Prevalence of Accessory Bones of the Foot in Turkish Patients

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ABSTRACT

Objective: The aim of this study was to investigate the prevalence and distribution of accessory bones of the foot by age and gender in a Turkish patient group.

Methods: Dorsoplantar and lateral foot radiographs acquired from the data related to outpatient clinics patients in 2014 were retrospectively examined for the presence of accessory bones. The computed radiography images were evaluated via a picture archiving and communication system. A total of 8204 radiographs were assessed and 6779 radiographs were found to be eligible for inclusion in the study.

Results: 47.4% of the radiographs were from males and 52.5% females. The prevalence of accessory bones in the whole study group was found to be 18.1%. Gender analysis showed that 17.5% of the female radiographs and 16.4% of the male radiographs had accessory bones. Among all the accessory bones found in the study group, os tibiale externum was found to be the most common accessory bone (32.1%).

Conclusion: In the present study, no significant difference was detected in terms of gender. Os tibiale externum was found to be the most common accessory bone of the foot. Os peroneum and os trigonum were found to be the second and third most common, respectively.

Keywords: Foot, radiography, accessory navicula, os trigonum

INTRODUCTION

Accessory bones are bony structures that occur because of a fusion failure at one of the ossification centers or as a development of an additional independent ossification center (1-5).

Many skeletal variations of the foot and ankle are known, including different accessory and sesamoid bones. Being familiar not only with normal anatomic structures but also with accessory bones is crucial in order not to confuse them with avulsion fractures while evaluating radiographs (6, 7), otherwise unnecessary consultations from orthopedic departments or excessive medications and cast applications, which would lead to costly and time-consuming treatments, would likely occur.

Clinical and radiological features of accessory bones and also differential diagnosis entities have been discussed in the literature; however, studies in this topic are very limited in Turkey. Therefore, the aim of this comprehensive study was to investigate the prevalence and distribution of accessory bones of the foot by age and gender in a Turkish patient group, as well as to obtain knowledge to assist physicians at emergency departments or family health centers.

METHODS

Institutional review board approval was obtained for the study. Due to the easy detection of most of accessory bones on dorsoplantar and lateral foot radiographs (4-6), these radiographs were retrospectively examined for the presence of accessory bones. These radiographs were acquired from the data related to outpatient clinics patients in 2014. Computed radiography images were evaluated via a picture archiving and communication system (PACS) (Infinitt PACS, Ankara, Turkey) of the hospital. Therefore, patient consents could not be obtained. Radiographs were recorded with hospital identification (ID) numbers to avoid reiterated evaluations. The gender and age of the patients were also noted. Since secondary ossification centers of the foot appear generally between the ages of 7 and 12 (7), children under 12 years old were excluded from the study.

Each day in 2014, the records were scanned separately by choosing "estimated day" on the calendar and "foot section" on the body part option on the PACS software. A total of 8204 foot dorsoplantar and lateral foot radiographs were found to be acquired between January 1 and December 31, 2014, and were included in the study. 1303 of the radiographs were excluded due to an insufficient technique in taking the radiograph or low picture quality (e.g., images on which some parts of the foot were cropped or non-foot radiographs) and 122 due to being repeats. Therefore, 6779 dorsoplantar and lateral radiographs were found to be eligible for the study. The gender discrimination of the whole study group was noted. Data were recorded in the same format using Microsoft Excel™ 2010 (Chicago, USA) software.

This study was presented at the 25th National Orthopaedics and Traumatology Congress (October 27 to November 1, 2015, Antalya, Turkey).

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Table 1. Prevalence and ratio of accessory bones of the foot and their gender distribution

Accessory bones	Prevalence in study group (%)	Ratio in all accessory bones (%)	Male (%)	Female (%)	Gender difference (p)
Os tibiale externum	5.8	32.1	39	61	<0.001
Os peroneum	5.3	29.3	43.6	56.3	0.001
Os trigonum	2.9	16	55.3	44.6	<0.001
Multipl accessory bones	0.6	3.1	40	60	
Os vesalianum	0.3	1.7	54.6	45.4	
Os supranaviculare	0.1	0.9	83.3	16.6	
Os subtibiale	0.1	0.8	66.6	33.3	
Os intermetatarseum	<0.1	0.4	20	80	
Os supratalare	<0.1	0.4	50	50	
Os supracalcaneum	<0.1	0.3	66.6	33.3	
Os subcalcis	<0.1	0.3	75	25	
Os calcaneus secundaris	<0.1	0.2	50	50	
Os cuboid secundarium	<0.1	0.2	50	50	
Os talotibiale	<0.1	<0.1	100	0	

Digital radiographs were first assessed by at least one of the four study orthopedic surgeons and a radiologist. The final decision was made by a reviewer with specific experience in foot pathologies.

Statistical Analysis

Statistical analyses were performed using Statistical Package for the Social Sciences 21.0 software (IBM SPSS Statistics; Armonk, NY, USA). A p value of less than 0.01 was considered to show a statistically significant result. The chi-square test was used for the gender distribution.

RESULTS

It was found that 47.4% of the radiographs (3214/6779) were from males and 52.5% of them (3565/6779) were from females.

The prevalence of accessory bones in the whole study group was found to be 18.1%. Gender analysis showed that 17.5% of the female radiographs and 16.4% of the male radiographs had accessory bones. Statistical analyses regarding the prevalence of accessory bones showed that there was no statistically significant difference between the genders (p=0.227). Among all the accessory bones found in the study group, os tibiale externum was found to be the most common accessory bone of the foot (32.1%), while os peroneum (29.3%) and os trigonum (15.4%) were found to be the second and third most common, respectively. Os peroneum was slightly more common in males (Figure 1). 3.6% of the patients were found to have multiple accessory bones (Table 1). Analysis of the radiographs containing multiple accessory bones showed that os peroneum (70.5%), os tibiale externum (65.9%), and os trigonum (29.5%) were the most common bones appearing in combination with other accessory bones of the foot. Statistical analyses were performed for the three most common accessory bones. In terms of os tibiale externum and os peroneum, the prevalence rates were significantly higher in females than in males; however, it has been found that the prevalence of os trigonum was significantly higher in males than in females (Table 1 and Figure 1).

Our study group was divided into three groups in terms of age: young, middle, and advanced age. The young age group was defined as below 30 years of age, while the advanced age group was defined as above 60 years of age, and the middle age group was defined between 30 and 60 years of age. Evaluation of the most common three accessory bones showed that while os tibiale externum and os peroneum were mostly diagnosed in the middle age group, os trigonum was mostly found in the young age group.

DISCUSSION

Accessory bones of the foot can be confused with avulsion fractures, which can lead to misdiagnosis and overtreatment in cases of trauma. Besides traumatic lesions, inflammatory situations, connective tissue disorders, dislocations, and subluxations are other conditions related with accessory bones. These disorders must be kept in mind in the differential diagnosis of painful feet, a limited range of motion, and overuse situations (1, 6, 8). Both in traumatic and non-traumatic situations, the history of the patient and a comprehensive physical examination are used to reveal the diagnosis. From the point of view of making a differential diagnosis, the main principle is to touch the patients affected foot. If the patient acts as if he or she was suffering from pain, the disease would be there. Vice versa is also true. Direct radiographies are needed at this point. By palpation, if the disturbing region and the region where the accessory bone is localized in graphs are in different places, there should not be a diseased situation. Moreover, on radiographs, cortical discontinuity is a basic finding of avulsion fractures. These simple key points are highly impor-

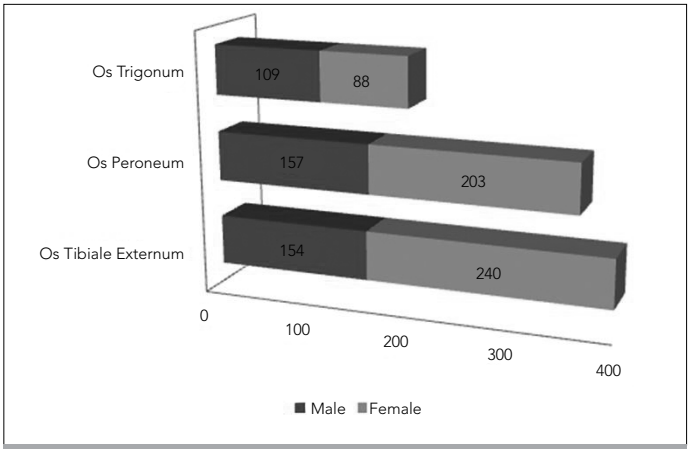

Figure 1. Gender distribution of the three most common accessory bones. The numbers show the number of patients with the accessory bones

tant for physicians in emergency departments and family health centers.

Accessory bones are generally diagnosed incidentally at radiographs that are at first performed for other reasons, due to their low priority in clinical practice (5, 6). The first order radiological approach in the evaluation of accessory bones is a plane radiograph. This study was structured as a screening research study and performed by examining plane radiographs. If a fracture, an inflammatory event, or necrosis is suspected, magnetic resonance imaging, computed tomography, or scintigraphy should be considered for further evaluation to make a definite diagnosis (2, 9).

Studies scrutinizing the prevalence of accessory bones in Turkish subjects are very limited. Among previous publications about this issue in Turkey, the most comprehensive one is the study conducted by Coskun et al. (6), in which the authors recruited 984 cases and found that 21.2% of them had accessory bones of the foot. The authors also reported that there was no significant difference in terms of gender or side. In their study, os tibiale externum was found to be the most common accessory bone of the foot (6).

On the other hand, Cilli and Akcaoglu (10) reported the prevalence of accessory bones of the foot as 18.3% in their study. Os peroneum was found to be the most common one. However, only male individuals were included in their study.

The third publication about this issue is the study conducted by Kır et al. (5). They reported the prevalence of accessory bones in Turkish subjects as 45.4%. We considered that the reason for this huge difference between our study results and their study results may be attributed to their relatively smaller study group. The exact rate of accessory bones may be misinterpreted since they performed the study with only 277 cases (5).

In terms of accessory bone rates of the foot, our results (18.1%) are very close to the authors mentioned above (6, 10). Our results are identical with Coskun et al. (6) but conflicting with Cilli and Akcaoglu (10), since we found os tibiale externum as the most common accessory bone of the foot. However, according to our study, especially in male individuals, the rates of os tibiale externum and os peroneum were very close to each other.

When we reviewed the literature, we found that the most common accessory bones of the foot found in studies were combinations of os tibiale externum, os peroneum, and os trigonum, respectively (1-5, 10). Our findings depicted the same descending order with the literature mentioned above.

In a study from China, Huang et al. (8) reported that 20.2% of symptomatic patients had accessory bones of their feet. The prevalence was slightly higher in females, and accessory bones were mostly seen in patients between 51 and 60 years of age. In our study, the general rate of accessory bones was similar with Huang et al. (8), besides we found that while os tibiale externum and os peroneum were mostly diagnosed in the middle age group, os trigonum was mostly found in the young age group. However, these findings are not clinically crucial because accessory bones do not occur or disappear by age.

Os tibiale externum (Figure 2a-c) was first described by Bauhin in the seventeenth century and is also known as accessory navicula, navicular secundum, accessory scaphoid, and prehallux. According to the literature, its overall prevalence is reported to be 10–14% (1, 3, 4). In this study, we found the prevalence to be 5.8% in the whole study group, and the rate was significantly higher in females than in males (Table 1). The autosomal dominant inheritance of os tibiale externum was reported in some papers (11, 12). Os tibiale externum may be seen in different shapes on plane radiographs. It is classified into three types: Type I os tibiale externum is as an oval or round bone at the distal end of the posterior tibialis tendon; Type II is triangular or heart-shaped and appears as a separate bone in which the ossification center is not united to the main bone; Type III identifies a united bone and is seen as a protrusion of the navicular bone (1). They are best seen on dorsoplantar and medial oblique radiographs (3).

Os peroneum (Figure 2a) is a bipartite or multipartite accessory bone that is embedded within the peroneus longus tendon like a sesamoid bone. It is located next to the calcaneo-cuboid joint and can be best visualized on lateral oblique radiographs of the foot. However, for a screening study, lateral views are also acceptable (5, 10). Os peroneum may be confused with cuboid avulsion fractures and in differential diagnoses, disruption in the marginal cortical continuity should be paid attention to (3, 7). The approximate prevalence of os peroneum is reported as 9% in the literature (3, 9). However, our results depicted the prevalence as 5.3% in our study, and the rate was significantly higher in females than in males (Table 1).

Os trigonum (Figure 3) is located next to the lateral tubercle of the posterior process of the talus. The estimated prevalence of os trigonum is 2–25%. It may be triangular, oval, or round shaped and is best visualized on lateral radiographs (3, 9). Os trigonum may be confused with fractures of the posterior process of the talus. Remarkably sharp edges and discontinuity of the cortical lining should be considered as a fracture (3, 7). Our results indicate its prevalence as 2.9%, which is consistent with the results in the literature. Contrary to the first two accessory bones mentioned above, the prevalence of os trigonum was significantly higher in males than in females in our study (Table 1 and Figure 1).

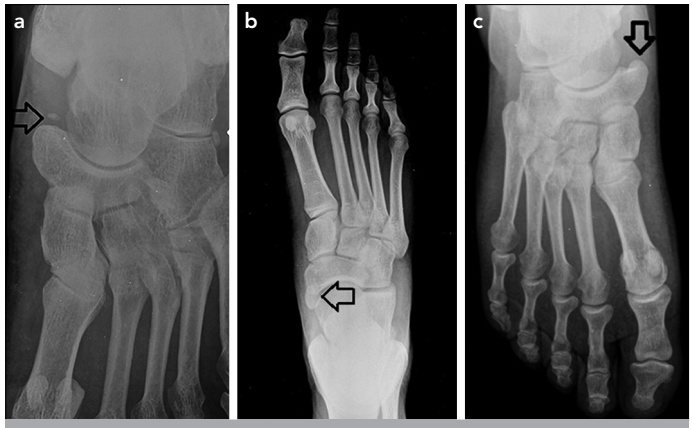

Figure 2. a-c. Types of accessory navicular bones (black arrows): (a): 24-year-old male with type I accessory navicula and os peroneum. Accessory navicula is a separated small accessory fragment located on the posterior tibialis tendon. Os peroneum (white arrow) is also seen at the calcaneocuboid joint. (b): 18-year-old female with type II accessory navicula. It is a bony fragment separated from the navicula. (c): 44-year-old female with type III accessory navicula. The united bone is seen as a protrusion of the navicular bone

Figure 3. Forty-six-year-old male with os trigonum (black arrow) seen on a lateral foot radiograph

Os vesalianum is localized adjacent to the base of the fifth metatarsal and may be confused with avulsion fracture. An uncorticated sharp fracture line is the key point to distinguish the fracture from the accessory bone (3, 7).

Os supranaviculare and os subtalare are neighbors and are best visualized on lateral radiographs. Os supranaviculare is located at the dorsal margin of the talonavicular joint, while the latter is located at the dorsal aspect of the talar neck. Consequently, they may be confused with a dorsal avulsion fracture of the navicula and talus (3, 7).

Os intermetatarseum is located proximally at the intermetatarsal space between the first and second metatarsals (3-8). It should be kept in mind since it may be confused with a "fleck sign" in Lisfranc injuries. In order to distinguish it from Lisfranc fracture–dislocations, tarsometatarsal discontinuity and widening of the first intermetatarsal space should be paid attention to (3).

Os calcaneus secundarius is located adjacent to the antero-superior facet of the calcaneus and may be confused with a calcaneus avulsion fracture (3, 7).

Other accessory bones are rare and the prevalence of them that we found are depicted in Table 1.

We calculated the overall prevalence of accessory bones of the foot as 18.1%, which is consistent with the results in the literature. This study was carried out on a huge population and all of the radiographs were assessed at least by two of the authors. As far as we know, this study is the most comprehensive one about this issue regarding the size of the study group. We consider that this study might be a good example to represent the whole population in our country and may give an idea about prevalence worldwide.

Although it is the most comprehensive study, this study has also some limitations. Since we could not gather both left and right radiographs of the foot for the same patients, we cannot tell any information about the bilaterality of the accessory bones.

CONCLUSION

In this study, the general prevalence of accessory bones in our study group was depicted as 18.1%. No significant difference was detected in terms of gender. Although os tibiale externum and os peroneum were slightly more common in females, the prevalence of os trigonum was higher in males. Evaluation of the most common three accessory bones showed that while os tibiale externum and os peroneum were mostly diagnosed in the middle age group, os trigonum was mostly found in the young age group.

Because of the large sample size and inter-observer reliability, this study may be the most comprehensive and reliable trial worldwide and may indicate the exact prevalence of accessory bones of the foot.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of İstanbul Medeniyet University Göztepe Training and Research Hospital.

Informed Consent: Because of retrospective design of the study and due to evaluating direct roentgenograms via softwares, informed consent of the patients were not needed for the study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – E.U.; Design – E.U., B.A.; Supervision – E.U., B.A.; Resources – M.K., T.Ö.; Data Collection and/or Processing – T.T.Ö., S.E.; Analysis and/or Interpretation – T.T.Ö., S.E.; Literature Search – B.A., T.T.Ö.; Writing Manuscript – E.U., M.K.; Critical Review – M.K., S.E.

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