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Thoracic Bone Tumors Every Radiologist Should Know

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The thoracic cage provides the structural support that makes respiration possible, provides protection to vital organs such as the lungs, heart, liver, and spleen, and serves as an anchor point for the upper extremities. Neoplasms of the bony thorax are not an uncommon incidental finding at both radiography and cross-sectional imaging. Some tumors have a characteristic appearance and it is important that an accurate differential diagnosis be provided. Misidentification could lead to unnecessary imaging or procedures with associated cost, morbidity, and mortality. The purpose of this article is to serve as a quick review of bone tumors commonly encountered in the thorax and that every radiologist should know. Please note that there are also several non-neoplastic osseous lesions that may mimic bone tumors such as osteomyelitis and eosinophilic granuloma; however, these entities are beyond the scope of this review and would not be discussed.

General Characteristics of Bone Tumors

Before delving into a description of the specifics of bone tumors commonly encountered in the chest, it is important to discuss a systematic approach for evaluating bone tumors (Fig 1). The first factor to take into account is patient demographics, namely the patient's age. As a prime example, metastases are rare in children whereas Ewing's sarcoma is rare in adults. Characterizing the neoplasm as sclerotic or osteolytic is also an important consideration. The next factor to consider is the zone of transition, that is, the margins between the lesion and the surrounding bone. A narrow zone of transition, consisting of well-defined margins, suggests slow growth and benignity. A wide zone of transition, that is, indistinct margins, suggests a more rapid, aggressive process such as malignancy. Other findings to discern are periosteal reaction (which can have a benign or aggressive pattern), cortical destruction (usually indicating malignancy or infection), location within the bone (such as proximity to an articular surface), and whether the tumor is matrix forming (chondroid vs osseous matrix), which may help suggest a particular tumor histology. Employing this systematic approach can help the radiologist avoid diagnostic pitfalls.

Benign Tumors

Most bone tumors encountered in the chest are benign. Often, benign tumors are asymptomatic and are identified incidentally on imaging. When possible, one should not equivocate when diagnosing a benign bone neoplasm to prevent any future morbidity and mortality or unnecessary cost that may be associated with additional imaging or biopsy (so-called "don't touch" lesions).[1] As mentioned earlier, general characteristics that support a diagnosis of benign bone tumor include a narrow zone of transition, benign (if any) periosteal reaction, and lack of cortical destruction.

Bone Islands

A bone island, also known as an enostosis, is the first and foremost of the skeletal "don't touch" lesions in adults. It represents an island of hamartomatous mature compact (cortical) bone embedded within the trabecular network of the surrounding cancellous bone.[2] It is believed that bone islands represent a failure of cortical bone resorption during endochondral ossification.[3] They are very common, can occur in patients of any age, and may be single or multiple. Enostoses occur with equal frequency in men and women and their prevalence is difficult to estimate as they are benign and are often underreported.[4] Bone islands can occur in any bone and in the chest they are usually found near the glenohumoral joints (within the scapulae or proximal humeri) but are common in the spine and ribs as well.

Bone islands are asymptomatic and are usually discovered incidentally with imaging. They can mimic pulmonary nodules on chest radiographs and may prompt further evaluation with computed tomography (CT) (Fig 2). The extreme density of these lesions and the fact that they project over the same bone on both frontal and lateral projections should raise suspicion. Most lesions are 1-20 mm in size, although they can occasionally be gigantic (> 20 mm), measuring up to 100 mm.[5] When located in the

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Findings favoring benignity	Factors favoring malignancy
Narrow zone of transition	Broad zone of transition
Benign periosteal reaction	Aggressive periosteal reaction (note this can be seen in benign and infectious processes)
Absence of cortical destruction	Presence of cortical destruction
Stability with time	Interval growth

Fig 1. Chart detailing features suggestive of benign vs aggressive lesions.

diaphysis of a bone, for example in the ribs, they are usually ovoid and oriented along the long axis of the bone. When near the metaphysis (spine, scapula, and humeral head) they are often round (Fig 2).[2]

Bone islands look like cortical bone on cross-sectional imaging and are homogenously dense. On CT, these lesions have spiculated or "paintbrush" margins with many small "thorny" radiations that project out into the surrounding medullary space (Fig 2). These represent continuity with the surrounding cancellous bone.[2] The surrounding cancellous bone is otherwise normal. On magnetic resonance imaging (MRI), bone islands have signal matching that of cortical bone, appearing as signal voids on all sequences. On radionuclide scintigraphy, bone islands do not show any increased radiotracer uptake and often appear as "cold" defects in the bone.[6]

In some instances, bone islands can be mistaken for osteoblastic metastases, but their appearance is usually pathognomonic. When discussing bone islands, it is worthwhile to mention osteopoikilosis ("spotted bone" disease), a benign, autosomal dominant condition where patients have innumerable bone islands, typically in a periarticular distribution (Fig 3). This is often mistaken for metastatic breast or prostate cancer, depending on the patient's gender. If the clinical history is not suggestive, a bone scan can be used to differentiate osteopoikilosis from osteoblastic metastatic disease, with the former showing little to no uptake and the latter typically showing marked uptake.[7]

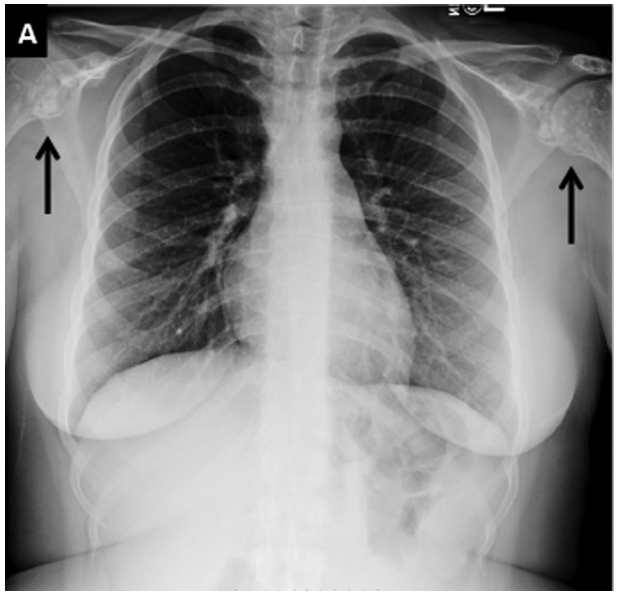

Fig 3. Osteopoikilosis: frontal chest radiograph (A). Note the innumerable punctate sclerotic lesions in the proximal humeri and scapulae (arrows). This is often mistaken for osteoblastic metastatic disease (typically prostate in men and breast in women). These lesions do not demonstrate any increased update on a bone scan whereas osteoblastic metastatic disease should show marked uptake.

Vertebral Hemangiomas

Intraosseous hemangiomas are the most common benign vertebral neoplasm, with an autopsy series showing a prevalence of 11%.[8] They are slightly more common in women. Histologically, hemangiomas consist of benign hamartomatous growth of thin-walled blood-filled vessels and sinuses lined by epithelium and interspersed among longitudinally oriented trabeculae of cancellous bone. It is not uncommon for these tumors to contain significant amounts of fibroadipose tissue.

The 2 most commonly encountered subtypes in the spine are cavernous and capillary hemangiomas. It is not uncommon for the capillary subtype, the less common of the 2, to have a component that grows outside the bone, leading at times to presentation with symptomatic compression of adjacent neurovascular structures. Another instance in which vertebral hemangiomas may cause symptoms is when they involve a large portion of the vertebral

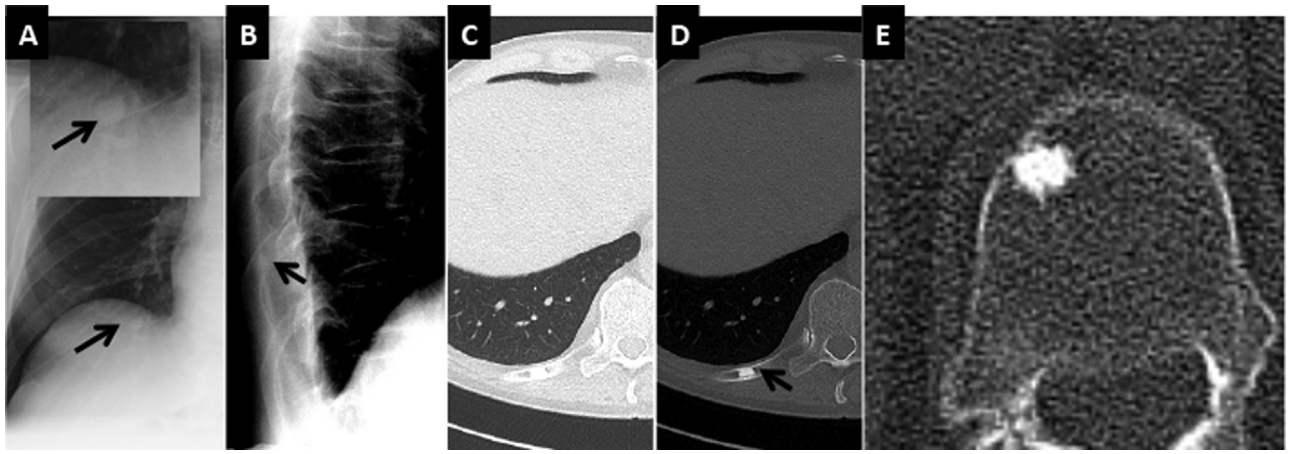

Fig 2. Bone island/enostosis: frontal chest radiograph (A) demonstrates an apparent right lower lobe nodule (arrow, inset). Retrospectively, the lesions can be localized to the right 10th rib on the lateral projection (B). Subsequent CT found no correlate in the lung (C) but there was an oblong sclerotic lesion within the rib at this level (D). Note that the bone island is oriented along the long axis of the rib (D). Axial CT image from a different patient (E) demonstrated the classic appearance of a bone island in the axial skeleton with spiculated "paintbrush" margins and a surrounding halo of lucency.