Automated Ring Removal Centre (ARRC)

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Problem Definition

Removing hand jewelry is commonplace in every hospital emergency room around the world. Rings must be removed from patients in cases where there is swelling of the hand or arm. In cases where rings cannot be removed easily, the process of removal can become costly, time-consuming, and risk the health of the patient.

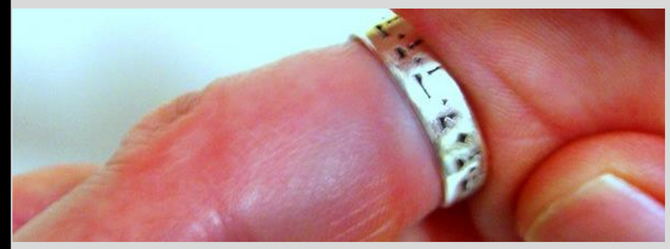


Figure 1 – Example of Swollen Finger and Stuck Ring (https://goo.gl/Dc0gnf)

Current Methods

In the event that a ring is not easily removable from a patient's finger there are only two widely accepted methods for removal of the ring: The Ring Cutter Method or the String Method. The most effective methods for removing a stuck ring employ compression of the finger to decrease the swelling long enough to remove the ring. Time is a critical factor in the emergency room, therefore the ring will eventually be removed via a small circular saw if efforts fail to remove the ring intact. Figure 2 shows a medical training textbook demonstrating the ring-cutter method (left) and the string method (right).

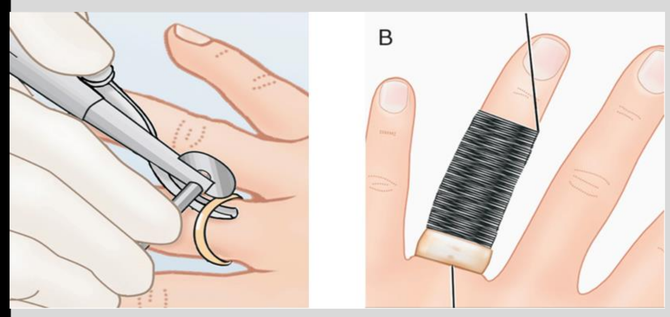


Figure 2 – Current Ring Removal Methods (Reichman, E. F. (2013). Emergency Medicine Procedures)

The ARRC Solution

Single Push Operation

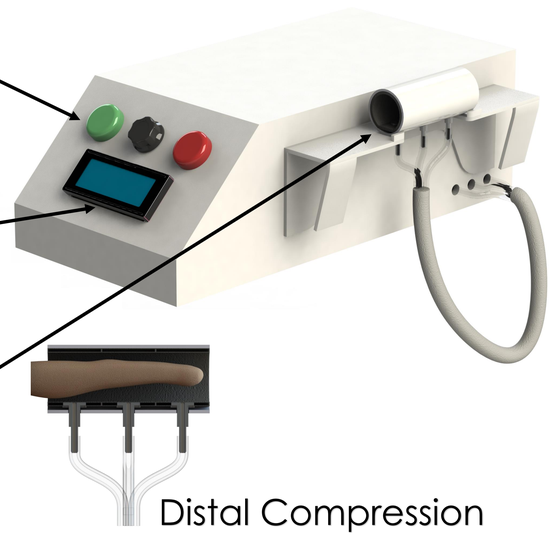
Large one-touch buttons for simple operation and control

Precision Display

20 x 4 Liquid crystal display displays live data during operation

Maneuverable Design

Flexible tubing provides extra reach for bedside use

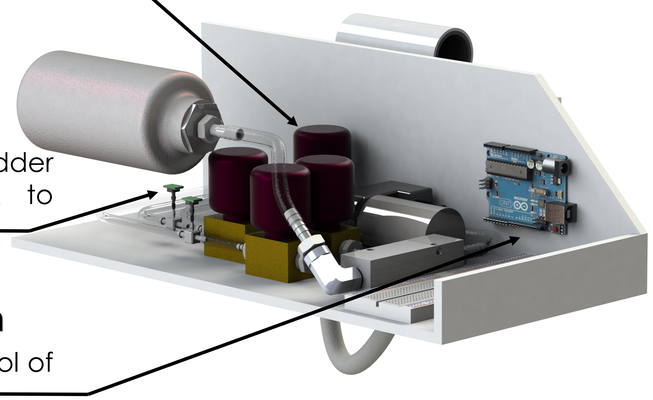


Distal Compression

Sequential bladder inflation allows for tip to base finger compression, effectively removing fluid.

Patient Safety in Mind

Solenoid valves relieve pressure rapidly and effectively as required



Full Automation

Pressure transducers monitor bladder pressures and send feedback to controller

Simple Control System

Arduino Uno allows for easy control of pump and solenoids

Design Summary

The ARRC performs the job safer, easier, and faster than current non-destructive methods. It does this by distributing the applied pressure over a greater surface area eliminating the risk of cuts, allowing a first-time user to successfully operate the ARRC by removing the manual manipulation of string and finger, and accomplishing all of this with a set time 2 minutes.

Testing and Validation

To assess the functionality of the finger compressing device, a testing model was developed to simulate the difficulties encountered by doctors in the ER without involving human testing.

The analogue was made using a 3-part urethane casting technique developed specifically for this application. As shown in Figure 3, a hard urethane was used for the bone, a soft open-cell foam for the intermediary flesh, and a thin urethane rubber was used for the outer skin. Water was used to simulate blood and edema flow through the open cell foam

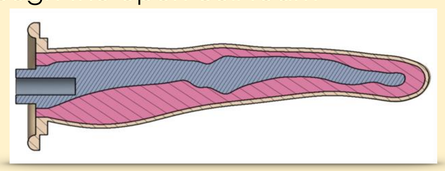


Figure 3 – Layered 3-Part Urethane Casting of Finger

Results

Several medical professionals with training in conventional ring removal techniques attempted to remove entrapped rings from the model using both conventional techniques and the ARRC. Figure 4 summarizes the results

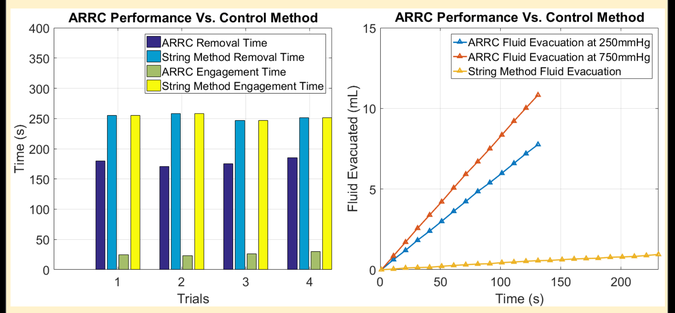


Figure 4 – Results of Preliminary Testing

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