Developing a 3D model of the tongue and mouth to assess pressure generation in predict bolus flow when swallowing

Project Design Specifications

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Function: JoAnne Robbins, Ph.D., Director of the UW/VA Swallowing Speech and Dining Enhancement Program (SWAL-ADE) will supervise this project concerning dysphagia, or difficulty swallowing, which affects many adults and children in the U.S. It often is a result of stroke or degenerative neurologic disease. This project will focus on developing a 3D model of the tongue and mouth that will be used to assess pressure generation within the oral cavity during swallowing. This is a third semester project, and we will concentrate on enhancing the tongue posterior movement, designing a mouth cavity compatible with pressure sensors (MOST device), and programming the device to simulate different disorders via tongue movement.

Client requirements: Our client requires a model that fulfills these requirements:

- Develop mouth cavity with a hard palate compatible with force sensors (MOST device)
- Programmed tongue movements that simulate various forms of dysphagia
- Posterior tongue movement

Design requirements:

1. Physical and Operational Characteristics
a. *Performance requirements*: The device should be able to have full tongue movement (posterior/anterior) and be compatible with sensors that are able to detect a range of pressures (MOST device).

b. *Safety*: This model would not be in direct contact with patients; therefore, typical medically ethical issues do not need to be considered. However, the model's electrical components should be contained as to not harm the operator.

c. *Accuracy and Reliability*: Our model should mirror the physiology and anatomy of healthy and unhealthy swallowing mechanisms found in humans as accurately as possible.

d. *Life in Service*: Our model is expected to last indefinitely, with continual updates to electrical components as technology advances.

e. *Shelf Life*: Our model will need to be stable on a flat surface and portable.

f. *Operating Environment*: The model should be able to maintain structural integrity when handled and if dropped.

g. *Ergonomics*: Our model is not a hand-held device and so ergonomics does not apply directly.

h. *Size*: Model should be consistent with typical human size. Mouth cavity: ~15 cm x ~15 cm.

i. *Weight*: Model (including electronics) should not exceed 4.5 kg.

j. *Materials*: Tongue is currently made of silicone. Hard palate in front of jaw should be constructed using a hard plastic; soft palate should be constructed out of silicone.

k. *Aesthetics*, *Appearance, and Finish*: Model should accurately represent the appearance of a human mouth.

2. Production Characteristics
a. *Quantity*: At least one functional prototype is needed. Design should be conscious of possible replication.

b*. Target Product Cost*: Device costs should not exceed 500 dollars.

3. Miscellaneous
a. *Standards and Specifications*: Model will not be in direct contact with patient; only basic safety specifications will be considered.

b. *Customer*: Functionality is a priority to the client.

c. *Competition*: Currently there are no devices that model the swallowing mechanisms of dysphagia. There is one current non-electrical model that demonstrates the mechanisms of swallowing for nurse education (Miss-Swallowing simulator).