BIOMECHANICAL IMPACT OF A SUBSEQUENT CHILDBIRTH ON THE FEMALE PELVIC FLOOR

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Introduction

More than one third of women throughout their lives will experience pelvic floor dysfunction (PFD) [1]. These disorders have been widely studied over the past few years, particularly about the effect of childbirth and pregnancy itself [2].
Model simulation of the pelvic cavity allows the study of PFD, as well as the analysis of the stresses and strains to which these structures are subjected when forces are involved, for example during childbirth [3].
Abaqus is one of the most used software for these simulations. The writing of scripts, which allow the parameterization of the models, makes it possible to perform simulations with different conditions, in a faster and more practical way.
The aim of this paper is to study the biomechanical impact of a first birth on the lesions that occur in the female pelvic floor in subsequent births. For this, in a first phase, the parameterization of the model was done. An algorithm was developed to parameterize the model in relation to the dimensions and constitutive parameters.

Methods

A simplified model of the fetal head (sphere) and pelvic floor muscles (cone) was created in Abaqus. This process was parameterized by creating a script, which allows the same simulation to be performed for different dimensions of the fetal head and pelvic floor muscles, as well as for different constitutive parameters or constitutive models (Figure 1).

```
# Fetal head
diameter = 125.0
# Muscles
thickness = 2.0
height = 80.0
radius1 = 60.0
radius2 = 37.5
## Fetal head creation
s.VerticalDimension(vertex1=v[0], vertex2=v[1], textPoint=(-4,
    -5), value=diameter)
## Muscles creation
s1.HorizontalDimension(vertex1=v[0], vertex2=v[3], textPoint=(18,
    12), value=thickness)
s1.HorizontalDimension(vertex1=v[1], vertex2=v[2], textPoint=(12,
    -18), value=thickness)
s1.VerticalDimension(vertex1=v[3], vertex2=v[2], textPoint=(24,
    -1), value=height)
s1.DistanceDimension(entity1=v[1], entity2=g[2], textPoint=(4,
    -20), value=radius2)
s1.DistanceDimension(entity1=v[0], entity2=g[2], textPoint=(6,
    68), value=radius1)
```

Figure 1: Part of the algorithm where the assignment of dimensions to the model structures is done.

The fetal head was modeled with a linear elastic model (E=250 MPa and ν=0.22) and with shell elements (S3).

The pelvic floor muscles were modeled with the hyperelastic Neo-Hookean constitutive model (C10=0.19 MPa and D=1E-05) and with hexahedral elements (C3D8H). To simulate the descent of the fetal head, the upper face of the muscles was fixed, and head movements were restricted.

Results

Figure 2 shows the distribution of stresses along the base of the muscles, at the points of highest stress, for different fetal head diameters.

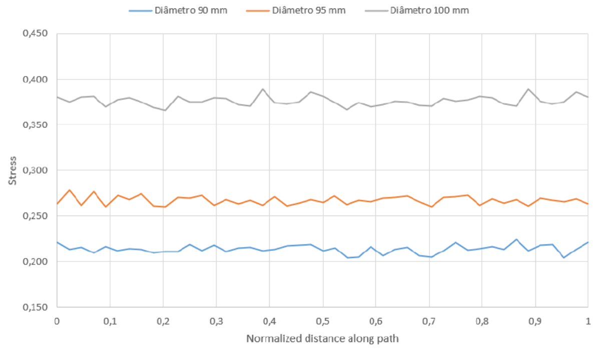

Figure 2: Distribution of stresses along the base of the muscles, for three fetal head diameters (90, 95 and 100 mm).

Discussion

Computational modeling allows better understanding of the influence of obstetric factors on the risk of pelvic floor muscle injury.
The script developed allows the simulation of fetal descent, evaluating its impact on pelvic floor muscles, for different dimensions and mechanical properties.
The next step will be to add damage to the constitutive model of the muscles, to study the biomechanical influence of a first vaginal delivery on the injuries that occur in subsequent deliveries.

References

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2. Parente et al. Int Urogynecol J, 19: 65-71, 2008.
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