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Original Article

Radiology-pathological Correlation of Primary Benign Bone Tumors: A Retrospective Study

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Abstract

Introduction: Benign primary bone tumors are relatively rare, which create some difficulty for diagnosis and treatment. Benign bone tumors occur most frequently between the ages of 5-25 years and in the areas of greatest bone growth, with about 60% of cases in the knee region.

Aim: The aim is to study the radiological and pathological correlation of benign bone tumors.

Materials and Methods: We have reported 62 cases of bone tumors during the study of 5 years in the Department of Pathology, Thoothukudi Medical College, India. The cases were thoroughly studied by histopathology and 28 cases were diagnosed as benign tumors among which 8 cases were benign osteoid-producing and 20 cases were diagnosed as benign cartilage-producing tumors conclusively. The histopathology diagnosis was correlated with the radiological features.

Results: In benign bone tumors, osteochondroma was the most common neoplasm. Computed tomography scan established the best choice in studying cortical lesions and nidus in osteoid osteoma. Magnetic resonance imaging can delineate the medullary extent. Multinucleated giant cells were seen in sections of chondroblastoma. Histopathology provided the final, conclusive diagnosis. The most common benign bone tumor occurring in children is osteochondromas, representing 10-15% of all bone tumors and 20-50% of all benign bone tumors.

Conclusion: Benign bone tumors frequently pose a diagnostic challenge for general surgical pathologists. Accurate pathologic diagnosis requires careful clinical, radiological, and histopathological correlation.

Key words: Benign bone tumors, Computed tomography, H and E stain, Magnetic resonance imaging, Radiograph

INRODUCTION

Inadequate investigations have resulted in erroneous diagnosis of benign lesions as malignant, resulting in unnecessary surgical procedures. Osteoid osteoma arises from the long bones of the limbs presenting with pain.[1] Osteoblastoma is a rare tumor, with a locally aggressive behavior. Osteochondroma is the most common benign tumor. Hyaline cartilage cap is the continuity of this lesion with the underlying native bone cortex and medullary canal that is pathognomonic of osteochondroma. Müller suspected osteochondromas to arise from erroneous differentiation of cells in the periosteum. Genetic linkage analysis has located three etiological genes for osteochondroma hereditary multiple exostoses (HME)-EXT1 (8q24.1),[2] EXT2 (11p11-p12),[3,4] and EXT3 (19p).[5] The Knudson theory's application to osteochondroma pathogenesis has been strengthened by noted EXT gene losses and mutations in chondrosarcomas arising from osteochondromas.[6-9] Loss of functional EXT1 or EXT2 in a chondrocyte alters its ability to attach heparan sulfate to the proteins intended for its in the cell surface and its immediate extracellular milieu.[10-12] Fibroblast growth factor-receptor 3 causes cell cycle exit by activating the transcription factor STAT1, which induces expression of p21.[13] In osteoid osteoma, currently percutaneous, radiofrequency ablation (RFA) is being used under computed tomography (CT) guidance which is being used

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with increasing frequency.[14] Osteoid osteoma resolves spontaneously overtime and can be treated conservatively with nonsteroidal anti-inflammatory drugs,[15] they account for 10% of all benign bone lesions and there is a male predilection.[16] Osteoblastoma is located in the spine or major bones of the lower extremity.[17,18] According to Dorfman and Weiss,[19] aggressive osteoblastoma is diagnosed microscopically by the presence of wider or more irregular trabeculae, osteoid trabeculae are bordered by epithelioid-appearing osteoblasts. Importantly, up to 3% of patients with HME will eventually develop a chondrosarcoma in the cartilaginous cap of the lesion.[20-23] The supposition that accelerated chondrocyte differentiation and early ossification could create a local excess of bone.[24,25]

Aim

The aim is to study the radiological and pathological correlation of benign bone tumors.

MATERIALS AND METHODS

We have reported 62 cases of bone tumors during the study of 5 years in the Department of Pathology, among which 28 cases were diagnosed as benign bone tumors conclusively. Among the 28 cases, 8 cases were benign osteoid tumors and 20 cases were benign cartilage producing tumors. The five basic parameters of importance in the diagnosis are the age of the patient, bone involved, specific area within the bone, radiographic appearance, and microscopic appearance. The data were stored in the department computer server was very much useful in the retrospective histopathology and radiology correlation study.

RESULTS

This retrospective study covered a total number of 62 cases reported, among which 28 cases were diagnosed by histopathology as various types of benign tumors. A total of 8 cases were osteoid-producing tumors and 20 cases were cartilage producing benign bone tumors conclusively at Thoothukudi Medical College, India. The details of age, sex, and location of various benign bone tumors were studied. Osteochondroma was the most common tumor reported with growth from the cortex away from the joint (Table 1).

The long bones are frequently involved in most of the benign tumors of bone and were around the knee joint showing a high frequency of involvement. Chondroma is one benign cartilage-producing tumor showing involvement of distal small bones of the hand and foot (Table 2).

The correlation was done with histopathological features with radiographic findings. The various radiological patterns in benign osteoid tumors is a nidus with a central translucent area with surrounding bone sclerosis and in benign cartilage-producing lesions is an area of translucency surrounded by calcifications. Histopathologically benign osteoid tumors showed a highly vascularized area with immature osteoid present. The cartilage-producing tumors showed cartilage production, calcifications were seen and a few cases showed giant cells surrounding them (Table 3).

Table 1: Various types of benign bone tumors

Tumor	Number of cases	Age group/sex	Site of lesion
Osteoid osteoma	6	The age group involved was between 12 and 23 years. Totally, 4 were male and 2 were female	Five lesions were found in the lower end of the femur and one in the fibula. Intense pain is the most prominent symptom
Osteoblastoma	2	Two cases were reported. The presenting symptom was pain and the age group involved was between 12 and 23 years	One lesion was found in L3 vertebra and one in the fibula
Chondroma	2	Two cases were reported. The presenting symptom was soft tissue swelling and the age group involved was between 18 and 28 years	Two lesions were reported from phalanges
Osteochondroma	14	Fourteen cases were reported. The presenting symptom was soft tissue swelling and vague pain and the presenting age group was between 8 and 12 years	Nine cases were male patients and five were female patients. Six cases were from the femur, five from humerus, one from the tibia, one from pubic ramus, and one from fibula
Chondroblastoma	2	Two cases were reported. The presenting symptom was soft tissue swelling and the involved age group was between 12 and 18 years	One lesion involved lower end of the femur and one case involved upper end of the fibula
Chondromyxoid fibroma	2	Two cases were reported. The presenting symptom was pain and the age group involved was between 14 and 22 years	Two lesions were from upper end of the tibia
Total	28		

Osteoid Osteoma

Six cases were reported. The age group was between 12 and 23 years of age. Most osteoid osteomas occur in long tubular bones of the limbs, proximal femur, but any bone may be involved. Five lesions were found in the lower end of the femur and one in the fibula. Intense pain was the most prominent symptom. Radiographically, the typical finding is a radiolucent central nidus that is not larger than 1.5 cm. Lesions of long bones are usually metaphyseal. An osteoid osteoma is composed of three concentric parts: Nidus, fibrovascular rim, and surrounding reactive sclerosis.

The pain associated with osteoid osteoma is characteristically more intense at night is due to the effect on nerves and vessels by osteoblast-produced prostaglandin E2, COX1, and COX2. The word nidus literally means "nest." The treatment of choice is surgical removal of nidus and surrounding tissue. Six cases of osteoid osteoma were reported. They were surgically removed with adequate margin. The pain relief after treatment is so dramatic that the patient realizes on recovery from anesthesia that the lesion has been removed (Figures 1 and 2).

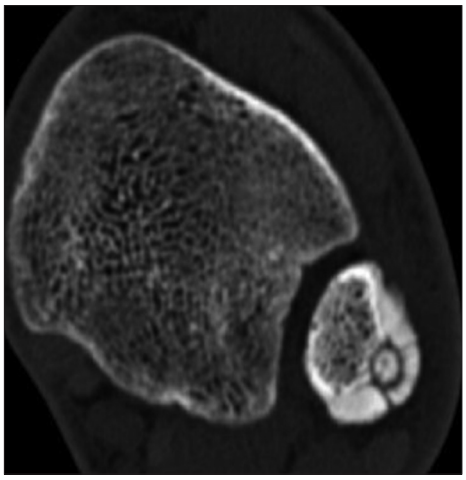

Figure 1: Typical nidus with a central translucency surrounded by dense sclerotic bone involving fibula

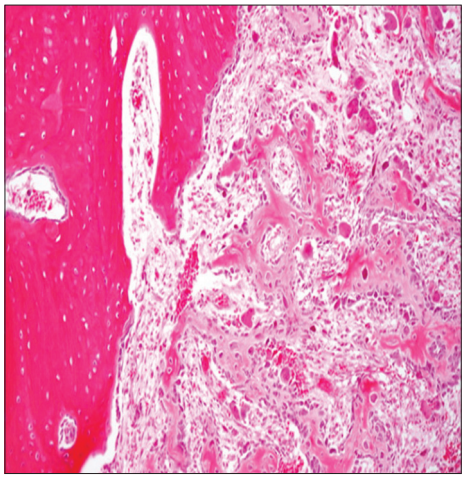

Figure 2: Central nidus composed of bony trabeculae seen in the right surrounded by a zone of sclerotic bone seen in the left one-third

Table 2: Bones involved in the study of benign tumors of bone

Tumor	Femur	Humerus	Tibia	Fibula	Vertebra and pubic ramus	Others
Osteoid osteoma	5			1		
Osteoblastoma				1	1	
Chondroma						2
Osteochondroma	6	5	1	1	1	
Chondroblastoma	1			1		
Chondromyxoid fibroma			2			
Total	12	5	3	4	2	2

Table 3: Correlation study between radiology and histopathology of various types of benign bone tumors

Tumor	Radiographic findings	Histopathological findings
Osteoid osteoma	CT scan shows an area of central translucency measuring <1.5 cm in diameter, in cortex surrounded by dense sclerosis. The reactive new bone is dense	Sections studied show a nidus with a fibrovascular core, plump osteoblasts are surrounding the anastomosing bone with dense sclerotic bone
Osteoblastoma	CT scan shows an area of translucency measuring more than 2 cm. In this case measuring 5 cm in diameter. The margins are irregular. Cortical expansion and thinning was noted	Sections studied show a nidus with plump osteoblasts rimming the broad irregular bone trabeculae
Chondroma	X-ray of the left-hand ring shows an area of translucency expanding the cortex and with a popcorn calcification distally	Sections studied show areas of cartilaginous tissue in lobules with areas of calcifications
Osteochondroma	X-ray shows a pedunculated growth from femur measuring 6 cm with the growth seen drifting away from knee joint	Sections studied show a cartilaginous cap overlying broad bands of bone trabeculae
Chondroblastoma	X-ray femur showing an area of translucency with calcification	Sections studied show highly cellular areas of mononuclear cells and giant cells with chicken-wire calcification
Chondromyxoid fibroma	T2 weighted MRI of lower femur shows a high signal intensity lesion in the metaphysis with cortex is spared	Section studied a hypocellular area in the center surrounded by areas of osteoclast type of giant cells and hypercellular fibrous areas in the periphery

CT: Computed tomography, MRI: Magnetic resonance imaging

The CT scan typically shows the typical nidus and the histopathological sections confirm a nidus with interlacing woven bone within a vascularized connective tissue, the study correlating perfectly. CT scan-guided RFA can be performed for ablation of the nidus in femur in future. Dr. Bhavin Jankharia is a skilled radiologist in providing RFA therapy in India.

Osteoblastoma

Two cases were reported. The presenting symptom was pain and the age group was between 12 and 23 years of age. One lesion was found in L3 vertebra and one in the fibula. Osteoblastoma is distinguished from the osteoid osteoma by the larger size of the nidus more than 2 cm, the absence of a surrounding area of reactive bone formative, and the lack of intense pain. The majority of osteoblastomas enlarge slowly, with consequent remodeling of bone around the lesion. Two cases underwent tumor tissue curetted and bone grafting was done (Figures 3 and 4).

CT scan shows a lytic mass lesion in fibula expanding the cortex. The tumor tissue was curetted and bone reconstruction was made. The histopathology section shows interlacing network of wide and broad osteoid woven bone rimmed by osteoblasts. The correlation study holds good here.

Chondroma

Chondroma is a common benign cartilaginous tumor that occurs most frequently in the small bones of the hands and feet, particularly the proximal phalanges. They begin in the spongiosa of the bone, from which they expand and thin out the cortex. The tumors are notoriously insensitive to therapy. Cartilage tumors have a tendency to be aggressive with each surgical interference. The T2-weighted magnetic resonance imaging (MRI) shows high signal intensity with a lobulated outline. MRI can delineate the medullary extent. CT can identify the calcification of cartilage. About 30% of chondromas are multiple. Ollier disease and Maffucci syndrome have an increased risk of developing chondrosarcoma. It is named after Louis Leopold Ollier. Microscopically, chondromas are composed of mature lobules of hyaline cartilage. Foci of myxoid degeneration, calcification, and endochondral ossification are common. A majority of enchondromas remain asymptomatic and require no treatment. If necessary, a curettage and bone grafting can be performed at a later time (Figures 5 and 6).

Two cases were reported. The presenting symptom was soft tissue swelling and the age group was between 18 and 28 years. Two lesions were reported from phalanges. X-ray of the left-hand ring finger shows an area of translucency expanding the cortex and with a popcorn calcification distally. For the two cases, curettage and bone grafting were performed. Sections studied show areas of cartilaginous tissue in lobules with areas of calcification.

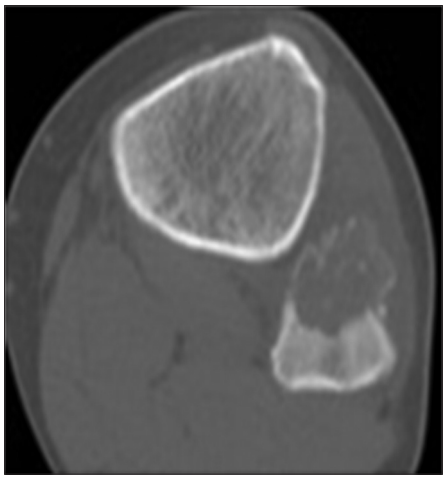

Figure 3: Lesion measuring more than 3 cms thinning out the cortex of fibula with surrounding dense sclerosis

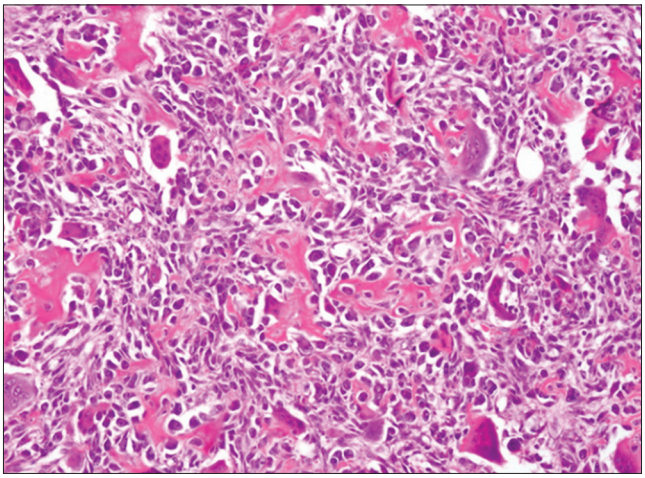

Figure 4: Plump osteoblasts lining irregular bony trabeculae with woven bone and lamellar bone

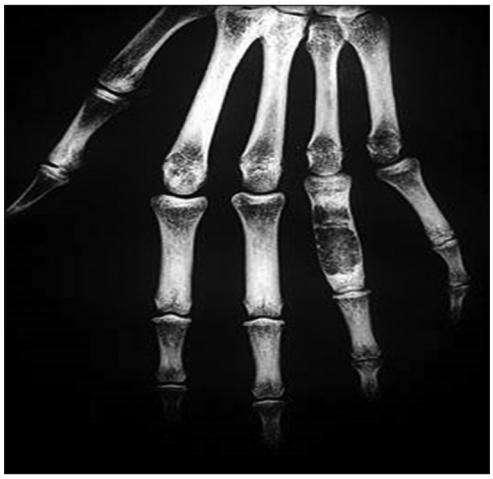

Figure 5: Central translucency in the phalange of left ring finger with popcorn calcification distally

The radiographic findings correlated with histopathology findings.

Osteochondroma

Osteochondroma is the most frequent benign bone tumor. The most common locations are the metaphyses of the lower femur, upper tibia, upper humerus, and pelvis. The radiographic appearance of osteochondroma is the tumors grow out in a direction opposite to the adjacent joint.

The most common symptom related to osteochondroma is a nontender painless mass, osseous deformity, fracture, vascular compromise, neurologic sequelae, overlying bursa formation, and malignant transformation. The average age of the patient at onset is approximately 10 years. The bulk of the lesion is made up of mature bone trabeculae located beneath the cartilaginous cap and containing normal bone marrow. The three-dimensional imaging CT shows cortical and marrow continuity of the lesion and parent bone in osteochondromas. Growth of osteochondroma continues till skeletal maturation is complete. Fourteen cases were reported with H/O soft tissue swelling and vague pain. Nine cases were male patients and five cases were female patients. Six cases were from the femur, five from the humerus, one from the tibia, one from pubic ramus, and one from fibula. The presenting age group was between 8 and 12 years of age (Figures 7 and 8).

Treatment

Most cases needed no absolute indication for surgery except for cosmetic reasons and complications. Fourteen cases underwent surgery. Larger symptomatic lesions were resected at their base where there is continuity to underlying bone. Pedunculated lesions are more easily removed. Sections studied show a cartilaginous cap overlying broad bands of bone trabaculae. In all the cases, the radiographic findings correlated with histopathology findings.

Chondroblastoma

Chondroblastoma is also referred to as Codman tumors, arises in the epiphysis or apophysis of a long bone in young patients. In 1931, this lesion was described by Ernest Armory Codman an American. Nearly 50% of chondroblastoma occurs predominantly in males under 20 years of age. Clinical presentation includes joint pain, muscle wasting, tenderness, and swelling as a local mass. It usually arises in the distal end of the femur, proximal end of the humerus, and proximal end of the tibia. MRI shows, T1: Lesion itself is of low to intermediate signal, T2/short T1 inversion recovery: Lesion is of intermediate to high signal. Microscopically, the presence of small zones of focal calcification is present with cellular areas of mononuclear cells. These zones range from a network of thin lines ("chicken wire") to obvious deposits surrounded by giant cells. Helpful features which suggest a clear cell chondrosarcoma include: Older age, larger mass, absent adjacent bone edema, and high T2 signal in MRI. Two cases were reported: One lesion involved lower end of the femur and one upper end of the fibula (Figures 9 and 10).

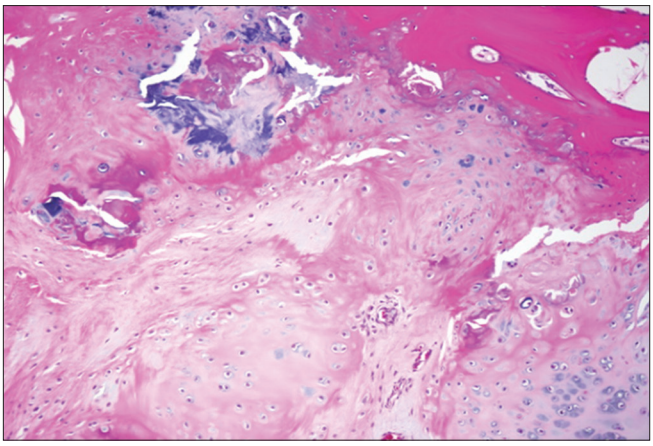

Figure 6: Chondrocytes are arranged in lobules, have benign appearance and foci of calcification are present

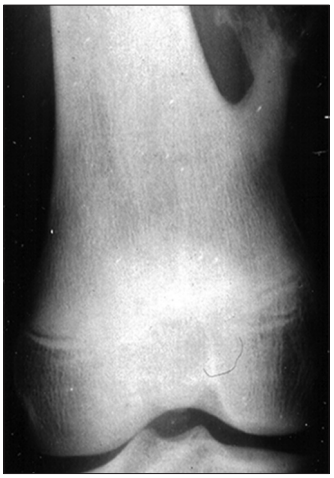

Figure 7: Exophytic growth in the femur measuring more than 5 cms away from the knee joint

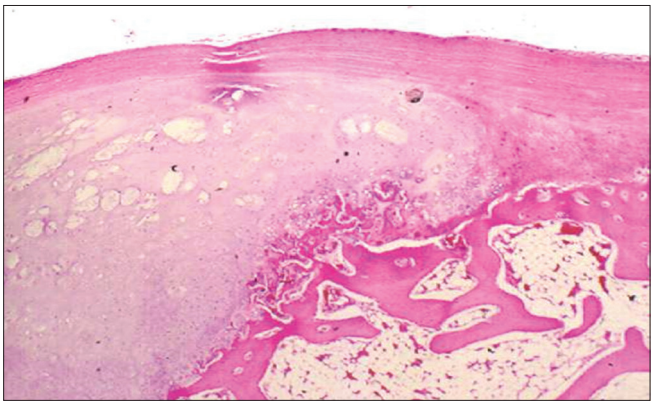

Figure 8: Cartilaginous cap with underlying bone trabeculae the chondrocytes are arranged in lobules and have benign appearance

The two cases were treated with curettage and packing of the resulting cavity with bone cement. X-ray femur showing an area of translucency with calcification. X-ray right femur showing an area of translucency with calcification. Sections studied show highly cellular areas of mononuclear cells and giant cells with chicken-wire calcification. RFA has also been used currently for therapy. The radiographic findings correlated with histopathological section findings.

Chondromyxoid Fibroma

Chondromyxoid fibroma of bone is a benign tumor of cartilaginous origin. Most chondromyxoid fibromas are located in the metaphyseal region of long bones (60%). The tumor consists of chondroid, myxomatous areas with giant cells. It usually occurs in a long bone around knee joint of a young adult. Radiographically, a radiolucent, eccentric space occupying lesion is seen in the metaphysis. Cortex is expanded. Grossly, it is solid and yellowish white or tan tissue, replaces bone, and thins the cortex. Microscopically, it comprises hypocellular lobules with a myxochondroid appearance, separated by intersecting bands of highly cellular tissue composed of fibroblast-like spindle cells and osteoclast-type of giant cells.

T2-weighted MRI of lower femur shows a high signal intensity lesion in the metaphysis with cortex is spared. Two cases underwent *en bloc* excision and bone grafting. Section studied shows a hypocellular area in the center surrounded by areas of osteoclast type of giant cells and hypercellular fibrous areas in the periphery. Radiographic features correlated with histopathology findings (Figures 11 and 12).

None of the benign osteogenic and cartilaginous tumors turned malignant after careful study and follow-up after treatment so far (Table 4).

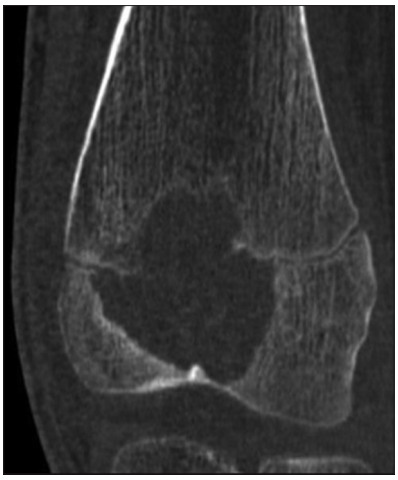

Figure 9: Translucent lesion involving lower end of femur with a calcification seen distally

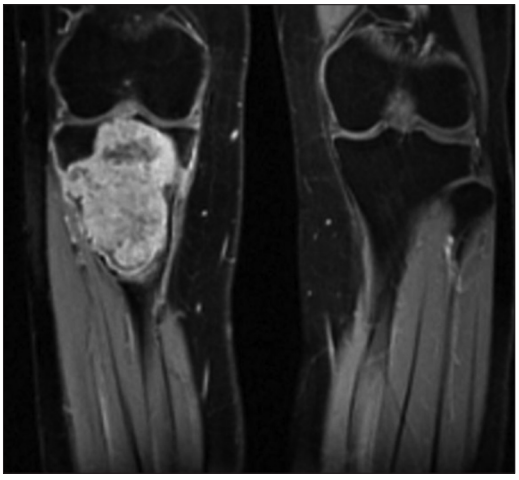

Figure 11: T2 Weighted MRI of lower femur shows a high signal intensity lesion in the metaphysis with cortex is spared

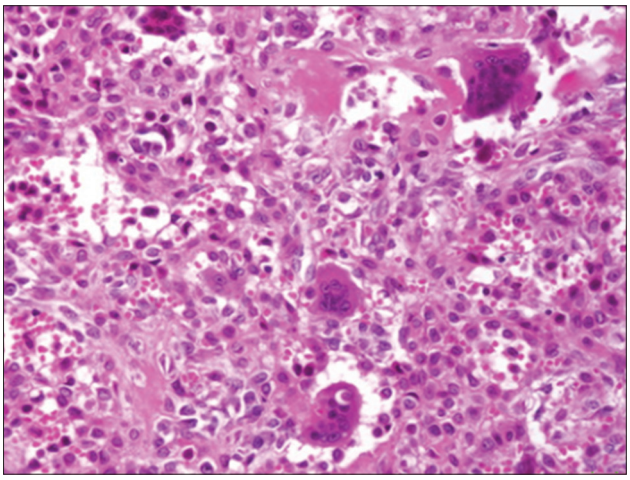

Figure 10: Cellular lesion with mononuclear cells with osteoclast type of giant cells and chicken wire calcification.

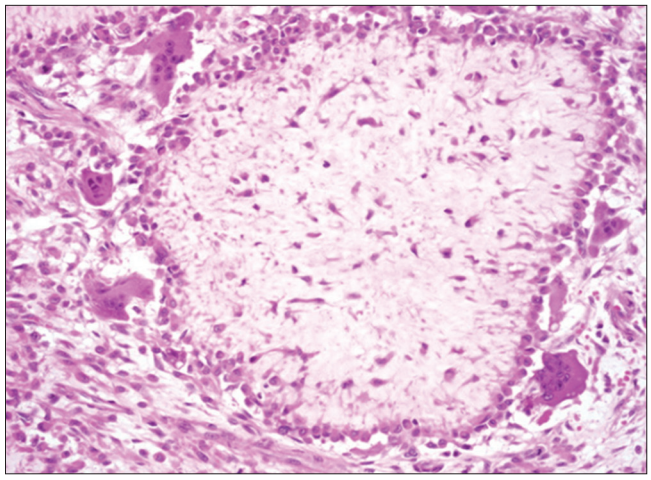

Figure 12: Lobules have a hypocellular center and increased cellularity at the periphery

Table 4: Final outcome of the study of benign bone tumors

Tumor	Surgery done	Cure rate (%)	Follow-up
Osteoid osteoma	Six cases underwent surgery. The nidus was surgically removed with a margin	100	Two cases are attending follow-up
Osteoblastoma	Two cases underwent tumor tissue curetted and bone grafting was done	100	No cases reported for follow-up
Chondroma	Two cases underwent curettage and bone grafting	100	One case reported for follow-up
Osteochondroma	Fourteen cases underwent surgery. Larger symptomatic lesions were resected at their base where there is continuity to underlying bone. Pedunculated lesions were more easily removed	100	Two cases reported for follow-up
Chondroblastoma	Curettement with bone cement filling was done for the two cases	100	No cases reported for follow-up
Chondromyxoid fibroma	Two cases underwent *en bloc* excision and bone grafting was done	100	One case reported for follow-up

DISCUSSION

The presentation of chondromyxoid fibroma is interesting as it occurs in the second and third decades, with 75% of cases occurring before the age of 30 years.[1,26,27] The tumor comprises a variable combination of chondroid, myxoid, and fibrous tissue components organized in a pseudolobulated architecture.[28] In osteoid osteoma, the pain relief after treatment is so dramatic that the patient realizes on recovery from anesthesia that the lesion has been removed. In future, non-invasive procedure such as CT-guided RFA in osteoid osteoma, osteoblastoma, and chondroblastoma may have a promising role. Treatment of osteoid osteoma with RFA has been extremely successful, with negligible complications.[29,30] Osteochondroma was the most common type of tumor, occurred commonly in male children. The peak incidence was in the second decade and the most common site was the lower extremity, particularly in the femur. Giant cells were found considerably in chondroblastoma and chondromyxoid fibroma leading to a suspicion of giant cell tumor. Enchondromas have similar histopathological appearance of low-grade chondrosarcoma. In these cases, imaging modality provided the final diagnosis. Highly cellular chondroid tumors have high signal intensity in T2-weighted MRI. Gadolinium-enhanced images help to differentiate between viable tumor, reactive edema and necrosis and guide the biopsy site. Twenty-eight cases underwent surgery. Six cases turned for follow-up. The cure rate was 100% with the team approach of radiologists, clinicians, and pathologists.

CONCLUSION

The histopathology is the final tool for the diagnoses of various types of benign tumors of bone both osteoid-producing and cartilage-producing tumors. The study also explains the pain in diagnosing benign and malignant cartilaginous tumors located peripherally in the bone that is a challenging task in histopathology reporting. Histopathology provides the final verdict for further treatment of the patient. The study provides the importance of other medical faculty, the surgeon, and radiologist to work as a team for a successful outcome. We correlated the histopathological findings with radiological findings. This resulted in perfect correlation between the histopathology study and radiology study.

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