Osteoblastoma is a primary neoplasm of bone that is composed of a well-vascularized connective tissue stroma in which there is active production of osteoid and primitive woven bone. Initially designated “giant osteoid osteoma” and “osteogenic fibroma,” osteoblastoma obtained its currently accepted name in 1956 from Jaffe and Lichtenstein. The precise relationship between this lesion and osteoid osteoma is not clear, and in recent years, an aggressive variety of osteoblastoma has been recognized. Generally, osteoblastoma is a benign tumor. It grows relatively slowly, but if not treated, it may attain considerable size and continue to grow for several years. After complete intralesional excision, the recurrence rate is relatively low. Recurrences are more common in aggressive lesions, which are managed better with wide resection.

Malignant change has been reported in a few cases considered to be correctly diagnosed as benign osteoblastoma. It is believed that most tumors that metastasize are not initially osteoblastomas but unrecognized low-grade osteosarcomas or osteosarcomas with atypical histologic features.

**Epidemiology**

Osteoblastomas accounted for approximately 3.5% of all benign primary tumors in the Mayo Clinic series and <1% of all bone neoplasms. The lesion is observed most frequently in patients <30 years old, with an age distribution ranging from 2 to 75 years (Fig 1). Men are affected more frequently than women (ratio of 2:1).

Osteoblastoma may affect any bone. The lesion has a distinct predilection for the vertebral column. The spine and sacrum are involved in 30% of cases and the long tubular bones in 34%. Other bones affected are the skull, mandible, or maxilla (15%); innominate bone (5%); and bones of the hands and feet (10%) as well as the ribs, sternum, patella, clavicle, and facial bones. In the long tubular bones, the lesion is located in the diaphysis in 75% of cases and in the metaphysis in the remaining cases; epiphyseal involvement is unusual. In the spine, 55% of the lesions are contained in the dorsal elements and 42% in both the dorsal elements and the vertebral body. Involvement of the vertebral body is less typical.

**Clinical Features**

Local pain is a common clinical manifestation of osteoblastoma (87%), although generally the pain is mild. Pain is often progressive and occasionally is characterized by accentuation at night and amelioration with salicylates. Local swelling, tenderness, warmth, and gait disturbances also have been mentioned.

Spinal lesions may be accompanied by muscle spasm, scoliosis, and neuro-
logic manifestations including paresthesias and weakness. Mirra et al.\textsuperscript{16} described a case of osteoblastoma associated with systemic symptoms such as weight loss, chronic fever, anemia, and systemic periostitis. The symptoms abated after amputation. Yoshikawa et al.\textsuperscript{17} described a benign osteoblastoma as a cause of osteomalacia.

**IMAGING**

The radiographic features of osteoblastoma are often nonspecific and may not suggest the true diagnosis. Osteolysis and osteosclerosis, alone or combined, may be observed (Fig 2A). Expansion of bone, cortical thinning, and a soft-tissue mass may accompany the lesion and in some cases may suggest a malignant process. Radiographs usually show an expansile, well-circumscribed, partially calcified lesion or a lesion similar to a large osteoid osteoma.\textsuperscript{18}

In tubular bones, 65% of the tumors are situated within the cortex and the other 35% in the medullary canal.\textsuperscript{10} The lesions have large areas of bone destruction and variable sclerosis. The margins are well-defined, poorly defined, or indefinite. The size of the lesion varies from 1 cm to 11 cm (mean: 3 cm). A calcified central nidus with a lucent halo suggestive of the diagnosis is infrequent (8 of 116 cases).

Reactive sclerosis is present in >50% of cases. Periosteal new bone formation is frequent. According to Lucas et al.\textsuperscript{19} on the basis of radiographic features, 72% of the lesions were thought to be benign, 10% malignant, and the rest indeterminate.

In the spine, a well-defined, expansile osteolytic lesion that is partially or extensively calcified or ossified and that arises from the posterior elements, especially in the thoracic or lumbar spine (Fig 3), should suggest the diagnosis of osteoblastoma.\textsuperscript{19,20} Scoliosis may accompany osteoblastomas of the thoracic or lumbar spine or of the ribs.\textsuperscript{21,22} Lucas et al.\textsuperscript{10} described 66 osteoblastomas of the spine; the size of the lesions varied from 1 to 15 cm (mean: 3.5 cm).

Other imaging methods such as bone scintigraphy, computed tomography (CT), and magnetic resonance imaging (MRI) may provide information about the extent of the lesion and the additional sites of involvement; however, these imaging modalities are unable to outline features that allow specific diagnosis.\textsuperscript{15} Bone scintigraphy reveals increased accumulation of the radionuclide at the site of the lesion, and CT and MRI allow full delineation of the extent of the process (Fig 2B).

**PATHOLOGY**

Lesions are reasonably well-circumscribed and may be subperiosteal, cortical, or medullary in location (Fig 4). Intracortical osteoblastomas are associated with extensive surrounding sclerotic bone similar to that found in an osteoid osteoma, but the nidus of an osteoblastoma is larger.\textsuperscript{1,11,23}

The tumor tissue is hemorrhagic, granular, purple to reddish brown in color, and friable because of its vascularity and its osteoid component, which shows variable calcification.\textsuperscript{1,13} Some tumors have a thin sclerotic rim, whereas others, especially those in the long bones of the extremities, have a zone of increased density as prominent

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**Fig 1:** Distribution of osteoblastomas in the Mayo Clinic series according to age and sex of the patient and site of the lesion. (Reprinted with permission from Unni KK. Dahlin's Bone Tumors: General Aspects and Data on 11,087 Cases. 5th ed. Copyright 1996, Mayo Foundation.)

**Fig 2:** AP radiograph (A) of the pelvis of a 19-year-old man showing mixed lytic and sclerotic changes involving the left acetabular area. Coronal MRI (B) showing expansile mass of the anterior column of the left acetabulum.
as that of the ordinary osteoid osteoma. Unlike long bone osteoblastomas, which seldom extend into the soft tissue, vertebral osteoblastomas not infrequently have epidural extension and may even extend into the paraspinal tissue or involve adjacent vertebrae. Microscopically, osteoblastoma is similar to osteoid osteoma, consisting of a well-vascularized connective tissue stroma in which there is active production of osteoid and primitive woven bone. The bony trabeculae are variably calcified.

Some osteoblastomas have abundant thick, pink osteoid trabeculae without mineralization, whereas others have a lot of calcification with the appearance of bony trabeculae (Fig 5). The bony trabeculae are lined with a single layer of osteoblasts, which may have small, inconspicuous nuclei with abundant cytoplasm or large, vesicular nuclei with prominent nucleoli. The intratrabecular stroma is composed of capillary proliferation and loosely arranged spindle cells without atypia.

Although mitotic activity may be found within the osteoblasts, it is not prominent, and atypical mitotic figures are not present. Areas resembling secondary aneurysmal bone cysts may be seen in as many as 10% of cases. Occasionally, osteoblastoma-like areas are found in an otherwise typical aneurysmal bone cyst; this distinction is sometimes arbitrary.

The histologic features of osteoblastoma must be differentiated from those of osteoid osteoma, a feature of classic osteosarcoma, may be seen focally (20% of cases). Cartilage usually is not considered a part of the histologic spectrum of osteoblastoma, but rare cases in which the tumor contained hyaline cartilage or chondroid matrix have been reported.

**Differential Diagnosis**

The radiographic features of osteoblastoma commonly do not allow the correct diagnosis. Expansile, partially calcified areas of osteolysis involving the posterior elements of the spine may be identified as osteoblastoma. In other areas, the radiographic appearance varies, and the differential diagnosis includes osteoid osteoma, aneurysmal bone cyst, eosinophilic granuloma, enchondroma, fibrous dysplasia, chondromyxoid fibroma, and solitary cyst. In aggressive osteoblastomas, the osseous expansion and soft-tissue extension that are evident radiographically can simulate osteosarcoma, Ewing's sarcoma, or other malignant tumors.

**Treatment**

Treatment depends on the stage and the localization of the tumor. In stage 1 (latent) or stage 2 (active) osteoblastoma, intralesional excision (curettage) and bone grafting of the defect may be indicated, along with local adjuvants. Curettage is especially used in vertebral localization, a growing metaphysis, or near a functionally important epiphysis.

In stage 3 (aggressive) osteoblastoma, marginal or wide resection is indicated. This is difficult in vertebral locations. In these cases, aggressive
intralesional excision is used in association with fusion and internal fixation. It is doubtful whether radiation is of help. Selective arterial embolization also may be useful immediately preceding surgery (vertebral or pelvic localization) to reduce hemorrhage during the operation.

**PROGNOSIS**

After complete removal of the tumor, recurrences are uncommon. Instances of aggressive osteoblastoma have been described, characterized by considerable expansion and local recurrence, at times with delayed metastasis. Many authors believe that tumors that metastasize are not osteoblastomas initially but rather are malignant lesions that were unrecognized because of the low grade of malignancy or because they were characterized by atypical histologic findings.

Malignant change has occurred in a few lesions considered to have been correctly diagnosed as benign osteoblastoma, for example, in one case in the Mayo Clinic series. The potential hazards of radiation therapy are indicated by one case in the Mayo Clinic series in which a fatal fibrosarcoma developed 10 years after irradiation of an osteoblastoma of the fifth cervical vertebra.

**REFERENCES**