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Original Article

Orthopaedics Section

Radiological Study of Ossified Fabella in Indian Knees: A Cross-sectional Study

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ABSTRACT

Introduction: The fabella is a sesamoid bone found in the posterior and lateral region of the knee, identified on X-rays behind the femoral condyle in a true lateral view. Occasionally, it is a source of knee pain and is associated with radiological evidence of osteoarthritic knees. Due to its uncommon occurrence, there are very few studies related to an ossified fabella. While posteromedial pain and varus are common entities in knee arthritis, attention needs to be given to posterolateral structures like the fabella, as its radiological appearance may indicate the presence of arthritis.

Aim: To determine the occurrence of the fabella and its association with arthritis and knee deformities, such as varus or valgus, in Indian knees on X-rays.

Materials and Methods: This was a single-centre, X-ray-based, cross-sectional study conducted in the Joint Replacement Unit-II of the Department of Orthopaedics between June 2022 and March 2023 at KLE's Dr. Prabhakar Kore Hospital in Belagavi, Karnataka, India. A total of 500 knees were radiologically studied using Medsynapse/Picture Archiving and Communication System (PACS), and Cohen's Kappa Test statistics were employed to measure the agreement between the radiologist and orthopaedician regarding the presence or absence of the fabella interpreted on X-rays.

Results: The occurrence of ossified fabella was observed in 87 (17.4%) subjects. Amongst these 27 (31.03%) had bilateral fabella, while remaining 60 (68.97%) had it either on left or right side. There was a high association between the occurrence of the fabella with age, Osteoarthritis (OA), and knee deformity (p-value<0.001), and a significant association with gender (p-value<0.05), while no association was found between the occurrence of the fabella with the side involved or any previous operations performed (p-value>0.05).

Conclusion: The study revealed that ossified fabella is significantly associated with knee OA, age, and knee deformities.

Keywords: Osteoarthritis, Posterolateral, Sesamoid bone, Varus, X-ray

INTRODUCTION

Fabella in Latin means “little bean” or a sesamoid bone present in the lateral head of the gastrocnemius muscle in 30% of individuals, which is easily identified radiologically on a lateral X-ray of the knee [1]. Occasionally, it is mistaken for a loose body or an osteophyte radiologically [2]. In the posterolateral corner of the knee, if not ossified, a cartilaginous fabella is found up to 66% of the time. Anatomically, it is associated with the fabella fibular ligament. The fabello-fibular ligament is a thickening of collagen that extends in a vertical orientation from the fibular styloid to the fabella [3].

Fabella has been present in animals for about 150 million years and varies in size from species to species. It has a varying range of prevalence among various ethnicities, and its cause-and-effect relation with OA has sparked new interest [4]. Rarely, it is associated with knee pain, mostly as a cause of atypical presentations [5], or arthritic pain in the posterolateral region, which can have serious implications if overlooked during the differential diagnosis with other relevant structures of the posterolateral corner [5].

On knee X-rays, two sesamoid bones are commonly identified, which are the fabella and the cyamella. The fabella overlies the lateral femoral condyle on the frontal view and sits posterior to the distal femur on the lateral view. Radiologically, it can be mistaken for loose bodies and osteophytes. However, the fabella, being an extra-articular structure, usually lies far away from the femoral condyles on x-rays, whereas loose bodies and osteophytes are intra-articular structures and lie in close proximity to the condyles [2,6]. Besides X-rays, Magnetic Resonance Imaging (MRI) has 80%-90% sensitivity and specificity for identifying the fabella and injuries of the fabello-fibular ligament [3].

In a literature search, no study was found on this topic in Indian subjects. Systematic reviews, meta-analyses, or studies done on the occurrence of the fabella in the available literature are mostly on non Indian subjects, along with some case reports [7-9].

Therefore, this study was conducted with an objective to investigate the occurrence of an ossified fabella on knee X-rays among Indian patients and also understanding the association of the fabella with knee OA.

Research hypothesis for the present study:

H0: There is no association between OA and Fabella.

H1: There is an association between OA and Fabella.

MATERIALS AND METHODS

This was an X-ray-based cross-sectional study conducted from June 2022 to March 2023 at the 2400-bed KLEs Dr. Prabhakar Kore Hospital and Medical Research Centre in Belagavi, attached to JN Medical College, KAHER Deemed to be University, Belagavi, Karnataka, India. The study was approved by the institutional ethical committee review (Ref No. DC/JNMCIEC/415) and was in accordance with the Helsinki Declaration rules.

Inclusion criteria: Knee X-rays studied of individuals above 18 years of age, regardless of gender were included in the study.

Exclusion criteria: Below 18 years of age and X-rays of individuals with fractures of the lateral distal femur condyle or any oncological lesions were excluded from the study.

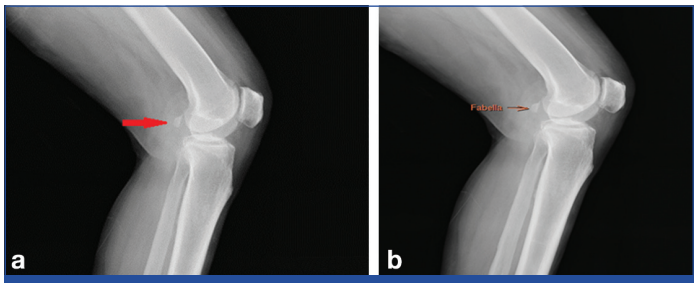
Sample size: The study design involved the following equation for sample size calculation:

Sample size= $z^2 * p(1-p)/e^2$

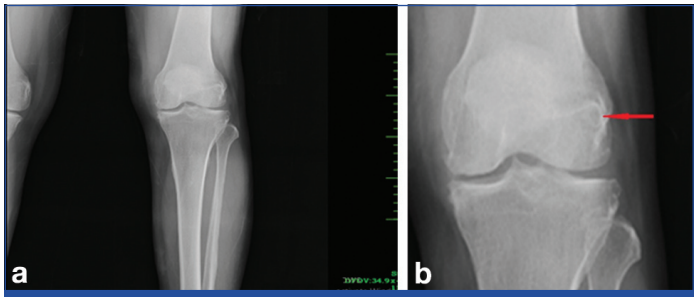
where, z=1.96, with a 95% confidence interval and 0.05 margin of error. Assuming the population to be 50% and considering 20% attrition, the sample size for the study was calculated as 460. However, 500 was the sample size considered for the present study. The study involved X-rays of Orthopaedics' OPD and casualty patients who were referred for knee ailments to the radiology department.

Study Procedure

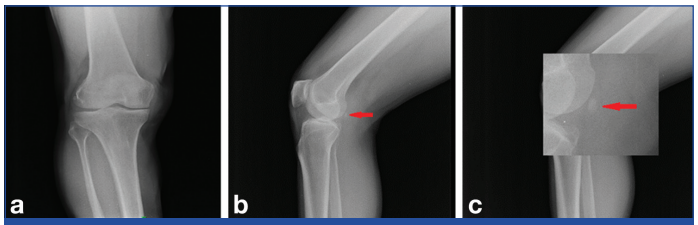
Data from randomly selected 1,300 patients with knee X-rays were screened. A total of 700 patients' X-rays were excluded, and 500 were included based on the inclusion and exclusion criteria. These 500 patients had 1000 knee X-rays with Anteroposterior (AP) and lateral views (i.e., each patient's X-ray was studied for AP and lateral views). The individual X-rays were separately screened for the presence or absence of a fabella by the specialist orthopaedic surgeon and radiologist, and K-L (Kellgren-Lawrence) grading [10] for osteoarthritic changes was conducted. The hospital's electronic database was analysed for X-ray screening. The Picture Archiving and Communication System (PACS) (Med synapse) was used to review the radiographs. Appropriate zoom views were utilised to observe the presence of the fabella in and at the posterolateral corners of all knee X-rays, as depicted in [Table/Fig-1-3].



[Table/Fig-1]: a) X-ray left knee lateral view (not zoomed) showing an ossified fabella behind the posterolateral femoral condyle. (Patient with easily identified fabella); b) X-ray left knee lateral view (with semi-zoom) showing a markedly large fabella indicated by the red arrow. (Of the same patient as in [Table/Fig-1a]).



[Table/Fig-2]: a) X-ray left knee AP view (not zoomed), fabella not visible; b) X-ray AP (with Zoom view), now fabella identified laterally. (Of the same patient as in [Table/Fig-2a]).



[Table/Fig-3]: a) X-ray right knee AP standing view. (fabella not visible); b) X-ray right knee lateral (not zoomed), but fabella faintly visible. (of the same patient as in [Table/Fig-3a]); c) X-ray right knee lateral view (zoomed), fabella markedly visible behind the posterolateral distal femoral condyle. (of the same patient as in [Table/Fig-3a,3b]).

X-ray screening: Initially, all individual knee X-rays were first examined in the lateral view for the fabella, and its absence or presence was documented after proper zoom views on the PACS software, as depicted in [Table/Fig-1-3]. Furthermore, the corresponding AP view of each X-ray was studied for the fabellar bone, and OA changes were documented on a Master chart based on the K-L gradings of Zero (0), Doubtful (1), Mild (2), Moderate (3), or Severe (4), depending on the tibiofemoral space and occurrences of osteophytes. This data was recorded along with varus and valgus knee deformities in relation to the laterally placed fibula in each knee X-ray. The study variables included the side involved (left, right, or both), gender, age, fabella (present/absent), deformity (varus/valgus), OA, and operations performed (previous knee surgeries such as nailings, platings, total knee replacements).

STATISTICAL ANALYSIS

Statistical analysis was conducted using IBM Statistical Package for Social Sciences (SPSS) Statistics 20.0 and Microsoft Excel worksheet. Chi-square tests were used to examine the association of the fabella with the above mentioned variables, and the association of age with OA was investigated, with the significance levels set at 5%, 1%, and 0.1%, respectively. SPSS and Excel were utilised for descriptive data analysis. Kruskal-Wallis Test statistics were employed to demonstrate differences in medians across age and OA. Cohen's Kappa Test Statistics were used to assess the agreement between the radiologist and orthopaedician regarding the presence or absence of the fabella on interpreted X-rays.

RESULTS

The ossified fabella was found to have a prevalence of 87 (17.40%) among the 500 adult knees. Among the 87 knees with a fabella, 27 (31.03%) had a fabella in both knees, while the remaining 60 (68.97%) had it on either side. It was also observed that the left knee (37.93%) had a slightly higher proportion of fabella compared to the right knee (31.03%) [Table/Fig-4,5].

	Fabella		
Side	Absent, n (%)	Present, n (%)	Total
Both	124 (82.1)	27 (17.9)	151
Right knees	138 (83.6)	27 (16.4)	165
Left knees	151 (82.1)	33 (17.9)	184
Total	413 (82.6)	87 (17.4)	500

[Table/Fig-4]: Sidewise distribution of fabella and its occurrence.
*Descriptive statistics (%) the prevalence of fabella is 17.4 %. {(87/500)*100}

	Side n (%)			
Fabella	Both	Right	Left	Total
Present	27 (31.03)	27 (31.03)	33 (37.93)	87

[Table/Fig-5]: Side-wise distribution (in the identified 87 fabella within the group).
*Descriptive statistics (%)

The gender-wise distribution of fabella showed its occurrence in 52 (21.1%) males, which was higher than that noted in females, 35 (13.8%) [Table/Fig-6]. Statistically, when the association between gender and the presence of fabella was analysed with Chi-square test statistics, Pearson and Fisher's-Exact Test values indicated a statistically significant association with a p-value of 0.03 [Table/Fig-7].

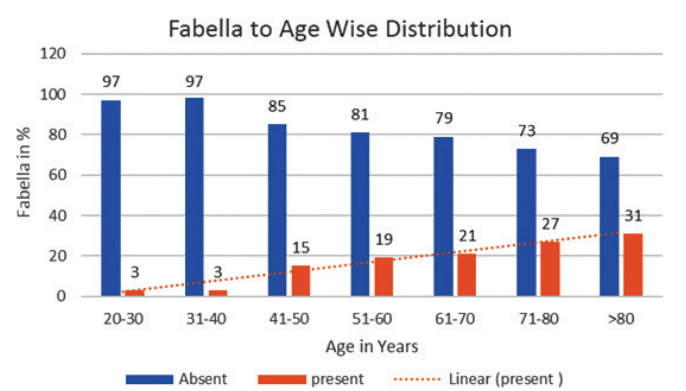
	Fabella n (%)		
Gender	Absent	Present	Total
Male	194 (78.9)	52 (21.1)	246
Female	219 (86.2)	35 (13.8)	254
Total	413 (82.6)	87 (17.4)	500

[Table/Fig-6]: Gender-wise distribution of fabella.
Descriptive statistics (%) shows occurrence of fabella in males to be more than females

Age-wise distribution of fabella indicated that as age progresses, the occurrence of fabella increases from 3-31% across the age groups [Table/Fig-8]. The association of fabella with age was assessed using Chi-square test and it showed a highly significant linear association between age and the occurrence of fabella, with a p-value<0.001 [Table/Fig-9].

Test statistics	Value	Df	p-value (Asymp.)	p-value (Exact)
Pearson Chi-Square	4.708[a]	1	0.030*	
Likelihood Ratio	4.210	1	0.040	
Fisher's Exact Test	4.730	1	0.030	0.034*
Linear-by-linear association	4.699	1	0.030	0.030*

[Table/Fig-7]: Association between gender and fabella by Chi-square test.
Test- Pearson Chi-sq,*level of significance - 5% (with p<0.05), a- 0 cells (.0%) have expected count less than 5



[Table/Fig-8]: Age-wise distribution of fabella.

Test statistics	Value	Df	p-value
Pearson Chi-square	18.179[a]	7	0.011
Likelihood ratio	22.452	7	0.002
Linear-by-linear association	16.227	1	0.0001***

[Table/Fig-9]: Association between age and fabella by Chi-square test.
[a]1 cells (10.0%) have expected count less than 5, Chi-sq test statistics, level of significance 0.1% (with p<0.001)

The distribution of 87 knees with fabella in OA and non OA knees showed that 48 (55.2%) patients had grade 4 OA, 19 (21.8%) had grade 3 OA, 15 (17.2%) had grade 2 OA, 4 (4.6%) had Grade 1 OA, and just 1 (1.2%) had no OA. Thus, 86 (99%) patients with the presence of fabella also had OA changes [Table/Fig-10].

Osteoarthritis (OA)	Fabella		
	Absent, n (%)	Present, n (%)	Total, n (%)
Grade 0	22 (5.3)	1 (1.2)	23 (4.6)
Grade 1	43 (10.4)	4 (4.6)	47 (9.4)
Grade 2	116 (28.1)	15 (17.2)	131 (26.2)
Grade 3	132 (32.0)	19 (21.8)	151 (30.2)
Grade 4	100 (24.2)	48 (55.2)	148 (29.6)
Total	413	87	500

[Table/Fig-10]: Distribution of fabella with non OA and OA knees as per K-L Grading.

Distribution of fabella, when studied with respect to deformity, showed that 34 (39%) had no deformity, 2 (2%) had valgus deformity, and 51 (59%) had varus deformity. It was also observed that varus deformity (135) was more prevalent compared to valgus deformity (12) out of the 500 patient knee X-rays [Table/Fig-11].

Test Statistics	Value	Df	p-value (Asymp.)	p-value (Exact)
Pearson Chi-square	4.708[a]	1	0.030*	
Likelihood Ratio	4.210	1	0.040	
Fisher's exact ttest	4.730	1	0.030	0.034*
Linear-by-linear association	4.699	1	0.030	0.030*

[Table/Fig-11]: Association between gender and fabella by Chi-square test. Test- Pearson chi sq , *level of significance 5% (p<0.05), a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 42.80

The Chi-square tests indicated that fabella had a highly significant association with deformity, OA, and age with p-value<0.001, and a significant association with gender with p-value<0.05. There was no association with the affected side and operations previously done [Table/Fig-12].

Variable	B	S.E.	Wald	Df	Sig.	Exp(B)
Deformity (varus/valgus)	0.968	0.224	18.719	1	<0.001***	2.632
Osteoarthritis (OA)	0.498	0.142	12.368	1	<0.001***	1.645
Gender	-0.525	0.214	4.730	1	0.030*	0.034
Side Involved	0.093	0.155	0.358	1	0.550	1.097
Operated	0.326	0.262	1.554	1	0.213	1.386
Age groups	-3.425	0.503	46.284	1	<0.001***	0.033

[Table/Fig-12]: Summary table for association of fabella with study variables by Chi-square.
Chi-sq test statistics, level of significance set at 5%.

The radiologist and orthopaedician agreed on the presence of fabella in 87 X-rays. In two X-rays, the orthopaedician identified fabella, but the radiologist denied its presence. Similarly, in three X-rays, the radiologist identified fabella which the orthopaedician did not. Hence, a discrepancy was noted in five X-rays. Cohen's κ test statistics were conducted to determine if there was agreement between the orthopaedician and radiologist's judgment on the presence and absence of fabella on X-rays. The test showed perfect agreement between the two specialists' judgments, κ=0.966 (95% CI, 0.963 to 0.969), p-value<0.001 [Table/Fig-13].

Observer 1 (orthopaedician)	Observer 2 (radiologist)		Total
	Present	Absent	
Present	87	2	89
Absent	3	408	411
Total	90	410	500

	Cohen Kappa				
	Value	Asymptomatic Standard Error	Approximate Significance	CI (95%) LL	CI (95%) UL
Measure of agreement	0.966	0.001	<0.001	0.963	0.969
N of valid cases	500				

[Table/Fig-13]: Cohen's Kappa Test Statistics measuring the agreement between the radiologist and orthopaedician on the presence of Fabella on X-ray.
Cohen's Kappa test was used to measure the agreement between two experts, with a level of significance of p<0.001, indicating very high significance

DISCUSSION

The present study suggests that the occurrence of the fabella was 87 (17.4%). It also demonstrated a highly significant (p-value<0.001) association of the fabella with varus knee deformity, OA, age, and a significant (p-value<0.05) association between the fabella and gender. The overall prevalence of the fabella indicates that it is not a universal structure and shows variation in occurrence. The occurrence of the fabella was observed on both sides, indicating a bilateral tendency for both knees, although the left knee had a slightly higher fabella presence compared to the right (37.93% vs. 31.03%). This suggests potential asymmetry in the presence of the fabella [Table/Fig-5]. Understanding the prevalence and distribution of the fabella could be crucial for clinicians, especially in contexts such as knee surgeries or knee clinics, where knowledge of anatomical variations is essential. This study found an occurrence of the fabella in 87 (17.4%) knee X-rays, which was similar to the Romanian population [2] where the occurrence was 16.93% in 562 patients. Similarly, in a study by Omar DAM et al., it was 24.1% in 813 knees [4], in a study by Hur JW et al., it was 57.2% in 2126 Korean subjects [8], and in a study by Hou W et al., on 1150 patients in 1359 knees, they showed a prevalence of 48.6% [11]. This difference in prevalence can be attributed to

the sample sizes; as they increase, there is an increase in the prevalence of the fabella.

This study showed no association of the fabella with respect to the side involved with p-value=0.550. This finding was similar to a study by Hou W et al., but their study didn't show a difference in the occurrence of the fabella with respect to gender, which was a contrary finding to the present study [11]. The data indicates a gender-based (p-value<0.05) difference in the presence of the fabella. Males show a slightly higher percentage of fabella presence compared to females (21.1% vs. 13.8%). This may suggest a potential gender-related anatomical variation in the presence of the fabella. In the study by Omar DAM et al., they identified the fabella in 28.6% of males and 20.0% of females, suggesting a higher male predilection, similar to this study [4].

The absence of any other study on Indian patients makes this study unique and helps to understand the occurrence in Indian knees. This study shows that males had a higher association of ossified fabella, but authors believe that more occurrences, including that of non ossified fabella, could be identified through future MRI-based studies to draw conclusions on gender or more posterolateral knee associations. This observation was made in an MRI-based study by Zhong J et al., on 1011 knee MRI scans, which had a prevalence of 39.8% [12]. Again, they had not undergone X-rays; hence, a dedicated study may include both X-rays and MRI [13].

The study suggests that regarding the association of the fabella with age, both the Pearson Chi-square and likelihood ratio tests show significant associations (p-value<0.01), but the likelihood ratio test is often considered more robust when sample sizes are relatively small or when assumptions of the Chi-square test are not met. In the linear-by-linear association test, with a p-value of 0.001, it suggests a linear relationship between age and the fabella [Table/Fig-8,9]. This means that as age increases (or decreases), there is a corresponding increase in the likelihood of fabella presence in the knee. Omar DAM et al., has similar findings to the present study (p-value<0.001) [4]. This study observed a 15% occurrence of the fabella in the age group of 40 years, which increased to 31% in the age group of 80-year-old. The probable reason for the increase in fabella occurrence with increasing age could be due to the laterally placed position of the fabellar bone. It may have faced more stretching forces acting posterior-laterally as seen in varus knees (which usually encounter medially compressive forces). Present study observes more varus entities and more fabella among these varus knees [Table/Fig-11], and this could be due to a cause-effect relationship or as a sequel of the more common fabella seen with increasing age and increasing varus entity in this study. This observation can also be justified as only two fabella were seen among 12 valgus knees, compared to 51 fabella in 135 varus knees. Yet, this interpretation will require dedicated research to confirm these types of probable associations [14].

In the study by Suri P et al., the distribution of OA grade across different age groups reveals a linear relationship between age and the likelihood of higher osteoarthritic severity grades, which is expected in age-related conditions like knee OA [15]. Thus, as age advances, the severity of knee OA and the occurrence of the fabella have also increased. In the present study, the distribution of fabella presence across different K-L (Kellgren & Lawrence) grades indicates a notable pattern. X-rays with ossified fabellae (86 knees or 99%) have demonstrated higher severity grades of OA, with 67 (77.2%). It is noteworthy that only 1 (1%) of knees with a fabella did not show signs of OA (Grade 0). Similar to South Korean [8] and Chinese studies [11], this study also shows an association of the fabella with knee OA and age with p-value<0.001. Similarly, in a study by Sari A et al., for the presence of the fabella with age, they suggested the fabella to be a significant predictor of OA (p-value<0.001). Their occurrence of the fabella rises with advancing age, unaffected by gender, and is closely linked to the presence of OA, with both factors influencing its presence and size as well. This study also has similar findings about age and knee OA with ossified fabella [16]. The Chi-square results indicate that the fabella has a highly significant association (p-value<0.01) with deformity (varus) and OA, showing potential clinical relevance in these contexts. The associations with gender and age groups further contribute to the understanding of the demographic factors influencing the presence of the fabella in the knee joint.

The kappa statistic is commonly employed to assess the agreement between raters. The significance of rater reliability lies in its indication of how accurately the collected data reflect the variables being measured in the study [17]. Cohen's κ was run to determine if there was agreement or disagreement about ossified fabella, thus the observer bias, which was expected in the study, has been overcome.

Limitation(s)

Clinical knee pains of posterior and lateral origins may be studied for both ossified and non ossified fabellae with the help of MRI, not just the ossified ones on X-rays as considered in this study. This study lacked MRI assessment, as purely MRI-based studies may yield a higher occurrence for non ossified fabellae as well, but the interpretation in a clinical context may be doubtful. Similarly, identification of fabellar association with posterolateral structures and its cause or relations to cultural habits like squatting or cross-leg sitting using both X-rays and MRI, assessing other factors like size and morphological variations, were not studied in this research.

CONCLUSION(S)

This study identified ossified fabellae with an occurrence rate of 17.4%. With an increase in the radiological arthritic knee scores, the occurrence of the fabella also increased. Ossified fabella were more prevalent as age progressed, and this increase highlights its degenerative aspects akin to osteoarthritic progression. Being prominently high in varus knees, this study also demonstrated a significant higher association between the fabella, age, and OA. This is a simple yet highly reproducible study, and we believe its data will help in understanding the prevalence of the fabella in the Indian context and in other future studies related to posterolateral knee structures in the global South and other regions.

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- Manual Googling: Dec 13, 2023
- iThenticate Software: May 01, 2024 (18%)

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