

Parametric study of lumbar belts in the case of low back pain with effects of patients' specific characteristics

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Introduction

Low back pain is pain affecting the lumbar segment of the spine. It is characterized depending on its origin and its duration. In this study, only common subacute or chronic low back pain, i.e. with a mechanical origin, is studied [1]. One of the treatments suggested is the use of a lumbar orthotic device. However, few studies exist so as to clearly elucidate the mechanism of action of these devices.

In our study, a single type of lumbar orthotic, used in the treatment of common subacute or chronic low back pain was analyzed using a numerical model: lumbar support belts. The objective is to perform an overall study elucidating how belts work, in order to determine main parameters influencing on the treatment of low back pain using a FE trunk model. The studied parameters will be related to the patient's morphology, the belt and the mechanical characteristics of the human trunk.

Methods

The 3D geometry of the trunk was acquired by parameters measurement in 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 six components (vertebras, annulus, nucleus, iliac crests, abdomen and other soft tissues) has been built. All components are represented by tetrahedral elements.

Mechanical properties of all the components of the model were taken from published data [2, 3].

The pressure was applied onto the trunk by lumbar belt wearing. This pressure was modeled by the Laplace's law [4]. Different boundary conditions were also studied to make sure the validity of the numerical model. Finally, we took the followings: upper surface of the trunk was only blocked for the longitudinal direction and for the lower surface the axis in the frontal plane passing through the iliac crests was blocked.

Different variables were studied by the design of experiments, built by a stratified Latin hypercube

method with 100 experiments. The output parameters are the abdominal pressure, the interdiscal pressure and the lordosis.

Results

The convergence study was done with a mean element size of 10 mm, corresponding to models from 242,230 to 481,850 elements. In the clinical study, the applied mean pressure is 1.12 KPa and 2.03 KPa, respectively, for a single and double fabric lumbar belts, and by Laplace's law, it was 1.06 KPa and 2.16 KPa, respectively.

Concerning the parametric study, the most important parameters for the intradiscal pressure are the belt type, the patient's height and waist circumference, while the least important parameter is Young's modulus of the skin.

Conclusions

Using a simplified model of the human trunk obtained on the basis of two radiographs, a parametric study made possible to determine the parameters influencing the treatment of low back pain with a lumbar belt. These parameters are the patient's morphology and the used lumbar belt. As perspective, the modeling of the applied pressure by Laplace's law could be improved so as to study the impact of the belt's architecture.

References

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