Amol Saxena *Editor*

Sports Medicine and Arthroscopic Surgery of the Foot and Ankle

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Chapter 1
First Metatarsophalangeal Joint Sesamoidopathy

Richard T. Bouché

1.1 Introduction

Hallucal sesamoids play a critical role in foot function as they protect the flexor hallucis longus tendon, increase the mechanical advantage of the flexor hallucis brevis tendon, facilitate load transmission to the medial forefoot, and minimize joint forces acting on the first metatarsophalangeal joint (MTPJ).[1-4] Disorders of these bones are not uncommon problems that pose a significant challenge to the foot surgeon as there are few good studies available that have studied the effectiveness of conservative and surgical treatments recommended to treat these disorders. These injuries can be disabling particularly for athletic patients and surgical extirpation may be contemplated. Concerning evidence-based medicine for surgical treatment, there are no level 1 or 2 prospective randomized studies to rely on with majority of studies being level 3, 4, or 5. Thus, recommended treatments are either anecdotal or based on limited case studies and few anatomical "bench studies." Because of this lack of knowledge, there have also been many myths that abound pertaining to sesamoid pathology and the treatments rendered thus adding to the confusion. The purpose of this section is to generally review hallucal sesamoidopathy with emphasis on the role of surgery specifically discussing incisional approaches and recommended procedures for specific pathological conditions.

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1.2 Definition

Simply defined, hallucal sesamoidopathy in this section refers to pathology affecting the sesamoids of the first metatarsophalangeal joint (MTPJ) specifically involving the tibial and fibular sesamoids and their articulation with the first metatarsal head.

1.3 Anatomy

First MTPJ anatomy should be well known to the foot surgeon and is of paramount importance especially as it applies to surgical procedures performed involving the hallucal sesamoids. It is important to appreciate that these bones are embedded in the tendon slips of flexor hallucis brevis which are bound together by the intersesamoidal ligament and the plantar plate. Like the lesser toe joint plantar plate, the hallucal sesamoid–plantar plate complex plays a significant role in anchoring the various static and dynamic stabilizers attaching to this region and is an integral part of the longitudinal and transverse tie-rod system previously described.[5] Static stabilizers include medial and lateral metatarsophalangeal joint (collateral) ligaments, medial and lateral sesamoidal ligaments (metatarsal [suspensory] and phalangeal components), joint capsule, plantar plate, intersesamoidal ligament, plantar fascial slips, and transverse intermetatarsal ligament.[6] Dynamic stabilizers include flexor hallucis longus (FHL) tendon, flexor hallucis brevis (FHB) tendon slips, abductor hallucis tendon, and oblique and transverse head of adductor hallucis tendon.[6] Having an appreciation of this anchor system allows the surgeon to make rational decisions when deciding on the various types of surgical procedures available related to sesamoidopathy.

Knowledge of the blood supply to the sesamoids is also crucial in making good decisions as it applies to choice of surgical incisions. Sesamoid arteries (one to three branches) arise from the plantar arteries of the hallux (proper plantar artery medially and first metatarsal artery laterally) which arise from either both the medial plantar artery and plantar arch (52% incidence), the plantar arch (24% incidence) or the medial plantar artery (24% incidence).[7]

1.4 Etiology/Pathomechanics

Sesamoidopathy can result from trauma (i.e., fracture, hyperextension or "turf-toe" type injuries, avascular necrosis), overuse (i.e., sesamoiditis), attrition (i.e., age-dependent "wear and tear") and/or iatrogenic (plantar plate disruption from triamcinolone injections) causes. Predisposing factors can be divided into mechanical (i.e., plantarflexed first metatarsal, shoe irritation from cleats) or systemic (i.e., rheumatoid disease) categories. The sesamoids are exposed to significant forces during

weight bearing (WB) and play a key role in providing static and dynamic stability to the first MTPJ. It has been estimated that 50–75% of WB forces are transmitted through the first MTPJ and these forces can account for up to three times body weight.[8] For these reasons, they are vulnerable to injury that can result in significant compromise in walking and running activities.

1.5 Clinical Evaluation

History, physical examination, differential diagnosis, and diagnostic testing comprise the clinical evaluation, the purpose of which is to establish an accurate diagnosis. A complete and thorough history provides the foundation for the remainder of the clinical examination. Any history relating to hyperextension of the first MTPJ should be scrutinized in detail. Predisposing factors should always be sought. Physical examination should be comprehensive, and if problem is unilateral, the contralateral side can be used for comparison. Exam should always include vascular, neurological, dermatological, and musculoskeletal (general and local) components. Musculoskeletal exam always considers static and dynamic evaluation as well as evaluation of hosiery and shoes. Inspection, joint range-of-motion (static and dynamic), muscle testing, systematic palpation, and provocative testing form the basis for examination. Upon completion of the examination, a broad differential diagnosis should be considered (Table 1.1). Depending on the differential diagnosis, appropriate diagnostic testing can be considered including diagnostic imaging, blood work, electrodiagnostic studies, gait analysis, Harris pressure mat testing, diagnostic injections, etc. Any clinical suspicions should be validated by some form of objective diagnostic testing if possible. From the aforementioned information, a "working diagnosis" can be confidently established and treatment options considered.

1.6 Diagnostic Imaging

Standard weight-bearing X-rays are ordered initially and include axial sesamoid views (Fig. 1.1). Bipartite sesamoids are common and generally have a larger overall configuration than unipartite sesamoids. Proximal migration of sesamoids indicates plantar plate or flexor hallucis brevis tear and is discussed in Chap. 2. Technicium bone scans are sometimes helpful to isolate sesamoid pathology from arthritidies such as gout, rheumatoid arthritis, etc. Increased uptake on the blood flow phase indicates acute fracture while uptake only on the delayed images is associated with sesamoiditis. Computed tomography (CT) scans are helpful to show cystic changes and isolate fractures; however, magnetic resonance imaging (MRI) is becoming more common, as 3 T machines with foot coil can show fractures and avascular necrosis (Fig. 1.2).

Table 1.1 Differential diagnosis

Intra-articular disorders	Chondral/osteochondral lesions
	Subchondral cysts
	Sesamoid displacement
	Plica
Congenital variations	Inherited disorders
	Absence
	Accessory sesamoid
	Symptomatic partism
	Coalition
	Size variations
Overuse	Avascular necrosis (see trauma)
	Sesamoiditis
	Chondromalacia
	FHL/FHB tendinitis
	Bursitis
Sesamoid trauma	Subluxation/dislocation
	Stress fracture
	Acute fracture
	Delayed/nonunion
	Avulsion fracture
	Diastasis
	Ligament/tendon rupture
	AVN dorsal capsular tear/strain (Sand Toe)
	Plantar capsular tear/strain (Turf Toe)
	Metatarsal or phalangeal fracture
	Subluxation/dislocation
Neurologic	Charcot neuroarthropathy
	Neuritis
Arthritis	Fibromyalgia
	Osteoarthritis
	Crystalline deposition disease
	Rheumatoid arthritis
	Seronegative arthritis
Infection	Osteomyelitis
Tumor	Bone
	Soft tissue
	Tumor-like conditions (i.e., Ganglion)
Dermatologic	IPK/callus/porokeratosis
	Epidermal inclusion cyst
	Ulceration
Iatrogenic	Hallux abductus (Valgus)
	Hallux adductus (Varus)
	Sesamoiditis S/P Lapidus procedure
Pain dysfunction syndromes	(i.e., CRPS)
Other	

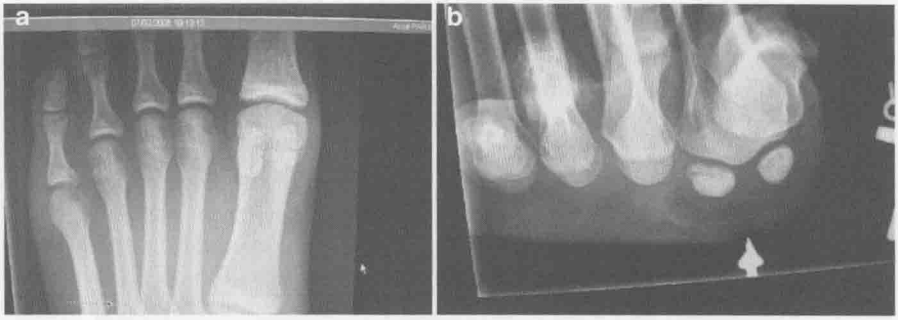

Fig. 1.1 (**a**) Weight-bearing AP X-ray of a patient with a symptomatic bipartite tibial sesamoid. (**b**) Axial sesamoid view depicting a fractured fibular sesamoid (Photo courtesy of Amol Saxena, DPM)

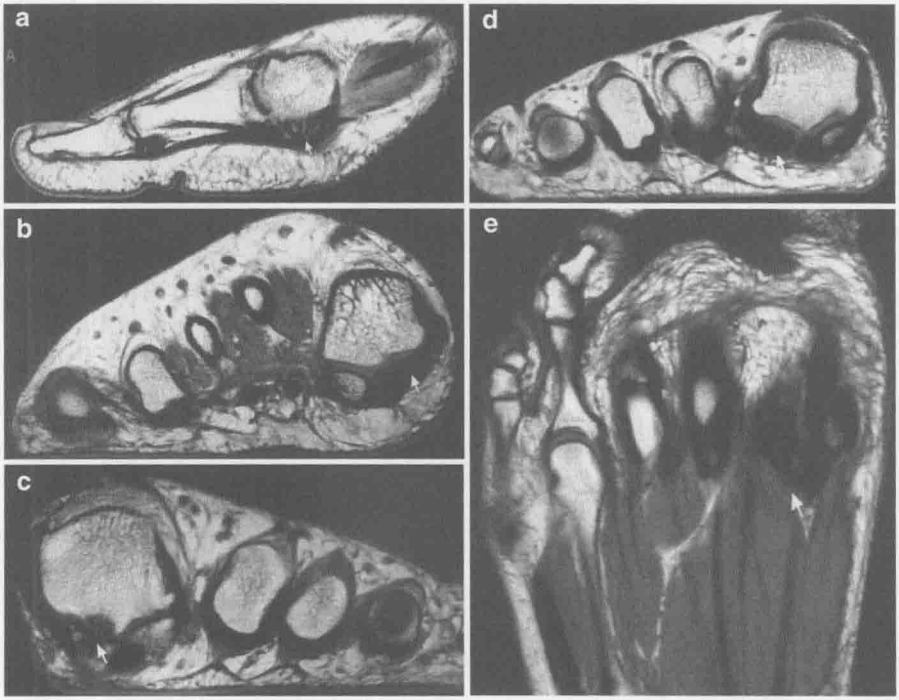

Fig. 1.2 (**a**) Sagittal T1 MRI image of a fractured tibial sesamoid. (**b**) Axial MRI view showing avascular necrosis (*AVN*) of tibial sesamoid. (**c**) Axial MRI of a patient with long-standing tibial sesamoidapathy revealing adjacent metatarsal degenerative disease. (**d**) Axial MRI showing fibular sesamoid fracture. (**e**) MRI showing AVN of fibular sesamoid (Photos courtesy of Amol Saxena, DPM)

1.7 Treatment

Appropriate and specific treatment is predicated on accurate diagnosis. Types of treatment can vary significantly and is pathology and patient-type (sedentary, active, athlete) dependent. As a rule, conservative (nonsurgical) treatment is attempted in most circumstances when there is a reasonable chance it will provide a predictable result. There are exceptions to this rule though, depending on the patient type. For example, high-level amateur or professional athletes may require more definitive and efficient treatment to allow an earlier return to activity. Thus, treatment plans will need to be individualized to each patient depending on their specific expectations and circumstances.

In the case of sesamoidopathy, conservative treatments are anecdotal and have not been studied carefully. For example, in the case of an acute sesamoid fracture, recommended treatments can vary significantly from immediate weight-bearing in an accommodative orthoses or short-leg walking (SLW or below-knee) boot to prolonged non-weight-bearing cast immobilization. Because of the significant difference in treatment approaches, it is not surprising to see a high rate of delayed and nonunions in this type of injury. This disparity in method of conservative treatment can apply to most pathologies that fit under the umbrella of hallucal sesamoidopathy. The author (RTB) has coined the term "sick sesamoid"[9] to apply to hallucal sesamoidopathy that is chronic in nature (>6 months), characterized by intractable pain and dysfunction, unresponsive to comprehensive conservative treatment, and pathology that has been validated by diagnostic testing. In this situation, further conservative treatment is usually futile and the patient can either live with their problem (which many patients do) or they can consider surgery. Many patients live with their problem because they are told by their health professional that sesamoid surgery does not work and the surgery will likely make them worse. This recommendation is commonly made by health professionals in general and is one of the myths that are propagated due to ignorance about this disorder.

1.8 Surgery

Surgery for hallucal sesamoidopathy can be successful and predictable even in athletic patients[10] but it must be approached in a rational manner. Generically, this surgery can be considered emergent (e.g., advanced grade traumatic dorsal first MTPJ dislocation) or elective (e.g., sesamoid planing for intractable plantar skin lesion). Fortunately, most of the cases involving hallucal sesamoids are elective cases. Patients who are considering surgery are not able to live with their problem due to severity, and conservative treatment has not been successful or is not practical based on their individual situation. There are many types of surgery to consider when attempting to address hallucal sesamoidopathy (Table 1.2) and though many

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Table 1.2 Surgical options

• Relocation
• Total-excision
• Hemi-excision
• Planing
• Fenestration/osteotomy
• Implant
• MTPJ fusion
• Lengthen PL
• Open reduction, internal fixation (ORIF)
• Percutaneous reduction, internal fixation (PRIF)
• Auto grafting

options are available, few have been universally accepted and recommended. Historically, surgical excision has been the mainstay but has been stigmatized by concern over postoperative complications including persistent pain, weakness, first MTPJ stiffness, and hallux deformity.[11-14] This author (RTB) feels that much of the problem with surgical excision has been related to two factors: poor incision choice and not preserving the flexor hallucis brevis tendon slips.[9,15] The blood supply (see sect. 1.3.2) is vulnerable to injury, and medial and plantar longitudinal central incisions have been recommended[7,9] that are safer. Preservation of the FHB tendon slips is paramount to avoid hallux deformity and weakness of the flexor apparatus.[16,17] Partial sesamoidectomies are preferred over total sesamoidectomies as the potential for postoperative weakness is greatly diminished.[16-18] When considering surgery, there are multiple preoperative concerns to consider including patient type, concurrent foot problems, and determining whether just one or both sesamoids are pathologically involved.

Patients can be classified as sedentary, active, and athletic. Expectations and demands of the athletic patient will be different (and many times more challenging) than the sedentary patient, and these issues need to be thoroughly discussed preoperatively. Concurrent problems need to be recognized and the effect of sesamoid surgery needs to be considered. For example, patients with hallux abducto valgus deformity that require a tibial sesamoidectomy may need to consider a prophylactic bunionectomy procedure to prevent worsening of the deformity. Likewise, patients who have a congenital hallux varus deformity with fibular sesamoid pathology could expect worsening of the deformity with isolated fibular sesamoidectomy alone. Finally, careful clinical evaluation with confirmatory diagnostic testing can determine if one or both sesamoids are pathologic. It has been generally recommended to avoid removing both sesamoids[2,10] though the author feels if both are pathologic, total sesamoidectomy of both sesamoids can be successfully performed if the flexor brevis tendon slips are preserved.[14]

In considering surgical approaches for sesamoidectomy, the ideal surgical approach would be to: provide visualization, protect vital structures, preserve FHB slips, and allow a "clean" excision. Based on these criteria, the author recommends

Fig. 1.3 Medial approach for isolated tibial sesamoidectomy

Fig. 1.4 Plantar-central approach for fibular sesamoidectomy and for both sesamoid removal/plantar plate and flexor repair

a medial approach to access the tibial sesamoid and a plantar longitudinal central incision for access to the lateral sesamoid[9] (Figs. 1.3 and 1.4). Specifically related to sesamoidectomy, if a partial tibial sesamoid excision is required, then a medial approach is recommended. For total tibial sesamoidectomy, a dorsomedial approach can be utilized if a concomitant bunionectomy is performed; otherwise, a medial or plantar-central incisional approach may be utilized. If a partial or total fibular or total tibial and fibular sesamoidectomy is to be performed, then a plantar longitudinal central approach is recommended. A plantar-central approach is recommended for a total tibial sesamoidectomy (without bunionectomy) because after the sesamoid is removed, a repair of the medial slip of the FHB to the intersesamoidal ligament is recommended (to prevent post-op lateral translation of the fibular sesamoid) and

Fig. 1.5 Several year post-op plantar incision in a triathlete with fibular sesamoidectomy (Photo courtesy of Amol Saxena, DPM)

may not be easily be performed through a medial incision. The plantar incision heals well if patients adhere to the recommendation of 3 weeks non-weight bearing post surgery (Fig. 1.5).

Newer and different sesamoid surgery techniques have been described[19,20] and though interesting more studies would be needed to rationalize their use. As an example, if a high-level athlete presents with an acute tibial sesamoid fracture, open or percutaneous reduction with internal fixation has been suggested[19] but would require a period of time NWB postoperatively followed by a period in a walking boot or cast and potential for another surgery to remove the fixation. The author has performed 3 partial tibial sesamoidectomies in the acute situation through a medial incision requiring 3 weeks NWB followed by 1–3 weeks in a SLW boot (Fig. 1.6). Partial sesamoidectomies result in minimal-to-no functional deficit as long as the FHB tendon slip is preserved, then this is a rational and viable choice allowing a predictable earlier return to sports activity for the athlete. Likewise, in the case of a chronic sesamoid nonunion, open curettement with bone grafting has been suggested[20] but partial sesamoidectomy is also another viable option that would likely be more predictable and would allow an earlier return to activities of daily living and sports activities. Further future studies will be needed to validate which surgical technique would be the best and most functional.

Fig. 1.6 (**a**, **b**) Pre- and (**c**) post-op partial tibial sesamoidectomy in a patient with a proximal avulsion (Photo courtesy of Amol Saxena, DPM)

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