

# Chondroblastoma and Chondromyxoid Fibroma

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## Abstract

Chondroblastoma and chondromyxoid fibroma are benign but locally aggressive bone tumors. Chondroblastoma, a destructive lesion with a thin radiodense border, is usually seen in the epiphysis of long bones. Chondromyxoid fibroma presents as a bigger, lucent, loculated lesion with a sharp sclerotic margin in the metaphysis of long bones. Although uncommon, these tumors can be challenging to manage. They share similarities in pathology that could be related to their histogenic similarity. Very rarely, chondroblastoma may lead to lung metastases; however, the mechanism is not well understood.

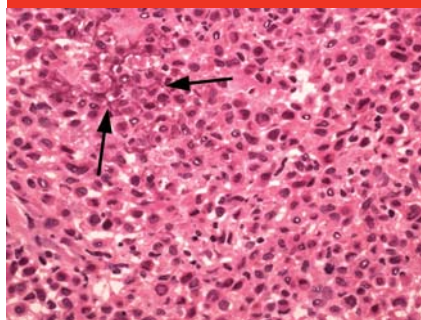
Chondroblastoma is a rare, benign bone tumor, usually located in the epiphysis or apophysis of long bones. It was first described by Kolodny in 1927 as a cartilage-containing giant cell tumor (GCT) but was better characterized by Codman in 1931, who believed it to be an “epiphyseal chondromatous giant cell tumor” involving the proximal humerus.<sup>1</sup> In 1942, Jaffe and Lichtenstein,<sup>2</sup> after a comprehensive review, included tumors in locations other than the proximal humerus and designated the tumor as benign chondroblastoma of bone, that is, as a different, separate entity from GCT. Historically, because of Codman's great contribution, chondroblastoma of the proximal humerus was referred as “Codman tumor.”

Chondromyxoid fibroma (CMF), a rare mixture of benign cartilage and fibrous and myxoid tissue that generally develops in long bones of the lower extremity, was described in 1948 by Jaffe and Lichtenstein.<sup>3</sup> Prior to their description, the lesion was thought to be a myxoma of the bone, enchondroma, or chondrosarcoma.

## Epidemiology

Chondroblastoma represents 1% to 2% of all primary bone tumors and approximately 5% of benign bone tumors.<sup>4,6</sup> The ratio of male to female patients is approximately 2:1.<sup>4,5,7-10</sup> Although chondroblastoma has been reported in patients ranging in age from 2 to 73 years, most patients are aged <20 years.<sup>7-9,11,12</sup>

The bone most affected by chondroblastoma is the femur, followed by the humerus and tibia.<sup>7,9-12</sup> Reports in the literature fluctuate between identifying the proximal humerus and proximal femur as the most affected site.<sup>7-9,11,12</sup> In the foot, chondroblastoma is located especially in the talus and calcaneus, in an apophysis or near the articular surface.<sup>13</sup> Chondroblastoma can also occur in flat bones, such as the scapula, patella, sternum, and skull bones.<sup>5</sup> The average age of patients with chondroblastoma in small or flat bones is higher than that of patients with chondroblastoma of long bones.<sup>6,13</sup> About 0.5% to 1% of chondroblastomas present on verte-

**Figure 1**

Photomicrograph of chondroblastoma. Note the diffuse and compact proliferation of mononuclear cells with indented nuclei with abundant eosinophilic cytoplasm and distinct cell borders. There is presence of focal pericellular (ie, chicken wire) calcification (arrows) on the top left corner (hematoxylin-eosin, original magnification  $\times 400$ ).

brae, generally in the posterior elements and/or the body.<sup>14</sup>

A prevalence of  $<0.5\%$  of all bone tumors is reported in many series describing CMF.<sup>6,15,16</sup> There is a slight male predominance.<sup>17</sup> CMF most commonly arises in young patients in the second or third decades of life.<sup>3,17,18</sup> Most of these tumors are located in the metaphysis of long bones with variable distances from growth plate, mainly in lower extremities.<sup>17</sup> Rarely, the lesion involves the epiphysis. The diaphysis can be involved, especially in large tumors. A lesion in small bones, such as phalanges, may involve the bone in its totality. The proximal tibia is the most common site, comprising 28% to 52% of all lower extremity lesions in the literature.<sup>17,19</sup> This site is followed by the ilium, ribs, distal femur, metatarsals, and distal tibia.<sup>17</sup> In contrast to chondroblastoma, CMF is rarely encountered in the humerus.<sup>15,17</sup>

## Etiology

Although cytogenetic abnormalities can be highly specific for some tu-

mors, there is no single characteristic abnormality or chromosomal breaking point specific for chondroblastoma or CMF.

The histogenesis of chondroblastoma and CMF is still uncertain. Romeo et al<sup>20</sup> confirmed the active role of cartilage-signaling molecules, both Indian Hedgehog/parathyroid hormone-related protein (IHH/PTHrP) and fibroblast growth factor, indicating that chondroblastoma is a neoplasm that originates from a mesenchymal cell committed toward chondrogenesis via active growth plate signaling pathways. This conclusion supports the chondrogenic nature of this tumor and the close relationship between the physis and the tumor.<sup>21</sup> CMF has myofibroblastic differentiation in its "fibrous" areas driven by transforming growth factor  $\beta$ -1.<sup>22</sup> A strong expression of the *Sox9* gene, which is responsible for chondrocytic differentiation as well as regulation of the expression of cartilage-specific genes in mature chondrocytes, especially the synthesis of collagen type II, was found in both chondroblastoma and CMF.<sup>23,24</sup> This demonstrates that the expression of *Sox9* in these tumors is consistent with its commitment to the early phases of cartilage differentiation, with chondroblastoma being a more "immature" tumor than CMF because of the greater presence of positive *Sox9* in CMF cells.<sup>23</sup>

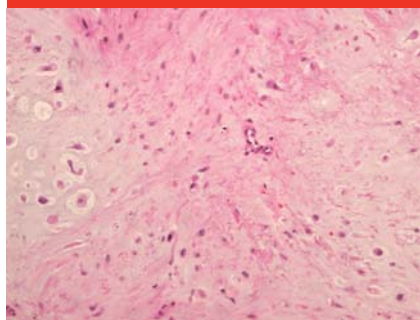
## Pathology

Grossly, a chondroblastoma is a gray-white tumor with yellowish areas, usually because of calcification, which can be soft, rubbery, or friable.<sup>2</sup> Microscopically, chondroblastoma reveals proliferation of mononuclear cells.<sup>10</sup> The tumor is characterized by compact areas of round, oval, or polygonal chondroblasts with well-defined cytoplasmic

borders. The cells contain one or two round, oval, slightly indented, or even multilobulated nuclei with or without nucleoli.<sup>8</sup> Occasional cells may have enlarged nuclei without nuclear atypia.<sup>4,25</sup> The presence of mitotic figures is scarce.<sup>2,4,25</sup> There are scattered multinucleated osteoclast-type giant cells among the chondroblasts.<sup>7,8</sup> There may be foci of chondroid matrix formed by the chondroblasts.<sup>25</sup> Dystrophic calcification is occasionally present and may surround individual cells, giving the classic "chicken wire" appearance<sup>7,8</sup> (Figure 1), although this is not mandatory for diagnosis.

In 15% to 32% of cases, chondroblastoma may be associated with secondary aneurysmal bone cyst (ABC).<sup>7-9,11</sup> Although the reasons for this association are unclear, hypotheses include mechanical stress, trauma, and hemorrhage.<sup>13</sup> More aggressive chondroblastoma that can cause metastases or recurrence shows no difference in histology compared with less aggressive chondroblastoma.<sup>25</sup> The histology is equivalent to that of the primary site, and the presence of atypical cells is rare.<sup>25</sup>

Grossly, CMF appears as lobulated, well-circumscribed, and sharply demarcated from the adjacent bone marrow. The lesion is firm and white. The cut surface shows a solid tumor mass that is yellow, grayish-white, or blue-gray.<sup>6</sup> Microscopic analysis of CMF reveals three components: myxomatous zones, fibrous zones, and fields that appear chondroid. The classic histologic features of CMF are lobules of stellate or spindle-shaped cells in abundant myxoid background or chondroid intercellular material. Scattered giant cells are found in approximately 50% of cases, usually at the edge of the lobules<sup>16,17</sup> (Figure 2). These lobules have a hypocellular center and a condensation of the nuclei toward the periphery, creating a hypercellular periphery. The inter-

**Figure 2**

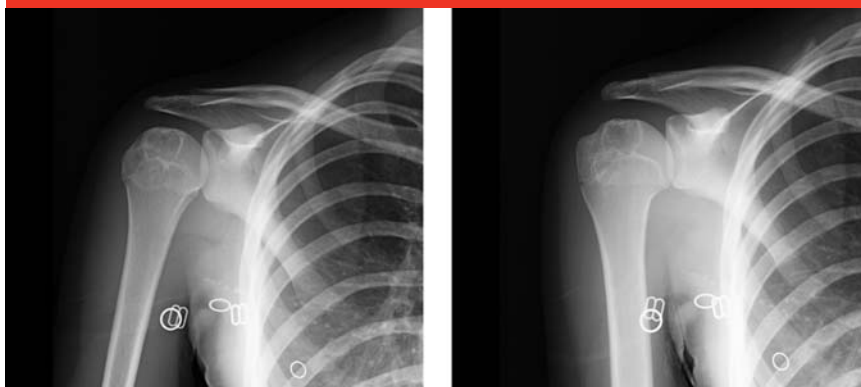
Photomicrograph of chondromyxoid fibroma. Note the stellate cells in a myxoid background. The stellate cells display mild atypia, but mitoses are rarely seen. The lesion has a lobulated appearance, with alternating cellular and more myxoid areas (hematoxylin-eosin, original magnification  $\times 200$ ).

lobular tissue is composed of oval or spindle-shaped cells.

Mitotic features are uncommon and are usually present in more concentrated cellular interlobular areas. Atypical mitotic features are not found, although some cells are large and have irregularities in the size and shape of nuclei.<sup>17</sup> Cellular atypia was reported in 18% of cases by Wu et al;<sup>17</sup> however, there was no change in the nucleocytoplasmic ratio. Lesions in hands and feet are more likely to have atypical cells.<sup>17</sup>

Myxoid stroma in CMF stains uniformly and does not show extensive liquefaction, as is present in myxoid foci of chondrosarcoma. Nevertheless, small foci of liquefactive changes are found in approximately 30% of CMF cases.<sup>6</sup>

Cyst formation, necrosis, foam cells, foci of secondary ABC, and frank hyaline cartilaginous areas are unusual findings.<sup>6,17</sup> Calcifications are present in approximately one third of the lesions and appear as fine lacelike or plaquelike deposits.<sup>6</sup> Histochemical analysis of chondroblastoma and CMF demonstrates great positivity to collagen type II and S-100 protein.<sup>8,10,24,26,27</sup>

**Figure 3****A****B**

AP (A) and AP with internal rotation (B) radiographs of a chondroblastoma of the proximal humerus of a 15-year-old girl who presented with right shoulder pain lasting 4 months. The lesion is located entirely in the epiphysis, is lucent, and has thin, sclerotic borders.

## Clinical Presentation

Chondroblastoma and CMF are usually classified, using the Enneking benign bone tumor classification, as stage 2 (ie, active) or 3 (ie, aggressive). The delay between the onset of symptoms and diagnosis varies from <1 month to years. Although presentation of these tumors can be similar, chondroblastoma is typically more painful than CMF.

Chondroblastoma normally has an insidious presentation. Symptoms vary from mild to significant pain and the presence of a soft-tissue mass or even a pathologic fracture. Patients with chondroblastoma may report pain lasting for several weeks, months, or even years. Pain with local tenderness in the involved bone and the adjacent joint is the most frequent complaint, followed by decreased range of motion.<sup>4,5,8,10-12</sup> Some patients attribute the pain to trauma, usually a minor or sports-related injury.<sup>7</sup> Swelling or joint effusion, a limp (when the affected bone is in the lower extremity), and muscle wasting may also be seen.<sup>5,7,10,12</sup> A palpable mass is uncommon but may

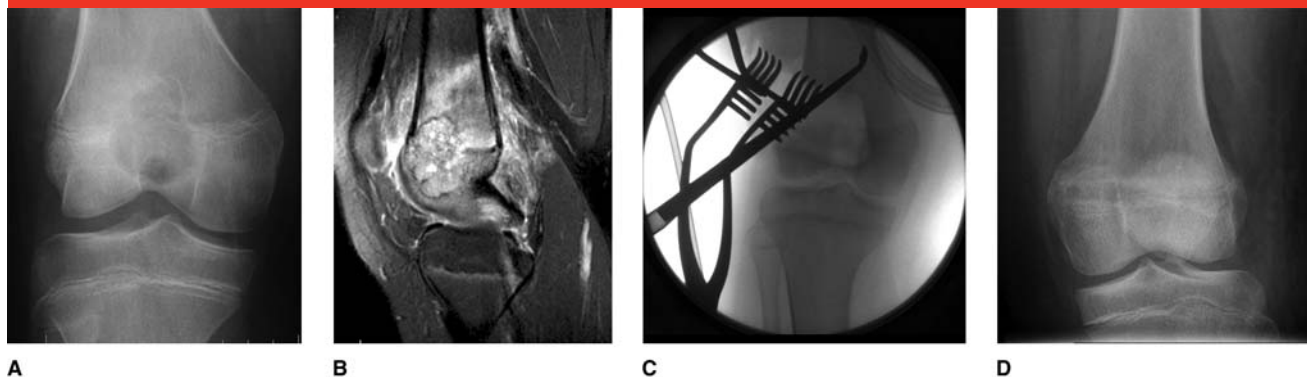
be present, if the patient has had symptoms for several years, because of expansion of the lesion.<sup>28</sup> Pathologic fractures in long bones are not common at presentation, but when the lesion is in the foot, subchondral fracture is frequent and painful.<sup>13</sup>

CMF may be found incidentally but more often presents with pain that is usually intermittent and not distressing. The duration of symptoms ranges from several months to years. The second most common presentation is local swelling, a lump, or a palpable mass. The patient may present with pain to palpation, and the lump may slowly increase in size. The local swelling or lump is more common in tumor of the small bones. Limping, limitation of adjacent joint range of motion, and pathologic fracture are rare.<sup>3,6,15,19,29,30</sup>

## Radiologic Evaluation

The classic radiographic appearance of chondroblastoma is a well-defined eccentric oval or round lytic lesion involving the epiphysis adjacent to an open growth plate<sup>4</sup> (Figure 3). A sharp sclerotic margin is often seen.



**Figure 4**

Curettage and bone grafting of a chondroblastoma of the distal femur in an 11-year-old girl with chronic knee pain. **A**, Preoperative AP radiograph demonstrating a lytic lesion on the distal femur that extends from the epiphysis into the metaphysis. **B**, Sagittal T1-weighted magnetic resonance image demonstrating peripheral lobulation and associated marrow edema. **C**, Intraoperative AP fluoroscopic image demonstrating curettage and bone grafting of the lesion performed through a cortical window, thereby avoiding damage to the unaffected surrounding physis. **D**, AP radiograph made at 7-month follow-up. The patient was asymptomatic, with no complications or recurrence.

At times, the lesion may be mottled or fuzzy or contain areas of calcification. Lesion size on radiograph varies, with most being <4 cm.<sup>2,5,8,11</sup> Calcifications are found especially in skeletally immature patients.<sup>7</sup>

It is uncommon to find periosteal bone formation on radiographs, but MRI usually depicts edema adjacent to the periosteum.<sup>31</sup> In rare cases, especially in older or neglected patients, chondroblastoma may have an atypical presentation that clinically and radiographically mimics an aggressive process.<sup>5,28,32</sup>

The small percentage of chondroblastomas with a secondary ABC in the histology usually show differences from regular chondroblastoma on radiograph, and these sometimes lead to confusion in the diagnosis. Cystic changes are seen more commonly when the lesion is located in bone, such as the patella.<sup>13,33</sup>

Most chondroblastomas involve the epiphysis of long bones.<sup>6</sup> A small lesion is usually confined to a part of the epiphysis or apophysis, although it may extend through the epiphyseal plate<sup>21</sup> (Figure 4). True metaphyseal chondroblastoma is rare; most reported cases are of an extension

from the epiphyseal lesion.<sup>21</sup> A few case reports of diaphyseal chondroblastoma have appeared in the literature.<sup>34</sup> Chondroblastomas located on small bones may be more aggressive, with loss of cortical continuity and bony destruction.<sup>35</sup>

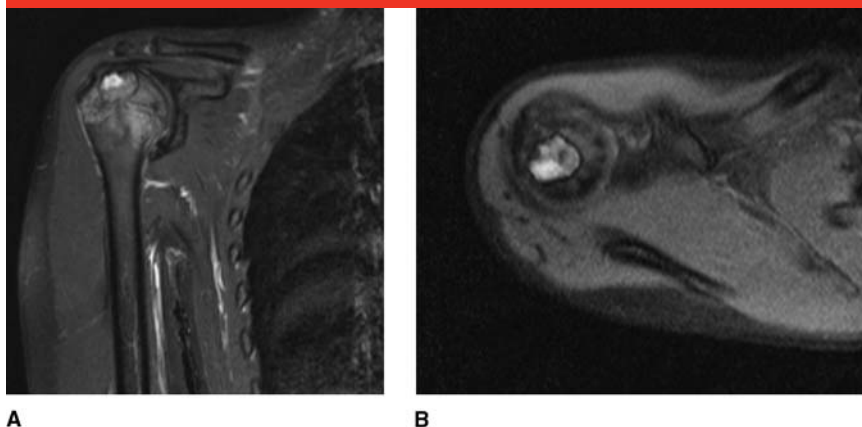
CT can help define the anatomic limits of the lesion, especially the distance to the growth plate and the relation of the lesion to subchondral bone. CT shows stipple calcification of the cartilaginous matrix, when present. In addition, CT is useful in delimiting lesions in unusual locations as well as subchondral fractures not visible on plain radiographs.<sup>13,14</sup>

In a few cases in which MRI was not used in conjunction with radiographs and the clinical presentation, this modality led to misdiagnosis or overestimation of tumor aggressiveness.<sup>31</sup> Chondroblastoma usually is hypointense on T1-weighted images and variably ranges from hypointense to hyperintense on T2-weighted images, with or without peripheral lobulation and the associated marrow and soft-tissue edema that enhances after administration of contrast material<sup>31</sup> (Figure 5). Bone

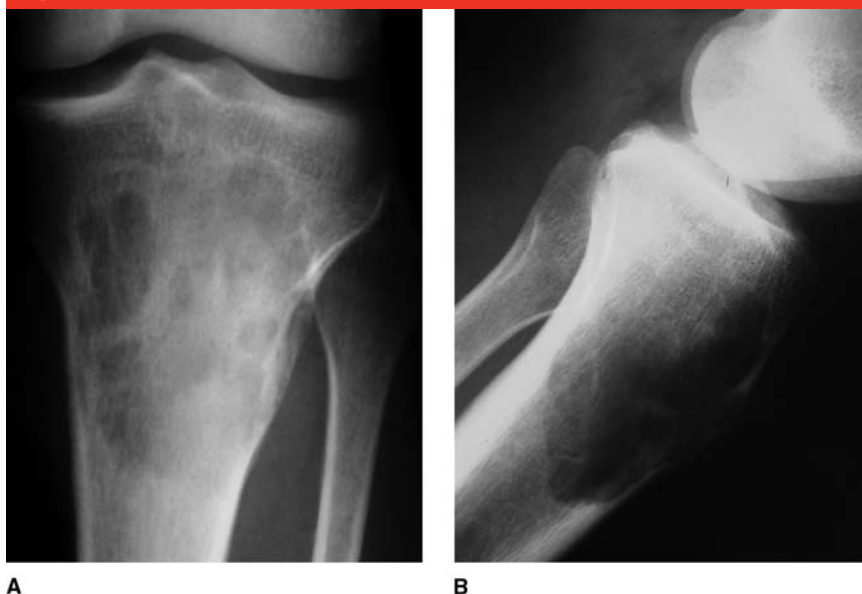
scan shows increased uptake but seldom is needed for diagnosis.<sup>21</sup>

CMF classically presents as a lytic radiolucent medullary lesion with a thin sclerotic rim (Figure 6). In most lesions, borders are sharp, with partial or complete effacement of the cortex.<sup>16,17,29,36</sup> CMF tends to be eccentrically located in the metaphysis of long bones. Rarely, or in advanced cases, the lesion crosses the growth plate into epiphysis or extends into the diaphysis.<sup>6</sup> In small bones, CMF generally occupies the entire width of the bone, causing thinning of cortices and fusiform expansion of the bone. The tumor typically has a scalloped border that is well defined by a narrow rim of sclerotic bone. Chronic bone reaction and cortical thickening are commonly present. Unusual periosteal reaction has been reported.<sup>16,17,36</sup> Pseudotrabeclulation, that is, ridges of the sclerotic rim at the edge of the lesion, is present. Gross and microscopic studies show that there is no complete bony septum.<sup>16</sup>

Unlike other cartilaginous tumors, calcification in CMF is unusual. The prevalence of calcification in CMF ranges from 2.4% to 16% of cases

**Figure 5**

The same patient as in Figure 3. Postcontrast T1-weighted fat-suppressed coronal (A) and T2-weighted axial (B) magnetic resonance images demonstrating heterogeneously increased signal. The bone marrow is normal.

**Figure 6**

AP (A) and lateral (B) radiographs of the proximal tibia of a 22-year-old man with chondromyxoid fibroma who presented with mild pain of the left knee lasting for 3 months. Note the mild expansion of the tumor and the scalloped borders defined by thin sclerotic bone. Biopsy was performed, and the diagnosis was confirmed. (Adapted and printed with permission from Dr. Olavo Pires de Carvalho, University of São Paulo, São Paulo, Brazil.)

radiologically, and from 6.8% to 34% of cases histologically.<sup>16,36</sup> Calcification presents more often in patients aged >40 years and in flat bones.<sup>36</sup> Pathologic fractures may be found but are unlikely.<sup>17</sup> CT and

MRI are the preferred imaging modalities. CT demonstrates cortical integrity and calcification of the matrix well. MRI shows low signal on T1-weighted images and increased signal on T2-weighted images and can help

with staging and preoperative planning<sup>30</sup> (Figure 7).

### Differential Diagnosis

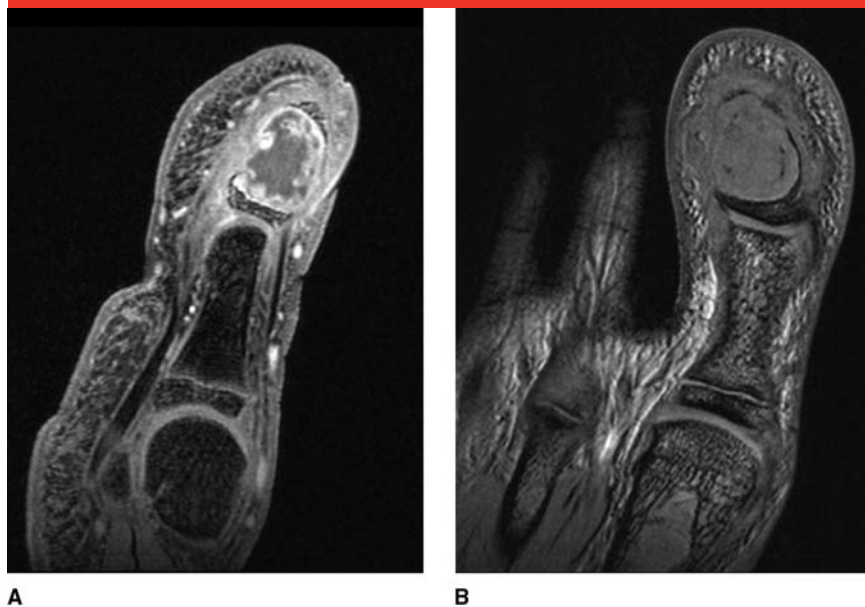
The differential diagnosis for chondroblastoma includes GCT, simple bone cyst, ABC, enchondroma, eosinophilic granuloma, fibrous dysplasia, clear cell chondrosarcoma, subacute osteomyelitis (ie, Brodie abscess), and, when a subchondral cyst is present, Legg-Calvé-Perthes disease or osteochondritis dissecans. Tuberculosis can mimic the periarticular pain and bone lesion of chondroblastoma and should be considered, especially in developing countries.<sup>6,8,21,25</sup>

The differential diagnosis for CMF includes benign lesions such as GCT, simple bone cyst, ABC, enchondroma, eosinophilic granuloma, fibrous dysplasia, osteoblastoma, osteofibrous dysplasia, and nonossifying fibromas.<sup>6,18</sup> Malignant conditions that must be differentiated are low-grade chondrosarcoma and myxoid chondrosarcomas.

### Management

The natural history of these tumors is not completely understood; to date, there has been no evidence of potential spontaneous healing.<sup>7</sup> Surgical management is advised for both types of tumors because no effective medical management is available. Both chondroblastoma and CMF generally have a favorable prognosis when identified and managed appropriately.

The benchmark management of chondroblastoma is curettage with bone grafting.<sup>8-12,25</sup> The entire tumor should be excised, with the surgeon following meticulous oncologic criteria of a thorough intralesional excision through a cortical and/or epiphyseal window (Figure 4), avoiding

**Figure 7**

Sagittal T1-weighted fat-suppressed (**A**) and coronal T2-weighted postcontrast (**B**) magnetic resonance images of a chondromyxoid fibroma of the distal phalanx of the great toe, demonstrating edema in the soft tissue and an expansive and solid lesion surrounded by a thin shell of residual bone. There is intralesional calcification with discrete contrast enhancement in the periphery of the lesion, characteristic of cartilaginous lesions.

the growth plate with the help of intraoperative fluoroscopy.<sup>9,10</sup> Curettage through the physis with obliteration of part or all of the growth plate is an option in patients who are near the end of skeletal growth.<sup>9</sup> Intra-articular exposure should be considered to access all of the tumor, if necessary.

Lehner et al<sup>37</sup> noted insufficient evidence supporting the use of adjuvant therapy. A high-speed burr is useful, with caution exercised near the growth plate and subchondral bone.<sup>9,37</sup> Electrocautery, phenol, argon bean coagulation, and cryotherapy also may be used with caution.<sup>5,9,11,37</sup> Bone graft is the preferred material to fill the cavitory defect after curettage.<sup>9,10</sup> In a series of 47 patients, Ramappa et al<sup>11</sup> reported no recurrence of tumor in 8 patients treated with polymethyl methacrylate (PMMA). Radiotherapy is proscribed because of the increased risk

of malignant transformation.<sup>5,7,38</sup>

Management of a lesion in the femoral head is challenging because of the difficulty of access—more so if the epiphysis is not fused.<sup>10,33</sup> The traditional approach for this lesion is through the base of the femoral neck or the trochanter, although a direct hip approach can also be used.<sup>7,12</sup> Both techniques carry the risk of spreading tumor into the femoral neck or the hip joint as well as of damaging the growth plate.<sup>10,33</sup> The use of arthroscopy to visually inspect the cavity following curettage via a minimally invasive approach, similar to core decompression, without compromising the articular cartilage of the adjacent joint, has been successful, although reported in only case reports.<sup>33,39,40</sup> A trapdoor procedure has also been described, but it can result in osteonecrosis and permanent damage to the cartilage.<sup>12,33,41</sup>

Radiofrequency ablation for chon-

droblastoma was recently described in a small series.<sup>42</sup> Results were best with small tumors (approximately 1.5 cm) and when location of the tumor provided limited risk of mechanical collapse of the adjacent articular surface. Limited data support this method of management, however, so patients must be selected carefully.<sup>42</sup>

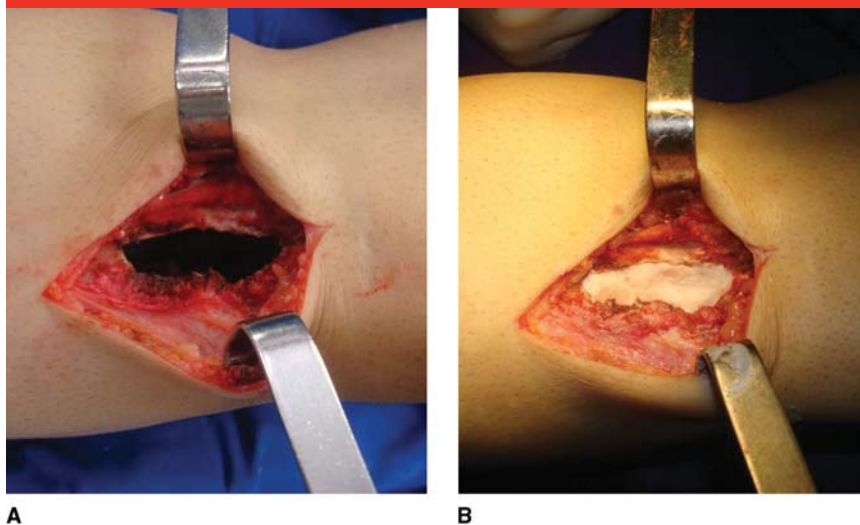
Some tumors can be widely excised, especially in bones such as ribs and fibula.<sup>9,10</sup> Lin et al<sup>9</sup> reported no recurrence in all six patients in whom chondroblastoma was treated through en bloc resection.

Aggressive recurrences historically treated with amputation can now be managed with limb-sparing techniques and endoprosthetic reconstruction, if feasible.<sup>5,12</sup>

No clear guideline exists for following patients with chondroblastoma. The risk of late recurrence and lung metastases, although extremely low, argues for prudent follow-up. Lin et al<sup>9</sup> suggested following patients on a yearly basis for at least 5 years.<sup>9</sup> Plain chest radiographs made preoperatively and at the annual visit are recommended.

Because CMF is extremely rare, most published articles are from series with patients who were treated over several decades; thus, there are no ultimate recommendations for management. The options include curettage and excision, with or without filling of the cavitory defect. Wide resection or en bloc excision is probably the best method to avoid recurrence, but not all locations allow the mechanical imbalance these procedures can cause, so bone grafting is advised.<sup>6,18</sup> CMF can be locally aggressive; thus, adjuvants such as PMMA are recommended (Figure 8). Curettage alone has resulted in a rate of high recurrence in most series.<sup>16-18,29</sup> Many authors report that bone grafting after excisional curettage reduces the recurrence rate, with some stating that the rate is



**Figure 8**

**A**, Intraoperative photograph demonstrating anterior access to the proximal tibia, allowing extensive curettage through a cortical window of the chondromyxoid fibroma shown in Figure 6. **B**, Intraoperative photograph demonstrating the cavity packed with polymethyl methacrylate. (Adapted and printed with permission from Dr. Olavo Pires de Carvalho, University of São Paulo, São Paulo, Brazil.)

similar to that observed after resection.<sup>6,18</sup> Use of PMMA as an adjunct after excisional curettage reportedly decreases the rate of recurrence.<sup>18</sup>

### Complications

Recurrence of the lesion is the most common complication following management of chondroblastoma and CMF. Although growth disturbances may occur following the resection of these lesions because of their proximity to the physis, major angular deformities and discrepancies are not common.<sup>9,11,12,33</sup>

Functional impairment, degenerative joint disease, and pathologic fractures can also result.<sup>11,33</sup> Suneja et al<sup>12</sup> described a series of 40 patients with chondroblastoma treated with curettage and bone graft with an average Musculoskeletal Tumor Society functional evaluation of 94.2%. The higher-scoring patients had lesions in more accessible areas.

Sarcomatous change has been reported in some series of CMF patients, but the prevalence is very low.<sup>6,17</sup>

### Recurrence

The recurrence rates of chondroblastoma vary from 5% to 40%; study results are inconclusive in determining which patients have greater chances of recurrence.<sup>9,10,12</sup> Most recent series report rates of 8% to 13%.<sup>9,10,12</sup> The recurrence rate for CMF ranges from 20% to 25%.<sup>16,18</sup>

Some authors state that recurrence in chondroblastoma arises more commonly in patients with an open epiphyseal plate, but others contradict this finding.<sup>7-12</sup> Recurrence in skeletally immature patients can be explained by inadequate curettage done to avoid damage to the growth plate.<sup>7,10</sup> The proximal femur and pelvis have higher rates of recurrence, likely related to difficulty in accessing these sites and obtaining

complete excision.<sup>7,9,11,12</sup>

Some authors have postulated that pelvic chondroblastoma may be more biologically aggressive than other forms of chondroblastoma.<sup>5,9,11</sup> Recurrences can occur between 5 months to 7 years after the initial procedure (average, 10 months following diagnosis).<sup>7,9,12</sup> Recurrence is not related to one specific mode of management, tumor size, patient sex, or duration of follow-up.<sup>8,10,11</sup> de Silva and Reid<sup>8</sup> reported a statistically significant relation between duration of symptoms and recurrence. They stated that patients with symptoms of <6 months had a greater chance of recurrence; however, to our knowledge, this has not been reported by other authors. Suneja et al<sup>12</sup> described a positive association of young age and higher recurrence rate, although this, too, has not been noted by others.<sup>7,9</sup> The association of chondroblastoma with ABC was reported by Huvos and Marcove<sup>43</sup> to have a higher recurrence rate; this association was refuted later by others.<sup>7,9,11,12</sup> Recurrence of chondroblastoma in the soft tissue surrounding the treated lesion is believed to occur because of implantation or incomplete curettage and the subsequent growth of the residual tumor cells, especially when the affected joint capsule was opened.<sup>25</sup> In sum, then, recurrence of chondroblastoma depends fundamentally on incomplete resection and biologic aggressiveness.<sup>9</sup>

Lesions that contain enlarged and irregular nuclei or have a prominent myxoid matrix are more likely to recur in CMF.<sup>16</sup> The type of management, however, is the most important factor that affects the rate of recurrence of this tumor. Curettage alone results in a very high recurrence rate in many series; Lersundi et al<sup>18</sup> reported that a recurrence rate of 38% after curettage alone diminished to 13% when the cavitory defect was

filled with bone graft. Of the 29 patients with CMF in their study, there was no recurrence in the 3 who underwent curettage plus PMMA or the 4 who were treated with wide resection.

## Metastasis

Metastases from chondroblastoma can arise from different primary sites. There is no reported relation of metastasis to previous surgery or nonsurgical treatment, tumor location, or patient age.<sup>25,44,45</sup> The incidence of metastases associated with chondroblastoma is not known but is thought to be very low. Rodgers and Mankin<sup>46</sup> described 2 patients of 80 (2.5%) with chondroblastomas treated for metastases at their institution. Selection bias can probably explain this elevated rate; most authors believe it to be <1%.<sup>45</sup> To date, there has been no published study on metastases from CMF.

The lung is by far the most common site of distant metastases. Bones different from those of the primary site, soft tissue, the skin, and the liver are also cited.<sup>11,25,44</sup> The time reported for metastases to manifest clinically ranges 5 months to 33 years (average, 8 years) from the initial diagnosis of chondroblastoma.<sup>25,46</sup>

Ostrowski et al<sup>47</sup> reported evidence of p53 mutation in one patient with chondroblastoma and metastases. In contrast, Hasegawa et al<sup>27</sup> found no evidence of p53 mutation in any of five patients with chondroblastoma without metastases. The p53 mutation is a late event in tumorigenesis and is present in many high-grade sarcomas, including osteosarcomas and chondrosarcomas.<sup>47</sup>

Patients usually survive several years with metastatic lesions; the prognosis is better when the metastases are resectable.<sup>25,44</sup> There is no reported benefit from chemotherapy.<sup>25</sup>

## Summary

Chondroblastoma and CMF are uncommon benign bone tumors that present with insidious bone pain. Chondroblastoma usually involves the epiphysis or apophysis of long bones; CMF is a metaphyseal tumor. The radiographic appearance of chondroblastoma is of a lytic lesion with sclerotic borders. CMF is also radiolucent with a sclerotic border, but it is usually larger than CMF and can have a bubbly appearance. Periosteal reaction is uncommon for both tumors. The chance of recurrence of chondroblastoma is 8% to 13% and, for CMF, 20% to 25%. Surgical management can be challenging because, especially in young patients with chondroblastoma, the ideal is to avoid the chance of recurrence while preserving the integrity of the physis. Metastases are very uncommon and have a good prognosis when they are resectable. Additional genetic studies can likely help identify the cause of metastases and explain the nature of the aggressive chondroblastoma.

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## References

*Evidence-based Medicine:* Levels of evidence are described in the table of contents. In this article, references 1-5, 7-12, 14-24, 26, 27, 30, 31, 33, 35-39, and 42 are level IV studies. References 25, 29, 32, 34, 40, 41, and 43-45 are level V expert opinion.

References printed in **bold type** are

those published within the past 5 years.

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