Research reveals dramatic implications with using the tibia loading model to treat osteoporosis

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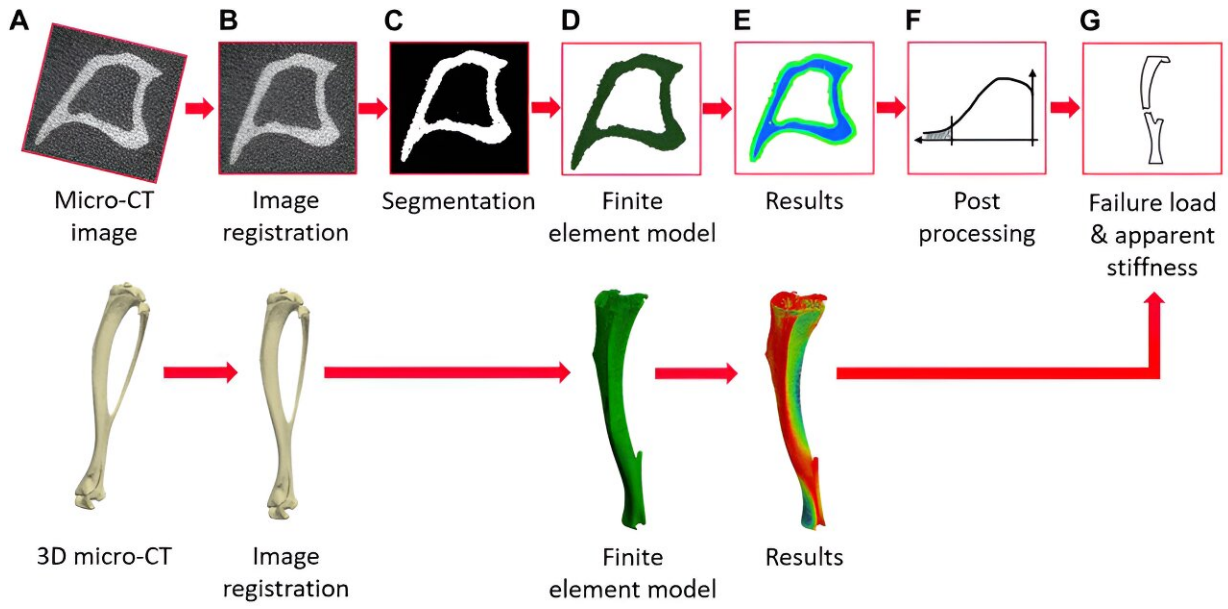

Flowchart illustrating the main steps of the pipeline to create the micro-FE models from the micro-CT images and to evaluate the apparent mechanical properties (from (A–G)) micro-CT acquisition, image registration, image segmentation (binarization), creation of the micro-FE models, results generation, post-processing of the local strains, calculation of failure load and apparent stiffness. Credit: *Frontiers in Bioengineering and Biotechnology* (2024). DOI: 10.3389/fbioe.2024.1335955

Research by Ph.D. student Saira Farage-O'Reilly highlights how the

direction of applying external force to the bone dramatically affects the strength of mouse tibia.

Bone is a dynamic tissue that changes over time due to biomechanical and biochemical stimuli. Osteoporosis is a health condition that weakens bones over time and makes them more fragile and likely to break.

Previous preclinical studies have examined the use of external methods, such as the use of the in vivo tibial loading model, to evaluate the effect of external loading on bone adaptation in mice. This non-invasive method involves placing the tibia within two loading caps to apply force to the bone and stimulate bone remodeling.

However, every time the leg is positioned in the device, it can be slightly misaligned which impacts the repositioning of the bone. As the device is used in vivo, the force is applied through the knee and ankle joints which creates uncertainty in the direction of the force onto the bone itself.

A preclinical study from the Healthy Lifespan Institute at the University of Sheffield used a computer model to test the effect of applying the force in over 500 different directions on the mechanical properties of the bone, including bone strength and stiffness.

The study was led by Ph.D. student Saira Farage-O'Reilly from the Healthy Lifespan and Insigneo Institutes at the University of Sheffield.

The findings, published in *Frontiers in Bioengineering and Biotechnology*, show that bone strength is affected by the loading direction, with changes ranging from half to double depending on the direction of the force.

"The findings highlight the sensitivity of the loading direction when

using the in vivo tibial loading model, which dramatically affects the bone strength. The study shows the importance of being aware of the consequences of applying the load in a certain direction, as in some directions the bone strength is stronger," says Saira Farage-O'Reilly.

"As well as being important for animal welfare through heightened risk of fracture of the leg of the mouse, this study provides more understanding to develop advanced multiscale computational models of bone remodeling which include both biomechanical and biochemical stimuli."

More information: Saira Mary Farage-O'Reilly et al, The loading direction dramatically affects the mechanical properties of the mouse tibia, *Frontiers in Bioengineering and Biotechnology* (2024). DOI: 10.3389/fbioe.2024.1335955

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