Asymptomatic Upper Arm Mass in a 37-year-old Woman

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History and Physical Examination

A 37-year-old woman presented with a painless left upper extremity mass that she first noticed after a long strenuous workout 2 weeks before presentation. The patient denies any medical history, significant family history, and history of recent or remote trauma.

On physical examination, there was a firm, fixed 3 cm × 2 cm nontender mass palpable in the upper anterior

aspect of the humerus. There were no overlying skin changes and she had full painless ROM of her shoulder and elbow.

Plain radiographs (Fig. 1) and MRI (Fig. 2) of the humerus were obtained.

Based on the history, physical examination, and imaging studies, what is the differential diagnosis?

Imaging Interpretation

Lateral scapular Y (Fig. 1A) and AP (Fig. 1B) radiographs of the humerus showed a well-circumscribed 2.2 × 1.1 cm mass, which was radiodense and contiguous with the anterolateral cortex of the humerus. There was no corticomedullary continuity seen with the underlying bone.

MRI showed a cortically based lesion with signaling characteristics similar to those of cortical bone on all sequences (Fig. 2). There was no corticomedullary continuity, no cartilaginous cap, and no soft tissue mass.

Differential Diagnosis

Osteochondroma
Myositis ossificans
Parosteal osteosarcoma
Periosteal chondroma
Bizarre parosteal osteochondromatous proliferation
Excisional biopsy was performed and the specimen was examined histologically (Fig. 3).

Based on the history, physical examination, imaging studies, and histologic picture, what is the diagnosis and how should the patient be treated?

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Fig. 1A–B (A) Lateral scapular Y and (B) AP radiographs of the left humerus show a well-circumscribed, radiodense mass with no corticomedullary continuity.

Histology Interpretation

The resected specimen was a well-circumscribed mass composed of a peripheral layer of fibrous tissue with underlying cartilage and woven bone anchored to the outer portion of the cortex (Fig. 3A). The fibrous tissue was composed of banal fibroblasts and intervening collagen that transitioned to a cartilage cap that was fibrous and hyaline in appearance (Fig. 3B). The cartilage underwent enchondral ossification that manifested as mineralized basophilic woven bone (Fig. 3C).

Diagnosis

Bizarre parosteal osteochondromatous proliferation (BPOP or Nora's lesion)

Discussion and Treatment

This young healthy woman presented with an asymptomatic upper arm mass. Physical examination showed a 2-cm firm, fixed mass attached to the humerus. The diagnosis of BPOP was made based primarily on the radiographic findings. Imaging studies show a cortically based radiodense mass without communication with the underlying medullary cavity. A radiodense mass arising from the cortex without corticomedullary continuity strongly suggests a diagnosis of BPOP. Histologic examination confirmed the diagnosis.

The differential diagnosis for the lesion in our patient included osteochondroma, myositis ossificans, parosteal osteosarcoma, and periosteal chondroma. BPOP can resemble all of these lesions but with important differentiating

characteristics. BPOP and osteochondroma appear similar on plane radiographs. However, in contrast to BPOP, osteochondroma displays corticomedullary continuity, which is absent in this lesion. Myositis ossificans presents differently, frequently with pain and a history of trauma. In addition it usually is not attached to the underlying cortex. In situations where there is no intervening tissue between the lesion and bone, histologic analysis reveals a characteristic zonation pattern of reactive fibroblasts and myofibroblasts in the center with bone formation of progressive maturity toward the periphery which is absent in our lesion [20]. Parosteal osteosarcoma radiographically resembles BPOP as both lesions have a heavily mineralized appearance and can arise from the cortex of long bones. However, parosteal osteosarcoma frequently invades the cortex and surrounding soft tissue and has a greater degree of histologic atypia [15, 25]. Periosteal chondroma, although primarily radiolucent, can contain calcification and mineralization from the adjacent cortex. Therefore, it can resemble BPOP as a mineralized mass arising from the cortex without corticomedullary continuity. Histologic examination differentiates these lesions. On low-power examination a periosteal chondroma consists of lobules of hyaline cartilage compared with the cartilaginous cap of BPOP [8].

BPOP is a rare benign pseudoneoplastic process most commonly located on the short tubular bones of the hands and feet but also can occur on the long bones. BPOP typically presents in the third and fourth decades of life with no sex predilection. Patients generally are asymptomatic, but symptoms may include mechanical pain or restricted ROM of the adjacent joint. BPOP lesions often are excised early and, as a result, their natural history is not entirely clear [6]. The few that have been observed with time exhibit evolution from a less organized periosteal soft tissue swelling with few calcifications toward a more mineralized lesion and eventually to a completely ossified mass [6, 14, 24]. This maturation process has been hypothesized to represent a reparative etiology in the response to trauma [11, 24, 27], despite that the majority of patients described in case reports lack a traumatic history. More recently, some reports have suggested BPOP is a neoplastic process instead of a reparative one [7, 12, 17, 22, 26, 28].

Diagnosis of BPOP typically is based on a combination of radiographs and histology, although radiographically classic lesions can be diagnosed without histopathologic confirmation [12]. The classic radiographic appearance of BPOP is a well-defined, mineralized round or oval mass with a broad base that arises from the cortex without flaring or corticomedullary continuity [14, 18]. MRI is useful to further characterize the radiographic features and display pertinent negatives, such as the absence of soft tissue swelling, soft tissue mass, and cortical destruction. Several case

Fig. 2A–C (A) T1-weighted (TR468/TE14) sagittal, (B) T1-weighted (TR483/TE14) axial, and (C) STIR sequence (TR3530/TE45) axial MR images of the left humerus show no corticomedullary continuity, no cartilaginous cap, and no soft tissue mass.

Fig. 3A–C Specimens from the excisional biopsy showed (A) a well-delineated nodular mass with a bone stalk and cartilaginous cap anchored to the outer portion of the cortex (Stain, hematoxylin & eosin; original magnification, $\times 2$), and (B) that the nodule is composed of banal fibroblastic proliferation at the periphery and hypercellular hyaline cartilage (Stain, hematoxylin & eosin; original magnification, $\times 4$). (C) The cartilage undergoes enchondral ossification and the chondrocytes are enlarged, with plump nuclei and some of the nuclei are binucleated (Stain, hematoxylin & eosin; original magnification, $\times 20$).

reports described histologically confirmed BPOP with atypical radiographic features, including cortical invasion, corticomedullary continuity, and medullary inflammation [1, 10, 12, 19, 21, 22, 26]. In these studies, histologic examination of the lesions was necessary to make the diagnosis. On gross pathologic examination, BPOP is characterized by cancellous bone covered by a cartilaginous cap.

Histologically, it consists of three components: cartilage, bone, and a fibroblastic component. The reactive fibroblastic component covers the hypercellular cartilage which contains binucleate cells and enlarged chondrocytes, often with vesicular nuclei. The cartilage is fibrous and hyaline in appearance and in the deeper regions has increased mineralization and enchondral ossification. The bone component

of BPOP consists of well-formed trabeculae of woven bone enmeshed in loose connective tissue [1, 14, 15, 23].

Surgery is the standard treatment for BPOP; however, the appropriate margins of resection are debated owing to the high incidence of recurrence [6, 12, 14, 18, 23]. Surgical approaches include marginal resection and continued local resection of any recurrent lesions. Some advocate for wide surgical margins, including the pseudocapsule and any periosteal tissue, in an effort to reduce recurrence [2, 3, 9, 10, 15, 16]. Berber et al. [3] reviewed 22 cases of BPOP treated with either marginal or wide resection and found similar recurrence rates of 28.6% and 25% respectively, with a mean followup of 32 months. The recurrence times reported in the literature range from 2 to 84 months [12, 18]. Yeun et al. [27] suggested recurrence is a result of premature excision and not surgical margins but no data currently support this. Despite the tendency of BPOP to recur locally, there has been no report of malignant transformation, and therefore surgical resection and margin status would be at the discretion of the surgeon and likely dictated by the local morbidities in any given location.

BPOP of the humerus is unusual but has been reported [4, 5, 13, 23]. In our patient, the uncommon location posed the greatest challenge in making the diagnosis based on radiographs alone. The additional pathologic analysis confirmed the diagnosis. The surgical approach for our patient included wide resection, including the underlying cortex of the humerus. Postoperatively, the patient was restricted to nonweightbearing activities of the upper extremity for 6 weeks, at which point the cortical window was radiographically healed. After 6 weeks of physical therapy, she had full ROM and full return to her preoperative function.

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