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► To cite this version:

Etienne Massardier, Jules Guinard, Jean-Paul Roux, Frédéric Rongieras, François Bermond, et al.. Microarchitectural characterisation of trabecular bone in metastatic patients using micro-computed tomography. 29th Congress of the European Society of Biomechanics, Jun 2024, Edinburgh, Scotland, United Kingdom. hal-04630198

HAL Id: hal-04630198

<https://hal.science/hal-04630198>

Submitted on 1 Jul 2024

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MICROARCHITECTURAL CHARACTERISATION OF TRABECULAR BONE IN METASTATIC PATIENTS USING MICRO-COMPUTED TOMOGRAPHY

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Introduction

Bone metastases in oncologic patients cause increasing fracture risk and impair their quality of life. The most frequent site of pathological fractures are vertebrae and proximal femur. Numerical models were developed to estimate the fracture risk and guide prophylactic fixation [1]. Previous reported studies showed altered mechanical properties in metastatic vertebrae [2], but few studied specifically the proximal femur [3]. As femoral bone presents a specific pattern of trabeculae, a better comprehension of bone architecture in pathologic areas could be a key element to estimate their mechanical properties, to incorporate them into numerical models. The aim of this study was to characterize the microarchitecture of metastatic and normal femoral bone.

Methods

After ethical approval, 5 human proximal femurs were harvested during a prosthetic replacement performed for a lytic bone metastasis (Figure 1). All patients presented a known solid cancer or a multiple myeloma.

Each sample was dehydrated and fixed in ethanol and scanned at 9 μm using a micro-CT device (Skyscan® 1176, Bruker, Kontich Belgium, 50kV, 500 μA , Al 0.5mm filter). Microarchitectural parameters, namely bone volume fraction (BV/TV), trabecular thickness (Tb.Th), trabecular separation (Tb.Sp), connectivity, and Structure Model Index (SMI) were evaluated on 3 specimens and compared in the normal and the metastatic area of each sample.

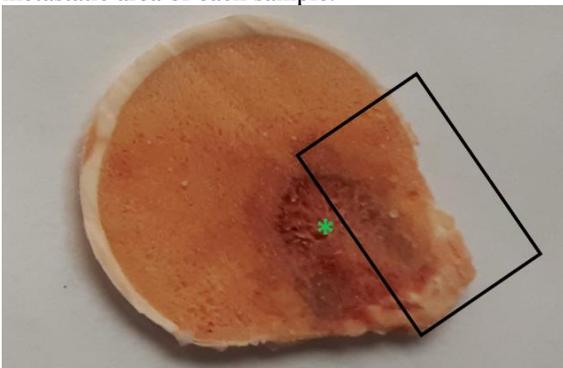


Figure 1 Femoral head presenting a lytic metastasis from a lung cancer. Black rectangle: area scanned with micro-CT. Green star: metastasis.

Results

As intended, BV/TV was lower in metastatic areas (2.3% [0.1-6.5%] vs 28.3% [19.4-44.7%]) (Figure 2).

Trabeculae were thinner (89 μm [76-98 μm] vs 192 μm [157-221 μm]) and more separated (1167 μm [411-1852 μm] vs 370 μm [231-481 μm]) than the normal bone. Connectivity was lower (355 [7-1024] vs 3365[225-6803]) and the SMI showed more “plates” than “rods” in the metastatic area (2.8 [2.6-3.0] vs 1.8 [1.8-1.9]).

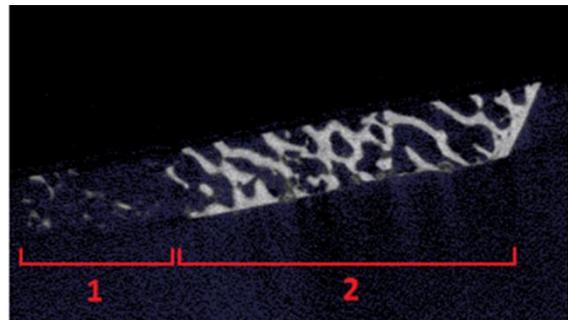


Figure 2: Micro-CT slice. 1: Metastasis. 2: Normal bone.

Discussion

Mechanical properties used in numerical models are frequently estimated using bone density. Nevertheless, this is not the only parameter determining bone resistance, as shown in osteoporotic patients [4]. Microarchitectural parameters need to be assessed in metastatic patients and linked to mechanical properties. More results are needed to confirm these data. Because of the different bone pattern in the different regions of the proximal femur, it may be necessary to evaluate separately the microarchitectural parameters depending of the localization of the metastasis.

Metastatic invasion of the bone tissue involves focal areas on lysis, surrounded by a border area with intermediate bone alteration. A better comprehension of the modifications of the bone pattern in these regions can improve the reliability of our numerical models.

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Acknowledgements

This work was supported by MSDAvenir and UCBL (AAP Accueil).

