



The prevalence, morphology and topography of fabella in knee joints in the polish population and its association with size of patella

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Received: 29 March 2025 / Accepted: 5 May 2025
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Abstract

Purpose The fabella is a sesamoid bone located posterior to the lateral femoral epicondyle within the gastrocnemius muscle. While commonly present in mammals, its prevalence in humans remains unclear, with reported rates ranging from 3 to 87%. Fabella is more frequently observed in Asian and Australian populations but is rare in European and American populations. Although often asymptomatic, it can sometimes cause knee pain, known as “fabella syndrome,” and may contribute to neurological symptoms when in proximity to the common fibular nerve. Given the limited awareness of fabella’s presence, this study aims to assess its prevalence and anatomical characteristics to aid in the differential diagnosis of knee pain.

Methods A retrospective analysis was conducted on 500 knee radiographs from 383 patients experiencing knee pain. Data collected included patient age and sex, fabella presence and dimensions, fabella location (distances to surrounding bony structures), patella dimensions, and patellotibial ligament length.

Results Fabella was detected in 31 females (14.76%) and 29 males (25.66%). Among the examined knees, fabella was present in 40 (12.82%) of female and 39 (20.74%) of male knees. The mean fabella length was 8.85 mm (SD=2.59), and thickness was 5.63 mm (SD=1.88), with no significant sex differences. No correlation was found between fabella size and patella dimensions. Notably, patients with fabella were older on average, and bilateral fabellae were significantly larger than unilateral cases ($p<0.05$).

Conclusion Fabella is a relatively common anatomical variant in Central European populations, present in one in six women and one in four men. Its increased prevalence in older individuals suggests a potential age-related development. A comprehensive understanding of fabella anatomy may aid clinicians in diagnosing and managing unexplained knee pain, particularly in elderly patients.

Keywords Fabella · Sesamoid bone · Knee joint · Knee pain

Introduction

The fabella [Figs. 1 and 2] is a sesamoid bone located in the posterolateral corner of the knee (PLC). It is typically found within the tendon of the lateral head of the gastrocnemius

muscle and consists of cartilage or bone tissue [7, 8]. In approximately 30–40% of cases, the fabella is connected to the fibula by the fabellofibular ligament [17]. The prevalence of the fabella is estimated to range between 10% and 30% in the global population, with considerable variation across different geographical regions [5, 7].

In most cases, the presence of the fabella is asymptomatic; however, in rare instances, it can lead to fabella syndrome [14]. This condition is characterized by sharp pain, localized tenderness, and increased pain around the posterolateral corner of the knee during full extension [24]. In extremely rare cases, the fabella may compress the common peroneal nerve, resulting in palsy [16, 23].

The fabella is the second most common sesamoid bone in the knee joint, following the patella. Another accessory

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Fig. 1 Fabella on a radiographic image of the knee joint



Fig. 2 A giant fabella identified in an elderly patient

sesamoid bone in the knee joint is the cyamella, which is far less common than the fabella. The cyamella occurs in less than 2% of the population and is located within the popliteus muscle [4]. Similar to the fabella, the cyamella is generally asymptomatic; however, in very uncommon cases, it may cause symptoms such as snapping knee [22], popliteal tendonitis [20], or posterolateral knee pain [3], which can mimic fabella syndrome.

To date, only a single study has been published describing the prevalence of the fabella in the Polish population, based on a limited sample of merely 52 radiographic images of knee joints [12]. The aim of this study is to provide a more precise estimation of the occurrence of the fabella within the Polish population and to characterize its morphometry. Furthermore, due to the absence of comparative analyses in the existing literature regarding the size relationship between the patella and the fabella, we seek to investigate whether a significant correlation exists between the dimensions of these two anatomical structures.

Materials and methods

Power analysis

The required sample size was calculated using the formula for estimating a proportion with a specified precision. Assuming an expected prevalence of the fabella between 5% and 35% (as was previously assessed in similar populations [2, 12]), a 95% confidence level ($Z=1.96$), and a margin of error of $\pm 5\%$, the required sample size ranged from 73 to 350 patients. Based on this range, a minimum of 350 radiographs was determined to be sufficient to ensure adequate power and precision for prevalence estimation.

Study design and subjects

Postero-anterior and lateral radiographs of knee joints from the radiological record system of the Orthopedic-Rehabilitation University Hospital in Zakopane, covering the period from 2008 to 2023, were analyzed retrospectively for the presence of fabellae. Radiographs with advanced osteoarthritis of the knee joint and those of poor quality were excluded. Initially, a total of 594 knee radiographs were evaluated; however, due to the aforementioned criteria, 94 were excluded — 86 because of advanced osteoarthritis and 8 due to poor image quality. Eventually, 500 consecutive knee radiographs of 383 patients obtained from the beginning of 2023 were included in the study. Each radiograph was analyzed collectively by all four authors (T.K., K.S., A.O., and M.O.) to make sure no fabella was omitted or misdiagnosed, with the final decision being rendered by D.T. — an experienced orthopedic resident. In cases where the fabella was present, measurements of its height, thickness, distance from the lateral femoral condyle, and distance from the apex of the fibula were taken in CareStream software. The height, width, and thickness of the patella were measured on all radiographs. Additionally, the distance between the patella apex (its most inferior part) and the uppermost part of the tibial tuberosity was measured whenever possible [Figure 3]. Every measurement was performed by four authors (T.K., K.S., A.O., and M.O.) to ensure standardization. In cases of measurement discrepancies between the authors, all authors (including D.T.) engaged in extensive discussions to identify potential errors and reach a consensus. Furthermore, the study collected data on patients' sex, patients' age at the time of performing the x-ray, the knee sides on which the radiographs were taken, as well as the laterality of the findings, when feasible. The approval from the local Research Ethics Committee was achieved (ID: 118.0043.1.103.2025).

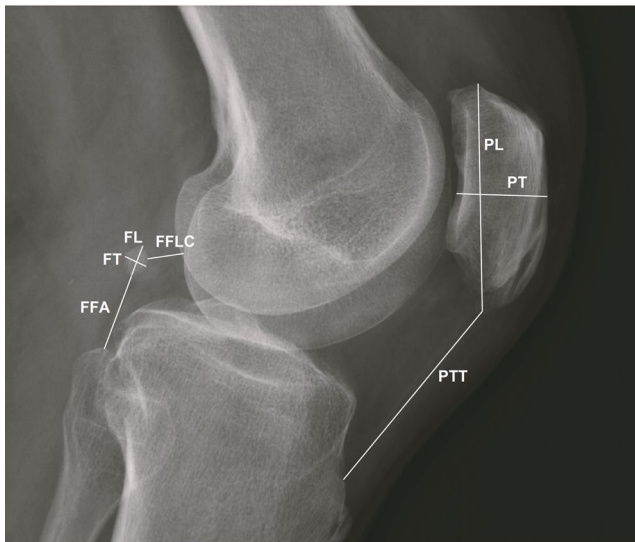


Fig. 3 Marked Measurements of the Patella and Fabella: FL - fabella length, FT - fabella thickness, FFLC - distance from the fabella to the lateral femoral condyle, FFA - the distance from the fabella to the apex of the fibula, PL - patella length, PT - patella thickness, PTT - the distance from the patella to the tibial tuberosity

Statistical analysis

Analysis mainly focused on estimating fabella's prevalence and anatomy, with comparison between sex-based subgroups. Additionally, potential correlation between fabellae and patellae sizes was investigated. Lastly, unilateral and bilateral fabellae had their anatomy compared, and bilateral fabellae were compared with each other.

All statistical analyses were performed with the PS IMAGE PRO 10.0 (IBM SPSS Statistics 29.0.2) software. For continuous data type, when the normal data distribution of the sample was met, the t-student test was utilized. Otherwise, the Mann-Whitney U test was performed. For the analyses involving direct comparisons between two fabellae of the same patient, the one-sample t-test was applied. Prevalence comparisons were made using the Chi-square test of independence. P value < 0.05 was considered statistically significant for all the calculations. The correlation was assessed using Spearman's rank correlation coefficient.

Results

Population characteristics

A total of 500 radiographs from 383 patients were included in the study. Females contributed for 312 radiographs and 241 patients, while males constituted 188 radiographs and 142 patients. The average age of patients during examination was 51.8 years (SD=18.1 years) with no significant difference ($p > 0.05$) between females (mean=53.3 years; SD=18.0 years; range 10–90) and males (mean=49.4 years; SD=18.0 years, range 11–79).

Fabella anatomy and prevalence

Overall, fabella was found in 60 patients (18.58%) and in 79 knee joints (15.80%). A total of 31 out of 241 females (14.76%) and 29 out of 142 (25.66%) males were diagnosed with fabella. Among 312 female and 188 male radiographs, 40 (12.82%) and 39 (20.75%) have had a fabella confirmed, respectively. The differences between sex-based subgroups were statistically significant for both patients ($p = 0.049$) and radiographs ($p = 0.019$) analyses. When present, the fabella was on average 8.85 mm long (SD=2.59 mm) and 5.63 mm thick (SD=1.88), located 7.16 mm (SD=5.47 mm) away from the lateral femoral condyle and 24.17 mm (SD=6.87 mm) away from the fibular apex. The analysis failed to prove any significant difference between males and females in regard to fabellae anatomy and location. Detailed data concerning this sex-based subgroups analysis can be seen in Table 1.

Fabella - patella correlation analysis

A total of 413 knees were found eligible for this analysis. Unlike fabellae, patellae tend to differ in size between males and females. Males in general, (as well as in the fabella positive and fabella negative subgroups) were reported with longer ($p < 0.001$), wider ($p < 0.001$), and thicker ($p < 0.001$) patellae than females. The distance between the patellar apex and the uppermost part of the tibial tuberosity was also

Table 1 Study population characteristics, fabella prevalence and anatomy: LFC - lateral femoral condyle, FA - fibular apex

Population	Mean age (years)	N of patients	N of knees	Fabella (+) patients	Fabella (+) knees	Fabella prevalence patients	Fabella prevalence knees	Fabella's length (mm)	Fabella's thickness (mm)	Fabella – LFC distance (mm)	Fabella – FA distance (mm)
All	51.75 (SD=18.08)	383	500	60	79	18.58%	15.80%	8.48 (SD=2.59)	5.63 (SD=1.88)	7.16 (SD=5.47)	24.16 (SD=6.87)
Males	49.36 (SD=17.99)	142	188	29	39	25.66%	20.74%	9.31 (SD=2.31)	5.85 (SD=1.71)	6.10 (SD=4.77)	25.10 (SD=5.73)
Females	53.27 (SD=18.02)	241	312	31	40	14.76%	12.82%	8.40 (SD=2.80)	5.43 (SD=2.04)	8.20 (SD=5.95)	23.25 (SD=7.78)
P value	0.217	-	-	-	-	0.049	0.019	0.055	0.177	0.131	0.184

Table 2 Comparison of patellar anatomy and fabello – patellar anatomy correlation between the gender-based groups: TT – tibial tuberosity

Population	N of knees	Mean age (years)	Patella length (mm)	Patella thickness (mm)	Patella width (mm)	Patella – TT distance (mm)
All patients	413	51.75 (SD=17.99)	48.11 (SD=4.80)	23.38 (SD=2.79)	52.84 (SD=5.73)	48.10 (SD=7.64)
All males	160	49.32 (SD=18.35)	51.33 (SD=4.81)	25.01 (SD=2.88)	56.47 (SD=5.99)	50.31 (SD=8.40)
All females	253	53.28 (SD=17.62)	46.09 (SD=3.53)	22.34 (SD=2.16)	50.43 (SD=4.05)	46.70 (SD=6.78)
P value	-	-	<0.001	<0.001	<0.001	<0.001
Fabella (+) males	38	56.18 (SD=19.38)	51.82 (SD=3.97)	25.76 (SD=2.90)	58.26 (SD=5.17) (27 knees)	46.53 (SD=7.66)
Fabella (-) males	122	47.18 (SD=17.56)	51.34 (SD=3.84)	24.77 (SD=2.67)	55.96 (SD=5.52) (94 knees)	51.49 (SD=7.21)
P value	-	0.004	0.969	0.131	0.025	0.003
Fabella (+) females	40	55.33 (SD=18.72)	46.25 (SD=3.98)	22.48 (SD=2.28)	50.71 (SD=4.48) (32 knees)	46.05 (SD=6.46)
Fabella (-) females	213	52.89 (SD=17.42)	46.06 (SD=3.68)	22.32 (SD=2.31)	50.37 (SD=4.28) (151 knees)	46.81 (SD=6.71)
P value	-	0.308	0.751	0.358	0.516	0.342

Table 3 Fabella anatomy with regard to its laterality: LFC - lateral femoral condyle, FA - fibular apex

Fabellae	N of patients	Mean age (years)	Fabella's length (mm)	Fabella's thickness (mm)	Fabella – LFC distance (mm)	Fabella – FA distance (mm)
Bilateral	19	59.08 (SD = 18.21)	9.24 (SD = 2.86)	6.18 (SD = 1.80)	6.37 (SD = 4.63)	24.32 (SD = 4.90)
Unilateral	10	58.00 (SD = 15.85)	7.60 (SD = 2.01)	4.20 (SD = 1.55)	5.90 (SD = 4.25)	21.80 (SD = 8.27)
P value	-	0.596	0.054	0.002	0.842	0.395

Table 4 The correlation between the dimensions of the fabella and the patella: LFC - lateral femoral condyle, FA - fibular apex, TT - tibial tuberosity

	Patella length	Patella thickness	Patella – TT distance
Fabella's length	0.293	0.365	0.218
Fabella's thickness	0.269	0.169	0.202
Fabella – LFC distance	-0.044	-0.181	-0.02
Fabella – FA distance	0.091	0.262	0.007

bigger in the male group ($p < 0.001$). No significant difference in patellae anatomy was found when fabella-positive and fabella-negative females were contrasted. However, the same analysis conducted in males revealed that fabella-positive males were on average older ($p = 0.0005$), had wider patellae ($p = 0.025$), and shorter distance between patellar apex and tibial tuberosity ($p = 0.003$). Detailed statistics concerning correlations between the fabella and the patella anatomy are shown in Table 2. Additionally, we compared all measurements of the patella and fabella conducted in our study. We did not find any significant correlation between the sizes of these sesamoid bones within the knee joint or in the measured distances from other anatomical structures (Table 3).

Fabella laterality analysis

A total of 29 patients (15 females and 14 males) were included in this analysis. Bilateral fabella was diagnosed in 19 of them (9 females, 10 males). The remaining 10 patients had a fabella only in one knee. The anatomy of bilateral and unilateral fabellae was generally consistent, with only one exception - bilateral fabellae were on average thicker

(6.18 mm versus 4.2 mm, $p = 0.002$) (Table 4). The analysis of bilateral fabellae revealed that fabellae from different knees of the same patient do not differ significantly in terms of anatomy and location.

Age-Related prevalence of the Fabella

In the studied population, no significant correlation was found between the presence of the fabella and patient age ($r = 0.0584$), nor between the presence of the fabella and year of birth ($r = -0.0385$). Additionally, there was no significant correlation between age and the length of the fabella ($r = -0.1923$), or between age and its thickness ($r = -0.0665$).

Discussion

The fabella, also commonly referred to as the “little bean,” is a notable anatomical variation of the knee joint [15]. It is an accessory sesamoid bone often located in the tendinous part of the lateral head of the gastrocnemius muscle, and frequently articulates with the lateral femoral condyle [15]. It is believed that the main role of the fabella is to stabilize the lateral femoral condyle and the fabella complex, which is made up of the gastrocnemius and plantaris muscles (oblique popliteal ligaments, fabellofibular, and arcuate ligaments) [13]. To the best of our knowledge, Miśkiewicz and Partyka in 1984 published the only existing study focused on estimating the prevalence of the fabella in the Polish community [12]. The authors performed a radiographic assessment of 52 knees and reported that the fabella was present in approximately 15% of them [12]. Since then,

no other research regarding this topic has been released, and up to this date, there is a lack of studies focused on investigating both the prevalence and anatomical characteristics of the fabella in the Polish population. Thus, the purpose of our study was to examine the prevalence of the fabella among 500 knee joints in the local population and, additionally, to assess its sex-specific distribution, morphology, and anatomical characteristics. Our study shows a slightly higher prevalence of the fabella in the examined population, amounting to nearly 19%. This result is lower than the average prevalence in the world population, which is estimated at 25% [2].

The prevalence of the fabella can vary significantly between populations [5], ranging from 3 to 87% [21]. The occurrence of fabella is notably high among Oceanian populations (about 48%) and Asian Mongoloid populations (including Southeast Asian countries, at 41%) [2]. The high prevalence in the Oceanian population may be due to a small research group and a limited number of studies. The study by Hedderwick et al., aiming to describe the anatomy of the knee joint and the oblique popliteal ligament in a New Zealand cohort, was conducted on 25 limbs obtained from 14 cadavers, as well as 14 volunteers who underwent MRI examinations of both lower limbs [10]. A larger number of limbs was examined by Corvalan et al. in an Australian population [6]. This study analyzed 111 limbs, of which 37 were paired and 37 were unpaired. The presence of the fabella was identified in 63 limbs (56.8% of all limbs and 65.7% of cadavers with at least one fabella).

Asian Caucasian, European, as well as North and South American populations demonstrate comparable outcomes regarding the prevalence of the fabella. In contrast, the African population shows a slightly lower prevalence, likely influenced by the limited number of studies. For example, in Adedigba et al.'s study [1] on the Nigerian population, fabella was present in 11.9% of the subjects, which is one of the lowest results [5]. A higher prevalence of the fabella was observed in the South African population in the study by Phukubye and Oyedele [18]. This research analyzed 102 limbs from 51 cadavers, identifying the fabella in 12 individuals (unilaterally in 6 cases and bilaterally in another 6). Due to the limited number of studies, it is challenging to accurately estimate the prevalence of the fabella in other parts of Africa.

In our study, the prevalence of the fabella did not differ significantly from that observed in other European populations [9, 19]. Similar to our study, most research indicates that the fabella occurs slightly more frequently in males than in females. However, unlike our findings, this difference is typically not statistically significant [2, 11, 15]. In our study, the p-value was slightly below 0.05, leading us to consider the observed sex-related difference in fabella prevalence

statistically significant. Nonetheless, it is plausible that this result could change with a larger sample size.

Zhong et al. [25] described the morphometry of the fabella in the Chinese population. In their study, the fabella measured an average of 7.52 mm in length, 4.53 mm in thickness, and 6.47 mm in width. Additionally, the distance between the fabella and the insertion of the lateral head of the gastrocnemius onto the femur averaged 33 mm. All these parameters showed statistically significant differences between sexes. However, no differences were observed between sides. In our study, we measured only the length and thickness of the fabella. Our results were, on average, higher than those reported in the Chinese population (length=8.85 mm, thickness=5.63 mm). Additionally, we did not find statistically significant differences between fabella size and sex. Most studies we reviewed focused primarily on the prevalence of the fabella across different populations, with less emphasis on its anatomy and morphometry. Further investigation into this topic is warranted to compare the morphology of the fabella across populations.

In their study, Berthoume et al. [5] demonstrated an increase in the prevalence of the fabella across all populations over the past 150 years. In our analysis, year of birth did not significantly influence the prevalence of the fabella. This may be attributed to the relatively small sample size, the limited range of birth years in our cohort compared to the aforementioned study, or simply to the absence of a stronger association between year of birth and fabella occurrence. Furthermore, we did not observe any significant correlations between patients' age or year of birth and the morphometric parameters of the fabella. To our knowledge, similar analyses have not been reported in the literature, indicating a need for future research on larger samples and in diverse populations.

In the available literature, we did not identify any studies directly comparing the fabella to the dimensions of other anatomical structures. Among the structures visible in knee joint radiographs, the patella was selected for comparison due to its clear visualization and measurable parameters. Upon analyzing the relationship between the dimensions of the fabella and the patella, no statistically significant correlations were observed. Therefore, it can be concluded that the size of the patella cannot be utilized as a predictive marker for estimating the dimensions of the fabella within the knee joint.

Conclusions

Our study demonstrated that the prevalence of the fabella in the Polish population is comparable to that observed in most other European populations [5]. We found no correlation

between the size of the fabella and the patella across any of the dimensions analyzed. A limitation of our study may be the single-center design. With a greater variety of origins of radiographs, the results of statistical analyses might differ in certain cases, even in a similar population. Nevertheless, our research provides the most comprehensive description to date of the prevalence, morphometry, and topography of the fabella in the Polish population.

To fully characterize the prevalence of the fabella across different regions of Poland, additional studies from various regions are necessary. The population examined in our study predominantly originated from southern Poland, making it intriguing to investigate potential differences in other populations.

Author contributions T.K., K.S., M.O., A.O., D.T. wrote the manuscript, K.S. analysed the data, T.K., K.S., M.O., A.O., B.J. collected the data, T.K., K.S., M.O., A.O. prepared figures. All authors reviewed the manuscript.

Data availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

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