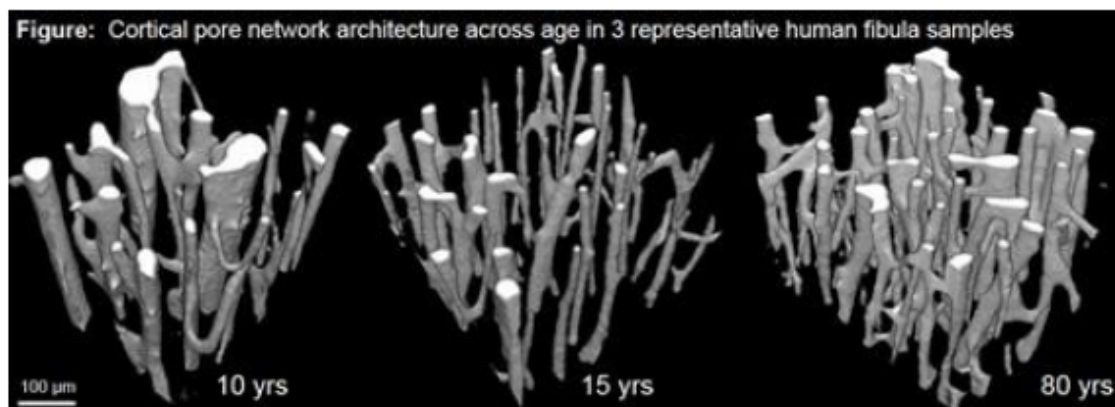


MO0032

Pore Network Architecture Determines Cortical Bone Elasticity During Growth and Aging. Yohann Bala^{*1}, Emmanuelle Lefèvre², Jean-Paul Roux¹, Cécile Baron², Philippe Lasaygues³, Martine Pithioux², Valérie Kaftandjian⁴, Hélène Follet⁵. ¹INSERM U1033, Université de Lyon, France, ²Aix-Marseille Université, CNRS, ISM UMR 7287, 13288 Marseille Cedex 09, France / APMH, Hôpital Sainte Marguerite, IML, Marseille Cedex 09, France, France, ³Laboratory of Mechanics & Acoustics, UPR CNRS 7051, Aix-Marseille University, Centrale Marseille, 13009 Marseille, France, France, ⁴Laboratoire Vibrations Acoustique, INSA Lyon, Campus LyonTech la Doua, 69621 Villeurbanne Cedex, France, France, ⁵INSERM UMR 1033, Université de Lyon, France

Cortical porosity is a major determinant of bone strength. Haversian and Volkmann's canals are 'seen' as pores in 2D cross-section but fashion a dynamic network of interconnected channels in 3D, a quantifiable footprint of intracortical remodeling. Given the changes in bone remodeling across life, we hypothesized that the 3D architecture of the cortical pore network is age-dependent and influences its stiffness. Cubes of cortical bone of 2 mm side-length harvested in the distal 1/3 of the fibula in 13 growing children (9M, 4F, mean age \pm SD: 12 \pm 4 yrs) and 16 adults (7M, 9F, 74 \pm 12 yrs) were imaged using desktop micro-CT (8 μ m isotropic voxel size). Pores were segmented as a solid to assess pore volume fraction (Po.V/TV, %), number (Po.N, 1/mm), diameter (Po.Dm, μ m), separation (Po.Sp, μ m) and connectivity ConnD, 1/mm³). Compression (C33) and shear (C66) elastic coefficients were derived by assessing waves velocity using ultrasonic measurements. Spearman correlation coefficients (r) are reported when statistical significance reached ($p < 0.05$). Pore volume fraction (Po.V/TV) did not differ between growing children and adults groups but originated from different architectural pattern (Figure). Relative to children, adults had 46% higher Po.N, 17% lower Po.Sp, 250% higher ConnD, 14% and 13% higher compressive (C33) and shear (C66) stiffness, respectively (All $p < 0.02$). In growing children, age was associated with a decrease in Po.V/TV ($r = -0.6$) due to decreasing Po.N ($r = -0.5$), Po.Dm ($r = -0.4$) and increasing Po.Sp ($r = 0.6$). C33 and C66 were inversely correlated with Po.V/TV, Po.N and Po.Dm (r ranging from -0.56 to -0.82), none of the correlations remained significant after adjustment for Po.V/TV contribution. Among adults, age was associated with higher Po.V/TV ($r = 0.7$) originating from an increase in Po.N ($r = 0.8$), Po.Dm ($r = 0.5$) and a decrease in Po.Sp ($r = -0.8$). C33 was inversely correlated with Po.V/TV ($r = -0.6$), Po.N ($r = -0.6$) and positively with Po.Sp ($r = 0.7$). Po.Sp remained correlated with C33 after accounting for Po.V/TV contribution ($r = 0.6$). No correlation was found between C66, Po.V/TV or pore network architecture. We infer that changes in intracortical remodeling across life alter the distribution, size and connectedness of the channels forming cortical porosity. These alterations in pore network architecture participate in compressive stiffness impairments with aging, independently of the age-related increase in porosity.



Figure

Disclosures: Yohann Bala, None.