Hallux Sesamoiditis - Radiological Diagnostics and Conservative Management

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ABSTRACT:
Sesamoid bones play an essential role in first metatarsophalangeal (MTP) joint biomechanics, together with other articular surfaces, joint capsule, plantar fascia, ligaments and tendons. They are prone to different acute and chronic injuries, such as acute fracture, stress fractures, chondromalacia, avascular necrosis, bursitis degenerative changes, inflammation etc., all of which clinically manifest as a painful condition and are often diagnosed under a broad term called sesamoiditis. The mechanism of injury is most commonly associated with overuse of the anterior part of the sole of the foot accompanied by excessive dorsiflexion of the great toe. Sesamoiditis presents with pain and localized swelling in the projection of the tibial sesamoid bone, which is affected more frequently than the fibular one. Diagnostic radiology plays a key role in determination of etiology of the disease, as well as in planning of its treatment. Typical radiological examination includes weight-bearing dorsoplantar, lateral, oblique medial and oblique lateral radiographs of the foot, together with a direct axial radiograph of sesamoid bones. Computerized tomography is used for distinction of acute fractures and early stage of stress fractures from other pathological conditions. Magnetic resonance imaging allows differentiation between bony pathology and soft tissue conditions. Sesamoiditis management is primarily conservative and it depends on duration and severity of the condition. Orthotic insoles customized according to pedobarographic findings may be useful for solving biomechanical deformities that could have led to development of sesamoiditis. Specific pads placed under the first MTP joint in order to prevent the great toe from dorsiflexion proved to be a very effective conservative treatment option. Surgical treatment is considered if conservative methods fail to provide sufficient management of the condition.

KEYWORDS: sesamoid bones; hallux; sesamoiditis; diagnostic radiology; sesamoiditis treatment;

SAŽETAK:

KLJUČNE Riječi: sesamoidne kosti; nožni palac; sesamoiditis; radiološka dijagnostika; liječenje sesamoiditis;
**Introduction**

Sesamoid bones (ossa sesamoidea) were first described by Galen in the second century, who compared them with sesame seeds. Sesamoid bones are inserted into tendons of certain muscles, usually where the tendon is passing over a joint, such as in the first metatarsophalangeal and first metatarso-ophalangeal (MTP) joints. They can less often be found in areas of interphalangeal joints both in the foot and in the hand. Also, this type of bone can be found in the lower extremity, located in tendons of triceps surae muscle, tibialis posterior muscle and peroneus longus muscle. The largest sesamoid bone is the patella, inserted into the tendon of the quadriceps muscle. Sesamoid bones can also be embedded into joint capsules or be divided by a synovial bursa from the underlying bone, wherein both cases the articular surface of the sesamoid bone is covered by hyaline cartilage. They play an essential part in first MTP joint biomechanics, together with other articular surfaces, joint capsule, plantar fascia, ligaments and tendons. In this complex we find two sesamoid bones, tibial (medial) sesamoid bone embedded into the medial head of the flexor hallucis brevis muscle (FHB) and fibular (lateral) sesamoid bone embedded into the lateral head of FHB.

Both of these bones are located under the head of the first metatarsal bone, with the tibial sesamoid being placed distally in comparison to the fibular sesamoid. A crest is located on the plantar surface of the first metatarsal bone, dividing two sesamoid bones and forming two joints: medial and lateral metatarsosesamoid joints. Their function is to distribute and ease the pressure produced during gait that affects the head of the first metatarsal bone, to lower the friction on the flexor hallucis longus muscle which passes between these two bones, as well as to act as a fulcrum for FHB. Sesamoid bones of the great toe ossify at age of 8-9 in girls and at age of 11-13 in boys. During the ossification process the tibial sesamoid bone can be divided into two or more parts, thus forming a bipartite or multipartite bone. Studies show that a bipartite tibial sesamoid bone has an incidence of 10% - 30%, where in fibular sesamoid bone partition rarely occurs. In 25% of the cases bipartite tibial sesamoid bone is present bilaterally.

**Etiology**

As a part of the first MTP joint complex, sesamoid bones are prone to different acute and chronic injuries, such as acute fracture caused by trauma, stress fractures, chondromalacia, osteocartilaginous injury, avascular necrosis, osteochondritis, bursitis, degenerative changes, inflammation, developmental anomalies, all of which is clinically diagnosed under a broad term called sesamoiditis. The mechanism of injury is most commonly associated with overuse of the anterior part of the sole of the foot accompanied by excessive dorsiflexion of the great toe. This usually occurs in sports that involve running and jumping, especially in the initial phase of running and during sprinting. Moreover, ballet dancers often use “relevé” position of the sole of the foot, thus putting a great amount of load on the head of the first metatarsal bone. Furthermore, deformities such as pes cavus, conditions like a rigid sole of the foot and hard surfaces where different sports are played can facilitate development of sesamoiditis, often colloquially called turf toe in such cases. Injury of plantar structures of the first MTP joint in American football players were first described by Bowers and Martin in 1976. and Rodeo et al. reported that 45% of American football players have suffered from turf toe during their sports career.

**Clinical presentation**

Sesamoiditis presents with pain and localized swelling in the projection of the tibial sesamoid bone, which is affected more frequently than the fibular one. Pain can occur acutely after trauma, or it can develop chronically, in a subler way, which happens in most cases. Putting static load on the first MTP joint area and wearing certain rigid types of footwear intensifies the pain, while running could be impeded. In the later phase of the disease, pain can occur on the lateral part of the foot, as patient inverts his foot while walking to avoid putting pressure to the great toe. During dorsiflexion of the great toe sesamoid bones move distally, as well as the area painful to palpation on the affected great toe (Figure 1). Swelling is often overlooked, due to the presence of adipose tissue in this area. Passive movements in the first MTP joint can be painless. On the other hand, projection of the sesamoid bones is painful to palpation, as well as plantar flexion against resistance in the first MTP joint, thus being classical symptoms of sesamoiditis.

**Diagnosis**

Diagnostic radiology plays a key role in determination of etiology of the disease, as well as in planning of it's treatment. Typical radiological examination of sesamoid bones include weight-bearing radiographs of the feet in two planes. The main task of radiologist is to determine the etiology of the disease, as well as in planning of it's treatment. Typical radiological examination of sesamoid bones include weight-bearing radiographs of the feet in two planes. The main task of radiologist is to determine the etiology of the disease, as well as in planning of it's treatment.

**Figure 1.** The passive axial compression test (PACT). A) The sesamoid bones are under the first metatarsal head. B) Maximal dorsal flexion of the hallucus produces distal migration of the sesamoid. C) Applying compression proximal to the sesamoids stabilizes them in their most distal position. D) Test is positive if passive plantar flexion in the metatarsoophalangeal joint produces pain.
dorsoplantar, lateral, oblique medial and oblique lateral radiographs (dorsoplantar radiograph with the foot angled 40 degrees medially/laterally) of the foot, together with a direct axial radiograph of sesamoid bones. For the axial sesamoid projection patient’s foot is in maximal dorsiflexion with toes pulled back towards the patient, with the tangential X-ray being directed from the anterior part of the foot towards the posterior part, providing a profile image of sesamoid bones at the first MTP joint. Radiographs may show malposition, bi-/multi-partition of sesamoid bones, hallmarks of osteoarthritis of the first MTP joint, fractures, osteonecrosis, stress fractures, translation and proximal retraction of sesamoid bones, infection etc. Distinction of fracture from bipartite sesamoid bones could be done by taking radiographs of both foot, as the bipartite sesamoid bones often present bilaterally. Fractures of sesamoids typically present on radiographs as comminutive puzzle-like fragments, with displacement and sharp, irregular edges. Formation of callus in follow-up radiographs may confirm fracture diagnosis. Bipartite sesamoid bone is usually bigger than the undivided bone with smooth
and sclerotic edges of the divided fragments. (Figure 2) Osteonecrosis is characterized by radiolucency, bone sclerosis and fragmentation in the later stage of the disease. (Figure 3) If an infection is present, radiographs may show focal osteopenia, periostal reaction (periostitis), focal bone lysis or cortical loss etc.

Bone scintigraphy is not used regularly, but it may be helpful in sesamoiditis diagnostics. Still, in almost 30% of cases the radiotracer uptake is increased in the area on the plantar side of the head of first metatarsal bone, so results have to be interpreted with caution. (Figure 4) Computerized tomography (CT) is used for distinction of fractures and early stage of stress fractures of sesamoid bones from other pathological conditions. Technetium-99m methylene diphosphonate single-proton emission computed tomography (SPECT) combines sensitivity of the radionuclide study with the superior anatomical detail of CT, enabling better localization of pathological uptake and evaluation of associated structural changes. (Figure 5) Disadvantage of those diagnostic methods (CT and SPECT) is ionizing radiation.

Ultrasound examination may be useful for determination of soft tissue edema, which is often overlooked on a clinical examination. Examination may show irregularity of the bony surfaces as well as discontinuity in case of fragmentation or fracture.

Magnetic resonance imaging (MRI) allows differentiation between bony pathology and soft tissue conditions. Because of possibility of MRI to show small amount of bone marrow edema, it may detect early stage of stress reaction, before stress fracture is developed. Coronal plane on MRI, perpendicular to the long axis of metatarsal bones, proved to be most useful, with sagittal plane also providing valuable information, while axial plane showed to be of least importance in sesamoiditis diagnostics. T1 images highlight fat, and T2 images highlight edema. While taking T2 images it is helpful to use short inversion time interval which is used to suppress fat tissue and to improve visualization of bone edema. (Figure 6)

**TREATMENT**

Sesamoiditis management is primarily conservative and it depends on duration and severity of the condition. Treatment process is fairly complex because it is hard to avoid putting pressure on sesamoid bones during gait. In the initial phase of treatment, a cast or a lower leg orthosis is used in order to relieve pressure from the foot. In mild cases, it is possible to put a soft padding under the first MTP joint. Orthotic insoles customized according to pedobarography findings may be useful for solving biomechanical deformities that could have
led to development of sesamoiditis. (Figure 7) Specific pads placed under the first MTP joint in order to prevent the great toe from dorsiflexion proved to be a very effective conservative treatment option. Nonsteroidal anti-inflammatory drugs can be used for pain relief, while the use of corticosteroid injections showed relief of symptoms, but is discussable because of its side effects, especially when used repeatedly. Saxena A. et al. described positive effect of radial soundwaves for sesamoidopathy in athletes. Surgical treatment is considered if conservative methods fail to provide sufficient management of the condition. It should be considered with caution regarding the role that sesamoid bones play in the great toe biomechanics. Sesamoidectomy may be performed after failed conservative management of different pathological conditions, ie, non-union or stress fractures, osteonecrosis, chondral malacia, infections etc. Studies show that this operation proved to be satisfying with 94.4% of patients returning to sports, of which 90.0% returning to level of activity they had prior to acquiring sesamoiditis. However, overall complication rate was 22.5% and the revision rate was 3.0%, 36, 37, 38, 39. Nevertheless, in some cases surgery is inevitable. Nowadays, it is possible to perform minimally invasive surgery in terms of arthroscopic sesamoidectomy, using different portals for approaching to either tibial or fibular sesamoid bone.

**Conclusion**

As the modern technologies are evolving and thus providing the possibility to diagnose etiology of injuries and other conditions that affect sesamoid bones, it is becoming obsolete to use the clinical diagnosis of sesamoiditis. Nevertheless, most of this conditions are still treated in the same manner. Novel concepts of treatment provide good results, with most of patients being able to return to the previous level of activity they had before acquiring any of above mentioned conditions.

**Author contributions:**

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

**Literature:**

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