levels have been found to correspond to cartilage lesions upon arthroscopic evaluation [14–17]. Lesions found in T2-weighted images and T2 maps have also been correlated with degradations of cartilage matrix (i.e., fibrillation, clefts [14,15]). T1ρ describes longitudinal relaxation in the rotating frame, and has been associated with proteoglycan loss, which is thought to precede the development of symptomatic.
Assessment of bone quality in OA using MR and micro-computed tomography (μCT) in bone samples has also revealed much information about bone density and micro-architecture.
Although the disruptive and degradative events accompanying the advent of disease progression in OA are known, the mechanisms and order in which these events occur is still an active area of research. Preclinical studies designed to address this need employ several animal models, which exhibit disease phenotypes similar to those observed in humans. These studies will be reviewed in this talk, and future directions will be identified.

Brief CV
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DEVELOPMENTS IN PRECLINICAL AND CLINICAL IMAGING

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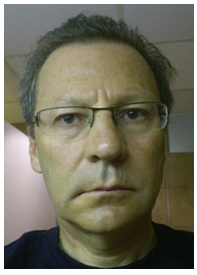
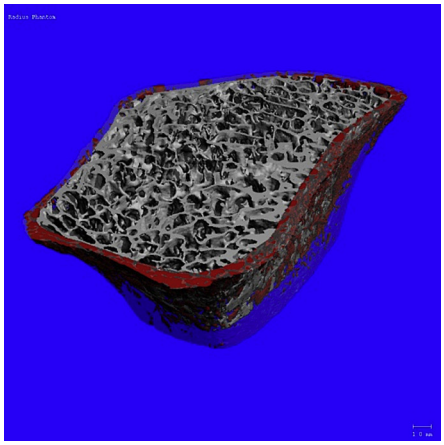
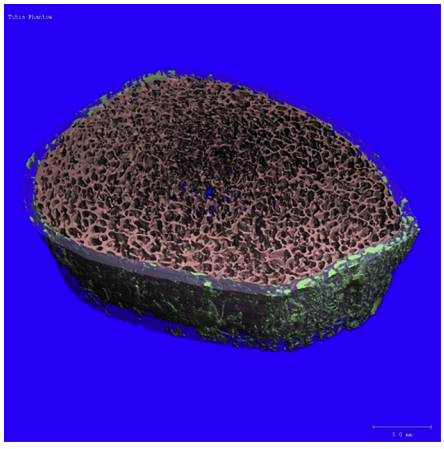


The XtremeCT (Scanco Medical AG, Bruttisellen, Switzerland) developed in 2004 was the first scanner to propose *in vivo* assessment of trabecular microarchitecture at the ultradistal radius and tibia. At that time we proposed a 2.8 min scan over a 9.02 mm region, with 82 μm voxel size, for a radiation dose lower than 3 μSv [Laib et al – Bone 1999].
This was the chance to pursue at the *in vivo* and organic level all the bone research done at the tissue level with restricted region of interest as per histomorphometry. Various studies exploited this new opportunity to better understand the mechanisms of bone loss in osteoporosis or the actions of drugs affecting bone metabolism.
During the past decade, applications focused on bone research are being developed as cortical bone analysis, finite element analyses or 3D registration. But bone is not the only field that can take advantage of the XtremeCT. Research in rheumatoid arthritis also finds interest into bone erosions, or joint space width in 3D that can be obtained from high resolution joint imaging [SPECTRA]. With the interest in sarcopenia growing in the community, we are currently validating a method to assess muscle volume to fully exploit the images obtained with XtremeCT, even on the low density range [Erlandson et al – ASBMR 2012]. Vascular calcification may also be assessed, in addition to bone microarchitecture changes in patients suffering chronic kidney disease, or diabetes [Patsch].
Movement artifacts are known to affect XtremeCT scans, notably at the radius. They impact the reproducibility of the measurements and reduce the number of valid scans in longitudinal studies on bone fragility or osteoporosis treatment efficacy [Pialat et al – Bone 2011].
This motivated the design of a new HR-pQCT scanner (XtremeCT II) to address the movement artifacts issue. Hardware improvements allow for scan time shortening with no cost on image quality, with two different scan protocols over a 10 mm range. The basic protocol was specified to be compatible with XtremeCT: 1.5 min scan, 82 μm voxel size and 3 μSv dose. The second protocol has better resolution and is still acceptable for patient scans: 61 μm voxel size, 2 min scan time and 5 μSv dose.
A set of 20 cadaver bone phantoms (EBS, UCSF) was scanned to compare results across the different scan protocols, between XtremeCT II, XtremeCT and μCT 100. We obtained excellent correlations between all datasets, and good agreements were met between XtremeCT II both at 82 and 61 μm when compared to XtremeCT. We also found that the accuracy of bone microarchitecture measurements improved as the voxel size decreased, with respect to μCT 100 results.
Reduced scan time should lead to significant improvements regarding movement artifacts on *in vivo* scans. Also a new forearm cast will help to limit patient mobility.
XtremeCT II is also able to scan at 30 μm voxel size, which may find use in *ex vivo* studies or preclinical research involving relatively large animals such as rabbits.
XtremeCT II does not only improve the research in osteoporosis, but is more flexible hence widening the horizon of its applications.





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