

Prevalence and Radiological Features of Fabella in a Saudi Arabian Population

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SUMMARY

Background. The fabella, a sesamoid bone in the posterolateral aspect of the knee, induces clinical conditions. Considering its ethnic variations and surgical importance, we measured the dimensions and recorded the prevalence of fabella in a Saudi population. This study aims to compare the features of fabella in Saudis with other populations and to test whether its incidence is associated with gender, side, laterality, and age.

Methods. In this retrospective cross-sectional study, we reviewed knee radiographs and magnetic resonance imaging films of 820 patients aged 20-90 years. Descriptive statistics were performed to estimate the prevalence of fabella. The chi-square test was used to evaluate the associations of sex, age, and laterality with the prevalence of fabella. The size of the fabella was measured and compared between the sexes and with other studies using independent t-tests. The level of significance was set at $p < 0.05$.

Results. The overall prevalence of bony fabellae was 20.73 %, but no cartilaginous fabella was identified. Its prevalence was significantly associated with age ($p = 0.009$), right side ($p = 0.003$) and laterality ($p = 0.002$). The mean length, thickness, and width were 6.4 mm, 6.07 mm, and 4.74 mm, respectively. The size was significantly larger in males than in females ($p < 0.001$). The size of the fabella in Saudis is significantly larger than in Turks and smaller than in Asians ($p < 0.001$).

Conclusions. The anatomical features and prevalence of fabella in Saudis vary from those of other ethnic populations. It is clinically crucial to comprehend its variations and features for health professionals, aiding in the differential diagnosis of pathological loose bodies and preventing complications during knee arthroplasty.

KEY WORDS

Fabella; gastrocnemius; prevalence; radiological; Saudi; knee pain.

INTRODUCTION

Fabella is a small bean-shaped sesamoid bone located in the anatomically complex posterolateral region of the knee joint. Topographically, fabella lodges within the tendinous lateral head of the gastrocnemius (1). It develops by endochondral ossification from a combination of genetic regulation and compressive load on the gastrocnemius lateral

head, which provides a biomechanical advantage (1, 2). As a genetically controlled structure, fabella originates from Sox9⁺/Scx⁺ progenitors under the regulation of transforming growth factor b (TGFB), while differentiation is mediated by BMP4 and BMP2 (3). The biomechanics of fabella are to alleviate friction-induced tendon injury, enhance the gastrocnemius muscle efficiency, and stabilize the postero-

lateral part of the knee by reinforcing the fabellofibular ligament. Additionally, the articulating groove on the back of the lateral femoral condyle stabilizes the fabella (4, 5).

Medical professionals must know its normal variations, prevalence, anatomy, and biomechanics to understand the pathological conditions associated with the knee joint and in the selection of treatment options (1, 6). According to ontogenetic theory, cartilaginous fabellae develop in fetuses as early as 15 weeks, and once they ossify, they are often evident on radiographs of the knee's lateral aspect (7). However, from a clinical point of view, it is crucial to categorize its anatomical characteristics from osteophytes, intra-articular loose bodies, and intra-meniscal calcifications in osteoarthritis (8). Although the fabella functions as a knee joint stabilizer, its presence can lead to knee disorders. These include chondromalacia, osteoarthritis, and Fabella pain syndrome. Additionally, fabella hypertrophy causes entrapment syndrome associated with the popliteal artery and common fibular nerve (1, 9).

It is common in non-human mammals, but observational epidemiological studies in humans have found that the prevalence rate varies widely from 3 to 87% across different populations (10, 11). Its prevalence is population dependent, 3.1% to 31.3% in Caucasians and 30.6% to 85.8% in Asians, with no significant difference between sexes (4, 10, 12, 13). As a result of this variation, studies on different populations are warranted. To the best of our knowledge, there are no baseline reports in the literature on the prevalence of fabella in the Saudi population. Against this background, in this study, we used radiographs and MRI images to describe the size and prevalence of fabella in a Saudi population. The secondary aim was to compare the features of fabella in Saudis with other populations and also to test the hypothesis of whether its prevalence is associated with gender, side of the limb, and age.

MATERIALS AND METHODS

Study design and subjects

This retrospective cross-sectional study was designed with 820 (410 males and 410 females, aged from 20 to 90 years, 1,640 knee MRI images) patients referred to the radiological department for radiological investigation between 2016 and 2022. This study protocol (SP21A/289/06) was approved by the Institutional Review Board of King Saud Bin Abdulaziz University for Health Sciences, Al Ahsa, Saudi Arabia. The inclusion criteria were patients aged more than 20 years. The exclusion criteria were patients with advanced osteoarthritis, knee fractures and injuries, ligament injuries, and if the posterior osteophytes and the fabella were not distin-

guished. The present study was conducted according to the principles of the Declaration of Helsinki.

Data collection method

The patient data was collected from the hospital's data management system (BESTCare 2.0) from the Radiology Department, King Abdullah Military City Hospital, Al Ahsa, Saudi Arabia. The digital bilateral radiographs and MRI scans of the knee were reviewed using the Picture Archiving Communication System (PACS). In general, radiographs of the knee were used to identify bony fabellae, and MRI scans to detect both bony and cartilaginous fabellae. All the identified fabella were osseous structures located in the lateral heads of gastrocnemius. The incidence of bony fabella on the MRI scans and radiographs of both sides of the knees was documented according to age and sex. The whole study group subjects were classified into five age groups at an interval of ten years. The following parameters, maximum length (**figure 1**), maximum thickness of the fabella (**figure 2**), and maximum width (**figure 3**), were measured using different MRI views (sagittal, and axial views). One researcher independently measured all the fabella measurements using the software-integrated ruler functionality. The measurements were repeated twice, and the average value was calculated.



Figure 1. Sagittal section MR image of the knee demonstrates the measurement of the maximum length of the fabella.

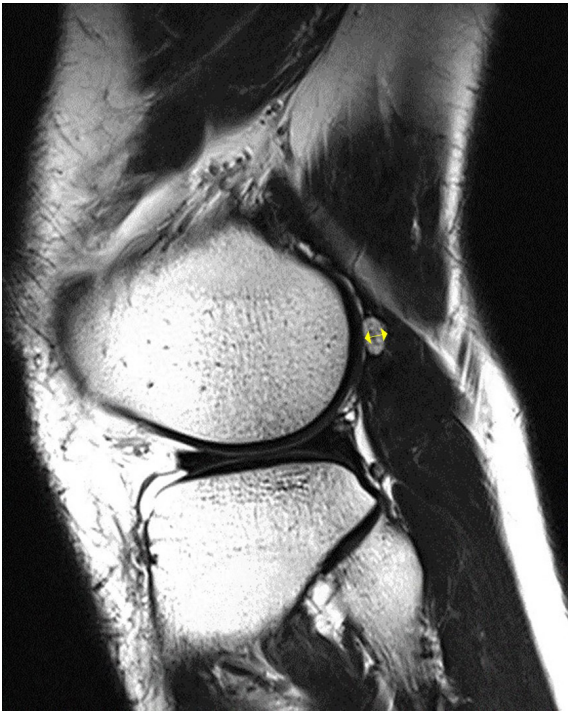


Figure 2. Sagittal section MR image of the knee demonstrates the measurement of the maximum thickness of the fabella.



Figure 3. Axial section MR image of the knee demonstrates the measurement of the maximum width of the fabella.

Statistical analyses

The IBM SPSS software package (ver. 23; IBM Corp., Armonk, NY, USA) performed the statistical analysis for Windows. Descriptive statistics (mean, standard deviation, frequency, minimum, and maximum) were used to evaluate the demographic and radiological features (size prevalence, side, and laterality). The chi-square test was used to determine the association of gender, age, and laterality with the prevalence of fabella. The fabella size was measured and compared between the sexes and with other studies using independent t-tests. The level of significance was set at $p < 0.05$.

RESULTS

The overall prevalence rate of fabella was found in 170 (20.73%) out of 820 subjects. The distribution of the fabella among the sexes is presented in **table I**. The prevalence of fabella was greater in males [93 (22.7%)] than in females [77 (18.8%)], with no significant differences. It was found bilaterally in 114 (14%) subjects [62 (15.1%) males and 52 (12.7%) females] and unilaterally in 56 (6.85%) subjects [31 (7.56%) males and 25 (6.1%) females] with significant difference ($p = 0.002$). Among unilateral cases (56 subjects), the prevalence of fabella was significantly greater ($p = 0.003$) on the right side (39 subjects) than on the left side (17 subjects). The distribution of the fabella according to different age groups is presented in **table II**. The prevalence rate of the fabella between the age category groups differed significantly ($p = 0.009$). Its prevalence was highest in the age category 41 to 50 years (28.6%), followed by the age categories 51 to 60 years (26.1%) and 61 to 70 years (27%), and decreased in the age categories over 70 years.

The overall mean length of the fabella was 6.4 ± 1.32 (4.1-9.1) mm, with 7.01 mm in males and 5.78 mm in females. The overall mean thickness of the fabella was 4.74 ± 1.29 (3.1-7.7) mm, with 4.99 mm in males and 4.49 mm in females. The mean width of the fabella in the overall population was 6.07 ± 1.30 (3.9-9.4) mm with 6.53 mm in males and 5.61 mm in females. The fabella was significantly ($p < 0.001$) longer, wider, and thicker in males compared to females (**table III**).

The fabella dimensions of the Saudis differ significantly from those in previous studies in terms of ethnicity. On average the Saudi fabella is significantly shorter than those of Singaporeans and Romanians, but significantly wider and narrower than the Chinese. In contrast, the Saudi fabella is significantly longer, wider, and thicker than the Turks fabella (**table IV**).

Table I. Crosstabulation of fabella laterality with sex.

Sex	Fabella absent, n (%)	Fabella present			Total
		Unilateral		Bilateral, n (%)	
		Right n (%)	Left n (%)		
Male	317 (77.32)	23 (5.61)	8 (1.95)	62 (15.12)	410
Female	333 (81.22)	16 (3.9)	9 (2.2)	52 (12.68)	410
Total	650 (79.27)	39 (4.76)	17 (2.07)	114 (13.9)	820

Table II. Crosstabulation of age and presence of fabella.

Age (years)	Fabella		Total
	Absent n (%)	Present n (%)	
20-30	88 (89.80)	10 (10.20)	98
31-40	92 (76.67)	28 (23.33)	120
41-50	108 (72)	42 (28)	150
51-60	96 (73.85)	34 (26.15)	130
61-70	89 (72.95)	33 (27.05)	122
71-80	87 (87)	13 (13)	100
81-90	90 (90)	10 (10)	100
Total	650 (79.27)	170 (20.73)	820

Table III. Comparison of parameters of the fabellae between Saudi males and females.

Fabella parameters	Male	Female	Total	P-value
	Mean ± SD (range)			
Length (mm)	7.01 ± 1.52 (6.89-9.1)	5.78 ± 1.33 (4.1-6.87)	6.4 ± 1.32 (4.1-9.1)	< 0.001*
Width (mm)	6.53 ± 1.54 (3.9-9.4)	5.61 ± 1.18 (3.91-7.43)	6.07 ± 1.30 (3.9-9.4)	< 0.001*
Thickness (mm)	4.99 ± 1.34 (3.1-7.7)	4.49 ± 1.21 (3.41-5.99)	4.74 ± 1.29 (3.1-7.7)	< 0.01*

Table IV. Comparison of the fabella dimension (mm) of the present study results with other studies.

Author	Ethnic group	Mean ± SD		
		Length	Width	Thickness
Zeng <i>et al.</i> (11)	Asian (China)	-	11.67 ± 2.68*	5.76 ± 1.28*
Chew <i>et al.</i> (17)	Asian (Singapore)	7.06 ± 1.90*	6.12 ± 3.26	4.89 ± 1.94
Ortega and Olave (12)	Caucasian (Chile)	7.32	-	3.22
Pop <i>et al.</i> (14)	Caucasian (Romanian)	8.71 ± 0.41*	4.81 ± 0.56*	-
Adedigba <i>et al.</i> (18)	African (Nigeria)	4.04	5.24	-
Özbay <i>et al.</i> (20)	Caucasian (Turkey)	6.05 ± 1.4*	5.92 ± 1.2*	4.63 ± 1.09*
Present study	Asian (Saudi Arabia)	6.4 ± 1.32	6.07 ± 1.31	4.74 ± 1.27

*Indicates the fabella dimensions of other studies that are significantly different from the present study.

DISCUSSION

Several epidemiological studies reported the prevalence of fabella using observational methods like radiography, computed tomography, MRI, or cadaver studies (**table V**). However, the reported prevalence rate varied among the methods, populations, sexes, and ages (4, 10-14). In light of its wide variations between the ethnic groups, we believe that general statistics on the presence of fabella cannot be extrapolated against other ethnic groups. As a result, in this study, we investigated the incidence of fabella in a Saudi population using a combination of MRI and radiography.

Asghar *et al.* (15) reported in a systemic review that the average prevalence rate of fabella worldwide from 34,733 knee joints is 25%. In the Saudi population, the prevalence of fabella is greater than the global average rate. As the literature review shows, fabella occurs more frequently in the East than in the West. Our study prevalence rate of fabella (20.73%) is on the higher end of the range reported (3.1%-31.3%) in Western populations, and it is much lower than the prevalence rates reported in East Asian

countries: China (86.9%) and Japan (85.8%) (4, 10-12). The highest prevalence rate of fabella was reported in the Oceanians, followed by the East Asian population (1, 15). In contrast, another Southeast Asian study from Singapore reported a lower incidence rate (31.25%) (17). Our findings were comparable to the lowest prevalence rates in South Africa (11.94%) and Nepal (12.3%) (18, 19). Recently conducted MRI studies on the Middle Eastern population include Turkish and Omanis (24.1%). In addition, our research on Saudis found a prevalence rate of 20.73%, which is identical to Turks (20.63%) and lesser than Omanis (24.1%) (20, 21). A variation in fabella prevalence among Middle Eastern populations lends credence to the notion that the prevalence of fabella differs among ethnic groups.

The type of method also has an impact on the prevalence rate of fabella. For instance, Asian studies conducted using cadavers reported a higher prevalence of fabella than radiological studies because both cartilaginous and bony fabella can easily be identified and described in cadavers, which might have contributed to the high prev-

Table V. Comparison of the prevalence of fabella in the present study with other studies.

Author	Year	Ethnic group	Method	Number of knee samples (n)	Prevalence of fabella (%)	M (%)	F (%)
Minowa <i>et al.</i> (4)	2004	Asian (Japan)	Cadaver	212	85.8	-	-
Kawashima <i>et al.</i> (23)	2007	Asian (Japan)	Cadaver	75	92	40.3	50
Silva <i>et al.</i> (10)	2010	Caucasian (Brazil)	Cadaver	64	3.1	-	-
Phukubye and Oyedele (22)	2011	South African	Cadaver	102	23.5	21.2	27.8
Piyawinijwong <i>et al.</i> (24)	2012	Asian (Thailand)	Cadaver	372	50.53	20.16	18.54
Zeng <i>et al.</i> (11)	2012	Asian (China)	Cadaver; Radiography	61	86.9	-	-
Tabira <i>et al.</i> (25)	2013	Asian (Japan)	Cadaver	102	68.6	-	-
Ehara <i>et al.</i> (13)	2014	Asian (Japan)	MRI	653	30.6	-	-
Chew <i>et al.</i> (17)	2014	Asian (Singapore)	Radiography; MRI	80	31.25	31.94	25
Hauser <i>et al.</i> (5)	2015	European (Switzerland)	CT	400	26.3	-	-
Egerci <i>et al.</i> (31)	2016	Caucasian (Turkey)	Radiography	1000	22.8	21.6	24
Ghimire <i>et al.</i> (19)	2017	Asian (Nepal)	Radiography	155	12.3	8.2	14.7
Ortega and Olave (12)	2018	Caucasian (Chile)	Radiography	400	31.25	20.45	42.3
Pop <i>et al.</i> (14)	2018	Caucasian (Romanian)	MRI	431	16.93	15.76	17.98
Calsikan <i>et al.</i> (30)	2020	Caucasian (Turkey)	MRI	500	28	31.88	23.21
Al Matroushi <i>et al.</i> (21)	2021	Asian (Oman)	Radiography; MRI	813;119	24.1	28.6	20
Adedigba <i>et al.</i> (18)	2021	African (Nigeria)	Radiography	754	11.94	14.55	10.04
Özbay <i>et al.</i> (20)	2022	Caucasian (Turkey)	MRI	1008	20.63	21.21	20.27
Present study	2024	Asian (Saudi Arabia)	Radiography MRI	870	28	31.88	23.21

M: male; F: female.

alence rate of fabella (4, 11, 22-25). Another reason for the high prevalence of fabella in the Asian population has been hypothesized to be a result of the daily activities that Japanese and Chinese engage in, such as kneeling, squatting, and tailor sitting. However, this plea alone does not explain the high prevalence (15). Although the Saudis and Omanis also have the habit of flexing the knee while offering ritual prayers, the incidence of fabella was minimally lower than in the Asian mongoloids (15, 21). The difference in knee joint alignment among ethnic groups may also explain the higher prevalence of fabella. The Oceanians, Chinese, and Japanese have a valgus alignment of the femoral angle as opposed to the varus alignment seen in Middle Eastern populations (26, 27). The valgus alignment shifts weight-bearing from the medial to the lateral compartment. The pressure of the fabella against the posterior aspect of the lateral femoral condyle might spur the development and ossification of the fabella (5, 28).

In this study on the Saudi population, the overall mean length, thickness and width of the fabella were 6.4 mm, 4.74 mm, and 6.07 mm, respectively. Fabella lengths in the range of 4 to 22 mm with a diameter of about 10 mm have been reported in symptomatic patients (12, 35). Overall, the dimensions of fabella in Saudis were significantly larger than those of African and Turkish populations (18, 20). On the other hand, the fabella size in the Asians was larger than in the Saudis (11, 17). Despite the ethnic differences with Saudis, the fabella size was significantly larger in males than in females among Turks and Romanians (14, 20). These variations in fabella size and prevalence across populations and genders may be due to biomechanical, genetic, and geographical factors (17, 18).

Apart from the emphasis on ethnic differences in fabella prevalence, it has been widely debated in the existing literature if gender, laterality, and side are associated with fabella prevalence. Lamentably, discussion of this point is difficult because only a few studies established a significant association, but most authors failed to demonstrate any significant association. The overall prevalence of fabella prevalence in Saudis was much higher in males (16.33%) than in females (14.33%), with no significant difference. Similar to our findings, different studies reported a higher frequency rate of fabella in males, whereas few other studies found it in females with no significant sex difference (5, 12, 17, 19, 22, 23, 29). In contrast, Hauser *et al.* (5) and Adedigba *et al.* (18) found approximately a 1:1 prevalence of fabella in males and females. Furthermore, Ortega and Olave (12) and Akdeniz *et al.* (29) study's found that the females outnumber males in the Chilean and Turkish populations by 1.5:1 and 2:1, respectively, with no significant differences. In contrast, another study from Turkey

by Caliskan *et al.* (30) found that male predominance was statistically significant.

In terms of fabella laterality, the bilateral *versus* unilateral case ratio was 2:1, with a significant difference. A similar ratio was found in studies conducted by Adedigba *et al.* (18), Phukubye and Oyedele (22), Piyawinijwong *et al.* (24), and Egerci *et al.* (31), but no significant difference was observed. In line with our study, Akkoc *et al.* (32) found a significant difference in the ratio. This pattern reveals that the bilateral presence of fabella was higher than unilateral, regardless of ethnicity. Regarding the symmetry of fabella incidence in Saudis, the unilateral incidence of fabella is significantly more common only on the right side. However, no significant sex difference was found on both sides of the knee. In contrast, Phukubye and Oyedele (22), Caliskan *et al.* (30), and Egerci *et al.* (31) found no statistically significant difference between the sides. Matroushi *et al.* (21) observed a significant sex difference in the occurrence of fabella in the left knee.

Although the exact age of fabellar ossification is ambiguous, ossified fabellae have been found as young as 12-14 years old. Several studies have examined the relationship between prevalence rates and ages (13). In line with our findings, Matroushi *et al.* (21), Phukubye and Oyedele (22), and Akdeniz *et al.* (29) reported that the ossification of the fabella increases with age. In this study, fabella prevalence increased approximately up to age 70 and decreased gradually after the age 70s. In contrast, Berthaume and Bull (1), Hauser *et al.* (5), Tabira *et al.* (25), and Egerci *et al.* (31) demonstrated no association between age and the presence of fabella. The structure of fabella has been characterized as either bony or nonbony in various anatomical investigations. Kawashima *et al.* (23) observed that the majority of the fabellae in the gastrocnemius's lateral head were cartilaginous (57.3%) than the bony (34.7%) in a Japanese population. According to histological studies, the nonbony fabella is composed of dense connective tissue with a cartilage matrix. The bony fabellae had a cartilage matrix, compact bone with bone marrow, filled by adipocytes (11, 22). Minowa *et al.* (4) categorized the fabella based on texture as hard and elastic. On the other hand, Chew *et al.* (17) and Maturishi *et al.* (21) reported that all the identified fabella were osseous structures in their investigation utilizing MRI scans. Similarly, all the observed fabellae were bony structures in the Saudis.

The strength of our study is that this is the first study to explore the prevalence and characteristics of fabella in a Saudi population using both plain radiographs and MRI films. Secondly, the medical images of the patients were enrolled from the archive system, allowing us to investigate big data sets with an accurate distribution of age

and gender across the population so the results would be more representative. However, this observational retrospective study has some limitations. Since this study is from a single region of Saudi Arabia, the outcomes do not apply to the entire Saudi population. Furthermore, it was a retrospective study for which selection bias may be concerned. In light of the current study, further multi-center clinical research with larger sample sizes emphasizing the radiological and histological characteristics of fabella would be beneficial in the clinical diagnosis and treatment of patients with knee pain.

CONCLUSIONS

In conclusion, the prevalence of bony fabella among Saudis is 20.73%, with males typically having larger fabella size than females. The prevalence rate correlated positively with age but was not influenced by sex or laterality. Compared to Turks, Saudis have a similar prevalence rate but larger fabella size, while Asians have a higher prevalence rate and larger fabella. Given variations across populations, understanding the fabella prevalence rate and characteristics in Saudis is crucial for accurate diagnosis and preventing complications during knee arthroplasty.

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DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTIONS

VP, KA: conceptualization, design. PV, KA, NS, ST: data extraction. PV, KA, SJ: data analysis and interpretation. SJ, ST: figures. PV, SN: writing – original draft. PV, KA, NS: writing – review & editing.

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CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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