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Enchondroma of the Foot

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ABSTRACT

The present study is a review of 20 patients with enchondroma of the foot treated from January 2005 to March 2012. All patients were examined clinically, followed by an evaluation of their enchondroma of the foot radiographically and an assessment of the outcome of their surgical intervention. The patients' sex and age, enchondroma location, findings from imaging studies such as plain radiography, computed tomography, and magnetic resonance imaging, clinical findings, operative findings, and treatment outcomes were recorded. The average postoperative follow-up period was 24 months. Eighty percent of the tumors were located in the proximal phalanx and 14 (70%) patients presented with pathologic fracture. The plain radiographs and computed tomography findings revealed 13 (65%) cases of internal calcification and 11 (55%) with endosteal scalloping. A periosteal reaction was seen only in 4 (20%) cases. Magnetic resonance imaging of 11 (55%) patients showed low T_1-weighted and high T_2-weighted signal intensity in all cases. Internal septa and nodules with low T_2-weighted signal intensity were observed in 9 (82%) out of 11 cases, and adjacent soft tissue edema was noted in 9 (82%). All patients underwent curettage of the tumor and bone grafting as their surgical treatment. No recurrence or postoperative complications were observed during the 24-month follow-up period. Enchondroma of the foot most frequently involves the proximal phalangeal bone and is often associated with pathologic fracture. The unique clinical signs and characteristic radiographic images are easily recognized, making this a relatively easy diagnosis. With appropriate treatment, a good surgical outcome can be expected.

Enchondroma is the second most common benign cartilaginous tumor after osteochondroma. It is typically found within the medullary cavity of the bone (1). Enchondromas have a distinct predilection for the appendicular skeleton and are composed of mature hyaline cartilage that is frequently found in the hands more than in the foot and ankle bones, in particular, the phalanges (2–4). They can also occur in the long bones of the upper arm and thigh. The most common location of an enchondroma is in the metaphyseal region, presumably owing to their origin from the growth plate. They can also occur in the diaphysis. They are rarely seen in the epiphysis, and the presence of a cartilaginous lesion in the epiphysis is more likely to be chondroblastoma (5) than enchondroma. The age of the patients has varied widely. Enchondromas are usually asymptomatic but can cause sharp pain secondary to a pathologic fracture or pressure resulting from an expanding lesion (4). Thus far, only a few reports on enchondroma of foot have been published, no doubt a reflection of the rarity of the tumor. Most of the published reports have been case series studies that lacked data to compare the various imaging modalities (6–8). The purpose of the present study was to evaluate the clinical significance and characteristic radiographic imaging features of enchondromas of the foot and to assess the outcome of the surgical treatment.

Patients and Methods

A review of 20 enchondromas in 20 patients with enchondroma that had been surgically treated and histopathologically confirmed was performed for patients treated from January 2005 to March 2012. None of the patients had Ollier's disease or Maffucci syndrome.

All radiographic images and computed tomography (CT) and magnetic resonance imaging (MRI) scans were reviewed, and all the findings from the operative notes from the medical records and pathology reports were analyzed. The clinical variables included patient age at diagnosis, sex, trauma history, tumor location, presenting symptoms (eg, pain, swelling, or constitutional symptoms), tumor size, and the presence of pathologic fracture. The imaging studies included plain radiography (all patients), CT (5 [25%] patients), and MRI (11 [55%] patients). We used CT and MRI to

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determine the detailed extent and internal nature of the lesions and to support the differential diagnosis. The images were evaluated by an experienced musculoskeletal radiologist without any knowledge of the patients' clinical history. The radiographic and CT analysis included the tumor margin and contour, sclerotic rim, matrix calcification, cortical change, periosteal reaction, endosteal scalloping, and expansion of the tumor. MRI analysis included the signal intensity of the tumor, internal septation or nodule, enhancement pattern, and the change in bone marrow and adjacent soft tissue. All patients underwent surgical treatment, with an average postoperative follow-up period of 24 months.

Results

The median patient age was 36 (range 12 to 56) years (5 males, 15 females). The mean tumor length was 8.7 (range 5 to 18.7) mm. In 80% of the cases, the tumor was located at the proximal phalangeal bone (n = 16), and 20% were located at the metatarsal bone (n = 4). A tumor location in the second (n = 4, 20%), third (n = 5, 25%), fourth (n = 5, 25%), and fifth (n = 4, 20%) toes was fairly evenly distributed. The great toe (n = 2) was the location for 10% of the lesions. Most lesions were eccentric. The most common symptom before diagnosis was pain associated with swelling (n = 18, 90%). The pain had ranged in duration from 1 week to 5 years. Also, 14 patients presented with pathologic fractures (70%; Fig. 1). On the radiographic and CT images (Fig. 2), the tumor margins were well-defined in all cases. A sclerotic rim was noted in 11 (55%) cases. The contours were smooth in 8 (40%) and lobular in 10 (50%) cases. Internal calcification was observed in 13 (65%) cases. Cortical thinning was present in 16 (80%) and expansion in 12 (60%). Endosteal scalloping was noted in 11 (55%) cases, and a periosteal reaction was seen in only 4 (20%) cases. Preoperative CT showed a distinct cortical status, including thinning, expansion, and disruption of the cortex due to fracture, in all 5 (100%) cases.

MRI examination was performed in 11 (55%) patients and showed a low T_1-weighted and high T_2-weighted signal intensity in all of these cases. Internal septa and nodules of low T_2-weighted signal intensity were seen in 9 (82%) cases. The enhancement pattern showed peripheral, septal, and/or nodular enhancement within the lesions in 9 (82%) cases (Fig. 3). Adjacent soft tissue edema was noted in 9 (82%) cases with pathologic fracture. Bone marrow edema was seen in 6 (55%). All patients underwent curettage of the tumor and bone grafting as a part of the surgical treatment (autograft in 8 [40%], allograft in 7 [35%], and bone substitute in 5 [25%]). Internal fixation was performed in 13 (65%) patients using with Kirschner wires for the pathologic fractures. During the follow-up period, no surgery-related complications, including infection, joint contracture, functional loss, postoperative fracture, and recurrence, were observed.

Discussion

Enchondromas are benign, intramedullary neoplasms of the hyaline cartilage and are relatively common lesions, accounting for about 10% of benign osseous tumors. Approximately one half of these cases will be found in the small bones of the hands or feet. Although only about 6% of all enchondromas develop in the foot, when present, they will most frequently be found in the phalanges and metatarsals of the foot (8–10). In our patients, the tumors were found in the short tubular bones, with the proximal phalanx (80%) the most common site. Gajewsk et al (2) reported that 47% of enchondromas in the foot were located in the proximal phalanx. Enchondromas can present as a solitary lesion or as multiple lesions, such as those that occur in multiple enchondromatosis (Ollier's disease). Maffucci syndrome is another disease associated with multiple enchondromatosis and is often accompanied by soft tissue hemangioma. When enchondromas become symptomatic, the most common chief complaint will be pain owing to the increased pressure secondary to an expansion of the lesion with deformity of the cortex of the surrounding bone. The patient can also present with a history of gradual enlargement of the digit (4). Other causes of pain include pathologic or stress fracture of the lesion, with or without a history of trauma or strenuous physical activity, and malignant conversion of the tumor. In our study, pathologic fracture occurred in 14 patients (70%) compared with 24% in the series reported by Gajewsk et al (2). This discrepancy might have resulted in part from our institution's status as a tertiary center, which leads us to receive a larger number of referrals for pathologic fractures instead of asymptomatic lesions, thereby skewing the data. The rate of pathologic fractures for patients with 102 enchondromas of the hand was 40% (n = 41) in the series reported by Sassoon et al (6).

According to our results, pathologic fractures occurred more commonly in the foot than in the hands. It is difficult to recognize the presence of the tumor in the foot before pain develops, because the most common site of such tumors, the proximal phalangeal bone, is buried underneath the interdigital web of the toe and thus, the lesion cannot be easily detected.

Radiographically, enchondromas present as well-defined, expansile, lytic lesions with varying degrees of stippled or punctate calcifications. They are located in the diaphysis or metaphyseal-diaphyseal

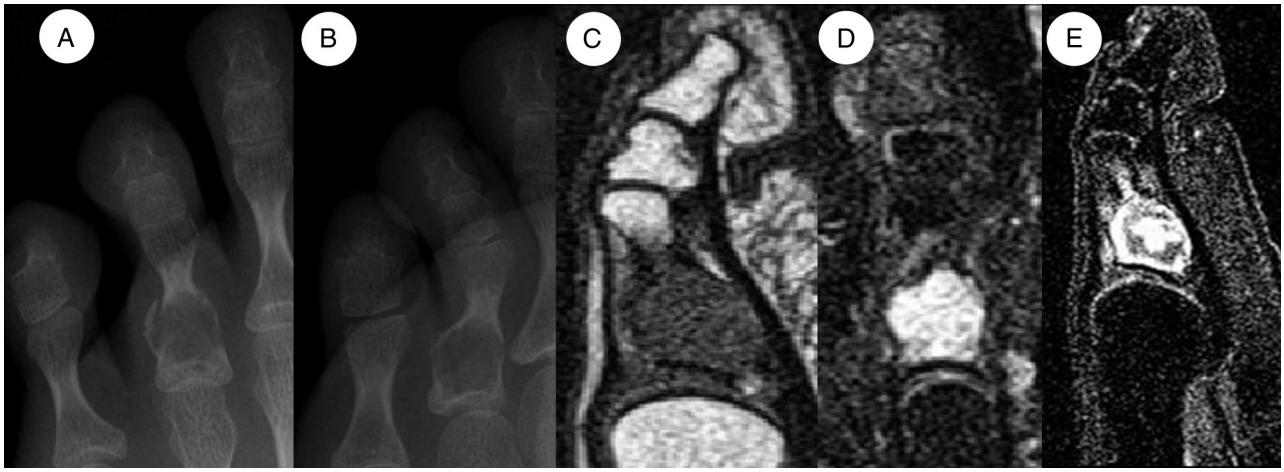

Fig. 1. Enchondroma in a 37-year-old female. (*A* and *B*) Radiographs revealing osteolytic intramedullary lesion in the fourth proximal phalanx with pathologic fracture and soft tissue swelling. (*C*) T_1-weighted magnetic resonance image showing a well-defined lesion of low-signal intensity. (*D*) T_2-weighted magnetic resonance image showing a high-signal intensity lesion. (*E*) Contrast-enhanced T_1-weighted magnetic resonance image showing peripheral and nodular enhancement of the lesion.