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Is computational bone assessment comparable with mechanical and micro-CT measures?

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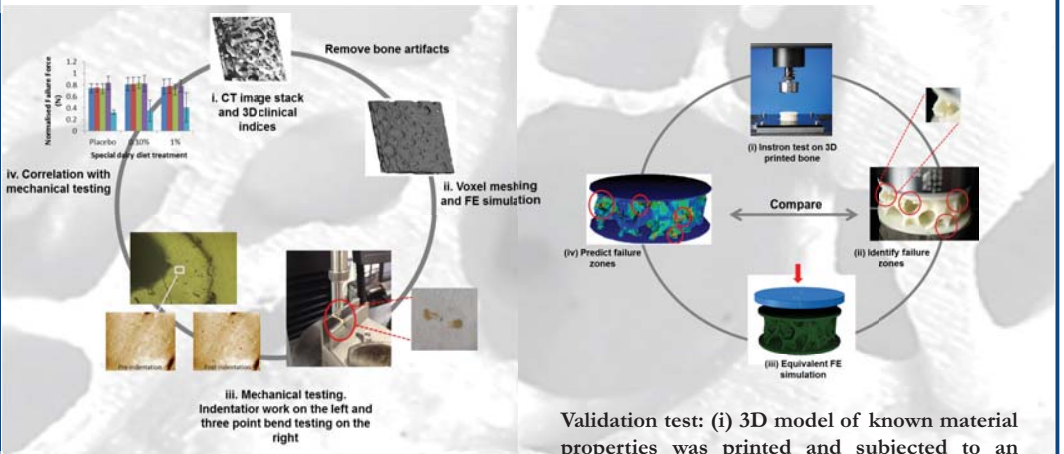
The aim of this study was to evaluate two questions of micro-FE bone mechanics:

- **Can computational modelling predict treatment effects on bone strength**
- **What is the effect on computational predictions when material properties are taken from different sources.**



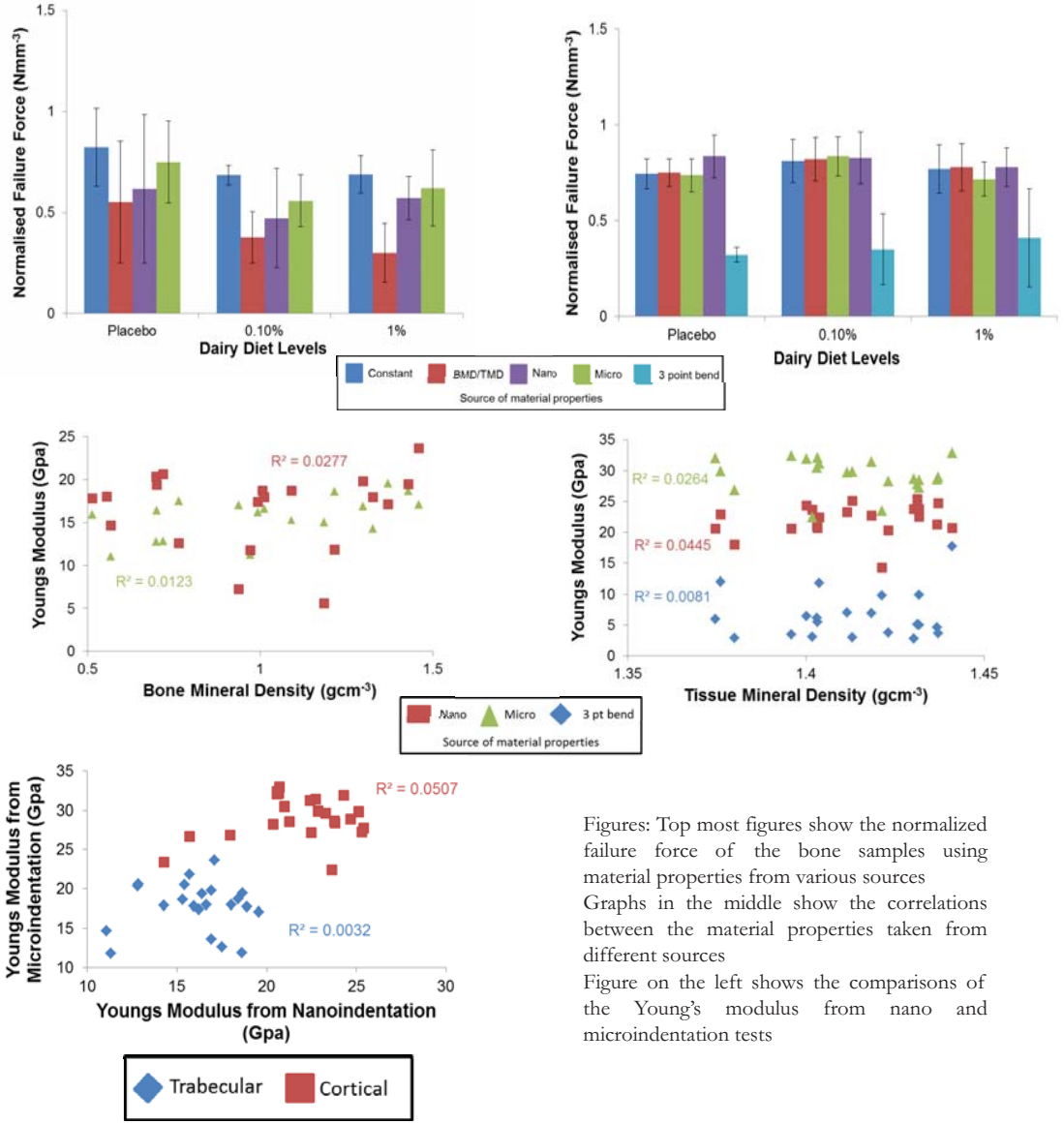
The above figure represents the modelling framework used for this study. (i) micro-CT scanning and measurement of indices, (ii) generation of a geometric mesh and computational finite element mechanical simulation, (iii) mechanical testing of the sample, (iv) correlation of both FE modelling and mechanical testing

Validation test: (i) 3D model of known material properties was printed and subjected to an Instron compression test. (ii) Zones of micro failure noted (red circles). (iii) Equivalent finite element simulation. (iv) A Von Mises failure criteria was used to note zones of predicted failure (red circles) and then compared to the actual failure sites. Strong correlations were shown between the predicted zones and the actual zones of failure.

- Our computer model correctly predicts the trends in strength for cortical and trabecular bone when material properties are normalised (due to bone architecture only).
- Secondly, computer predictions of strength varied greatly in magnitude for trabecular bone but less for cortical bone when taken from nano and microindentation and micro-CT phantom derived properties.
- We also show that there were no correlations between the material properties taken from different sources.

TRABECULAR BONE

CORTICAL BONE



Figures: Top most figures show the normalized failure force of the bone samples using material properties from various sources
Graphs in the middle show the correlations between the material properties taken from different sources
Figure on the left shows the comparisons of the Young's modulus from nano and microindentation tests