Diagnostic Imaging of Benign and Malignant Osseous Tumors of the Fingers[1]

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Abbreviation: STIR = short inversion time inversion-recovery

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SA-CME LEARNING OBJECTIVES

After completing this journal-based SA-CME activity, participants will be able to:

- List the most common osseous lesions of the fingers.
- Describe the imaging findings of benign versus malignant osseous finger lesions.
- Discuss the advantages and disadvantages of various imaging modalities in differentiating benign from malignant lesions.

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TEACHING POINTS

See last page

Primary lesions of the tubular bones of the digits are not uncommon, and the vast majority of these lesions are benign. Benign intramedullary lesions such as enchondromas are frequently discovered incidentally, unless they are associated with a pathologic fracture. Expansile lesions or lesions that are pedunculated and protrude from the cortex may manifest with pain and functional deficits from local inflammatory reactions. Systemic disorders such as sarcoidosis and local soft-tissue lesions with involvement of adjacent bone may mimic primary phalangeal bone tumors. Primary or secondary malignant lesions of the phalanges, most commonly chondrosarcomas, are extremely rare, and their characterization may require the use of multiple modalities, including radiography, computed tomography, and magnetic resonance imaging. Although ultrasonography is extremely useful in the evaluation of soft-tissue lesions of the hand, its role in the evaluation of osseous lesions is limited. The authors describe the imaging features of the most common benign osseous and chondral lesions of the fingers, including enchondromas, cystic lesions, and osteochondromas. In addition, they discuss malignant entities that may occur in the fingers (eg, chondrosarcomas and metastatic lesions) and commonly encountered mimics of primary osseous lesions (eg, glomus tumors, intraosseous epidermal inclusion cysts, infectious entities, and manifestations of systemic diseases). They also discuss the advantages and disadvantages of the most commonly used imaging modalities in differentiating benign from malignant lesions.

Introduction

Primary bone tumors of the hand are rare, reportedly accounting for 2%–5% of all skeletal tumors (1). The vast majority of osseous tumors of the phalanges and metacarpal bones are benign. These benign entities are often found incidentally at radiography performed for unrelated injuries or for pain due to pathologic fracture. A multimodality imaging approach is frequently required for further characterization of such lesions. Radiography, computed tomography (CT), and magnetic resonance (MR) imaging help in the evaluation and triage of these lesions, whereas ultrasonography (US) plays only a limited role in the evaluation of osseous tumors and tumor-like lesions of the fingers.

In this article, we describe the imaging features of the most common benign lesions of the fingers—including enchondroma, osteoid osteoma, giant cell tumor, and other cystic lesions—and their mimics. In addition, we discuss malignant entities (eg, chondrosarcomas) that may occur in the fingers and describe their imaging features. We also discuss the advantages and disadvantages of various imaging modalities in differentiating benign from malignant lesions.

Imaging Modalities and Techniques

Radiography

Teaching Point

Imaging evaluation of the hands and fingers usually begins with conventional radiography, especially when the patient presents with traumatic or nontraumatic pain or with complaints of a palpable abnormality of a digit. Three views of the digits, including anteroposterior, lateral, and oblique views, are usually adequate for assessment of an osseous abnormality (2).

Teaching Point

A systematic approach is imperative for the assessment of bone tumors, with special attention paid to the size, number, and location of lesions; margins and zone of transition; periosteal reaction; matrix mineralization; and presence of a soft-tissue component. It is challenging to precisely determine the origin of a bone lesion in the metacarpal bones and phalanges, since the entire diameter of the bone may be involved, making it difficult to determine from which part of the bone the lesion originated (ie, cortical, juxtacortical, or medullary) (3).

Computed Tomography

Although CT is rarely required for lesions of the hands and fingers, it may help in the evaluation of cortical continuity or disruption, such as with pathologic fractures or aggressive lesions, which may be superimposed on radiographs and poorly delineated on MR images. In addition, CT can aid in the evaluation of matrix mineralization of the lesions and in diagnosis. Furthermore, CT is superior to radiography for identifying any soft-tissue component within a lesion.

Ultrasonography

US may be particularly useful for dynamic evaluation of tendon and pulley injuries of the fingers and in evaluating soft-tissue masses of the hand such as ganglion cysts and giant cell tumors of the tendon sheath. However, it is of limited utility in primary osseous lesions of the phalanges or metacarpal bones. Small, high-resolution–high-frequency transducers (preferably hockey stick type) with color Doppler and a high level of expertise in musculoskeletal US are required for thorough evaluation of finger abnormalities (4). Mimics of primary osseous lesions (eg, glomus tumors), which may cause osseous resorption and consequent deformity of the adjacent phalanges, may be identified at US.

MR Imaging

Teaching Point

In recent years, with high-field-strength systems widely available and improvements in coil technology providing an enhanced signal-to-noise ratio, MR imaging has become integral to the evaluation of disease entities of the hands and digits. MR imaging helps assess the extent of soft-tissue and bone marrow involvement of lesions of the fingers. Of note, MR imaging findings may lead to overestimation of the aggressiveness of lesions, since benign lesions may cause bone and soft-tissue edema, and correlation with radiographic or CT findings is imperative to fully understand the nature of the lesion.

Several technical considerations should be taken into account for optimal MR imaging of the fingers. Dedicated surface coils and a small field of view are imperative for detailed visualization of the finger anatomy. Although specific protocols vary, a common approach to imaging of the digits includes axial spin-echo T1-weighted and fast short inversion time inversion-recovery (STIR) or fat-suppressed fast spin-echo T2-weighted sequences, with corresponding longitudinal sequences. Gadolinium-based contrast material–enhanced fat-suppressed T1-weighted imaging in three planes allows improved characterization of soft-tissue and osseous lesions. Fat suppression is necessary because of the large amount of fat in the subcutaneous tissue of the fingers (5). Ideally, the patient should be scanned in a prone ("superman") position with the region of interest (ie, finger) in the center of the bore. Because motion artifacts are common with this scanning position, an alternative is supine imaging with the patient positioned off-center and the dedicated coil as close to the center of the bore as possible. Another possibility is the use of a dedicated extremity scanner, with the patient sitting in a chair and the hand positioned in the center of the extremity coil.

Approach to Osseous Tumors of the Fingers

As with any bone lesion in any part of the body, it is critical to know the precise location of the tumor as well as the age of the patient to narrow the differential diagnosis. As alluded to previously, the margin of the lesion and the zone of transition between the lesion and adjacent bone are key factors in determining the aggressiveness of the lesion. A lesion with well-defined, sharp margins on radiographs or CT images is considered nonaggressive, whereas a broad zone of transition and poorly defined borders suggest an infiltrative osseous process, such as an aggressive tumor or a destructive metabolic or infectious process. The presence of a periosteal reaction can also help elucidate the nature of an osseous lesion, with a smooth, solid-appearing periosteal reaction denoting a slow, nonaggressive process and a disrupted or "sunburst" appearance suggesting an aggressive lesion.

Mineralization and opacity of a lesion can be appreciated at radiography, although they are better characterized with CT, and can help determine the origin of the lesion. Identification of a matrix with a "rings-and-arcs" appearance indicates a lesion with a chondral origin (eg, enchondroma or chondrosarcoma). On the other hand, an opaque, cloud-like matrix is suggestive of osseous mineralization (3). Lytic lesions are frequently encountered on skeletal radiographs and can be included in a wide variety of differential diagnoses, known by the mnemonic "FEGNOMASHIC" (*f*ibrous dysplasia, *e*nchondroma or *e*osinophilic granuloma, *g*iant cell tumor, *n*onossifying fibroma, *o*steoblastoma, *m*etastases or *m*yeloma, *a*neurysmal bone cyst, *s*imple bone cyst, *h*yperparathyroidism, *i*nfection, and *c*hondroblastoma or *c*hondromyxoid fibroma) (6).

Benign Lesions of the Fingers

Enchondromas

Benign cartilaginous tumors of the bones of the hands are not uncommon and include enchondroma, chondromyxoid fibroma, and chondroblastoma (7). Enchondroma is the most common benign tumor of the hand. It is usually asymptomatic and is frequently discovered incidentally on radiographs. Associated pain should raise suspicion for pathologic fracture (Fig 1), which, if nondisplaced, may be better characterized on CT images than on radiographs. An enchondroma appears at radiography and CT as a well-marginated lucent lesion arising in the medullary cavity near the physis, which may cause local bone expansion as well as thinning and endosteal scalloping of the cortex, predisposing to pathologic fracturing. Characteristic chondroid matrix with a stippled rings-and-arcs appearance may be seen. Enchondromas are hyperintense on T2-weighted MR images due to the high water content of the extracellular matrix and frequently have a lobulated appearance on T1-weighted images. Because enchondromas are avascular, gadolinium-enhanced images typically demonstrate only peripheral nodular and septal enhancement (8,9).

Enchondromas associated with severe new pain, interval growth at imaging, loss of marginal definition, cortical disruption, or local periosteal reaction raise concern for malignant degeneration, although this condition is exceedingly rare in the hands. However, the likelihood of this complication is reported to increase the closer the lesion is to the axial skeleton (6).

Treatment options for enchondromas depend on the clinical picture. Asymptomatic or incidental enchondromas are usually followed up and do not require treatment. Enchondromas associated with symptoms or pathologic fracture often require surgical intervention, specifically, curettage with or without bone grafting (Fig 2). In a study of 21 patients with solitary enchondromas of the digits, Kuur et al (10) found that eccentric enchondromas can frequently be treated efficiently with curettage alone, whereas central forms of the tumor require curettage and filling of the cavity with cancellous bone chips.

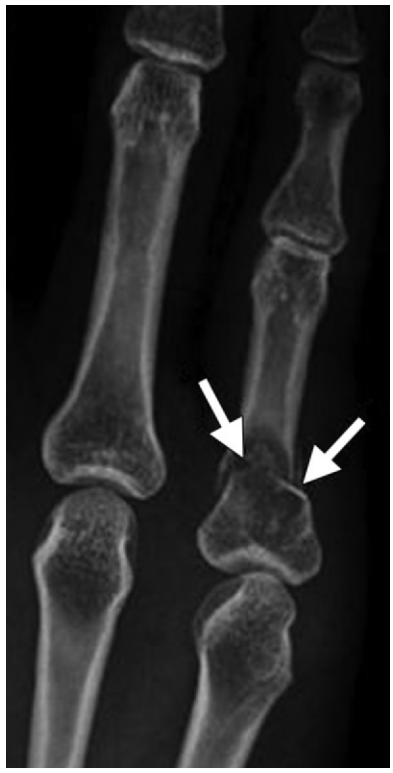
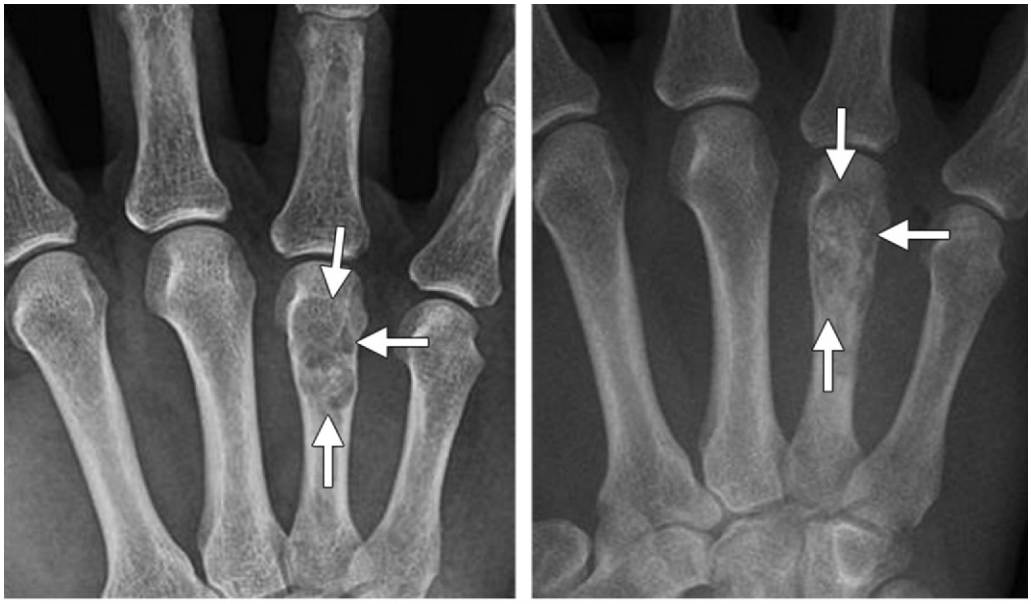


Figure 1. Enchondroma in a 49-year-old woman with sudden onset of pain in the little finger. Frontal radiograph demonstrates a pathologic fracture through an enchondroma of the fifth proximal phalanx (arrows).

Multiple Enchondromatosis

Multiple enchondromatosis, also known as Ollier disease, is a rare nonhereditary disorder with a reported prevalence of one in 100,000 persons and a mean age at diagnosis of about 13 years (11). It usually manifests as multiple enchondromas in an asymmetric distribution frequently involving the small bones of the hands, resulting in skeletal deformities (Fig 3). The metacarpal bones are more frequently involved than the phalanges.

The most dreaded complication of this entity is malignant transformation to chondrosarcoma, whose reported prevalence is highly variable (5%–50%), with an increased risk when the enchondromas are located in the long bones and axial skeleton (11). The mean age at diagnosis in



a. b.

Figure 2. Enchondroma in a 49-year-old man with pain in the fourth digit. **(a)** Frontal radiograph demonstrates a well-marginated, mildly expansile lucent lesion with chondroid matrix (arrows), a finding that is consistent with an enchondroma. **(b)** Frontal radiograph obtained 3 months later after curettage with bone graft reconstruction shows interval treatment changes (arrows).

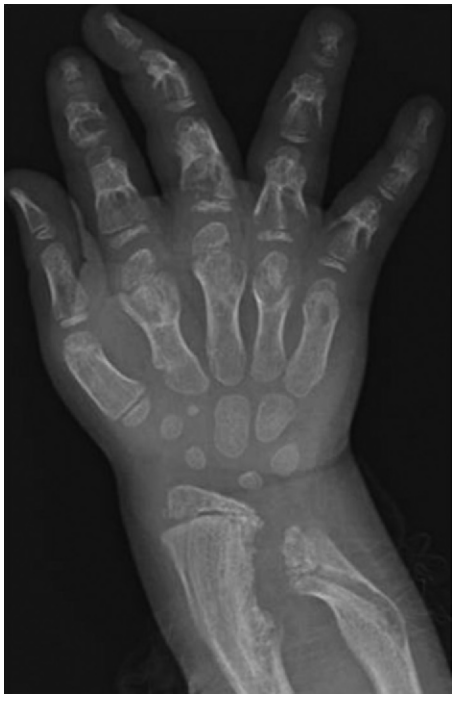


Figure 3. Multiple enchondromatosis (Ollier disease) in a 3-year-old boy with deformity of the hand. Frontal radiograph demonstrates multiple expansile lucent lesions involving the metacarpal bones and proximal and middle phalanges, findings that are consistent with multiple enchondromas.

patients with malignant transformation is about 33 years (11). These patients are also at risk for developing multiple synchronous or metachronous chondrosarcomas. No specific therapy for Ollier disease exists, and surgical intervention is considered only if complications such as disabling deformities, pathologic fractures, or malignant transformation occur.

Periosteal Chondromas

Periosteal (juxtacortical) chondromas are benign hyaline cartilage tumors. They are akin to enchondromas, except that they arise from the periosteum on the surface of the bone (Fig 4). Unlike enchondromas, periosteal chondromas of the fingers are rare. These lesions most frequently occur in the metaphyses of long bones. On radiographs and CT images, periosteal chondromas appear as surface lesions with erosion and saucerization of adjacent cortical bone and may thus be mistaken for periosteal osteosarcoma, with the final diagnosis often being made at pathologic analysis (8,12).

Osteochondromas

Osteochondromas are the most common benign bone tumors, accounting for approximately 35% of all such tumors and 10% of all bone tumors (8,13). Approximately one in 10 osteochondromas are reported to occur in the small bones of the hands and feet. Osteochondromas are composed of cortical and medullary bone with an overlying hyaline cap, and radiologic continuity

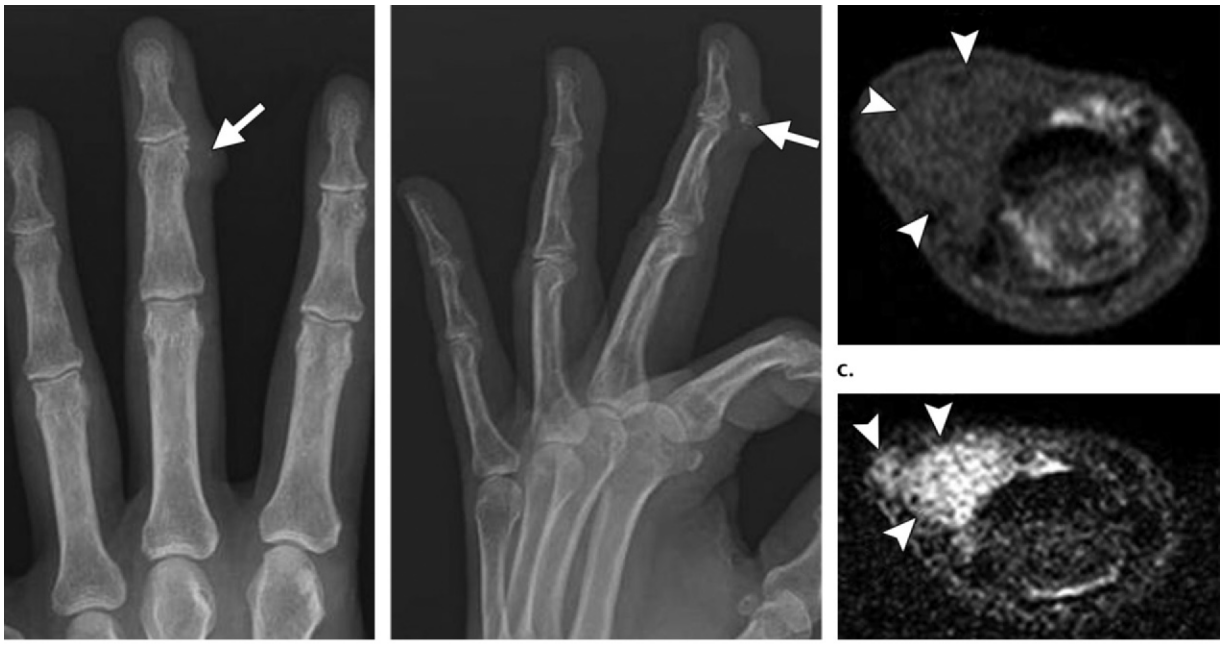


Figure 4. Juxtacortical chondroma in a 66-year-old woman with nodular soft-tissue swelling of the third digit. **(a, b)** Frontal **(a)** and oblique **(b)** radiographs demonstrate a coarse calcification in the region of the third distal interphalangeal joint (arrow). **(c, d)** Axial T1-weighted **(c)** and fat-saturated T2-weighted **(d)** MR images of the third digit demonstrate a lesion arising from the surface of the phalanx. The images show the lesion with intermediate signal intensity (arrowheads in **c**) and hyperintense signal (arrowheads in **d**), respectively. The lesion proved to be a juxtacortical chondroma at pathologic analysis.

with the underlying parent bone cortex and medullary cavity is pathognomonic for these tumors. Osteochondromas may be found incidentally at imaging, or they may manifest with a variety of symptoms, most frequently a progressive, painless deformity around a joint. Other potential complications of osteochondromas include fracture, vascular compromise, neurologic sequelae due to mass effect on neurovascular bundles, bursa formation, and malignant degeneration.

There are two distinctive radiographic appearances of osteochondromas: sessile (broad based) (Fig 5) and pedunculated (having a slender stalk or pedicle). Osseous continuity between the parent bone and the exostosis is often easy to visualize on radiographs, especially in pedunculated lesions, which characteristically point away from the nearest joint. Sessile lesions may pose more of a diagnostic challenge at radiography.

CT can be especially helpful in the characterization and identification of an osteochondroma. Thin sections may help confirm cortical and marrow continuity between the lesion and the parent bone. The subtle chondroid matrix of the hyaline cap can also be better evaluated at CT than at radiography, and the thickness of the cap can be measured.

As previously noted, MR imaging also demonstrates osseous continuity between the exostosis and the parent bone and, with its excellent characterization of bone marrow, is superior to other modalities in identifying exostoses that are in unusual or complex anatomic areas such as the short bones of the hands. In addition, MR imaging can depict the local effect of lesions on surrounding structures, possibly demonstrating high T2 signal along tendons or neurovascular bundles from mass effect. Finally, MR imaging is the best modality for evaluating the hyaline cartilage cap, with mineralized portions of the cap demonstrating low signal intensity with all sequences and nonmineralized components demonstrating high T2 signal and intermediate T1 signal.

Osteochondromas cease to grow at skeletal maturity. Progressive growth of these lesions in adulthood may be a harbinger of malignant transformation to low-grade peripheral chondrosarcoma, although this is reported to occur in less than 1% of cases (13). At imaging, osteochondromas with a cartilage cap greater than 1.5–2 cm have an increased likelihood of malignant transformation (13). Features that suggest malignant transformation of an exostosis include interval growth of the lesion, indistinct cortical margins or erosion of the lesion and adjacent parent bone, and a large soft-tissue component. Treatment of solitary osteochondroma is usually sought when the lesion is symptomatic, with

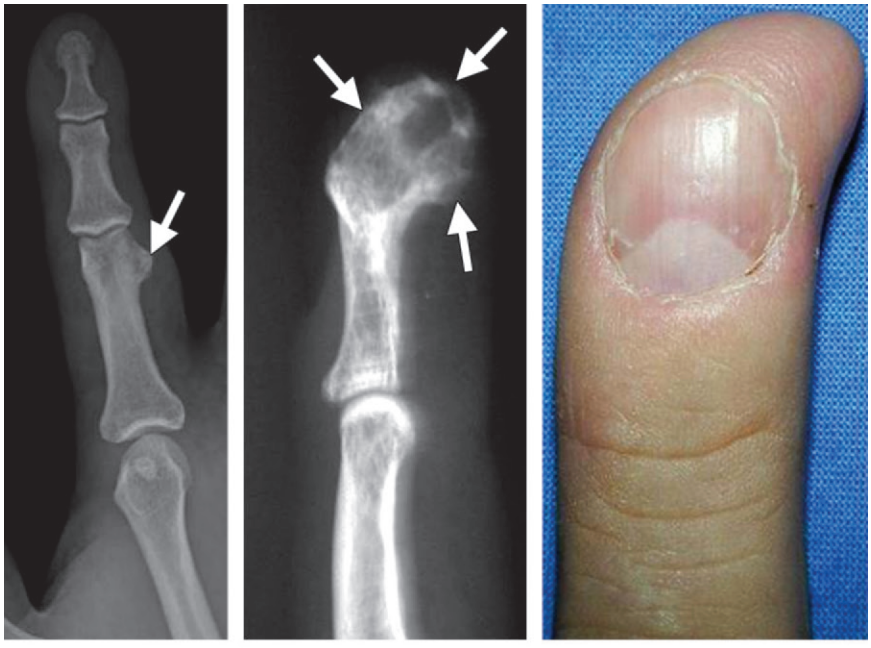
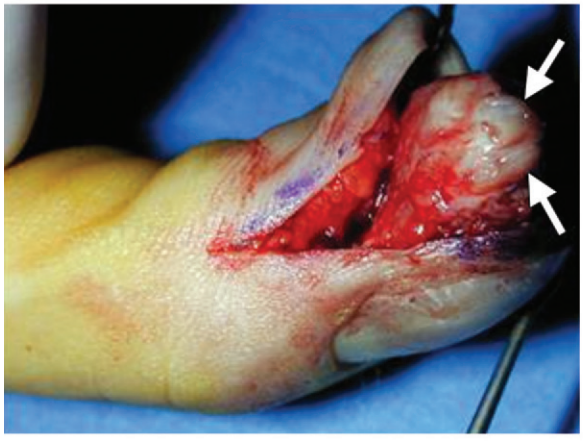


Figure 5. Osteochondroma (exostosis). **(a)** Frontal radiograph of the hand in a 37-year-old man demonstrates a broad-based bone exostosis (arrow) along the ulnar aspect of the second proximal phalangeal neck. **(b, c)** Radiograph **(b)** and clinical photograph **(c)** obtained in a different patient show an exostosis of a distal phalangeal tuft (arrows in **b**) with associated cosmetic deformity. **(d)** Intraoperative photograph shows a chondromatous cartilage cap with the typical "pearl" appearance (arrows).



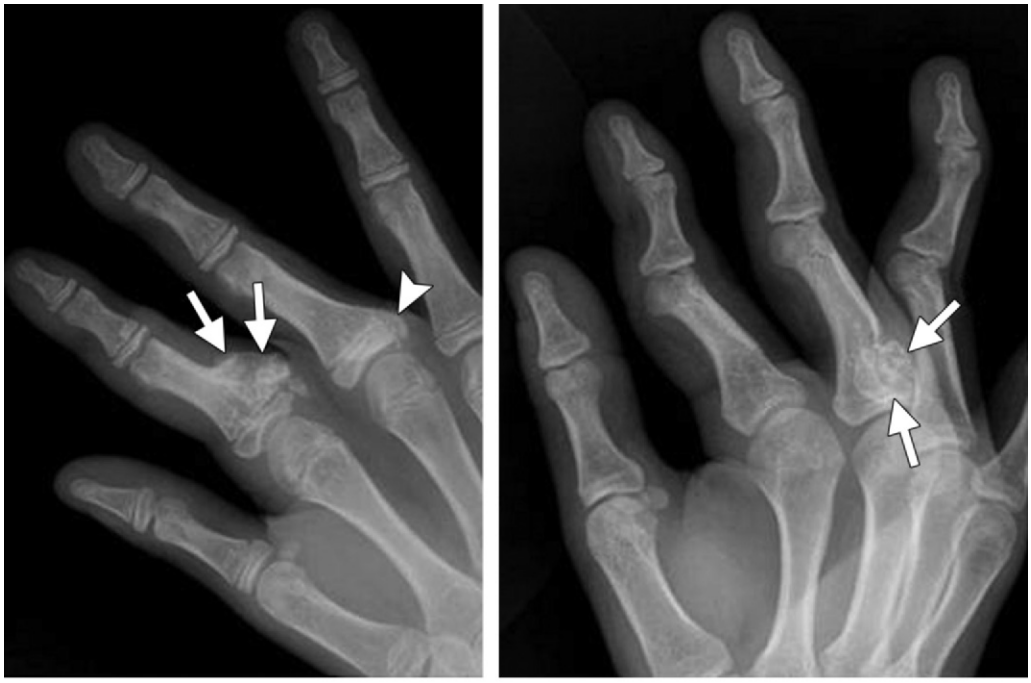
surgical resection at the base of the lesion being the primary treatment option. The recurrence rate following resection is reported to be around 2% but is higher if the lesion is not resected in its entirety (Fig 6) (13).

Hereditary Multiple Exostoses

Hereditary multiple exostoses (Fig 7), also known as familial osteochondromatosis, are characterized by the development of multiple osteochondromas and exhibit an autosomal dominant inheritance pattern. Men are affected 1.5 times more frequently than women, likely due to incomplete penetrance in women (13). The distribution of characteristic osseous lesions is variable, with approximately 20%–30% of affected patients having lesions in the small bones of the hands (13). Osteochondromas in hereditary multiple exostoses are typically sessile and have a slightly increased propensity for malignant degeneration, with a reported prevalence of 3%–5% (13). Patients with hereditary multiple exostoses require periodic clinical and radiographic surveillance to look for progression of deformities and other possible complications.

Subungual Exostoses

Despite their name and their having a radiographic appearance similar to that of osteochondromas, subungual exostoses are histologically distinct from osteochondromas and show no continuity with the cortex of the medullary canal of the adjacent bone at radiography. Also known as Dupuytren exostosis, this lesion is thought to represent a sequela of prior insult, such as infection or trauma, and arises on the dorsal aspect of the distal phalanx, under or adjacent to the nail bed. The lesion typically manifests as a painful mass adjacent to or under the nail bed with possible skin ulceration. Radiographs show a pedunculated or sessile bone spur in the distal phalanx extending into the nail bed (Fig 8a). Radiography or cross-sectional imaging may demonstrate a cartilage cap, which is usually larger than the base of the lesion. MR imaging most clearly depicts the effect of a subungual exostosis on surrounding structures and allows differentiation of this lesion from an osteochondroma (Fig 8b). Of note, the fibrocartilaginous cap in subungual exostosis is hypointense with all MR imaging sequences, whereas the hyaline cap in osteochondromas is hyperintense with T2-weighted sequences (14). Treatment consists of complete surgical excision, although the recurrence rate is high.



a. b.

Figure 6. Osteochondromas (exostoses) in a 15-year-old patient with finger deformities. **(a)** Frontal radiograph shows exostoses projecting off the medial aspects of the metaphyses of the bases of the second (arrows) and third (arrowhead) digits. **(b)** Frontal radiograph obtained 1 year after surgical resection demonstrates no recurrence of the exostosis of the second digit, but interval recurrence and growth of the exostosis of the third digit (arrows).

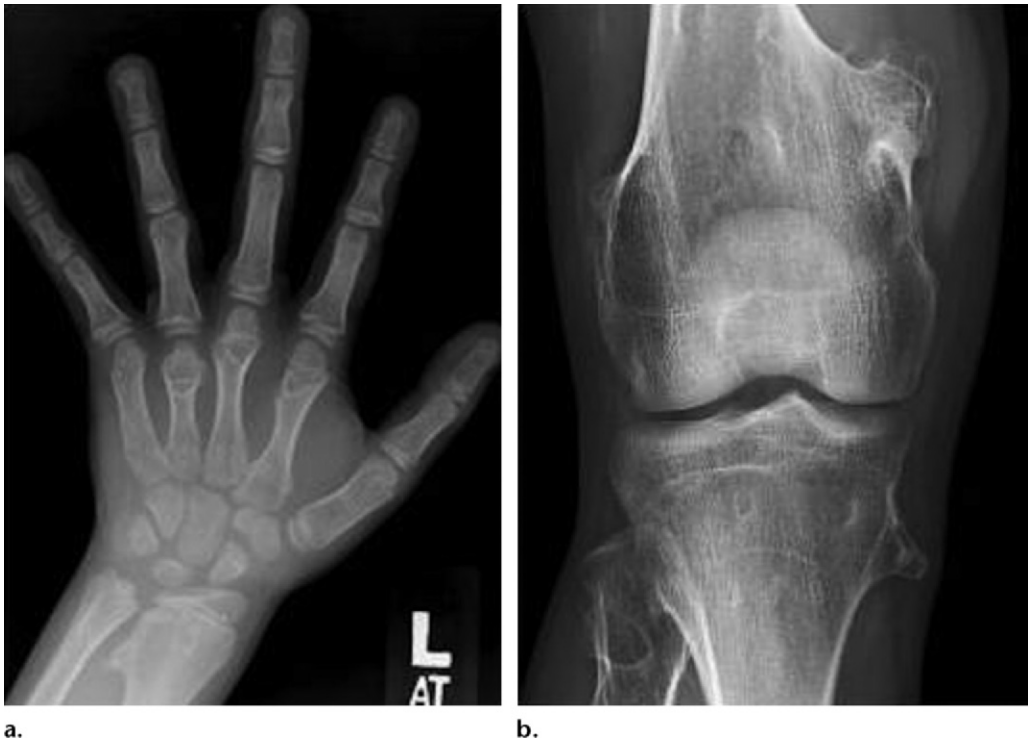


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Figure 7. Hereditary multiple exostoses in an 11-year-old boy. Frontal radiographs show multiple sessile exostoses of the heads and bases of the metacarpal bones and distal radius **(a)** and in the knee region **(b)**.

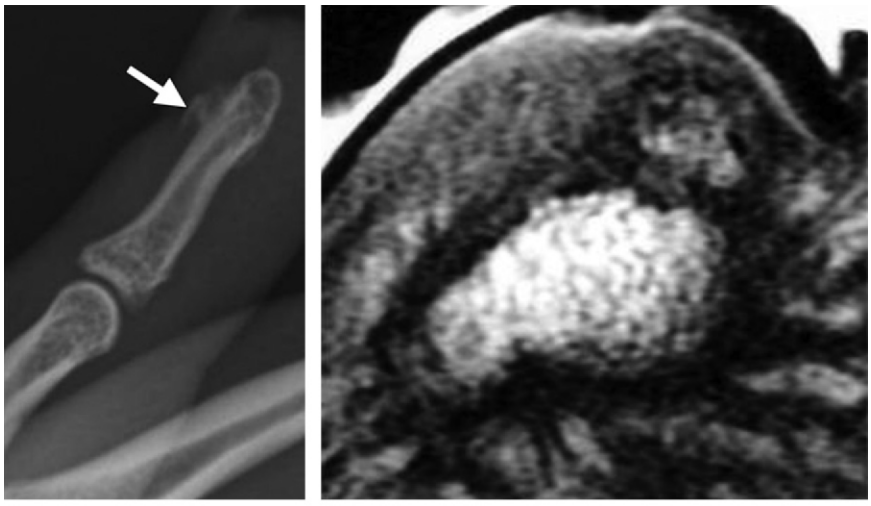


Figure 8. Subungual exostosis. **(a)** Lateral radiograph demonstrates a bone spur (arrow) in the region of the nail bed. **(b)** Short-axis proton-density–weighted MR image obtained in a different patient demonstrates a subungual bone spur originating from the cortex, with no continuity of bone or marrow.

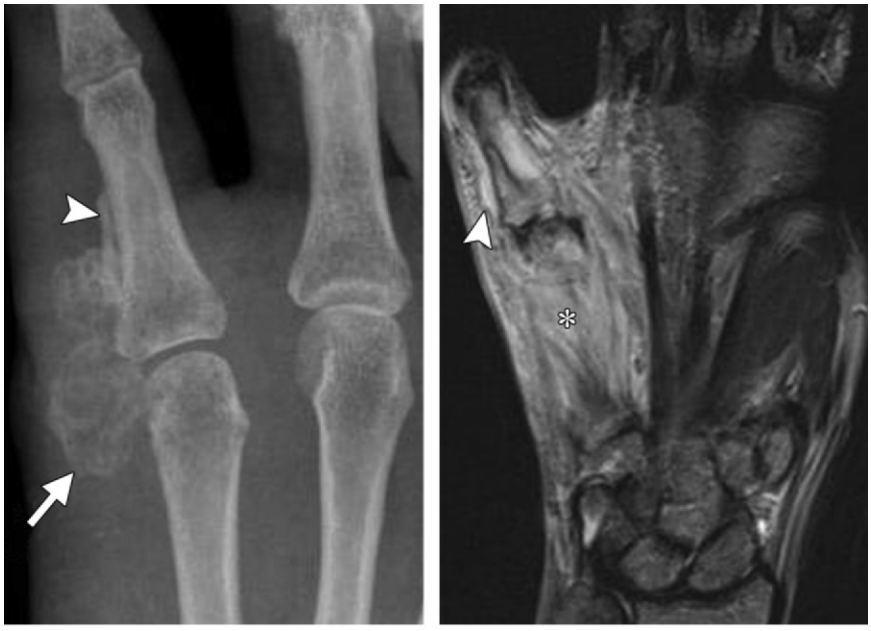


Figure 9. Florid reactive periostitis. Frontal radiograph **(a)** and coronal proton-density–weighted MR image **(b)** of the hand demonstrate florid reactive periostitis along the first digit. Note the lamellar (arrowhead) and compact (arrow in **a**) periosteal reaction, with integrity of the cortical bone. Diffuse soft-tissue edema is also seen (∗ in **b**).

Florid Reactive Periostitis

Florid reactive periostitis typically involves the small bones of the hands and feet and affects young adults 20–30 years of age (15). These lesions occur most frequently in the index finger, followed by the middle and little fingers, but they may be seen in any of the digits, with a predilection for the proximal phalanx (15). Patients typically present with progressive painful inflammatory swelling of the finger. Radiographs demonstrate a paraosseous mass with calcifications and lamellar or compact periosteal reaction (Fig 9). Close-interval follow-up radiographs may show maturing periosteal reaction without bone destruction (16). Typically, a radiolucent band is present between the paraosseous mass and the cortex of the adjacent bone at radiography.

Bizarre Parosteal Osteochondromatous Proliferation

Named for its atypical and "bizarre" histologic appearance, bizarre parosteal osteochondromatous proliferation, also known as Nora lesion, is a benign exophytic surface lesion of the bone that frequently affects the small tubular bones of the hands and feet, with a predilection for the proximal and middle phalanges of the hand. The vast majority (92%) of these lesions of the hand are situated in the diaphyses and metaphyses of the phalanges, with the remaining 8% found in the metacarpal bones (17). This lesion is thought to be a reactive mass of heterotopic mineralization arising from the periosteal aspect of an intact cortex, without involvement of the medullary canal. It typically manifests with painless progressive

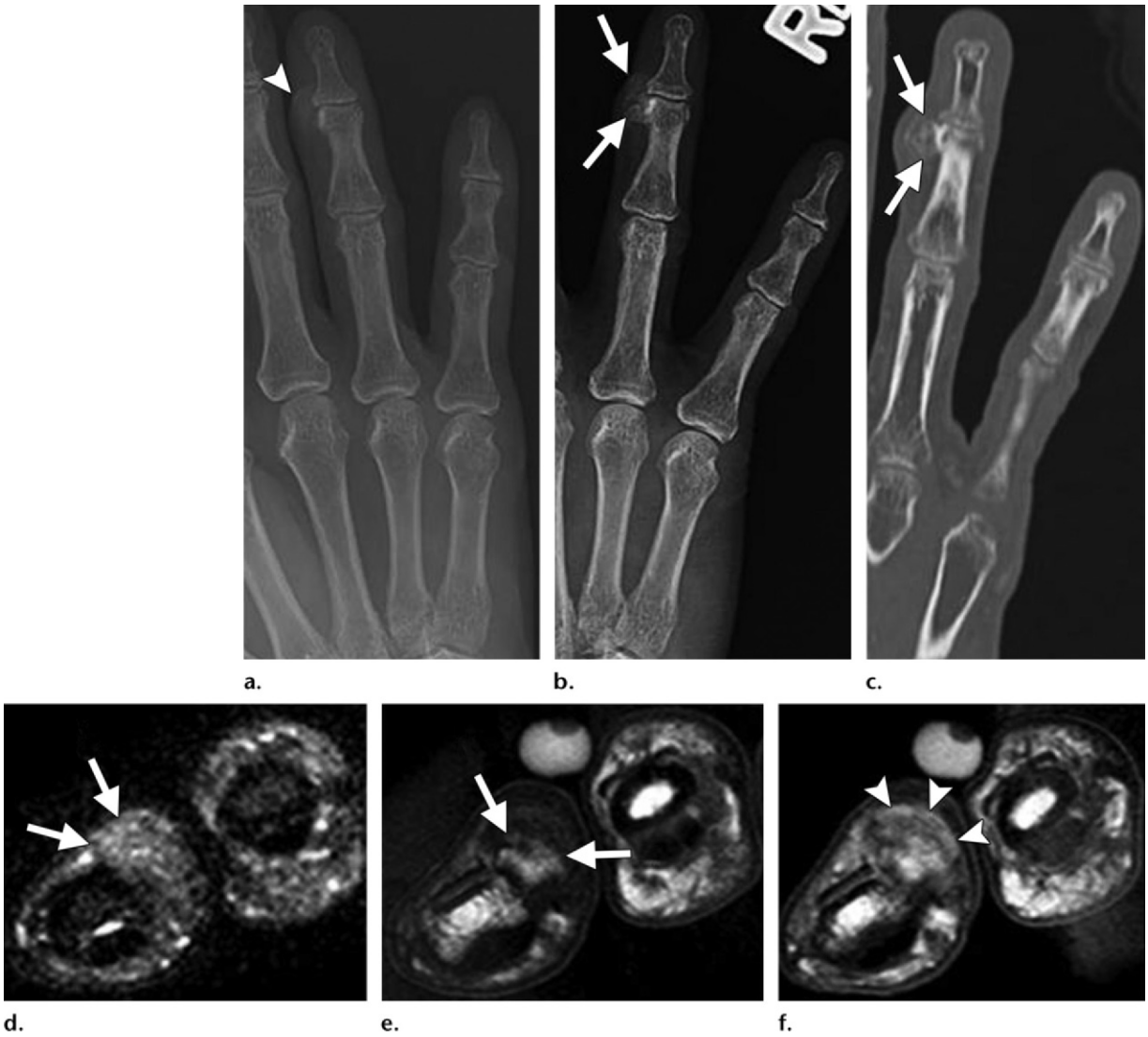
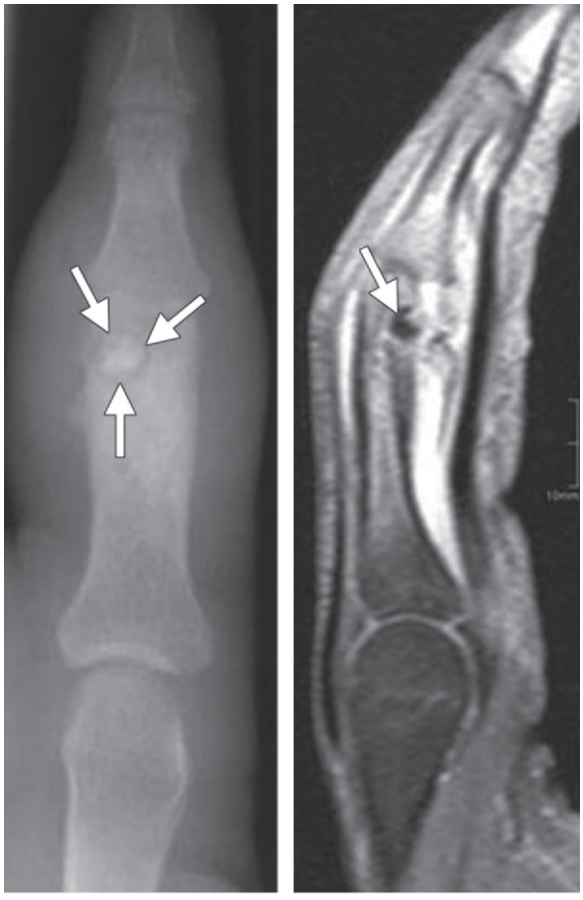


Figure 10. Bizarre parosteal osteochondromatous proliferation (Nora lesion). **(a, b)** Frontal radiographs obtained in 2008 **(a)** and 2011 **(b)** demonstrate interval growth of an osseous excrescence (arrowhead in **a**, arrows in **b**) at the radial aspect of the distal interphalangeal joint of the ring finger, with central internal matrix. **(c)** Coronal nonenhanced CT image shows a well-corticated nodular osseous lesion at the middle phalanx of the ring finger (arrows). Note the lack of continuity with the underlying marrow. **(d, e)** Short-axis STIR **(d)** and T1-weighted **(e)** MR images show an exophytic pedunculated osseous lesion (arrows) arising from the radial aspect of the middle phalanx of the fourth digit, with a heterogeneous hyperintense cap on the STIR image. **(f)** Gadolinium-enhanced fat-suppressed T1-weighted MR image shows the cap with intense enhancement (arrowheads).

swelling of a digit, and motion may be limited if the lesion occurs in proximity to a joint. Radiographs frequently demonstrate a well-marginated, ossified, broad-based lesion arising from bone cortex, usually without cortical erosion. Radiography and CT demonstrate cortical and medullary discontinuity with the underlying affected bone (Fig 10a–10c). At MR imaging, bizarre parosteal osteochondromatous proliferation is characteristically hypointense on T1-weighted images, hyperintense on T2-weighted images, and uniformly enhanced on gadolinium-enhanced images (Fig 10d–10f) (18). MR imaging findings should also confirm a lack of cortical and medullary continuity between the bone and the lesion, a key feature that allows differentiation between a Nora lesion and an osteochondroma, although reports of such continuity do exist (19,20). Periosteal reaction is usually absent. Surgical excision with wide margins is the definitive treatment and is usually undertaken in symptomatic patients. However, the reported recurrence rate is fairly high (up to 55% of cases within 2 years of excision) (21,22).

Osteoid Osteomas

Although osteoid osteomas account for 12% of all benign bone tumors, they occur only infrequently in the small bones of the hands and feet



a. b.

Figure 11. Osteoid osteoma. Frontal radiograph **(a)** and sagittal gadolinium-enhanced fat-suppressed T1-weighted MR image **(b)** of the proximal phalanx demonstrate a sclerotic nidus (arrows) with surrounding lucency, findings that are typical of osteoid osteoma. Note also the surrounding soft-tissue edema.

(23). One study of 25 patients demonstrated a mild predilection of these lesions for the proximal phalanx (24). Affected patients may present with persistent pain. The classic clinical presentation consists of nighttime bone pain relieved by aspirin, although symptoms in the hand may be different and may be accompanied by soft-tissue swelling and nail deformities if the lesion occurs in the distal phalanx. Osteoid osteomas consist of a highly vascularized osteoid-producing nidus with varying degrees of surrounding reactive sclerosis (8).

On radiographs, osteoid osteoma may manifest as a peripheral region of sclerosis (Fig 11a). CT is the best modality for identifying the characteristic nidus when osteoid osteoma is suspected. At MR imaging, the nidus appears as an area of hyperintensity on T2-weighted images, with peripheral hypointensity on T1-weighted (Fig 11b) and T2-weighted images that represents sclerosis. MR imaging may also provide additional details regarding adjacent soft-tissue inflammatory reaction. The use of gadolinium increases the conspicuity of the nidus.

Although percutaneous CT-guided thermal ablation of osteoid osteomas is a preferred treatment option in other parts of the body, surgical excision still plays a major role in treatment of these lesions in the small bones of the hands and feet, given the proximity of neurovascular structures. Complete removal of the nidus is essential to ensure that there is no recurrence.

Aneurysmal Bone Cysts

Aneurysmal bone cysts are composed of multiple cavities filled with blood. These lesions usually occur in children and young adults and manifest with swelling and pain. Although classically described in the metaphyses of long bones, aneurysmal bone cysts do occur in the tubular bones of the hands, usually the metacarpal bones. At radiography, they manifest as expansile lucent lesions that thin out the cortex of the affected bone. Internal septations and trabeculations may produce a multiloculated appearance.

Giant Cell Tumors

Giant cell tumors are lytic tumors that develop at the end of bones after epiphyseal closure. Although they are primarily benign, approximately 20% of giant cell tumors are malignant (6). In the hands, they demonstrate a predilection for the metacarpal bones. On radiographs, giant cell tumors characteristically manifest as metaepiphyseal osteolytic lesions that extend to the subarticular cortex of the bone (Fig 12a) (6). Giant cell tumors can be locally aggressive and may demonstrate cortical disruption, periosteal reaction, and a soft-tissue mass, features that are best appreciated at CT and MR imaging (Fig 12b).

Mimics of Primary Osseous Lesions

Teaching Point

A variety of pathologic processes in the hand, including soft-tissue lesions, infection, trauma, and systemic disorders, may have osseous manifestations in the phalanges or metacarpal bones and may be confused with primary osseous lesions.

Glomus Tumors

Glomus tumor is a benign hamartomatous tumor that reportedly accounts for up to 5% of all hand tumors (14). Clinical manifestations include excruciating pain and temperature sensitivity. Glomus tumors may occur anywhere in the body, although the vast majority occur in the hands, with a predilection for the fingertips. Radiographs frequently reveal pressure erosions of adjacent bone. MR imaging features of glomus tumor include hyperintensity on T2-weighted images, hypointensity

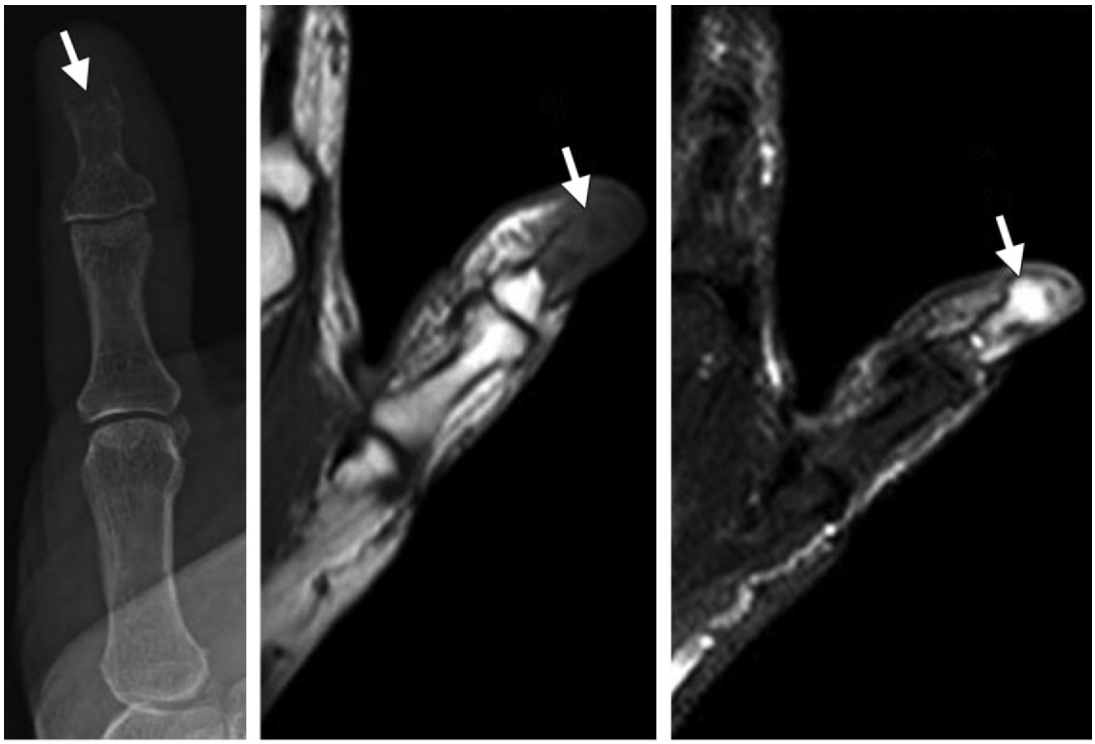


Figure 12. Giant cell tumor of the bone in a 54-year-old woman with a history of renal cell carcinoma and a 1-month history of swelling of the tuft of the first digit. **(a)** Frontal radiograph demonstrates aggressive-appearing lytic destruction of the tuft of the first digit (arrow). **(b, c)** Corresponding coronal T1-weighted **(b)** and fat-saturated T2-weighted **(c)** MR images demonstrate a destructive T1-hypointense and T2-hyperintense lesion (arrow). Imaging findings raised concern for possible metastatic disease from primary renal cell carcinoma, or perhaps infection. Pathologic analysis revealed a giant cell tumor of the bone.

on T1-weighted images, and avid enhancement on gadolinium-enhanced images (Fig 13).

Intraosseous Epidermal Inclusion Cysts

Epidermal inclusion cysts are benign cystic lesions caused by proliferation of epidermal cells. In the hands, these lesions can be found in a subungual location. Intraosseous epidermal cysts affect the phalanges of the hands and feet and are thought to be the result of erosion of subungual soft-tissue epidermal cysts into adjacent bone. They can manifest with pain and swelling of the fingertip. Radiographs may show osteolysis, most commonly in the terminal phalanges of the fingers (17). At MR imaging, epidermal inclusion cysts have intermediate signal intensity on T1- and T2-weighted images, with central debris and peripheral enhancement (Fig 14). Extensive inflammation of the surrounding soft tissue on MR images may suggest rupture of these lesions.

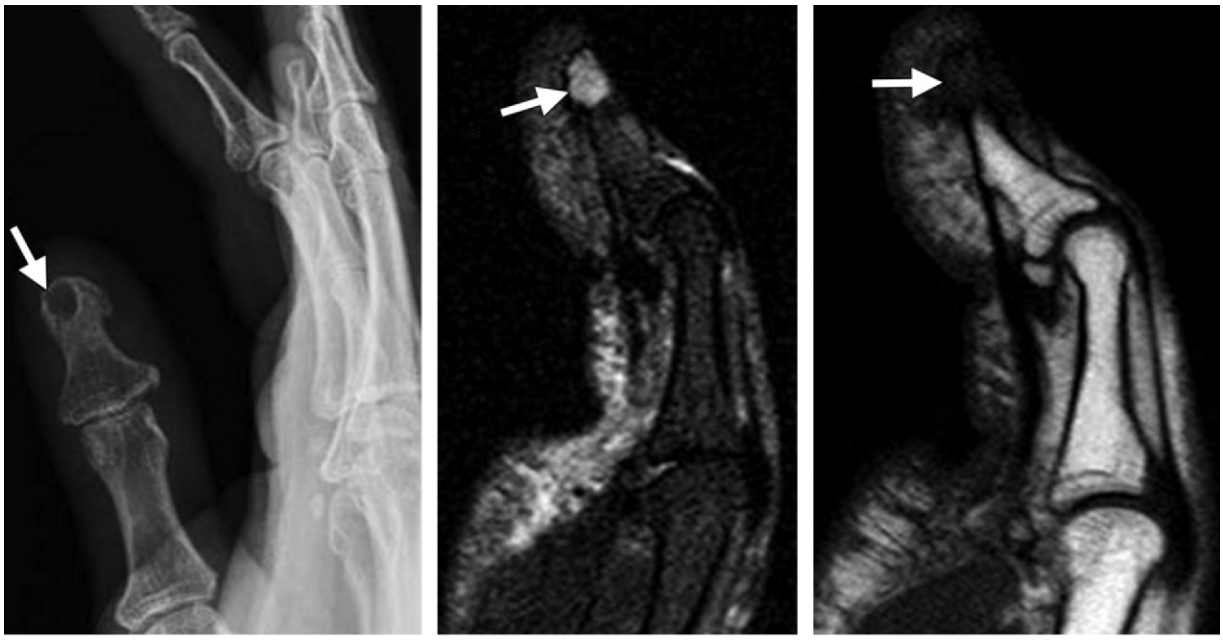
Trauma, Infection, and Systemic Diseases

A variety of systemic processes can affect the small tubular bones of the hand and may mimic primary bone lesions. Sarcoidosis can involve multiple organ systems, with skeletal involvement reported in up to 13% of cases (25). When the hands are affected, radiographs may demonstrate lacelike osteolysis (Fig 15). MR images may show cortical destruction and periosseous soft-tissue extension of granulomatous nodules (25). Other systemic disorders with manifestations in the hands include tophaceous gout, hyperparathyroidism with formation of brown tumors, rheumatoid arthritis with typical juxtaarticular changes, and possible pressure erosions from overlying rheumatoid nodules. Trauma with unusually shaped fracture deformities can occasionally be confused with osteochondromas. Finally, infection can cause focal areas of lysis, often with associated periosteal reaction and regions of sclerosis. Radiography, CT, and MR imaging may demonstrate cortical breakthrough and a soft-tissue mass.

Malignant Tumors

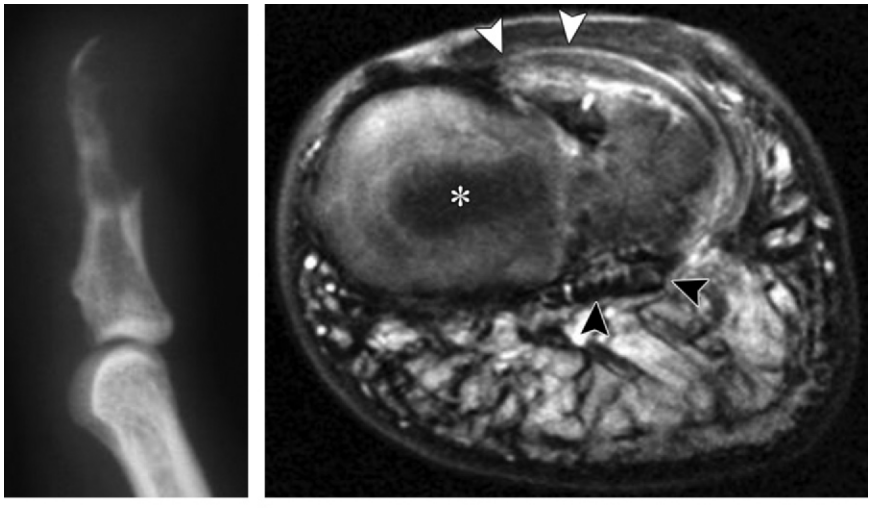
Primary malignant osseous tumors of the hands are exceedingly rare, but reported tumors include chondrosarcoma, hemangioendotheliosarcoma, osteosarcoma, fibrosarcoma, and Ewing sarcoma.

Chondrosarcomas are the most common primary malignant bone tumors of the hand, most



a. b. c.

Figure 13. Glomus tumor mimicking a primary bone lesion. **(a)** Lateral radiograph demonstrates a lucent lesion in the tuft of the first digit (arrow). **(b, c)** Sagittal fat-saturated T2-weighted **(b)** and T1-weighted **(c)** MR images shown the lesion with high and low signal intensity, respectively (arrow), findings that are typical of glomus tumor. Gadolinium-enhanced imaging demonstrated avid enhancement. Pathologic analysis revealed a glomus tumor.



a. b.

Figure 14. Epidermoid inclusion cyst mimicking a primary bone lesion. **(a)** Radiograph demonstrates a well-delineated, irregular lucent lesion of the tuft of the distal phalanx with cortical disruption. **(b)** Axial fat-saturated T2-weighted MR image reveals an epidermoid inclusion cyst invading the tuft (black arrowheads) and extending to the nail bed, pushing back the ungual matrix (white arrowheads). The inclusion cyst contains T2-hypointense keratin lamellae centrally (*).

frequently affecting the proximal phalanx (26,27). They may arise de novo or from malignant transformation of benign cartilaginous lesions such as enchondromas. At imaging, it may often be difficult to distinguish chondrosarcomas from their benign chondroid counterparts such as enchondromas (28). Phalangeal chondrosarcomas are locally aggressive and, unlike chondrosarcomas of other skeletal structures, rarely metastasize (27). Radiography and CT may reveal a mixed lytic and sclerotic appearance of the affected bone arising from the medullary canal, with sclerotic regions representing chondroid matrix mineralization (Fig 16). Higher-grade lesions tend to demonstrate less matrix mineralization and may exhibit a more aggressive pattern of bone lysis, such as a moth-eaten or permeative appearance (7). Cortical breakthrough, irregular cortical thickening, and a soft-tissue component are all suggestive of chondrosarcoma rather than benign tumors such as enchondroma (29). Recurrence of these tumors after resection or curettage has been reported.

Occasionally, primary tumors of the nail bed, including squamous cell carcinoma and malignant melanoma, can infiltrate adjacent bone (14,30,31).

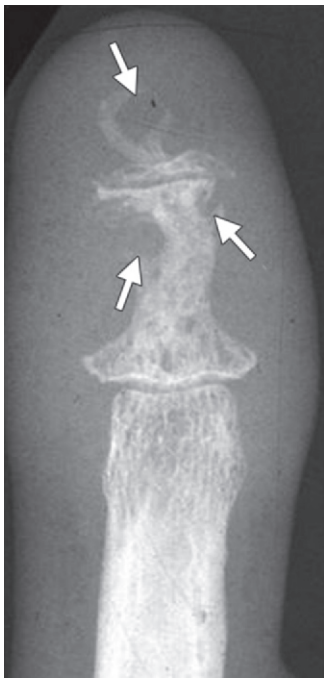
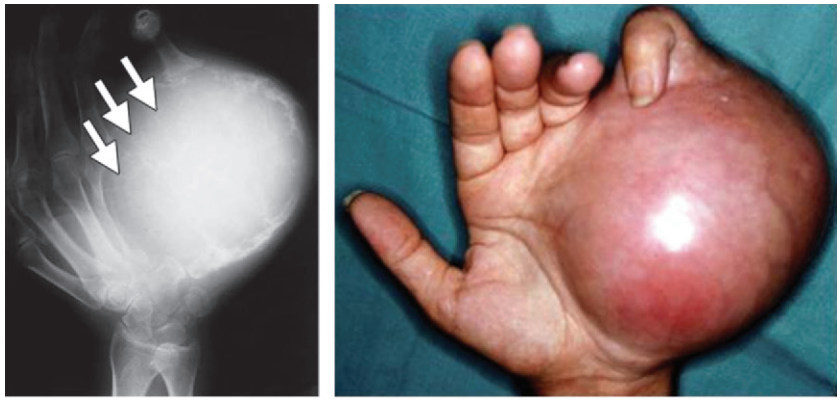


Figure 15. Sarcoidosis. Frontal radiograph shows a lacelike osteolytic process (arrows) in the middle and distal phalanges. Note the soft-tissue swelling around the finger.



a. b.

Figure 16. Chondrosarcoma. **(a)** Frontal radiograph demonstrates a large lobular lesion of the fifth metacarpal bone causing ballooning of the cortex. Note also the regions of internal chondroid matrix (arrows). **(b)** Clinical photograph shows a large deformity along the ulnar aspect of the hand.

Squamous cell carcinoma is the most common malignant tumor of the nail unit and is seen more often in men than in women, with a peak prevalence between the ages of 50 and 69 years (30). One retrospective study of squamous cell carcinoma of the nail bed over a 15-year period showed that the majority of lesions were found in the second and third digits, and that involvement of adjacent bone did occur, albeit rarely (30).

Metastatic lesions of the tubular bones of the hands are extremely rare but are associated with a poor prognosis (32,33). When they do occur, the distal phalanx is the most common site of involvement. Primary tumors associated with subungual metastases include (in descending order of frequency) tumors of the lung, genitourinary tract, and breast, with the most common histopathologic findings being squamous cell carcinoma and renal cell carcinoma. Of these lesions, more than 90% exhibit osseous involvement (32). Occasionally, metastasis to the fingers may be the primary manifestation and may be confused with infection at initial workup.

Conclusion

Tumors and tumor-like lesions of the small tubular bones of the hand are exceedingly rare, and when these lesions do occur, they are more often benign than malignant. Changes in the radiographic appearance of a previously known nonaggressive-appearing lesion, or development of persistent new symptoms associated with the lesion, may be harbingers of malignant transformation. A variety of systemic and local processes can mimic aggressive bone lesions of the hand. A multimodality approach to imaging of the fingers is often needed to characterize bone lesions and assess related complications.

Teaching Point

***Disclosures of Conflicts of Interest.*—A.G.:** *Activities related to the present article:* disclosed no relevant relationships. *Activities not related to the present article:* stockholder in Boston Imaging Core Lab; consultant for Sanofi Aventis, Merck Serono, and Tissue Gene. *Other activities:* disclosed no relevant relationships. **F.W.R.:** *Activities related to the present article:* disclosed no relevant relationships. *Activities not related to the present article:* stockholder in Boston Imaging Core Lab. *Other activities:* disclosed no relevant relationships.

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RadioGraphics

Diagnostic Imaging of Benign and Malignant Osseous Tumors of the Fingers

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Page 1955
Imaging evaluation of the hands and fingers usually begins with conventional radiography, especially when the patient presents with traumatic or nontraumatic pain or with complaints of a palpable abnormality of a digit.

Page 1955
A systematic approach is imperative for the assessment of bone tumors, with special attention paid to the size, number, and location of lesions; margins and zone of transition; periosteal reaction; matrix mineralization; and presence of a soft-tissue component.

Page 1955
In recent years, with high-field-strength systems widely available and improvements in coil technology providing an enhanced signal-to-noise ratio, MR imaging has become integral to the evaluation of disease entities of the hands and digits. MR imaging helps assess the extent of soft-tissue and bone marrow involvement of lesions of the fingers.

Page 1963
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Page 1966
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