Radially Expanding Uterine Cervical Dilator

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Abstract

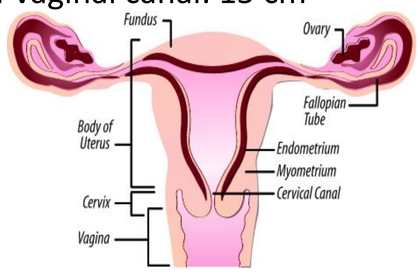
Dr. Dan Lebovic would like a uterine cervical dilator that, once inserted through the cervical canal, can be radially expanded by the use of a dial, which will be controlled by a doctor. Current methods for dilating the cervix are very tedious and tiresome for the doctor performing the procedure. These methods also put patients at a higher risk for uterine perforations. Our goal is to simplify the dilation process by creating a device that can radially expand after it is inserted into the cervical canal. We will do this by using a cone-like design that has a "screwing" mechanism, which can be controlled by a doctor. A prototype of our design was built and testing was performed to determine the accuracy and functionality of the device.

Motivation

- Make dilation easier and simpler for doctors performing procedure
- Decrease risk of uterine perforations in patients during dilation

Background

- Anatomy of uterus
  - Average length of uterus: 7 cm
  - Average length of cervical canal: 3.5 cm
  - Average length of vaginal canal: 15 cm
- Procedures
  - Cleaning uterus
  - Sample of tissue
  - Termination of pregnancy
  - Miscarriage
- Current Devices
  - Hegar dilators
  - Pratt dilators

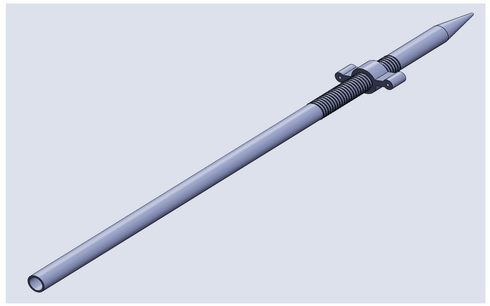


Design Criteria

- Minimum size: 3 mm in diameter
- Maximum size: 10 mm in diameter
- Radial expansion while in cervical canal
- Expansion in increments of 1 mm in diameter
- Dial to control expansion and indicate diameter dilated
- Indicator to let doctor know when dilator is completely inserted into cervical canal
- Must withstand 52.4 N of force

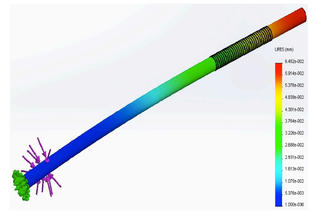
Final Design

- "Ring" piece attached to tenaculum
- "Cone" piece screwed through "ring" and into cervix
- Minimum diameter: 3 mm
- Maximum diameter: 10 mm
- "Cone" piece is hollow to allow for laparoscopic camera to be inserted through device
- Materials used:
  - Delrin acetal
  - Acrylic
  - 316L stainless steel

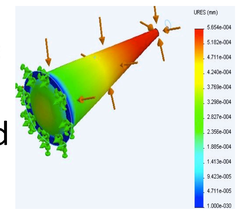


Testing

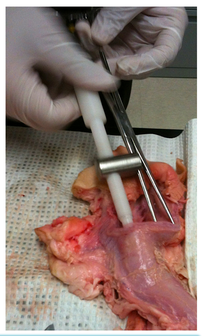
- SolidWorks
  - Applied 60 N force
  - FOS of 1,135 for straight shaft
  - FOS of 352 for cone tip



- Pig's uterus
  - Tested functionality of device



- Accuracy
  - Each team member measured diameter every 2 revolutions
  - Calculated mean, standard deviation and percent error
  - Mean diameters within 0.1 mm of expected diameters
  - Standard deviation ≈ 0.03 mm
  - Percent error ranged from 0% to 4.03%



Future Work

- Implement different materials
  - Clear Lexan
  - Medical grade stainless steel
- Improve dial design
- Perform more testing
  - Human's uterus
- FDA approval

Acknowledgements

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