Accessory ossicles and sesamoid bones of the foot. Review of the anatomy and clinical relevance

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Learning objectives

- Know the anatomy of the foot and normal variants.
- Learn to differentiate accessory ossicles and bony avulsions or calcifications in clinical practice.

Background

Normal variants are commonly found in foot. Fig. 1, 2 and 3.

DEFINITIONS

- Accessory center of ossification: Variant center of ossification associated with a bone.
- Sesamoid: Ossicle arising within a tendon.

ACCESSORY CENTERS OF OSSIFICATION:

- **Os supranaviculare**, also called os talonaviculare dorsale or Pirie bone: dorsal, proximal margin of navicular.

- **Accessory navicular**, also called os tibiale externum: ossicle at median eminence of navicular. Fig 4-13.

Type 1: Sesamoid in tibialis posterior tendon.

Type 2: Accessory center of ossification joined to navicular by synchondrosis. Most frequent.

Type 3 (also called cornuate): Enlarged media eminence of navicular.

- **Os intercuneiform**: dorsal aspect foot, between 1st and 2nd cuneiforms

- **Cuboides secondarium** (secondary cuboid): Proximal medial aspect of cuboid, between cuboid and navicular.
- **Pars peronea metatarsalis primi**: Plantar aspect foot, between base 1st metatarsal and 1st cuneiform.

- **Os vesalianum**: Base 5th metatarsal.

- **Os intermetatarseum**: Dorsal, between 1st and 2nd metatarsals.

- **Os calcaneus secondarius**: Dorsal, adjacent to anterior process calcaneus.

- **Os trigonum**: Posterior region of talus, is present in 10% of the population.

In some circumstances is possible to develop the syndrome of os trigonum, that is caused by trauma or repeated stress (excessive subtalar pronation with talar adduction, plantar flexion) that occurs in the case of athletes and ballet dancers. Fig 26, 27 and 31.

In the case of fusion with talus is known like trigonal process or process of Stieda. Fig. 28, 29 and 30.

- **Os sustentaculi**, is a rare accessory ossicle located posterior sustentaculum tali, joined to calcaneus by a fibrocartilaginous tissue.

**SESAMOIDS**

- **Os peroneale** (also called os peroneum): Sesamoid within peroneus longus muscle, seen adjacent to lateral margin of cuboid. Fig 14-17.

- **Sesamoids of great toe.**

  - Medial (tibial) sesamoid: Beneath metatarsal head, within flexor digitorum brevis and abductor hallucis.

  - Lateral (fibular) sesamoid: Beneath metatarsal head, with flexor digitorum brevis and adductor hallucis. Fig. 18 and 19.

  - 30% bipartite or multipartite (may not be symmetric on contralateral foot)
- Interphalangeal sesamoid: At interphalangeal joint, within flexor hallucis longus tendon. Fig. 22

- **Sesamoids of 2nd -5th toes.**

- Variably present
- May be at metatarsophalangeal or interphalangeal joints.
- May have both medial and lateral sesamoids at 5th metatarsophalangeal joint. Fig. 20 and 21.

**MISCELLANEOUS NORMAL BONY VARIANTS.**

- Intermetatarsal joint of 1st and 2nd digits
- Articular facet between bases of 1st and 2nd metatarsals variably present.

- Position of 2nd tarsometatarsal joint
- Always proximal to 1st tarsometatarsal joint.
- May be proximal to or in same plane as 3rd metatarsal joint

- Failure of segmentation: middle and distal phalanges of 5th toe commonly fail to segment.

**MUSCLE VARIANTS**

- Quadratus plantae: May be absent
- Opponens digiti minimi: Variably present muscle slip of flexor digiti minimi
- Peroneus tertius: absent in 10% of population

**HOW TO DIFFERENTIATE BETWEEN FRACTURES AND ACCESSORY OSSICLES**

We use different image techniques like digital radiography, CT an MR to distinguish between accessory ossicles and fractures.
Fracture characteristics
- Jagged fracture plane.
- Acute angle at fracture margin.
- Nonsclerotic margin (if acute)
- Bone marrow edema on MR

Accessory ossicle/ bipartite ossicle characteristics
- Smooth, rounded margins
- Obtuse angle at margin between ossicles
- Surrounded by cortex
- Bone marrow edema sometimes present on MR if injured

- Accessory centers may be symptomatic, due to injury of synchondrosis between ossicle and parent bone. If symptomatic, edema will be seen on MR, centered on synchondrosis.

- Another important point to consider is that normal variants may not be bilaterally symmetric.

**SESAMOIDITIS**

Is an inflammatory condition of sesamoid bones caused for repetitive injury in the plantar aspect toe. Findings in MR reveal an edema in the bone marrow (intensity decrease on T1 and hyperintensity on T2). The affection of both sesamoid bones guide to diagnostic of sesamoiditis. Reactive changes in soft tissue include tendinitis, synovitis and bursitis. Differential diagnostic is necessary in the majority of cases. Fig 23, 24, 25, 38 and 39.

**TARSAL COALITION**

Congenital tarsal coalition is an entity that sometimes mislead to inappropriate conclusions in young people who refer pain in ankle and toe.

It represents the abnormal fusion between two or more bone tarsals and is a frequent cause of pain in ankle and toe. The two most common types are the calcaneonavicular and talocalcaneal coalition. There are other bone coalition combinations possible but they are very rare. The coalitions may be fibrous, osseous and cartilaginous.
Calcaneonavicular coalitions are easily detected by simple radiography in oblique projection while the rest of tarsal coalitions require studies of CT and MR, that give us detailed information. Fig 40-44

ANEXO

OS SUBPERONEAL AND OS SUBTIBIAL

Another accessory bones to consider are os subperoneal and os subtibial.

Fig 32-35.

Images for this section:

**Fig. 1:** Schematic drawing of accessory bones of foot. Plantar view.
Fig. 2: Schematic drawing of accessory bones of foot. Medial view.
Fig. 3: Schematic drawing of accessory bones of foot. Lateral view.
Fig. 4: Accessory navicular type 1.

Fig. 5: Accessory navicular type 1. Increased zoom.
Fig. 6: Accessory navicular type 2.

Fig. 7: Accessory navicular type 2. Increased zoom.
**Fig. 8:** Accessory navicular type 2.

**Fig. 9:** Accessory navicular type 2. Increased zoom.
Fig. 10: Accessory navicular type 2. Foot MR. Sagital T1.
**Fig. 11:** Accessory navicular type 2. Foot MR. Axial T1.

**Fig. 12:** Man 22 years old with pain in navicular bone. Accessory navicular type 2.
Fig. 13: Man 22 years old with pain in navicular bone. Accessory navicular type 2. Tridimensional reconstruction (3D)
Fig. 14: Os peroneale.

Fig. 15: Os peroneale. Increased zoom.
Fig. 16: Os peroneale.
Fig. 17: Os peroneale. Increased zoom.

Fig. 18: Medial sesamoid 1st toe bipartite.
Fig. 19: Lateral sesamoid 1st toe bipartite.
**Fig. 20:** Sesamoid of 5th toe.

**Fig. 21:** Sesamoid of 5th toe. Increased zoom.
Fig. 22: Interphalangeal sesamoid of great toe.
**Fig. 23:** Lateral sesamoiditis of great toe. Axial T2 FAT SAT view. Hyperintensity in T2 and hipointensity in T1 that means bone marrow edema.
**Fig. 24:** Lateral sesamoiditis of great toe. Coronal T2 FAT SAT view. Hyperintensity in T2 and hipointensity in T1 that means bone marrow edema.
**Fig. 25:** Lateral sesamoiditis of great toe. Coronal T1 view. Hyperintensity in T2 and hipointensity in T1 that means bone marrow edema.
Fig. 26: Os trigonum.
Fig. 27: Os trigonum. MR. Sagital T1 and Coronal T2 EG.
Fig. 28: Trigonal process.

Fig. 29: Trigonal process (arrows). MR foot. Sagital and axial T1. Addicionally there is an os subperoneal.
Fig. 30: Trigonal process (red circle) and os peroneal (yellow arrow)
Fig. 31: Os trigonum (yellow arrow) and sesamoid of 5th toe (green arrow).

Fig. 32: Os subtibial.

Fig. 33: Os subtibial. MR ankle. Sagital T1 and coronal T2 EG
**Fig. 34:** Os subperoneal.

**Fig. 35:** Os subperoneal. MR ankle. Sagital and axial T1
Fig. 36: Soleus accessory muscle of low insertion. Axial and sagital T1 views.
Fig. 37: Peroneus quartus tendon. MR ankle. Axial T1 views.
**Fig. 38:** Medial sesamoid bone of great toe bipartite and bone marrow edema. MR foot. Coronal STIR and T1 views.
**Fig. 39:** Medial sesamoid bone of great toe bipartite and bone marrow edema. MR foot. Axial STIR. The same patient showed in Fig. 38.
Fig. 40: Man 22 years. Fibro-osseous talocalcaneal coalition bilateral. Ankle CT. Coronal and sagital views.
**Fig. 41:** Man 22 years old. Fibro-osseous talocalcaneal coalition bilateral. Ankle CT. Axial view.
**Fig. 42:** Man 22 years old. Fibro-osseous talocalcaneal coalition. Left ankle MR. Coronal T1 and T2 EG views.
**Fig. 43:** Man 22 years old. Fibro-osseous talocalcaneal coalition. Left ankle MR. Sagital T1 and STIR views.
**Fig. 44:** Man 22 years old. Fibro-osseous talocalcaneal coalition. Left ankle MR. Coronal T1 and T2 FAT SAT views.
Imaging findings OR Procedure details

Digital radiography, MR, CT

Conclusion

- It is of interest of the radiologist recognize the sesamoid bones of the foot and accessory ossicles, as well as differentiate them of an avulsion fracture.

- Accessory ossicles can suffer bone microtraume, degenerative changes or other disorders that could lead to clinical entities, as in the case of the os trigonum, accessory navicular type II, the first toe sesamoiditis, among others.

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