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Reviewing the Evaluation of Primary Bone Tumors using Magnetic Resonance Imaging

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Key words

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Abstract

Circulation through the vascular bed of bone is essential for maintaining its viability. Under normal physiologic conditions, bone receives between 5 - 10% of the cardiac output. In the metaphyseal region near the capsular attachment and in the synovial reflections, there are rich capillary plexuses from which vessels enter the bone dividing to supply epiphysis and metaphysis. The arterial supply to the diaphysis comes primarily via nutrient artery

1. Introduction

The basic structural unit of bone is Haversian system, which consists of a series of concentric laminations surrounding a central canal[9]. In the centre of each Haversian system is a central canal which contains interlacing reticular tissue, osteoblasts and osteoclasts in various stages of activity and neurovascular bundle. The

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central canal runs parallel to the long axis of the bone and is united with canaliculae and Volkmann's cannals which pierce the bone from outer and inner surfaces. The bone is surrounded by periosteum, which is made up of elastic fibrous a outer layer and an inner cambium layer which has a looser composition, is morevascular and contains cells with osteogenic potency. It is responsible for periosteal osteogenesis, in which bone substance is increased by a process of accretion. Cuboidal mononuclear cells called osteoblasts create a contagious monolayer across the bone's surface. They are not capable of undergoing mitosis and instead originate from marrow stromal cells via the differentiation of pre-osteoblasts. Protein-producing cells have an abnormally positioned nucleus and an abundance of rough cytoplasm. The alkaline phosphatase levels are also rather high. The osteoblasts produce type 1 collagen and other key bone proteins like osteocalcin that are not collagenous. It also plays a role in bone mineralization. It's also crucial in regulating the osteoclastic process.

Osteocytes and lining cells -

Active osteoblasts may get trapped in the matrix they produce and become deeply buried in the bone. These osteocytes keep in touch with one another and the superficial lining cells through a lengthy procedure. One possible mechanism for the fast exchange of calcium between bone and fluid outside the cell is the cellular system. Although its exact function is still up for debate.

Large, multinucleated, surface-attached gigantic cells called osteoclasts break down bone. The number of nuclei ranges from fifteen to twenty. It is the primary factor in the breakdown of healthy bone. They are a form of circulating monocyte or macrophage that originate from haematopoietic progenitor cells. The World Health Organization's (WHO) categorization of bone tumors was also examined for clarity.

2. Review of Literature

In 1980, Enneking et al. developed a staging system for tumors of bone and soft tissue. In 1985, Zimmer et al. studied 52 people who had injuries to their bones. Fifteen had skeletal metastases, seven had benign bone neoplasms, and five were bone tumor mimics. Twenty-five had original malignancies.

In 1986, Aisen AM et al. used MR imaging & computed tomography to examine 26 individuals with primary malignancies of bone or somatic soft tissues.

Fourty aneurysmal bone cysts that were related to or associated with other bone diseases were examined by Levy WM et al.16 in 1975.

The MR imaging features of patients with osteosarcomas were investigated in 1986 by Zimmer WD et al.17.

In 1987, Boyko OB et al investigated 20 patients using a 0.15-TMRI to establish the utility of MR inside the diagnosis and treatment of osteogenic (11 instances) and Ewing's (nine cases) sarcoma and to design the optimum protocol for MR imaging.

Anatomical staging for bone osteosarcomas was investigated by Masciocchi C et al. in 1988.

In 1988, Martinez V. et al. analyzed a collection of 639 bone lesions to investigate the characteristics of a aneurysmal bone cyst as well as its relationship to other disorders.

CT and MR imaging were evaluated for their sensitivity and specificity for histological diagnosis of lesion size by Reuther G et al in 1989.

The use of stark difference MR imaging using gadopentetate dimeglumine for musculoskeletal tumors was first reported in 1991 by Beltran J.et al.

In 1992, **Davies AM** stated that, MR imaging remains preeminent in the staging of musculoskeletal tumours.

Subjective MR criteria appear unhelpful in identifying osteosar comas patients who are good responders to chemotherapy.

Geirnaerdt MJ et al[26] correlated Gadolinium-enhanced MR images with histopathologic findings in patients with cartilaginous tumours in 1993.

In 1993, **Burr BA et al**[27] presented a case of unicameral bone cyst with fluidlevels evaluated with CT and MRI.

The value of serial MRI investigations in determining tumor resection feasibility, timing, and extent was assessed by Cohen IJ et al. in 1994.

An enostosis, also known as a bone island, is a concentration of mature compact (cortical) bone inside the cancellous bone, as mentioned by Greenspan A. in 1995. (spongiosa). "Not only is MR imaging maximum sensitive to a presence of musculoskeletal soft-tissue abnormalities," Weatherall PT. wrote.

None of the evaluated factors were found to be helpful in the diagnosis of osteochondromas by De Beuckeleer LH et al31 in 1995.

According to a 1996 research by Balzarini L. et al. Examining CT's and MRI's diagnostic strengths and weaknesses.

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In 1998, Jung WH et al. matched MR imaging results of non-ossifying fibroma with histological investigation.

To wit: Priolo F. Maas EJ etal showed an uncommon case of simple bone cyst (SBC) having fluid-fluid levels on MR and cementum like material on microscopy in an unique site in the distal femur, demonstrating that radiography provides more information compared to any other imaging modality.

Pre-operative parameters for distinguishing aneurysmal bone cysts versus unicameral bone cysts were investigated by Sullivan RJ et al. in 1999. The necessity for a single staging system for primary malignant soft tissue and bone tumors was discussed by Funovics M et al.. Imaging characteristics of primary lymphoma of bone have been observed, and they may be seen on conventional radiographs, CT scans, and MRI scans, as described by Mulligan ME et al.

Fibrous dysplasia (FD), fibroxanthoma (no ossifying fibroma), cortical desmoid, desmoplastic fibroma, fibrosarcoma, and malignant fibrous histiocytosis are all examples of tumors of fibrous origin, as described by Smith SE et al in 2000. (MFH). Geirnaerdt JM et al. investigated 37 individuals to show the value of rapid contrast-enhanced MR imaging in distinguishing benign from malignant cartilaginous tumors.

Using morphological traits, signal characteristics, and contrast-enhancement patterns, Wortler K et al. (2000) evaluated MR imaging data of 38 patients with histologically confirmed primary aneurysmal bone cyst.

By M. Breitenseher et al. Giant cell tumors are considered benign neoplasms, yet they are very aggressive locally and have a high recurrence rate (30-50%).

In 2002, **Azouz EM et al**[47] stated that a benign bone lesion may have atypical appearance on plain radiographs. **Kaim AH et al**[49] analyzed and compared the radiological and magnetic resonance imaging (MR1).

in 2003 a retrospective MR imaging analysis of seventy two patients of confirmed clear cell chondrosarcoma (CCCS) was carried out by Collins MS et al.Clinical, radiological, and therapeutic aspects of seven cases of aneurismal cyst of the spine were studied by Primary bone lymphoma is a rare malignancy, making up less than 5 percent of all primary bone tumors, as reported by Dekeuwer P et al51 and Krishnan A et al. Mahnken AH, et al. looked at the reliability and use of several imaging characteristics in diagnosing primary aneurysmal bone cysts (ABC).

Short tau inversion recovery (STIR) or T1-weighted, contrast-enhanced MRIs were compared by Tokuda O et al. in 2004. Rafique MZ et al. used MR imaging to assess 30 individuals suspected of having primary bone tumors.

James SL., determined the diagnostic significance of measuring the amount of bone marrow oedema around focal bone lesions in 2006.

In 2008, Rodallec MH et al. investigated spinal tumors that occurred on their own. Blancas C. conducted a retrospective study of 18 chondroblastoma patients. et al. (2008).

In 2010, Rubin BP et al. developed a technique for analyzing bone tumor specimens, and Obalum DC et al. looked back over 25 years to analyze instances of primary bone tumors at three different institutions.

According to Kransdori et al., of the three types of osteiod osteoma, the cortical variation is the most prevalent, followed by the cancellous and subperiosteal types.

Inside the joint capsule and synovium, but outside the synovial cavity proper, is where intraarticular osteoidosteomas form, as described by Kattapuramet et al.

According to P.Goswamie et al., MR imaging may be used to consistently show the nidus.

NA. Due to synovial thickness, reactive joint effusion, and inflammation, MR imaging may better identify neighboring soft tissue, as mentioned by Pendse et al.

Both osteoid osteoma or osteoblastoma, as described by NAJambhekar et al., are benign bone tumors characterized by an osteoid nidus encased in sclerotic bone.

Lesions less than 1.5 cm in diameter were classified as osteoid osteomas by Mcleod et al., whereas those larger than 1.5 cm were classified as osteoblastomas. In 30% of instances, the spine is involved (as reported by Tripathy P, et al).

The optimal time to start for is between the ages of 3 and 14, as reported by Shahryar Nordin et al.

When a malignant change is suspected, MR imaging

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should be performed, as stated by Meyerding.

According to S.Kumar et al., 3%-5% of individuals with numerous hereditary exostosis and diaphyseal aclasis have malignant transformation, whereas only 1% of isolated osteochondromas undergo malignant transformation. Mark. According to the findings of D. Murphey et al., the thickness of the hyaline cartilage cap varies with a person's level of skeletal development. Mark. The signal strengths of osteochondroma on several MR sequences were previously published by D. Murphey et al.

Clyde Helms wrote that enchondroma always, with the exception of phalanges, has calcified chondroid matrix.

Mark. D. Murphy et al[79]had stated the imaging criteria for identifying chondro-sarcomata's changes in an enchondroma.

Benign fibrous tumours: Due to their benign character, they belong to a group of lesions that do not require histopathological sampling for further diagnosis. "Depending on the appearance of tumour matrix, **R. Kumar et al**[81] classified lesions asa) ossifying fibroma when bone predominates in the matrix of the lesion b) cementifying fibroma when spheroid calcification is presentc) cementifying fibroma when both bone and calcification is present."

According to **Hettsetal**[82] NOF are common type of benign fibrous lesions that tend to occur commonly in lower extremities around knee joint.MR imaging features of aneurysmal bone cyst were studied by **J.Beltran et al**[83].

R.Sherman et al[84] studied the radiographic features of ABC in 43 histologically proven cases. **Manjunath Rai et al**[85] demonstrated 25 cases of giant cell tumours in their study and stated that GCT usually do not cause periosteal reaction unless associated with a cortical break.

Shaligram Purohit et al[86] stated that GCT shows low intensity on T1W images and heterogeneously high intensity on T2W images

Malignant Bone Tumours:

Murphy et al[87] stated most cases of osteosarcoma present in 2nd and 3rddecade with 75% cases occurring in age group of 15-25 years. A male-to female ratioof 1.5:1 was noted with femur being the most common site (40 - 45 %).**Redmond et al**[88] evaluated 14 cases of histologically proven osteosarcoma by MR imaging. **SV. Phatak et**[89] in his case report on osteosarcoma described the different subtypes of osteosarcoma. **M.Murphy et al**[91]in his study of primary chondrosarcoma.

Based on their analysis of 27 individuals, VyakantVohar et al. found that the lower extremities and the pelvic girdle were the most prevalent areas.

In nine patients with biopsy-proven Ewing's sarcoma, Boyko et al. analyzed MRI results.

Mini brain sign inside an expansile lesion has been found to be diagnostic of plasmacytoma by Nancy Major et al.

Multiple myeloma patients were analyzed by F.Lecouvet et al. to determine the prevalence and appearance of spinal compression fractures on magnetic resonance imaging.

3. Conclusion

The appendicular skeleton was the primary target of the injuries. Our research found that most bone tumors spread from the metaphysis to the epiphysis or the diaphysis, or both. Many instances have a confirmed histopathological connection. MR imaging is a very effective tool for distinguishing benign from malignant lesions. Moreover, MRI is superior at distinguishing between tumor and soft tissue or joint involvement.

Eighty-two percent of the injuries were located in the appendicular bones. The tibia and femur were the most typically affected appendicular bones. The majority of bone tumors in our research originated in the metaphysis and spread to either the epiphysis or the diaphysis. Thirteen instances were found to have calcification, while 13 cases were found to have trabeculations or internal septations. The diagnostic process for the lesions was helped along by the fact that they exhibited these features. While MRI was able to show the tumor's many parts, patterns varied little across tumors of different histologies.

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