



Thyroid Retractor

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Client: Dr. Amanda Doubleday - UW-SMPH

Advisor: Dr. Ed Bersu - UW-Madison Department of Biomedical Engineering



Abstract

During an operation that involves thyroid retraction, the endocrine surgeon must retract the thyroid gland medially in order to gain access to the recurrent laryngeal nerve, to dissect the thyroid gland from vascular attachments, and to find parathyroid glands. Surgeons often use one or two Rochester-Pean forceps with a piece of gauze at the tip referred to as a "peanut." Working with only one forcep, occasionally there are not enough points of contact on the thyroid which causes the gland to be difficult to retract and hold. The goal presented by the client is to create a device that is similar to standard forceps, but has two prongs that are able to retract the thyroid from multiple points of contact. The final design is an Adapted Weitlaner that is composed of a ratcheting mechanism to allow for ease of adjustability, two blunt prongs for two points of contact, and surgical caps to allow for more friction between the thyroid and retractor. Future work includes ergonomic testing once a prototype has been 3D printed, research into manufacturing the final design into stainless steel, and continuing this project into the fall of 2021.

Problem - Motivation

- Create a device to aid in the 130,000+ thyroid and parathyroid surgeries conducted each year [1]
- Accommodate for different thyroid shapes and sizes through a single forcep and multiple points of contact
- Using a forcep that needs two hands to use successfully decreases efficiency by needing a larger surgical team
- The client requests a surgical instrument that has two prongs to retract the thyroid gland from multiple points of contact.

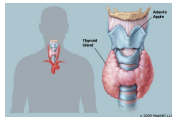


Figure 1: The anatomical depiction of the thyroid gland [2]

Background

- The thyroid is important in hormone secretion of thyroxine (T_4) and triiodothyronine (T_3), and have a great effect on the majority of organ systems [4].
 - Thyroids are 4-4.8 x 1 to 1.8 x 0.8-1.6 cm, and weight about 10-20 grams [5]
- The parathyroid gland regulates calcium and phosphorus in the bloodstream [6]
- The current surgical tool used by Dr. Doubleday's team is a 'Peanut' forcep seen in figure 2.
- Two are used in cases with larger thyroid glands (see figure 3).



Figure 2: The current peanut forceps used in Dr. Doubleday's team [3]



Figure 3: An image from one of Dr. Doubleday's surgeries that required two peanuts.

Design Specification

- Two pronged
- Ability to touch multiple parts of the thyroid
- Adjustable between prongs & tips of forceps
- No atypical protrusions
- Typical surgical instrument specifications
 - Stainless steel
 - Mirror finish
 - Length: ~ 8 in. [7]
 - Weight: ~ .09 lbs. [8]

Design Process

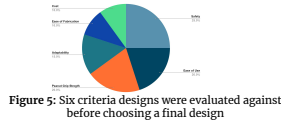
Preliminary Designs

- Adapted Weitlaner
- Two Fused
- Nut and Bolt



Figure 4: Three preliminary design ideas

Preliminary Design Evaluation



Final Design



Figure 6: Adapted Weitlaner design (left), CAD model of the disposable rubber shod (right)

- Adapted Weitlaner retractor
- Disposable rubber shods
- Adjustable locking mechanism
- Curved shod decreases difficulty of dissection
- One-handed design

Testing and Results

- Shod will not be exposed to great forces
- SolidWorks testing performed
- Maximum stress well below modulus
- Minimal strain or deformation
- Future mechanical and ergonomic testing of the composite design

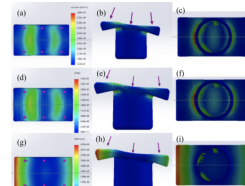


Figure 7 : CAD Representations of stress (a, b, c), engineering strain (d, e, f), and deformation (g, h, i) of a 1 N applied force to the shod

Conclusion

- SolidWorks testing showed that the shod will be able to withstand the forces that are applied to it
- Testing showed minimal deformation
- Device will be able to withstand forces applied to it
 - Future testing will need to be completed that evaluate the mechanics of the actual model

Future work

- Conduct more testing
 - Qualitative ergonomics testing with 3D model of forceps
 - Will gauge how well the forceps are able to complete their intended purpose
- Research into stainless steel manufacturing for the forcep component of the design
- Project is being continued into the fall

Acknowledgements

- Dr. Ed Bersu
- Dr. Amanda Doubleday
- UW-Madison BME Department



References

- [1] S. M. Kim, A. D. Shu, J. Long, M. E. Montez-Rath, M. B. Leonard, J. A. Norton, and G. M. Chertow, "Declining Rates of Inpatient Parathyroidectomy for Primary Hyperparathyroidism in the US," *PLoS one*, 16-Aug-2016. [Online]. Available: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4986953/>. [Accessed: 23-Feb-2021].
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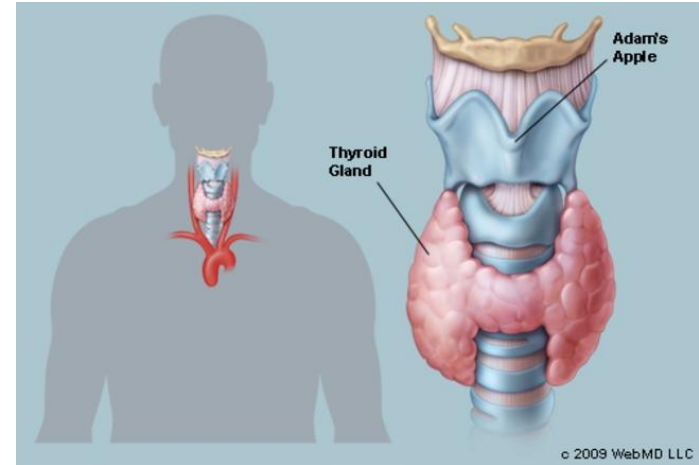


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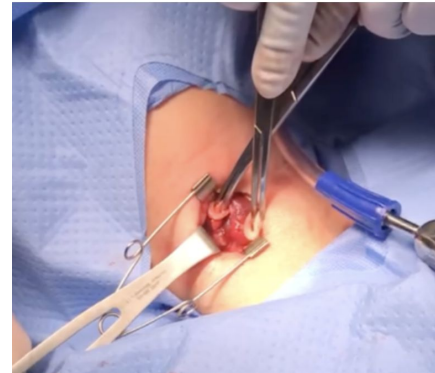


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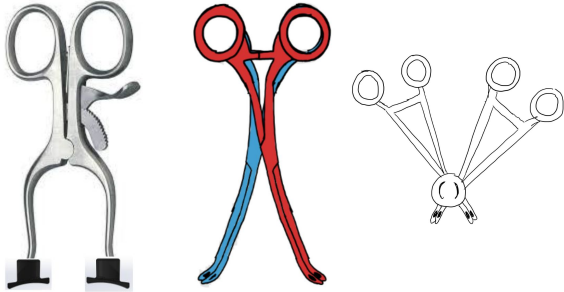


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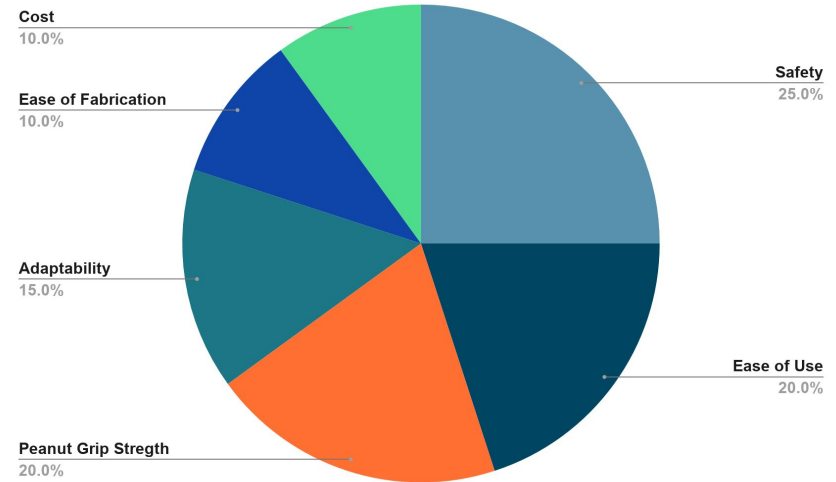


Figure 5: Six criteria designs were evaluated against before choosing a final design

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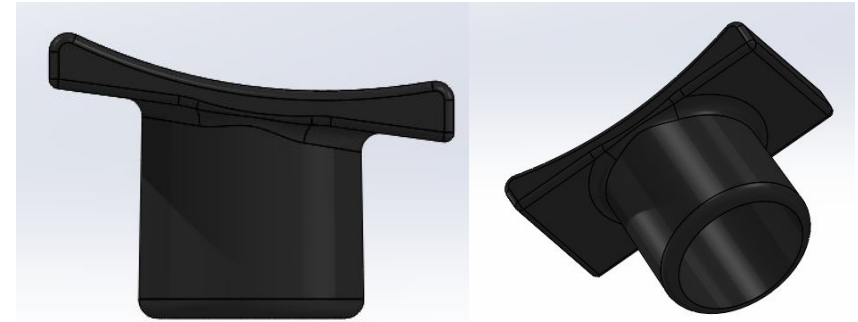


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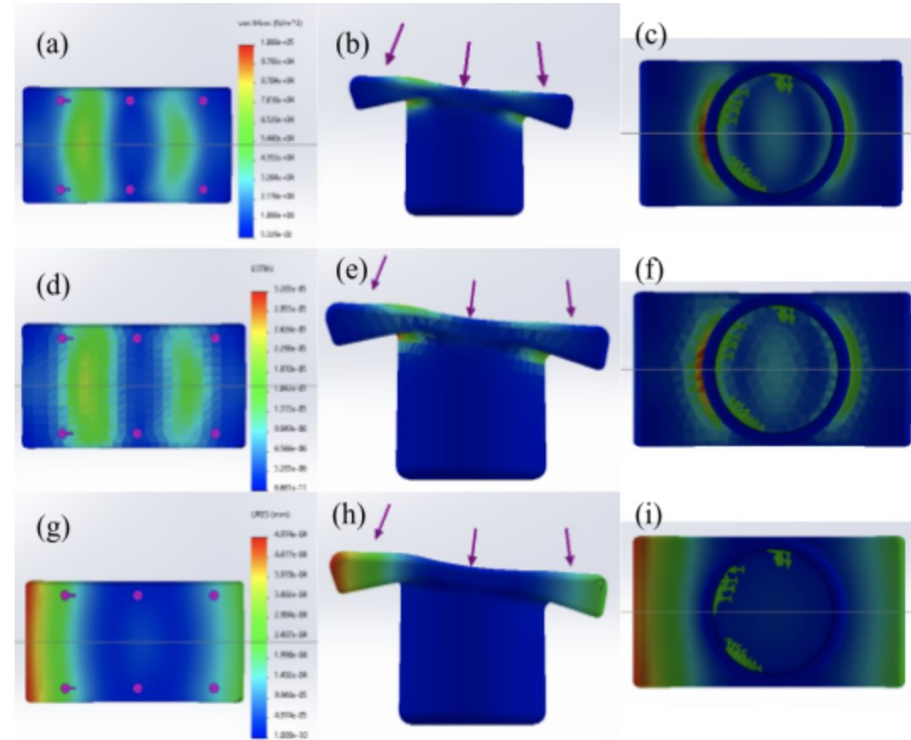


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References

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