Structural analysis of trabecular bone of the proximal femur using multislice computed tomography: a comparison with dual X-ray absorptiometry for predicting biomechanical strength in vitro.

We investigated whether trabecular microstructural parameters determined in multislice spiral computed tomographic (MSCT) images of proximal femur specimens differed in male and female donors and improved the prediction of biomechanical strength of the femur compared to bone mineral density (BMD) and content (BMC) determined with dual X-ray absorptiometry (DXA) as the standard diagnostic technique. Proximal femur specimens (n = 119) were harvested from formalin-fixed human cadavers (mean age 80 +/- 10 years). BMD was determined using DXA. Trabecular microstructural parameters (bone volume fraction, fractal dimension, and trabecular thickness, spacing, and number) were calculated in MSCT-derived images of the proximal femur. Failure load (FL) was measured using a biomechanical side-impact test. An age-, height-, and weight-matched subgroup (n = 54) was chosen to compare male and female donors. BMC, BMD, and structural parameters correlated significantly with FL, with r up to 0.75, 0.71, and 0.71, respectively. In a multiple regression model, an increase up to r = 0.82 was obtained when combining trabecular structural parameters and BMC. BMD differed between males and females only at the trochanter. BMC showed significant gender differences in all regions. This experimental study
showed that a combination of BMC and microstructural parameters could improve the prediction of FL, suggesting that bone mass and trabecular structure carry overlapping but complementary information and that a combination of the two provides the best prediction of bone strength. Male donors had larger femora even after adjustment for body size and height, but no differences in trabecular structure were found between males and females.