Mechanisms of perineal tear during childbirth

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Introduction

The perineum is a multi-layered structure made of soft tissues whose mechanical properties ensure the integrity of the pelvic floor, particularly in women (Figure 1). During childbirth, the perineum undergoes very large deformations which often lead to tears going from the skin and vagina to the anus (1 to 4 in Figure 2).
In the long term, these tears cause urinary and anal incontinence as well as pelvic organs prolapse.

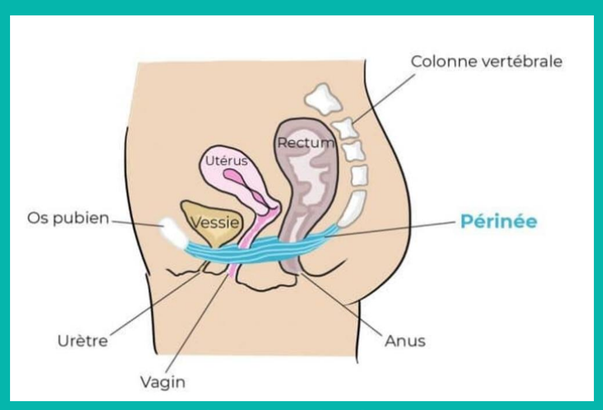


Figure 1. Organes pelviens et périnée (FitMumsBelgium, 2020)

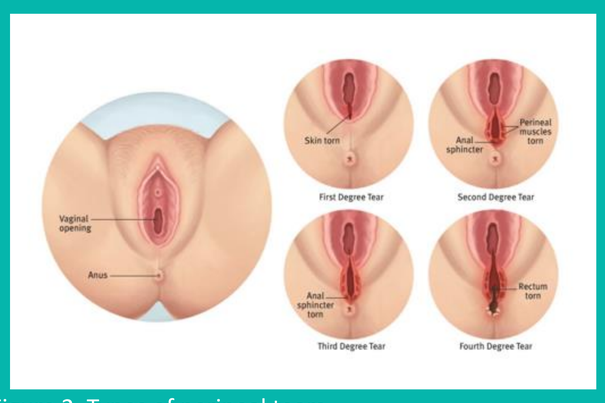


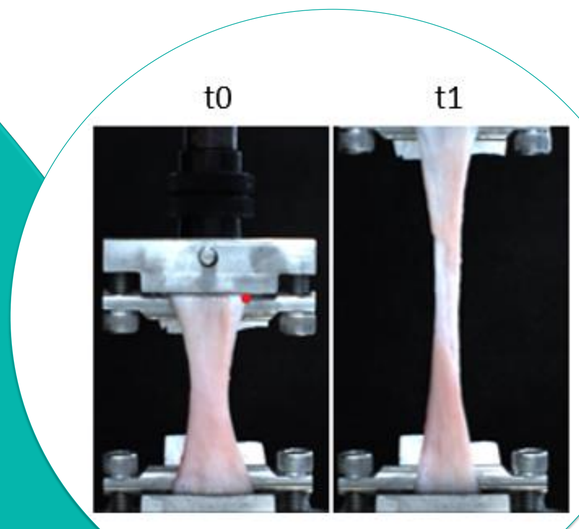
Figure 2. Types of perineal tears (Perineal tears, Queensland clinical guidelines, August 2018)

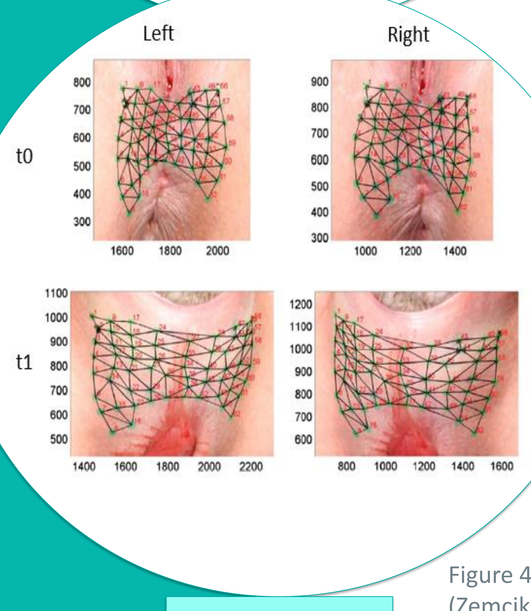
Objectives

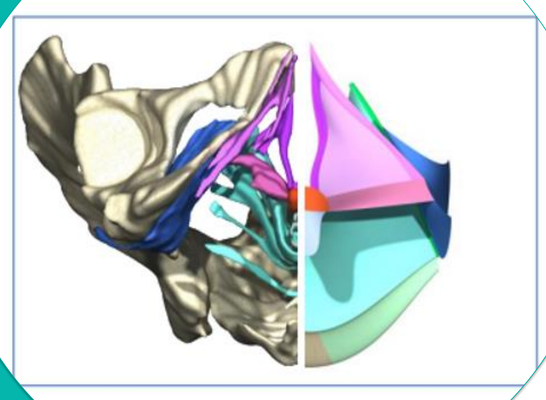
- Understand the mechanical behaviour of the perineum.
- Gather data and develop a patient specific model to evaluate the risk of perineal tear.

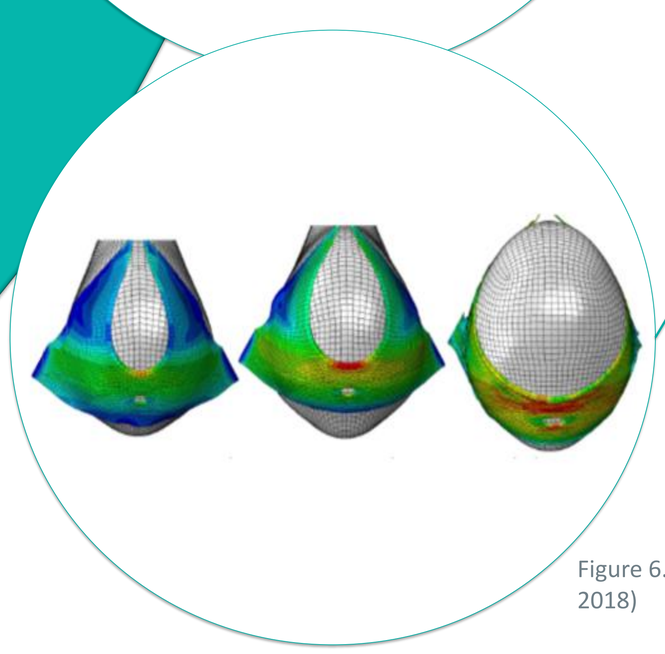
How can this research be useful?

This work can help develop a tool to assist medical practionners in their decision making for high risk pregnancies.









1. Behaviour law and material properties identification of the sow's perineal structures

- Design of an experimental protocol using sow perineum.
- Behaviour law identification of the different layers of the sow perineum: skin, vagina, anal sphincter muscles, anal mucosa.
- Study of the hyperelasticity, anisotropy, viscosity.

Figure 3. Uniaxial tensile test on a vagina sample

2. Design of a stereophotogrammetry system to evaluate in-vivo 3D deformations of the female perineum during childbirth

Camera choice and development of a synchronised recording program → 3D digital image correlation (DIC) to compute deformation at the tissue surface → Clinical trial application to compute the deformation of the perineum during childbirth

Figure 4. Stereophotogrammetry of the perineum during childbirth (Zemcik, 2012)

3. 3D reconstruction of the perineal structures

- Geometrical model reconstruction of the pelvic organs and perineal muscles from MRI images.
- Patient specific model

Figure 5. 3D surfacic reconstruction of the female pelvic organs and perineal muscles (Jean Dit Gautier, 2018)

4. Numerical simulation of childbirth

- Material definition of the geometric model elements (elastography obtained from the clinical trial).
- Integration of the deformation data obtained by the stereophotogrammetry as boundary conditions.
- Simulation of different delivery scenarios and determination of perineal tear severity and direction.

Figure 6. Pelvic system modelling and childbirth simulation (Jean Dit Gautier, 2018)

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