SIMULATION OF A LOW BACK PAIN TREATMENT USING A GENERIC FINITE ELEMENT MODEL

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Introduction

Every year, about 50% of French population is suffering of low back pain [Fassier, 2011]. A usual part of treatment is lumbar belt wearing. Nevertheless the biomechanical and physiological impacts are not clearly understood. In this study, the application of lumbar belt on the trunk is simulated by a finite element model. The objective of this model is to determine the impacts of wearing lumbar belt in abdominal pressure, spine posture and inter-vertebral disc pressure.

Methods

The 3D geometry of the trunk was acquired by lateral radiography (vertebral length, width and endplate slope) and in patients (bust, waist, hips and stature measurement). Thanks to these parameters, a generic model with three components (vertebras, intervertebral discs and soft tissues) are built. All components are represented by tetrahedral elements.

Mechanical properties of all the components of the model were taken from published data [Goel, 1993], [Sylvestre, 2007], [Clin, 2011]. Materials were modelled as linear elastic.

Pressure was applied to the trunk to simulate lumbar belt wearing according to the Laplace's law [Dubuis, 2012]:

$$P = T/R \qquad (1)$$

with P the pressure, T the line tension and R the radius of curvature. Depending on lumbar belt type, mean pressure was between 4 and 13 kPa. Following boundary conditions were applied on the model: upper surface of the trunk was fixed in space and lower surface was blocked to only allow rotation in lateral axis.

Results

Figure 1 shows the obtained finite elements model of the trunk. Model contains more than 1 200 000 elements.

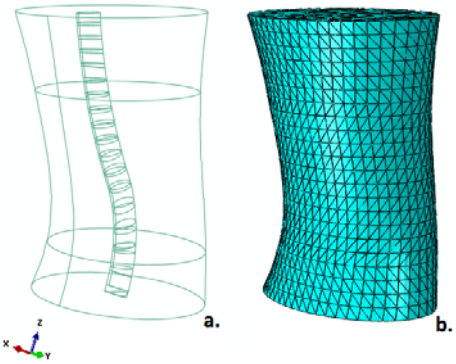

Figure 1: a. Entire model, b. Meshing model

Modification of the spine posture is characterized by the existence of a displacement gradient (up to 3mm for the trunk and 2.5mm for the spine). The mean abdominal pressure variation is 15 kPa when the stiffer lumbar belt is used (mean applied pressure of 13 kPa).

Discussion

Finite elements model developed in this study is the first model to simulate impact of lumbar belt wearing. Interface pressure applied to the model according to the Laplace's law is equivalent to pressure applied by the lumbar belt to a patient according to a preliminary experimental study. Forthcoming studies will concern the comparison of numerical results to experimental data (interface pressure and displacement measurement) and the numerical simulation of different kind of lumbar belts.

References

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