THE IMPORTANCE OF MODELLING INTERACTIONS AND MATERIAL PROPERTIES IN NUMERICAL SIMULATION OF A FRACTURE FIXATION CONSTRUCT

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Introduction

There has been considerable debate on the importance of modelling interactions [MacLeod, 2012] and nonlinear material behaviour while simulating the mechanical response of dynamic compression and locking plates constructs applied to bone. This study examines the importance of these features using numerical simulation of previously conducted experiment [Yánez, 2012] .

Methods

FE model of a DCP construct with two screw locking elements (SLE) was assembled to correspond with the experimental compression tests [Yánez, 2010, 2012] (Fig. 1)

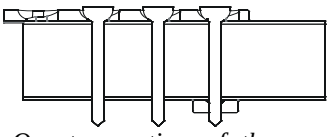

Figure 1: Quarter section of the computational model.

As the experimental test was dynamic, cyclic tests were carried out to determine the dynamic properties of the surrogate bone.

Two different interaction approaches were tested (Table 1) and three different sets of material properties were applied (Table 2). Simulations were conducted to evaluate the performance of the six models, using the load-displacement curve to compare to the experimental results.

	Screw-Near cortical	Screw-Trabecular	Screw-Far cortical
1	Tied	Tied	Tied
2	Friction μ=0.25	Tied	Tied

Table 1: Interaction approaches tested.

	Cortical	Trabecular
L	Linear	Linear
NLcort	Non linear	Linear
NL	Non linear	Non linear

Table 2: Three different approaches of material properties for cortical and trabecular bone.

Results

The results are shown in Figs. 2 and 3.

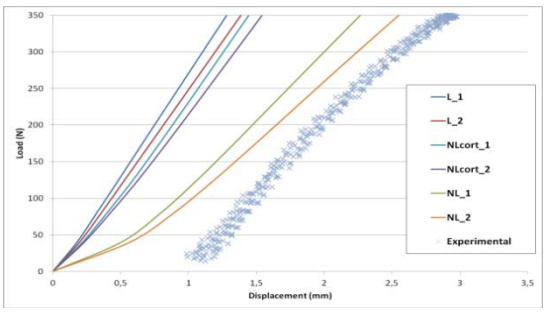

Figure 2: Six load-displacement curves and the experimental results.

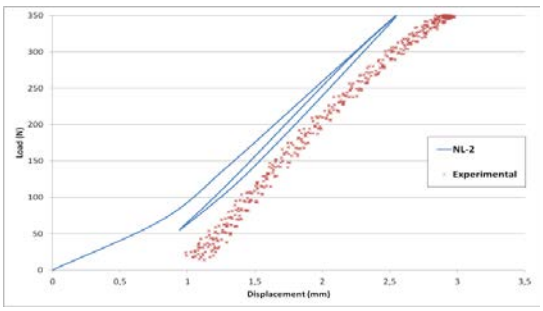

Figure 3: One cycle of load and unload of NL-2 compared to experimental results.

Discussion

The importance of comparing the slopes of the load-displacement curves rather than single values of stiffness cannot be over-emphasised. It is observed that using linear properties (L and NLcort) produces larger stiffnesses than the experimental results. Additionally, the influence of changing from linear to non linear properties seems to have more effect when applied to trabecular bone than cortical. Lastly, the model NL-2 (with friction interaction) led to the closest agreement with the experimental data (taking into account the initial settlement in the experimental tests) as shown in Fig. 3.

References

MacLeod AR *et al*,J Biomech,45:1712-6, 2012

Yánez A *et al*, Med Eng Phys, 32:532-4, 2010.

Yánez A *et al*, Med Eng Phys, 34:717-24, 2012.