SEMINAIRE DE LA MATIERE CONDENSEE

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Biophysical assessment of osteoporosis using Spectroscopic and Diffraction techniques: introducing additional biomarkers

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Osteoporosis is a systemic skeletal disorder stemming from bone remodeling imbalance and leading to decreased bone strength and increased fracture risk. Current clinical practice relates osteoporosis largely to absolute mass loss and consequently to bone mineral density (BMD) for the evaluation of bone strength. However, ongoing research shows that fracture resistance is a highly complex property determined by both structural and compositional variables such as the spatial distribution of the bone elements, the structural integrity of the bio-apatite and the inherent properties of the molecular groups that comprise both the inorganic and the organic phase of the bone tissue.
The term “bone quality” takes into account the biophysical and biochemical properties related to bone strength specified as “intrinsic determinants”. These mainly include mineral composition, collagen quality, morphological and structural factors, cellular activity, and microdamage. The first three comprise a large part of our research dedicated to the evaluation of normal and osteoporotic bone tissue in an effort to find specific biormarkers able to explain fracture susceptibility.
Our research demonstrated that values of calcium/phosphorus (Ca/P) ratio in bone apatite along with its 3D spatial distribution are closely related to osteoporosis. Variable experimental techniques were employed to estimate the Ca/P ratio including Auger electron spectroscopy (AES), energy dispersive X-ray spectroscopy (EDX) and a newly developed dual energy analysis (DEA) technique applied on a μ-CT scanner. Collagen cross linking was studied with infrared spectroscopy (FTIR). The same technique was applied to the study of mineral/matrix ratio and of carbonate and phosphate substitutions into the apatite structure. Multivariate statistical analysis successfully discriminated normal from diseased tissues based on apatite’s molecular groups. X-ray and neutron diffraction experiments are under way (*collaboration between CEA and University of Ioannina*) for the determination of structural alterations related to osteoporosis.
References

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3. Hadjipanteli, A., Kourkoumelis, N., Fromme, P., Olivio, A., Huang, J., Speller R. A new technique for the assessment of the 3D spatial distribution of the calcium/phosphorus ratio in bone apatite (2013) Physiological Measurement (under review)

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