Lesions of the hand and wrist may originate in either soft tissues or bone. They can be divided into two groups, tumorlike lesions and true neoplasms, with the latter subdivided into benign and malignant tumors. Although there are a relatively large number of lesions and subtle variations, established principles of tumor management provide a logical and systematic approach to both diagnosis and treatment. Collaboration with a musculoskeletal radiologist and a pathologist is frequently important for arriving at the correct diagnosis and applying the proper treatment. Although many of these lesions can occur in other parts of the body, their presentation and treatment may differ in the hand and wrist.

**Classification**

Benign neoplasms have been clinically classified into three types: latent, active, and locally aggressive. Latent tumors either remain unchanged or heal spontaneously and therefore may not require treatment other than observation. An example is a soft-tissue hemangioma undergoing involution. Active tumors continue to grow but are constrained by anatomic boundaries. They usually require surgery, either by intralesional or marginal excision. Common examples are enchondromas and lipomas. Locally aggressive tumors continue to grow beyond their natural anatomic boundaries; an example is a giant cell tumor of bone that destroys the cortex and extends into adjacent soft tissues.

**General Principles**

On initial evaluation, any lesion is more likely to be a common rather than a rare condition. The most common soft-tissue lesion in the hand and wrist is a ganglion; the most common bone tumor is an enchondroma. An unusual presentation of a common lesion is more frequent than the occurrence of a rare lesion. However, errors can be made when a seemingly innocent-appearing mass is not appropriately evaluated.

Evaluation begins with a detailed history that includes any pertinent medical conditions or events (eg, renal disease, parathyroid disease, prior malignancies) and a family history of similar lesions. The history also should include information concerning the lesion’s rate of growth, changes in consistency or color, associated pain or neurologic symptoms, and any prior trauma to the area. Rapid growth, night pain, and/or increase in pain should raise the suspicion of a malignant tumor, although such symptoms also may occur with benign lesions.

During the clinical examination, the location of the lesion should be carefully documented using anatomic landmarks as references. A sketch of the hand and wrist depicting the location and dimensions of the mass is often helpful as a reference for future examinations, when
changes in size or configuration are evaluated. The color of the overlying skin, mobility of the mass, movement with adjacent tendons, and consistency (eg, firm, soft, lobulated, cystic) also should be documented. Some lesions may be pulsatile, have a thrill or bruit, or increase in size with dependency of the hand (gravity-induced filling).

Conventional radiographs always should be obtained, even for soft-tissue masses. They may show calcific densities within the lesion, such as phleboliths in a hemangioma, or changes in the cortex of the bone because of pressure from the overlying mass. In complex lesions for which plain radiographs are not diagnostic, computed tomography (CT) can be used to visualize bony details. CT images are obtained in 2-mm slices, together with coronal and sagittal reconstruction. Magnetic resonance imaging (MRI) is useful to determine the extent and characteristics of soft-tissue lesions. For vascular lesions, magnetic resonance angiography (MRA) and/or conventional angiography are commonly used. Bone scans are helpful if other sites of involvement are suspected.

Surgical Principles

Useful diagnostic tests include needle aspiration of a soft-tissue cyst such as a ganglion, or core needle biopsy (with radiographic guidance) for some bone lesions, such as giant cell tumors of bone and aneurysmal bone cysts. Excisional biopsies can be safely performed for small tumors (<2 cm) and for some larger tumors (such as lipomas) that have both the clinical and radiographic features of benign lesions. For most tumors or when the diagnosis is in doubt, an incisional biopsy should be done before excision.

The biopsy is the final step in the workup that establishes the definitive diagnosis, and the importance of adhering to strict principles when performing this procedure cannot be overstated. If there is any possibility that the lesion could be malignant, only the physician who will perform the definitive surgery should perform an open biopsy. Improperly performed biopsies have resulted in significant complications, often requiring alterations in the preferred course of treatment that may result in a compromised outcome. Use of a compressive bandage to exsanguinate the limb should be avoided because of the risk of spreading tumor cells. Instead, the limb is elevated for several minutes before tourniquet inflation. Longitudinal incisions are preferred to transverse incisions because they are more easily incorporated into a definitive resection. The surgical approach should be the most direct route and, if possible, through a single anatomic compartment to minimize tumor cell contamination of surrounding tissues. Meticulous hemostasis and closure of tissue planes also reduce the risk of tumor spread. Because infections can imitate virtually any tumor, cultures of the biopsy specimen are advisable.

With a skilled musculoskeletal pathologist, a frozen section of the biopsy specimen is often sufficient for definitive diagnosis, and excision of the entire lesion often can be done at the same surgery. However, when the diagnosis is in doubt, definitive treatment should be delayed until the permanent sections are reviewed. Even when frozen sections are inconclusive, they are helpful because they determine whether adequate tissue is present to allow diagnosis with the permanent sections. Communication with the pathologist is critically important, particularly when there is a pathologic fracture, because the presence of fracture callus may confuse the diagnosis.

Tumorlike Lesions of Soft Tissues

Ganglion

A ganglion is the most common soft-tissue mass occurring in the hand and wrist. Although the exact etiology is unknown, mucoid degeneration of collagen tissue is the most likely cause. The tendency for these lesions to fluctuate in size may be the result of a one-way valve mechanism. Although a ganglion can develop at any joint or tendon sheath, the most common locations in order of frequency are the wrist, flexor tendon sheaths of digits (retinacular cysts), and distal interphalangeal joints (mucous cysts). In the wrist, most lesions are situated dorsally and originate from the scapholunate joint. When they appear on the volar surface, they usually arise from the radiocarpoid or scaphotrapezial joint. Ganglia also can arise from other joints, such as the distal radioulnar and ulnocarpal joints. The typical presentation is a smooth, firm mass that is sometimes tender and painful. When sufficiently large, the ganglion will transilluminate. A volar radial ganglion of the wrist can cause compression of the median nerve in the carpal canal; a volar ulnar ganglion can cause compression of the ulnar nerve in Guyon’s canal.

Nonsurgical treatment, including aspiration and a corticosteroid injection of the lesion, or simply disrupting the mass with multiple punctures, has a recurrence rate of 13% to 100%. Although recurrence after aspiration is high, the procedure can relieve pain and is diagnostic when a viscous, jellylike clear mucin is obtained; thus, one attempt at aspiration can be justified. However, aspiration of a radial volar wrist ganglion should be avoided because of the risk of injury to the radial artery, which is usually in intimate contact with the mass.
Ganglia always should be excised at their origin to reduce the risk of recurrence. Although most surgeons think that the capsule should be left open, some advocate closure. After excision of a volar ganglion, the wrist should be immobilized in slight extension for 7 to 10 days; after excision of a dorsal ganglion, the wrist should be immobilized in a slight flexion to avoid a capsulodesis effect that can result from postoperative scarring.

A mucoid cyst is associated with some degree of degenerative arthritis of the underlying distal interphalangeal joint and the presence of an osteophyte that may or may not be evident on conventional radiographs. When the cyst is small (several millimeters in diameter), no treatment is necessary. A corticosteroid injection is generally avoided because it can cause further thinning of the overlying skin, which can easily tear and lead to a joint infection. When the skin is already very thin, cyst excision is warranted, and removing the osteophyte reduces the risk of recurrence to about 10%. Care must be taken to avoid injury to the germinal matrix. When the skin overlying a large cyst is extremely thin, it should be excised together with the cyst. Coverage with a skin graft is usually necessary; an excellent donor area for a full-thickness graft is the thenar crease of the palm. An elliptical graft can be harvested from this site leaving little, if any, visible scar.

**Epidermal Inclusion Cyst**

Epidermal inclusion cysts are the third most common mass of the hand, following ganglia and giant cell tumors of the tendon sheath. Epidermal inclusion cysts result from penetrating trauma, with deposition of keratin-producing epithelial cells into the soft tissues. Consequently, they are most commonly found on the tactile surfaces of the digits, where they are slow growing, firm, and usually painless. When large, an inclusion cyst frequently will cause pressure erosion of the underlying phalanx. In some instances, the erosion is so severe that the bone is markedly weakened. Treatment requires not only excision of the cyst but also a bone graft to restore skeletal stability. Recurrence after surgery is uncommon.

**Foreign-Body Granuloma**

The lesion may be difficult to differentiate clinically from an epidermal inclusion cyst, especially when it is on the tactile surface of a digit. Conventional radiographs can aid in the differentiation when the foreign material is radiodense. Treatment is determined by the accessibility of the lesion, and usually only symptomatic lesions are excised.

**Fibromatosis/Calcifying Aponeurotic Fibroma**

Dupuytren’s disease is a fibromatosis involving the palmar fascia of the hand that may cause finger contractures. However, the diagnosis may not be evident with the initial presentation of nodules, which generally are nontender although they are sometimes transiently painful in the early stage of the disease. The nodules contain contractile myofibroblasts and are commonly associated with dimpling of the overlying skin. Knuckle pads (Garrod’s nodes), another form of fibromatosis, are found on the dorsum of the proximal interphalangeal joints. They occur in 20% to 40% of patients with Dupuytren’s disease and are more common when the other diatheses of the disease, such as Peyronie’s disease (penile involvement) and/or Ledderhose’s disease (plantar fascia involvement), are present. Knuckle pads almost never require excision, and treatment of Dupuytren’s nodules in the absence of any joint contracture also is nonsurgical. Corticosteroid injections may provide some symptomatic relief for a painful nodule. The pain is more likely to be secondary to a tenosynovitis of the underlying flexor tendon sheath rather than a result of the nodule itself. If pain persists and the accuracy of the diagnosis is in doubt, biopsy is warranted.

Calcifying aponeurotic fibroma (juvenile aponeurotic fibroma) is a rare tumor that was originally reported in infants and young children. More recently it also has been reported in adults and thus is more appropriately referred to as calcifying rather than juvenile. It usually presents as a slow-growing, painless, nontender mass. Radiographs typically show a soft-tissue mass with fine, granular calcifications. At surgery, the tumor is a firm, gray mass with poorly defined borders, giving it an ominous appearance. Histologically, the tumor consists of fibrous tissue containing foci of chondroid metaplasia and areas of calcification. Treatment requires wide resection. The recurrence rate is high and may exceed 50%, but it decreases with age, as does its rate of growth. Because malignant transformation has not been reported, recurrence is treated with observation or, when the lesion is symptomatic, with repeat resection.

**Gout/Tophaceous Pseudogout**

Gout is caused by either overproduction or underexcretion of uric acid, resulting in precipitation of monosodium urate crystals within synovial or tenosynovial tissues. The crystals generally elicit an intense inflammatory response characterized by marked swelling, erythema, and pain. The appearance of gout can be mistaken for infection, rheumatoid arthritis, or even neoplasm. Gouty flexor tenosynovitis in a finger can be confused with a suppurative tenosynovitis. Gouty tenosynovitis also can affect the flexor tendons more proximally in the carpal canal and the extensor tendons under the extensor retinacu-
lum. In chronic disease, tophaceous deposits are common, affecting metacarpophalangeal and interphalangeal joints as well as carpal joints. The diagnosis is confirmed by the identification of needle-shaped, negative-birefringent crystals on joint or tenosynovial aspiration.

An acute attack is treated with colchicine and anti-inflammatory medication. Treatment of painful chronic tophi is more problematic because they are not likely to resolve with medication, and complete excision usually is not feasible because they are not encapsulated. However, tophi can be debulked, which is indicated for impending skin breakdown, for pain relief, to control drainage or infection, and to improve function and cosmesis. Frequently, more extensive procedures are necessary, such as excision of necrotic tendons, arthroplasty, and arthrodesis. In some cases, amputation of a severely affected finger is required.

Tophaceous pseudogout (tumoral calcium pyrophosphate deposition disease) is characterized by deposition of calcium pyrophosphate in tumorlike masses. Pseudogout crystals, unlike the monosodium crystals of gout, are rhomboid-shaped and weakly positive birefringent under polarized light microscopy. Radiographically, the lesion presents as a soft-tissue mass with calcification and occasional bone erosion. Wrist involvement is common and is characterized by calcification of the triangular fibrocartilage complex. Like gout, pseudogout can cause severe inflammation. Treatment for the acute flare-up is rest, immobilization of the inflamed joint, and anti-inflammatory medication. Treatment for a large pseudogout lesion is the same as that for a gouty tophus (debulking or more extensive procedures).

**Vascular Aneurysms**

A true vascular aneurysm is differentiated from a false or pseudo-aneurysm by the presence of all three layers of the arterial wall—endothelium, tunica media, and tunica adventitia. True aneurysms result from repetitive blunt trauma that causes a weakening of the vessel wall and progressive dilation of its three components. They usually involve the ulnar artery in the hypothenar area of the palm and occur in individuals who use that area as a hammer (hypothenar hammer syndrome).

A false aneurysm develops as a consequence of a penetrating injury that causes a partial laceration to the arterial wall. The hematoma at the site of injury organizes, recanalizes, and forms an outer wall for the injured vessel. The endothelium, the only layer of the original artery that remains, communicates with the new outer wall cavity. The medial and adventitial layers of the original artery are not part of the wall of a false aneurysm. The interval between injury and aneurysm can range from weeks to years. Although trauma is the most common cause of both true and false aneurysms, they also can be caused by infection, atherosclerosis, arteritis, tumor infiltration, and metabolic disorders.

The most common presenting complaint is a painless mass that is not always pulsatile. Obtaining a complete history from the patient is important because prior trauma to the area can indicate the possibility of the lesion. Additional symptoms and clinical signs may result from the aneurysm's compressing adjacent structures (particularly nerves) or from the shedding of emboli into the fingertips. Although angiography remains the most effective means of diagnosis, pulse volume recordings, duplex scanning, and Doppler ultrasound recordings also provide valuable information.

Treatment is the same for true and false aneurysms. Because the natural history for each is a progressive increase in size with possible thrombosis and shedding of emboli, resection is recommended. At surgery, a true aneurysm is usually more uniform in shape than a false aneurysm, which tends to have a sac-like appearance. The decision to ligate the proximal and distal ends of the artery or to repair the artery is determined by the adequacy of collateral circulation. In patients with inadequate collateral circulation, the artery is repaired either end-to-end or, when the gap is large, with an interpositional vein graft.

**Vascular Malformation**

Vascular malformations result from errors in development of the vascular system during the fourth through tenth fetal weeks. These malformations are present at birth, although they may not become clinically evident until adulthood. Vascular malformations generally are classified as low-flow (capillary, venous, lymphatic) or high-flow (arterial) lesions. Clinically differentiating a vascular malformation from a hemangioma is not always possible. One major difference is that a hemangioma often will spontaneously involute, whereas a vascular malformation will not.

Venous malformations are the most common of low-flow lesions. They present as a blue swelling or a mass that increases in size with the hand dependent and decreases with the hand elevated. Patients typically present because of a cosmetic deformity and an uncomfortable, heavy feeling in the hand, especially when it is in a dependent position. They also may complain of pain caused by either local neurovascular compression or thrombophlebitis. Imaging studies such as MRI, MRA, and conventional angiography can delineate the extent of the lesion. Surgery is indicated to relieve pain when nonsurgical measures such as compression garments, elevation, and pain medications are unsuccessful, as well as...
to improve the aesthetic appearance of the area. Recurrence after complete excision is uncommon, but when the lesion is diffuse and extensive, complete excision frequently is not feasible. In such cases, staged resections or simply debulking the lesion usually will provide temporary symptomatic relief. Repeated debulkings are sometimes necessary, and in severe cases, amputation of a digit may be required.

**Tumorlike Lesions of Bone**

**Cystic Lesions**

In order of relative frequency, radiographically apparent cysts of the wrist and hand are intraosseous ganglions, aneurysmal bone cysts, and unicameral bone cysts. As a group, these lesions are far more common outside the hand and wrist.

An intraosseous ganglion is the most common bony cystic lesion of the hand and wrist, usually occurring in a carpal bone (Fig. 1). It is far less common than a soft-tissue ganglion, although the histologic characteristics are identical. The etiology of an intraosseous ganglion remains unknown, and controversy continues concerning the existence of a connection between lesion and joint. For the symptomatic cyst, treatment is curettage and grafting.

An aneurysmal bone cyst is a benign, locally aggressive lesion of unknown etiology that clinically behaves similarly in the hand and wrist as elsewhere in the body. Aneurysmal bone cysts involving the hand account for approximately 5% of cases throughout the body. They are more common in metacarpals than in phalanges. Adolescents and young adults are more commonly affected. Conventional radiographs show an expansile, lytic lesion with cortical destruction. Fluid-filled lesions on MRI can confirm the diagnosis. Treatment depends on the location of the lesion and the extent of bone destruction. Curettage and packing with either autogenous bone graft or, more recently, graft substitutes and/or allografts, is usually sufficient. When an aneurysmal bone cyst destroys the entire cortical shell of the bone, a primary amputation can be considered. That is more suitable for a lesion in a distal phalanx as an amputation at that site causes less functional impairment than would a more proximal amputation. Recurrences are common (up to 50%) and are treated with repeat curettage.

A unicameral bone cyst is rare in the hand and wrist. However, the clinical and radiographic features of these cysts are similar to those in the proximal humerus and femur. They usually are discovered either as an incidental finding on radiographs taken for an unrelated problem or after a pathologic fracture. A variety of treatments has been recommended, including observation, aspiration and injection of steroids into the lesion, and curettage and grafting with autogenous graft or bone substitute material.

**Giant Cell Reparative Granuloma**

Giant cell reparative granuloma is a benign, reactive, intraosseous lesion of unknown etiology that develops in the metaphyseal/diaphyseal area of small tubular bones. The lesion does not cross an open epiphyseal plate, although in skeletally mature patients it can involve the epiphyseal end of the bone. Clinically, most patients are young (10 to 25 years) and present with pain, swelling, and tenderness following minor trauma. Radiographically, the lesion appears expansile and radiolucent with cortical thinning (Fig. 2). Microscopically, a giant cell reparative granuloma is composed of a fibrous stroma with spindle-shaped fibroblasts and multinucleated giant cells arranged in a patchy distribution. There are also areas of metaplastic bone formation and hemorrhage. The lesion may be difficult to differentiate from other lytic lesions containing giant cells, such as aneurysmal bone cysts, giant cell tumors, and brown tumors of hyperparathyroidism. Treatment is curettage and grafting. Recurrences range in frequency from 20% to 40% and are treated similarly.

**Brown Tumor**

Brown tumor is a common lesion associated with both primary hyperparathyroidism (parathyroid adenoma) and secondary hyperparathyroidism (chronic renal disease with inability to excrete phosphate). Both conditions result in an increased production of parathyroid hormone that causes increased osteoclastic activity, leading to bone resorption and trabecular fibrosis (osteitis fibrosa cystica). Brown tumors develop in areas of excessive bone resorption and hemorrhage, and they are commonly seen in distal phalanges. Radiographic features include endosteal resorption and scalloping associated with an intraosseous lytic lesion. The
diagnostic workup should include a complete screening panel to determine the nature of metabolic dysfunction.

**Reactive Bone Surface Lesions**

Reactive bone surface lesions include florid reactive periostitis, bizarre parosteal osteochondromatous proliferation (Nora’s lesion), and acquired osteochondroma (turret exostosis). These lesions are most commonly found in the phalanges of adults (25 to 45 years). Although each lesion presents as a different clinical pathologic entity, a single unifying etiology has been proposed. Each lesion may represent a different stage in the maturation and organization of subperiosteal hemorrhage that follows an initial traumatic event.

Florid reactive periostitis, the first stage in the process, appears as an ill-defined density arising from the surface of the bone. The lesion, containing varying amounts of calcific material, will sometimes grow rapidly over days or weeks. Microscopically, it resembles early fracture callus with active proliferation of cartilage cells and fibroblasts.

Bizarre parosteal osteochondromatous proliferation (Nora’s lesion) is the next stage in the maturation process. Radiographically, there is a clearly defined, cap-shaped lesion attached to the surface of the bone, containing a patchy or linear pattern of mineralization. Histologic sections show periosteal lamellar bone, irregularly covered with hypercellular cartilage (Fig. 3). There is usually atypia of the cartilage cells that can be mistakenly diagnosed as a malignancy if the pathologist is unaware of the clinical and radiographic features of the lesion.

Acquired osteochondroma or turret exostosis is the end stage of the maturation process. Radiographically, the lesion has a well-developed pattern of linear mineralization at its base that is fused with the cortex of the underlying bone. A subungual exostosis is a turret exostosis that arises from a distal phalanx.

**Benign Tumors of Soft Tissues**

**Giant Cell Tumor of the Tendon Sheath**

A giant cell tumor of the tendon sheath is the second most common lesion of the hand and wrist. It is also referred to as localized nodular tenosynovitis, pigmented villonodular tenosynovitis, fibrous xanthoma, and benign synovioma. A giant cell tumor of the tendon sheath presents as a slow-growing, firm, nontender fixed mass with a predilection for the radial three digits, particularly in the area of the distal interphalangeal joints. The tumor is often multinodular and has a propensity to involve the neighboring joint. Radiographs may appear normal or show a soft-tissue mass. Long-standing lesions adjacent to bone may cause pressure erosion of the cortex; rarely is there any bony invasion (Fig. 4, B).

Histologically, the tumor is similar to intra-articular pigmented villonodular synovitis, although it tends to be more solid and nodular. Treatment is excision of the tumor. The surgical dissection should be meticulous to ensure that any extension of tumor into the joint is removed (4, C). This will notably reduce a recurrence rate that is reported to range as high as 50%. Recurrences also are treated with local...
Although the lesions can be quite invasive.

**Fibroma of the Tendon Sheath**

A fibroma of the tendon sheath is a circumscribed tumor, rarely >2 cm in diameter, attached to the tendon sheaths of digits. The thumb is the most commonly involved digit. Histologically, the tumor resembles a giant cell tumor of the tendon sheath but with much less cellularity and without xanthoma cells or giant cells.

**Lipoma**

These lesions are composed of mature adipose tissue and clinically are usually soft and nontender, although they may feel firm with indistinct borders when located beneath muscle or fascia. A lipoma can grow to an unusually large size and still be asymptomatic. On MRI, lipomas are homogeneous, well-circumscribed masses with signal intensities similar to those of normal fat. At surgery, the tumor usually can be easily separated from surrounding structures by blunt dissection. Care must be taken to identify and protect neurovascular structures that are often displaced by the tumor. Recurrence after marginal excision is rare.

**Hemangioma**

A hemangioma consists of proliferating blood vessels and usually appears within the first few years of life. Typically, the tumor has a rapidly growing proliferative phase that may last up to 1 year, followed by an involutinal phase during which the tumor gradually fades and regresses. Approximately 50% of hemangiomas involute by age 5 years and 70% by 7 years. Tumors that do not present within the first few years of life are less likely to spontaneously involute.

The clinical appearance of a hemangioma varies depending on its location. When superficial, it has a circumscribed appearance, but when it is deep, it may be difficult to distinguish from a venous malformation. MRI and/or angiography are helpful in establishing the diagnosis. Treatment for tumors that appear during infancy consists of observation and reassuring the parents that it is likely to involute by age 7 years. Hemangiomas are sometimes complicated by bleeding, ulceration, infection, or a coagulopathy. Bleeding and ulceration are fairly common and are treated by compression of the lesion and local wound care. Infections generally respond rapidly to antibiotics. The coagulopathy is a thrombocytopenia secondary to platelet trapping in the tumor (Kasabach-Merritt syndrome). This rare condition usually is associated with large hemangiomas in major muscle groups outside the hand.

Surgery is reserved for tumors that do not undergo spontaneous involution and remain symptomatic, that cause functional impairment, or that are aesthetically displeasing. Recurrence is related to the size, location, and degree of soft-tissue infiltration of the original lesion, as well as to the completeness of the primary excision. Recurrence of hemangiomas in the hand is very low, with a reported incidence of 2%.

**Glomus Tumor**

A glomus body is an apparatus regulating normal blood flow and temperature, located in the dermal reticular layer of the skin. Glomus bodies are situated throughout the body, but they are most common in subungual areas, the lateral aspects of digits, and the palm. A glomus tumor is a benign tumor that contains modified perivascular smooth muscle cells, a component of a glomus body. The classic clinical pic-
ture is a blue-red subungual lesion accompanied by the symptom triad of cold hypersensitivity, paroxysmal pain, and exquisite point tenderness. The history and physical examination usually are sufficient to make the diagnosis, and surgical excision of the tumor is curative. When the tumor is subungal, the nail is removed and a longitudinal incision is made in the nail bed. The tumor then can be identified and excised. The nail bed usually can be repaired, but if this is not feasible, a graft from either an adjacent area of the same nail bed or from the nail bed of a toe can be harvested. The nail is then replaced because it serves as an excellent biologic dressing. Multiple glomus tumors occur in approximately 10% of patients.\textsuperscript{20}

**Schwannoma (Neurilemoma) and Neurofibroma**

A schwannoma, often referred to as a neurilemoma, is a benign nerve tumor composed almost entirely of Schwann cells. The tumor consists of hypercellular (Antoni A cell) and hypocellular (Antoni B cell) areas; the nuclei of the spindle cells have a palisading arrangement referred to as Verocay bodies. Most schwannomas are asymptomatic, but some can cause neurologic deficits resulting from compression of nerve fibers. When superficial, the tumor may be palpated, and there is often a Tinel sign with percussion over it. A schwannoma typically is well circumscribed and eccentrically located on a peripheral nerve. The fascicles of the nerve do not enter the tumor but are splayed over it. With large tumors, there may be compression of the fascicles, resulting in some neurologic deficit. Most schwannomas are solitary lesions, but multiple lesions within a single nerve or nerve trunk do occur. The tumor is excised using magnification and microsurgical techniques to reduce the risk of iatrogenic injury to the nerve fibers. Malignant transformation of a schwannoma is extremely rare.\textsuperscript{23,24}

Clinically, solitary neurofibromas behave in a fashion similar to that of a schwannoma, but with several important differences. Although both tumors arise from Schwann cells, neurofibromas contain peripheral cells, fibroblasts, and mucoid material. They also are more likely to be associated with multiple lesions, a condition referred to as neurofibromatosis or von Recklinghausen's disease. Unlike a neurilemoma, a neurofibroma is intimately connected with the nerve fascicles, and it is usually not possible to separate the two surgically. This is not a problem when the tumor is subcutaneous and presents as a firm, circumscribed nodule; then it is simply excised, and often the diagnosis is not made until microscopic sections of the lesion are studied. However, treatment for the neurofibroma of a large nerve, such as the median or ulnar nerve, is more problematic. To remove the tumor, the involved nerve segment is excised, followed by end-to-end repair or interposition of nerve grafts when the tumor is large. Because such treatment results in some permanent neurologic deficit, it is reserved for the lesion that is very symptomatic or demonstrates malignant characteristics, such as rapid growth or increasing pain. If excision is not done, an intralesional biopsy is warranted for definitive diagnosis. A similar treatment protocol is followed with multiple tumors. Whereas the potential for malignant degeneration of a solitary neurofibroma is rare, malignant degeneration in neurofibromatosis has been reported to be as high as 15\%.\textsuperscript{23,25} This percentage is for lesions in all locations; no specific figures are available for lesions isolated in the hand.

**Extraosseous Chondroma and Synovial Chondromatosis**

Extraosseous chondromas are usually pain free. Angiomyoma, also referred to as a vascular leiomyoma or angioleiomyoma, is a vascular variant of a leiomyoma. It
is sometimes calcified and usually is painful.

**Granular Cell Tumor**

A granular cell tumor usually presents as a small, poorly circumscribed nodule in subcutaneous tissues. The tumor is most commonly found in African-American women in their fourth through sixth decades. Rarely is the correct diagnosis made before microscopic examination of the biopsy specimen. These tumors were originally referred to as granular cell myoblastomas, but because it is generally accepted that they arise from neural tissue, “myoblastoma” has been dropped from the description.

**Benign Tumors of Bone**

**Cartilage-Forming Tumors**

Cartilaginous tumors are the most common type of primary bone tumor in the hand. Some are found incidentally; others present with pain, swelling, limited range of motion, and sometimes a pathologic fracture. Cartilage-forming tumors include enchondromas, periosteal chondromas, and osteochondromas. (Chondroblastomas and chondromyxoid fibromas are exceedingly rare in the hand and wrist.)

The enchondroma is the most common primary bone tumor in the hand, and it represents approximately 40% of cases throughout the body.\(^{29}\) In the hand, enchondromas usually occur in proximal phalanges, followed in frequency by metacarpals and middle phalanges. Radiographically, the lesion is centrally located, well circumscribed, radiolucent, and often associated with punctate calcifications. Medullary expansion and cortical thinning are frequent (Fig. 6). The histologic characteristics of enchondromas in the hand are sometimes different from those of enchondromas at other sites in the body. In the hand, there is often greater cellularity and atypia, which are not a concern if the clinical examination and radiographs are consistent with a benign lesion. Frozen sections of the tumor at surgery are therefore unnec-
necessary unless radiographs suggest a malignant tumor. If there is any doubt, definitive treatment should be deferred until the permanent sections are available.

Treatment is curettage of the tumor and packing with autogenous cancellous bone, bone graft substitute, and/or allograft. When autogenous bone is used, the donor area for the graft should be segregated from the tumor site by using separate instruments and different gloves. If the pathologic fracture site is unstable, it is preferable to defer surgery for several weeks until the fracture becomes stable; if there is no instability, surgery need not be delayed. Recurrence is rare and usually is the result of an incomplete curettage. Treatment is repeat curettage and bone grafting.

Malignant transformation of a solitary enchondroma into a chondrosarcoma or osteosarcoma is rare. However, with multiple enchondromatosis (Ollier’s disease), malignant transformation has been reported to develop in 25% of cases, and in Maffucci’s syndrome (multiple enchondromatosis with multiple hemangiomas or multiple lymphangiomas), the incidence of malignant transformation is even higher.30

Periosteal chondromas are cartilage tumors that usually involve long bones, such as the femur and humerus. In the hand, they most commonly occur on the cortical surfaces of phalanges in young patients (10 to 25 years). Radiographs show cortical scalloping. These tumors occur far less frequently than do enchondromas, but their histologic appearance is sometimes more aggressive. Treatment is surgical excision, accomplished either intralesionally or by en bloc resection.

Osteochondromas are cortical bony prominences with cartilaginous caps that arise in continuity with the intramedullary canal of the bone. Solitary osteochondromas are common in the upper extremity, but they are rare in the hand.12 They are most frequently seen in multiple osteochondromatosis. When a solitary osteochondroma does occur, it usually involves a proximal phalanx (Fig. 7). Excision is reserved for large lesions that interfere with digital function or are cosmetically unacceptable. Malignant degeneration in a solitary lesion in the hand is extremely rare.

Bone-Forming Tumors

Osteoid osteomas and osteoblastomas are benign bone-forming tumors that generally become symptomatic in the second and third decades of life. Pain and local ten-
darness are the most common complaints. Pain tends to be more severe at night and usually is relieved by nonsteroidal anti-inflammatory medication (NSAIDs). The pain probably is related to the high levels of prostaglandin E2 and prostacyclin found in the tumor.31

Osteoid osteomas also can be painless, especially when they occur in the fingers. Most lesions occur in proximal phalanges. Local swelling is usually the most important clinical sign in such cases, and it can mimic an inflammatory process.32 The classic radiographic appearance is a small, central, radiolucent lesion or nidus <1 cm in diameter surrounded by an area of reactive sclerosis (Fig. 8). In approximately 25% of cases, a nidus is not seen on conventional radiographs. In these situations, CT can help to confirm the diagnosis. Treatment is surgical excision of the nidus. Persistence of pain postoperatively is more common with osteoid osteoma lesions in the hand and wrist than elsewhere, probably because of incomplete excision of the nidus. In some cases, the nidus is very small and can be missed at surgery. Because some osteoid osteomas eventually “burn out,” nonsurgical treatment is an option in patients who respond favorably to NSAIDs. An osteoblastoma is a rare bone-forming tumor that is histologically similar to an osteoid osteoma, but with several differences. Osteoblastomas are larger (usually ≥2 cm in diameter), generally do not respond to NSAIDs, and tend to increase in size. Resection is usually curative. With local bone destruction or a recurrence, marginal resection followed by reconstruction is indicated.

Giant Cell Tumor of Bone
Giant cell tumor of bone is a rare benign lesion that should be distinguished from other giant cell lesions, such as giant cell reparative granuloma, aneurysmal bone cyst, and brown tumor of hyperparathyroidism. Giant cell tumors in the small tubular bones of the hand represent only 2% to 5% of all such tumors, but they are associated with a higher postoperative recurrence rate than are similar tumors elsewhere in the body.33 The most common presenting complaints are pain and swelling. Radiographs typically show an aggressive-appearing, radiolucent, expansile lesion with indistinct borders involving epiphyseal bone. Frequently, there is cortical destruction and extension into the soft tissues (Fig. 9). Some giant cell tumors are nonepiphyseal in location and show nonspecific radiographic fea-

Figure 8 A, Osteoid osteoma of the proximal phalanx of the middle finger with local swelling and tenderness. B, Posteroanterior radiograph showing a radiolucent lesion or nidus surrounded by sclerotic bone. C, Photomicrograph of the nidus showing irregular trabeculae of woven bone (arrow) bordered by osteoblasts (left of the arrow) and osteoclasts, separated by blood vessels (hematoxylin-eosin, original magnification ×120).
tures similar to those of giant cell reparative granulomas and aneurysmal bone cysts.

Treatment can be problematic because of the tumor’s aggressive nature. Although the recurrence rate after curettage and grafting is high, one attempt is still a reasonable surgical approach. For recurrent tumor, en bloc resection and bridging the defect with autograft, allograft, and/or bone graft substitute is necessary. For a tumor that causes extensive bone destruction and extends into the soft tissues, particularly when it involves a phalanx, partial or total amputation of the finger may be required.

Summary

The diagnosis and effective treatment of tumorlike lesions and tumors of the hand and wrist require the collaboration of the orthopaedic surgeon, radiologist, and pathologist. The first steps in the diagnostic workup are a complete history and clinical examination. Radiographs are useful even when the lesion is in the soft tissues because radiodensities may provide valuable clues to the nature of the lesion. There may be phleboliths in the lesion (vascular tumor), or the lesion may contain areas of mineralization in the form of calcification (cartilage matrix) or actual bone. More specialized imaging studies, such as CT, MRI, MRA, and angiography, also may be indicated. Oncologic surgical principles always should be followed, and whenever there is any doubt as to the nature of the lesion, an incisional biopsy should be done before proceeding with the definitive surgical procedure.

References