722

Valdmanova L[1], Krcmar M[2], Krofta L[2], Hyncik L[1], Janstova J[1], Grohregin K[2], Feyereisl J[2]
1. *New technologies research centre, University of West Bohemia,* ***2.*** *Institute for the care of mother and child*

DISTRIBUTION OF LEVATOR ANI MUSCLE STRESS DEPENDING ON INITIAL POSITION AND ROTATION OF FETAL HEAD

<u>Hypothesis / aims of study</u>

Female pelvic floor dysfunction is very often associated with damage of the levator ani muscle. During a vaginal delivery the levator muscle performs large deformations to allow throughpass of the fetal head. These stresses may lead to injuries of levator muscle such as muscle tearing. Therefore, it is very important to understand the anatomy and physiology of levator ani muscle during vaginal delivery. The objective of this study was to develop an MRI-based finite element model of the female pelvic floor to assess stress analysis during the vaginal delivery. Distribution of levator muscle stress depending on changes of initial position and orientation of fetal head was computed.

<u>Study design, materials and methods</u>

a) Model geometry and finite element mesh

The model consists of the female pelvis, the levator ani muscle and the fetal head. Presented simulations are focused on levator muscle and thus the other organs are neglected. In addition it is assumed that the other tissues are pushed during the delivery without any bigger reaction forces.The geometry of fetal head and female pelvic floor are based on live subject MRI data. The model was constructed from axial 3T MRI images All slices were 2 mm thick. A distance between the slices was 0 mm. Asked volunteer was a healthy, nulliparous, 25 years old female.The initial 3D geometric model was constructed using 3D Slicer software. The resulting geometry and mesh were created in HyperMesh software.

b) Boundary conditions

To simulate the real deformation of the levator ani muscle, boundary conditions were considered. The fetal head trajectory was given by anatomy of pelvis, it follows the curvature of the sacrum and the coccyx to simulate the curve of Carus. The initial flexion and head rotation is considered.

c) Material properties

Pelvis as well as fetal head were modeled by rigid bodies. During vaginal delivery the levator any muscle performs extremely large deformations. Therefore some elastic, vicsoelastic or hyperelastic material is suitable to use. The viscoelastic Ogden material, commonly used in biomechanical simulations was used in this study.

<u>Results</u>

The model was used for stress von Mises analysis of levator ani muscle during the second stage of labor. The analysis was performed for three different initial positions of fetal head. All of them were in normal position - the head first. The first one was also in normal presentation - left occipitoanterior position (LOA). The second one was in - left occipitoposterior position (LOP). The last one was in left brow position (LB). The simulated stress von Mises distribution generated in levator muscle is shown in three head positions along the curve of Carus. The first one represents the first contact between the fetal head and the levator ani muscle. The second one is in the middle time of simulation. The head is fully situated inside of muscle. In the last station the fetal head starts to leave the area of muscle and the muscle starts to return to its original position. The final stress distribution in the levator ani muscle during the fetal birth is shown in figure 1.

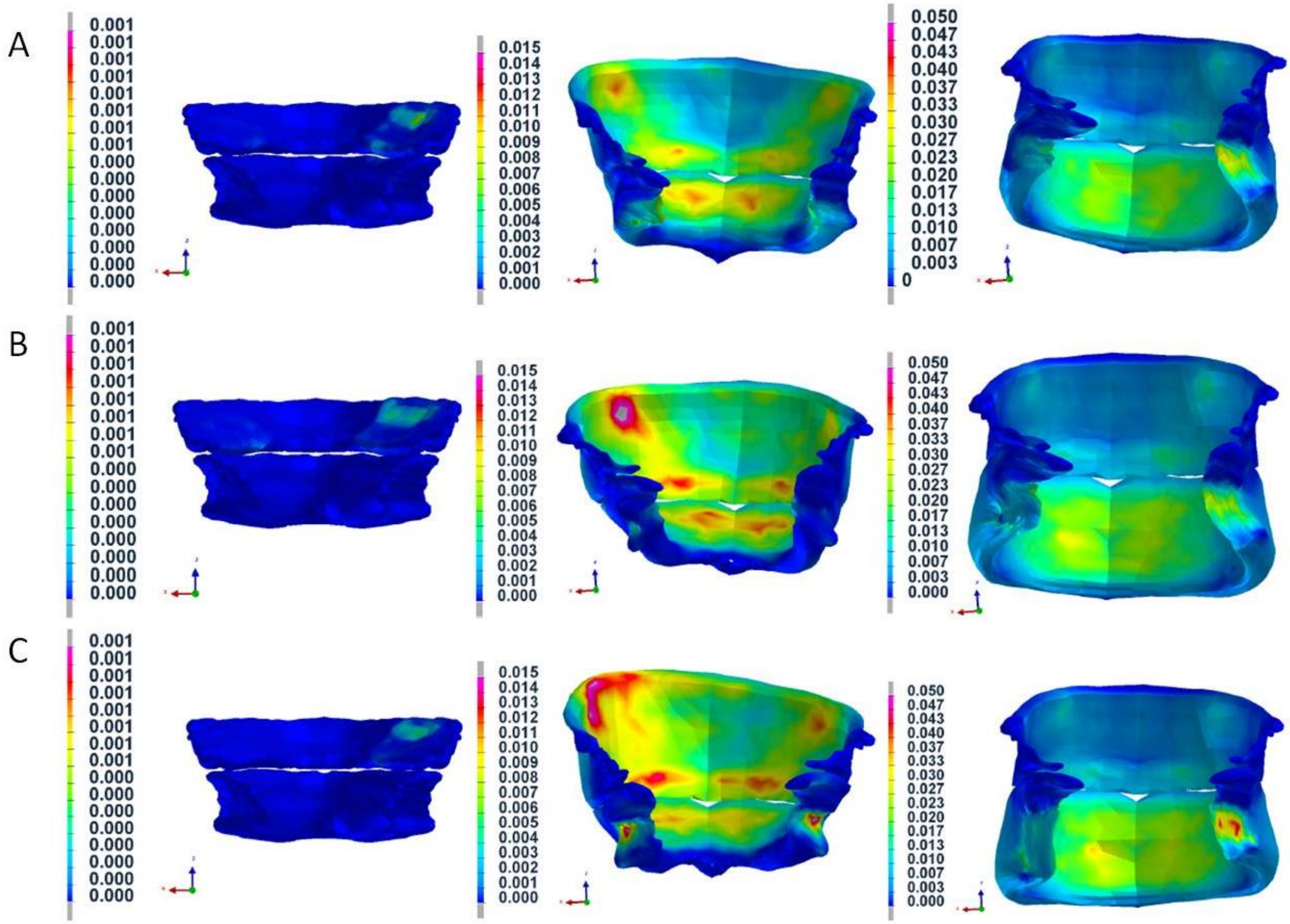
<u>Interpretation of results</u>

During the first stage the stresses did not achieve any big values. The stress increased little bit on the left upper part of levator muscle. In the second stage three obvious stress peaks appeared - in the right upper arcus, in the middle part of whole muscle and in its attachments. The stress was generated mainly in the upper and middle part of muscle. In the last stage the stresses remained in the lower muscle part. The biggest values were still in the muscle attachments.The most problematic areas seem to be on the left muscle attachment, the arcus of muscle especially on the right hand side and in the middle of muscle. The maximal stress generated in the left muscle attachment was found for LB presentation. As expected the smallest values were for LOA presentation. The stress values in the right parts of muscle arcus were the biggest for LB presentation and the smallest for LOA presentation again. The stresses in the middle part of levator ani muscle were quite the same for all presentation. The differences were only in the size of acted area. The biggest area of stress action was found for LOP presentation. More over while the peak stress of attachment was generated at the end of simulation and for a short time, the peak stress of arcus acted on the muscle for a long time.

<u>Concluding message</u>

3-D pelvic floor modelling appears to be a promising possibility for future mapping of pelvic trauma development.

Fig. 1.: The distribution of von Mises stress (given in GPa) in levator ani muscle during the second stage of labor: A - LOA. B - LOP. C - LB.



Disclosures
Funding: PRVOUK P32 Research supporting grant from 3rd Faculty of Medicine, Charles University, Prague **Clinical Trial:** No
Subjects: NONE