MECH 4V96.004, Shop Design

Mechanical Engineering

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THE UNIVERSITY OF TEXAS AT DALLAS

Collapsed Lung Anchor Preliminary Testing Apparatus

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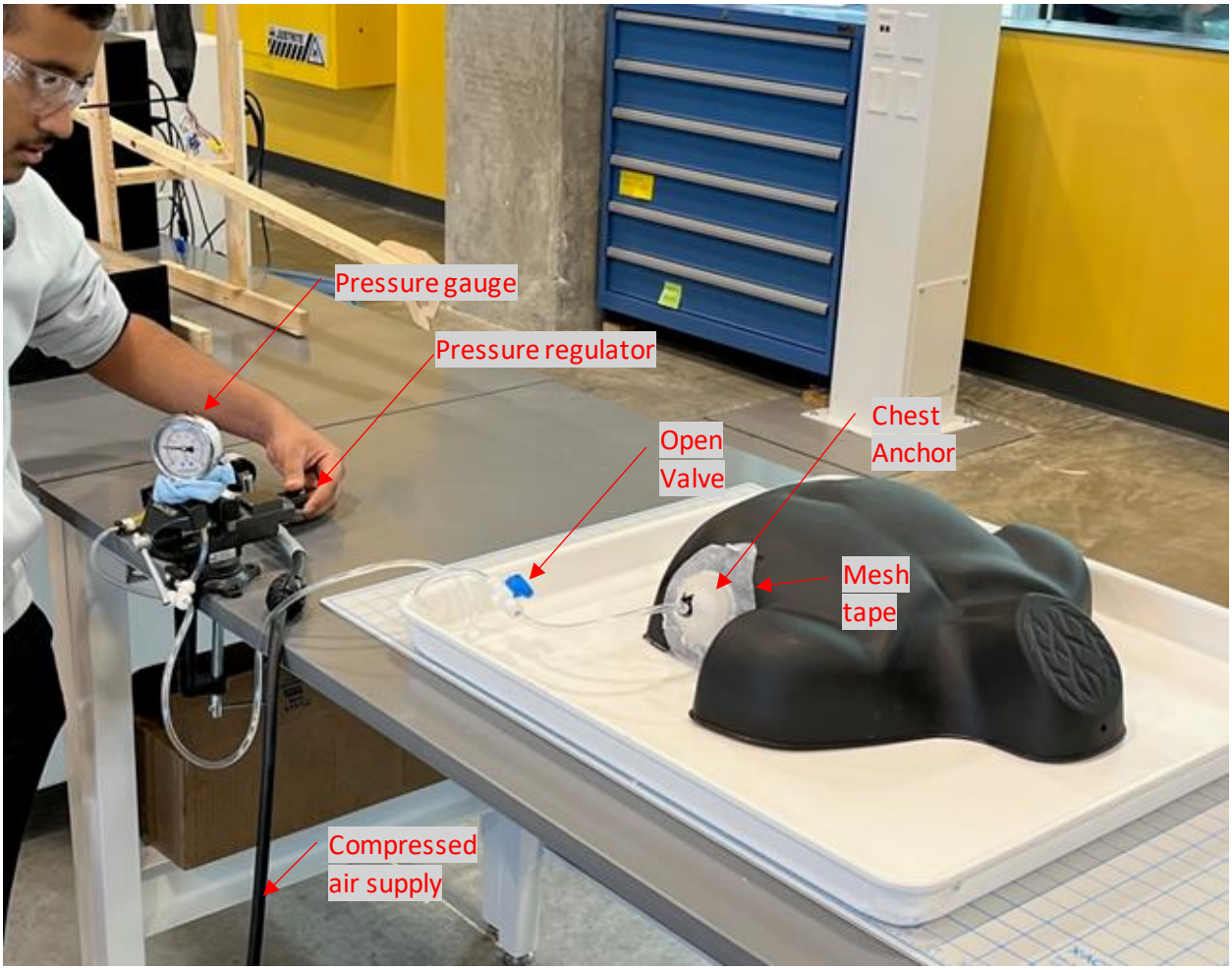
Executive Summary

A testing apparatus is used to check the maximum pressure that the chest tube anchor can withstand. The results indicate that the strength of the chest tube anchor exceeds that of the tape to the plastic mannequin.



Section 1, Problem Identification

A testing device needs to be built to ensure the collapsed lung chest tube anchor will seal with the victim's skin and not allow any release of pressure or liquid.

Section 2, Criteria and Goals

The goal of this project is to measure the maximum air pressure required to break the seal of an adhesive device that is adhered to (simulated) skin. The criterion is to use soap-water and check for leaks around the chest anchor.

Section 3, Research

A mannequin was purchased online at a low cost. The material is hard plastic. The plastic does not represent the qualities of the human skin. Therefore, the test is preliminary and additional testing should be performed on simulated skin in the future.

Section 4, Brainstorm

The test setup includes a compressed air line with a regulator. Compressed air is applied to the tube and soap-water is used to check for leaks. Since an existing test setup is available in the lab and the adhesives are provided, the setup is used with minimal brainstorming.

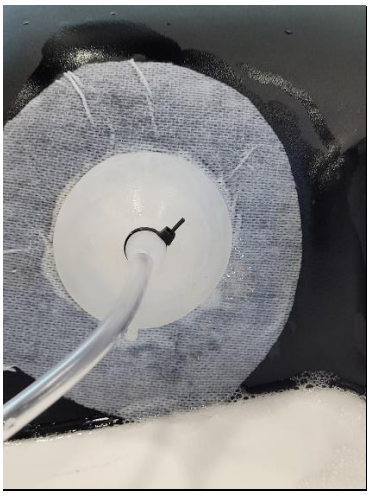
Section 5, Analyze Solutions & Develop Requirements

The test requirements are defined as follows. The

#	Requirement	Pass/Fail	Proposed Modification / Additional Notes
1	No pressure leakage through the mesh adhesive	Fail	A different mesh adhesive to the skin is recommended.
2	No pressure leakage through the tube insertion point	Pass	A zip-tie will be tied around the entrance point of the life anchor and tube for security

Section 6, Develop & Test Models

The testing apparatus contains a pressure gauge by which to measure all outgoing pressure through the pipe.

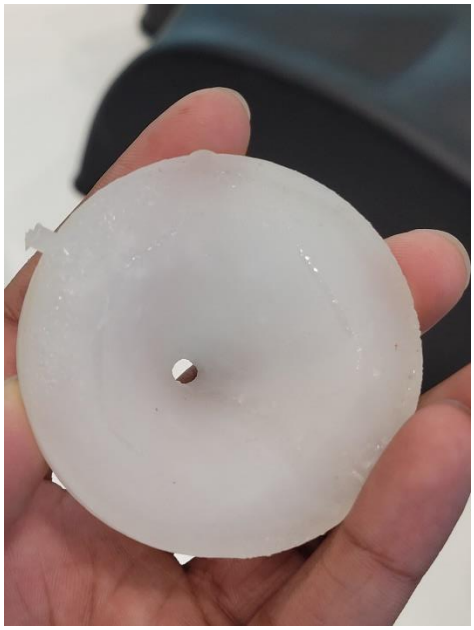


Model Preparation + Steps

To prepare the life anchor part for testing, the following procedures were used for the glue and epoxy setup.

1. The life anchor part was positioned in the center of a circular piece of the gauze adhesive, approximately 8-10” in diameter. A hole was cut in the center of the adhesive, the area where the life anchor part blocks from view.
2. Glue or epoxy was applied to the base of the life anchor, which was then positioned and pressed against the gauze-adhesive, and then left to rest.
   The glue required about 20 minutes to set, whereas the epoxy required 2-3 hours to set.
3. The pipe for the pressure-testing apparatus was inserted into the top hole of the life anchor part and tied with a zip-tide. This for extra security, though the life anchor part gripped the tube rather firmly.

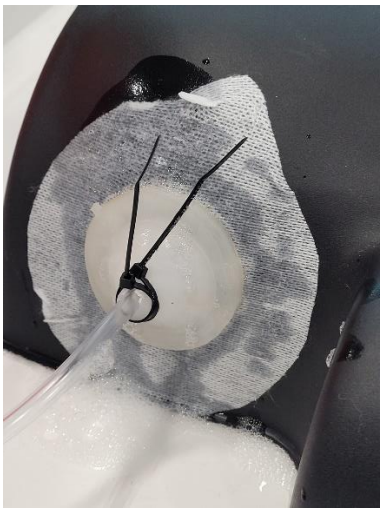
4. The film over the back of the gauze adhesive was peeled off and the part fixed to the mannequin, the testing surface for the adhesive.
5. A mixture of soap and water was applied lightly to the adhesive and the life anchor part. Any bubbles seen would signal the leakage of pressure from any location.
6. The testing apparatus is reset to being testing.
7. The control valve for the testing apparatus was opened, and the pressure steadily increased until pressure leakage was observed. This can be noted in the formation of bubbles on the surface of the adhesive or the peeling of the adhesive itself, off the mannequin.
8. Pressure testing was continued until the adhesive on the base of the life anchor part completely peeled off, or bubbles at the tip of the life anchor mold were observed.
9. The control valve was turned off and the pressure apparatus reset appropriately.



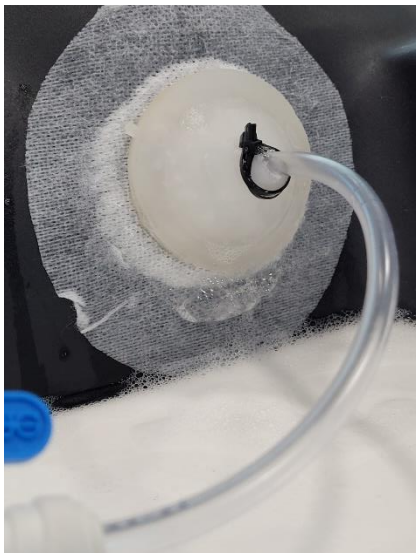
Stage 1 Testing

The first stage of testing, conducted with Andrew Kocsis on November 17, 2022, was done with glue and epoxy as a source of adhesion for the life anchor onto the gauze-like adhesive.

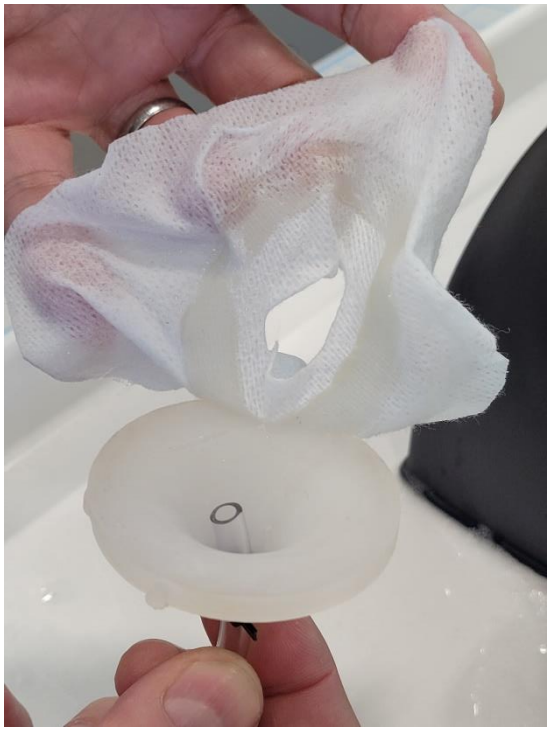
Epoxy



Leakage from an edge of the adhesive was observed at about $2.0\ psi$, though testing continued at much higher pressures. At approximately $5-8\ psi$, dramatic leakage around the rest of the adhesive, as well as leakage through the tip of the life anchor part was observed.



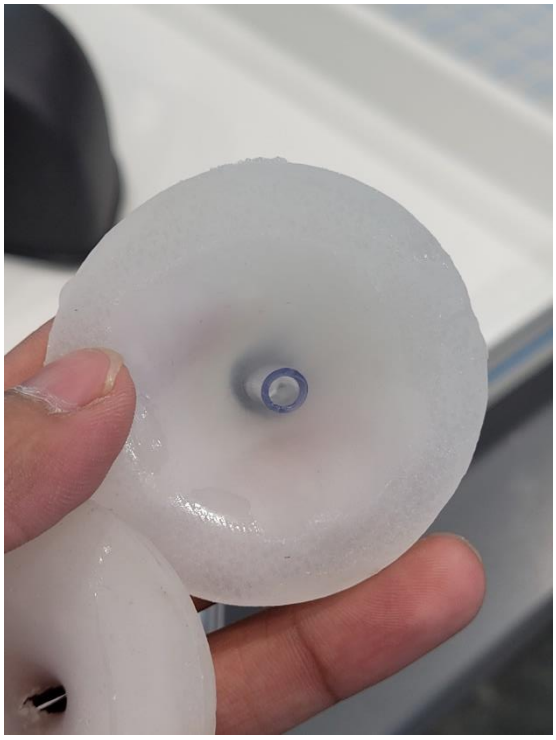
Observe the complete separation of the life anchor part and adhesive from the testing surface (mannequin) at about $8-10\ psi$.



Upon removal of the gauze adhesive, a layer of the life anchor part having been removed itself can be observed. This is likely due to the chemical bonding that takes place during the initial adhesion process (between the life anchor part and the gauze adhesive) which suggests that the parts are not reusable.

Glue

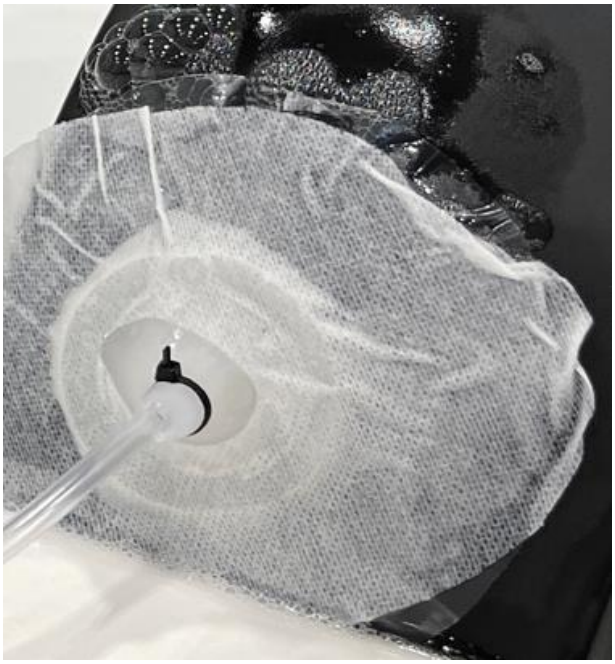
Due to the early pressure leakage, an effective pressure gauge reading was unable to be observed, though it can be estimated to be around $1.5 - 2\ psi$.



The leakage of air pressure was audible during this part of the experiment, after the pressure had been slightly increased, at what point in time the complete removal of the base adhesive towards the edge could be observed.

Stage 2 Testing

The first model developed is to test whatever our test setup is valid for conducting the necessary experiments. The first requirement that was checked is the ability of the setup to hold a seal without leaking air at the required pressure values. The first step taken is a setup where the cup part is attached to two different candidates for the adhesive to be used.



The initial test setup to the left failed to hold a seal at 1 PSI while the test setup to the right using double sided tape failed to hold a seal at 1.5 PSI, though part of the gauze has been placed on top of the rubber life anchor seal part. This may constitute an improper setup for the application to a patient. Additionally, the setup on the right is difficult to apply in a timely manner.

7, Make a Decision (CDR Presentation)

This project does not require a CDR presentation. It is a quick experiment to test for leakage using provided adhesives and a pressure setup developed by ECSW Project Workshop member Tan Hoang.

8, Communicate & Specify

All costs for this project were handled by Dr. Phillip Jarrett. Dr. Jarrett provided the adhesive material, a gauze-like material on which the life anchor part is to be attached to. He also provided glue, epoxy, and an alternate adhesive by which to attach the life anchor part and base adhesive to the testing apparatus.

A mannequin was purchased by Dr. Dani Fadda for the ECSW Project Workshop. This mannequin was used as an application surface for the adhesive during this testing process.

The life anchor molds used in this project are readily available from a previous project sponsored by Dr. Phillip Jarrett. Both TPE pellets and an aluminum mold are available should more production be required.

9, Implement

The life anchor parts produced in the previous project were more than satisfactory in containing the tube and preventing pressure leakage though the adhesive chosen for the experiment proved to be ineffective.

The adhesive itself appeared rather porous, allowing much force from the air to freely travel through the mesh, and thereby produce the results observed. Not to mention, the testing procedure involved wetting the surface of the applied adhesive, a testing decision that may have acted against the intended usage of the mesh. A different testing procedure may indeed have produced better results, organized by one who is more aware of the processes normally done within a medical setting or cadaver study.

10, Review and Assess

All adhesives on which the life anchor parts have been applied have proven to be insufficient to prevent leakage of pressure under more than 1 psi. While this may be sufficient for general medical applications, a more secure adhesive or assembly should be considered.

Repeating this experiment by use of a different experimental procedure, distinct metrics, or an alternate surface on which to fixture the adhesive may produce different results.

Obstacles:

- For the stage 1 experiment, in which the glue and epoxy adhesion was tested, the pressure was constantly increased as to test for leakage through the life anchor part itself. However, due to the initial leakage at the adhesive application, the pressure gauge could not effectively measure the pressure exerted throughout this testing process.
    - A different method of sealing the lower adhesive or measuring pressure during the experiment should be better designed to test the limitations of the life anchor part.
- The produced life anchor parts were less elastic than desired, hence why a pipe diameter of only 0.5" could be utilized for testing. As the life anchor is intended to work with tubes of differing sizes, it would be beneficial to test pressure conditions with other appropriate pressure inlets.
    - A modified mold or a more elastic material can be used to conduct a similar experiment on the life anchor part.
- For the second stage of the experiment, which used the alternate adhesive as a base with the gauze adhesive, the method of application was done differently. At one point, the gauze adhesive was applied over the top of the life anchor part and the other adhesive under the life anchor part.
    - Such a setup leaves open air near the sharp corners of the life anchor, a structural weakness where the adhesive is not properly secured to either the life anchor part or the testing surface.
    - This inconsistency in testing procedure was done was the new adhesive was applied under the gauze adhesive, yet the gauze adhesive has no sticky portion on its top surface. While adapted as possible for this procedure, this may be the cause for any observed inconsistencies between the testing procedures between stages 1 and 2.