Rare and common ossicles of the lower extremity: Imaging manifestations and clinical implications

Poster No.: C-1600
Congress: ECR 2013
Type: Educational Exhibit
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Keywords: Education and training, Education, MR, Digital radiography, CT, Musculoskeletal system, Extremities, Bones
DOI: 10.1594/ecr2013/C-1600

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Learning objectives

1. Review the imaging manifestations of common and uncommon accessory ossicles of the lower extremity
2. Discuss the pathophysiology which results in symptoms from these various ossicles
3. Discuss the clinical relevance of the various ossicles with regards to common symptomatic presentations and patient management

Background

- Accessory ossicles are generally considered to represent normal anatomic variants
- However, many times these ossicles may result in symptoms as a result of a variety of different syndromes or other causes
- In this educational exhibit we will review the common imaging findings and clinical relevance for a variety of ossicles of the lower extremity
- These include common entities such as the os acetabuli, fabella, os peroneum, os trigonum and os naviculare
- Rarer entities such as the meniscal ossicle, os intermetatarseum, os vesalianum pedis, os subfibulare, os subtibiale, os supratalar, os supranaviculare are also reviewed
- We will also discuss an exceedingly rare ossicle known as the cyamella

Imaging findings OR Procedure details

Os Acetabuli

- Originally thought of as an unfused ossification center at the acetabular rim
- However, it may represent an acetabular rim fracture secondary to cam type femoroacetabular impingement (FAI)
• It is thought that the aspheric portion of the head impinges on the acetabulum causing a stress fracture of the acetabulum

- However controversy regarding the true nature of an os acetabuli still exists

  • Martinez et. al. suggest that in a true os acetabuli the orientation of the cartilaginous growth plate is more parallel to the joint surface, whereas in patients with FAI the separation line was perpendicular to the joint surface

  • This indicates that there may be a morphological difference between what we consider an os acetabuli versus the acetabular rim fragment seen in patients with FAI

- Figures 1 through 3 demonstrate examples of os acetabuli

Fabella

- Small sesamoid bone within the lateral head of gastrocnemius muscle

- Present in 10-30% of individuals

- Can be bipartite or even tripartite in appearance

- May be difficult to differentiate from loose body or osteophyte in some cases

- Fabella Syndrome

  • Friction of the fabella on the posterolateral femoral condyle causing posterolateral knee pain

  • Typically treated with conservative measures although excision has been reported in refractory cases

- Relationship with posterolateral corner structures

  • Both the arcuate and fabellofibular ligaments are only present in 67% of patients

  • The fabellofibular ligament is present alone in 20% of cases

  • The arcuate ligament is present alone in 13% of cases

  • Presence or absence of fabella suggests the type of anatomy present:

1. Absent fabella suggests and absent fabellofibular ligament
2. Large fabella suggests an absent arcuate ligament

- Figures 4 through 6 demonstrate cases of fabella

**Os Peroneum**

- Accessory ossicle within the distal peroneal longus tendon near the cuboid
- One of the most common ossicles of the foot, seen in approximately 26% of cases
- Fracture may occur secondary to direct trauma or forceful dorsiflexion of the foot
- Fracture may be difficult to differentiate from the commonly visualized bipartite os peroneum

- Painful os peroneum syndrome (POPS)
  - Should be considered in the differential diagnosis for patients with lateral plantar foot pain
  - POPS is associated with a spectrum of pathologies:
  1. An acute os peroneum fracture or a diastasis of a os peroneum resulting in discontinuity of the peroneus longus tendon
  2. Chronic os peroneum fracture or diastasis of a multipartite os peroneum with callus formation, resulting in stenosing peroneus longus tenosynovitis
  3. Partial or complete rupture of the peroneus longus tendon proximal or distal to the os peroneum
  4. Presence of a large peroneal tubercle on the lateral aspect of the calcaneus entrapping the peroneus longus tendon
and/or os peroneum during tendon excursion

- Figures 7 and 8 demonstrate cases of os peroneum

**Os Trigonum**

- The os trigonum is a secondary ossification center at the posterior process of the talus

- Seen in 7-14% of patients and often bilateral

- Articulates with the lateral tubercle of the talus via a synchondrosis

- Posterior surface of the os trigonum is non-articular but is a site of attachment for the posterior talofibular and posterior talocalcaneal ligaments

- Associated with posterior ankle impingement and referred to as os trigonum syndrome

**Os Trigonum Syndrome**

- Secondary to microtrauma and chronic inflammation leading to disruption of the synchondrosis between the os trigonum and lateral tubercle of the talus

- MRI Findings
  1. Bone marrow edema located with the posterior talus, the posterolateral talar process, and/or os trigonum:
  
    A. Edema is thought to be the result of bone impaction, leading to bone contusions or occult fractures

  2. Fluid surrounding os trigonum

  3. Fluid within the synchondrosis

  4. Less specific findings include:
A. Isolated flexor hallucis longus tenosynovitis

B. Posterior ankle or subtalar synovitis

- Figures 9 and 10 show cases of trigonum

**Os Naviculare**

- Also known as an os tibiale externum

- Secondary ossification center at the navicular tuberosity

- Second most common ossicle in the foot after os trigonum

- 3 Types of os naviculare
  
  - Type 1: Round or oval shaped sesamoid bone embedded within the distal posterior tibial tendon
  
  - Type 2: Triangular or heart-shaped ossicle with a fibrous or cartilaginous synchondrosis with the navicular

1. Majority of the posterior tibial tendon inserts onto ossicle

2. Type 2a ossicle sits relatively more superior and is prone to increased tension forces

3. Type 2b ossicle sits more inferiorly and is prone to shearing forces

  - Type 3: Prominent tubercular process fully incorporated without a synchondrosis

1. Also known as a cornuate navicular

- Os naviculare syndrome
• Type 2 os is most commonly symptomatic leading to inflammatory changes within the navicular, synchondrosis and/or ossicle

• In valgus injury the ossicle may fracture across its base or synchondrosis resulting in displacement of the posterior tibial tendon and resultant flatfoot deformity

• Often times conservative treatment is attempted. However, in refractory cases resection of the ossicle and tendon reinsertion may be necessary

- Figures 11 through 16 demonstrate cases of os naviculare

Meniscal Ossicle

- As the name suggests, the meniscal ossicle is exactly that, an intrameniscal ossification

- Etiology of this ossicle is still debated with three primary theories
  • It may represent a normal anatomic variant as it is seen as a normal finding in animals such as rodents, cats, and dogs
  • It may be post-traumatic in nature, resulting in heterotopic ossification
  • Lastly, it is thought that mucoid degeneration may lead to a focus of intrameniscal ossification

- Histologically it demonstrates cancellous bone with fatty bone marrow surrounded by cortex and covered by hyaline cartilage

- It is typically seen in the posterior horn with a greater incidence in the medial meniscus

- Differential diagnostic considerations on radiographs include:
  • Osteochondral loose bodies
  • Calcium pyrophosphate deposition disease (associated with chondrocalcinosis)
  • Osteophyte
  • Synovial osteochondromatosis
- The above described differential diagnoses are easily excluded by MRI which demonstrates typical characteristics of a meniscal ossicle as evidenced by:
  - Its intrameniscal location
  - Marrow signal intensity on all sequences
  - Surrounding rim of low signal intensity corresponding to cortex

- Clinical relevance
  - Commonly asymptomatic
  - When symptomatic patients present with most commonly present with pain, less commonly a sensation of locking
  - MRI diagnosis of this ossicle is important so as to preclude unnecessary arthroscopy
  - Like many ossicles, conservative measures are first attempted. If these measures fail, resection of the symptomatic ossicle may be performed

- Figures 17 and 18 demonstrate a case of meniscal ossicle

**Os Intermetatarseum**

- Accessory ossicle usually found superiorly between the bases of the first and second metatarsal bones

- Occurs in a variety of shapes and sizes appearing as a round, oval, kidney-shaped or linear ossicle.

- It may even present as a rudimentary metatarsal

- Painful os intermetatarseum
  - Neuropathy of the medial branch deep peroneal nerve secondary compression by this os
  - Associated with dorsal midfoot pain and paresthesias and numbness along the first intermetatarsal web space extending to the hallux and second metatarsal
- Surgical excision has been shown to relieve symptoms

- Figure 19 demonstrates a case of an os intermetatarsale

**Os Vesalianum Pedis**

- Accessory bone located within the distal peroneal brevis tendon, near the base of the fifth metatarsal

- Uncommon ossicle, seen in approximately 0.5% of the population

- Typically asymptomatic although it has been reported to cause pain in the forefoot

- Differential Diagnostic Considerations
  - Normal ossification center at the fifth metatarsal tuberosity
    1. This entity is parallel to the metatarsal shaft rather than obliquely as in the os vesalianum pedis
  - Avulsion fracture of the apophysis of the fifth metatarsal
    1. This entity is transverse to the metatarsal shaft rather than obliquely as in the os vesalianum pedis
    2. Associated with inversion injuries and sprains and may be easily overlooked
      - Iselin’s Disease
        1. Traction apophysitis at the base of the fifth metatarsal
        2. Normal apophysis will be noted on radiographs helping to differentiate from os vesalianum pedis
    3. Rare entity, with only a few cases reported in the literature
4. History and clinical symptoms are helpful in differentiating from other causes such as Jones or stress fracture

5. Focal tenderness at base of fifth metatarsal worse with activity with relief at rest

6. History of trauma is usually absent

- **Figure 20 demonstrates a case of os vesalianum pedis**

**Os Subfibulare**

- Ossification either submalleolar in location or between the lateral malleolus and talus

- Etiology is debated as with many ossicles
  - Is it an unfused ossification center?
  - Is it a supernumery ossicle?
  - Is it a healed posttraumatic deformity?

- An article in Journal of Bone and Joint Surgery suggests that the os subfibulare is indeed a non-united avulsion fracture of the anterior talofibular ligament (ATFL)

- Four patients with ankle instability and an os subfibulare were explored intraoperatively. Operative findings confirmed this os to represent an avulsion fracture related to the ATFL

- **Figure 21 demonstrates a case of os subfibulare**

**Os Subtibiale**

- Accessory ossification center resulting from failure of fusion of a separate ossification center of the medial malleolus in childhood

- Appears to be quite rare with very little information in the current literature
- Prevalence is estimated at approximately 0.9%

- Has been shown to be rarely symptomatic, likely a result of mechanical irritation

- Os subtibiale versus acute avulsion fracture:
  - Os subtibiale margins are smooth as opposed to an acute avulsion fracture where borders are irregular
  - Os subtibiale tends to be bilateral. Obtaining contralateral ankle radiographs may be helpful
  - Os subtibiale will generally present without any appreciable defect of the medial malleolus as would be seen with an avulsion fracture

- **Figure 22 demonstrates a case of os subtibiale**

**Os Supratalare**

- Accessory ossicle located at the superior aspect of the talar beak

- As with other ossicles, this os demonstrates smooth borders

- Relatively rare, with a reported prevalence of 0.9%

- **Figures 23 and 24 demonstrates two cases of os supratalare**

**Os Supranaviculare**

- Also known as a talonavicular ossicle or Pirie's bone

- It is an ossicle at the dorsum of the talonavicular joint

- Like other ossicles described previously, this ossicle is relatively rare, with a reported prevalence of 1%
- Rarely symptomatic for which surgical resection has been shown to relieve symptoms.

- Os supranaviculare versus navicular avulsion fracture
  - Avulsion fracture is due to injury to the talonavicular capsule
  - Fracture is most commonly seen in middle aged women, in particular those who wear high heeled shoes
  - Avulsion fracture usually presents as a small flake of bone as opposed to the os which appears well corticated with smooth borders
  - Clinical circumstances are also key in helping differentiate acute avulsion versus an os

- Os Supranaviculare association with navicular stress fractures
  - Pavlov et al. reported a series of 23 navicular stress fractures, of which 22% demonstrated an os supranaviculare
  - Proposed etiology for this association:
    1. There is typically a cortical depression along the dorsum of the navicular with an os supranaviculare
    2. From a biomechanical standpoint this is thought to increase stress along the dorsum of the navicular
    3. Due to this increased stress, an insult to this region which would not normally progress has an increased chance of progressing to stress fracture

- Figure 25 demonstrates two cases of os supranaviculare

Cyamella

- Also known as a popliteal fabella or fabella distalis
- It is a sesamoid bone of the popliteus tendon which is extremely common in primates but exceedingly rare in humans

- Has been reported in the literature as a cause of posterolateral knee pain, swelling and locking

- There are very few case reports of symptomatic cyamella in the literature. However, it appears that all cases were treated conservatively with relief of symptoms

- Differential Diagnostic Considerations
  
  • Loose body
  1. Tend to occur intraarticular rather than in the periphery of the joint

  2. Have different signal features on MRI than sesamoid bones in many cases
    • Fabella
    1. Overlies the lateral femoral condyle on frontal radiographs as opposed to the cyamella which is seen in the popliteal notch of the lateral femoral condyle on frontal radiographs

    2. Is clearly differentiated from a cyamella on MRI by showing its location within the lateral head of the gastrocnemius tendon
      • Heterotopic ossification
        1. Typically related to history of prior trauma or surgery

        2. Early stages show irregular borders and inflammatory changes of adjacent soft tissues
3. Late stages show an ossific appearance with evidence of marrow. However the borders still tend to be irregular and larger than would be expected with a cyamella
   - Bone forming soft tissue malignancy
1. Unlikely to present with normal marrow/cortex or adjacent soft tissues

- Figures 26 and 27 demonstrate a case of a cyamella

Images for this section:

![Os Acetabuli](image)

Frontal radiograph of the pelvis demonstrates subtle round ossific densities adjacent to the lateral acetabuli consistent with os acetabuli.

Fig. 1
Frontal radiograph of the right hip in a different patient demonstrates a larger oval shaped ossified body adjacent to the lateral acetabulum also consistent with an os acetabuli.

Fig. 2
Coronal T1 image of the right hip of the same patient confirms a well corticated ossification adjacent to the acetabulum consistent with an os acetabuli.
Lateral and frontal radiographs demonstrate a well corticated ossification along the posterolateral soft tissues of the knee, characteristic of a fabella. Even on radiographs, the soft tissue shadow of the lateral head of the gastrocnemius muscle can be detected.

Fig. 4

Sagittal and axial CT images of a different patient demonstrate a well corticated ossicle within the lateral head of the gastrocnemius muscle compatible with a fabella.

Fig. 5
**Meniscal Ossicle**

Coronal T1 and Sagittal proton density images confirm a well corticated ossified structure within the posterior horn of the medial meniscus. Notice how inapparent this meniscal ossicle becomes on the sagittal T2 weighted image on the right. This is due to the fact that the fatty marrow within the ossicle is suppressed on this fat saturated sequence.

**Os Intermetatarsaeum**

Frontal radiographs of the foot demonstrate a well corticated ossification at the proximal aspect of the first intermetatarsal space. The location of this ossicle is characteristic of an os intermetatarsaeum.
Os Vesalianum Pedis

Frontal and oblique radiographs of the foot demonstrate an ossification adjacent to the base of the fifth metatarsal.

The typical oblique orientation of this ossicle is consistent with an os vesalianum pedis.
Oblique and frontal radiographs of a patient demonstrate a well corticated ossification adjacent to the lateral malleolus. This is consistent with an os subfibulare. As discussed previously, the etiology of this ossicle is unclear and this finding may be posttraumatic in etiology.

Fig. 21
Os Subtibiale

Oblique and frontal radiographs from two different patients demonstrate well corticated ossifications adjacent to the tip of the medial malleolus. The smooth margins and lack of any bony defect at the medial malleolus indicate os subtibiale rather than an avulsion fracture.

Fig. 22

Os Supratalare

Lateral radiograph of the ankle demonstrates a well corticated ossification dorsal to the head of the talus. The smooth borders and lack of bony abnormality of the talus are most consistent with an os supratalare.
Sagittal T1 weighted image of the ankle in a different patient demonstrates a large well corticated ossification dorsal to the head of the talus. This patient had no reported history of recent or remote trauma and therefore this finding was felt to most likely represent an os supratalare rather than a posttraumatic deformity.
Lateral radiographs of the ankle in two patients demonstrate well corticated ossifications dorsal to the navicular bone. While this could represent a remote avulsion fracture, a fracture in this region is typically due to a capsular injury and would result in a linear fleck of bone rather than a large round or triangular ossification.

Fig. 25
Frontal radiograph shows a well corticated ossified structure adjacent to the lateral femoral condyle which could represent a fabella or intra-articular body. Orange arrow demonstrates the expected location of a fabella on lateral radiographs, absent in this case. This entity turned out to represent the rare cyamella.
Meniscal Ossicle

Frontal radiograph demonstrates a subtle well corticated osseous structure in the region of the intercondylar notch.
Lateral radiograph better demonstrates an oval shaped ossified body in the expected location of the posterior horn of the medial meniscus. Note the incidental fabella.

Fig. 17

Os Naviculare

T1 sagittal, T2 fat saturated sagittal, and T2 fat saturated axial images of the foot in a different patient demonstrate a type 2 os naviculare. Notice the marrow edema within the os as well as the navicular bone at the level of the synchondrosis. This is consistent with os naviculare syndrome.

Fig. 16
Os Naviculare

T1 axial, T2 fat saturated axial and sagittal T1 images demonstrate an ossification within the posterior tibial tendon consistent with a type 2 os naviculare. There is mild marrow edema within the os suggesting early changes of os naviculare syndrome.

Fig. 15

Fabella

Axial T2 fat saturated, Coronal T1 and sagittal proton density images demonstrate an ossicle within the lateral head of a gastrocnemius muscle consistent with a fabella.

Fig. 6
Os Peroneum

Multiple oblique foot radiographs from three different patients demonstrate well corticated ossific densities adjacent to the cuboid bone. The characteristic appearance and location of these ossicles are consistent with os peroneum.

Fig. 7

Os Peroneum

T1 axial, T2 fat saturated sagittal and T1 coronal sequences demonstrate an ossification within the peroneal longus tendon compatible with an os peroneum.

Fig. 8
Fig. 9

Lateral radiographs of a patient demonstrate a well corticated ossification posterior to the talus consistent with an os trigonum. Sometimes it can be difficult to distinguish this entity from a prominent posterior process of the talus if no clear separation is seen at the synchondrosis.

Fig. 10

Lateral radiographs of two different patients demonstrates similar findings of well corticated ossifications posterior to the talus consistent with os trigonum.
Os Naviculare

Frontal radiograph of the foot demonstrates an ossification within the medial midfoot, with suggestion of a synchondrosis between it and the adjacent navicular bone. Findings are compatible with a type 2 os naviculare.

Fig. 11

Os Naviculare

Sagittal and axial CT images of the foot in a different patient demonstrate a similar appearing ossicle within the posterior tibial tendon indicating an os naviculare.
**Fig. 12**

*Os Naviculare*

Axial, sagittal and coronal T1 images of the foot again demonstrate a type 2 os naviculare within the posterior tibial tendon.

**Fig. 13**

*Os Naviculare*

T1 axial image of the same patient more proximally demonstrates thickening and increased signal within the posterior tibial tendon consistent with tendinopathy which is not uncommon in patients with os naviculare.
MRI confirms a well corticated ossicle within the popliteus tendon compatible with a cyamella. Notice that the cyamella follows marrow signal on the proton density and short tau inversion recovery images confirming its ossified nature.
Conclusion

1. Accessory ossicles are often thought of as asymptomatic normal variants

2. However, as we have learned in this presentation, there are clinical implications for many of these ossicles

3. The radiologist should be aware of their existence and common imaging presentations

4. The possibility of ossicle related pathology as a cause for a patient's symptoms should be considered in the appropriate clinical setting

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