may lead to a misdiagnosis as a second metatarsal fracture. The estimated frequency ranges between 1.2% and 10% (Faber, 1934).

2.2.5. *Os Supranaviculare*

The os supranaviculare, sometimes referred to as Pirie's bone and the os talonaviculare dorsale, is situated close to the middle of the talonavicular joint (Coskun et al., 2009). The os supranaviculare and the navicular may combine to form a little spur (Gomez et al., 2019). The lack of a donor site, soft tissue swelling, and focal tenderness should help to identify this ossicle from avulsion fractures, even though their radiological appearance can occasionally be challenging (Holland, 1928). It is estimated to affect between 1% and 3.5% of the population (Keles-Celik et al., 2017).

2.2.6. *Os Infranaviculare*

The os infranaviculare, often referred to as the cuneonavicular ossicle, is a dorsal ossicle that lies between the navicular and the first cuneiform and typically replaces the os supranaviculare (Keles-Celik et al., 2017). Advanced degenerative change is typically asymptomatic, but it can be the primary source of foot pain (Kim and Roh, 2013).

2.2.7. *Os Vesalianum*

A little accessory ossicle called the os vesalianum pedis is situated next to the well-developed tuberosity of the fifth metatarsal and is lodged in the peroneous brevis tendon (Holland, 1928).

According to estimates, 0.1% to 0.4% of the population suffers from it (Coskun et al., 2009). Using a lateral oblique radiograph, it is possible to see accessory ossicles and their articulations the best. It typically has no symptoms and is only identified as a result of a routine radiographic exam. Os vesalianum pedis, however, may be mistaken as a fifth metatarsal avulsion fracture in the event of trauma, which might cause lateral foot pain (Kose, 2009).

2.2.8. *Os Supratalare*

The Os supratalare is a small oval-shaped accessory bone located on the dorsal side of the talar neck. The frequency of this accessory ossicle is 0.2-0.9% (Coskun et al., 2009). On lateral foot and ankle radiographs, the anterior ankle capsule and dorsal talonavicular ligament attach to the dorsal aspect of the talar neck. This ossicle could be confused with talus dorsum flake fractures from avulsion injuries (Bayramoglu et al., 2009). Even though the majority of os supratalare cases are asymptomatic, Kim et al., 2013 reported a symptomatic os supratalare case with a hard bump and dorsal hindfoot pain. Furthermore, overuse and trauma can cause pain or degenerative changes (Kim et al., 2013).

2.2.9. *Os Talotibiale*

About 0.5% of persons have an extremely uncommon ossicle anterior to the tibiotalar joint called the os talotibiale (Keles-Celik et al., 2017). The lack of a donor site, soft tissue swelling, and focal tenderness should help to identify this ossicle from avulsion fractures, even though their radiological appearance can occasionally be challenging (Nwawka et al., 2013).

2.2.10. *Os Subcalcis*

Os subcalcis is found just behind the plantar fascia insertion on the plantar aspect of the calcaneus. This bone could be up to 10 mm in diameter. Because there are no reported cases in some literatures, understanding of this bone is limited (Coughlin, 2006).

2.2.11. *Os Calcaneus Secundarius*

The os calcanei secundarium is located dorsal to the calcaneus, between the anteromedial aspect of the calcaneus, the proximal aspect of the cuboid and navicular, and the head of the talus (Keles-Celik et al., 2017; Kose, 2012). It could be triangular or circular in shape. There is a large accessory bone visible on a lateral oblique radiograph of the hindfoot. The radiographic features of the anterior process of the calcaneus and the os calcanous secundarius are nearly identical, and the os calcanous secundarius can be confused with a calcaneus avulsion fracture (Kose, 2012).

2.2.12. *Os Subtibiale*

The posterior side of the medial malleolus is home to the os subtibiale. The frequency ranges from 0.7% to 1.2%, making it a rare incidental accessory bone (Kohler and Zimmer, 1968). Os subtibiale on ankle radiographs can resemble accessory ossification centers, posttraumatic ossification, or avulsion fractures and look as an aberrant ossification (Summers et al., 2015). An unfused ossification center can be distinguished from an os subtibiale by its closeness to an anterior or posterior colliculus. Os subtibiale may cause posterior tibial tendon weakness in addition to confusing acute fractures (Park et al., 2005).

2.2.13. *Os Subfibulare*

The os subfibulare lies at the tip of the lateral malleolus. This unusual bone has a comma or spherical form (Powell, 1961). It can be seen rather clearly on anteromedial radiographs of the ankle joint. Os subfibulare has been observed as

1.7%, according to Lee et al., 2020. A lateral malleolus avulsion fracture and os subfibulare might be mistaken for each other. Prior to Lee et al., 2020, it was believed that the auxiliary ossicle was a result of skeletal variation and was therefore related to trauma (Lee et al., 2018).

2.3. Related Research

2.3.1. *Accessory Ossicles*

In general, the frequency of accessory ossicles in the foot and ankle ranges from 18.3% to 36.3%. (Coskun et al., 2009). With an incidence of 11.7%, the accessory navicular bone was the most common accessory bone in radiography investigations from Turkey and Japan (Coskun et al., 2009). According to Kalbouneh et al., 2021, the os trigonum was the most prevalent accessory ossicle (15.4%), followed by the accessory navicular (13.7%) and the os peroneum (11.5%). Other accessory bones were the os intermetatarseum (0.2%), os calcaneus secundarius (0.3%), os supratalare (0.3%), os vesalianum (1.1%), os subfibulare (0.6%), os supranaviculare (0.7%), os infranaviculare (0.3%), os talotibiale (0.4%), os subfibulare (0.6%), and os subtibiale (0.1%).

Furthermore, in 0.9% of radiographs (9/1000), multipartite ossicles were seen; bipartite os peroneum was reported in 8 cases, and a bipartite supratalare was seen in 1 case (Kalbouneh et al., 2021).

Kalbouneh et al., 2017 reported that the occurrence of os trigonum and accessory navicular was significantly high (26.1% and 22.9%, respectively).

In another study carried out on 484 subjects in Turkey, the incidence of accessory bone was approximately 18% and the frequent accessory ossicle was the os peroneum (31.7%), followed by accessory navicular (28.3%), os trigonum (23.6%) (Cilli et al., 2005).

An Italian study reported an os peroneum in 40 (7.9%) patients(most common), an os trigonum in 34 (6.7%) patients, an os supranaviculare in 6 (1.2%) patients, an os vesalianum in 43 (8.5%) patients, an os supratalare in 13 (2.6%) patients, an os supratalare in 13 (2.6%) patients, an os intermetatarseum in 6 (1.2%) patients, and an accessory navicular bone in 34 (6.7%) patients (Longo et al., 2013).

According to Kalbouneh et al., 2021, the reported frequency of os peroneum and os vesalinum was 22% and 1.6% respectively.

According to Coskun et al., 2009, the accessory ossicles, such as the os intermetatarseum, os calcaneus secundarius, os supratalare, os vesalianum, os subfibulare, os supranaviculare, os infranaviculare, os talotibiale, os subfibulare, and os subtibiale, were less documented in the literature.

Candan et al., 2022 reported recently that os trigonum (9.8%), accessory navicular bone (7.9%), and os peroneum were the most common accessory ossicles (5.8%). os supratalare (0.48%), os calcanei secundarium (0.42%), os subfibulare (0.42%), os supranaviculare (0.36%), os vesalianum (0.30%), os subtibiale (0.24%), os intermetatarseum (0.12%), and os subcalcis (0.12%) were also found.

A study carried out by Sharma et al., 2022 showed that the accessory navicular (13.06%), os peroneum (7.16%), and os trigonum (2.32%) were the frequent ossicles among all accessory ossicles. The accessory navicular is the most frequent ossicle in the foot, with types I (5.32%), II (6.58%), and III (1.16%).

Uygur et al., 2016 reported that the accessory navicular was the most frequent accessory bone of the foot (32.1%), followed by the os peroneum (29.3%) and the os trigonum (15.4%). Also, males had a slightly higher prevalence of Os peroneum than females. Multiple accessory bones were discovered in 3.6% of the patients. In addition, the os peroneum (70.5%), os tibiale externum (65.9%), and os trigonum (29.5%) were the most common bones found in combination with other foot accessory bones. In addition, he stated that the frequencies of accessory navicular and os peroneum were significantly higher in females than in males; however, the frequency of os trigonum was higher in males than in females.

A study carried out in Korea involving 448 participants reported the frequency of the accessory bones to be from 46.9 to 52.5%. Adults had the highest prevalence of accessory bones, with 34% for the accessory navicular, 5.8% for the os trigonum, 3.9% for the os peroneum, and 1.7% for the os subfibulare. The study population lacked the os calcaneus secondarius, os vesalianum, os intermetatarseum, and os supranaviculare (Lee et al., 2020).

According to Padmanban et al., 2021, the accessory navicular was the most commonly detected accessory ossicle, with 71 patients (7.1%) having it out of 1000 radiographs collected, followed by os peroneum, os vesalianum, and os trigonum.

In a study in Singapore involving 439 patients, asymptomatic os navicular was found in 46.0% of cases, with 76.7% being bilateral. A unilateral os naviculare was found in 23.3 percent of the study participants, with 46.8% (22) occurring in the right foot and 53.2% (25) occurring in the left foot (Stacy et al., 2021).

2.3.2. *Sesamoid Bones*

Sesamoid bones can be bipartite or multipartite (Nwawka et al., 2013). Omanis had a lower frequency of bipartite hallux sesamoid bones than Americans (16%) and Europeans (12.7%) but were slightly higher than Middle Eastern populations (3%) (Yammine, 2015). When compared to other Middle Eastern populations such as Bahrain (3.9%) and Turkey (2%), the observed prevalence at the interphalangeal joint was relatively higher (9.9%) (Dharap et al., 2007). The frequency observed was 11.6% at the fifth MTP joint in a literature reported by Shabibi et al., 2020.

In a previous Turkish study, in 2.7% of instances, a bipartite hallucal sesamoid was discovered. In this study, bipartite medial hallucal sesamoid accounted for 2.1% of the total, while bipartite lateral hallucal sesamoid accounted for 0.4% (Coskun et al., 2009). In 0.4%, 0.2%, 0.1%, and 4.3% of instances, MTP sesamoid bones were found in the second, third, fourth, and fifth digits. 2% of patients had a hallucal IP sesamoid (Coskun et al., 2009).

In the foot, sesamoid bones being related to the first metatarsophalangeal joint (MTP) is common in many studies that have been carried out while additional sesamoid bones at other metatarsophalangeal joints and interphalangeal joints are rarely seen (Boelch et al., 2015).

In a Chinese study of 8,204 radiographs, sesamoid bones plantar to the hallucal MTP joint were reported with a frequency rate of 99.96%. Sesamoid bones at the MTP joint of the second, third, fourth, and fifth toes occurred at a rate of 3.08%, 0.39%, 0.69%, and 8.94%, respectively. There were 8,086 radiographs with

paired sesamoid bones and 118 radiographs with a single lateral sesamoid bone, indicating a prevalence rate of 98.53% for paired and 1.44% for single hallucal sesamoid bones. Only three (0.04%) radiographs revealed the lack of hallucal sesamoid bones. A single medial hallucal sesamoid bone was not visible on any of the 8,207 radiographs. In 4,860 (59.22%) of radiographs, a single sesamoid bone was found plantar to the IP joint of the hallux (Sun and Wang et al., 2016).

Furthermore, it was discovered that sesamoid bones coexist at two or more MTP joints as well as the hallucal IP joint(Sun and Wang et al., 2016)..

A study on the residents of Rawalpindi showed that the presence of sesamoid bones at the first metatarsophalangeal joints in both feet of subjects with a frequency of 100% while at the second, third fourth and fifth metatarsophalangeal joints, the frequency of sesamoid bones found were 12%, 0%, 0%, and 18%, respectively (Saeed et al., 2020).

A study conducted in Italy amongst 505 women showed that the fifth metatarsal sesamoid bone was common in 97 patients (19.2%), followed by the second metatarsal sesamoid bone in 15 patients (3.0%), the third metatarsal sesamoid bone in 6 (1.2%) patients, and the fourth metatarsal sesamoid bone in 9 (1.8%) patients. Hallucal sesamoid bones were found in all of the patients. Five (1.0%) and two (0.4%) individuals, respectively, had bipartite and tripartite hallucal sesamoid bones. In 21 (4.2%) cases, an interphalangeal sesamoid bone of the hallux was discovered (Longo et al., 2013).

The coexistence of partite hallux sesamoids and sesamoids at other MTP joints follows a pattern, which can aid in differential diagnosis. Sun et al., 2018 identified four types of coexistences, with a prevalence rate of 0.42% overall. Partition and sesamoids were discovered at the second and fifth MTP joints, as well as partition and sesamoids at the other four MTP joints.

Sun et al., 2018 discovered extra MTP sesamoids in 9.6% of the feet and only hallux sesamoids in 90.4% of the feet. There were 10.89% and 89.11% of feet with and without extra MTP sesamoids, respectively. Partition was discovered in 7.17% of feet that only had hallux sesamoids and 3.93% of feet that had extra sesamoids.

In a recent Turkish study, it was reported that in 1651 radiographs 1.8% had bipartite hallux sesamoid and in 0.7% had interphalangeal sesamoid bone of the hallux. Metatarsophalangeal sesamoid bones were found in 0.6%, 0.06%, 0.6%, and 5.8% of the second, third, fourth, and fifth digits, respectively (Candan et al., 2022).

Arslan et al., 2018 reported that the medial unilateral hallucal sesamoid bone was found in only one patient, while hallucal sesamoid bones were found in all the patients. In the literature, however, the incidence of partite sesamoids varies. In 79 patients (9.7%), a tripartite hallucal sesamoid bone was found, with 66 (8.1%) showing medial division and 13 (1.59%) showing lateral division. Bilateral medial and lateral divisions were found in three patients. The interphalangeal sesamoid was detected in 34.6% of the patients and 12 cases (0.49%) showed a bipartite structure. Metatarsophalangeal sesamoid bones were reported in the study to have the corresponding values of 2%, 0.7%, 1.1%, and 14.6%, respectively (Arslan et al., 2018).

According to a Nigerian study, the hallucal sesamoid of the interphalangeal joint was not seen, and the sesamoid of the first metatarsophalangeal joint was the most common with 81.5% prevalence (Udoaka and Didia, 2013).

In a recent study carried out in India, hallux sesamoids were found in all individuals; with IP joint sesamoid of the great toe and 5th lesser metatarsal sesamoid being the second and third most common, respectively. The hallux sesamoids vary greatly. It includes medial bipartite (3.38%), lateral bipartite (0.58%), and absent medial hallux (1.16%) (Sharma et al., 2022).

Another study conducted in a Pondicherry population of 1000 patients showed that sesamoid bones were found in 104 patients (10.4%), with 12 of them having more than one sesamoid bone. The hallux sesamoid bone was found in almost all the patients. The frequent sesamoid bone found in the foot and ankle is the bipartite medial hallux, which was found in 7.4% of the patients (Padmanaban et al., 2021).

CHAPTER III

Methodology

3.1. Study Design and Participants

This retrospective study utilized a selection method of radiographs that showed the foot sesamoid and accessory bones. Due to the retrospective nature of the study, the informed consent form was waived. Clinical data was obtained on each of the radiographs of patients.

3.2. Participants/Population and Sample/ Study Group

During the period of October 2019 and June 2022, a total number of 788 radiographs of patients were collected from the Radiology Unit of Dr Burhan Nalbantoglu State Hospital in Turkish Republic of Northern Cyprus.

3.3. Data Collection Tools and Material

After obtaining ethical approval from the Ethics Board of Dr Burhan Nalbantoglu State Hospital, all radiographs were viewed electronically on a PACS Oasis desktop. All radiographs of patients of all age groups older than 14 years were included and also high-quality foot radiographs showing the foot and ankle regions. Radiographs of patients who have had foot surgeries prior to when the radiographs were taken and defects in the foot were not included.

Anteroposterior, oblique, and lateral foot radiographs of 788 subjects' feet were examined for the presence and distribution of accessory ossicles and sesamoid bones.

3.4. Statistical Analysis

Data obtained during this study were subjected to analysis using the Statistical Package for Social Science (SPSS) and Chi-square test to check the relationship of the bones with their partitioning.

CHAPTER IV

Findings and Discussion

4.1. Accessory Bones

Table 1.

Frequency of Accessory Bones of the foot seen in the population of TRNC

Accessory bones	Frequency (%) n=788	Male (%) n=577	Female (%) n=211
Accessory navicular	2.8	0.6	2.2
Os intermetatarseum	0.4	0	0.4
Os calcaneus secundarius	0.1	0.1	0
Os peroneum	4.3	1.3	3.0
Os talotibiale	0.1	0	0.1
Os trigonum	6.5	0.9	5.6
Os vesalinum	0.7	0.1	0.6
Total	14.9	3.0	11.9

Frequency of accessory bones in the foot is shown in Table 1. Accessory ossicles were found in 118 (15.0%) of the 788 radiographs. In our study, the most common accessory bone of the foot was found to be the os trigonum. It was found in 51 (6.5%) radiographs. Os peroneum was detected in 34 (4.3%) radiographs, accessory navicular in 22 (2.8%) radiographs, os intermetatarseum in 3 (0.4%) radiographs, os vesalinum in 6 (0.7%) radiographs, os calcaneus secundarius in 1 (0.1%) radiograph and os talotibiale in 1 (0.1%) radiograph. In males, the accessory bones were found in 3.0% of the radiographs while in females, it was 11.9% of the radiographs. Distribution of the frequencies of the common accessory ossicles in male and female was significantly different. The accessory ossicles are more in females (11.9%) than in males (3.0%).

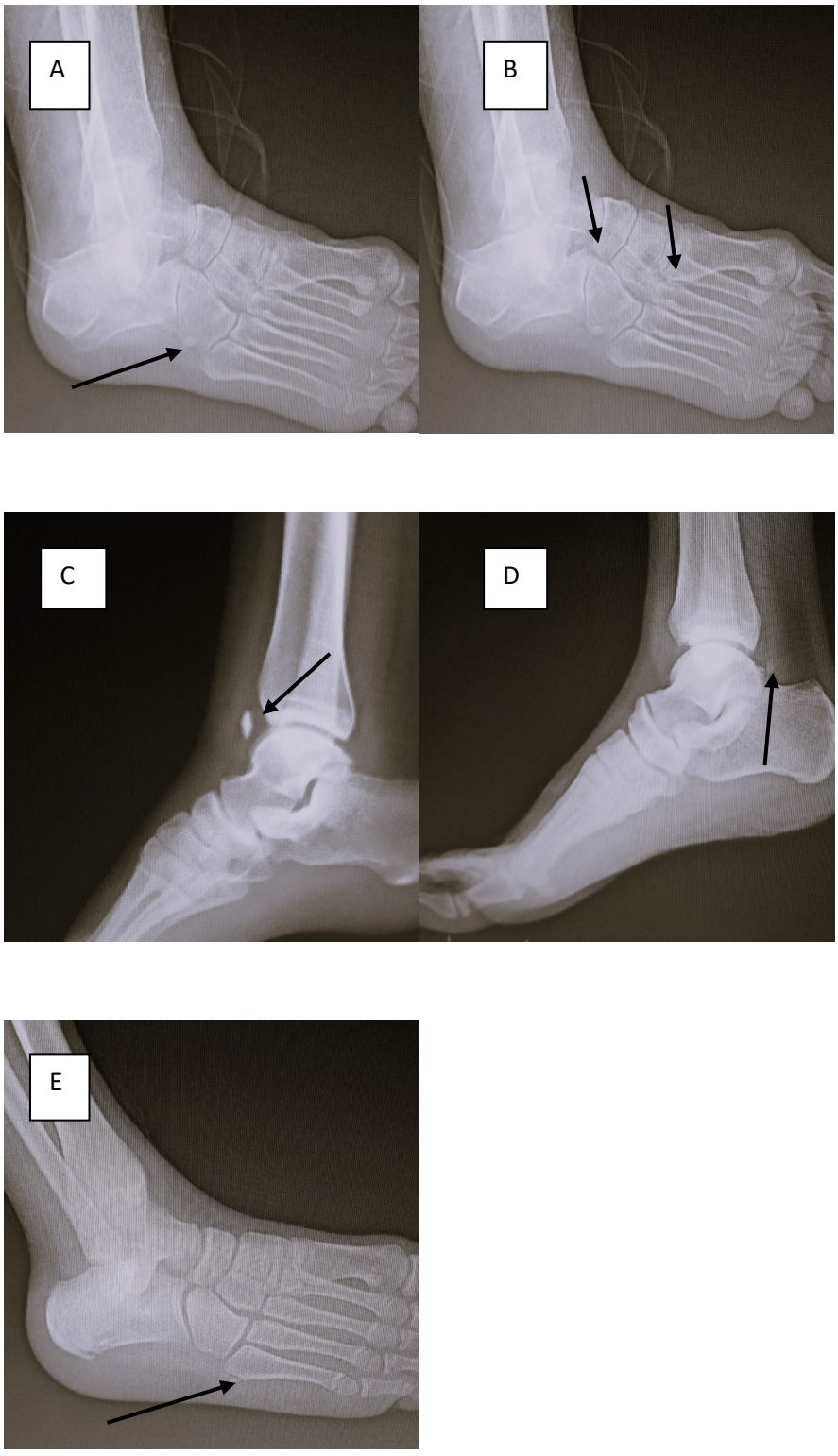

Figure 1: Radiographs showing the various accessory bones; (A) Anteroposterior view of patient's radiograph showing the accessory navicular bone; (B) Oblique view of patient's radiograph showing the os calcaneus secundarius and os intermetatarseum; (C) Lateral view of patient's radiograph showing the os talotibiale; (D) Lateral view of patient's radiograph showing the os trigonum; (E) Oblique view of patient's radiograph showing the os vesalinum

4.2. Sesamoid Bones

Table 2.

Frequency of Sesamoid Bones of the foot seen in the population of TRNC

Sesamoid Bones	**Frequency (%) n=788**	**Male (%) n=577**	**Female (%) n=211**
1st interphalangeal sesamoid	0.7	0.4	0.3
2nd metatarsal	2.2	1.8	0.4
3rd metatarsal	0.8	0.5	0.3
4th metatarsal	1.3	1.0	0.3
5th metatarsal	7.6	6.2	1.4
Hallucal sesamoid	100	73.2	26.8
Total	12.4	9.5	2.7

Hallucal sesamoid bones were present (100%) in all the radiographs, while other sesamoid bones were found in 98 (12.4%) radiographs or in 9.5% of male patients and in 2.7% of female patients. Bipartite hallucal sesamoid was observed in 20 (2.5%) radiographs. In 23 (2.9%) radiographs the medial hallucal sesamoid and in 1 (0.1%) radiographs the lateral hallucal sesamoid were found to be bipartite. Interphalangal sesamoid of the hallux was found in 5 (0.7%) radiographs.

In this study, the most frequent sesamoid bone in the foot asides the hallucal sesamoid was the fifth metatarsal sesamoid bone found in 60 (7.6%) radiographs. The fourth metatarsal sesamoid was found in 10 (1.3%) radiographs, second metatarsal sesamoid was found in 17 (2.2%) radiographs and third metatarsal sesamoid was found in 6 (0.8%) radiographs.

We also found the coexistence of two different sesamoid bones in 72 (9.1%) radiographs, coexistence of two different accessory bones in 5 (0.6%) radiographs and coexistence of sesamoid and accessory bones in 114 (14.5%) radiographs.

Figure 2: Anteroposterior views of radiographs of showing various sesamoid bones (A) 2nd-5th metatarsal; (B) Lateral and medial hallucal sesamoid; (C) Bipartite 5th metatarsal and bipartite medial hallucal sesamoid; (D) 2nd and 5th metatarsal; (E) Oblique view of patient's radiograph showing the 1st interphalangeal sesamoid

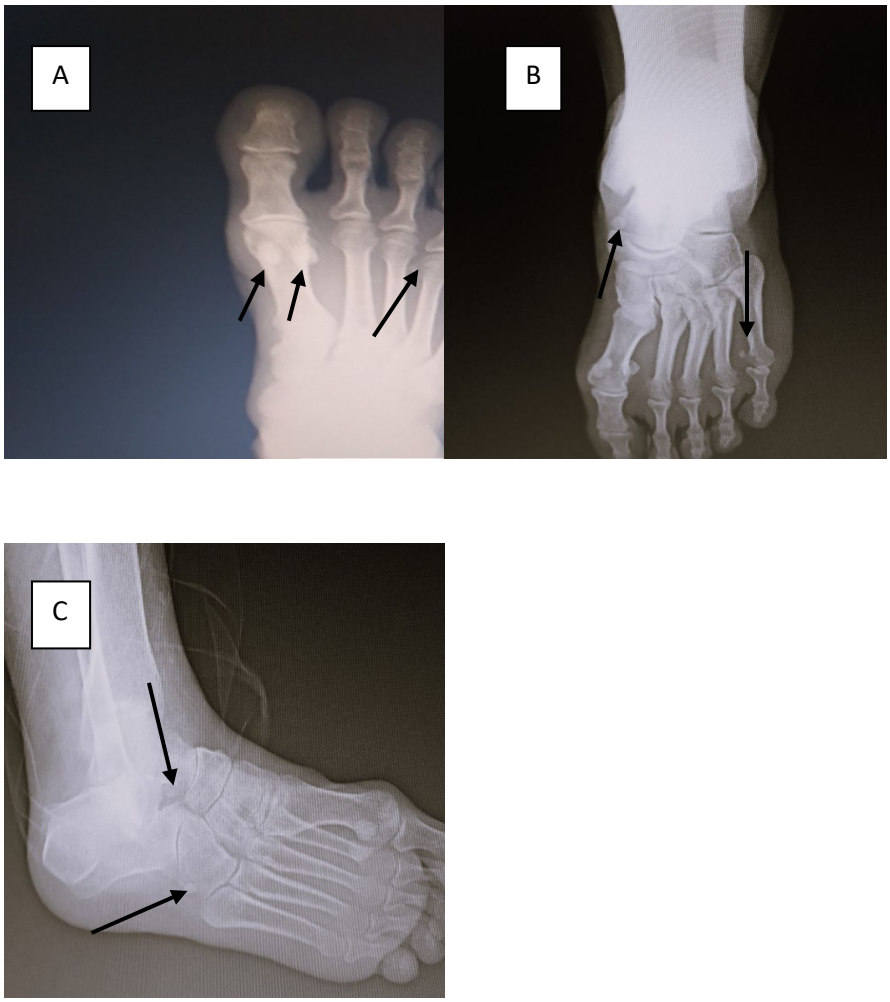

Figure 3: Types of coexistences between the bones of the foot; (A) Coexistence between two or more sesamoid bones (hallucal sesamoid and 4th metatarsal); (B) Coexistence between accessory bone and sesamoid bone (Accessory navicular and 5th metatarsal); (C) Coexistence between two accessory bones (os calcaneus secundarius and os peroneum)

4.3 Partitioning of Sesamoid and Accessory Bones

4.3.1. *Partitioning of Sesamoid Bones*

Table 3.

Sesamoid bones of the foot that is partite and not partite

Sesamoid Bones	**Bipartite Male n=577**	**Bipartite Female n=211**	**Total Bipartite n=788**	**Total Not Bipartite n=788**
1st interphalangeal	0%	0%	0%	0.6%
2nd metatarsal	0.3%	0%	0.3%	2%
3rd metatarsal	0%	0%	0%	0.7%
4th metatarsal	0.1%	0%	0.1%	1.1%
5th metatarsal	0.6%	0.1%	0.7%	7%
Lateral hallucal sesamoid	0.1%	0%	0.1%	3%
Medial hallucal sesamoid	2.4%	0.6%	3%	0.1%
Total	3.6%	0.6%	4.2%	14.2%

Table 3 shows partitioning was found in 4.2% of the sesamoid bones; the lateral hallucal sesamoid was found to be bipartite in 1(0.1%) of the radiographs, medial hallucal sesamoid was found in 23(3.0%) radiographs, fifth metatarsal sesamoid was found to be bipartite in 5(0.7%) radiographs and second metatarsal sesamoid was found to be bipartite in 2(0.3%) radiographs and fourth metatarsal sesamoid was found to be bipartite in 1(0.1%) radiograph.

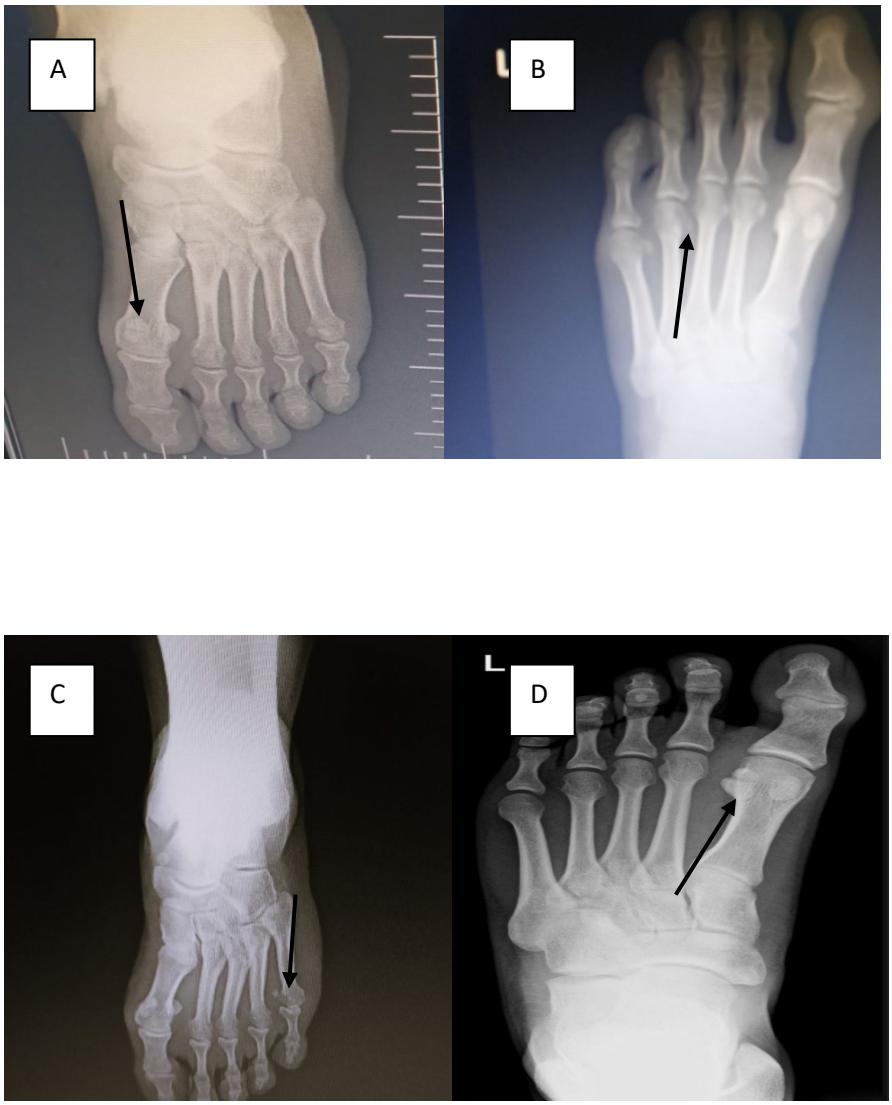

Figure 4: Anteroposterior views of radiographs of patients showing partitioning in various sesamoid bones (A) Bipartite medial hallucal sesamoid; (B) Bipartite fourth metatarsal; (C) Bipartite fifth metatarsal; (D) Bipartite lateral hallucal sesamoid

Table 3 and Table 4 shows the frequency of partition in the sesamoid bones

4.3.2. *Chi-square Test*

Table 4.

Chi-square test of relationship between sesamoid bones of the foot and its partition

	Value	**Df**	**Asymptotic Significance (2-sided)**
Pearson Chi-Square	624.451[a]	7	.000
Likelihood Ratio	209.339	7	.000
N of Valid Cases	910		

a. 8 cells (50.0%) have expected count less than 5. The minimum expected count is .18.

*p< .05Chi-square test was performed to check the relationship between sesamoid bones and its partition. Table 5 shows that there exists a significant relationship between sesamoid bones and its partition in the population of TRNC because the p value is less than 0.05.

4.3.3. *Partitioning of Accessory Bones*

There was no partition in the 118 accessory bones of the 788 radiographs that was examined. Hence, the Chi-square test conducted showed no relationship. Table 8 shows that there is no Chi-square computed values for accessory bones and its partition because all the accessory bones were not partitioned in the population of TRNC.

CHAPTER V

Discussion

In the literature, the incidences of accessory bones in the foot were reported as 14-36% (Cilli and Akcaoglu, 2005; Mellado et al., 2003; Kruse and Chen, 1995). The incidence of accessory bones in our study was within the range as it was seen 15% in all subjects.

The frequent accessory bones in different studies are the os peroneum, accessory navicular and os trigonum (Cilli and Akcaoglu, 2005). In our study, the frequent accessory bone is the os trigonum (6.5%), followed by the os peronum (4.3%) and accessory navicular (2.8%) (Table 1, Figure 1). The frequency rates in our study were lower than the 15.4%, 11.5% and 13.7% reported by Kalbouneh et al., (2021). A recent study by Candan et al., (2022), showed that os trigonum (9.8%), accessory navicular bone (7.9%), and os peroneum (5.8%) were the most common accessory ossicles which almost consistent with our study.

However, according to Coskun et al., (2009), the accessory navicular was the most prevalent accessory bone in radiography investigations from Turkey with an incidence of 11.7% followed by the os peroneum and os trigonum. Also, many other studies reported the higher incidence of accessory navicular bone as the second frequent bone after the os peroneum and os trigonum in their reports (Cilli et al., 2005; Kalbouneh et al., 2017).

On the other hand, the frequency rates of the os intermetatarseum (0.4%), os vesalinum (0.8%), os talotibiale (0.1%) and os calcaneus secundarius (0.1%) were relatively low in our study which is almost consistent with previous studies (Table 1, Figure 1). The other accessory bones os infranaviculare, os supranaviculare, os supratalare, os subfibulare, os subtibiale were not seen. In a study by Lee et al., 2020, the os vesalinum, os calcanei secundarius, os intermaetatarseum, os infranaviculare, os supranaviculare were not seen. Also, these bones were rarely documented in a study by Coskun et al., (2009).

Candan et al., 2022, reported the frequency rate of os supratalare (0.48%), os calcanei secundarium (0.42%), os subfibulare (0.42%), os supranaviculare (0.36%), os vesalianum (0.30%), os subtibiale (0.24%), os intermetatarseum (0.12%), and os

subcalcis (0.12%). Our study shows that the frequency rate of accessory bones is higher in females (11.9%) than in males (3.0%).

Table 5.

Comparison of the Frequency of Accessory Bones with Other Literatures

Accessory Ossicles	**This study**	**Coskun et al., 2009**	**Cilli et al., 2005**	**Lee et al., 2020**	**Kalbouneh et al., 2017**	**Kalbouneh et al., 2021**	**Candan et al., 2022**
Os trigonum	6.5	2.3	23.6	5.8	26.1	15.4	9.8
Os peroneum	4.3	4.7	31.7	3.9	-	13.7	5.8
Accessory navicular	2.8	11.7	28.6	34.0	22.9	11.5	7.9
Os intermtatarseum	0.4	0.2	-	-	-	0.2	0.12
Os vesalinum	0.8	0.4	-	-	-	1.1	0.30
Os supranavicular e	-	1.6	-	-	-	0.7	0.36
Os infarnaviculare	-	-	-	-	-	0.3	-
Os calcaneus secundarius	0.1	-	-	-	-	0.3	0.42
Os talotibiale	0.1	-	-	-	-	0.4	-
Os supratalare	-	0.2	-	-	-	0.3	0.48
Os subtibiale	-	-	-	-	-	0.1	0.24
Os subfibulare	-	-	-	1.7	-	0.6	0.42
Os subcalcis	-	-	-	-	-	-	0.12

Furthermore, our study sought to determine the frequency of sesamoid bones. Furthermore, our study aimed to show the frequency of sesamoid bones. The prevalence of sesamoids in the foot varies greatly among individuals. Normally, the sesamoid bones of the first metatarsophalangeal joint which is the hallucal sesamoids are seen as a normal part of the bones of the body while the sesamoid on the lesser toes are rarely seen. Congenital absence of the hallucal sesamoid is not so common (Kiter et al., 2006). Although Sun et al., (2016) reported the absence of hallucal sesamoid, there was no detection of the absence of hallucal sesamoid in this current study.

The hallucal sesamoid bones were present in all radiographs (Table 2, Figure 2). Hallucal sesamoids that are bipartite are twice as abundant as those that are multipartite (Helal, 1981). . The frequency of bipartite hallucal sesamoid was reported to be between 1.8% to 34% by Bizarro, 1920. In this study, the frequency of bipartite hallucal sesamoid is 3.0% which is within the range with previous literatures. The bipartite medial hallucal sesamoid was 2.4% while the bipartite lateral hallucal sesamoid was 0.1% (Table 3, Figure 4).

Some literatures recorded the presence of tripartite hallucal sesamoids (Arslan et al., 2018), but in our study tripartite hallucal sesamoids were not detected. Also, in the foot, the 2^{nd} -5^{th} digital sesamoids are commonly seen in the 2^{nd} and 5^{th} digits than on the 3^{rd} and 4^{th} digits. In a Chinese study of 8,204 radiographs, sesamoid bones at the MTP joint of the second, third, fourth, and fifth digits occurred at a rate of 3.08%, 0.39%, 0.69%, and 8.94%, respectively (Sun and Wang et al., 2016). In another study by Coskun et al., (2009), In 0.4%, 0.2%, 0.1%, and 4.3% of instances, MTP sesamoid bones were found in the second, third, fourth, and fifth digits.

In our present study, the frequency of MTP sesamoid bones found in the second, third, fourth and fifth digits as 2.2%, 0.8%, 1.3% and 7.6% respectively (Table 2, Figure 2). We also found out partition in sesamoid bones of some toes. Bipartition occurred in the second metatarsal with a frequency rate of 0.3%, in the fourth metatarsal with a frequency of 0.1% and in the fifth metatarsal with a frequency rate of 0.7% (Table 3, Figure 4).

There is also a pattern to the coexistence of partite hallux sesamoids and sesamoids at other MTP joints, which can help with differential diagnosis. Sun et al., (2016) identified four different types of coexistences, with an overall prevalence rate of 0.42%. Also, Sun et al., (2018) also detected 9.6% of feet with extra MTP sesamoids and 90.4% of feet with only hallux sesamoids, 10.89 % and 89.11% of feet with and without extra MTP sesamoids were also found respectively. Partition was found in 7.17% of feet with only hallux sesamoids and 3.93% of feet with extra sesamoids (Sun et al., 2018).One foot may have many accessory bones (O'Rahilly, 1957). In our study, we also found the coexistence of two different sesamoid bones in 72 (9.1%) radiographs, coexistence of two different accessory bones in 5 (0.6%) radiographs and coexistence of sesamoid and accessory bones in 114 (14.5%) radiographs (Figure 3). However in a study by Coskun et al., (2009), the reported frequencies for the coexistence of two different accessory ossicles and coexistence of accessory ossicles with sesamoid bones in the feet were 6% and 7% respectively.

Anatomically, the interphalangeal sesamoid of the hallux is a variation with a reported incidence of 2–13% (Nwawka et al., 2013). However, the frequency of interphalangeal sesamoid in our study was observed to be 0.6%. This agrees with a prevalence rate reported by Candan et al., (2022), but higher prevalence has been reported by Coskun et al., (2009), Arslan et al., (2018) and Sun et al., (2016) (2%, 34.6% and 59.22% respectively). The use of computed tomography, which is more sensitive than plain radiography in finding sesamoid bones, may have contributed to the study by Arslan et al., (2018) high prevalence rate of the hallucal interphalangeal sesamoid bone.

Table 6.

Comparison of the Frequency of Sesamoid Bones with Other Literatures

Sesamoid Bones	**This study**	**Coskun et al., 2009**	**Sun and Wang et al., 2016**	**Longo et al., 2013**	**Sun et al., 2018**	**Candan et al., 2022**	**Arslan et al., 2018**	**Udoaka and Didia 2013**
Hallucal sesamoid	100.0	100	99.96	100	100	100	100	81.5
Bipartite hallucal sesamoid	3.0	2.7	-	1.0	7.17	1.8	89.8	-
Second metatarsal sesamoid	2.2	0.4	3.08	2.8	3.15	0.6	2.0	-
Third metatarsal sesamoid	0.8	0.2	0.39	1.2	0.40	0.06	0.7	-
Fourth metatarsal sesamoid	1.3	0.1	0.69	1.8	0.72	0.6	1.1	-
Fifth metatarsal sesamoid	7.6	4.3	8.94	19.2	9.06	5.8	14.6	-
Bipartite 5^{th} metatarsal sesamoid	0.7	-	8.94	-	-	-	3.2	-
First interphalangeal sesamoid	0.6	2	59.2	4.2	-	0.7	34.6	-

Numerous reasons, such as interethnic disparities, intergenetic factors, and mechanical stressors, may be to blame for the significant variations in the occurrence of sesamoid bones in the foot documented in various literatures (Bizarro, 1921). The genetic and/or environmental variables that may be to blame for the variations in the occurrence of sesamoid bones in various populations will likely require further study.

CHAPTER VI

Conclusion and Recommendations

6.1. Conclusion

This study provides a thorough account with a focus on the frequency of sesamoid and accessory foot bones in the studied group of TRNC population. The findings of the study (accessory bones) appear to be very different from similar findings in other communities and literatures. The study's data indicate that individual differences in sesamoid and accessory bone frequency are significant.

A detailed understanding of the bones is necessary to aid clinicians in the identification and treatment of bone problems that are frequently ignored in patients who present with foot pain and discomfort.

6.2. Recommendations

This study suggests using additional radiological tests like scintigraphy, CT, MRI, and ultrasound to better understand the presence and disease of the bones in order to avoid mistaking them for fractures in much greater numbers of the subjects.

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Appendices

Appendix A

Temitope Ayomikun Oyenekan

PERSONAL

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Telephone: +905391013952

Email: oyenekantimilehin@gmail.com

Date of Birth: 14th April, 1998

PROFILE

An independent graduate with passion for professional competence in student and work relationship with strong work ethics and finding solutions to students challenges in practical work and also technological issues around the office environment. I am self-motivated and a very good team player.

EDUCATION

Near East University **February 2020;**
Nicosia, Cyprus

Human Anatomy (MSc. in view)

Bowen University **2014- 2018; Osun State, Nigeria**

B.Sc Human Anatomy

Grade: Second Class Upper

Dissertation: Protective effects of Vitamin E on the prefrontal cortex of Atropine-induced Wistar rats

WORK EXPERIENCE

Near East University **March 2020 – Present; Nicosia, Cyprus**

(Laboratory Assistant)

- Help students in their practical sessions
- **National Youth Service Corps (NYSC)** **August 2018 – August 2019 Ekiti, Ekiti State University**
- Lecture Diploma Students
- Help the medical students with their practicals and dissection
- Prepare students reports using Spreadsheet

ADDITIONAL SKILLS AND INTERESTS

Skills

- Basic knowledge in Microsoft word, Excel and Powerpoint
- Excellent oral and communication skills
- Passionate and fast in learning new information
- Creative thinking
- Good people relational skills

Interests: listening to music, braiding, adventures

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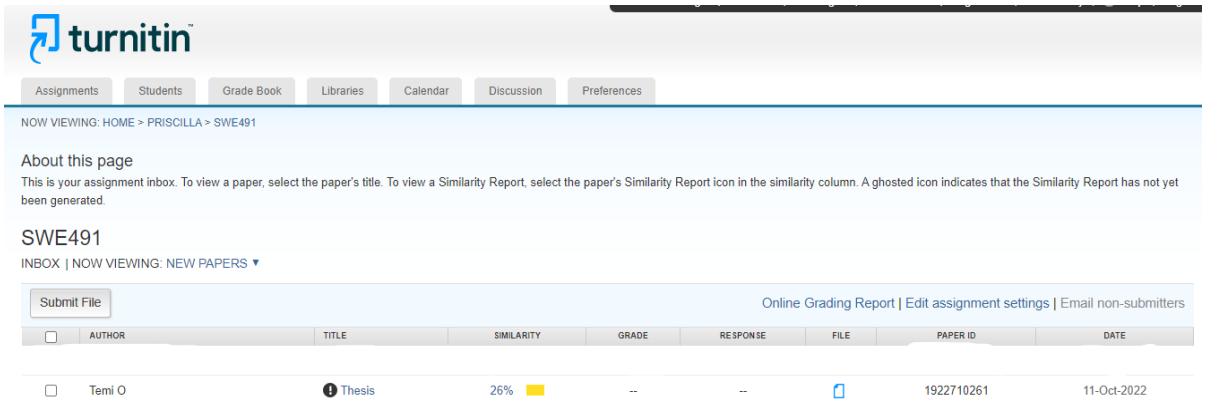
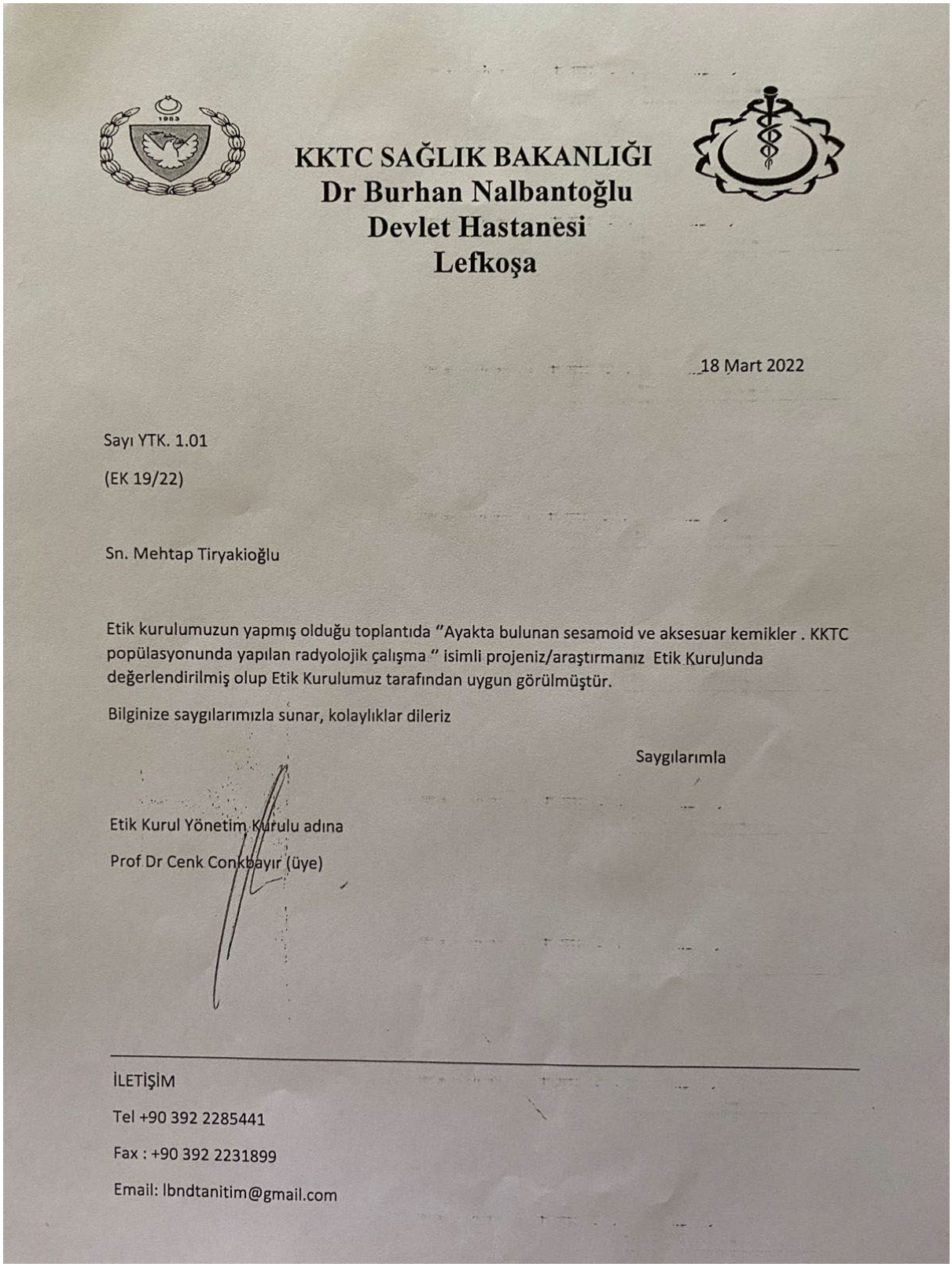
Appendix B

Turnitin Similarity Report



Appendix C

Ethics Approval Form



KKTC SAĞLIK BAKANLIĞI
Dr Burhan Nalbantoğlu
Devlet Hastanesi
Lefkoşa

18 Mart 2022

Sayı YTK. 1.01

(EK 19/22)

Sn. Mehtap Tiryakioğlu

Etik kurulumuzun yapmış olduğu toplantıda "Ayakta bulunan sesamoid ve aksesuar kemikler . KKTC popülasyonunda yapılan radyolojik çalışma " isimli projeniz/araştırmanız Etik Kurulunda değerlendirilmiş olup Etik Kurulumuz tarafından uygun görülmüştür.

Bilginize saygılarımızla sunar, kolaylıklar dileriz

Saygılarımla

Etik Kurul Yönetim Kurulu adına

Prof Dr Cenk Conkbayır (üye)

İLETİŞİM

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Appendix D

Waived Consent Form

INFORMED CONSENT FORM FOR ADULTS

(FOR THE PATIENTS / PARTICIPANTS)

You are invited to participate in a research study conducted by [name of investigator(s)], from the NEAREAST UNIVERSITY [departmental affiliation(s)]. I have learned that [state what the study is designed to discover or establish]. You were selected as a possible participant in this study because [state why the subject was selected].If you decide to participate, [describe procedures, including their purpose, how long they will last, their location and frequency. If activities are to be audio or videotaped, indicate this]. [Describe risks, discomforts, inconveniences, and how these will be managed. Describe any alternative procedures or courses of treatment, if applicable. Indicate costs of participating, if any]. [Describe benefits to subjects and humanity expected from the research]. However, I cannot guarantee that youpersonally will receive any benefits from this research. [If subject will receive compensation, describe amount and when payment is scheduled].Any information that is obtained in connection with this study and that can be identified with you willremain confidential and will be disclosed only with your permission or as required by law. Subjectidentities will be kept confidential by [describe coding procedures and plans to safeguard data]. [If participants will remain anonymous, then reword the above to reflect that and state how the information will be kept anonymous.] [If information will be released to any other, for any reason, state the personal agency to whom the information will be furnished, the nature of the information, and the purpose of the disclosure].Your participation is voluntary. Your decision whether or not to participate will not affect yourrelationship with [name agency, school, etc. where subject was recruited]. If you decide to participate,you are free to withdraw your consent and discontinue participation at any time without penalty. If you have any questions about the study, please feel free to contact [phone number, e-mail, and address]. [If student, also provide advisor name and phone, and identify as your advisor]. If you havequestions regarding your rights as a research subject, please contact the NEAR EAST INSTITUTIONALREVIEW BOARD. You

will be offered a copy of this form to keep.Your signature indicates that you have read and understand the information provided above, that youwillingly agree to participate, that you may withdraw your consent at any time and discontinueparticipation without penalty, that you will receive a copy of this form, and that you are not waiving anylegal claims.

Participant

Name, Surname:

Address:

Phone:

Signature:

Witness

Name, Surname:

Address:

Phone:

Signature:

Interviewer:

Name, Surname:

Address:

Phone:

Signature:

Appendix E

Criteria List

FILE NO	GENDER	SB(+/-)	IF(+),WHAT SESAMOID	PARTITE/NOT PARTITE	AB(+/-)	IF(+),WHAT ACCESSORY BONE	PARTITE/NOT PARTITE