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Osteoid Osteoma and Osteoblastoma of the Spine

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Osteoid osteomas and osteoblastomas are rare causes of neck and back pain but are common causes of painful scoliosis in children and adolescents [1]. Osteoid osteomas were first described by Jaffe [2] in 1935, and osteoblastomas were subsequently defined in 1956 independently by Jaffe [3] and Lichtenstein [4]. Osteoid osteomas and osteoblastomas are bone-producing lesions that are frequently located in the long bones. Only 20% of osteoid osteomas and 40% of osteoblastomas occur in the spine [5,6]. Histologically, osteoid osteomas and osteoblastomas are similar, containing osteoblasts that produce osteoid and woven bone [7]. Osteoblastomas, however, are larger [8], tend to be more aggressive, and can undergo malignant transformation [9], whereas osteoid osteomas are small, benign, and self-limited. As imaging and surgical techniques continue to evolve, the diagnosis of these lesions can be made earlier and more precise resection is possible. The purpose of this article is to review the clinical presentation, radiologic findings, treatment, and outcomes in osteoid osteoma and osteoblastoma of the spine, with an emphasis on the difference between the two lesions and the surgical management and outcomes in recent years.

Clinical presentation

Osteoid osteomas are 4 to 10 times more common than osteoblastomas [10]. The thoracolumbar spine is the most common location of occurrence in the spine, and they predominantly involve the posterior elements, such as the spinous processes, transverse processes, facets, lamina, and pedicles [7,10–15]. There seems to be a male predominance with osteoid osteomas (2:1–4:1) [5] and osteoblastomas (1.8:1–4.5:1) [7,12–15] of the spine, although the predominance was not universally found in all series [7,10–15]. The most common age of presentation is in the second decade of life during adolescence or early adulthood, and the average duration of symptoms before presentation is approximately 20 months [7,10–15]. The common nature of the presenting symptoms of these entities was thought to be responsible for the considerable delay in their diagnoses before the advent of modern imaging modalities. Most patients (80%–100%) present with neck or back pain [7,10–15], which is usually localized but occasionally radicular, and the pain can correlate with activity, be nocturnal, or respond to aspirin or nonsteroidal anti-inflammatory drugs (NSAIDs; 14%–90% of patients have pain that is alleviated by aspirin) [7,10–15]. Although scoliosis was found in patients at presentation in all series, the incidence was quite variable (4.5%–100%) [7,10–15]. Scoliosis associated with osteoid osteoma and osteoblastoma is usually painful; this differentiates it from idiopathic juvenile scoliosis, which is painless and localized to the thoracic spine. It also exhibits a marked male predominance (4.7:1); this is another distinguishing feature from idiopathic juvenile scoliosis, which is more common in female patients [7]. In patients who have osteoid osteoma/osteoblastoma and scoliosis, the tumor is always located on the concave side of the apex, and the scoliosis is thought to be induced by muscle spasm secondary to inflammatory effect around the tumor [16]. With

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MRI analysis, edema in the soft tissue and bone surrounding the tumor is seen in 90% of patients (Fig. 1D) [12]. Interestingly, most patients who have cervical lesions present with painful torticollis and reduced cervical range of movements instead of scoliosis [7,10–15]. Neurologic deficits are much more common in patients who have osteoblastomas than in patients who have osteoid osteomas. Approximately 25% to 70% of patients who have spinal osteoblastomas present with a neurologic deficit compared with 0% to 30% of patients who have osteoid osteomas [7,10–15].

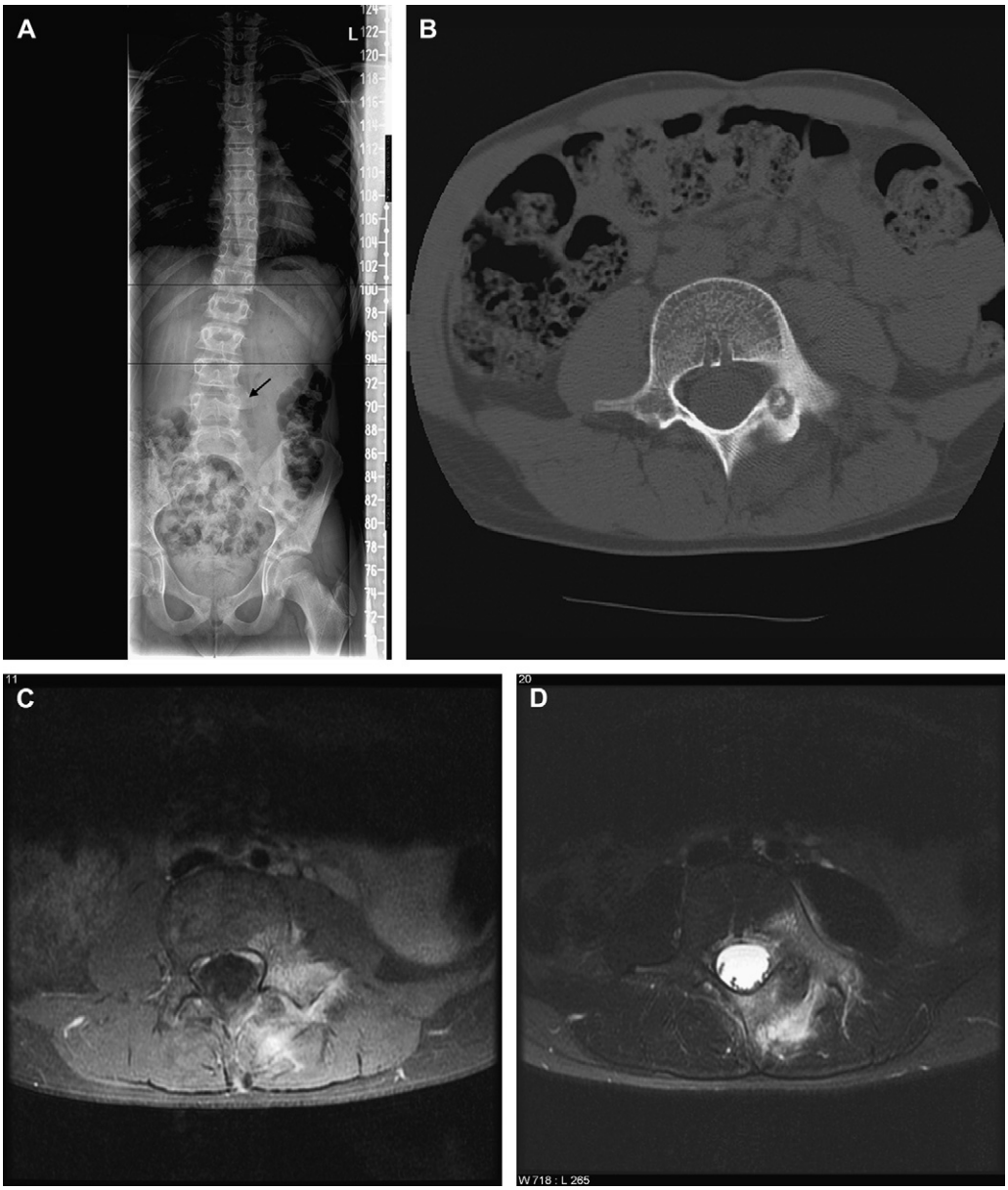

Fig. 1. (*A*) Plain radiograph of a 10-year-old girl who presented with scoliosis. The left L4 pedicle (*arrow*) appeared sclerotic. (*B*) CT scan of the same patient revealed a lucent defect at the junction of the left pedicle and pars interarticularis, with a central calcific nidus and adjacent bone sclerosis. (*C*) T1-weighted image with contrast demonstrated an enhancing lesion involving the L4 vertebral body and pedicle. (*D*) T2-weighted image showed the marked edema within the adjacent paraspinal musculature. Pathologic evaluation revealed osteoid osteoma.

The stronger association of neurologic deficits with osteoblastomas is related to the higher incidence of soft tissue extension, neuroforaminal encroachment, and epidural compression in osteoblastomas. The reported incidence of epidural involvement in osteoblastomas is 56.6% [12]. Furthermore, when a neurologic deficit occurs, it can be severe, taking the form of monoparesis, paraparesis, neurogenic bladder, or cauda equina syndrome [7,10–15].

Radiologic findings

Osteoid osteomas and osteoblastomas are both solitary lesions. On plain radiographs, most osteoid osteomas are osteosclerotic, with or without a visible nidus (Fig. 1A). In contrast, osteoblastomas are predominantly lucent or lytic in approximately 50% of cases, sclerotic in only 30% of cases, and mixed in the remaining 20% of cases [7]. On plain radiographs, osteoblastomas are typically expansile (unlike osteoid osteomas), with a scalloped or lobulated appearance, and their margins are well defined, with a sclerotic rim evident in approximately 30% of patients [7]. A sclerotic rim is much more common in osteoid osteomas than in osteoblastomas [15]. CT is helpful in preoperative planning to define the exact location and extent of bony involvement (Fig. 1B and Fig. 2A, B), whereas MRI is useful to identify spinal cord or nerve root compression and extraosseous soft tissue involvement. For osteoid osteomas, the calcification within the nidus and the surrounding sclerosis is of low signal intensity on T1- and T2-weighted images. With gadolinium administration, there may be intense enhancement within the vascular nidus (Fig. 1C). In osteoblastomas, regions of vascular stroma can be of high signal intensity on T1-weighted images (Fig. 2C) and osseous trabeculae may be seen as irregular linear areas of signal void. The surrounding bone and soft tissue involvement can often present as high signal intensities on T2-weighted images [12]. Technetium bone scan remains the most sensitive tool (with only one false-negative result reported [17]) in the diagnosis of osteoid osteoma and osteoblastoma, with intense focal radionuclide uptake at the lesion. It is particularly useful when other routine modalities failed to demonstrate the lesion. Some investigators have even reported the use of intraoperative bone scanning to guide and document complete resection [14]. Spinal angiography generally reveals a nonspecific pattern of hypervascularity in these lesions but is rarely indicated and should not be performed on a routine basis.

The differential diagnosis for osteoid osteoma and osteoblastoma includes aneurysmal bone cyst, giant cell tumor, osteosarcoma, Ewing's sarcoma, cartilaginous tumors (enchondroma, osteochondroma, and chondrosarcoma), and osteomyelitis. The location of the lesion within the vertebral column and its imaging characteristics should differentiate between most of these lesions; however, in some cases, the diagnosis can only be made with microscopic examination. Metastasis should be included in the differential diagnosis with older patients, and fibrous dysplasia should be considered if the pattern of involvement is polyostotic.

Histopathologic findings

On histologic examination, osteoid osteoma consists of a yellowish to red nidus of osteoblasts that produce osteoid and woven bone with interconnected trabeculae and a background and rim of highly vascularized fibrous connective tissue (Fig. 3). There are variable degrees of sclerosis surrounding the lesion [15]. Osteoblastoma is similar to osteoid osteoma histologically. It also consists of a fibrovascular stroma with a nidus of numerous osteoblasts, osteoid tissue, and well-formed woven bone [15]; however, the large vascular spaces and reactive giant cells commonly seen in osteoblastoma are rare in osteoid osteoma [15], and osteoblastoma tends to be more aggressive, with local invasion, and is capable of malignant sarcomatous degeneration to osteosarcoma and metastasis [18,19]. In the past, a lesion was frequently distinguished as osteoid osteoma and osteoblastoma based on size alone. McLeod and colleagues [8] arbitrarily defined lesions that were 1.5 cm or less in diameter as osteoid osteomas and lesions that were more than 1.5 cm in diameter as osteoblastomas. Recently, some investigators have abandoned such size-based classification and emphasized the use of biologic behavior to classify these lesions. Raskas and colleagues [14] suggested that all lesions with neural and soft tissue involvement should be termed *osteoblastomas* regardless of size.

Treatment

Medical management of pain from osteoid osteoma consists of NSAIDs or aspirin, especially

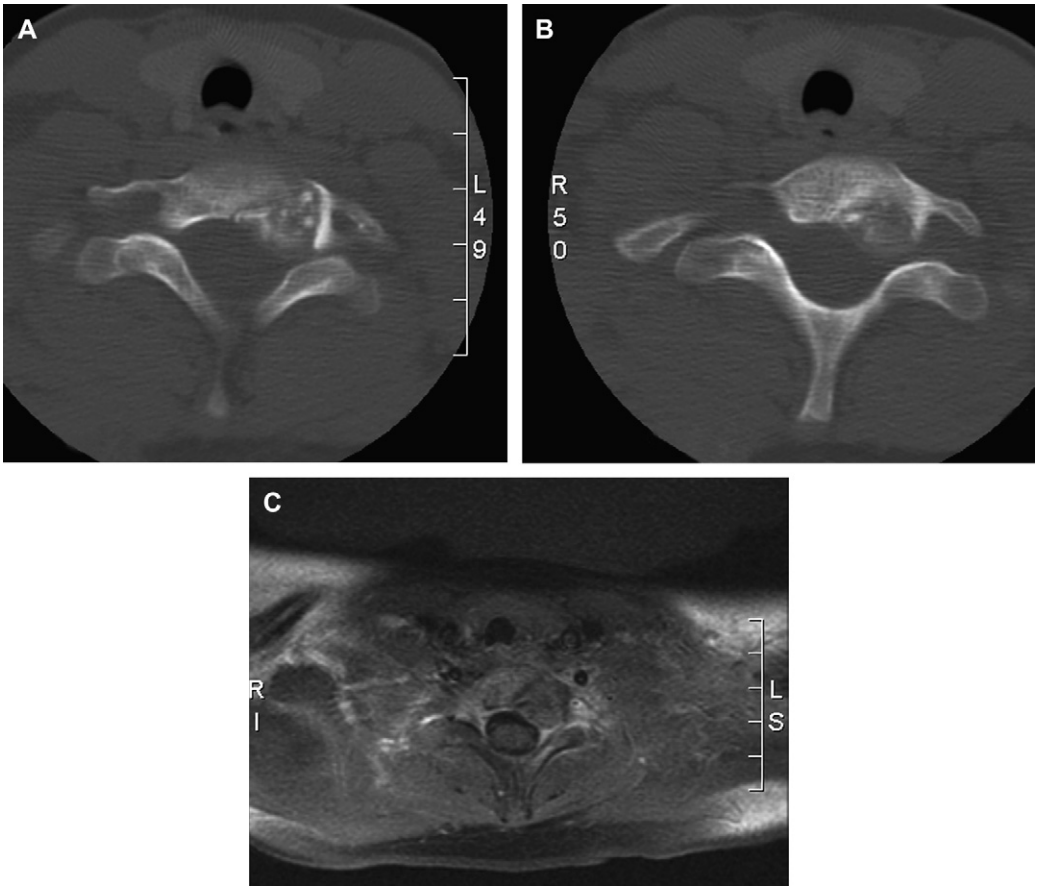

Fig. 2. An 8-year-old boy presented with neck pain. (*A, B*) Axial CT scans revealed an expansile, lytic, destructive lesion involving the left pedicle and the base of the posterior arch of C7. (*C*) Axial T1-weighted image with contrast of the same patient demonstrated an expansile lesion with a nidus of enhancement. Pathologic analysis revealed osteoblastoma.

for nocturnal pain. As pain becomes more severe and less responsive to medication, surgery becomes the primary treatment for osteoid osteoma and osteoblastoma, and complete resection is usually curative. The indications for surgery are similar to those of other primary tumors of the spine and include pain, deformity, tumor growth, diagnosis, and oncologic cure. In general, standard posterior approaches are used to resect abnormal spinous/transverse processes, laminae, pedicles, and facets. Posterior instrumentation is performed (usually simultaneously) when spinal instability occurs as a result of tumor destruction or wide surgical resection of facets and pedicles. Most investigators have reported that between 20% and 50% of patients in their series have required a simultaneous fusion as determined by the surgeon based on intraoperative stability after resection [7,10–15]. Infrequently, anterior approaches are used to perform a corpectomy in the rare case of vertebral body involvement, usually from anterior extension of the tumor. At surgery, the nidus appears as a reddish punctiform spot that is in contrast to the surrounding white bone. The general principle is to remove the nidus with a curet and then gradually excise the surrounding reactive bone. With modern surgical techniques, complete resections are achieved in most (>90%) cases [12,15]. Incomplete resections are more common with osteoblastoma because of its size and extraosseous tissue involvement. Osteoblastomas recur in approximately 10% to 15% of cases as a result of incomplete resection [18–21], whereas the recurrence rate of osteoid osteoma is only 4.5% [5]. Because of the potential risk for postradiation sarcoma and its poor

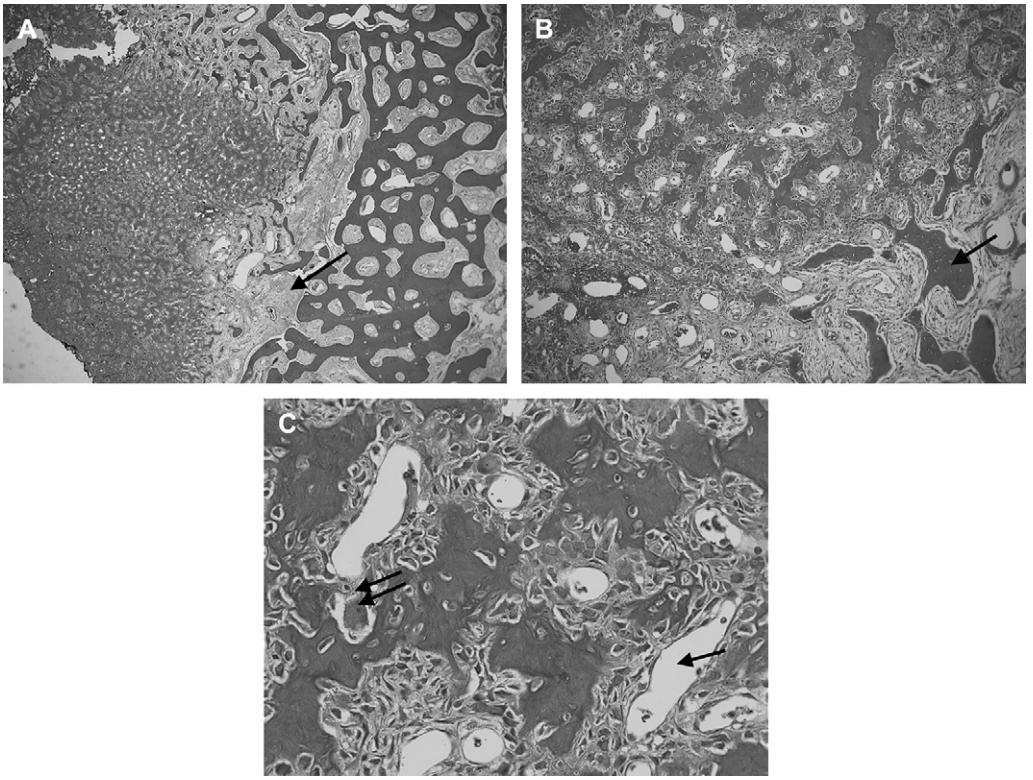

Fig. 3. Histologic studies of osteoid osteoma. (*A*) Photomicrograph of the nidus revealed trabeculae of well-calcified host woven bone on the right side. The interface between the lesion and the surrounding bone trabeculae is demarcated by a sheet of loose fibrovascular tissue (*arrow*). (*B*) Photomicrograph shows curved trabeculae of primitive woven bone (*arrow*). (*C*) Fibrovascular stroma is generally rich in capillaries (*arrow*). Osteoclasts (*double arrow*) can also be seen in this high-power field.

prognosis, radiotherapy is reserved for patients who have an incomplete resection and progressive disease.

Outcome

Overall, the outcome after surgical treatment of osteoid osteoma and osteoblastoma is excellent. Complete pain relief was achieved in more than 90% of patients in most surgical series [11,13,15], and the pain relief usually occurred early in the postoperative course (within hours to days after surgery). Persistence of pain is often indicative of residual tumor with incomplete resection, and pain recurrence is suggestive of recurrent disease. In either case, further investigations are warranted, and repeat resection should be offered if residual or recurrent disease is identified. In patients who have preoperative scoliosis, most (70%–90%) improved [11,12,14]. Interestingly, patients who present with a shorter duration of deformity (<15 months) tend to respond to surgery better and have a larger correction of their scoliosis [13]. The deformity, if long standing, may not respond to treatment; it is postulated that this is because the growth plate on the concave side of the curve can be damaged or the paraspinal muscle can undergo degeneration and fibrosis secondary to chronic inflammation [16,22]. As for postoperative neurologic recovery, all patients had some improvement and most of them (72.7%–100%) made a complete recovery.

Summary

Osteoid osteoma and osteoblastoma of the spine are rare lesions that occur primarily in adolescents and young adults. They present with similar clinical findings and are histologically similar. The major difference between osteoid

osteoma and osteoblastoma lies in the potentially more aggressive biologic behavior of osteoblastomas, which results in a more frequent presentation of neurologic deficits. These lesions should always be considered in the differential diagnosis of adolescents presenting with painful scoliosis. Primary treatment for both diseases is complete resection, which usually results in favorable outcomes of pain relief and deformity correction.

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