Disorders of the accessory bones and sesamoids of the foot and ankle

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Learning objectives

To review and understand disorders of the accessory bones and sesamoids of the foot and ankle.

Background

Sesamoids are found embedded in the tendons near many joints. The two largest sesamoids in the foot reside near the first metatarsophalangeal (MTP) joint. Injuries to these sesamoids comprise 12 percent of injuries to the great toe complex. Small sesamoids are occasionally seen elsewhere in the foot, most notably beneath the fifth MTP joint.

There are about 15 accessory bones in a foot and ankle. Most of them are asymptomatic; however, some are associated with foot and ankle pain.

Imaging findings OR Procedure details

1) Sesamoids

The hallucal sesamoids seat in the metatarsal grooves (Fig 1) and lie in the medial and lateral slips of the flexor hallucis brevis (Fig 2). The medial sesamoid is slightly larger than the lateral one.

The function of hallucal sesamoids is as follows:

a) To disperse impact forces

b) To elevate the 1st metatarsal head

c) To increase the mechanical advantage of the flexor hallucis brevis

Sesamoid disorders
Sesamoid disorders include separated (fragmented or bipartite) sesamoids, fractures, sesamoiditis, osteochondritis, avascular necrosis (AVN) and arthritis.

Medial sesamoid is separated without significant trauma. Jahss et al report a fragmented sesamoid is a kind of congenital anomalies and its frequency is about 8-33%.

The sesamoiditis is due to a separated sesamoid with osteosclerotic change and it is caused by overuse. It is often seen in young athletes. Soft tissue swelling over the involved sesamoid is usually present as well (Fig 3).

Acute trauma may cause sesamoid fracture. However, stress fracture of sesamoid is more common than that with acute trauma. Sesamoid fractures are usually transverse and involve the medial sesamoid (Fig 4).

Osteochondritis and AVN are associated with fragmentation and stress fractures, and sesamoiditis with trauma.

Arthritis may result from a progression of sesamoid disorder. It is characterized by erosion of articular cartilage and osteophytes.

Severe valgus deformity of 1\textsuperscript{st} toe includes dislocation of sesamoids. The insertion of the adductor hallucis into the base of the proximal phalanx and lateral sesamoid also contributes to the deviation of the proximal phalanx laterally, resulting in hallux valgus deformity.

2) Accessory bones

There are about 15 accessory bones in a foot and ankle (Fig 5,6). Most of them are asymptomatic; however, some are associated with foot and ankle pain.

The most common accessory bones are os trigonum (13%), os tibiale externum (accessory navicular) (10%) and os perineum (10%).

a) Os subtibiale and os subfibulare (Fig 7)

Os subtibiale and os subfibulare are analogous to a secondary ossification center. They are thought to represent an unfused epiphyseal ossification center.
The os subtibiale is uncommon accessory bone that occurs immediately distal to the medial malleolus; it is found in 0-9% of ankles. The os subtibiale is often round and may contain a dense central nucleus (Fig 8).

The os subfibulare is usually small and located at the tip of the lateral malleolus. Symptomatic os subfibulare is very rare. However, when local sign and symptoms of lateral malleolus may suggest a history of remote injury. It is important to rule out avulsion fracture (Fig 9).

b) Os trigonum

The os trigonum is one of the largest of the accessory ossicles and is located adjacent to the posterior margin of the talus (Fig 10). The os trigonum is triangular in shape, is slightly large (up to 15mm) in size and is more commonly bilateral than unilateral. The os trigonum is connected to the talus by a cartilaginous synchondrosis. Ossification of this process occurs between the ages of 7 and 13 years. Fusion usually occurs within a year of ossification forming Stieda's process. A separate ossicle remains in 7 to 14% of patients.

Os trigonum syndrome may be due to acute trauma or overuse. The syndrome includes process fracture, FHL tendinitis, and posterior tibiotalar impingement. Treatment of os trigonum syndrome is conservative in most case, but resection of the os trigonum in indicated when conservative measures fail (Fig 11).

c) Os talotibiale (Fig 10)

Os talotibiale is less common accessory bone. Tsuruta et al. reported that the os talotibiale was found in 16 of the 3460 feet (0.5%). The os talotibiale may be associated with anterior impingement syndrome.

d) Os tibiale externum (accessory navicular) (Fig 12)

Os tibiale externum is visualized in approximately 10 to 15% of children. It is situated adjacent to the medial and posterior margins of the navicular and is usually bilateral.

The ossicle is detected on radiograph in 9-11 years (girls up to 2 years earlier). Os tibiale externum lies within the Tibialis posterior tendon (TP) and is connected by the TP to the navicular. This relationship results in pain and flatfoot. Especially, a large os tibiale externum can elevate the TP from its normal insertion to the medial navicular, leading to rotation of the ossicle,
When symptoms persist, the ossicle can be excised and TP can be reattached to the navicular.

e) Os peroneum

Os peroneum is located within the peroneus longus tendon in the region of the cuboid tunnel (Fig 13,14). It is bilateral in approximately 30% of cases. The os peroneum fracture can occur after trauma and may be associated with a peroneus longus tendon tear. In addition, the os peroneum can lead to painful syndrome and undergo degenerative changes of the peroneus longus tendon and ankle (Fig 15).

Images for this section:
Fig. 1: Medial sesamoid shows osteosclerotic change suspicious for osteonecrosis caused by sesamoiditis (arrow).
Fig. 2: Anatomy of MTP joint at the level of sesamoids. The medial sesamoid is embedded in the tendons of the abductor hallucis (abh) and medial head of the flexor hallucis brevis (FHB). The lateral sesamoid embedded in the tendons of the lateral head of the FHB and transverse and oblique heads of the adductor hallucis (adh).
Fig. 3: Sesamoiditis with soft tissue swelling. The medial sesamoid shows low signal change suggestive of edema and osteosclerotic change on T1 weighted coronal image. Soft tissue swelling is visualized under the medial sesamoid.
Fig. 4: Medial sesamoid fracture. The medial sesamoid shows typical transverse fracture.
Fig. 5: Illustration of sesamoids
Fig. 6: Illustration of accessory bones, lateral view of foot and ankle.
Fig 6A, B Os subtibiale and os subfibulare

Fig. 7: Os subtibiale and os subfibulare Oval shaped bones consisted with os subtibiale and os subfibulare are visualized.
Fig. 8: CT and MRI of the Ankle Os subtibiale is visualized under the medial malleolus. Soft tissue swelling is noted around the os subtibiale. On MR of the Ankle (Proton density fat suppression coronal image), the os subtibiale and medial malleolus shows high signal intensity suspicious for conflicted bone marrow edema.
**Fig. 9:** CT and MR of the os subfibulare Os subfibulare is visualized under the fibula. On MR of the ankle (T1 weighted coronal image), the os fibulare shows no evidence of bone marrow edema suspicious for inflammatory change.
Fig. 10: Os trigonum and os talotibiale Radiograph of the ankle, lateral view shows rounded bones in the anterior aspect of tibia and behind the talus. Os talotibiale (arrow) and os trignum (arrowhead) are suspected. Soft tissue swelling is noted in front of the os talotibiale. On CT of ankle, os talotibiale (arrow) and os trignum(arrowhead) are visualized. Distal tibia shows spur formation with loose bodies suggestive of arthritis.
Fig. 11: Resection of the os trignum under arthroscopy. There is evidence of the os trignum on the right side. FHL is visualized adjacent to the os trignum (a). Resection of the os trignum and proliferated synovium is performed under the arthroscopy (b). Post-resection surgery (c).
**Fig. 12:** Os tibiale externum (Accessory navicular). On Radiograph of the foot, rounded bone suggestive of os tibiale externum is visualized in the medial and posterior aspect of navicular (arrow). On, MR of foot (T1 weighted axal image), the os tibiale externum shows low signal intensity consisted with bone marrow edema (arrow). Tibialis posterior tendon is attached to the os tibiale externum (arrowheads).
Fig. 13: Illustration of peroneus longus and brevis tendon.
Fig. 14: Normal anatomy of Peroneus longus and brevis tendon. The peroneus longus tendon courses behind the peroneus brevis tendon (arrowhead) at the level of the ankle joint, travels inferior to the peroneal tubercle, and turns sharply in a medial direction at cuboid bone (arrows). The peroneus brevis tendon inserts into the proximal aspect of 5th metatarsal bone. The peroneus longus tendon inserts into the lateral aspect of the plantar 1st metatarsal and medial cuneiform.
Fig. 15: Radiograph and MR of the foot Small rounded bone consisted with os perineum is visualized near the cuboid bone (arrow). On MR of foot (T2 weighted axial image), two small bones consisted with Os peroneum is visualized within peroneus longus tendon (arrow).
Conclusion

Sesamoids and accessory bones are commonly located within tendons of the foot and ankle. Although in the vast majority these "os" are normal variants of anatomy, they often result in tendoninosis, tendonitis or rupture, and may develop manifestations of arthritis by their location.

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