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The Prevalence and the Clinical Importance of *os vesalianum pedis*

Prevalence a klinický význam os *vesalianum pedis*

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ABSTRACT

PURPOSE OF THE STUDY

Os vesalianum pedis (OVP) is a rare accessory bone of the foot located at the base of the fifth metatarsal bone. It is usually asymptomatic and incidentally seen on radiographs. When symptomatic, it manifests itself with lateral foot pain. OVP, which can become symptomatic as a result of traumatic injuries, can also be confused with fracture.

The aim of this study is to determine the prevalence and morphometric characteristics of OVP in the Turkish population.

MATERIAL AND METHODS

Radiographic images of 5268 individuals aged 16 years and older (mean 39.65±17.21) who completed ossification of the fifth metatarsal bone were evaluated for OVP. Of the cases included in the study, 44.8% were female and 55.2% were male. The general and sex-based prevalence of OVP was calculated, and morphometric measurements were done.

RESULTS

OVP prevalence in the Turkish population was found to be 0.15% regardless of sex. OVP prevalence was calculated to be 0.24% in men and 0.04% in women.

CONCLUSIONS

Anatomy, radiology, orthopedics and emergency medicine physicians are frequently encountered with foot disorders in clinical and educational practices. It is important to keep in mind the rare presence of OVP (0.15%), in the preliminary diagnosis.

Key words: *os vesalianum pedis,* accessory ossicle, foot, radiography.

INTRODUCTION

Accessory bones of the foot are developmental anomalies of the skeletal system which results from abnormal division of the ossification center or failure of the uniting of the ossification centers (18). These bones, which can be adjacent to or separated from the main bone, can be located unilaterally or bilaterally (8, 24). These bones are usually small, oval or nodular with well-defined cortical borders. Although most of them are well defined, studies have been conducted to determine their prevalence (6, 16, 21). A total of 24 different accessory bones in the foot are mentioned in the literature (17). One of these accessory bones is a rare bone located at the base of fifth metatarsal bone. It was first mentioned by Andreas Vesalius, the founder of modern anatomy, in his book "De Humani Corporis Fabrica" (32). Later, this accessory bone was named "*os vesalianum pedis*" (25). The prevalence of this bone, which is relatively rare when compared to other accessory bones, varies between 0.1–1.6% in publications (1, 6, 7, 8, 16, 31).

Os vesalianum pedis (OVP) is usually asymptomatic and is usually discovered incidentally using imaging methods. If symptomatic, it may be associated with symptoms such as lateral foot pain, swelling, tenderness and erythema. There is no definitive information about the reason of the asymptomatic presentation. Although trauma is thought to be the cause in some of the cases, there are cases that cannot be explained by trauma (4, 14, 26).

The number of studies with large sample size specific to OVP in the Turkish population is insufficient (1, 6, 7, 8). However, studies on larger samples are needed to obtain accurate data on rare variations. Therefore, the aim of this study is to determine the prevalence of OVP by sex and localization in the Turkish population using radiographic images. In addition we examined the morphological and morphometric properties of the detected OVPs.

MATERIAL AND METHODS

This retrospective and observational study was designed to include 5698 radiologic images from 5268 cases (2357 females and 2911 males) scanned in Radiology Department of Muğla University Training and Research Hospital, Muğla, Turkey between June 2019 and June 2021. The age of the patients ranged between 16 and 101 (mean 39.65±17.21). Bilateral foot radiographs were present in 430 (8.2%) of the cases, while

the images were unilateral in the others (46.3% right foot, 45.5% left foot).

Male and female cases aged 16 years and older who completed the ossification of the fifth metatarsal bone were included in this study. Tumors, trauma, congenital anomalies that disrupted bone integrity, and cases who had surgery or did not complete their ossification were excluded from the study.

All observations were taken electronically on anteroposterior, oblique, and lateral foot radiographs displayed on a PACS (Picture archiving and communication systems). A total of 5698 foot radiographs were evaluated and cases with OVP were recorded. All cases underwent evaluation by both a radiologist and an anatomist. Suspiciously assessed images were additionally reviewed by an orthopedist. In instances where an OVP diagnosis was established in 8 cases, a consensus was reached among all experts following comprehensive evaluation. The prevalence of OVP in men and women was calculated. Morphological and morphometric evaluation was performed. Morphometric measurements were taken on the plane and in the position where the bone boundaries of the OVP were most clearly visible. Among these measurements, the longest axis was considered as the length (1st dimension), while the second axis perpendicular to the length was taken as the width (2nd dimension). The data were measured twice by a radiologist specialist to calculate their averages.

Statistical analyzes were performed using Statistical Package for Social Sciences, SPSS version 22, property of IBM Corporation. Descriptive statistics were made.

Ethical approval was taken from the ethical committee of the clinical investigations of Muğla Sıtkı Kocman University, Muğla, Turkey with grant number of 30.07.2021/160.

RESULTS

The age distribution was found between 16 and 93 in men (2911 cases; 55.2%) and 16 and 101 in women (2357 cases; 44.8%). The mean age of the male patients was 36.85±16.25, whereas the mean age of the female patients was 43.09±17.71.

OVP was seen in 0.15% (n = 8) of 5268 cases. OVP prevalence was calculated as 0.24% in men and 0.04% in women. OVP was detected in the left foot in 4 cases and in the right foot in 4 cases (Fig. 1). It was observed that OVP always articulated with fifth metatarsal bone. The largest OVP was sized as 17x15 mm, and the smallest OVP was sized as 8x4 mm.

Contralateral foot radiographs of 3 of 8 cases with OVP could be accessed. As a result of the radiography evaluation of these 3 cases, OVP was not found on the contralateral side; therefore, these three cases were diagnosed as unilateral OVP. Since the contralateral foot radiographs of the remaining 5 cases could not be

Fig. 1. Direct radiographs shows os vesalianum pedis in the left foot (a, b) and the right foot (c, d).

reached, it could not be evaluated in terms of bilaterality.

DISCUSSION

Although the exact mechanism of the formation of OVP, which is one of the accessory bones of the foot skeleton, is not known, some theories have been suggested regarding the developmental process. In order to better understand these theories, it is necessary to know the ossification process of the fifth metatarsal bone. During the development of the foot, the fifth metatarsal bone ossifies from two main ossification centers. The primary ossification center is located in the shaft, while the secondary ossification center is located in the head. The ossification of the shaft begins before birth, and the ossification of the head begins at 2–5 years of age. These two ossification centers fuse at 14–16 years of age (9, 18).

Around 9–10 years of age in girls and 12–13 years in boys, an additional apophyseal line emerges at the base of the fifth metatarsal bone, which subsequently fuses within 2–4 years (10). Considering the ossification of the fifth metatarsal bone, cases over the age of 16 who completed their ossification were included in our study.

The first theory of OVP formation is the failure of the ossification of the shaft and base of the fifth metatarsal bone (persistent epiphysis). The second theory of OVP formation is a separate tuberosity of the fifth metatarsal bone due to an avulsion fracture (3). However, it is not possible to explain bilateral OVP cases with these two theories. Northover et al., on the other hand, suggest that OVP may be an incomplete polymetatarsal remnant, but they have no evidence for this (23). Despite all the theories, the idea that the OVP as an accessory bone is more commonly accepted (2).

In studies conducted with radiological images, the prevalence of accessory bones in the foot has been reported to be 18.3–26.1% in the literature (6, 7, 8, 31). In a study with CT images, this rate was found as 48.2% (1). The highest prevalence (1.6%) of OVP, one of these accessory bones, is seen in the study of Kalbouneh et al. (16). While Lee et al. did not find any OVP in their series study of 224 cases (21), the lowest prevalence detected in OVP was found to be 0.1% in the study of Tsurata et al. (31). Tusurata et al.'s study also has the highest number of cases after our study. In previous studies conducted in Turkey, the prevalence of OVP was found as 1.5% at the highest and 0.3% as the lowest (1, 6, 8).

The prevalence of OVP varies between 0.0–1.6% according to the studies in the literature (Table 1). In this study, the prevalence of OVP was found 0.15% in the foot. We think that the reason for this wide range in prevalence may be the sample size, the age, sex, population and the differences of the imaging method. At the same time, studies on larger series are needed to obtain accurate data on such rare bones. When our study is evaluated from this point of view, we think that it fills an important hole in the literature.

Another reason for the underdetection of OVP prevalence is the asymptomatic presentation. OVP, which is rarely symptomatic, causes lateral foot pain in the area around the base of the fifth metatarsal bone. Clinically, swelling and tenderness in the same area can also be detected in addition to lateral foot pain. There is no consensus on the reason of symptomatic OVP. A compelling acute trauma (2, 5, 13) (such as spraining the ankle, kicking an object with the foot) or repetitive microtraumas have been reported to initiate symptoms (26). However, it has been suggested that OVP may become symptomatic without acute or recurrent trauma (4, 14).

Other diseases such as Jone's fracture, avulsion fracture, stress fracture and Iselin's disease should be

Table 1. The list of serial studies about the os vesalianum pedis

First author	Year	(n)	Sex		Age (year)	Os vesalianum		
			Male (n)	Female (n)		%	Sex	Side
Tsuruta T. (31)	1981	3460	1639	1821	7<	% 0.1	4***	**
Çilli F. (7)	2005	464	464	0	20–46	% 1.08*	5 Male	**
Coskun N. (8)	2009	984	528	456	14–72	% 0.4	3 Male 1 Female	R=4
Arslan S. (1)	2018	717	401	316	15–74	% 1.5	11***	**
Pitchandi M. (27)	2019	1000	589	411	12–80	% 1.5	9 Male 6 Female	**
Lee JH. (21)	2020	448	224	224	7–69	% 0	**	**
Kalbouneh H. (16)	2021	622	346	278	14–82	% 1.6	7 Male 3 Female	R=6 L=4
Candan B. (6)	2022	1651	847	804	**	% 0.3	2 Male 3 Female	R=3 L=2
Current study	2023	5268	2911	2357	16–101	% 0.15	7 Male 1Female	R=4 L=4

* This ratio is given in the data of the study of Çilli et al; ** data not given in the study; R: right; L: left; *** The sex data not given in the study.

considered in the differential diagnosis of symptomatic OVP cases. Therefore, radiological examination provides reliable data for definitive diagnosis. Radiographically, a Jones fracture is a transverse fracture that does not extend distally between the metaphysis and the diaphysis (12). Avulsion fracture related to the fibularis brevis muscle is located proximal to the fifth metatarsal bone. A stress fracture of the fifth metatarsal bone is seen proximal to the diaphysis, and Iselin's disease is seen as a vertical fracture line along the shaft. On radiographs, OVP is diagnosed as a well-demarcated bone that articulates with the basis of the fifth metatarsal bone, with a distinct cortex.

Arslan et al. (1) determined the dimensions of OVP as 2.5–5.3 mm in their study with CT, while Kalbouneh et al. (16) divided OVP into two types according to their size (Type I, small, 2–4 mm; type II, large, 10–20 mm), and stated that the smallest was 2 mm and the largest was 20 mm. OVP dimensions in our study are similar to the study of Kalbouneh et al. The reasons why Arslan et al. found OVP sizes to be smaller are the different methods used and the low number of cases measured. In addition, because of this wide range in OVP sizes, clinicians and radiologists should be more careful when interpreting radiographs, especially in terms of small OVPs.

Conservative treatment is the priority in the treatment of symptomatic OVP. Especially in cases of trauma-related symptoms, rest, physiotherapy, shoes designed to relieve the lateral edge of the foot, and nonsteroidal anti-inflammatory drugs help to reduce symptoms (13, 20, 26) . Surgical procedures can be applied in cases that do not respond to conservative treatment or recur. Surgical options include excision or internal fixation of the OVP. There is also evidence of satisfying results with surgery in the literature (2, 5, 13, 14, 26, 29, 33). However, it is difficult to make a reliable statement as to which of the surgical procedures yields more satisfactory results because the literature on these procedures is limited to individual case reports.

There are more case studies than serial studies in the literature. In 16 symptomatic cases (6 women, 10 men) that we could reach in the literature, the most common symptom was chronic pain in the lateral area of the foot and the aggravation of this pain after acute trauma. Only, one of the symptomatic cases was under 16 years of age. Although it is difficult to diagnose OVP in cases that have not completed ossification, it is seen that in the specific case. According to case reports, OVP is usually bilateral. OVP was bilateral in 10 of the reported cases (5, 11, 13, 14, 15, 19, 22, 26, 28, 30), and unilateral in 6 of them (2, 3, 4, 23, 29, 33). When we look at the different serial studies in the literature together with this study, it was seen that all of the OVPs were unilateral, unlike the case reports. The reason for this difference can be considered as the retrospective nature of the serial studies and therefore the inability to evaluate the cases from both side images. In this study, although the archive data of 8 cases with OVP were scanned, radiographs of the contralateral side could only be accessed in three cases.

In addition, when the cases are examined in terms of sex, although OVP is more common in males, there is not enough information to interpret sex and side-specific differences due to the low number of cases and the asymptomatic nature of OVP (Table 1). As the number of cases diagnosed with OVP increases in the literature, it will be more accurate to evaluate the effect of sex and side.

CONCLUSIONS

Accessory bones cause various foot disorders and may mimic foot bone fractures. The anatomical locations and clinical significance of these bones should be well known in order to reduce false pre-diagnoses and unnecessary orthopedic consultations. Our study provides detailed information about the prevalence of *os vesalianum pedis*, due to our large number of cases.

Limitations

Since our study was retrospective, in most of the cases examined, both sides of the foot radiography were not available. Therefore, the number of cases with bilateral radiography was quite limited. In addition, the clinical status of our cases and the inaccessibility of detailed information can be counted among our limitations.

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