PARAMETRIC MODELING OF THE FEMALE PELVIC FLOOR SYSTEM

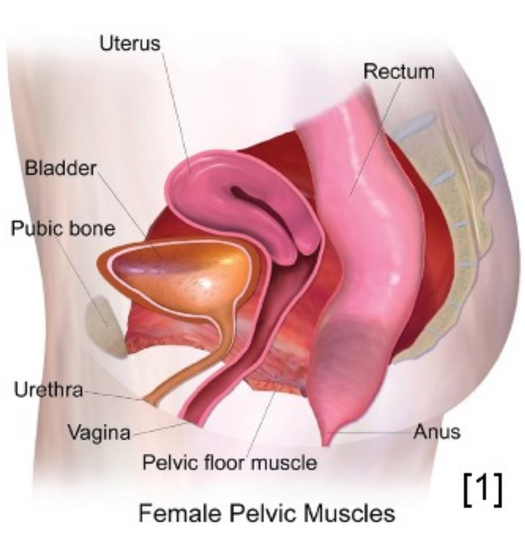
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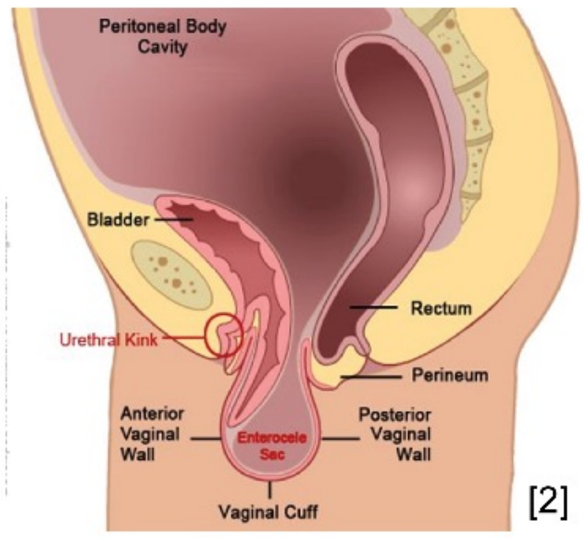
BioTiM-Us
Biomedical soft
Tissue and implants
Modelling
Upscale

BACKGROUND

Pelvic organs and ligaments have physiologically limited motion to allow for natural function, such as miction or defecation. However, abnormal motion, known as pelvic prolapse, may lead to urinary or fecal incontinence. This occurs when pelvic tissue is significantly weakened and stretched. 1/3 of women have faced a degree of pelvic prolapse. The treatments offered for this condition do not have good longevity. Statistics have found that up to 40% of these prolapse surgeries will fail within five years post-operation. This has led to the BioTiM-US group to research pelvic implants which requires better modeling of the pelvic system; this is the purpose of this project.



Female Pelvic Muscles [1]



[2]

OBJECTIVE

• To study the woman pelvic system composed of organs, muscles, tendons. ligaments, and bones

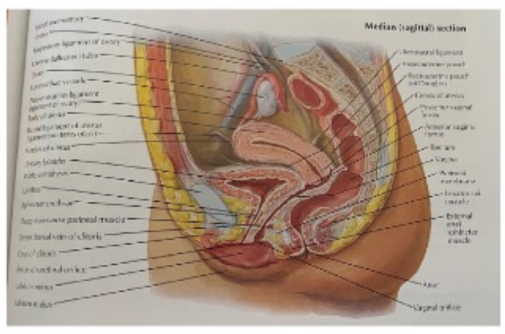
- Develop a parametrized computer-aided design (CAD) model that:
  - o Renders anatomy of said pelvic system using low number of variables that define every pelvic component's relevant parametric geometry separately and completely
  - o Visually depicts the system and allows easier and accurate reconstruction for simulation and analysis

REQUIREMENTS

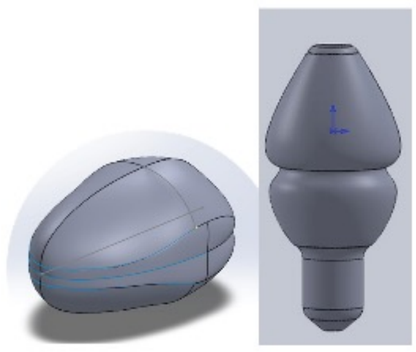
• Use CAD software to develop model that parametrizes female pelvic system to client specifications:

- o Render the bladder, rectum, vagina, pelvic floor muscles, and pelvic bone
- o The models shall be controllable through a limited number of variables
- o The models shall be able to change to represent the patient-specific anatomy from MRI Images, sharing a similar tolerance and accuracy.

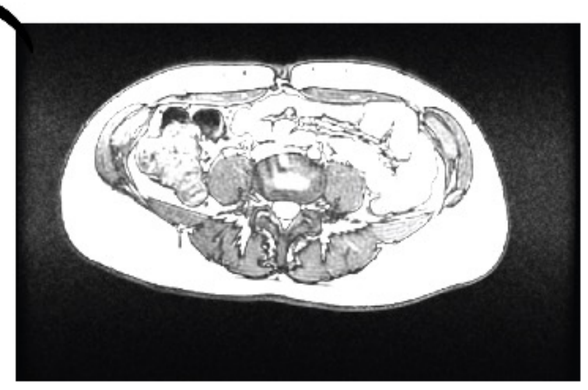
DESIGN APPROACH



Anatomy Review

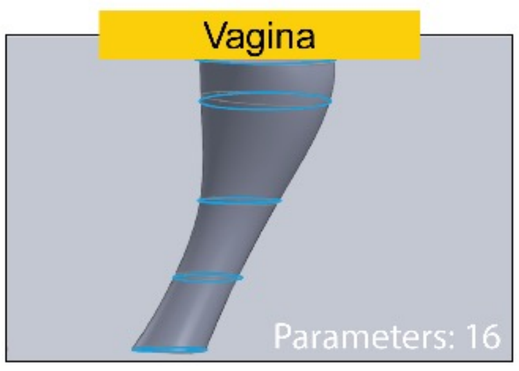

Create Individual CAD Models of Anatomy

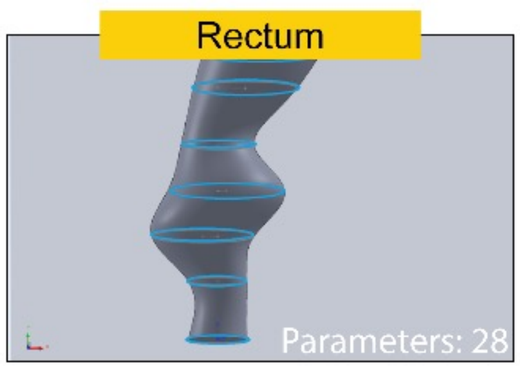

Parameterize and Assemble

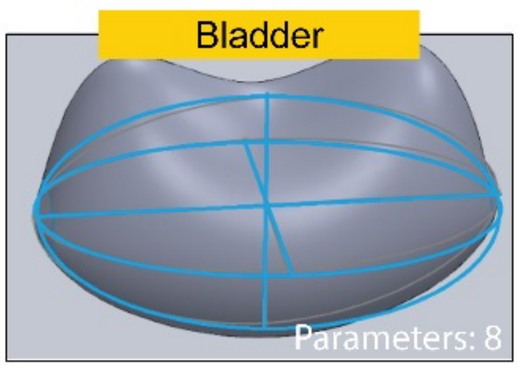

MRI Imaging Dimensions Used to Recreate Patient Anatomy

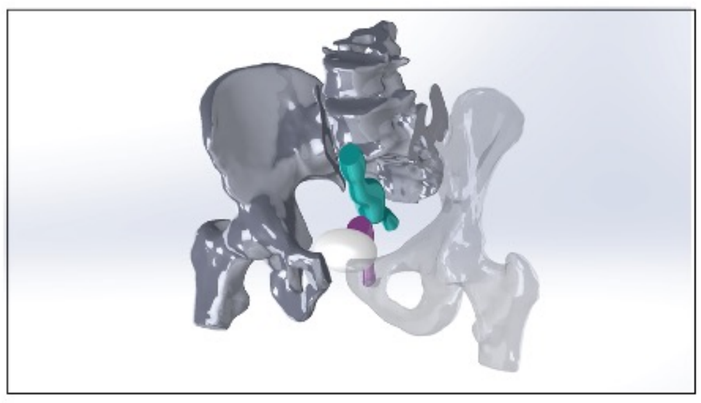
RESULTS

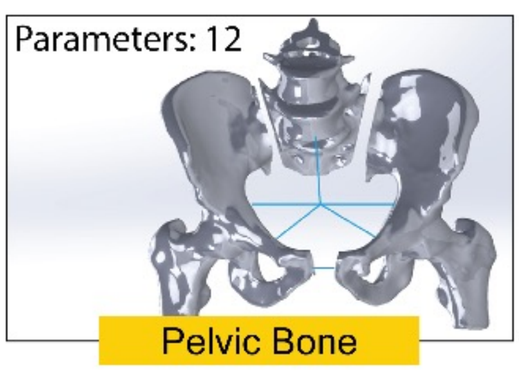
The pelvic floor assembly was designed in a way to adapt to each patient's anatomy through each individual organ, bone, or set of muscles. This was created with simple parameters for each model that can be adjusted depending on an individual's anatomy. The models created for the pelvic floor assembly included: the vagina, the rectum, the pelvic floor muscles, the pelvic bone, and the bladder. Each model had an average of 6 parameters per model that can be changed individually using information gathered from a patient's MRI image. This can be shown in the images of each model to the right.













Note: The colored lines represent the models parameters.

CONCLUSION

In summary, the team was tasked with the generation of a parametrized model of the bladder, vagina, rectum, pelvic floor muscles, and pelvic bones along with the generation of an assembly of all these parts. The division of work led to each member of the team being responsible for one of the components and the development of the assembly done through collaborative efforts. Team members honed their skills in SolidWorks utilizing its many features in their attempts to create accurate, yet also parametrizable CAD models of their respective body part. These year-long efforts were aimed towards offering a potential solution to the issue of failing prolapse surgeries by providing an alternative method to the current standards of analyzing patient MRI images when preparing these procedures.

REFERENCES

[1] "The Pelvic Floor - Overview and Function," Physiopedia, [Online]. Available: https://www.physio-pedia.com/Pelvic_Floor_Anatomy. [Accessed 28 09 2021].
[2] B. Blaus, "Pelvic Muscles (Female Side).png," 11 07 2017. [Online]. [Accessed 10 2021].