Device for Automatic De-epithelialization

BME 200/300 Fall 2020

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Abstract

- De-epithelialization (De-epping): a technique used to remove the epithelial layer of skin. Often performed for breast reconstruction.
- Client desires a device that reduces the time traditional de-epping takes and increases the efficiency of the process while maintaining patient safety.
- The Epicut is a competing device made for de-epping breast tissue, but it is expensive
- The team's solution to this problem is a Modified Epicut design, which uses similar design aspects, but allows for reuse
- Testing was done to demonstrate the ease of use of the device and the consistency of depth in the cuts

Background

- Skin is made up of three layers[1]
  - Epidermis
  - Dermis
  - Subcutaneous Tissue
- The breast tissue is significantly thinner, more elastic, and more sensitive than most other tissues [2]
- De-epithelialization is the process by which the epidermis is removed from the rest of the skin [4]
- The current method for de-epping breast tissue involves scoring the tissue and using scissors and scalpels to peel back the epidermal layer [5]
- There are two competing devices on the market right now
  - The Dermatome [6]
  - The Epicut [7]

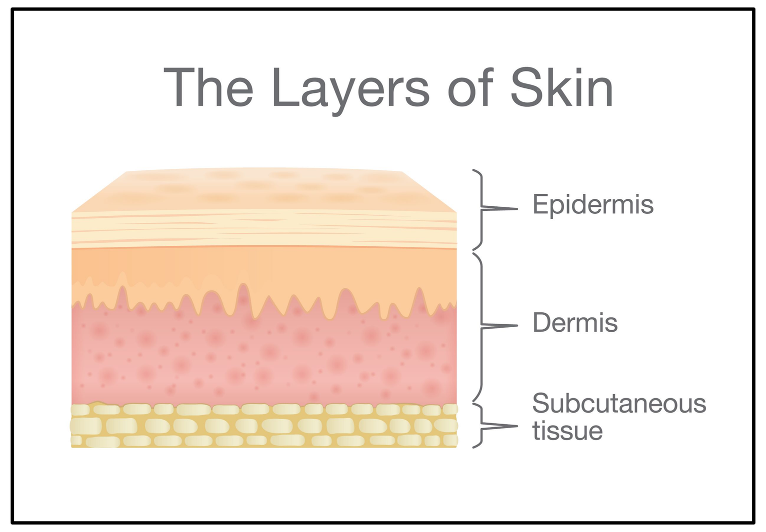


Figure 1: The layers of the skin. The epidermis makes up approximately 10% of skin thickness [3]

Design Criteria

- The device must be efficient and significantly decrease the amount of time it takes for surgeons to de-epithelialize the skin.
- The device must be reusable.
- The device should be as safe as current deepithelialization techniques. The underlying dermal layer should not be damaged or disturbed.
- The device must also be easy to use. There cannot be a significant learning curve for surgeons using this device for the first time.
- The device must be able to consistently cut at a uniform depth.

Final Design

Modified EpiCut

- 3 parts
  - Handle
  - Left and Right arm
- Scalpel blades attached to the arms

Dimension and description

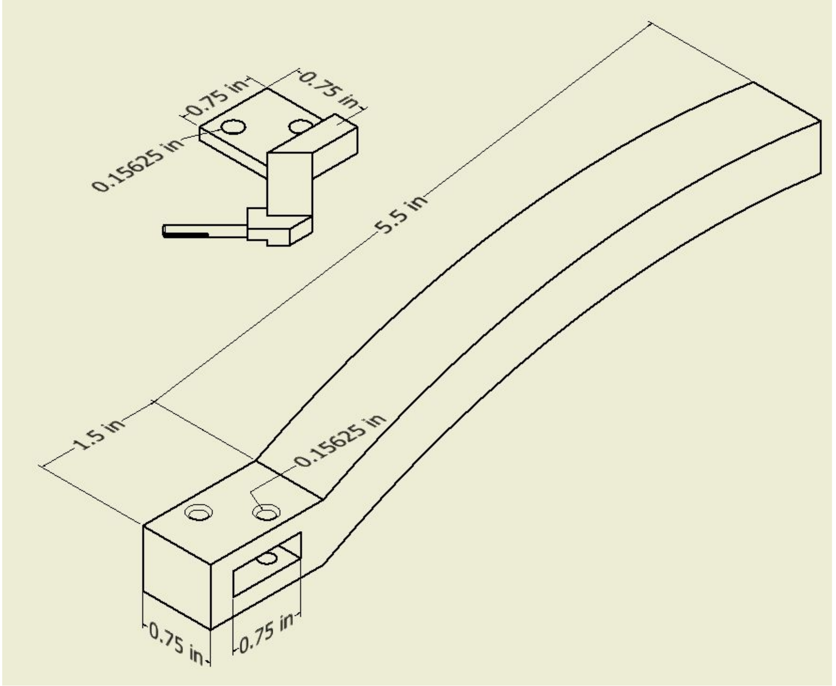


Figure 2: Cad model of the Prototype design. The design shows the left arm and handle. The left arm has a mirrored right arm, and both are inserted into the opening at the base of the handle.

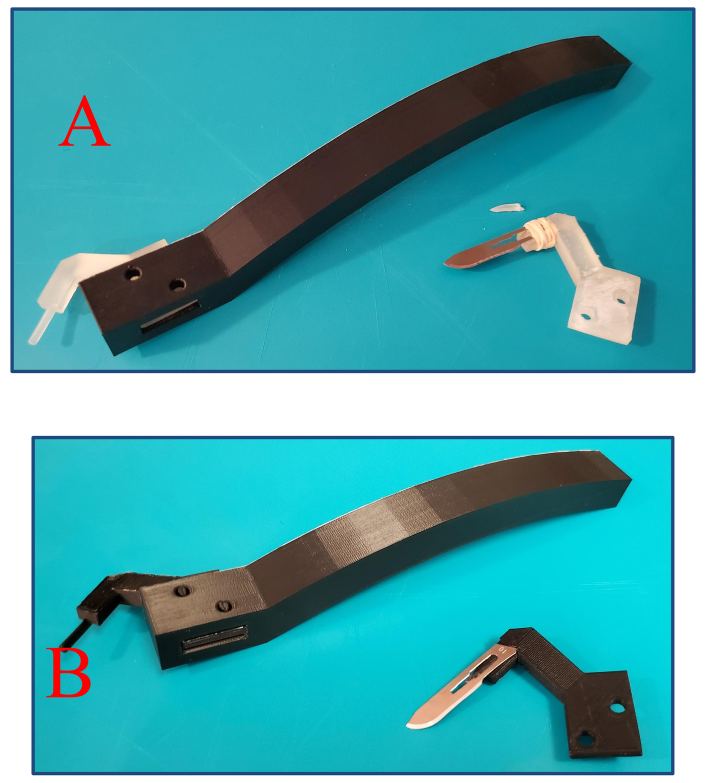


Figure 3: 3D printed prototype using High temp (A) and Tough PLA (B) arms. Both models only have the right arm in the handle due to inaccurate printing. The scalpel blade was held to the left arm, also due to a printing error

Testing

Testing was done using Chicken and Pork samples

Figure 4 (above): A cut of chicken that was removed during testing. The cut is rough and an entry incision was needed to begin the process

Figure 5 (above): Kinovea analyzed strip of cut chicken. 24 cut depth data points were collected from the Figure 4 cut of chicken using Kinovea's calibration tool

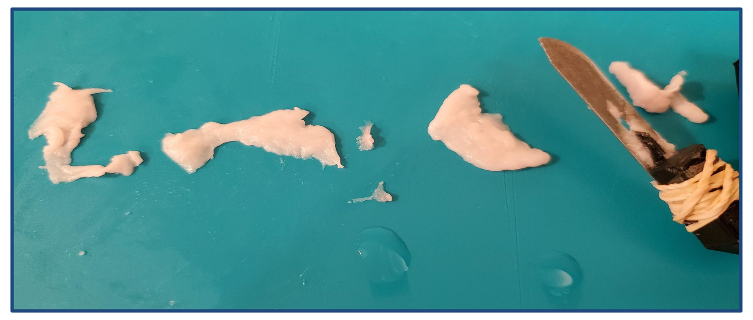


Figure 6 (above): 3D printed prototype with samples of pig tissue that were cut off. These three cuts were the only ones that were able to be successfully removed. All three lack consistency and are rough cuts due to the scalpel attachment

Results/Discussion

Results

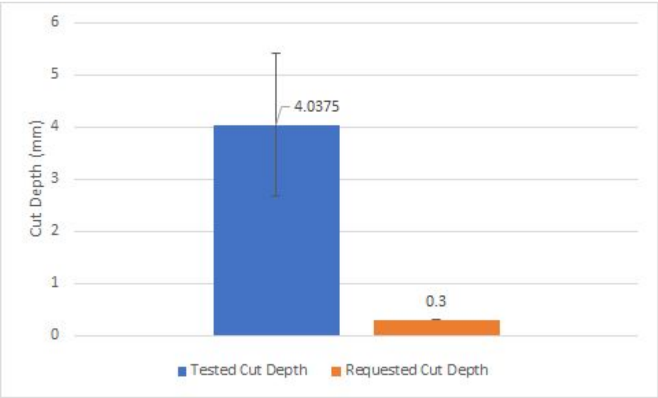
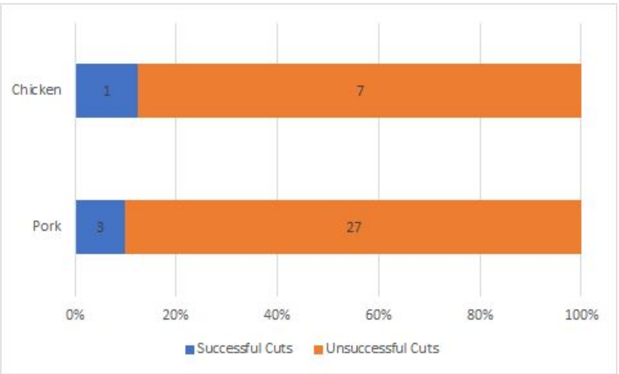


Figure 7: Graph of tested chicken cut depth vs the requested cut depth (left)
Figure 8: Graph of successful cut rate (Below)



- Both Tissues
  - Samples were short and inconsistent in length and thickness

Discussion

- The device is able to cut through and remove tissue sometimes
- The cuts are uneven because cuts needed to be redone multiple times, which can be seen in the standard deviation of **Figure 7**
- Keeping the skin taut is still problematic at the beginning, however it becomes more manageable after it comes through the device

Materials

- Intended final material is stainless steel (AISI 316L "surgical steel")
- Can withstand 400°C [8] - essential for autoclave (121°C)
- Tough and resistant to corrosion
- Same metal as most commonly used scalpels

Future Work

- Adjusting the final prototype to improve accuracy and consistency
- More adjusting of the device to obtain better skin tautness
- More testing using pig and human skin to ensure consistency in cuts

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