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A VALIDATED TECHNIQUE TO PREDICT THE LOAD-DISPLACEMENT BEHAVIOUR OF VERTEBRAL BODIES UNDER COMPRESSION UP TO THE YEILD REGION

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Predicting the behaviour of the spine under load relies on the accurate representation of the load displacement behaviour of vertebral bodies (VB). A number of FEA studies are available that model VB behaviour and the agreement achieved with experimental data - in the elastic region - is generally good. The fit between experiment and prediction, however, is lost as the VB enters the plastic region (see for example Wilcox et al, 2007), the very region of interest if failure modes are to be predicted. In this study we present a validated specimen specific FEA technique that allows the elastic behaviour and the onset of yield to be accurately modelled. Six porcine VBs (from C2 to C7) were dissected from a spine specimen, potted in PMMA bone cement and Micro-CT imaged using a Nikon XT225 ST scanner (Nikon Metrology UK, Hertfordshire, UK). A compressive load was applied to each specimen with an Instron 5967, 30kN materials testing machine (Instron, High Wycombe, UK) at a rate of 1000N/min. FE models of all specimens were created by segmenting and meshing the micro-CT images (ScanIP, Simpleware, UK), material properties were assigned from the grayscale value and the compression experiment was repeated in-silico. Conversion factors for the Young's modulus (k_E), the Yield stress (k_y), the Tangent ($k_{\tan}$) and the density (k_ρ) were determined for the grayscale values to minimise the error between experimental and numerical load-displacement behaviour. This allowed a very good match between experiment and simulation results (Figure 1). In this study a technique allowing the prediction of the load-displacement behaviour of VBs subject to compression was developed. The novelty in the proposed approach rests with the fact that the onset of yield, crucial in determining subsequent failure modes, can also be modelled. This paves the way for more accurate FEA models aimed at predicting the failure modes of the spine.

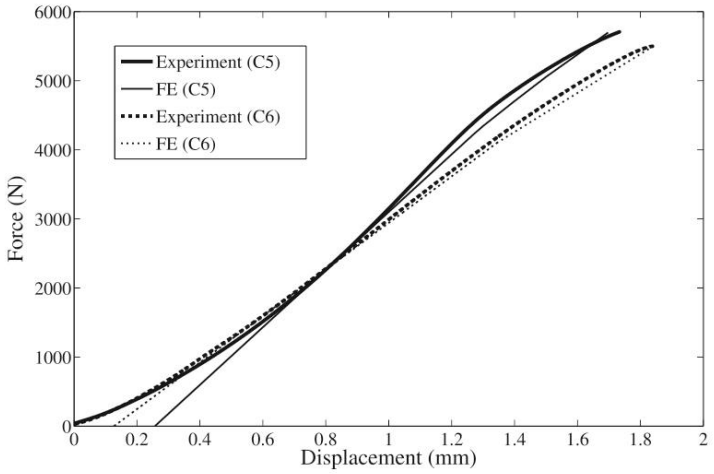

Figure 1: Experimental and numerical load-displacement curves for C5 and C6.