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A COMPUTATIONAL MODEL OF AN INDENTATION TEST OF HUMAN BREAST TISSUE

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1 INTRODUCTION

Along women's life, it is known that the mechanical properties of breast tissues change due to age, pregnancy, lactation and pathology [1]. Breast tissues have been characterized in literature in the elastic and hyperelastic domains. Some studies [2][3][4] have been investigating the hyperelastic properties of breast tissues, however a small indentation depth (in mm) has been applied. In this preliminary study, an increase on the indentation depth was tested in order to study larger deformations.

2 METHODOLOGY

A computational model of an indentation test of breast tissue was developed, using Abaqus software. The indentation profile was based on an experimental protocol carried out by the group with breast tissue samples, in which 3 mm of indentation load was applied. For that, the indenter was modeled as a rigid body, with a diameter of 5mm. Regarding the breast tissue sample, it had a diameter of 20mm and height of 10mm, being modeled with an hexahedral element formulation as an 8-node linear brick, hybrid, constant pressure (C3D8H), presented in figure 1. The material was defined as isotropic and tested for three different hyperelastic strain energy functions: Yeoh, Ogden (N=3) and Polynomial (N=2), being the coefficient values based on [4].

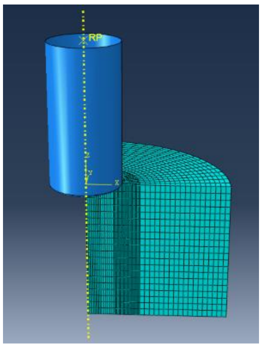

Figure 1 – Numerical finite element mesh

3 RESULTS AND DISCUSSION

Looking to figure 2, it is possible to observe that the model developed for large deformation was able to successfully converge to the defined displacement. In figure 3, the force-displacement curves are presented for the finite element models used. With this approach it is possible to work in the high deformation domain, using different constitutive models.

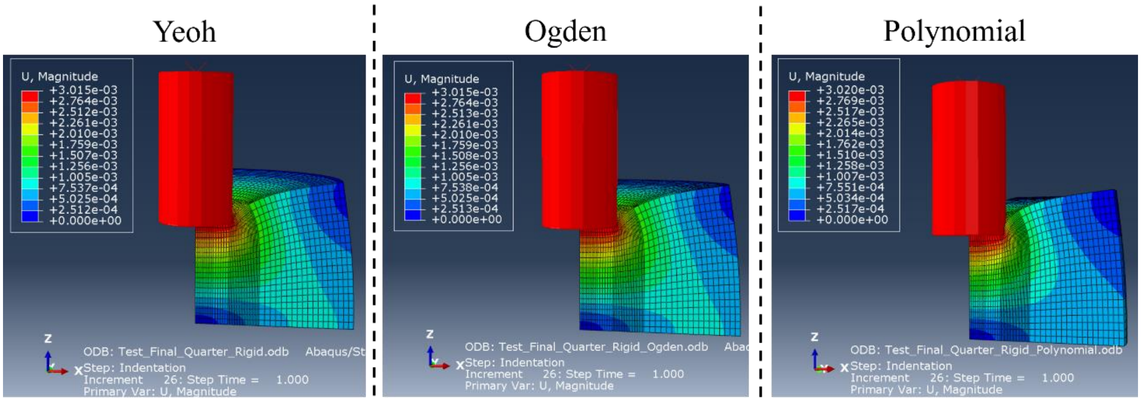

Figure 2 – Displacement results for each hyperelastic model tested: Left – Yeoh model; Middle – Ogden model; Right – Polynomial model (N=2)

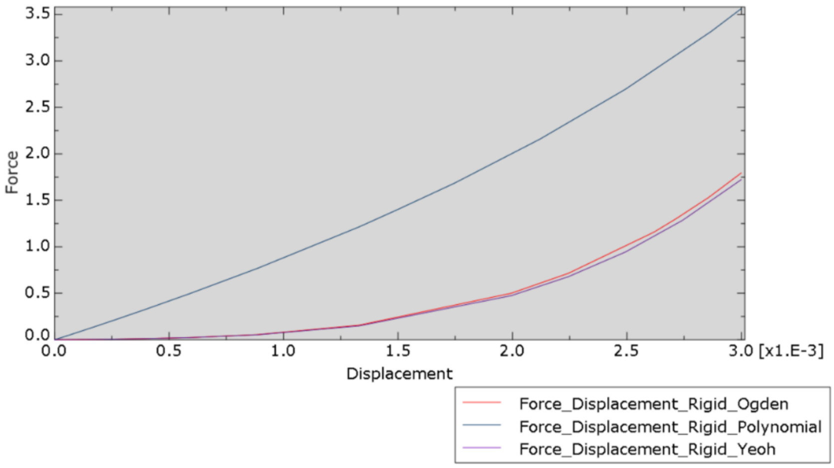

Figure 3 –Force (N) vs. Displacement (m) results for each model used

4 Conclusions and Future Work

This study shows a computational model of an indentation test, in which the indentation amplitude was increased, when compared with literature, going in line with the experimental work. This is from higher importance, since the hyperelastic properties play a relevant rule in the behavior of breast tissues. As future work, an inverse finite element approach will be carried out to obtain the hyperelastic properties of the breast tissue samples tested in the experimental work.

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