Diagnosis & Treatment

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Review

Sesamoiditis of the metatarsophalangeal joint

S Atiya*, C Quah*, A Pillai*

Abstract

Introduction

Sesamoiditis of the Metatarsophalangeal joint is a broad term categorizing a range of pathologies that can be painful and disabling. The aim of this review was to discuss sesamoiditis of the metatarsophalangeal joint.

Conclusion

As its definition and categorization is inconsistent throughout the literature available, more clinical data and audits are needed to increase the existing pool of literature in establishing a universal definition. However, a high index of suspicion of sesamoiditis and MRI scan remains the key for diagnosis after any pathology arises in the MTP joint, as it is an easily missed condition.

Introduction

Pathology to the sesamoids and ligamentous structures of the first metatarsophalangeal (MTP) joint can be painful and disabling. They can result in a substantial loss of function, if not treated appropriately. Sesamoiditis is a broad term to categorize different pathologies affecting the sesamoids of the first MTP. Limited literature is available in the context of this disease and there seems to be different opinions in the categorization and definition of sesamoiditis. This article review seeks to define sesamoiditis and its aetiologies along with the different treatment options. It also discusses the anatomy and biomechanics of the hallucal sesamoids.

* Corresponding author
Emails: samiatiya@hotmail.com; colin.quah-2@student.manchester.ac.uk; aorthopod@yahoo.co.uk

Department of Orthopaedic Surgery, University Hospital South Manchester, UK

Discussion

History

Galen first described the sesamoids of the feet circa 180 AD. The name sesamoid is derived from the Greek word, *sesamoeides*, meaning resembling a sesame seed. In ancient Hebrew text, it was believed that the medial sesamoid was indestructible and would house the soul after death. However strong, the sesamoids are subjected to numerous pathologies[1].

Anatomy

Sesamoid is defined as a bone that is partially or totally embedded in a joint capsule or tendon. Anatomically, they act as a gliding mechanism that reduces friction and protects the tendon[2]. The most common sesamoid known would be the patella sesamoid; however, numerous other sesamoids are found in the hand and foot. The hallucal sesamoids are located centrally and plantar to the first metatarsal head, embedded in the first MTP joint capsule. There are two sesamoids present, known as the medial or lateral sesamoid of the great toe. Both are firmly attached to each other by a thick intersesamoid ligament[3]. However, in 13% of patients, a sesamoid bone may be found at the level of the great toe interphalangeal joint within the substance of the flexor hallucis longus tendon[4].

These bones, as their historical background implies, are semi-oval and resemble a seed-like structure with an average diameter of 10 mm. The medial sesamoid is larger and elongated, compared to the ovoid-shaped lateral sesamoid. The medial sesamoid is also the attachment site of the medial head of the flexor halluces brevis and abductor hallucis. The lateral sesamoid receives the attachment of the lateral head of the flexor hallucis brevis, and the oblique and transverse heads of the adductor halluces.

The primary blood supply of the sesamoids arises from the plantar arch (25%), medial plantar artery (25%), and sometimes both (50%). The sesamoids usually receive a single sesamoid artery supply; however, 2–3 arteries per sesamoid have been reported[5]. The sesamoids receive their blood supply from a proximal and plantar direction. However, distally, the vascular supply is minimal and has an important role in pathologic conditions such as osteonecrosis and non-union of the sesamoids. Understanding this is important to preserve the vascularity in the hallucal sesamoids during surgery[6].

Embryology

The sesamoid begins to present itself in the third month of foetal life[1]. They begin to ossify by the age of eight years in girls and 12 years in boys[7] beginning with lateral, followed by medial sesamoid. However, in 5%–30% of individuals, the hallucal sesamoids were not completely fused, forming a partition or multiple partitions termed bipartite or multipartite sesamoids, respectively[8]. This is an important feature in differentiating between a normal physiological finding and a fracture line, which may go untreated. The medial sesamoid is more frequently partitioned than the distal sesamoid. There is a 10% chance of incomplete fusion occurring in the medial sesamoid and 25% chance occurring bilaterally[10]. The lateral sesamoid is rarely bipartite. The process of incomplete ossification is thought to be due to increased weight-bearing trauma resulting in vascular injury

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before ossification[6]. Other authors have reported that there are multiple ossification centres as well that might contribute to incomplete fusion.

Biomechanics and function

The main function of the sesamoid is to absorb, disperse weight bearing and the impact from the metatarsal head, providing a cushioning effect, to protect the flexor hallucis longus tendon while also increasing the moment arm of the flexors, producing powerful flexion by increasing the distances between MTP and intrinsic muscles of the hallux. It acts as pulleys in gait push-off by joint flexion[10]. It also lifts the metatarsal head off the ground so that it will be slightly higher than the other metatarsals during standing and walking, receiving more weight as opposed to the other metatarsals[1]. The hallucal sesamoid complex transmits up 50% of the body weight and can transmit as much as 300% of the body weight during the push-off stage of gait[11]. The medial sesamoid is more vulnerable to injury as opposed to the lateral sesamoid due to its location and size under the first metatarsal.

Sesamoiditis: Introduction

Sesamoid disorders account for 9% of foot and ankle injuries. Etiology includes stress fracture (40%), acute fractures (10%), chondromalacia, synovitis, sesamoiditis (30%), osteochondritis (10%), arthritis (5%), and bursitis (5%). Depending on the definition and classification, sesamoiditis might make up half of all sesamoid pathology, because of a broad and loose classification system[12]. Definition of sesamoiditis is varied throughout literature with different pathologies that fall under its umbrella term depending on the literature. Boike et al. has defined sesamoiditis as, 'any painful inflammatory condition of the sesamoid bone devoid of radiographic changes typically caused by repetitive stress.' Others define it as, 'inflammation and swelling of the peritendinous structure of the sesamoid[13].' Sesamoiditis also includes tendinitis, synovitis, chondromalacia, and sesamoid bursitis[11]. Sesamoiditis has associated inflammatory changes of the surrounding tendon and soft tissue structures and can be considered equivalent to focal chronic tendonitis[14]. It is known to be associated with degeneration, or chrondromalacia of the sesamoid articular cartilage[16]. Chronic stress may cause painful conditions in the hallux sesamoids, associated with chondromalacia, osteochondritis, osteonecrosis, and stress fracture, which are part of the same pathological spectrum, share a common etiological factor, and present clinically with a painful syndrome which has been termed sesamoiditis[16], most commonly affecting young adults. Chronic repeated stress in athletes and dancers causes compressive forces between the sesamoid and the metatarsal head and is also contributed by repeated tensile forces from vigorous 'toe-off' activity resulting in sesamoditis[17]. Specific activities related to sesamoids such as local pressure from the cleat of a football shoe, excessive dorsal stretch stress associated with sprinters, and some documented findings of spotted appearance of the sesamoids in flamenco dancers[18]. Sesamoiditis has also become increasingly common because of the present enthusiasm for jogging and long distance marathon running among casual athletes. In inactive patients, there is depression of the first metatarsal head, which causes excess local weight bearing, which leads to soft-tissue swelling. It is the enlargement of normal thin-walled collapsed bursa found under the metatarsal head[4]. Anatomical pathologies such as asymmetry in size, rotational malalignment, and condylar malformation have also been found to cause sesamoiditis[19].

Clinical Presentation

Patients usually present with insidious onset of activity-related medial forefoot pain, which improves with rest. Pain is exaggerated upon dorsiflexion of MTP joint. Sesamoiditis can present as minimal focal swelling, tenderness confined over the plantar aspect of the first MTP joint, and pain on weigh bearing. Pain with direct palpation or passive distal push on the sesamoid apparatus, passive dorsiflexion of the hallux and crepitus along the distal FHL with oedema, bursa thickening, and inflammation plantar is also present. It can also present with ecchymosis over plantar aspect of the MTP joint[20]. Sesamoid pathology is varied and can be difficult to differentiate clinically from other forms of pathology at the level of the first MTP joint, making diagnosis difficult as it presents similarly in stress fracture syndrome or metatarsalgia. As sesamoiditis is a diagnosis of exclusion, other sesamoid pathologies must first be ruled out before the diagnosis can be confirmed.

Investigations

It is recommended to obtain a weight bearing antero-posterior, lateral, and axial radiographs in a patient with suspected stress fracture or sesamoiditis. The lateral oblique and medial oblique is useful in the imaging of the lateral and medial sesamoids, respectively. A special sesamoid view can be obtained as an oblique coronal radiograph in which the beam is directed tangential to the metatarsosesamoid articulation, which provides direct view of the joint[21]. Care must be taken to be able to differentiate between fracture lines and lines of incomplete ossifications in bipartite or multipartite sesamoids. Several suggestions have been made as to how to differentiate between these two features. Fractures tend to show a sharp, radiolucent, and uncorticated line often fit together well. The bipartite sesamoid has two corticated fragments, which do not fit, and are

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larger, more rounded, and smoother than a fracture line[22]. Technetium bone scans are helpful in diagnosing occult stress fractures of the sesamoids because plain films may be negative for the initial three weeks after injury. However, they have been shown to be sensitive, but non-specific as Chisin et al. have shown that 26% to 29% of asymptomatic patients showed increased uptake in the sesamoid region[23]. Radiographs are typically unremarkable in sesamoiditis, as most changes affect the soft tissue, and sesamoiditis is a diagnosis made by the exclusion and absence of radiographic changes. Contrasts enhanced MR imaging are used more often and can usually distinguish sesamoiditis from a vascular necrosis. Subtle T1 MR changes, significant enhancement, and adjacent reactive soft tissue changes are useful radiological criteria in sesamoiditis[24].

Treatment

Conservative

Non-operative treatment is usually the first line of treatment for sesamoiditis.

Rest, immobilization, ice compression, and elevation are essential at the early stages of presentation. Decreasing the weight bearing under the first metatarsal head, and stopping activities responsible for pain such as running or dancing are also important[18].

However, as sesamoiditis is due to repetitive stress, an important aspect of conservative management would be to correct the biomechanics of lift off by using orthotics. Offloading shoes and decreasing the height of the heels will decrease the weight bearing over metatarsal heads[28]. Numerous orthotics have been mentioned throughout the literature available and options may vary significantly from physician to physician. However, the principle remains the same as any gel inserts, pads, or orthotics that rely on distributing the weight and restricting the motion of the MTP would aid in decreasing inflammation of the joint[22]. Anti-inflammatory agents, such as NSAIDS, may offer some pain relief but it is only symptomatic treatment rather than cause. Injection of steroids can be considered, but must be kept to a minimal, along with ultrasonic irradiation to aid in pain relief[27]. In sports-specific sesamoiditis, such as football, removal of one of the cleats and screw post that is directly under the sesamoid bone will cause significant improvement alongside the use of orthotics. In sprinters, the dorsiflexion of the first MTP when a sprinter starts out at the block can cause irritation to the sesamoid. It is possible to stiffen the toe of the shoe with celastic to reduce the movement of the first MTP.

Operative

Prior to the mid-1980s, excision of the sesamoids was the primary surgical treatment for all sesamoid pathology. Many authors still recommended excision as the primary surgical intervention for sesamoid pathology, including sesamoiditis that is not relieved by orthotic management of at least six months duration[27]. In 1911, Muller[28] described the earliest reports of surgical removal that yielded relief of symptoms for sesamoid pathology. A year later, Speed recommended that if sesamoid excision was to be performed, 'both should be removed, for if one is left without its companion support it would soon become the source of irritation on account of its localized pressure[29].' However, according to Aper and colleagues, who looked at the effect on the moment arm of the flexor hallucis longus (FHL) and the flexor hallucis brevis, resection of both sesamoids significantly affected the moment arm of both tendons. Hemi-resection or partial excision did not appear to affect the joint mechanics[30]. Hence, surgical resection of both sesamoids can lead to alteration of joint mechanics, which in turn causes a cock up deformity of the hallux because of the loss of plantar restraints. Resection of both sesamoids is not recommended. Sesamoidectomy has shown to have significant morbidity. In a report by Mann and colleagues, in 21 patients, 13 underwent sesamoidectomy, 50% had continuous pain, 60% with plantar flexion weakness, 33% with loss of range of motion, and only 5% with altered hallux alignment[31]. However, based on a report by Brodsky, only 2 out of 23 patients had postoperative weakness of plantar-flexion[32]. Lee and colleagues reported 32 patients who underwent tibial sesamoidectomy, 90% returned to normal activities with no changes in the intermetatarsal or hallux valgus angle after this procedure. In addition, no altered plantar pressures were recorded in the region of the hallux MTP joint. Isokinetic measurements of ankle plantar flexion push off strength shows no significant side-to-side differences[33]. Pain relief following sesamoidectomy is often incomplete. In the 1930s, Inge and Ferguson found 41% of patients achieved complete pain relief, whereas Mann and colleagues reported 50% pain relief. Brodsky noted 6 out of 23 (26%) had mild to moderate pain following surgery. Despite the conflicting results of pain relief and function, sesamoidectomy still remains the main surgical option after conservative management has failed.

Complications

In single sesamoid excision, there is an increased incidence of hallux varus with fibular sesamoid removal, and hallux valgus deformity with removal of the tibial sesamoid[34]. Chronic pain and specific nerve injuries occur with different approaches. Plantar approach can result in lateral plantar nerve injury and neuroma formation. Medial approach – both intra- and extra-articular – puts medial plantar cutaneous nerve at risk. Digital nerves of the first intermetatarsal

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space can be injured with the dorsolateral approach to the fibular sesamoids. Curettage with grafting has been suggested to avoid these[12]. Two-thirds of either sesamoid can be removed without disturbing the ligamentous attachments. This may relieve pain while avoiding total sesamoidectomy[35].

Surgical approaches

Intra-articular medial approach

There is an advantage of visualizing and inspecting the MPJ 3–4 cm medial incision from the proximal flare of the metatarsal head to mid-shaft of the proximal phalanx. Be aware of medial plantar nerve. Capsulotomy is performed inferior to abductor hallucis. Plantar capsule consists of the retinaculum, and metatarso-sesamoid ligament can be incised to visualize the tibial sesamoid articular surface as well as the metatarsal head and proximal phalangeal base. Beaver blade is used to circumscribe the sesamoids in order to shell them out. Closure is done by using 2-0 absorbable sutures for plantar capsular repair and 3-0 absorbable sutures for approximation of the medial capsular incision[12,26].

Extra-articular medial approach

Useful for plantar shaving surgery, medial incision is made as previously described. Full thickness flap is made using a holding suture to elevate the flap off the under-surface of the tibial sesamoid protecting the FHL tendon. Approximately, 30%–50% of plantar surface is removed as planned using a saw, while rongeur or a rasp is used to recontour the remaining bone[12,26].

Dorsolateral approach

For fibular sesamoid excision, a 3-cm incision is made in the first intermetatarsal space dorsally. Dissection is similar to lateral intermetatarsal space release, in bunion surgery. The first structure encountered is the deep transverse intermetatarsal ligament (DTIL). After transecting, care should be taken in avoiding damage to the common digital nerve. The adductor hallucis tendon is removed from the proximal phalax, lateral aspect of the first MPJ capsule, and lateral fibular sesamoid. The tendon is tagged for replacement later.

Intersesamoidal ligament is incised to gain full access to the fibular sesamoid. Avoid damage to the FHL tendon. Excision is performed and the adductor tendon is reattached to the lateral capsule and a layered closure is performed as per surgeon's preference[12,26].

Plantar approach

To avoid painful plantar scar, incision is placed in the first intermetatarsal space, instead of directly beneath the metatarsal head and sesamoid. A curvilinear incision is made extending from the medial portion near the second digit back to the proximal extent of the metatarsal fat pad. After the incision, the lateral plantar digital nerve of the hallux should be identified and protected either just lateral to the sesamoid or over it. Metatarsal fat pad is retracted medially with the nerve and the fibular sesamoid is sharply excised from the adductor tendon and the FHB tendon. Layered closure is performed as per surgeon's preference[9].

Surgical techniques

Tibial sesamoidectomy

Average of 3-cm plantar medial incision is made. Medial branch of the plantar digital nerve is identified and retracted to avoid injury. Sesamoid is located by palpation and differentiated from the metatarsal head. Great toe is flexed 20–30 degrees and the FHL retracted, the intersesamoid ligament is incised, and the tibial sesamoid is pulled medially. The sesamoid is peeled out, by sharp dissection using a small-blade knife. Excision is accomplished by proximal release of the medial head of the flexor halluces brevis and its continuation distally to the base of the proximal phalanx of the hallux. The medial side of the capsule is closed with absorbable sutures and the skin is closed with non-absorbable sutures[9].

Fibular sesamoidectomy: dorsal incision

First intermetatarsal space is 2–3 cm proximal to the apex of the web space and is extended proximally by 5–7 cm. Deep peroneal nerve is identified and protected. The interval between the adductor hallucis longus and the joint capsule is opened. The tendon of the adductor hallucis longus is reflected from the lateral sesamoid, and the lateral capsule-sesamoid ligament is incised. The sesamoid is grasped firmly and displaced laterally and the intersesamoid ligament is severed. Fibular sesamoid is displaced rather laterally, released proximally and distally, and then removed. The depth of the wound should be inspected to ensure that the FHL tendon is intact and the neurovascular bundle to the first web has been preserved. The skin is closed with interrupted sutures[9].

Plantar removal for the fibular sesamoid

Fibular sesamoid can be removed through a plantar approach. With the ankle held in dorsiflexion, the hallux is flexed and extended to locate the sesamoid. Longitudinal incision is made, beginning 1 cm to 1.5 cm distal to the metatarsophalangeal joint and extending proximally 3.5 cm to 4.0 cm between the first and second metatarsals. Once the skin and septa within the forefoot pad have been separated, with blunt dissection the neurovascular bundle to the first web space is retracted laterally or medially. The sesamoids are palpated and the hallux is flexed and extended to locate the FHL tendon. The pulley over the FHL tendon is opened, and the tendon is retracted medially. This is made easier by holding the foot in dorsiflexion at the arch with one hand and flexing the

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MTP joint to relax the FHL tendon with the opposite hand. Intersesamoid ligament will come into view and should be divided completely. Move the scalpel 1 mm or 2 mm lateral or medial to find the groove between the sesamoids. The cleavage plane between the two sesamoids is incised while the FHL tendon is retracted medially and the neurovascular bundle is retracted laterally. The fibular sesamoid is grasped with a strong pick up or small Kocher clamp, and the lateral head insertion of the FHB muscle is removed from the proximal end of the sesamoid under direct vision. Once the medial and proximal restraints of the sesamoid have been released, the attachment of the adductor hallucis muscle to its lateral distal edge close to the bone is severed. The last attachment of the sesamoid is severed distally where the plantar plate continues its distal insertion to the proximal phalanx. Once the sesamoid has been removed, the wound is carefully inspected for bleeding. The cuff of residual tendon of the FHB as well as any intersesamoid ligament should be repaired with 2-0 absorbable sutures while holding the hallux in 15 to 20 degrees of plantar flexion. A Kirschner wire is passed obliquely across the first MTP joint. Care should be taken to evert the skin edges to minimize scarring[9].

Tibial sesamoid shaving

Alternative to sesamoid excision, a longitudinal plantar medial incision can be made if there is normal mobility of the first metatarsal. The medial branch of the plantar digital nerve is carefully retracted. The sesamoid is exposed and the MTP joint is flexed 10 to 20 degrees. The plantar fat pad is retracted and the plantar half of the tibial sesamoid is resected with a sagittal saw. Since the articular surface of the sesamoid is concave, gradual shaving of the sesamoid to desired thickness is recommended to avoid damaging the articular surface. The FHL tendon lies lateral to the tibial sesamoid, and should be protected. The sharp edges of the sesamoid are smoothed with a rongeur. Compressive forefoot post-operative dressing is used, and a rigid-sole shoe is worn for approximately two weeks. Weight bearing is allowed to tolerance with or without crutches, and the patient is allowed to wear a wide, deep shoe. Alternatively, a short-leg walking cast can be applied[9].

Conclusion

The hallucal sesamoid bones are subjected inflammatory pathologies that can be the cause of disabling pain among highly active patients such as athletes and dancers. As the definition and categorization of sesamoiditis is broad and inconsistent throughout literature, sesamoiditis might be an easily missed condition that can take valuable time away from athletes and dancers from training and rehearsal. A thorough history, physical exam, and most importantly MRI would be highly valuable to early diagnosis of sesamoiditis. However, conservative treatment must always be considered first, and operative treatment must always be reserved as a last resort. Since we lack consistent knowledge throughout the literature, this has room for improvements as more clinical data and audits should be carried out to increase the existing pool of resources.

Abbreviations list

DTIL, deep transverse intermetatarsal ligament; FHL, flexor hallucis longus; MTP, metatarsophalangeal

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