Feline Ovariohysterectomy Surgical Training Model

BME 200/300 Fall 2024
Sofia Yeates-Delahoz, Kennedy Young, Tess Fitzgerald, Therese Kalt
Client: Dr. McLean Gunderson, BS, DVM Advisor: Dr. Anupama Nair, PhD

Problem Definition

Motivation

- Feline ovariohysterectomy surgery reduces stray cat populations and also prevents ovarian and uterine cancers
- Current surgical training model is not anatomically accurate for students
- Anatomically accurate training models lead to higher confidence in practicing students [1]
- Important to practice on anatomically correct models to prevent complications during surgery
- Veterinary schools lack access to affordable and anatomically accurate surgical training models

Background

- The feline ovariohysterectomy surgery is the removal of the uterus and ovaries in a cat [2]
- The felines ovaries are located just behind the kidneys, which sit just below the ribcage [3]
- Uterine horn lies just between the colon and the bladder
- Current model in use is a tupperware container that provides limited anatomical accuracy

Design Criteria

- Maintain anatomical accuracy
  - Includes costal arch, blood vessels, kidneys, and pubis
- Environment
  - Withstand a temperature of 18-30°C [4]
  - Withstand sterilization fluids
  - Shelf life of 3 to 5 years
  - Withstand use by 100 students three times each per semester
- Mimic the dimensions of an average sized cat (~22-25 cm) [5]
- Design should be able to accommodate loads ranging from 33.38 to 121.35 N [6]

Material Costs

Component	Cost of Component
Arched Shell Model Fabrication	$39.50
Organ Tray Fabrication	$12.13
Latches (4)	$0.18
Screws (8)	$0.43
Total Cost	**$52.24**

Table 1: Table that consists of all the material expenses required to fabricate a complete feline ovariohysterectomy model.

- Cost to fabricate one spay model is $52.24
- This is significantly below the budget of $120

Final Design

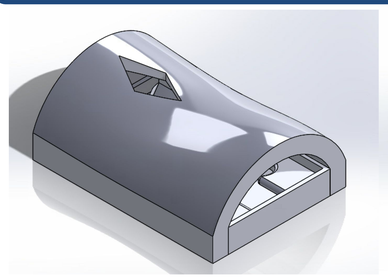

Figure 1: Solidworks image of the Arched Enclosed Spay model containing the organ tray.

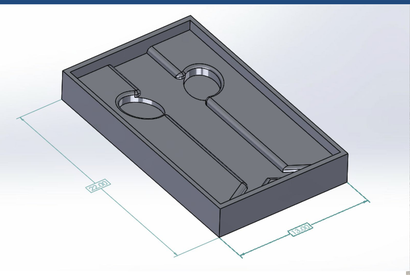

Figure 2: Solidworks image of the Organ Tray that contains the outline of the kidneys and blood vessels.

Figure 3: Assembled model of the Arched Enclosed Spay Model containing the organ tray.

- Final design includes an arched and enclosed model made of Polylactic Acid (PLA) which houses an organ tray
- Organ tray will provide latches to secure the organs in place
- Organ tray contains clips that will provide resistance in order to mimic ligaments
- Artificial skin will be pinned to the exterior of the model
- Organ tray is easily removable in order to maximize efficiency

Testing and Results

Statistical Analysis

- A survey was created for 1st - 3rd year students at the UW Veterinary School to evaluate the efficacy of the surgical training model

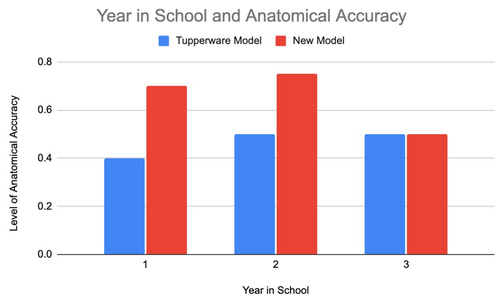

Table 2: Table comparing the level of anatomical accuracy to the year in school

- Table 2 compares the anatomical accuracy of each model, resulting in a P-value of 0.011
  - Indicates significant statistical evidence that the new training model is more anatomically accurate

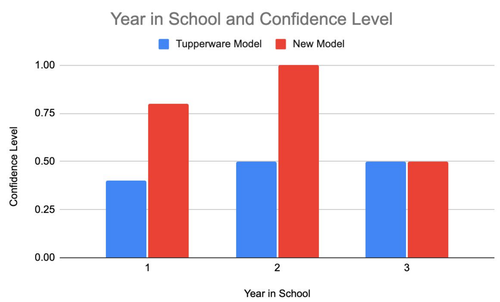

Table 3: Table comparing the level of anatomical accuracy to the year in school

- Table 3 compares the confidence level of each model, resulting in a P-value of 0.001
  - Indicates significant statistical evidence that the new training model provides students with more confidence

Mechanical Testing

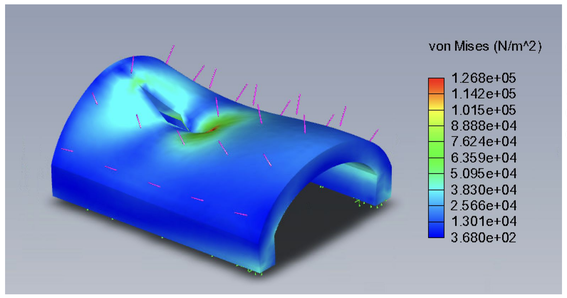

Figure 4: Heatmap depicting the allowable stress under 122 N of compressive load on the model.

- Mechanical testing was conducted on Solidworks Simulation Wizard to determine the allowable stress on the shell model
- Spay model can withstand up to 3.680 x 10^2 Pa of stress under a load of 122 N
- Sufficiently strong for the purposes of the surgical training

Discussion

- Model can be used many times throughout a semester due to easily removable and reconstructed organ tray
- Model can be printed and used in various locations with access to SolidWorks file due to use of accessible materials
- Model is made with PLA, which is a long shelf-life material and can be stored in limited space
- The model's shell originally had an incision window with 1cm thickness, but after printing and meeting with the client, the window size was widen significantly to allow for greater accessibility to the organs (due to the stiffness of the material providing no movement)

Future Work

- Conduct additional testing with a larger sample size
- Increase the length and width of the incision window and attach foam to the borders to create a malleable opening
- Improve the method for assembling the organ tray model with the current organs

Acknowledgements

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- UW Design and Innovation Labs

References

[1] M. Badman, M. Tullberg, O. V. Höglund, and R. Hagman, "Veterinary Student Confidence after Practicing with a New Surgical Training Model for Feline Ovariohysterectomy," Journal of Veterinary Medical Education, vol. 43, no. 4, pp. 427–433, Nov. 2016, doi: 10.3138/jvme.1015-165R2.
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[5] J. A. Helgren, "List of selected shorthair breeds," Encyclopaedia Britannica, https://www.britannica.com/animal/cat/List-of-selected-shorthair-breeds (accessed Sep. 18, 2024).
[6] F. S. Reina Rodriguez, C. T. Buckley, J. Milgram, and B. M. Kirby, "Biomechanical properties of feline ventral abdominal wall and celiotomy closure techniques," Veterinary Surgery, vol. 47, no. 2, pp. 193–203, Feb. 2018, doi: 10.1111/vsu.12751.