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Imaging for the Diagnosis and Monitoring of Osteosarcoma

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Summary: **Case Report**

Osteosarcoma is the most common primary malignant bone tumour. The aim of this study is to illustrate the contribution of imaging to diagnosis, extension assessment and therapeutic follow-up. Thirty cases were collected in the radiology department, including 10 men and 5 women. The average age was 25 years. The preferred site was the lower extremity of the femur. Standard radiology and CT scans were performed in all patients, and eleven patients underwent MRI. Standard radiography showed poorly limited geographic osteolysis with periosteal reaction, cortical rupture and soft tissue invasion in 8 cases, mitted osteolysis in 4 cases and permeative osteolysis in 1 case. CT revealed osteolysis with cortical rupture and soft tissue invasion in all 12 cases. MRI showed an osteolytic process with T1 hypersignal, T2 hypersignal and contrast with cortical rupture and soft tissue invasion in 11 cases, with skip metastases in 1 case and intra-articular effusion in 2 cases. All patients were evaluated for metastases. Histological confirmation was obtained by biopsy. Although simple films can be used to diagnose malignant tumours, MRI remains the preferred technique for assessing locoregional extension, prognosis, tumour response to induction chemotherapy and long-term monitoring.

Keywords: Osteosarcoma, Imaging, MRI, Osteolysis, Diagnosis.

INTRODUCTION

Osteosarcoma is the most common primary malignant bone tumour. Although rare, this tumour is distinguished by the direct production of bone or osteoid tissue by the tumour cells. Diagnosis is based on a combination of epidemiological, clinical, radiological and pathological data. Its prognosis, often dreadful and linked to the size and extension of the tumour at the time of diagnosis, has improved considerably thanks to the use of neoadjuvant chemotherapy: the 5-year survival of chemo-sensitive patients has increased from 20% to 75%. In addition, the onset of lung metastases has been delayed by several years, and thanks to advances in reconstructive surgery, many limb amputations have been avoided. This improvement requires a multidisciplinary approach that is heavily dependent on imaging. While the diagnosis can be suspected as early as standard radiography, MRI is now the preferred method for assessing locoregional extension. This examination is unique in that it can analyse both intraosseous and soft-tissue extension with near-anatomical precision. In addition, dynamic MRI after contrast injection can be used to assess tumour response to induction chemotherapy prior to surgery.

MATERIALS AND METHODS

This retrospective study concerns 15 cases collected in the radiology department of

the ARRAZI hospital of the CHU Mohamed VI, over a period of 3 years, from January 2022 to December 2024. All patients underwent a standard radiograph (face and profile) and a computed tomography (CT) scan in axial slices, with a slice thickness varying from 3 to 5 mm, performed before and after injection of a contrast medium. In addition, 11 patients underwent T1- and T2-weighted spin-echo MRI, with and without fat suppression, in all three spatial planes, before and after bolus injection of gadolinium. A thoracoabdomino-pelvic CT (TAP) scan was also performed to assess the extent of the disease in all patients.

RESULTS

The cases were predominantly male, with 10 men and 5 women. The average age of onset was 25 years, with extremes ranging from 15 to 45 years. Clinically, local pain at the tumour site was the main symptom, accompanied by local swelling. Skin changes such as redness and heat, as well as fractures, were observed in advanced forms of the disease. The tumours were mainly located in the long bones of the limbs, distributed as follows:

- Lower extremity of the femur: 7 cases
- Upper end of the tibia: 3 cases
- Upper end of the femur: 3 cases
- Humeral head: 2 cases

The diagnosis of bone tumour was suspected on standard radiography, which revealed poorly defined geographic osteolysis, accompanied by a periosteal reaction, cortical rupture and soft tissue invasion in 8 cases. Mitotic osteolysis was also observed in 4 cases and permeative osteolysis in 1 case. Computed tomography (CT) confirmed the presence of osteolysis with cortical rupture and soft tissue invasion in all 12 cases examined. MRI revealed a T1 hypersignal, T2 hypersignal osteolytic process with contrast, cortical rupture and soft tissue invasion in 11 cases, as well as skip metastases in 1 case and intra-articular effusion in 2 cases. The diagnosis was confirmed by biopsy in all patients. Five patients had lung metastases. Treatment consisted of neoadjuvant chemotherapy followed by tumour removal. After a few months' follow-up, 7 patients were in remission, 2 of whom developed local recurrence, 2 were lost to follow-up and 3 had persistent lung metastases.

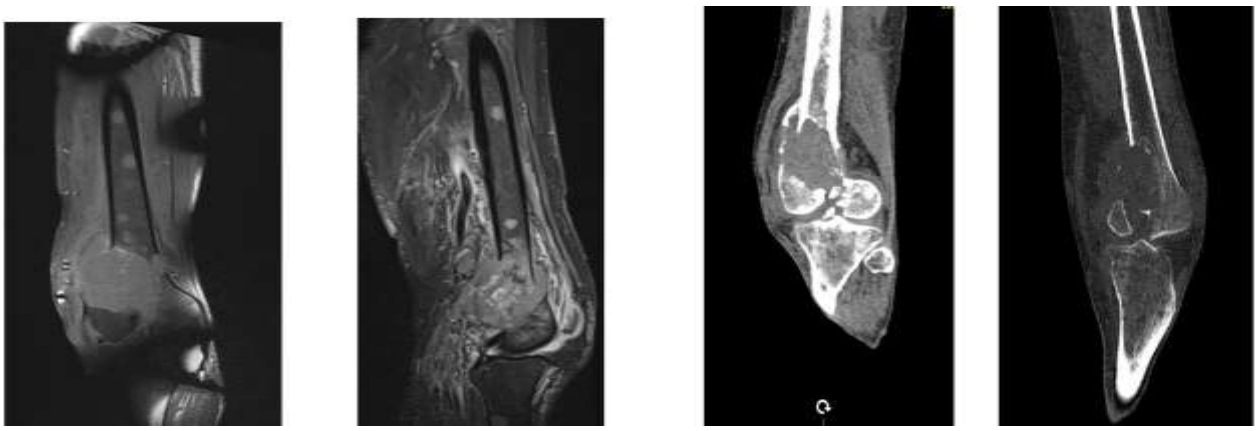

Figure 1: Aggressive epiphyseal-metaphyseal lesion of the lower extremity of the left femur with soft tissue invasion and joint extension: osteosarcoma associated with skip metastases

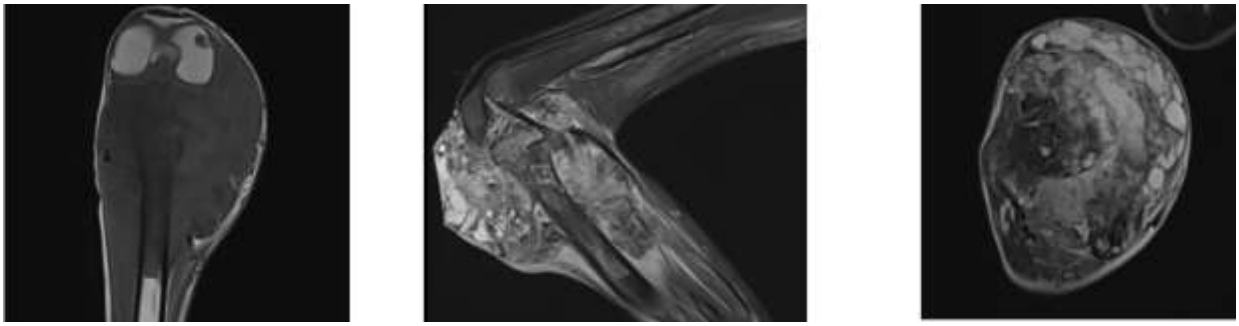

Figure 2: Right inferior femoral process locally infiltrating adjacent muscular and ligamentary structures and the femorotibial joint

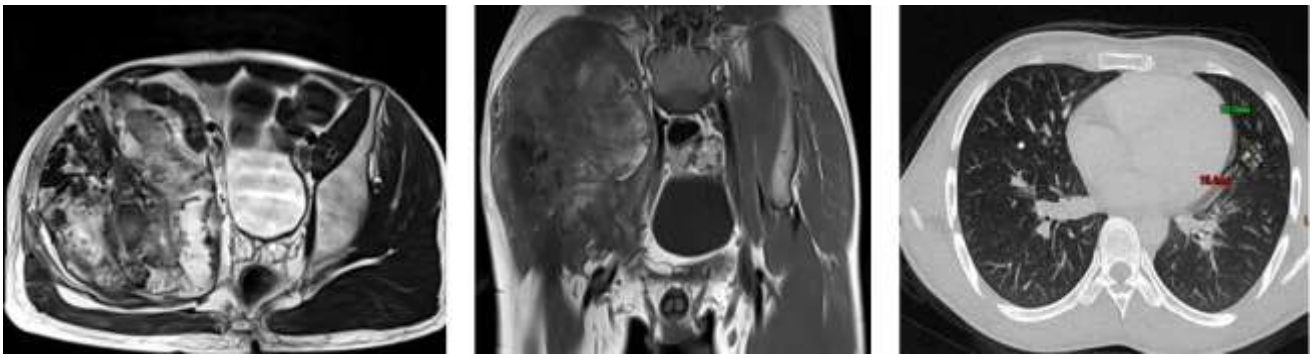

Figure 3: Locally infiltrative lytic tumour process centred on the iliac arch and the right coxofemoral joint. Nodular lesion metastatic to the lung

DISCUSSION

Osteosarcoma accounts for 42% of primary malignant bone tumours, with a male preponderance (sex ratio of 3/2) and a peak in frequency in the second decade of life. This tumour mainly affects the long bones, in particular the lower metaphysis of the femur, the upper metaphysis of the tibia and the humerus, with 75% of cases occurring near the knee and far from the elbow.

Histologically, osteosarcoma is derived from primitive mesenchyme and is characterised by an osteoid matrix and malignant osteoblasts. Several tumour grades can be distinguished, ranging from well-differentiated to anaplastic forms. Clinical symptoms include persistent pain at the tumour site, often attributed to minimal trauma. In advanced stages, swelling, redness, heat and fractures are observed.

Biological abnormalities are not very specific. In terms of imaging, standard X-rays suggest the diagnosis through signs of osteolysis, periosteal reactions and soft tissue involvement. Computed tomography (CT) offers a better analysis of bone condition, tumour mineralisation and soft tissue extension. However, it has limitations in detecting skip metastases and bone marrow infiltration.

MRI is essential prior to surgical biopsy to assess extension. It uses T1- and T2-weighted spin echo sequences to visualise active areas, cortical osteolysis and periosteal reaction. Post-chemotherapy MRI is used to assess tumour response. MRI surveillance is crucial if recurrence is suspected. There are two fundamental objectives: to define operability and to identify prognostic factors (Table I).

Metastatic spread occurs via the blood-borne route, mainly to the lungs. A chest X-ray is the first examination to be carried out, followed by a thoracic CT scan to detect small nodules.

Table I: Prognostic factors for osteosarcoma (according to standard options and SOR recommendations)

Factors Prognosis	Criteria used	Values
Tumour size or local spread	Less than 10 cm Crossing the conjugation cartilage	Favourable Unfavourable
Location	Humerus, tibia (Upper extremity) Axial tumour, fibula	Favourable Unfavourable
LDH Alkaline phosphatases	High: over 2N	Favourable
Response to chemotherapy	Good answering machine	
Initial metastasis	Presence	Unfavourable
Age	Under 12s Over 21 years old	 Unfavourable

CONCLUSION

Osteosarcoma is a malignant bone tumour whose prognosis, initially worrying, has been significantly improved by chemotherapy. Its management requires a multidisciplinary approach, strongly influenced by imaging techniques. Although the diagnosis can be suggested by a standard X-ray, MRI is currently the most appropriate method for assessing tumour extension with a view to surgery, and for analysing tumour composition when assessing response to induction chemotherapy.

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