Thyroid Retractor

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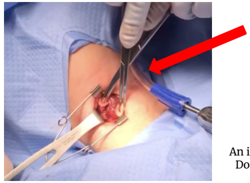
Abstract

In a thyroid retraction, surgeons often use one or two Rochester-Pean forceps with a piece of gauze, collectively referred to as a "peanut." However, the single point of contact may cause folding or slippage on the thyroid. Out of three potential designs, the adapted Weitlaner design was chosen and iterated to the required specifications. A simulated surgery and ergonomic testing was conducted. Future work includes manufacturing the retractor in stainless steel and approaching the Wisconsin Alumni Research Foundation to submit a patent application.

Problem - Motivation

- Two Peanuts are used in order to retract larger thyroid glands. This results in both of a surgeon's hands being lost.
- A thyroid retractor with a single handle and two prongs to retract the thyroid from multiple points of contact is necessary



Anterior view of a patient's neck. Notice two peanuts are being used

Figure 1: An image from one of Dr. Doubleday's surgeries.

Background

- The current thyroid retractor in use allows for one point of contact, which does not allow for complete retraction of larger, or irregularly shaped thyroids (see Figure 1)
- Since thyroidectomies are performed over 130,000 times per year [1], the effect of this retractor may go beyond

Figure 2: Image of Rochester Pean Forceps [2]

Thyroid

- Thyroid Dimensions
  - 4-4.8 x 1 to 1.8 x 0.8-1.6 cm [3]
  - 10-20 grams [3]
- Reasons for operation:
  - Thyroid is important in hormone production
  - Parathyroids regulate calcium
- Single point of contact difficulties: folding over and lack of traction

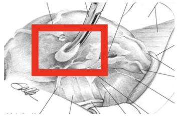


Figure 3: Diagram of a medial thyroid retraction using a peanut [4]

Design Specifications

- Surgical instrument specifications:
  - Surgical grade stainless steel
  - Length: ~ 20 cm [5]
  - Weight: ~ 50 g [6]
- Separated into two prongs
- Adjustable distance between prongs
- Safe for use on patient
- No atypical protrusions

Design Process

Preliminary Designs

- Shod Weitlaner
- Spring Weitlaner
- Treaded Weitlaner

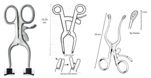


Figure 4: Three preliminary design ideas shown respectively

Preliminary Design Evaluation

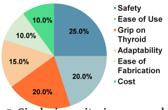


Figure 5: Six design criteria were evaluated before choosing a final design

Final Design

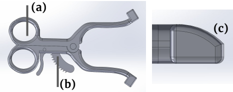


Figure 6: Treaded Weitlaner design (left) with tissue-contacting geometry (right)

Treaded Weitlaner

- All-in-one reusable design with no disposable components
- Ergonomic handle for single-handed use (a)
- Locking mechanism (b)
- Tissue contacting geometry for increased surface contact and minimal potential for damage (c)

Testing and Results

Methods

- Simulated surgery of a tissue analog with optical markers for motion capture
- Video file analyzed in Kinovea software to determine maximum acceleration and forces
- Calculated forces and clinical thyroid constants applied to computational model [7]
- Model interactions of thyroid and device as two distributed loads

Results

- Large deformations observed, required to dislocate thyroid from resting anatomy
- Maximum von Mises stress below failure strength for soft tissues [8]
- Maximum engineering strain below rupture point for soft tissue [9]

Figure 7: Simulated surgical displacement of one lobe of the thyroid gland, using a tissue analog(left). The video file is analyzed in motion capture software Kinovea (center) and exported to Matlab to determine maximum acceleration and forces

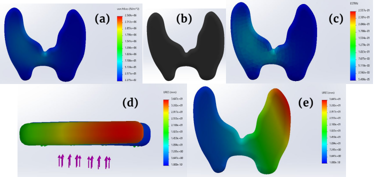


Figure 8: Computationally modeled interactions of the thyroid and tissue-contacting device. Von Mises stresses in N/m^2 (a). Thyroid model used in calculations (b). Engineering strain (c). Displacement perpendicular to the loading plane, shown as purple arrows (d). Displacement parallel to the loading plane (e).

Discussion

The team designed and prototyped a novel surgical device to be used in thyroid surgeries. The device improves on previous methods by incorporating multiple points of contact to the tissue. This allows for distribution of the applied forces and decreased possibility of traction loss or thyroid folding during retraction. To test the device, a simulated thyroidectomy of a single lobe was performed and analyzed in motion capture software. The maximum values were used in a computational model which demonstrated von Mises stresses and engineering strain well below the threshold for soft tissue failure, as demonstrated in Fig 8. Future work includes finalizing the CAD model with clinician feedback, as well as manufacturing the device in surgical grade stainless steel.

Future work

- Finalize CAD model with feedback from client and other clinicians
- Modify the spring component of the locking mechanism to improve reliability
- Cadaveric testing in simulated endocrine surgery
- Determine a cost effective method to manufacture in AISI 420 steel
- Approach WARF to inquire about a patent application

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UW BME Design

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