Bone tumors affecting metaphysis - a pictorial review

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Learning objectives

1- To point and differentiate the most common bone tumours affecting metaphysis;

2 - Show the main radiographic pathologic findings in each bone tumour.

The authors analysed the data of all patients with bone tumour treated in our hospital and selected those which lesions were located in the metaphysis.
Background

Bone tumors are a broad category encompassing benign and malign neoplasms and tumor-like conditions. Risk factors, age, as well as imaging features like tumor location, zone of transition, periosteal reaction, mineralization, size, number of lesions and soft tissue component are all together a great part of the tumor type diagnosis.

The two most important aspects of evaluating a bone tumor are the location of the tumor and the age of patient. Knowledge of this information alone is enough to narrow the differential diagnosis without even looking at any images. The specific radiographic appearance should then help narrow the list even further and will often lead to the single correct diagnosis.

Why metaphysis? This is the fastest growing area of a bone, and also the most likely area for a primary neoplasm to arise. This is especially true in the distal femur and proximal tibia, which are the fastest growing metaphyseal areas in the skeleton. The metaphysis also has the best blood supply of the bone, so entities such as infection or metastasis will commonly be seen in this area as well.
Imaging findings OR Procedure details

Benign tumors affecting metaphysis

• **Osteochondroma**

Osteochondroma is a benign tumor or just a development bone anomaly which is very common, with an estimated incidence of 1-2% in the population. Represents about 20-50% of all bone tumors. Its origin is unknown, and the factors that may be associated are radiotherapy and trauma.

These tumors consist in a proliferation of bone of variable size covered by hyaline cartilage. They can join the bone by a pedicle - osteochondroma pedunculated or have a broad-based deployment- sessile osteochondroma. In both cases it is observed continuity between cortical and medullary bone of origin with the medullary and cortical the osteochondroma Fig. 1 on page 7 and Fig. 2 on page 7 . Most of these tumors are solitary but may be multiple as occur in Hereditay Multiply Exostosis, with autosomal dominant inheritance and a high risk of progression to chondrosarcoma.

• **Enchondroma**

Enchondroma is frequent, being the most common benign tumor of the hand. The majority of this kind of tumors are asymptomatic, being an imagiologic finding, or can present with pathologic fractures in young people Fig. 3 on page 8 and Fig. 4 on page 9 . They are usually solitary, if they are multiple can be generally associated with Maffucci syndrome and Ollier syndrome, whose probability of developing chondrosarcoma ranges from 20-30%. Like the osteochondroma, these tumors are caused by a change in development of cartilage of the bone and therefore have a metaphyseal preferred location and a growth capacity until the osseous maturation.

Malignant bone tumors affecting metaphysis

• **Metastases**

Metastatic bone tumors are the most common malignant tumors of the skeleton, occurring mostly after the age of 40. Approximately 70% of all malignant tumors are metastatic in origin, with only 30% being primary in nature. Most malignant tumors of bone are metastases from a primary extraskeletal focus, the majority epithelial in origin. The most common sites are breast, lung, prostate, kidney, thyroid and bowel. Due to hematogenous dissemination, the tumors most commonly affect the axial skeleton, skull and proximal extremities. Typical patterns of lytic, blastic ( Fig. 5 on page 10 ) and mixed lesions prevail with occasional pathologic fracture.
• **Multiple myeloma**

Multiple myeloma (MM) is a malignant clonal neoplasm of plasma cells of B lymphocyte origin that commonly results in overproduction of large amounts of monoclonal immunoglobulins. The cause of MM is unknown and radiation exposure may play a role. It is the most common cause of primary malignant bone tumor. Typically the great majority of patients are between 50-70 years of age, with an average age of 60. This disease characteristically causes lytic lesions because of the bone marrow achievement and affects more commonly flat bones (clavicle, ribs, skull and scapula), axial skeleton and diaphyseal/metaphyseal region of long bones (Fig. 6 on page 11).

• **Osteosarcoma**

Following multiple myeloma, osteosarcoma is the most common malignant primary bone tumor. It is derived from undifferentiated connective tissue and forms neoplastic osteoid. There are five distinct clinical types: central osteosarcoma, parosteal osteosarcoma, secondary osteosarcoma, multicentric osteosarcoma and extraosseous osteosarcoma. 75% of cases occur in the 10-25 year age range, with a 2:1 male predominance. The metaphysis of the distal femur, proximal tibia and proximal humerus are the most common target sites. There are three basic presentation patterns: 50% are sclerotic lesions, 25% are purely lytic and 25% are mixed lesions (Fig. 7 on page 12 and Fig. 8 on page 13). The most frequent metastatic sites are lung, bones and kidneys. The prognosis is poor, an 20% 5 year survival rate has been described.

• **Chondrossarcoma**

Chondrossarcoma is a malignant tumor of chondrogenic origin, arising from chondroblasts and collagenoblasts. It is the third most common primary bone tumor, following multiple myeloma and osteosarcoma and occur mostly in the elderly (>40 years-old). This tumor can be primary (90%) or secondary (10%), if there is a pre-existing cartilaginous tumor (osteochondroma, enchondroma). According to their location they can be central (great majority), arising intramedullary, or peripheral, arising on the surface of the bone. Chondrossarcoma arise in any bone preformed in cartilage and the most common sites are the pelvis and the proximal femur (Fig. 9 on page 14).

**Tumor-like processes affecting metaphysis**

• **Aneurysmal bone cyst**
Aneurismal bone cyst is a non-neoplastic lesion of bone consisting of a cystic cavity filled with blood. Its true pathogenesis is still unknown. 75% of cases present between the ages of 5-20 years and occur mostly in females. It can be divided in primary aneurismal bone cyst if no other lesion is associated, occurring mostly in young people (till the age of 30 years), and secondary if another tumor is associated. Long tubular bones, such as humerus (Fig. 10 on page 15), femur and tibia metaphysis, and spine are the most common target sites.

• Nonossifying fibroma

Nonossifying fibroma is a common benign lesion, almost always an incidental radiographic finding. Nonossifying fibromas are well-circumscribed, solitary fibrous proliferations (Fig. 11 on page 16). The lesions are most commonly found in children, predominating in males. The process is nonneoplastic and occurs almost always in the diaphyseal/metaphyseal region in the inferior extremities of the long bones. Its patognomic imaging does not need further characterization by biopsy.
Fig. 1: The x-ray shows the characteristic aspect of pedunculated osteochondromas in the right femur (yellow arrows) and sessile osteochondromas of right fibula and tibia (blue arrows). Note the presence of continuity between the medullary and cortical of the native bone with the tumor, which is pedunculated. This patient had Hereditary Multiple Exostosis.

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Fig. 2: As seen in the x-ray: Pedunculated osteochondromas (yellow arrows) and sessile osteochondromas (blue arrows). MR confirmed this disease. No further investigation was done. Follow up with MR is necessary due to its malignant potential.
**Fig. 3:** The X-ray show a characteristic presentation of an enchondroma localized in the proximal metaphysis of the right tibia in an asymptomatic 42-year-old woman (yellow arrow). This is an oval, lobulated and lithic lesion, of well defined contours and with punctate matrix calcification inside.

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**Fig. 4:** The MR (T1-weighted sequence) confirmed the lesion seen in the X-ray (yellow arrow), excluding the possibility of being a chondrosarcoma which would be more aggressive (with cortical disruption).

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Fig. 5: 62-year-old woman presented with persistent severe pain in her right shoulder. Bone biopsy was made and the result was an osteoblastic metastasis caused by a colon cancer. The figure shows sclerotic lesion with aggressive behavior - cortex disruption and marked sunburst periosteal reaction in the metaphysis of the right arm (yellow arrow). In the diaphysis we can see also a pathologic fracture (red arrow).

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Fig. 6: 81 year-old man, presented with severe pain in right shoulder associated with severe functional limitation. Bone biopsy was performed and confirmed the suspicion of multiple myeloma. The x-ray shows an irregular lesion, heterogeneous and predominantly lytic, affecting the metaphysis of the right humerus.

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Fig. 7: This is a case of a 25 year-old man with painful functional limitation of the right leg. The X-ray shows a typical mixed aggressive lesion, lytic and sclerotic, with cortical disruption and a Codman’s reactive triangle, in the distal metaphysis of tibia (yellow arrow).

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Fig. 8: A MR was performed, weighted T2 sequence (sagital plane) confirmed the soft tissues invasion and cortical disruption (yellow arrow). This patient was amputated below the knee.

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**Fig. 9:** 36 year old woman with left knee tumefaction. The CT shows an expansive lesion with coarse calcifications inside (chondroid matrix), with disruption of cortical and exophytic growth. The biopsy result was chondrosarcoma and the treatment was surgical excision.

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**Fig. 10:** Aneurysmal bone cyst in a 8 year-old child with pain and tumefaction of the left shoulder. X-ray shows an eccentric, metaphyseal, radiolucent, and saccular protusion of the bone, extending to proximal epiphysis of the left humerus (yellow arrow). Note the periosteal buttress in the distal edge of the lesion.

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**Fig. 11:** Nonossifying fibromas in a 26 year-old asymptomatic male. In the X ray we can see lytic, polilobulated lesions, with a sclerotic border, located in the inferior extremities of the left tibia (yellow arrow).

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Conclusion

The x-ray is indispensable to evaluate clinical suspicious of bone tumor and to orientate the future diagnostic plan with eventual necessity of staging by CT, MRI or bone biopsy.

The knowledge of the tumor clinical aspects as well its bone location is very important to make the differential diagnosis and to establish a fast orientation.
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