DYNAMIC SPLINT FOR PEDIATRIC DISTAL RADIUS FRACTURES

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Abstract

Casts are most commonly used to treat pediatric distal radius fractures, but improper application may result in loss of reduction and pressure sores. Furthermore, cast-saw burns may harm the child during removal of the cast. Splints are an alternative to casts. The goal of this design project was to design a splint with a lining that allows dynamic and controllable pressure loading. This semester, an adult-sized prototype was created and tested to demonstrate that this design provides the correct pressures to provide three-point bending. In the future, testing within a clinical setting and pediatric patients will be performed.

Introduction

Background

- 3.5 million children sustain a pediatric distal radius fracture yearly[1]
- Casts are commonly used to reduce, or realign, the fracture
- Casting requires a large learning curve for doctors
- Improper techniques may result in pressure sores or improper healing[2]

Recent studies have shown that splints are just as effective as casts in treating non-displaced distal radius fractures that crack but maintain alignment[3]. However, the current splints do not provide 3-point bending, like casts, which help to maintain reduction is displaced fractures as shown in Figure 1.

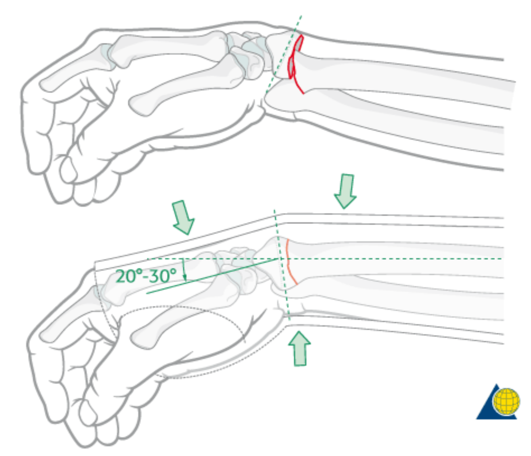

Figure 1: Illustration of the fracture (top) & reduced fracture with application of the 3 loads[4].

Motivation

Compared to casts, a splint is a cheaper alternative that is easier to apply in the hospital and more versatile for children in daily activities[5]. Table 1 compares and contrasts splints and casts.

Casts vs	Splints
No difference in healing and pain	
Relies on technique of doctor	Reduces the need for follow up visits
Risk of loss of reduction if poor fit	Less inhibiting on lifestyle
~$300-400	~$30
Cast saw can frighten and burn children	Current Splints don't offer 3 point stabilization

Table 1: A Comparison of Casts and Splints[2,6]

Design Criteria

- Easy application and removal for doctors and patients
- Dynamic and controllable pressure lining for pressure adjustment
- Comfortable fit for a pediatric wrist
- Non-irritating, hypoallergenic materials to eliminate allergic reactions and pressure sores
- Radiolucent materials so the device can be used in x-rays

Final Design

The final design consists of an adult-sized splint with 3 inflatable airbladders and 3 stabilizing bladders. The inflatable airbladders (green) provide the three-point bending. The user pumps the bladders to the pressure to stabilize the fracture.

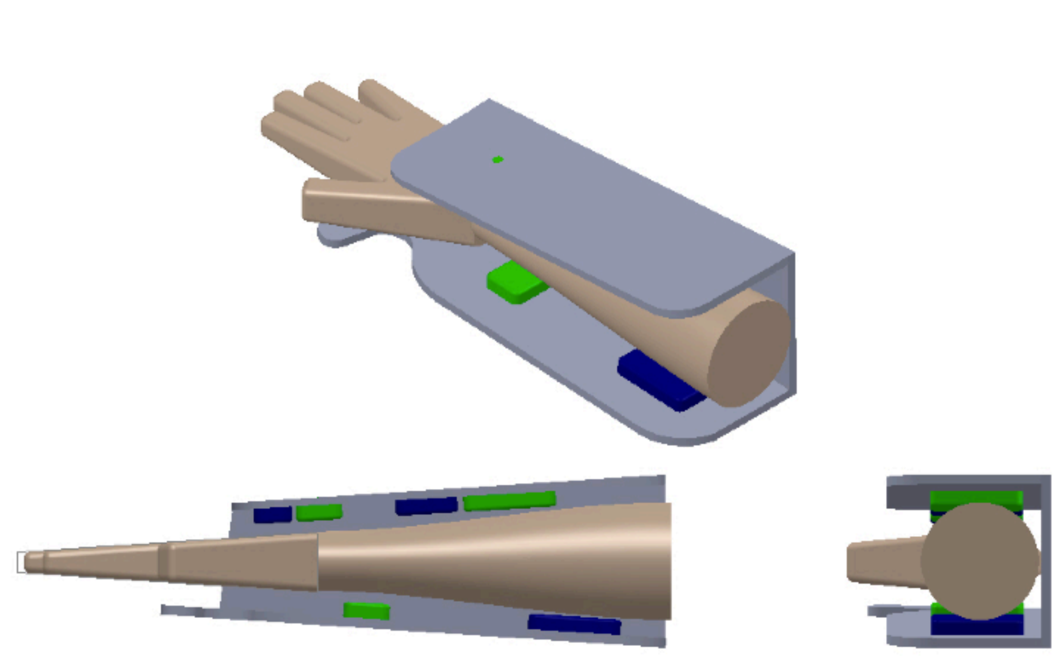

Figure 2: The prototype in use. Green bladders represent inflatable airbladders. Blue bladders stabilize the arm and do not inflate.

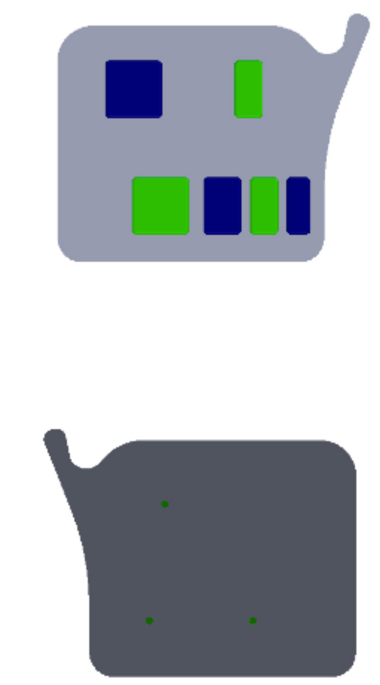

Figure 3: Inside lining of the splint (top). A schematic of the airbladder layout.

Results

A short-term and longitudinal study analyzed the accuracy of the prototype to the pressures obtained during casting. Piezoelectric sensors (Tekscan A401-25 Flexiforce®) were placed on the forearm as shown in Figure 4. A multimeter displayed the resistance. The pressure was determined with calibration of the sensors and conversion calculations.

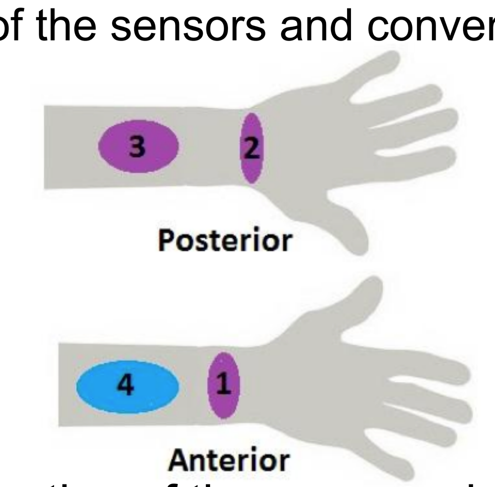

Figure 4: Location of the sensors during testing. Purple represents the three-point bending.

The short-term study analyzed the pressure at 5 minute intervals for 15 minute after initial application. The longitudinal study analyzed the pressure of the splint over 3 hours at 1 hour intervals. The testing proved the prototype obtains the same pressure of casting.

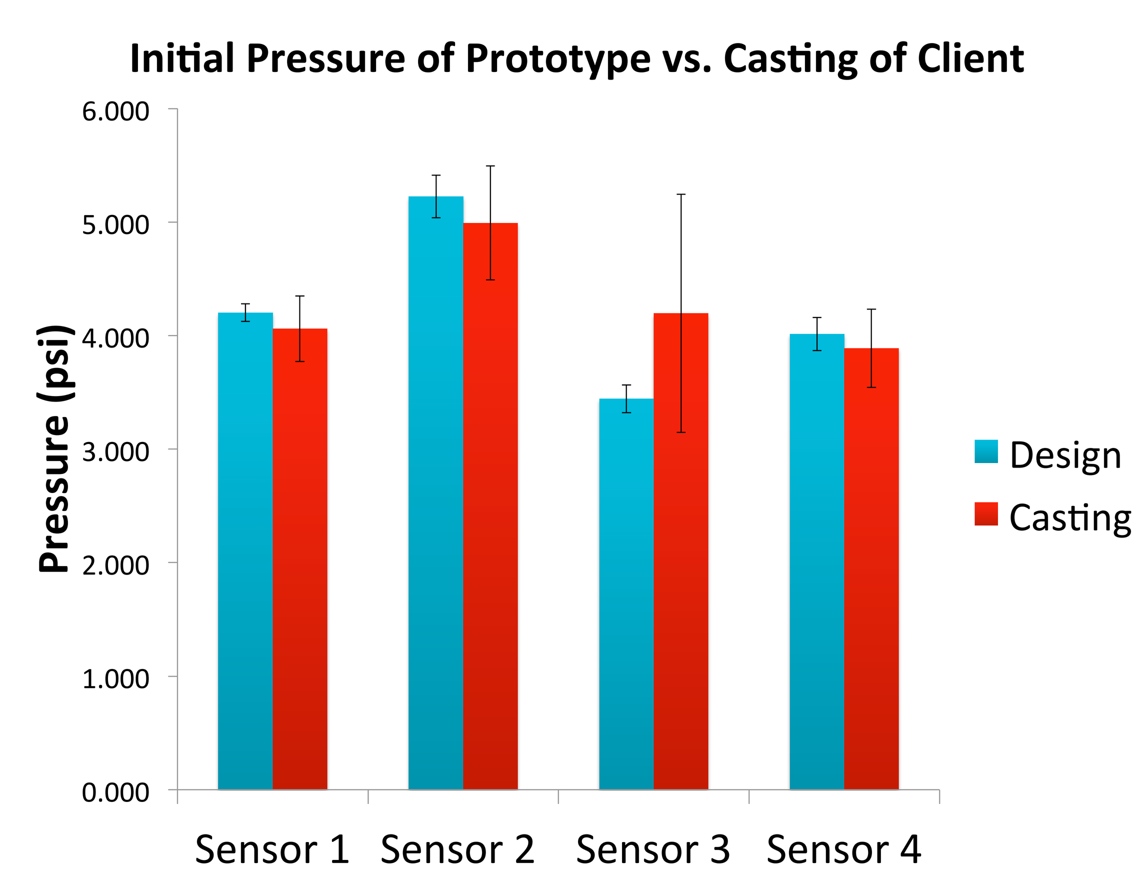

Table 2: Pressure values obtained during the initial application of the splint or cast. No statistical difference between methods (p=0.848, 0.823, 0.950, 0.736, for sensor 1-4, respectively.)

Testing

The prototype was tested to determine its ability to maintain pressures for three hours. Table 4 displays the initial application of the prototype compared to the pressures. A t-test determined there is no statistical difference in the pressure of each sensor 1-4 three hours later.

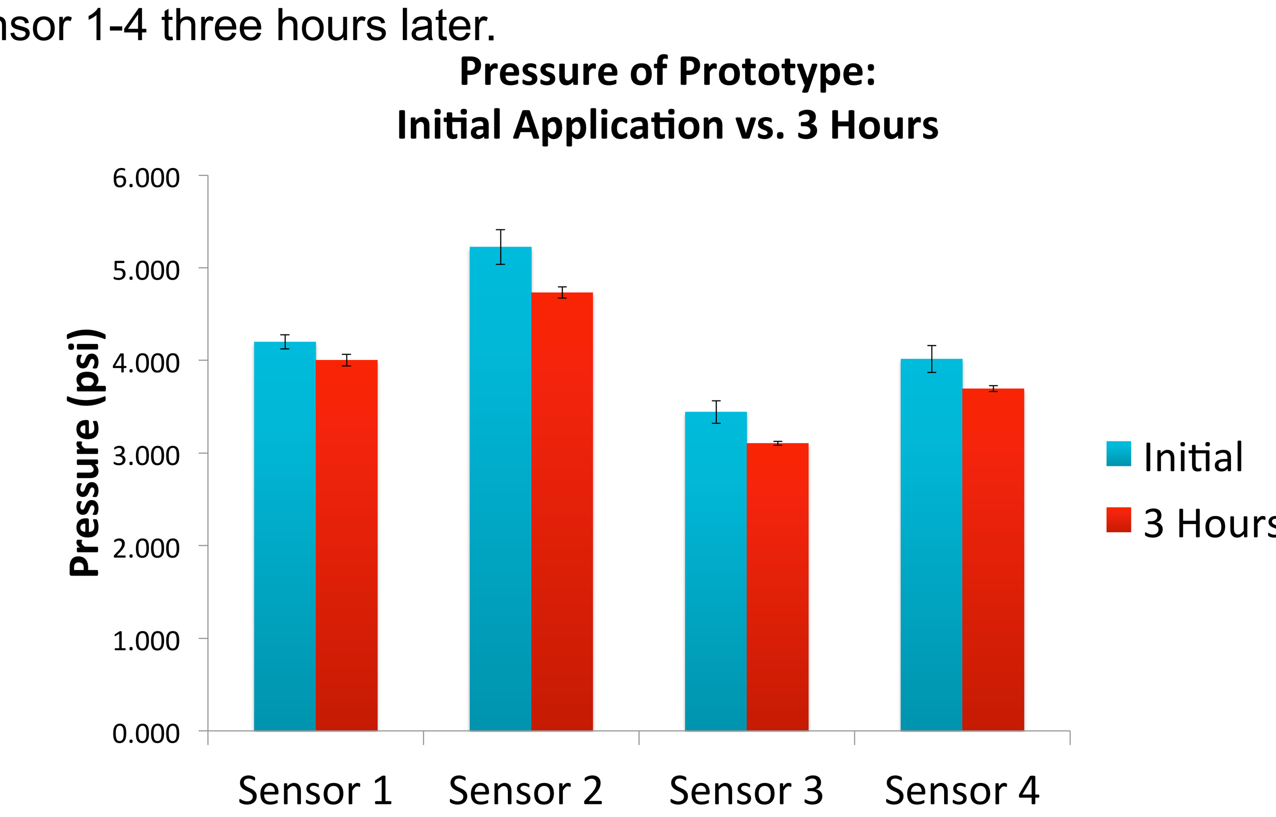

Table 3: Pressure Testing of Prototype. Mean and standard deviation of each sensor at the initial application and three hours later. (P-value of sensor 1,2,3 and 4: 0.999, 0.999, 0.999 and 0.998, respectively.)

Production Cost

The cost of the prototype, shown in Table 4, is $73.00. However, when mass produced, the Super Splint will cost approximately $80.00, based on estimated values for the mass production of the inflatable pads.

Splint	$20
Padding	$3.00
Vinyl	$7.00
Nozzle (3)	$30.00
Heat Sealer	$13.00
Total	**$73.00**

Table 4: Cost of prototype.

Future Work

- Test on the Fracture Model
- Create a pump with pressure gauge
- Finalize prototype and scale to pediatric size
- Long-term testing (1-2 weeks) for ease of use and duration of use
- IRB certified human trials
- WARF patent process

Acknowledgments

- Dr. Matthew Halanski, Client
- Sarah Sund
- Professor Paul Thompson, Advisor

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