SUCTION CUP PLACEMENT IN INSTRUMENTED VAGINAL DELIVERY

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Introduction

Delivery is a very complex natural and physiological process, which depends on the morphology and configuration of the maternal pelvis as well as uterine contractility and fetal size [1]. When the course of labor is not favorable, it can be performed with the help of instruments, such as the suction cup, which allows minimizing trauma to the fetus. The correct placement of the suction cup is crucial to ensure the success of the suction cup extraction process. Currently, there is an established flexion point on the fetal head that is ideal for suction cup placement, but this may not be appropriate for fetal heads with unusual morphologies. The implications of the suction cup placement point on the fetal head and maternal muscles need to be evaluated. Computational models are valuable tools that allow the analysis of the mechanisms of childbirth in a non-invasive way.

Methods

The morphing of several fetal head morphologies was performed in order to simulate the impact of instrumented delivery on the maternal pelvis. For this purpose, MATLAB was used, and an algorithm was adapted that allowed morphing these structures, based on the finite element model of a standard fetal head, which is shown in Figure 1.

a. b.

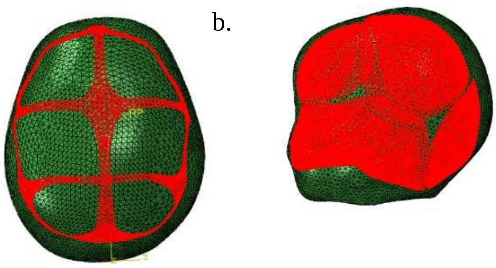
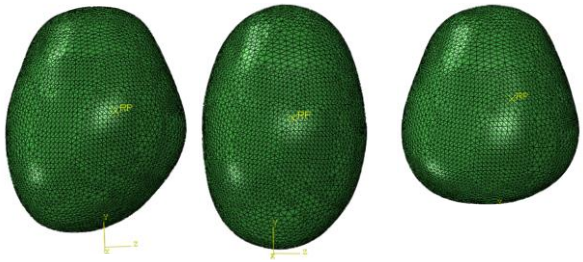


Figure 1: Fetal head FE model used. In red are (a.) sutures and (b.) bones.

In addition to morphing for several percentiles, including prematurity and macrocephaly, morphing was also performed for situations that introduced asymmetries in the head (craniosynostosis). To ensure the success of the morphing, the ABAQUS software was used.
The methodology chosen for morphing the fetal head for different percentiles included defining the biparietal diameter (BPD) and occipitofrontal diameter (OFD) and establishing their relationship with the cephalic perimeter. In the case of craniosynostosis, it was necessary to establish other diameters and relationships between them, to cause the desired deformation.

Results

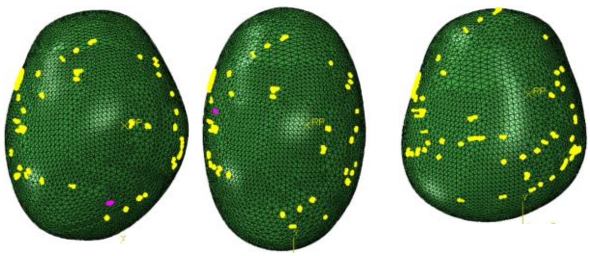
Figure 2 the morphing results for each of the craniosynostoses in study.



a. plagiocephaly b. scaphocephaly c. brachycephaly

Figure 2: FE mesh obtained after morphing for each of the craniosynostoses in study.

To understand how the morphing performed on the mesh changed its quality, a mesh quality analysis was performed (Figure 3).



a. plagiocephaly b. scaphocephaly c. brachycephaly

Figure 3: Quantification of the distortion of the elements, where in yellow are the warnings and the pink ones the errors.

Discussion

The developed algorithm achieved the proposed objectives, with relatively low percentage relative errors and with meshes with good quality. In the future, the goal will be to simulate the vaginal delivery of the different heads created by placing the suction cup in the position considered ideal and analyze if it is the appropriate position for fetal heads with unusual morphologies.

References

1. Estevão, "Vacuum-Assisted Vaginal Delivery: a Biomechanical Study," MSc Thesis, Porto, 2021.

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