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Array transducer applied to low-frequency guided wave ultrasonography: an in vivo study on human radius and tibia

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Velocity (V_{FAS}) of a first arriving signal for $f < 0.5$ MHz is expected to have an enhanced sensitivity to endosteal osteoporotic changes as compared to using higher frequencies. In this study a group of males and females (aged 10-87 years) was measured by using a new array probe ($f_c = 0.4$ MHz) on the radius and tibia. In addition, peripheral quantitative computed tomography was used to assess the bone mineral density (BMD) and cortical thickness (CTh) at the same bone locations. Initial results (n=57) showed that the repeatability error of the V_{FAS} data (CV_{rms}) was 0.5%. When V_{FAS} data for the radius was plotted by age it characterized well, yet better than BMD or CTh, the typical growth and loss curve of bone. V_{FAS} for the radius was strongly correlated with total BMD ($r = 0.84$, $p < 0.001$), cortical BMD ($r = 0.77$, $p < 0.001$), subcortical BMD ($r = 0.66$, $p < 0.001$) and CTh ($r = 0.59$, $p < 0.001$). Corresponding results for the tibia were similar but clearly weaker than those for the radius. In conclusion, the low-frequency V_{FAS} had good accuracy and it predicted well both the geometry and material properties throughout the cortex.