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# Fabella Syndrome: Anatomy, Diagnosis, Treatment, and Outcomes

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**Abstract:** The fabella is a rare sesamoid bone found within the posterior aspect of the knee joint. Patients can suffer from fabella syndrome which is characterized as pain with extension of the knee, ultimately limiting motion and causing a clicking or catching sensation. There is debate in the literature regarding operative excision versus nonoperative management for patients with fabella syndrome. This review seeks to provide a comprehensive overview of fabella anatomy and fabella syndrome presentation, diagnosis, treatment, and outcomes.

**Keywords:** fabella; fabella syndrome; knee; knee pain; sesamoid; orthopedic; orthopedic surgery



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## 1. Introduction

The fabella is historically an uncommon sesamoid bone seen within the posterolateral aspect of the knee. The name of this small bone is derived from the Latin term "little bean". Growing research suggests its prevalence is quickly increasing despite other sesamoid bone occurrences staying consistent [1]. The fabella has been noted to have a particular occurrence in Asian populations. Zeng et al. reported that 57.9% of the fabellae found within a Chinese population were not discovered on radiographs, while Tabira et al. described findings of 70 fabellae in 102 knees studied in a Japanese population [2,3].

Fabella syndrome is recognized as pain with extension of the knee and may be accompanied by a clicking or catching sensation with repeated movement. As the fabella articulates with the lateral femoral condyle, the bony prominence causes a painful pressure, limiting motion. In addition to pain, the fabella is associated with osteoarthritis, fracture, and even common femoral nerve impingement. Reportedly, this fibrous bone resides within 10–30% of the population [4,5]. Another cadaveric study suggests the fabella may present in up to 66% of the population and is often undetectable in radiography [6,7]. Most individuals with a fabella will have no underlying issues and remain asymptomatic; however, those suffering from fabella syndrome often present with localized tenderness and sharp pain with full extension at the knee joint.

Both genetic and environmental influences play a role in the development of the fabella and drastically change the lives of those affected from elite athletes to normally active individuals [8,9]. The prevalence of the fabella has increased roughly 3.5 times within the last century, suggesting its anatomic and clinical importance in the future [1]. There is a diverse opinion on operative excision versus nonoperative manipulative treatment with few definitive guidelines on proper management. This comprehensive review seeks to clearly depict fabella syndrome and provide supported suggestions towards proper treatment of the debilitating condition.

## 2. Anatomy

Sesamoid bones are commonly found within muscle or tendon. Their primary role is to assist in reducing the stress of that muscle or tendon when in the active state and develop further with continued usage [10]. One example of a sesamoid bone found in humans is the patella, which functions as a fulcrum at the knee joint to increase the force of pull of the quadriceps muscle by increasing the lever arm. Sesamoid bones are also observed in the foot where the hallux sesamoid bones play a similar role with relation to the flexor hallucis brevis and longus muscles.

The fabella is a lesser-known sesamoid bone in the posterolateral aspect of the knee (Figure 1). It is a small sesamoid bone located behind the lateral femoral condyle of the femur and typically ossifies by 12 years of age [1,2]. The location of the fabella near the lateral femoral condyle is often referred to as the fourth compartment of the knee. While the fabella may be located in the medial head of the gastrocnemius muscle, this is rare with less anatomical attachments to the sesamoid bone itself [2]. However, fabellae located laterally have a much more complicated anatomy, as seen in Figure 1 and described below. A cadaveric study assessing 150 gastrocnemius muscles in 75 knees found 99 fabellae, 44 (29.3% of the gastrocnemii) of which were completely ossified. A proportion of 99.7% of the bony fabellae were in the lateral gastrocnemius, indicating an origin of endochondral ossification [7]. However, fabellae that are not completely ossified (cartilage fabellae) may not be visible on plain radiographs, with nearly half being absent on imaging [2].

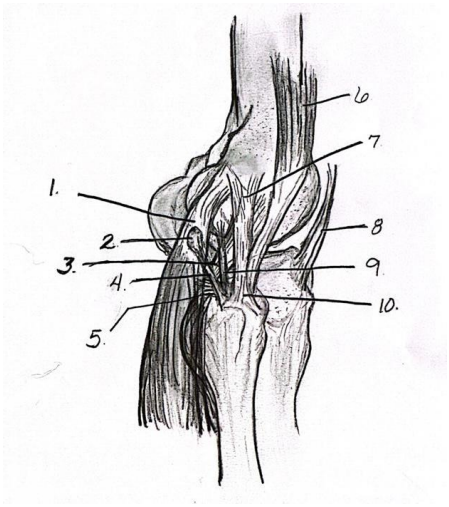


**Figure 1.** Posterolateral illustration of the knee: 1. gastrocnemius muscle; 2. fabella; 3. popliteus tendon; 4. fabellofibular ligament; 5. popliteofibular ligament; 6. biceps femoris tendon; 7. lateral collateral ligament; 8. iliotibial band; 9. arcuate ligament; 10. conjoint tendon.

The size of the fabella is larger in males, averaging dimensions of 9.18 × 7.47 × 5.47 mm in males and 8.42 × 7.10 × 5.36 mm in females [7]. Since the fabella is situated near the oblique popliteal ligament, lateral gastrocnemius tendon, and fabellofibular ligament, it experiences considerable tensile force in a range of directions. The bony fabella has been particularly linked with the thickening of the fabellofibular ligament as the two are always observed in tandem [5]. An anatomic study conducted by Zeng et al. demonstrated no statistically significant difference between the cross-sectional area of the fabellofibular ligament and the texture or radiographic appearance of the fabella [2].

The true function of this anatomic variant is somewhat debated. The lack of articular cartilage, embedment within fixating collagen fibers, and suspension of the fabellofibular ligament from its base suggest that it serves to stabilize the soft tissues of the knee [11]. In rare cases, the fabella can serve as an additional origin for the popliteus muscle [1]. While its presence is often variable within individuals, the fabella's relationship with musculature and joint space can elicit pain with activity that requires management.

As the fabella develops, its calcification may cause aggravation and entrapment of the underlying structures of the knee including the common peroneal nerve as it transverses the lateral head of the gastrocnemius muscle, which innervates the anterior compartment and lateral compartments of the leg. Once the nerve is compressed, stretched, or has disrupted vascularity, patients can experience common peroneal nerve palsy. Symptoms of this entrapment include neurologic pain, inability to raise the big toe, and foot drop among other debilitations [12]. This may occur naturally as the fabella limits the mechanics of the knee but has also been reported after surgical procedures such as arthroplasty. In the case of arthroplasty, the impingement of the fabella can result from either catching on the posterior side of the polyethylene tibial prosthesis during flexion, causing a painful snap, or catching on the lateral femoral component [13,14]. While it is a rare postoperative complication, the fabella must be considered after presentation with suspicion of common peroneal nerve palsy and/or localized pain to the popliteal fossa. After surgical interventions, varus or valgus malalignment leads to excess strain within the posterolateral aspect of the knee, introducing new impingement on the common peroneal nerve [15]. These effects on the lower extremity are typically noticeable and may even lead to the fracturing of the fabella.

Fractures of the fabella, while rare, can occur due to chronic exaggeration of these tensile forces, eliciting painful recoveries which can impede patient adherence to weight bearing and physical therapy. The improper distribution of forces can be resultant of other operative procedures, but traumatic impact also causes fractures of the sesamoid bone, commonly overlooked by radiographic study. Fabella fractures can lead to enlarged osteoarthritic fabellae, contributing to fabella dislocation and common peroneal nerve impingement [16]. Thus, it is vital to consider the fabella for a thorough and complete assessment of the knee joint.

## 3. Presentation and Diagnosis

Fabella syndrome, as reported by Berthaume and Bull, has a prevalence between 3 and 87% but is particularly noteworthy in Asian populations, where the prevalence of the fabella is higher [1]. This syndrome is characterized by posterolateral knee pain and dysfunction. Fabella syndrome can manifest through various mechanisms, including irritation and impingement of the fabella against the lateral femoral condyle, impingement secondary to knee arthroplasty, trauma, or dislocation, making it a multifaceted condition with diverse presentations [8,17,18].

Patients with fabella syndrome typically present with posterolateral knee pain exacerbated by activities involving knee extension, such as squatting, climbing stairs, or prolonged standing. The pain is often intermittent but can become persistent over time, accompanied by tenderness over the posterolateral knee joint. Acute onset of symptoms can occur following trauma. Neurological symptoms such as numbness or tingling may arise due to the compression of surrounding nerves, contributing to functional impairments like difficulty walking [17,19].

The primary mechanism of injury involves repetitive compression and shearing forces between the fabella and the lateral femoral condyle during knee movement. This can lead to inflammation, osteophyte formation, and chondromalacia of the fabella's articular surface. Anatomical variations in fabella size and position relative to the femoral condyle alter mechanical stress patterns during knee flexion and extension, contributing to the development of fabella syndrome. Its presence within the muscle belly of the gastrocnemius likely exacerbates associated pain complaints. [17,19].

Diagnosing fabella syndrome can be challenging due to its symptom overlap with other knee conditions. Common differential diagnoses include meniscal tears, presenting with knee pain exacerbated by movement, a clicking or locking sensation, and swelling [8,17,19,20]. Osteoarthritis, characterized by gradual onset of knee pain, stiffness, and limited range of motion [15,17,19,21]. Biceps femoris tendinopathy presents with pain in the posterolateral knee exacerbated by knee extension and hip flexion [21]. Common peroneal nerve entrapment includes foot drop and sensory changes along the lateral leg and dorsum of the foot [15,22,23].

And popliteal cyst (Baker's cyst) exhibits swelling and tightness behind the knee aggravated by flexion [8].

Fabella syndrome does not always present with immediate signs or symptoms and onset can vary with the exact size and location of the fabella at the time of hardware placement. Okano et al. present a patient diagnosed with fabella syndrome just 6 days after a total knee arthroplasty was performed, but Kimura et al. describe a patient with previous total knee arthroplasty developing fabella syndrome 8 years after their initial procedure [24,25]. The Okano report details an arthroscopic examination which confirmed the absence of abrasion or noteworthy damage to the polyethylene components, ruling out failure of the implant and indicating another elicited issue determined to be the fabella [24]. Both operations resulted in the alleviation of symptoms after fabellectomy was performed, suggesting that altered mechanics in arthroplasty and the enlargement of the fabella may lead to fabella syndrome and peroneal nerve entrapment [24,25].

The recommended imaging sequence for diagnosing fabella syndrome includes plain radiography for an initial assessment of the knee to identify fabella characteristics [8,19,26,27]. MRI is used for a detailed evaluation of soft tissues, cartilage, and synovium around the knee joint, confirming signs of impingement and joint changes [19,22,26–28]. Ultrasound is used to assess dynamic changes and detect fluid accumulation or inflammation around the fabella during knee movement [19,22,23,27]. Computed tomography can be used for a precise evaluation of the bony anatomy and identifying detailed structural changes [21,27,29]. These insights underscore the clinical relevance and diagnostic challenges associated with fabella syndrome, emphasizing the importance of thorough evaluation and appropriate imaging for accurate diagnosis and management.

## 4. Treatment and Outcomes

While fabellae are commonly asymptomatic and require no intervention, a symptomatic fabella may require treatment ranging from conservative treatment and physical therapy to surgery. Conservative care options for fabella syndrome include steroid injections, immobilization with a splint or a cast, activity restrictions, and analgesics [30]. Additionally, manual therapy and radial extracorporeal shock wave therapy (rESWT) have been identified as effective [20].

Seol et al.'s case report indicated rESWT's effectiveness particularly in cases involving enthesopathy of the fabella complex. Three of the four patients reported a reduction in their pain score from an 8 to a 1, while the fourth patient reported a reduction in their pain score from 4 to 0 [20]. Manual therapy, as supported by Zipple's case report, involves sustained pressure along mobility-restricted cutaneous and fascial tissues enveloping the gastrocnemius–soleus complex [31]. Specific techniques used include transverse stretching of the lateral head of gastrocnemius, medial to lateral fabella mobilization with knee flexed 30 degrees (three and four oscillations for 3 min) and inferior glide of the knee at knee flexion positions of 75, 90, and 120 degrees. In this case, pain did not recur 16 months post manual therapy intervention [31].

There is no established standard duration for nonoperative management. Weiner and Macnab suggest 6 months of conservative care before considering surgery, while Dekker et al. recommends 8 weeks of nonoperative management along with a single intra-articular corticosteroid injection for patients [28,30]. Despite some effective nonoperative interventions, Kuur notes that some of these often provide only transient or no pain relief, prompting surgical intervention after failed conservative management [32].

The surgical procedures used to excise symptomatic fabellae include open, arthroscopic-assisted, or all-arthroscopic fabellectomy. An open surgical approach begins with an evaluation of the affected knee at the lateral femoral condyle. An incision is made in a "hockey stick" fashion and the iliotibial band is perforated, exposing the biceps femoris muscle. Continuing from superficial to deep, the peroneal sheath is released. The knee can be moved through its range of motion at this point to accurately palpate the fabella and identify the source of any clicking. Cauterization allows for the removal of any calcification

and removal of the fabella. The knee must then be tested in full range of motion to confirm the pathology has been resolved [15]. Open procedures allow for more easily identifiable landmarks, the visualization of the peroneal nerve, and minimizes the resection of the surrounding tissue. However, this approach is more labor-intensive, permits more blood loss, and results in a larger wound that increases the risk of infection, larger superficial scar formation, and postoperative arthrofibrosis [26].

Arthroscopic-assisted procedures include landmarks such as Gerdy's tubercle, the superficial layer of the iliotibial band, the lateral aspect of the fibular head, and the joint line. A transverse oblique incision is made along the joint line marking from the posterior aspect of the iliotibial band and 8–10 cm proximally from Gerdy's tubercle. Blunt retraction of the subcutaneous tissue is performed, and the iliotibial band is incised 1–2 cm anterior to posterior. This step must be performed with care as there is a risk of damaging the anterolateral ligament, fibular collateral ligament, popliteus tendon and posterior to the biceps complex, in which lies the peroneal nerve. Blunt dissection is then performed along the long head of the biceps femoris through the space between the lateral gastrocnemius and fibular collateral ligament, keeping particular focus on the distal medial fibular head. The final step before arthroscopy placement involves blunt dissection for adequate placement of a Cobb elevator and separating adhesion between the lateral head of the gastrocnemius and posterolateral capsule. At this point, the fabella is palpated within this separated space and secured via an Alice clamp. Excision has not yet been performed. Standard portals are placed for knee arthroscopy, and, after diagnostic analysis, a 70° arthroscope is inserted into a posterolateral portal to visualize the lateral condyle of the femur. The intra-articular portion of the procedure is performed and the fabella can now be removed from the lateral gastrocnemius under direct visualization with an arthroscope [33].

All-arthroscopic fabella excision is a less common surgical method that may serve as a viable, minimally invasive approach to treating fabella pain syndrome. A case series and literature conducted by Shuo-Po Weng et al. concluded that this technique offers a smaller wound, decreased postoperative pain, and quicker rehabilitation time while offering similar results to more invasive techniques [17]. Under general anesthesia, the patient is positioned supine and standard anterolateral and anteromedial portals are established for knee arthroscopy. The knee is flexed to 80 degrees and the arthroscope is inserted into the anterolateral portal to visualize as the posteromedial portal is established. The arthroscope is then inserted into this posteromedial as a spinal needle is inserted into the lateral compartment. The safe zone for this posterolateral portal is between the lateral collateral ligament and the anterior part of the biceps femoris, or at the point that the posterior cortex of the fibula intersects with the knee joint line [17]. Finally, with the scope in the posterolateral portal, thermal cautery is used to release the fabella and it is excised. Depending on the size of the fabella, the lateral portal incision may require extension to complete the excision.

The surgical outcomes associated with fabella excision are not extensively documented in the literature. The largest study conducted by Dekker et al. reports that 8 out of 10 patients, with a 21-month follow-up, were able to return to their desired activity levels following arthroscopically assisted fabella excision [28]. A comparative analysis of the preoperative and postoperative scores revealed an improvement of 16.9 points in the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score, and a 13.6-point improvement in Lysholm scores [28]. Additionally, a case report by Weng et al. on all-arthroscopic fabella excision demonstrated significant reductions in visual analog scale (VAS) scores, with decreases from 6 to 1, 5 to 1, and 6 to 2 from the preoperative to postoperative assessments [17]. While these findings suggest favorable outcomes following surgical excision, further research is needed to determine the optimal surgical approach.

## 5. Conclusions

Throughout this review, our objective was to provide a thorough and comprehensive description of the fabella, along with relevant anatomy, presentation, diagnosis, treatment,

and overall outcomes. There are thought to be both environmental and genetic factors contributing to the formation and enlargement of this anatomical variant, but no exact origin is agreed upon. Often asymptomatic, fabellae can become problematic in patients due to several known mechanisms including fracture of the fabella secondary to trauma, overuse leading to inflammation of the fabella complex, and mechanical impingement after knee arthroplasty.

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