Beaks and peaks in adult skeleton, Part II: Bony excrescences in lower extremity

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ABSTRACT

Bony protuberances are frequently seen in imaging of the adult skeleton. Congenital or acquired, some of these bony excrescences can be clues to the underlying disorder in the appropriate clinical context. It is important to know their imaging findings and typical location in order to establish an accurate diagnosis and have a grasp on their clinical significance. The first part of this review series covered the upper extremity and skull base. In this second part, we briefly describe common and clinically important bony excrescences in the lower extremity.

KEY WORDS
Deformity; Exostoses; Lower extremity; MR imaging; Radiography; Excrescences/osseous

Introduction
Bony protuberances in the adult skeleton may arise due to various reasons, including osteophyte and enthesophyte formations in chronic traction injuries, degenerative and inflammatory disorders, acquired or developmental abnormalities of the bone and congenital variations. The exact aetiology of these bony “bumps” is often not known.

When present, the most common symptom associated with such lesions is pain, which may arise secondary to friction and compressions of the adjacent tissues, bursa formation and internal derangement or inflammation of the joints if they have a juxta-articular location. Most of these lesions have characteristic imaging findings at typical anatomic sites, which may be an important clue to the underlying disorder.
In the first part of this review series, (Akkaya Z, Çoruh AG, Şahin G. Beaks and peaks in adult skeleton, Part I: Bony excrescences in skull base and upper extremity. Hell J Radiol 2020; 5(1): 28-37) we covered some common and some infrequent bony excrescences which may be clinically significant in the skull base and the upper extremity. The purpose of this second part is to overview bony excrescences and their associated clinical conditions in the lower extremity and pelvic bones.

1. Pelvis and hip joint

1.1. Hip joint

Femoroacetabular impingement results from abnormal contact between femur and acetabulum and is associated with pain and early degenerative changes in the hip joint. A recent consensus panel has defined this syndrome as “a motion-related clinical disorder of the hip with a triad of symptoms, clinical signs and imaging findings” [1-3].

The two intraarticular types of femoroacetabular impingement are “cam” and “pincer” types and in many patients a combination of the two may be observed. The “bump” at the anterolateral femoral head-neck junction, which is also called the “cam” or “pistol-grip” deformity, is observed as a bony outpouching of the femoral head, with the epiphyseal scar extending caudally and laterally into the femoral neck region (Fig. 1) [2, 3]. This bony protuberance at the femoral head-neck junction is reported in asymptomatic healthy individuals with high prevalence [4]. Thus it is recommended that, when present, it should be addressed as “cam morphology”, to emphasise the fact that in the absence of relevant clinical findings, this morphologic feature alone does not constitute a diagnosis [1, 4].

1.2. Pelvis

Additional abnormal bony protuberances can be associated with hip impingement syndromes. Extraarticular impingement syndromes of the hip are the second most common cause for failed hip-preserving surgery requiring revision, following inadequate “cam” or “pincer” osteotomy [5]. Subspine impingement, one of the extraarticular forms, can clinically mimic femoroacetabular impingement, thus rendering imaging particularly important for accurate diagnosis [6-9].

An abnormally prominent anterior inferior iliac spine (AIIS) may cause bony impingement due to abnormal contact with the femoral head or neck, during flexion, adduction and internal rotation of the hip, at a more distal location than the point of contact in cam or pincer femoroacetabular impingements [10]. This type of extraarticular hip impingement is called “subspine impingement”.

Morphology of the AIIS has been shown to be significant in subspine impingement, where a prominent AIIS is associated with the highest risk [7].

Patients presenting with subspine impingement often report a previous avulsive trauma at the AIIS or affecting the rectus femoris muscle in their adolescence, possibly leading to progressive hypertrophic changes in the AIIS, resulting in an acquired prominent AIIS morphology (Fig. 2) [11-13]. This type of impingement and prominent AIIS morphology is especially common in football players [14]. AIIS may also be a site of enthesopathy in axial spondyloarthropathies, particularly juvenile spondyloarthropathy which may show the same clinical and imaging findings [15].

2. Knee

2.1. Distal femur and proximal tibia

2.1.1. Osteophytes

Although knee joint is one of the most commonly in-
involved joints in osteoarthritis, it is beyond the scope of this article to review all aspects of the disease. However, given the high prevalence of knee involvement in osteoarthritis, the osteophytes at the knee joint are worth a brief caption here (Fig. 3). They are frequently seen in patients over the age of 60 and most frequently in the medial compartment. Although they are the hallmarks of osteoarthritis, it should be noted that about 40% of the population with knee joint osteophytes are asymptomatic. Furthermore, progression of osteoarthritis is not affected by the size of osteophytes but, besides other factors, it is associated with malalignment of the knee joint [16-18].

2.1.2. Exostoses
Exostoses are the most frequent benign bony tumour-like
excrescences in long bones. In 4% of cases, solitary osteochondromas are seen around the knee joint [19-21]. Unless part of hereditary multiple exostoses syndrome (Fig. 4a), which is also known as diaphyseal aclasia, osteochondromas are usually solitary [20].

Solitary exostoses of the pes anserinus tendon attachment site, also called pes anserine spurs, differ from typical osteochondromas as they do not have a cartilage cap (Fig. 4). Due to their shape they have been referred to as “cloth hook exostosis” [22] with an “icicle” appearance in radiographs [23]. Thus, some researchers recommend the use of the name “pes anserine bony spurs” instead of osteochondromas for these lesions. Surgical resection is often limited to patients with pain despite the conservative measures [24].

2.1.3. Healed Segond fracture

Another bony bump that can be observed in the proximal tibia is the small osseous protuberance at its lateral aspect that develops as a result of a healed "Segond" fracture [25]. The relationship between the anterior cruciate ligament, meniscal tears and Segond fracture -the small avulsion fracture at the lateral capsular attachment site of proximal tibia- is well established in the literature [26-28]. However, when this fracture heals, a bony protuberance with a characteristic appearance (Fig. 5) can be observed on imaging studies. A healed Segond fracture may rarely mimic an osteophyte or an osteochondroma. However, direct relation to the articular surface of the tibia approximately 3-6 mm to the lateral tibial plateau and the parallel orientation to the joint, unlike an osteochondroma, are useful hints in recognising this bony bump [25].

A “reverse Segond” fracture, which represents avulsive injury of the deep capsular component of the medial collateral ligament, can be considered as a subtle bony fragment detached from the medial tibial condyle. This injury, like the Segond fracture, is associated with more severe soft tissue damage, particularly disruption of posterior cruciate ligament and medial meniscal tear. Similar to a healed Segond fracture, a healed reverse Segond fracture may potentially result in a bony bump at the edge of proximal medial tibial condyle [29].

2.1.4 Pellegrini-Stieada lesion

"Pellegrini-Stieada" lesion represents a post-traumatic
Ossification/calcification near the medial femoral condyle, secondary to injury of the medial collateral ligament or the tendon of the adductor magnus muscle (Fig. 5c). This lesion is typically seen 3-4 weeks after knee trauma in patients of 25-40 years of age and more commonly in males. If pain accompanies the radiographic changes, then it is termed as "Pellegrini-Stieda" syndrome. Mendes et al. have described four patterns of ossification at this location and found that, depending on the structure that is involved (medial collateral ligament and/or distal adductor magnus tendon), the two particular types, “a beak-like appearance with an inferior orientation and femoral attachment” and “an elongated appearance with a superior orientation, parallel to the femur” may especially resemble exostotic bony lesions originating from the distal femur [30].

![Fig. 5. Anteroposterior knee radiograph of a 19-year-old male patient at his initial admission (a) after a knee injury during skiing shows the Segond fracture (arrow in a). Postoperative control radiograph at 8th month (b) after anterior cruciate ligament (ACL) reconstruction surgery demonstrates a bony bump on the lateral aspect of proximal tibia representing a healed Segond fracture (thick arrow in b). The tibial and femoral tunnels (black arrows) and endobutton (curved arrow) which is used to anchor the reconstructed ACL graft are clues to the patient’s prior trauma and ACL reconstruction surgery. Note that, although the initial radiograph does not depict an avulsed fragment on the medial side of the proximal tibia, a slight bony irregularity has developed at the typical location of a reverse Segond fracture in the follow up radiograph (open arrow in b). The patient has sustained injury of the deep medial collateral ligament at its tibial attachment site (not shown here). In the anteroposterior knee radiograph of another patient with a history of knee injury 4 weeks ago (c) the Pellegrini-Stieda lesion is appreciated (arrow in c).](image1)

![Fig. 6. Lateral (a) and skyline (b) radiographs of the left knee in a 64-year-old male patient are shown. The enthesophyte at the upper pole of the patella (arrow in a) creates the "tooth" sign in the skyline view (arrow in b).](image2)
2.1.5 Rare findings

Rarely, a hypertrophic medial tibial crest may result in the homonymous friction syndrome which is mostly seen in cyclists and shows soft tissue and subcortical bone marrow oedema ipsilaterally [31]. Another rare finding, which is demonstrated with bony outgrowth, is the presence of enthesophytes in patients with axial spondyloarthropathy and knee joint involvement. Younger patient age and locations such as posterior cruciate ligament, patellar tendon, iliobibial band insertion and joint capsule attachment sites, which are remote from the joint space, are hints in diagnosing these enthesophytes [32, 33].

2.2. Patella

2.2.1. Enthesophytes

Degenerative changes in the quadriceps tendon result in enthesophyte formation at the upper pole of the patella, where the tendon inserts. The new bone formation at the patellar insertion site can be readily appreciated on skyline knee radiographs as contour irregularity that was described as the patella “tooth” sign (Fig. 6) [34]. Although initially considered as a clinically insignificant radiographic finding, quadriceps tendon rupture in association with patellar “tooth” sign has been reported in later years [35].
3. Ankle and Foot

3.1. Talus

3.1.1. Osteophytes

Osteophytes are frequent in the ankle joint. They can be often found at the dorsal surface of the talus or navicular articular surface of the talar head, but also at the distal margin of the trochlea and anterior or anteromedial aspect of the tibia (Fig. 7a-b). In athletes, particularly in football and rugby players, runners and ballet dancers, talar osteophytes may be associated with various ankle impingement syndromes. Anterior or anteromedial tibial and talar osteophytes are known to be associated with respective impingement syndromes, which are common causes of ankle pain particularly in patients younger than 40 years of age [36, 37].

The anterior impingement in which anterior osteophytes of tibia and talus are often present was first described as “athlete’s ankle” [38]. These osteophytes are thought to arise after direct trauma. Patients with anterior impingement typically present with restriction of dorsiflexion and anterior joint pain [38-40].

3.1.2. Stieda process

Another excrescence of the talus is the elongated lateral tubercle of posterior process, also known as Stieda process (Fig. 7c-d, Fig. 8d). With forced plantar flexion or repetitive episodes of plantar flexion, a prominent Stieda process can be associated with posterior ankle impingement. In this clinical entity, tenosynovitis or entrapment of flexor hallucis longus tendon and local synovitis result in irritation and posterior ankle pain [41]. The posterior impingement view radiograph, obtained by placing the medial side of the ankle against the detector with the ankle 25° externally rotated, provides better diagnostic performance in the evaluation of posterior ankle bony anatomy compared to standard lateral ankle radiographs [42].

3.1.3. Hypertrophic talar ridge

Another bony protuberance at the dorsal aspect of the talus neck is the hypertrophic talar ridge (Fig. 8a-b) which represents the enthesophytic change at the bony attachment sites of tibiotalar joint capsule and talonavicular ligament, about 7-14 mm distal to the trochlear articular surface. Hypertrophic talar ridge can also be found in the same group of athletes as well as in patients with diffuse idiopathic skeletal hyperostosis (DISH) [40, 43].

3.1.4. Talar beak

This particular triangular shaped bony excrescence of talus at its dorsal surface (Fig. 8c-d) is known to be associated with tarsal coalition, particularly at the middle subtalar joint [44]. It is postulated that talar beak arises due to excessive traction at the talonavicular joint by the abnormal subtalar joint kinematics. It is not clear if this beak is a unique outgrowth or one that represents an extreme talar ridge hypertrophy [43].

3.2. Calcaneus

3.2.1. Hypertrophic lateral calcaneal tubercle and retrotrochlear eminence

Hypertrophic lateral tubercle (Fig. 9), also known as “peroneal tubercle” which can be seen in up to 30% of calcanei, may be associated with lateral ankle pain by causing stenosing peroneal tendosynovitis, peroneal tendon disorders and tears. Its aetiology is not clear and some authors suggest a congenital variation while others report previous trauma. For refractory cases, where symptomatic relief is not achieved conservatively, surgical resection of the bony tubercle can be performed [45, 46]. Another bony prominence just posterior to this tubercle is the retrotrochlear eminence of the calcaneus. Saupe et al. defined a cut-off height of 5 mm or more to define enlargement in both of these bony protruberances in the lateral side of the calcaneus [47].

3.2.2. Elongated anterior calcaneal process

Elongated anterior calcaneal process is seen in calcaneonavicular coalition, where an anomalous bony bar is present resembling an “anteater’s nose” on lateral ankle views (Fig. 10) [48, 49]. Calcaneonavicular coalition is the most common type of tarsal coalition, followed by middle subtalar joint coalition [50]. This condition is best demonstrated on 45° internal oblique views. In addition to the anteater’s nose sign, talar hypoplasia may indicate calcaneonavicular coalition [49, 51].

3.2.3. Calcaneal plantar enthesophytes

The plantar calcaneal enthesophyte (Figs. 10a, 11a, 12a), a bony spur which is most commonly seen at the medial calcaneal tuberosity, can be associated with heel pain [52, 53]. Heel pain in the presence of a plantar cal-
Fig. 9. Hypertrophic peroneal tubercle of lateral calcaneus (dashed line) on T1-weighted (a) and fat suppressed T2-weighted (b) images of a 70-year-old male patient. The hook-like bony prominence is separating peroneus longus (curved arrow) and peroneus brevis (open arrow) tendons. Note the mild subcortical bone marrow oedema (thin arrow in b) in the hypertrophic peroneal tubercle. The retrocalcaneal eminence (asterisk) lies posterior to the peroneal tubercle. In another 52-year-old female patient with lateral ankle pain, the prominent peroneal tubercle with its pointy tip (thick solid arrow) and accompanying bone marrow oedema are shown on this coronal fat suppressed proton density image (c). Note that in this patient there is tenosynovitis and partial thickness tear in the peroneus longus tendon (curved open arrow). The peroneus brevis tendon is normal (short open arrow).

Fig. 10. Lateral ankle radiograph (a) and sagittal fat suppressed proton density MR image (b) of a 53-year-old female patient with right ankle pain are presented. Note that the anterior process of the calcaneus that articulates with the navicular bone at the talonavicular coalition (thick white arrow) is elongated (black arrows), mimicking the nose of an anteater. Additionally a plantar calcaneal enthesophyte (white open arrow) is present. MR image shows degenerative changes involving both sides of the coalition (thick white arrow).

Fig. 11. Sagittal (a) and coronal (b) T1-weighted images of a 41-year-old female patient with chronic heel pain are shown. The calcaneal spur at the inferior calcaneal process of plantar fascia insertion (arrow) and accompanying severe atrophy of adductor digiti minimi muscle (star in b) are compatible with Baxter’s neuropathy.
caneal enthesophyte is thought to be due to irritation or impingement of the medial or lateral plantar nerves or their branches [53-55]. Entrapment of the inferior calcaneal nerve, the first branch of lateral plantar nerve, can occur in the presence of large calcaneal enthesophytes and this painful clinical syndrome is called “Baxter neuropathy” (Fig. 11) [56]. Calcaneal plantar enthesophytes can be found at the insertion sites of abductor digiti minimi and flexor digitorum brevis muscles, deep to the plantar fascia, within the plantar fascia and at the insertion site of the short plantar ligament [53]. Mechanical alterations in the hindfoot causing a tug lesion, rheumatological disorders, mainly seronegative spondyloarthritides, DISH and ageing could be related.
to the development of plantar calcaneal enthesophytes [57-59]. The aetiology may not always be so clear-cut in calcaneal spurs but, when bony erosions together with whiskering and periosteal new bone at the insertion site of plantar aponeurosis are seen, these findings favour the diagnosis of spondyloarthritis, particularly reactive arthritis. In DISH and osteoarthritis, both of which are non-inflammatory conditions, no erosive bone changes are seen. In fact, these two disorders are where calcaneal spurs are most commonly reported, with the incidence of 91% and 81% respectively. Large, well-defined calcaneal spurs, lack of bony erosions and presence of Achilles or peroneal tendon calcifications at their insertion sites are useful tips to discriminate DISH from inflammatory conditions [60].

3.2.4. Haglund deformity
This common but poorly understood deformity of the posterior calcaneus has quite a lot synonyms such as retrocalcaneal exostosis, cucumber heel, prow beak deformity and “pump bump” [61]. Although the exact aetiology is not known, this deformity is more common in patients with altered foot biomechanics such as hindfoot varus and pes cavus, or those who wear low-back shoes, exerting chronic stress. It is more common in females and usually bilateral. In addition to this deformity, presence of soft tissue inflammation at the superficial bursa, Achilles tendon and retrocalcaneal bursa, leading to a painful posterior heel is known as Haglund syndrome [62, 63]. On lateral radiographs, the bony projection at the posterosuperior aspect of the calcaneus and loss of radiolucency in the retrocalcaneal recess can be seen. MRI can further elaborate the soft tissue changes such as retrocalcaneal and retro-Achilles bursae and bone marrow oedema at the calcaneal tuberosity (Fig. 12) [63].

3.2.5. Hypertrophic lateral plantar process of calcaneal tuberosity
The lateral intrinsic muscles of the foot anchor onto
the lateral process of the calcaneal tuberosity. The lateral process is much smaller than the medial. However, its size is found to be positively correlated with body mass index and the size of the peroneal tubercle [64]. A hypertrophic lateral process of the calcaneal tuberosity (Fig. 13) should not be confused with an exostosis.

3.3. Toes
3.3.1. Tuft exostosis
A more frequent but underappreciated great toe excrescence is the tuft exostosis at the medial or lateral aspects of the base of the distal phalanx (Fig. 14). Having been addressed as an enthesophyte by some researchers, they are rarely associated with clinical findings, pain being the most common one if any. They have been observed more commonly in females and in patients with hallux valgus deformity which suggests a possible common aetiology or association with tight shoe-wear [65].

3.3.2. Subungual exostosis
The most well-known symptomatic bony protrusion of the distal phalanx of the great toe is a subungual exostosis. It presents as a firm swelling in the nail bed and can cause nail deformity, particularly in adolescence. Although it can be seen in any digit, the great toe is affected most commonly. On imaging, it is seen as a bony outgrowth taking origin from the dorsal aspect of the distal phalanx in the nail bed (Fig. 15). In some cases, a thin cartilage cap covering the lesion may be observed, representing an osteochondroma variant [20, 66].

Discussion
This review summarises developmental and acquired bony protuberances in the lower extremity in the light of their clinical significance and imaging findings. Some of these lesions have been described on plain radiographs by earlier researchers but, with the increasing use of MRI and CT, their imaging findings on cross-sectional imaging modalities and radiographs are recapplied one more time.

Radiologists should be familiar with these bony excrescences and their imaging findings on different modalities in order not to mistake them for other pathologies. Furthermore, in some instances, being familiar with the clinical context that they are found, a single joint imaging can shed light to the underlying generalised or systemic disorders that the patients may be suffering from.

Conflict of interest
The authors declared no conflicts of interest.
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