

# Paracervical Block Training Model



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## 1. PROBLEM STATEMENT

The goal of this project is to create a realistic, reproducible, and low cost model that includes a realistic cervicovaginal junction to simulate paracervical block injections to train healthcare professionals to make this procedure more accessible.

## 2. BACKGROUND

- Women's gynecological procedures are hugely underestimated in terms of pain, with minimal existing methods to manage it, the most common and effective of which is the paracervical block (PCB) [1].
- Insert speculum through vagina to gain better viewing window (Figure 1).
- Where the uterus and cervix meet, the cervicovaginal junction, preliminary injections will be placed at the 12 O'clock position on the cervix face followed by tenaculum placement.
- Lastly, 4 additional lidocaine injections will be placed at the 2, 4, 8, 10 positions, again thinking of the cervix like a clock face (Figure 2).
- We need a better training kit to teach these procedures to physicians.
- Lack of research and funding into women's health
- Women's pain is not taken seriously during medical procedures such as IUD insertion. [4]

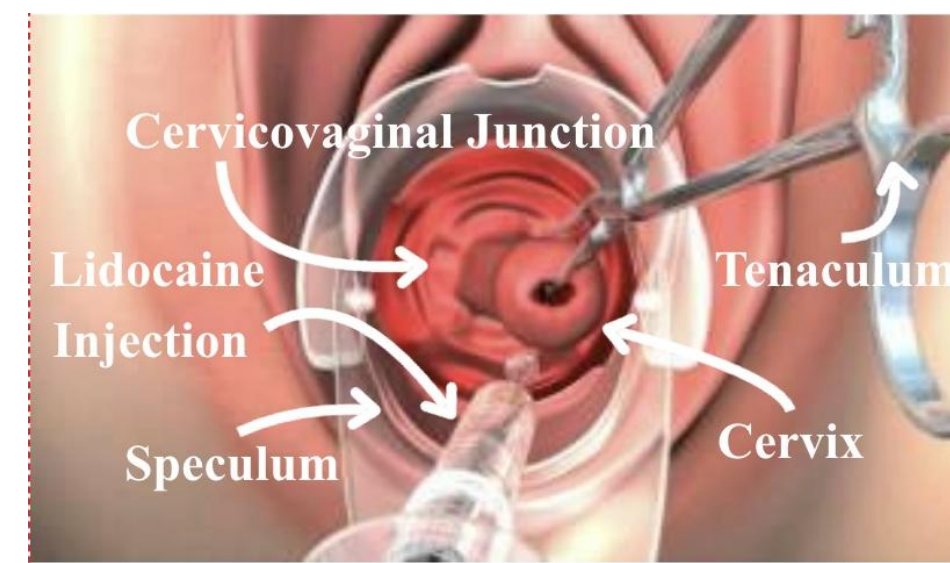


Figure 1: Paracervical Block [2]

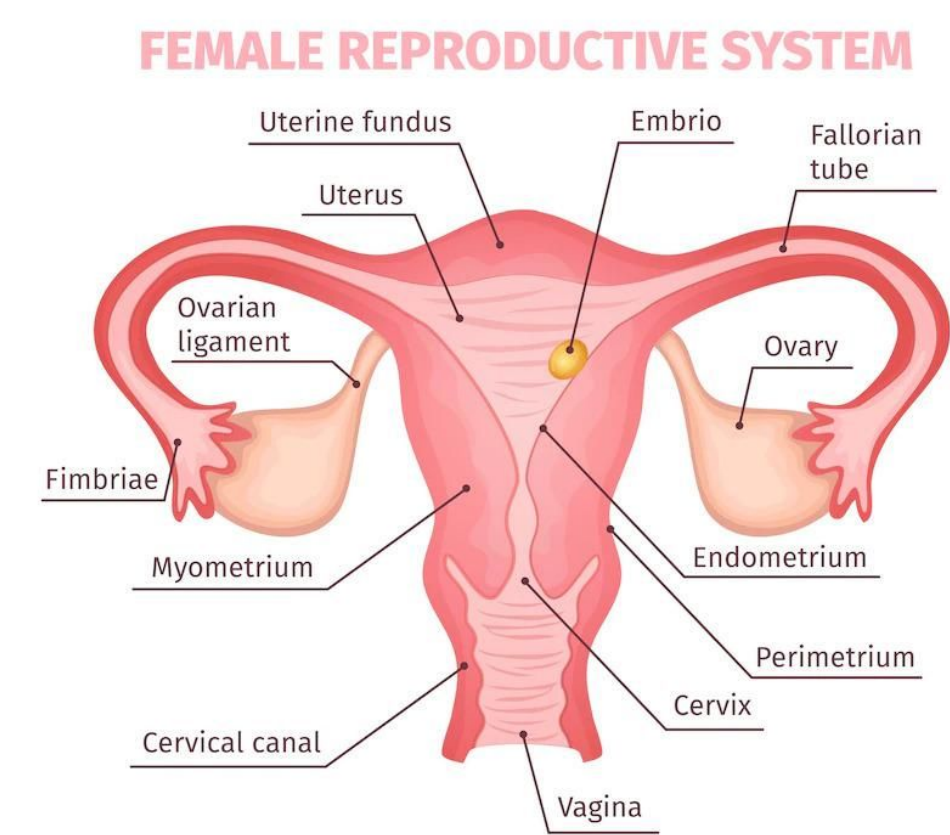


Figure 2: Female Reproductive System [3]

## 3. MOTIVATION

- Current models lack an anatomically accurate cervicovaginal junction and properly sized uterus.
- Practitioners are unable to practice necessary procedures effectively.
- Proper performance of procedures is essential for patient pain management and safety.
- Increased practitioner confidence allows practitioners to be better prepared, improving quality of treatment for patient.



Figure 3: Current training model

## 4. DESIGN CRITERIA

### Materials

- Flexible and durable.
- Accurately portray reproductive tissues.

### Weight

- Easily liftable weight, around 0.23-0.68 kg.

### Operation Environment and Time

- Standard room temperature (around 70F) and humidity (30-50%).
- Be able to withstand multiple training sessions, have replaceable components.

### Size

- Anatomy at user's eye level.
- Easily transportable.
- Anatomy should be accurately dimensioned.

## 5. FINAL DESIGN

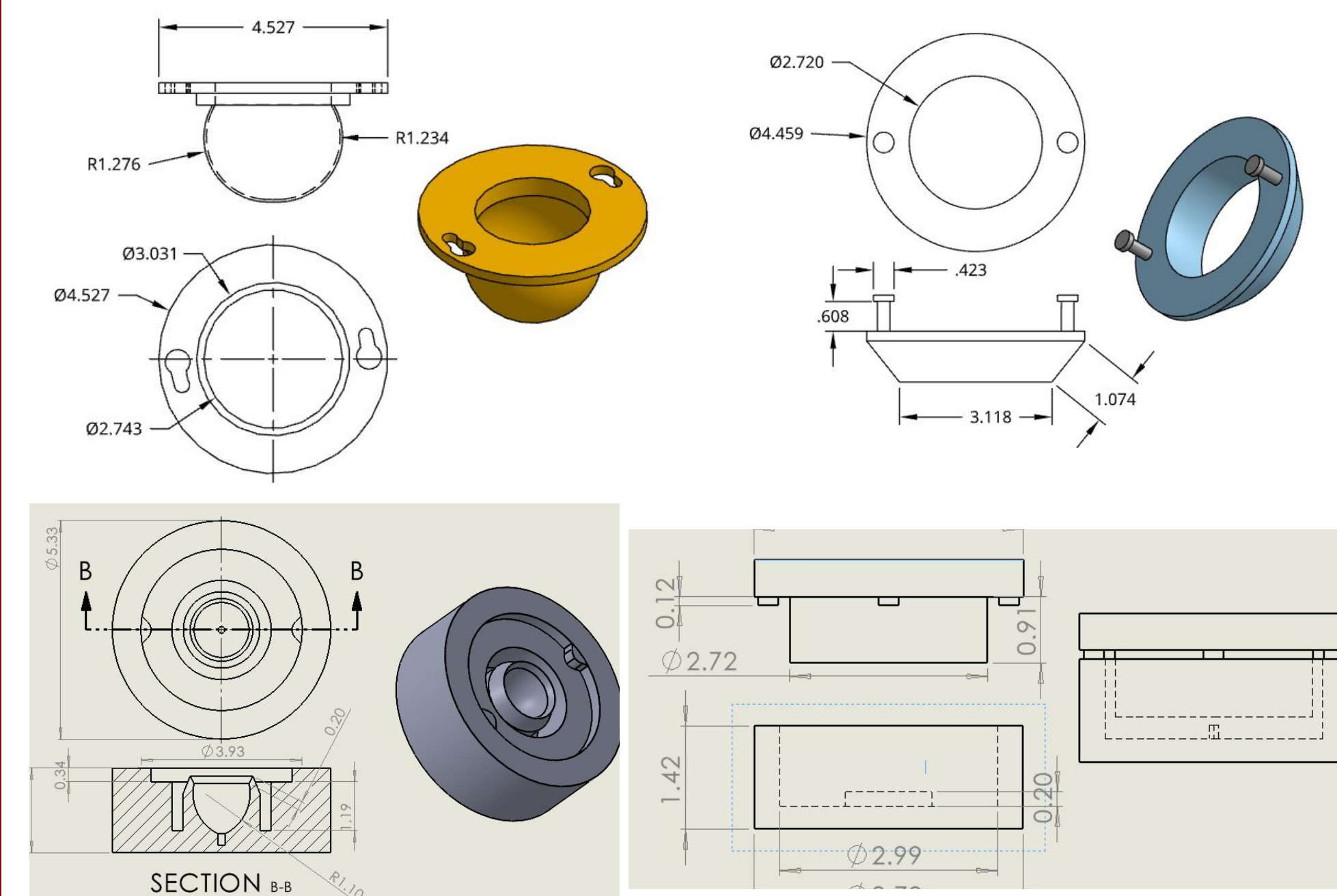


Figure 4: SolidWorks drawings of uterus, connecting piece, cervical mold, and vaginal mold

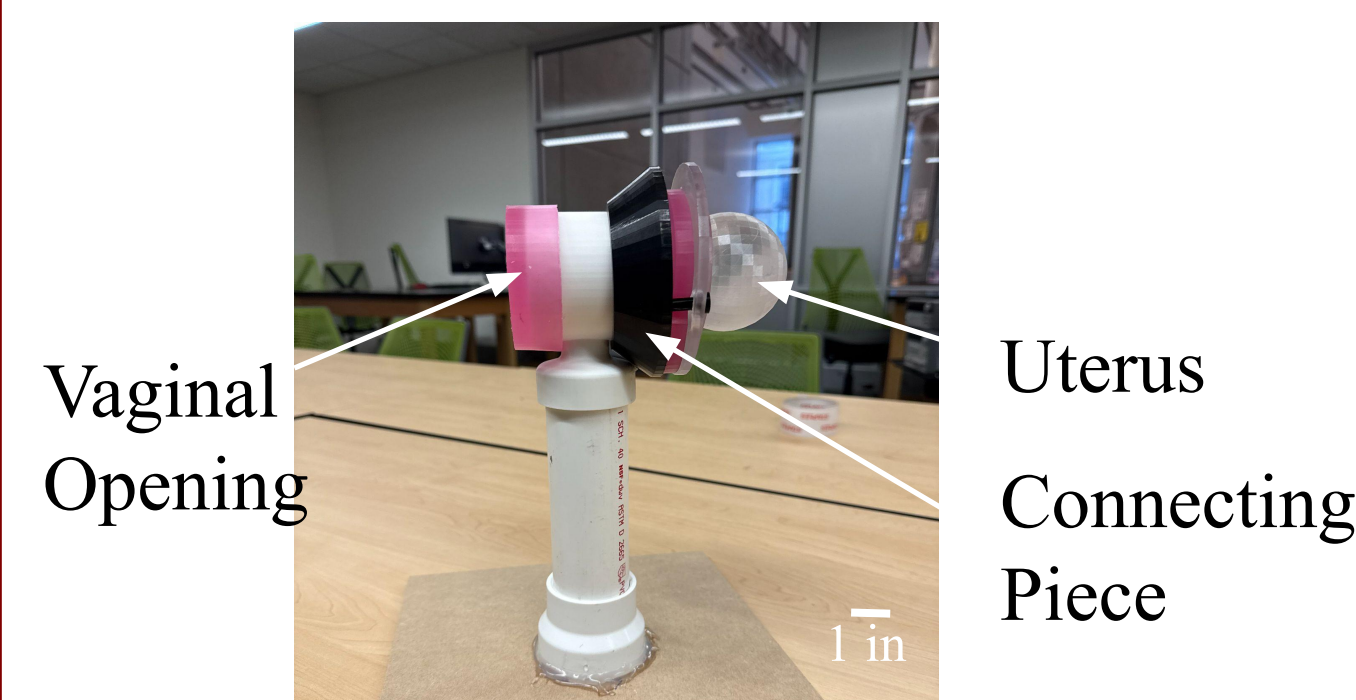


Figure 5: Final model from the side view.

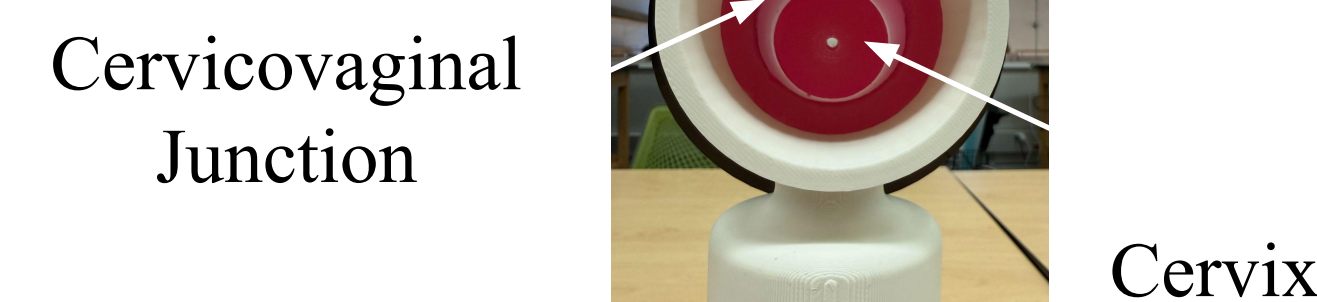


Figure 6: Final model looking down the vaginal canal with the vaginal opening removed.

### Function

- Provide a realistic simulation of the paracervical block procedure.
- Accurately represents the cervix, vaginal canal, and cervicovaginal junction anatomy.
- Compatible with standard clinical tools (speculum, tenaculum, syringe, needles).
- Uterus, connecting piece, and charlotte pipe are 3D-printed in PLA; cervix and vaginal opening cast in Ecoflex-002.

## 7. DISCUSSION

### Material Testing

- Materials had correct properties that fell within the reported literature values of reproductive tissue.
- Large variability in due to limited research for women's health and unreliable data.
- Physician input was crucial to ensuring accuracy.

### Physician Review

- Model was successful in providing physicians with a more realistic design compared to current models (100% recommended).
- Technical issues with tissue properties and speculum placement. Device has ability for improvement due to modularity.
- Molds will be given to client to reproduce silicone components or introduce new materials.

### Uterus Design

- Changed from an opaque PLA material to Clear V5. Allows clinicians to see into the uterus, but was ineffective as showing needle placement.
- Efforts to make an anatomically accurate uterus were unsuccessful due to time restraints and printing limitations.



Figure 7: MTS Testing of Ecoflex 00-20

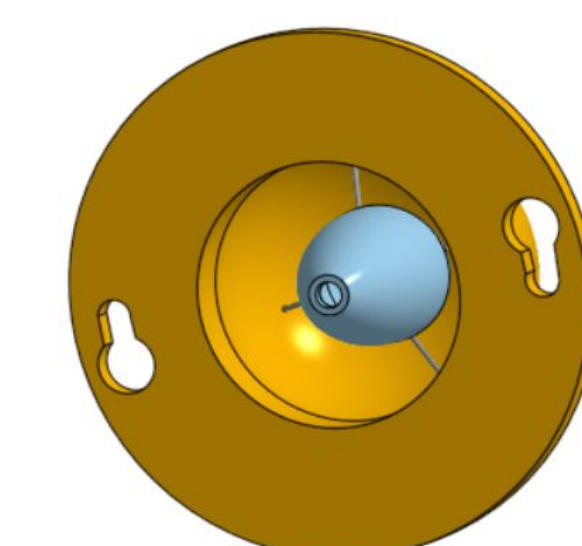


Figure 8: Anatomical Uterus Sketch

## REFERENCES

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- [2] Hologic, Inc., "Paracervical block video - Animation," (Nov. 04, 2015). Accessed: Oct. 02, 2025. [Online Video]. Available: <https://www.youtube.com/watch?v=m0EyyHouT00>
- [2] "Diagram of Female Reproductive System and Its Anatomy - %siteName%," GeeksforGeeks. Accessed: Sept. 30, 2025. [Online]. Available: <https://www.geeksforgeeks.org/diagram-of-female-reproductive-system-and-its-anatomy/>
- [3] National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division; Board on Population Health and Public Health Practice; Committee on Assessment of NIH Research on Women's Health, Overview of Research Gaps for Selected Conditions in Women's Health Research at the National Institutes of Health: Proceedings of a Workshop—in Brief. In The National Academies Collection: Reports funded by National Institutes of Health. Washington (DC): National Academies Press (US), 2024. Accessed: Dec. 04, 2025. [Online]. Available: <http://www.ncbi.nlm.nih.gov/books/NBK606165/>

## 6. TESTING AND RESULTS

### Ecoflex 00-20 Material Evaluation

**Tensile Testing:** Dumbbell-shaped samples were tested on an MTS uniaxial machine in tension according to ASTM D412 Type C standards. Young's modulus was 0.389 MPa, falling within the physiological range for cervicovaginal tissue (~0.01–1 MPa), indicating comparable stiffness.

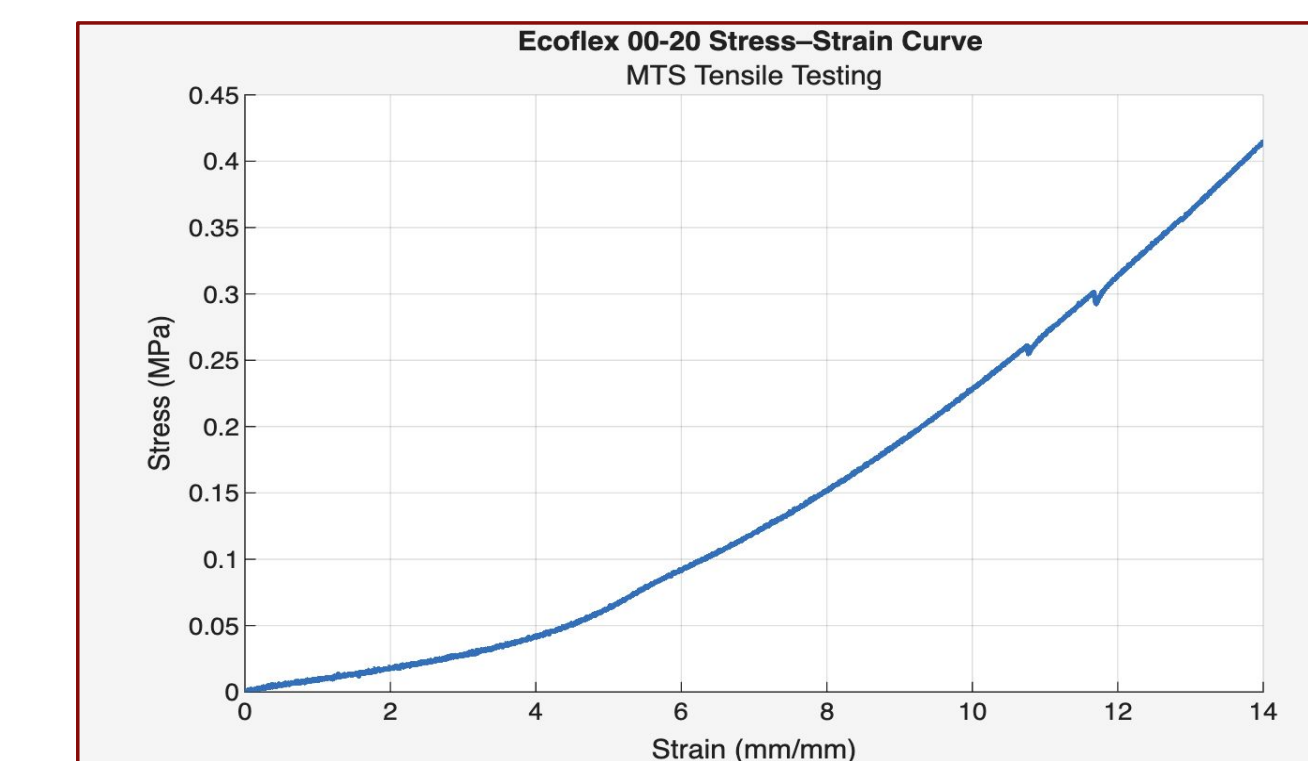


Figure 9: Stress-strain curve in tension.

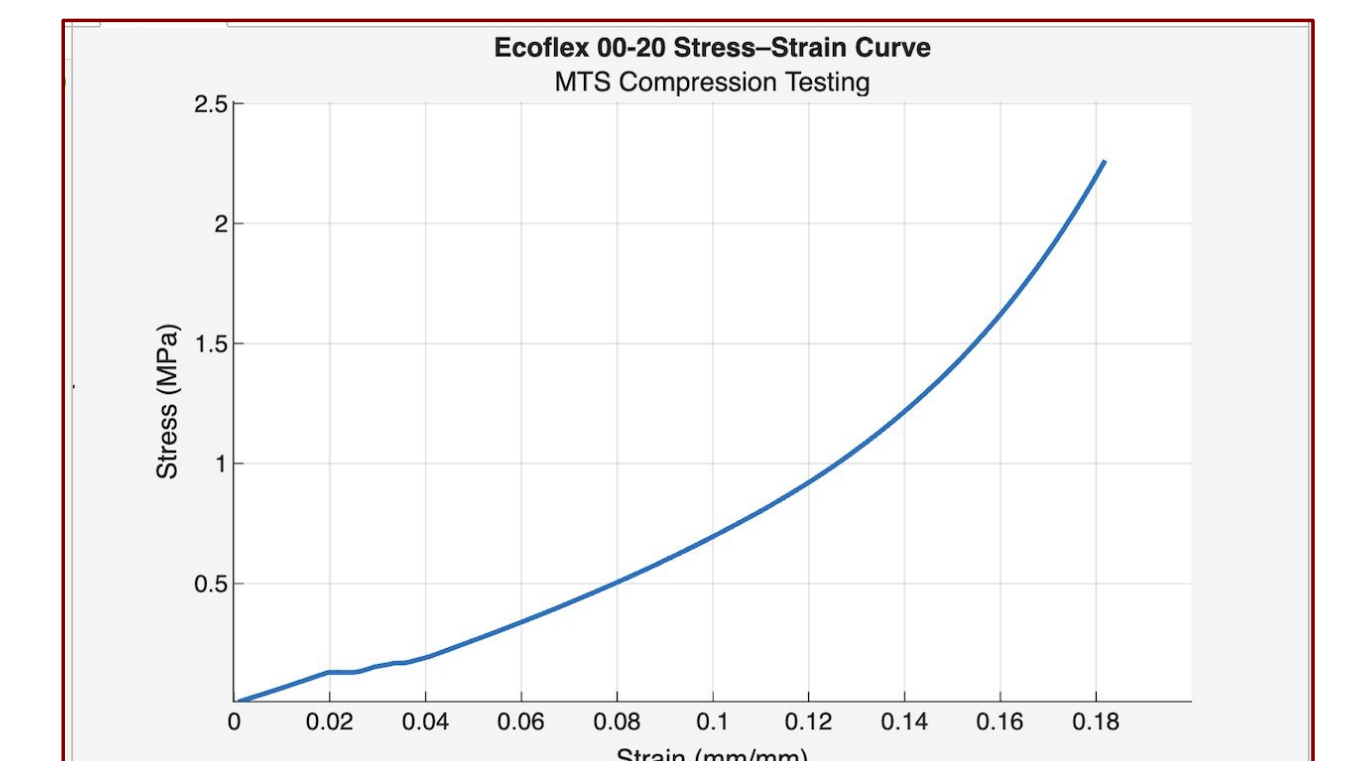


Figure 10: Stress-strain curve in compression.

**Compressive Testing:** Cylindrical samples were compressed according to ASTM D575 Type C. Compressive modulus was 0.071 MPa, lower than tension as expected for hyperelastic materials. Stress-strain behavior confirmed nonlinear, mode-dependent response, yet remained physiologically relevant.

### PBCTM Physician Feedback

**Quantitative Scoring:** Physicians rated the training model across success categories, using a 1–10 scale via a feedback form. Mean scores and standard deviations were calculated to assess performance and consistency. Overall, the model performed strongly across evaluated domains.

- 100% of physicians recommend the model.
- 82.5% overall success in satisfaction and effectiveness.
- High scores in realism, intuitivity, and ease of use further supported the model's functional design.

### Qualitative Feedback:

- Effective usability as a training model.
- Appreciation for the overall structure, feel and instructional clarity of the device.
- Introduce greater variability in tissue material.
- Refine the cervical tilt angle.

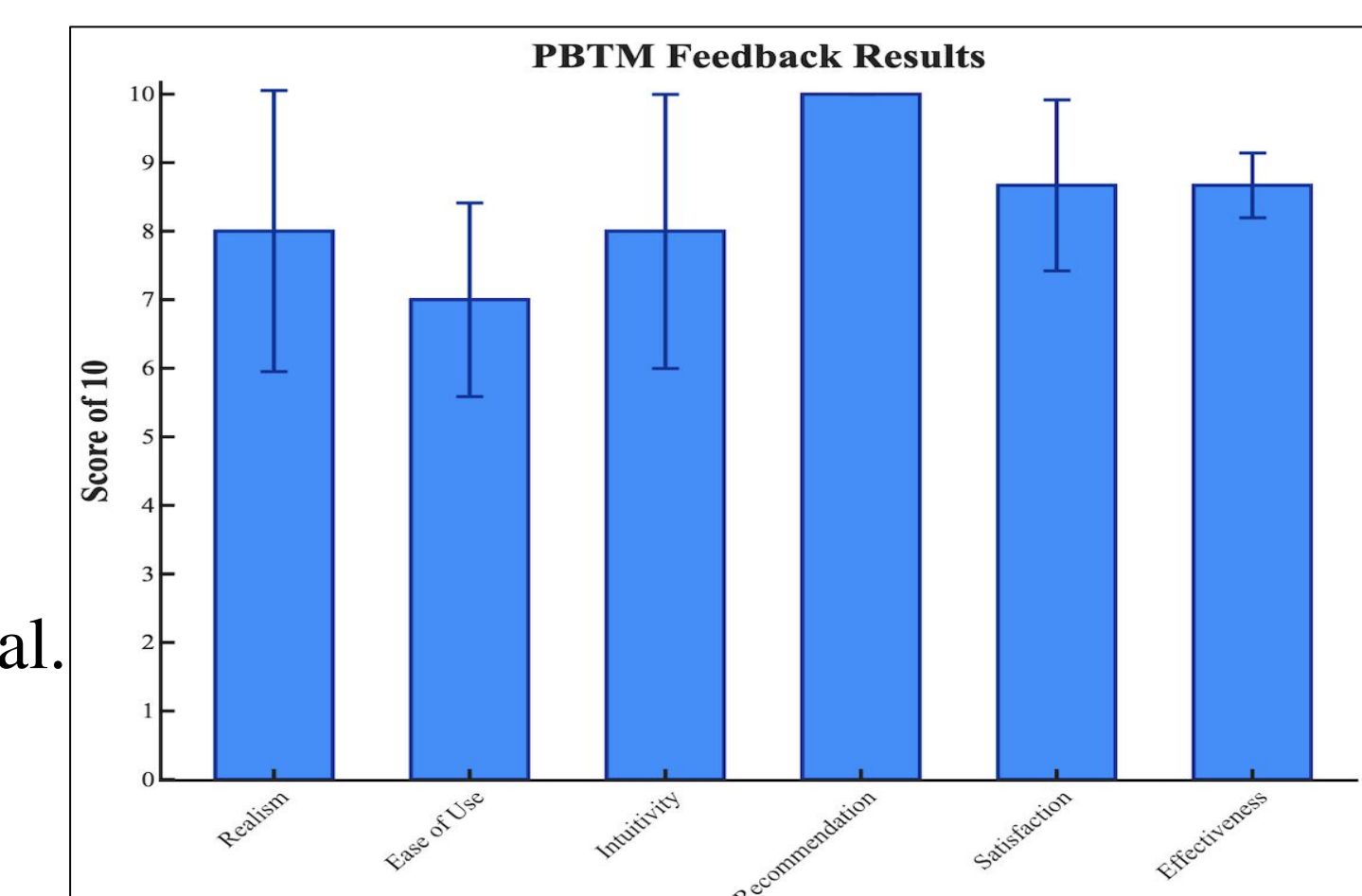


Figure 11: PBCTM Feedback Results

## 8. FUTURE WORK

### Materials:

- Make a more streamline process for mold removal of the cervix.
- Find a material that will allow us to print a clear uterus to allow for visualization.
- Change the stiffness of the cervix to make it more firm for tenaculum placement.
- Vaginal opening with better stability for speculum.
- Cervical angle tilt.
- Create 10 more models for our client to use at national conventions.
- Make an interior uterus component that better matches the actual anatomical shape.
- Add an electronic component that buzzes (operation game) if paracervical block is performed incorrectly.