CHAPTER **20**

# BENIGN BONE TUMORS OF THE FOOT AND ANKLE

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Benign bone tumors of the foot and ankle typically present both a diagnostic and therapeutic challenge to podiatric surgeons. These lesions have a relatively low incidence of occurrence in the foot and ankle when compared to other regions of the body, and the behavior of these lesions may mimic malignant tumors. Not only is it important to recognize a specific lesion to insure proper treatment, but the ability to differentiate a benign from malignant process is of utmost importance.

It is difficult to determine the true incidence of benign bone tumors of the foot and ankle. Most large studies do not distinguish individual tarsal bones, nor is there a distinction made between proximal and distal aspects of the tibia and fibula. Dahlin's Bone Tumors has reported findings of the Mayo Clinic up until 1993.[1] Of a total of 2334 benign bone tumors affecting the whole body, 3.3% involved the foot and 19.3% involved the tibia and fibula. Of a total of 5642 malignant bone tumors affecting the entire body, 1.3% involved the foot and 12.4% involved the tibia and fibula.

Table 1 displays the percentage of each lesion found in the leg and foot. The lesions represent a percentage of local lesions compared to the total number of lesions reported for the studies. It does seem apparent that the overall incidence of foot and ankle involvement is relatively low, but some tumors do occur with a somewhat frequent rate. Primarily, enchondroma, osteochondroma, osteoid osteoma, simple (unicameral) bone cysts, and aneurysmal bone cysts are somewhat common in the foot and ankle.

## RADIOGRAPHIC CHARACTERISTICS OF BENIGN BONE TUMORS

Several radiographic parameters have been described to differentiate between benign and malignant bone tumors. Although there are exceptions to each of these parameters, most lesions can be differentiated by following these guidelines. None of these guidelines alone can make the diagnosis of a benign or malignant bone tumor.

**Table 1**

**SKELETAL LOCALIZATION OF BENIGN BONE TUMORS**

| **Dahlin & Unni(1)** | **Tibia** | **Fibula** | **Foot** | **Total Lesions** |
|---|---|---|---|---|
| Enchondroma | 2% | 1% | 2% | 748 |
| Osteoid osteoma | 19% | 1% | 6% | 332 |
| Osteochondroma | 10% | 4% | 1% | 748 |
| **Resnick & Niwayama(2)** | | | | |
| Enchondroma | 3% | 2% | 7% | 1028 |
| Osteoid osteoma | 24% | 4% | 11% | 661 |
| Osteochondroma | 18% | 4% | 6% | 1604 |
| Simple Bone Cyst | 6% | 5% | 1% | 884 |
| Aneurysmal Bone Cyst | 15% | 7% | 8% | 465 |

Cortical destruction is usually associated with malignant lesions. Most benign lesions will have a well-defined, intact overlying cortex within the bone of origin. Exceptions include benign processes such as giant cell tumors, aneurysmal bone cysts, eosinophilic granulomas, and infection, all of which can be associated with a variable degree of cortical thinning and/or destruction.[3]

Periosteal reactions are non-specific findings which can occur in response to any process which irritates the periosteum. Trauma, fracture healing, infection, as well as benign and malignant tumors, can cause periostitis. Most benign periosteal reactions are characterized by a thick, dense pattern where the affected bone has the ability to respond to the underlying pathology. This can generally occur because most benign processes are slow growing and allow adequate response time of the bone. On the other hand, a malignant or aggressive periosteal reaction is characterized by a non-uniform region of bone production. Examples would include sunburst or lamellated periosteal reactions where bone production is rapid and non-uniform. Most benign processes are characterized by benign periosteal reactions, although an aggressive reaction can be seen in benign tumors such as aneurysmal bone cysts, aggressive giant cell tumors, eosinophilic granulomas, and osteoid osteomas.[3] In general, malignant lesions will not cause benign periostitis.

The zone of transition is the border or margin which surrounds a lesion within the bone of origin. Helms states this is one of the most reliable indicators of a benign versus malignant lesion.[3] A "narrow" or well-defined zone of transition is characterized by a margin that can be readily traced with a pencil or ball point pen. In contrast, a "wide" zone of transition or ill-defined border cannot readily be outlined or traced. Resnick describes three patterns of bone destruction: geographic, moth-eaten, and permeative.[4] Most benign bone tumors are characterized by a "narrow" (geographic) zone of transition, whereas malignant or aggressive benign tumors are associated with a "wide" (moth-eaten or permeative) zone of transition.

Finally, the orientation of a lesion with respect to the long axis of a long bone can help to determine a benign from malignant process. Most benign tumors of long bones will have a long axis that is parallel to the long axis of the bone that is affected. This is probably the least reliable feature as there are numerous exceptions, and probably has little to no value when evaluating tumors of the tarsal bones.

Table 2 lists several radiographic features that can be used to help determine if a lesion appears benign or malignant on radiographs. No one feature is pathognomonic.

## ENCHONDROMA

An enchondroma is a benign cartilage growth that occurs in the medullary cavity of a bone. This lesion can occur in any bone that is preformed in cartilage. Enchondromas account for approximately 12% of primary bone tumors. The lesion typically arises during growth of the child, but does not manifest symptoms until the third to fourth decade. It is the most common tumor of the small bones of the hand.[1]

**Table 2**

**RADIOGRAPHIC FEATURES OF BENIGN AND MALIGNANT BONE TUMORS**

| X-RAY EVALUATION | BENIGN | MALIGNANT |
|---|---|---|
| cortical break | rare | extensive |
| periosteal reaction | single layer | multi-layer |
| zone of transition | "narrow" (geographic) | "wide" (permeative) |
| trabeculation | coarse | fine |
| marginal sclerosis | thick | thin |
| tumor size | small | large |
| overall appearance | geographic | moth-eaten |

Enchondromas are thought to represent the most common tumor of the foot.[1,5,6] Common sites include the phalanges, metatarsals, and tarsal bones. The lesion is typically associated with painless swelling unless pathologic fracture occurs. Fractures through the lesion are common.

The radiographic features are by no means unique. Typically, a radiolucency is encountered with a variable degree of thinning of the overlying cortex. Often, punctate radio-densities can be appreciated which represent calcification of the matrix within the lesion. The presence of pinhead-to match head-sized radiopacities (reflecting calcification) in the regional area helps to clinch the diagnosis.[7] The tumor is most commonly located in the central to distal aspect of the phalanges and metatarsals.

Treatment should be aimed at the prevention of pathologic fracture, especially if the lesion is found in the small bones of the hands and feet. Curettage with bone grafting is the most common method of treatment. Curettage with cryotherapy is another treatment modality. The recurrence rate after resection of the lesion is low.

## OSTEOID OSTEOMA

An osteoid osteoma is characterized by a central nidus that is typically less than one centimeter in size. Another distinct feature is that the nidus is usually surrounded by a variable degree of reactive sclerosis.

Osteoid osteomas account for approximately 11% of all primary bone tumors. Most patients with this lesion are between the ages of 10 and 25 years old. The lesion is characterized by nocturnal pain that is frequently rapidly relieved by the administration of aspirin or nonsteroidal anti-inflammatories. There is evidence that the pain may be mediated by prostaglandins.[8]

Osteoid osteomas probably represent the second most common tumor of the foot, with the talus being most commonly affected.[6] All other tarsal and leg bones can be affected. The pain associated with the lesion is often worse with weight bearing and ambulation. Clinical signs can include pain with joint range of motion, an antalgic gait, and muscle atrophy which may mimic a neuromuscular disease or a systemic form of arthritis. Most commonly, the lesion will reveal localized edema and tenderness on physical examination.

The radiographic features of the lesion can be distinct when present. The lesion is characterized by a central nidus (appears radiolucent) and a variable amount of reactive sclerosis. These findings are usually very obvious if the lesion is present in long bones and has a cortical location. Lesions occurring in primary cancellous bone may not show such distinct features. Three out of ten osteoid osteomas of the foot reported by Shereff et al. had normal routine radiographs, but were detected with tomography.[8] When lesions are not visualized by plain radiographs, most can be located with the use of a CT scan.

The mainstay of treatment seems to be complete surgical resection of the nidus. Often, incomplete resection of the nidus may afford partial to total relief of symptoms.[10] In order to adequately resect the lesion, it must first be localized within the parent bone. Most often this is accomplished by the use of a CT scan, but other methods which have been described include the use of radioactive isotopes (such as technetium), and tetracycline with UV light fluorescence. Surgical resection seems to be associated with an approximately 2% recurrence rate. Spontaneous regression of untreated osteoid osteomas has been reported, although no histologic confirmation was obtained in many of the cases.[10]

## OSTEOCHONDROMA

An osteochondroma is a hyaline cartilage capped protrusion on the external surface of a bone. Osteochondromas are the most common primary bone tumors and account for approximately 50% of all benign bone tumors. Almost any age group can be affected, although most patients will present with this lesion in the second to third decade. Malignant transformation has been described in approximately 1% of these lesions, and should always be suspected if this lesion is painful. Complications that have been described with this lesion include fracture at the base of the lesion, infarction of the osseous stalk, impingement of local tendons and nerves, pseudoaneurysm of adjacent blood vessels, and bursae formation over the tip of the lesion.[10]

When present in the foot, the lesions seem to occur most commonly in the metatarsals, tarsal bones, and phalanges. It can also be found near the metaphyseal region of the tibia and fibula about the ankle joint. Most frequently, the lesion

will present as a painless mass that can be aggravated by weight bearing and ambulation. The lesion is often found incidentally when routine radiographs are obtained.

The radiographic features of this lesion are unique and distinct from any other bone tumor. The lesion is characterized by a "stalk" that usually emanates from the metaphyseal region of a long bone. The base and stalk of the lesion contain cortical and medullary bone that are in direct continuity with the bone of origin. The lesion also frequently points "away" from the joint near which it arises.

One lesion that must be differentiated from an osteochondroma is a subungual exostosis. Major differences include the following:

A subungual exostosis does not exhibit cortical or medullary continuity with the bone of origin.

A subungual exostosis arises from the tip of a phalanx (which is not metaphyseal bone).

The cartilage cap of a subungual exostosis consists of fibrocartilage, whereas the cap of an osteochondroma consists of hyaline cartilage.

A subungual exostosis displays histologic features which consist of spindle cell proliferation.

The treatment of an osteochondroma typically consists of excision of the tumor flush with the bone of origin. Not all lesions need to be resected, but indications would include pain or disability, an abnormal increase in size or pain, or radiographic features that suggest malignancy. Resection has been associated with an approximately 2% recurrence rate.

## SIMPLE (UNICAMERAL) BONE CYST

Simple bone cysts are fluid-filled solitary cysts that typically arise in the metaphyseal region of long bones. These lesions are most frequently seen in the femur and humerus of children and adolescents. In adults the lesion is most commonly found in the calcaneus and ilium. The lesion is rarely symptomatic unless pathologic fracture has occurred. Often the lesion will produce mild and vague symptoms, but attention is usually directed to the lesion as a result of minor or incidental trauma.

The cyst is usually found in the central aspect of long bones. In the calcaneus, the lesion can be found inferior to the posterior facet. The cortex of the parent bone is always intact, unless fracture has occurred. A characteristic feature is the fallen fragment sign. This represents a free fragment of cortical bone which by gravity falls to the lowest portion of the cyst. The fragment can fall freely as the result of the cyst being fluid filled and unilocular.

Curettage and bone grafting of the lesion is the conventional method of treatment. Scaglietta et al. showed favorable results in 90% of patients treated by intra-lesional injection of methylprednisolone acetate.[1] The cyst is observed for opacification over the next 3 to 6 month period to evaluate for healing. Regardless of the method of treatment, recurrence rates have been reported as high as 20% to 50%.

## ANEURYSMAL BONE CYST

This lesion accounts for approximately 6% of primary bone tumors. Nearly 80% of these lesions occur in patients less than 20 years of age. Of 257 cases of benign bone tumors of the foot treated at the Bone Tumor Center of the Rizzoli Institute, approximately 10% of the tumors were aneurysmal bone cysts.[11]

There is some confusion in the literature as to whether this is a primary or secondary lesion. Some authors believe that the tumor is a primary lesion that arises as an independent entity, whereas others believe the lesion arises from another pre-existing lesion. Two lesions which seem to commonly give rise to an aneurysmal bone cyst include giant cell tumors and chondroblastomas.

Pain and swelling of varying duration are the most common presenting symptoms. Lesions which are in close proximity to joints may cause pain with joint motion or even an apparent synovitis. Pathologic fracture is common. Aneurysmal bone cysts often show rapid enlargement during pregnancy.

Plain radiographs often reveal a metaphyseal lesion located in an eccentric position. Cortical thinning and osseous expansion are frequently noted features. Fluid-fluid levels are characteristic and seen on both CT scans and MRI. The fluid-fluid levels represent loculated areas within the cyst that contain degraded blood products, serum, and tumor fluid.

The most successful treatment reported by Dahlin has been surgical removal of the entire lesion, or as much of it as possible.[1] Bone grafting of the resultant defect may be required. Curettage with cryotherapy and *en bloc* resection have also been described. Excision of the lesion is associated with a 10% to 30% recurrence rate.

## SUMMARY

Recognition of benign bone tumors of the lower extremity is an important skill for podiatric surgeons. Not only is it important to be able to recognize individual benign bone tumors, but it is also very important to be able to distinguish benign from malignant lesions. Treatment and appropriate referral of bone tumors is based on the ability to recognize the lesion, an understanding of current treatment methods, and the skills of the surgeon.

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