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Prevalence and Distribution of Sesamoid Bones in the Hand: A Radiological Study

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ABSTRACT:
Purpose: Sesamoid bones are small, round or oval-shaped bones. They are located in close proximity to the articular surfaces of tendons. They are partially or completely embedded in a tendon or joint capsule. The purpose of this study is to examine the prevalence and distribution of sesamoid bones by gender and extremity side, and any anatomical variations, through a retrospective examination of adult hand radiographs.
Material and Methods: In this study, the files of adult individuals who underwent hand radiographic imaging at Sivas Cumhuriyet University Health Services Practice and Research Hospital were retrospectively reviewed**.**
Results: According to the results of our study, sesamoid bones were found in 100% of the first metacarpal bone, 40.64% in the second metacarpal bone, 2.32% in the third metacarpal bone, 0.59% in the fourth metacarpal bone, 61.33% in the fifth metacarpal bone, and 21.41% in the first interphalangeal joint.
Conclusion: We believe that the statistically significant higher number of sesamoid bones in the fifth metacarpal and first interphalangeal joints in women is related to women's superior fine motor skills compared to men, and that sesamoid bones develop accordingly.
Keywords: *Hand; motor skills; radiological imaging; sesamoid bones; upper extremity*

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INTRODUCTION

Sesamoid bones are small, round or oval-shaped bones (Akkoç et al., 2018). They are located in close proximity to the articular surfaces of tendons (Terzi et al., 2016). They are partially or completely embedded in a tendon or joint capsule. Their functions include regulating pressure, protecting tendons by reducing friction, changing the angle of muscle pull, and assisting muscle movement (Eğerci et al., 2017). In the hand, sesamoid bones are commonly found in the first and second metacarpals and are less common in other metacarpals and phalanges (Öner, 2022).

Sesamoids generally develop as cartilaginous nodules. Ossification begins at age 10 and is completed by age 13 in females, while it begins at age 11 and is completed by age 14 in males (Akkoç et al., 2018). The number of sesamoid bones in the adult human skeleton can vary greatly among individuals. The precise distribution of these bones is also unknown (Coşkun et al., 2009; Standring, 2016). Some sesamoid bones complete ossification, while others remain cartilaginous (Standring, 2016).

While some sesamoid bones have a predictable location, many vary in their location and formation process (Öner, 2022). Sesamoid bones can be unilateral or bilateral and exhibit significant morphological variation (Nwawka et al., 2013). Sesamoid bones are generally asymptomatic but can cause painful syndromes or degenerative changes

due to overuse or trauma (Coşkun et al., 2009; Zabierek et al., 2016). Trauma can lead to incorrect radiological diagnosis and treatment, mistaking sesamoid bones for avulsion fractures. Therefore, it is essential to recognize normal anatomic variations and be familiar with the locations of sesamoid bones (Kır et al., 2011).

When examining the anatomical and physiological components of hand motor functions, multiple components underlie a voluntary motor movement. These components include movement desire, goal setting, prior experience with the same or similar tasks, neural stimulation, simultaneous reception, processing, and interpretation of afferent input from the environment, and the physical execution of the movement (Erkocaoğlu, 2022; Metcalf et al., 2014; Enoka & Duchateau, 2008). Fine motor functions are associated with various factors, such as intrinsic muscle strength, extrinsic muscle activity, hand muscle fatigue, or general fatigue (Schieber, 1995; Olafsdottir et al., 2008; Sartorio et al., 2020). Sesamoid bones allow the tendons passing through them to generate greater force by creating an angle. Therefore, individuals with a higher number of sesamoid bones will also have better force production and fine motor skills. Sesamoid bones develop in response to applied stress and appear earlier in women (Yeung & Garg, 2022).

The purpose of this study was to retrospectively examine adult hand radiographs to determine the prevalence, distribution, and anatomical variations of sesamoid bones by gender and extremity side. The aim is to provide clinicians with more detailed information about sesamoid bone variations through a large dataset, contributing to a more accurate diagnosis and treatment process.

MATERIAL and METHODS

Purpose and Type of the Study

Our study was conducted under the supervision of a radiologist at the Department of Radiology, Sivas Cumhuriyet University Faculty of Medicine. The files of adult individuals who underwent hand radiography at Sivas Cumhuriyet University Health Services Practice and Research Hospital between January 1, 2023, and December 31, 2024, were retrospectively reviewed (Fig. 1).

Figure 1. Hand Radiographic Image

Sampling and participant

The files of individuals who did not have posteroanterior radiographs, who underwent radiographs due to hand fractures or bone deformities, and who were younger than 18 years of age were excluded. Our study sample size comprised the entire population. Therefore, no sample size analysis was performed.

Data Collection Tools

Data obtained from radiological images were recorded in the file prepared by the researchers.

Statistical Analysis

Data obtained from the study were analyzed using the SPSS 23.0 (SPSS, Chicago, Illinois) package program. The prevalence of sesamoid bones by gender and extremity side was assessed using the chi-square test. Categorical data were expressed as frequencies and percentages.

Ethical Approval

The ethics committee approval required to conduct our study was obtained from the Sivas Cumhuriyet University Non-Interventional Clinical Research Ethics Committee with the decision numbered 2024/09-55 on 19/09/2024.

RESULTS

A total of 6,391 hand radiographic images were obtained at Sivas Cumhuriyet University Health Services Practice and Research Hospital between January 1, 2023, and December 31, 2024, the period covered by our study. Of these images, 1,508 images that met the inclusion criteria were analyzed (Fig. 2). The average age of the individuals included in our study was found to be 38.83. The distribution of the data we included in the analysis in our study according to gender and extremity side is given in Table 1. The prevalence and distribution of the data obtained from the study by gender are given in Table 2. The prevalence and distribution of the data obtained from the study according to the extremity side are given in Table 3.

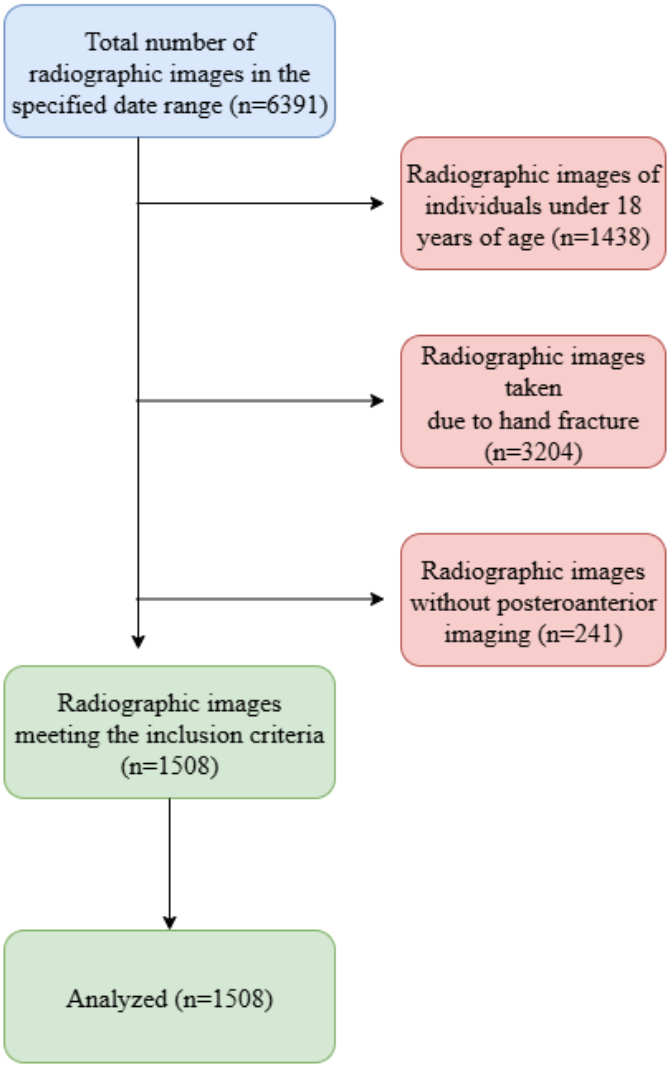

Figure 2. Flow Chart

Table 1. Distribution of Data by Gender and Extremity Side

	Male (%)	Female (%)	Total (%)	p Value
Right (%)	396 (26,26)	387 (25,67)	783 (51,92)	
Left (%)	357 (23,67)	368 (24,40)	725 (48,07)	0,607
Total (%)	753 (49,93)	755 (50,07)	1508 (100)	
p Value		0,517		

Table 2. Frequency and Distribution of Sesamoid Bones According to Gender

		Male (%)	Female (%)	Total (%)	p Value
MC 1		753 (100)	755 (100)	1508 (100)	1
MC 2		285 (37,84)	328 (43,44)	613(40,64)	0,28
MC 3		18 (2,39)	17 (2,25)	35 (2,32)	0,866
MC 4		3 (0,39)	6 (0,79)	9 (0,59)	0,507
MC 5		427 (56,70)	498 (65,96)	925 (61,33)	0,000261
IPJ 1		130 (17,26)	193 (25,56)	323 (21,41)	0,000096
	PP	3 (0,39)	0 (0)	3 (0,19)	
2nd Finger	**MP**	0 (0)	0 (0)	0 (0)	0,124
	DP	0 (0)	0 (0)	0 (0)	
	PP	2 (0,26)	0 (0)	2 (0,13)	
3rd Finger	**MP**	0 (0)	0 (0)	0 (0)	0,249
	DP	0 (0)	0 (0)	0 (0)	
	PP	1 (0,13)	1 (0,13)	2 (0,13)	
4th Finger	**MP**	0 (0)	0 (0)	0 (0)	0,999
	DP	0 (0)	0 (0)	0 (0)	
	PP	1 (0,13)	2 (0,26)	3 (0,19)	
5th Finger	**MP**	1 (0,13)	0 (0)	1 (0,06)	0,513
	DP	0 (0)	0 (0)	0 (0)	

*MC: Metacarpal; **IPJ1: 1. Interphalangeal joint; ***PP: Proksimal phalanx; ****MD: Medium phalanx; *****DP: Distal phalanx

Table 3: Frequency and Distribution of Sesamoid Bones According to Extremity Side

		Right (%)	Left (%)	p Value
MC 1		783 (100)	725 (100)	1
MC 2		311 (39,72)	302 (41,65)	0,463
MC 3		18 (2,29)	17 (2,34)	0,953
MC 4		7 (0,89)	2 (0,27)	0,181
MC 5		486 (62,06)	439 (60,55)	0,561
IPJ 1		177 (22,60)	146 (20,13)	0,258
	PP	1 (0,12)	2 (0,27)	
2nd Finger	**MP**	0 (0)	0 (0)	0,611
	DP	0 (0)	0 (0)	
	PP	2 (0,25)	0 (0)	
3rd Finger	**MP**	0 (0)	0 (0)	0,500
	DP	0 (0)	0 (0)	
	PP	2 (0,25)	0 (0)	
4th Finger	**MP**	0 (0)	0 (0)	0,500
	DP	0 (0)	0 (0)	
	PP	0 (0)	3 (0,41)	
5th Finger	**MP**	0 (0)	1 (0,13)	0,115
	DP	0 (0)	0 (0)	

*MC: Metacarpal; **IPJ1: 1. Interphalangeal joint; ***PP: Proksimal phalanx; ****MD: Medium phalanx; *****DP: Distal phalanx

DISCUSSION

By retrospectively examining the hand radiographic images of adult individuals who applied to Sivas Cumhuriyet University Health Services Practice and Research Hospital, we determined that many studies in the literature were similar to our study, which

aimed to investigate the frequency, distribution and anatomical variations, if any, of sesamoid bones according to gender and extremity side (Akkoç et al., 2018; Yıldız et al., 2021; Chen et al., 2015; Seki et al., 2013; Yammine, 2014).

Akkoç et al. (2018) retrospectively evaluated the posteroanterior hand X-rays of 700 adults aged 25 and above, comprising 231 males and 469 females. In their study, they found the presence of sesamoid bones in 100% of the first metacarpal bone, 67% in the second metacarpal bone, 8.1% in the third metacarpal bone, 4.6% in the fourth metacarpal bone, 87% in the fifth metacarpal bone, and 47.9% in the first interphalangeal joint (Akkoç et al., 2018). In our study, sesamoid bone is detected in 100% of the first metacarpal bone, 40.64% in the second metacarpal bone, 2.32% in the third metacarpal bone, 0.59% in the fourth metacarpal bone, 61.33% in the fifth metacarpal bone, and 21.41% in the first interphalangeal joint. We believe this difference is related to the number of participants and gender distribution. Akkoç et al. completed their study with 700 hands. Our study included 1508 hands. In our study, the number of female participants (755) and male participants (753) are almost equal. In Akkoç et al.'s study, the number of female participants was twice the number of male participants. Our results indicate that the prevalence of sesamoid bone in the second metacarpal bone, fifth metacarpal bone, and first interphalangeal joint was higher in female participants than in male participants. The unequal gender distribution and the higher number of female participants is a factor that increases the prevalence of sesamoid bones.

In their 2021 study examining 1501 hands, Yıldız et al. (2021) found the presence of sesamoid bones in the first metacarpal bone to be 100%. After that the highest rate was in the 5th metacarpal bone with 58.3%. They found sesamoid bones at a rate of 40% in the second metacarpal bone, 0.5% in the third metacarpal bone, 0.1% in the fourth metacarpal bone, and 32.5% in the first interphalangeal joint (Yıldız et al., 2021). In our study, the presence of sesamoid bones is found at a rate of 100% in the first metacarpal bone, 40.64% in the second metacarpal bone, 2.32% in the third metacarpal bone, 0.59% in the fourth metacarpal bone, 61.33% in the fifth metacarpal bone, and 21.41% in the first interphalangeal joint. The sample size of this study is similar to ours, which supports the similarity of the results with ours.

Chen et al. (2015) included 850 individuals and investigated the frequency of sesamoid bones according to the extremity side in their study published in 2015. In the first metacarpal bone, 100% sesamoid bones were detected on both sides. In the second metacarpal bone, 61.8% were detected on the right side and 59.9% on the left side; in the third metacarpal bone, 3.6% were detected on the right side and 4.1% on the left side; in the fourth metacarpal bone, 0.9% were detected on the right side and 1.6% on the left side; in the fifth metacarpal bone, 59.7% were detected on the right side and 58.5% on the left side; and in the first interphalangeal joint, 18.8% were detected on the right side and 13.1% on the left side (Chen et al., 2015). The results of our study are very similar to this study. The presence of sesamoid bone in the first metacarpal bone, regardless of side, is 100%. In the second metacarpal bone, the presence of sesamoid bone is 39.72% on the right side and 41.65% on the left side. In the third metacarpal bone, the presence of sesamoid bone is 2.29% on the right side and 2.34% on the left side. In the fourth metacarpal bone, the presence of sesamoid bone is 0.89% on the right side and 0.27% on the left side. In the fifth metacarpal bone, the presence of sesamoid bone is 62.06% on the right side and 60.55% on the left side. In the first interphalangeal joint, the presence of sesamoid bone is 22.60% on the right side and 20.13% on the left side. The only dissimilar result between Chen et al.'s study and ours was the finding in the second metacarpal bone. We believe this difference may be due to the unequal distribution of male and female individuals in studies conducted without gender discrimination or to the population in which the study was conducted.

Seki et al. (2013) included 650 individuals between the ages of 16 and 95 (mean 53.5±18.1) and examined only the sesamoid bones in the phalanges of the participants. They found the presence of sesamoid bones in the first interphalangeal joint at a rate of 67% on the right side and 66% on the left side. They reported the presence of sesamoid bones at a

rate of 1% in the fifth finger on the right, 1% in the third finger on the left, 1% in the fourth finger, and 1% in the fifth finger (Seki et al., 2013). The results of our study are largely similar to this study. In our study, sesamoid bones are found at a rate of 22.60% on the right and 20.13% on the left side in the first interphalangeal joint. On the right side, sesamoid bone is detected in 0.12% of the second finger, 0.25% of the third finger, and 0.25% of the fourth finger. On the left side, sesamoid bone is detected in 0.27% of the second finger, and 0.25% of the fifth finger. The only difference is in the first interphalangeal joint. We believe that the reason for this difference in results is that the study was conducted without regard to gender and the age range of the participants included.

Yammine (2014) published a meta-analysis study on approximately 4000 hand radiographic images in 2014. In this study, the frequency of sesamoid bone occurrence was examined according to gender, extremity side, and population. The presence of sesamoid bone was reported as 99.89% in males and 99.9% in females in the first metacarpal bone, 30% in males and 34.8% in females in the second metacarpal bone, 0.97% in males and 2.4% in females in the third metacarpal bone, 1% in males and 1.08% in females in the fourth metacarpal bone, 47.6% in males and 45.4% in females in the fifth metacarpal bone, and 74.4% in males and 76.7% in females in the first interphalangeal joint (Yammine, 2014). The regions where this study and ours showed similarity by gender are the first metacarpal bone, the third metacarpal bone, and the fourth metacarpal bone. The regions where the findings differed are the second metacarpal bone, the fifth metacarpal bone, and the first interphalangeal joint. We believe that this difference is due to the fact that Yammine's study was a meta-analysis and that the prevalence of sesamoid bones varies across different populations. Yammine (2014) reported the presence of sesamoid bones in the first metacarpal bone as 99.89% on the right side and 99.75% on the left side, in the second metacarpal bone as 33.6% on the right side and 34.4% on the left side, in the third metacarpal bone as 1.7% on the right side and 1.6% on the left side, in the fourth metacarpal bone as 0.84% on the right side and 0.97% on the left side, in the fifth metacarpal bone as 47.8% on the right side and 48.1% on the left side, and in the first interphalangeal joint as 60.9% on the right side and 61% on the left side. The areas that differ between this study and ours appear to be the fifth metacarpal bone and the first interphalangeal joint. We believe this is due to differences in the participant population. As a result of studies conducted according to the population, Yammine (2014) reported the presence of sesamoid bones in the first metacarpal bone in 99.83% of Middle Easterners, 99.74% of Africans, 99.8% of Europeans; in the second metacarpal bone in 39.4% of Middle Easterners, 23.2% of Africans, 45% of Europeans; in the third metacarpal bone in 1.5% of Middle Easterners, 0.27% of Africans, 1.47% of Europeans; in the fourth metacarpal bone in 0.8% of Middle Easterners, 0.27% of Africans, 1.3% of Europeans; in the fifth metacarpal bone in 46.6% of Middle Easterners, 26.4% of Africans, 71.3% of Europeans; in the first interphalangeal joint in 24.9% of Middle Easterners, 95.1% of Africans, and 57.4% of Europeans (Yammine, 2014). The results of our study are consistent with the prevalence values of Middle Eastern individuals according to the results of this meta-analysis study.

When the results of our study were examined, no statistically significant differences were observed in the extremity side parameters. Regarding gender, there was a significant difference in the presence of more sesamoid bones in women only in the 5th metacarpal bone and the 1st interphalangeal joint. No significant differences were observed in the other fingers. There are studies in the literature demonstrating that women are superior to men in fine motor skills (Yücel & Bumin, 2010; Jiménez-Díaz et al., 2015). We believe that women are more successful in fine motor skills due to the greater stress on their hand bones compared to men, starting in adolescence, and that women develop more sesamoid bones.

In our study, the presence of sesamoid bones was most common in the first metacarpal bone (100%), followed by the fifth metacarpal bone (61.33%) and the second metacarpal bone (40.64%). Sesamoid bone rates were observed in the third metacarpal bone (2.32%) and fourth metacarpal bone (0.59%).

This is likely due to the greater role of the first, second, and fifth fingers in fine motor skills, and the more active function of the muscles in these fingers. We believe that the lesser role of the third and fourth fingers in fine motor skills and the less active function of the muscles contribute to sesamoid bone development. The presence of specific muscles in the first, second, and fifth fingers also contributes to this result.

In studies investigating the prevalence of sesamoid bone, the gender distribution of the individuals included in the study is important. A higher proportion of males among the included individuals will result in a lower prevalence rate. Therefore, we believe that conducting studies that consider gender distribution will reveal significant differences in sesamoid bone distribution. Furthermore, we believe that further studies investigating the prevalence of sesamoid bone across populations are warranted.

CONCLUSION

In conclusion, our study found a 100% prevalence of sesamoid bone in the first metacarpal bone. The most common locations for sesamoid bone after the first metacarpal are the fifth metacarpal bone (61.33%), the second metacarpal bone (40.64%), and the first interphalangeal joint (21.41%). Sesamoid bone is occasionally observed in the third metacarpal bone (2.32%) and fourth metacarpal bone (0.59%). When examining the fingers, sesamoid bones were rarely observed in the proximal and middle phalanges, but no sesamoid bones were found in the distal phalanges. This study will assist clinicians and radiologists in the diagnosis and treatment process.

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Conflict of Interest

None of the authors report having a conflict of interest.

Authors Contributions

Idea/concept: MK, İO; Design: MK, İO; Control/supervision: İO; Data Collection and/or processing: MK; Analysis and/or interpretation: MK; Literature review: MK; Writing the article: MK, İO; Critical review: İO.

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