NOVEL METHOD FOR ANALYZING FEMUR GEOMETRY VARIATION

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Designing effective orthopaedic implants requires detailed knowledge of variation in human bone form. Incomplete characterization of this variation can result in implants – such as femoral intramedullary nails – that may not accurately reflect individual patients' bone shapes and may lead to poor clinical outcomes.

The purpose of this research is to quantify femoral variation and provide an improved basis for implant design. CT images were collected from 40 human femora divided into sex, race, and age categories (30-40, 70-80 yrs). Scans were reconstructed in 3D using Amira software, and bone lengths, curvature, diameters, and location of maximum curvature were quantified.

Results demonstrate that the average radius of femoral curvature is less than that of current intramedullary nails. Sex was the primary influence on bone length and diaphyseal thickness, with age also significant, and race was the main factor influencing curvature. Based on these results, average CAD models were generated for the entire sample and subsamples using PolyWorks software by averaging corresponding nodal coordinates. Using the average models, a length-standardized function was derived to create a geometrically optimized IM nail for the entire sample as well as for one for each subsample.

Further research will require dynamic finite element methods (simulating the nail insertion process) to predict possible failures, and determine optimal implant geometries that characterize patient variation and improve patient outcomes.