UNIVERSAL ABSCESS DRAIN

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Abstract

Abscesses produced by the presence of bacteria or foreign objects are defined as localized infections under the skin. Untreated abscesses result in the accumulation of pus which may potentially lead to systemic infection. The most common method of treatment is surgical incision and drainage of pus from the abscess cavity using a Penrose drain. The project goal was to design a novel surgical drain to eliminate the need for the suturing, packing and specialized nursing care associated with the current treatment method. Ideally this drain would minimize the cost, time and pain associated with current practices. Three design alternatives were proposed and evaluated using a design matrix: the A-drain, the scissor frame and the spool drain. The A-drain and scissor frame were fabricated into preliminary prototypes using two different fabrication methods: lost wax casting and 3-D printer negative molds. After a functional analysis of the two preliminary prototypes the A-drain was pursued further and several variations were designed and tested using CAD simulation software. In addition to CAD simulation data, client feedback along with basic functionality evaluations led to the selection of one specific design variation: the single-curved-bar A-drain. Future work includes proof of concept testing using cadaver models, continued mechanical testing and designing a drain sleeve to assist with insertion.

Background

What is an Abscess?

- Abscesses are pus-filled, localized infections under the skin
- Caused by bacterial build-up or the presence of a foreign object
- If left untreated, abscesses may potentially lead to systemic infections

Project Motivation

- An abscess needs to be drained in order to heal
- Current treatment methods are costly, time consuming and painful for the patient
- If dislodged, current drains require specialized medical care to be replaced

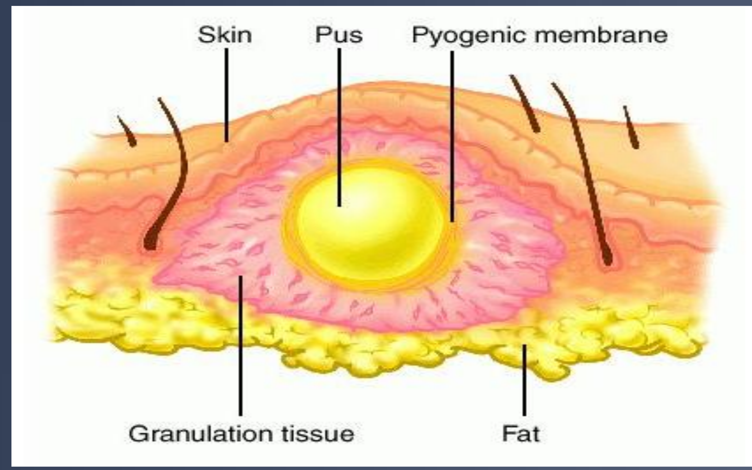


Figure 1: Subcutaneous abscess [1]

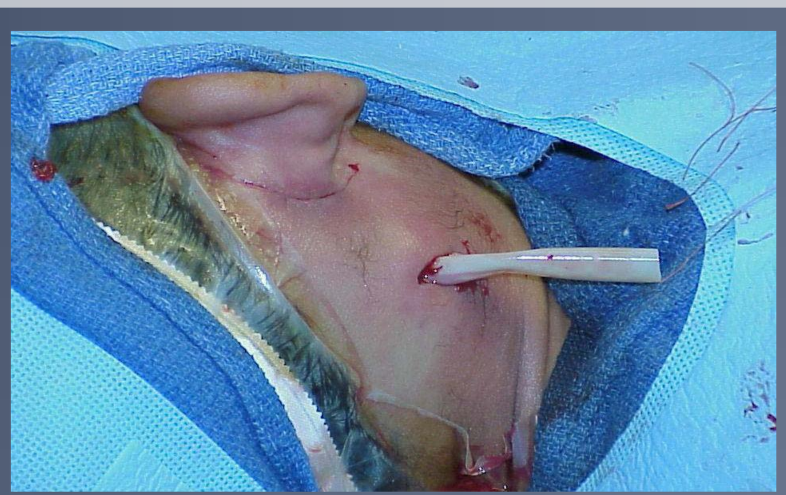


Figure 2: Penrose drain inserted in an abscess [2]

Design Requirements

1. Eliminate necessity for sutures
2. Minimize wound pressure & associate pain
3. Reduce need for specialized medical attention
4. Construct drain from medical-grade silicone rubber
5. Design *simplicity* is paramount

Cost Analysis

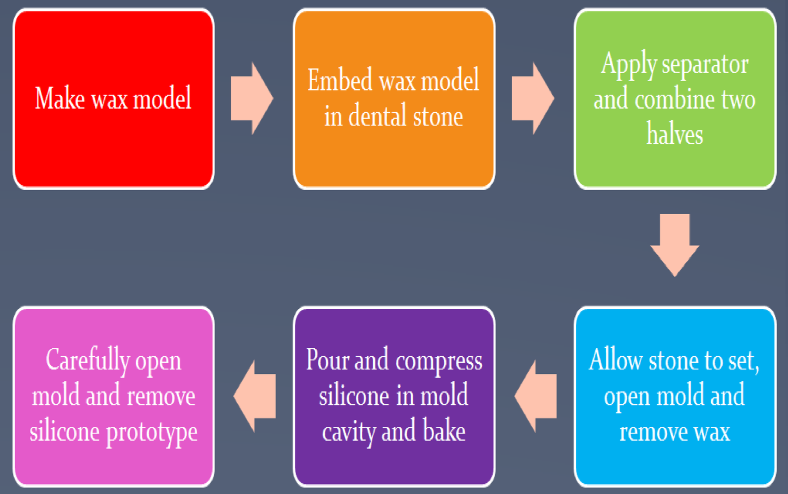
Table 1: Cost of materials used for creating prototypes

Item	Cost
Tin Foil Substitute (Separating Film)	$32.35
Vel-mix Dental Stone	$132.96
Baseplate Wax	$56.17
Silicone Welding Glue	$45.31
Mold Construction Miscellaneous Materials	$28.76
TOTAL	$295.55

Fabrication Process

Lost Wax Casting


Figure 3: Wax model embedded in dental stone



3-D Printer Negative Mold

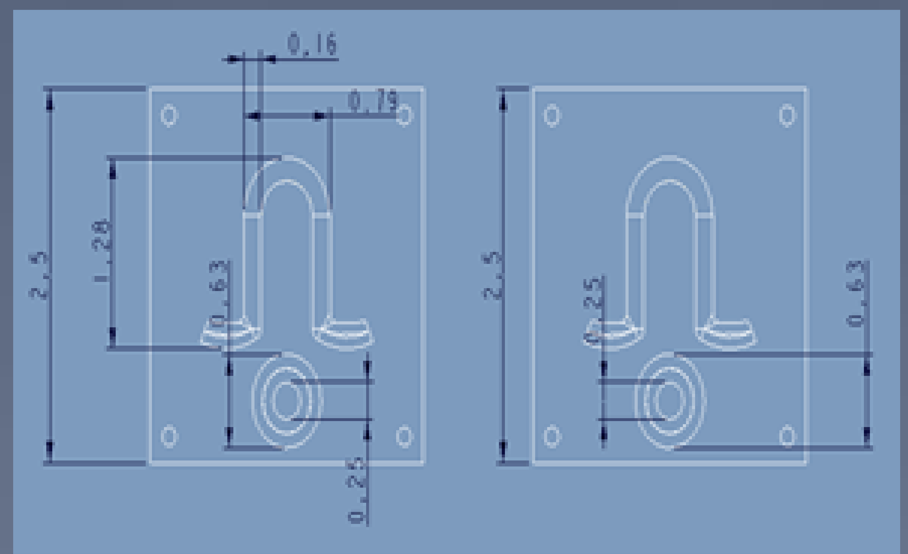
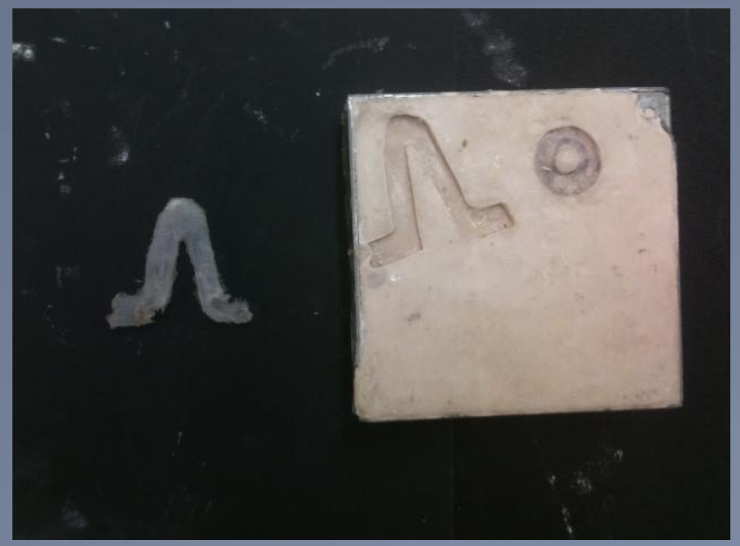


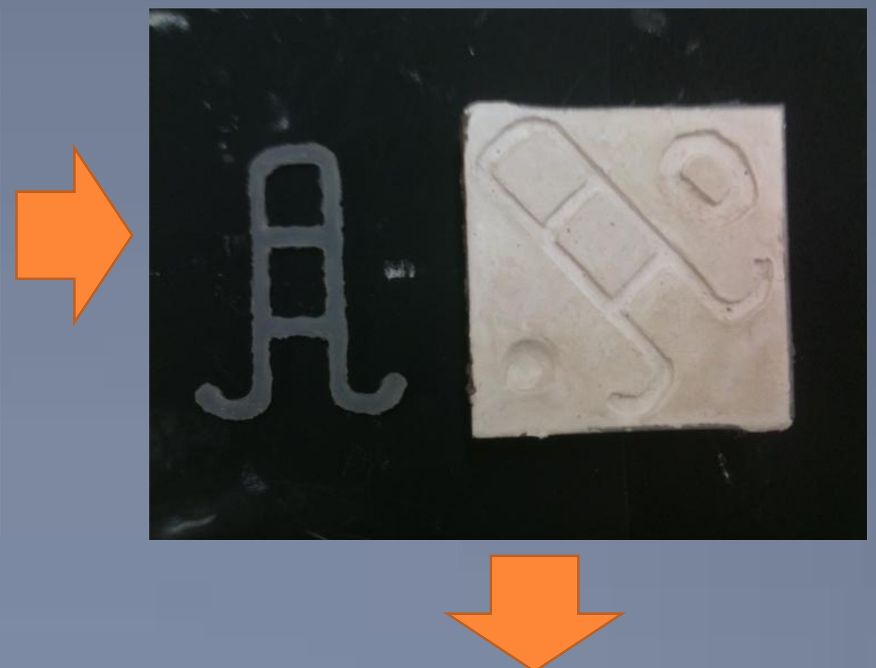
Figure 4: Pro-Engineering CAD model for 3-D printer

Design Development

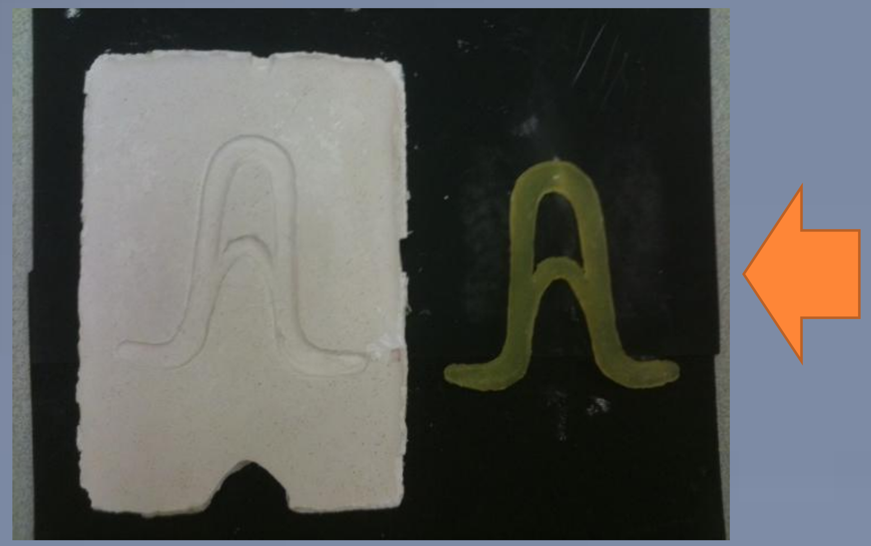
1st Generation Model



2nd Generation Model



4th Generation Model



3rd Generation Model

Final Design

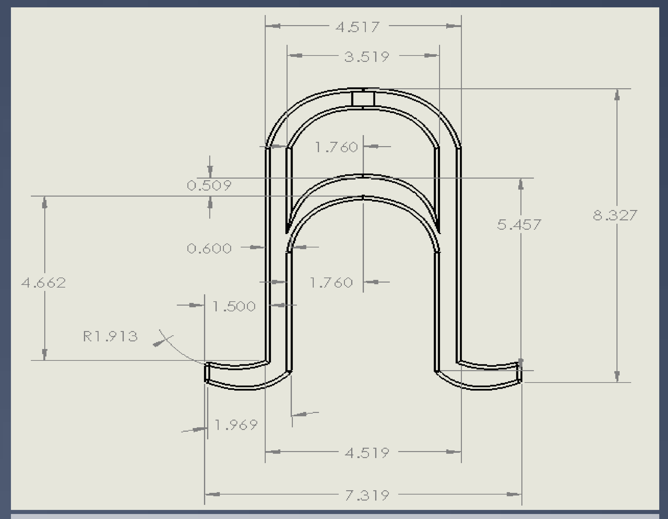


Figure 5: CAD model with dimensions

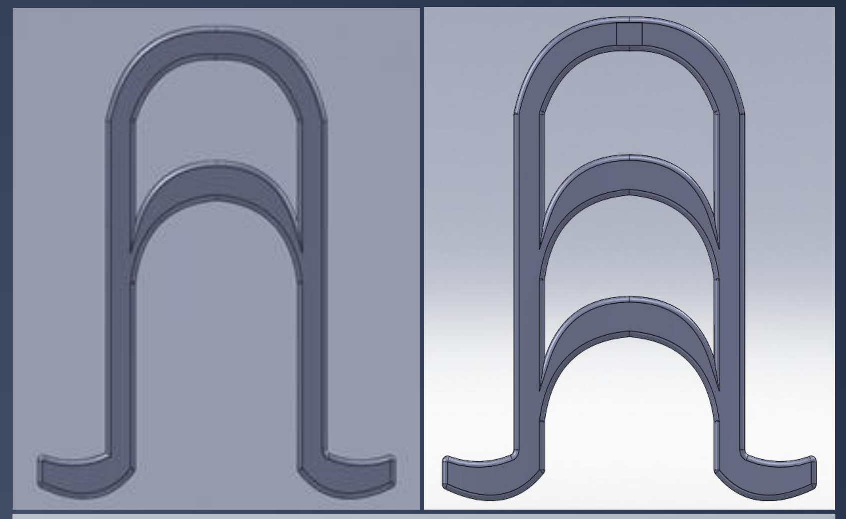


Figure 6: One-curved-bar and two-curved-bar A-drains

- Design based on progression of prototypes, client feedback and CAD simulation testing
- Optimal silicone for strength and comfort determined to be unrestricted 50A durometer
- Multiple curved-bars incorporated to increase universality

Testing

- Tested using SolidWorks SimulationExpress software package
- 5 N force applied on different parts of prototype body
- Three durometers (30A, 50A, 70A) and four varations (curved/straight, one/two bars)
- Compared design variations, silicone durometer and full compression test data

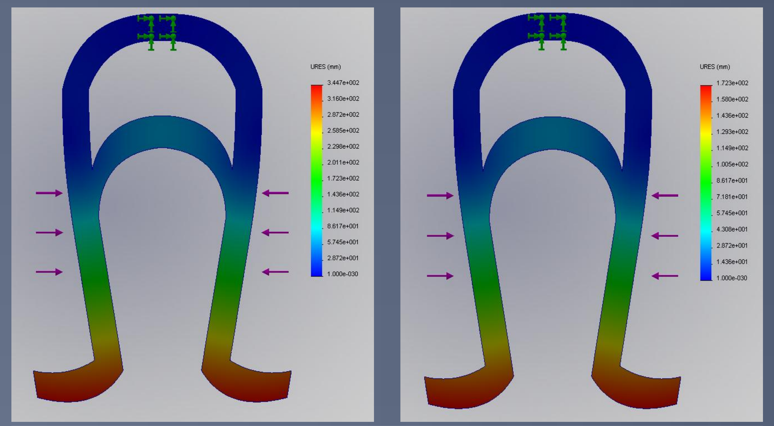


Figure 7: 30A & 70A durometer models

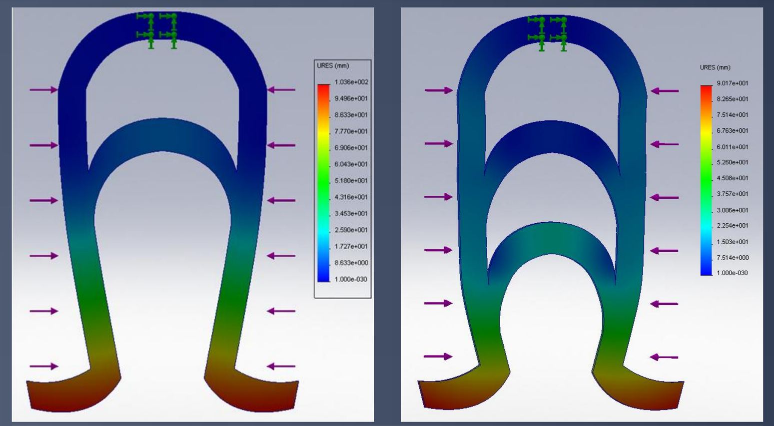
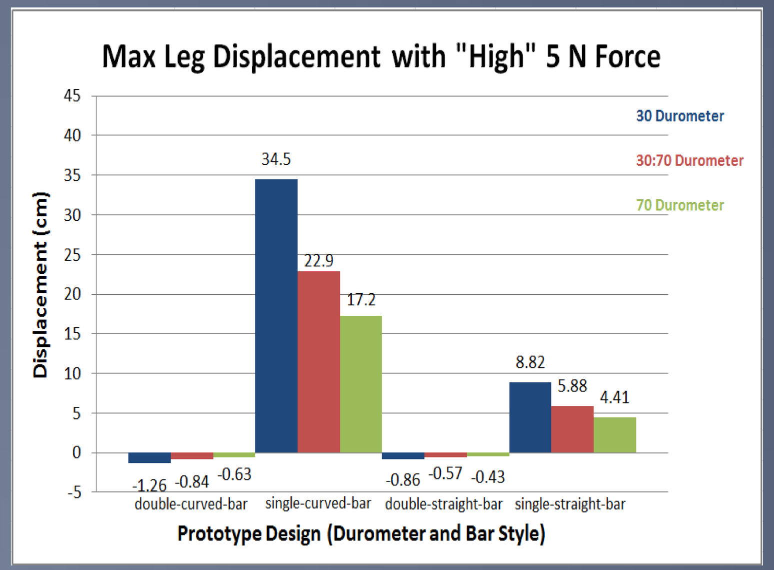
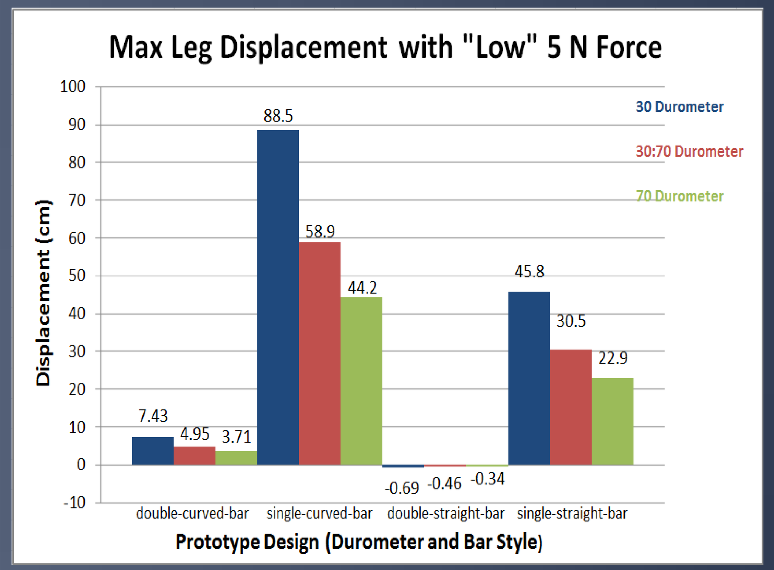


Figure 8: Full compression test, 30A/70A 1:1 mixture





Future Work

- Further testing to optimize mechanical properties
- Cadaver testing to prove prototype efficacy *in vivo*
- Adjustment and re-design as dictated by subsequent testing
- Additional features such as saline port and insertion sleeve
- Discuss patentability with WARF

Acknowledgements/References

- Advisor Willis Tompkins, Ph.D.
- Client Ramzi Shehadi, M.D.
- Consultant Greg Gion, MMS, CCA
- Professors Tim Osswald, Sarah Gong, and John Puccinelli

- [1] http://medical-dictionary.thefreedictionary.com/_/viewer.aspx?path=dorland&name=abscess.jpg
- [2] http://emedicine.medscape.com/article/994656-media