"Super Splint" – Dynamic splint for pediatric distal radius fractures

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UW BME Design

Client Description

- Dr. Matthew Halanski
  - Orthopedic Surgeon at UW Hospital

Overview

- Background: Wrist Fractures
- Motivation: Casts vs. Splints
- Problem Statement
- Design Requirements
- Design
- Testing
- Goals for Semester
- Future Work
- Design Improvements
- Future Testing
- Budget

Wrist Fractures

- 3.5 million children a year
- Most common treatment: Casts
  - Bones are reduced to correct deformity
  - 4-12 weeks depending on fracture
  - Complications arise if cast is not applied correctly

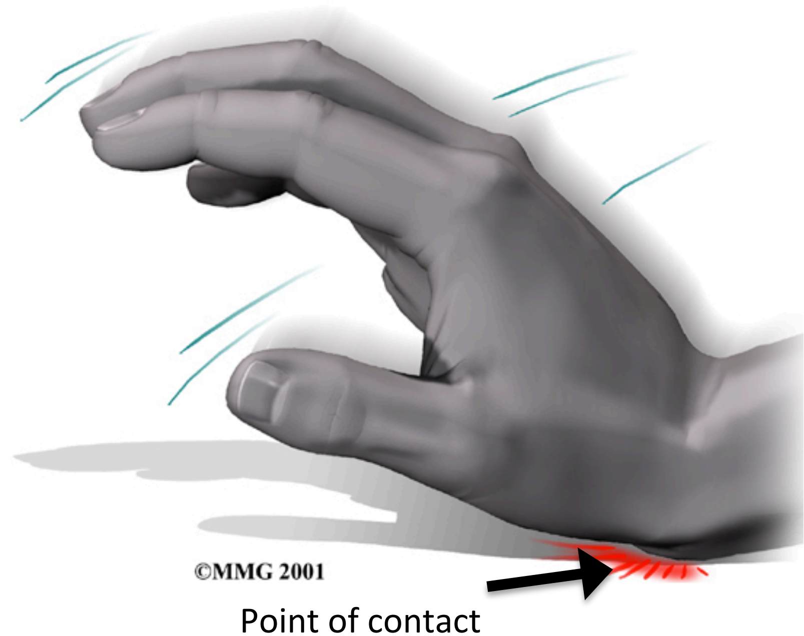


Figure 1: Wrist fracture as a result of a fall.

Motivation: Casts vs. Splints

Casts	Splints
No difference in healing and pain	
Relies on technique of doctor	Reduces the need for follow up visits
Risk of reduction loss 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

Problem Statement

- If a splint existed with an adjustable pressurized lining that can be applied accurately and easily by the doctor, then patients could receive the needed pressure for proper healing without the inconvenience of a cast.

Figure 2: Casts need to have covers while bathing and swimming.

Figure 3: Casts need to be removed with cast saws.

Design Requirements

- Maintain reduction
- Easy to implement
- Dynamic and controllable pressure lining
  - Three point loading
- Radiolucent materials
- Non-irritating lining

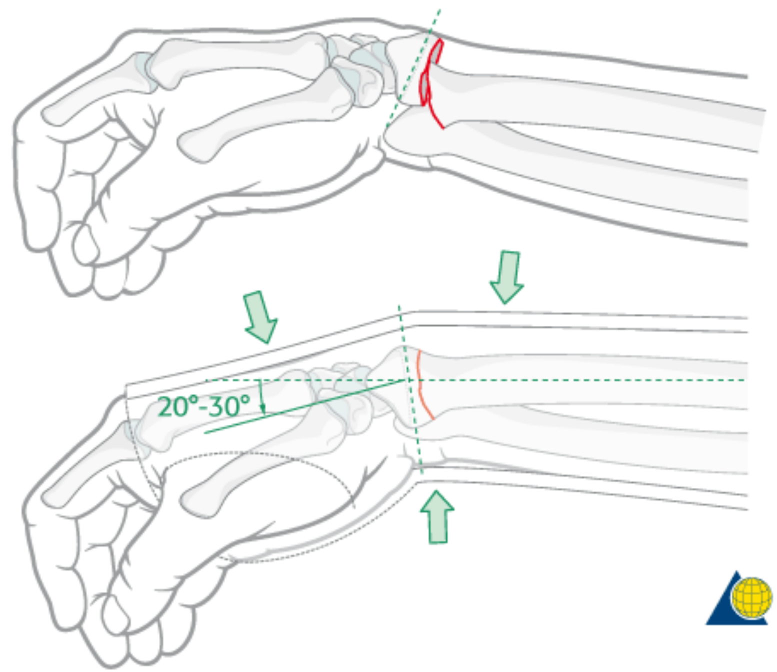
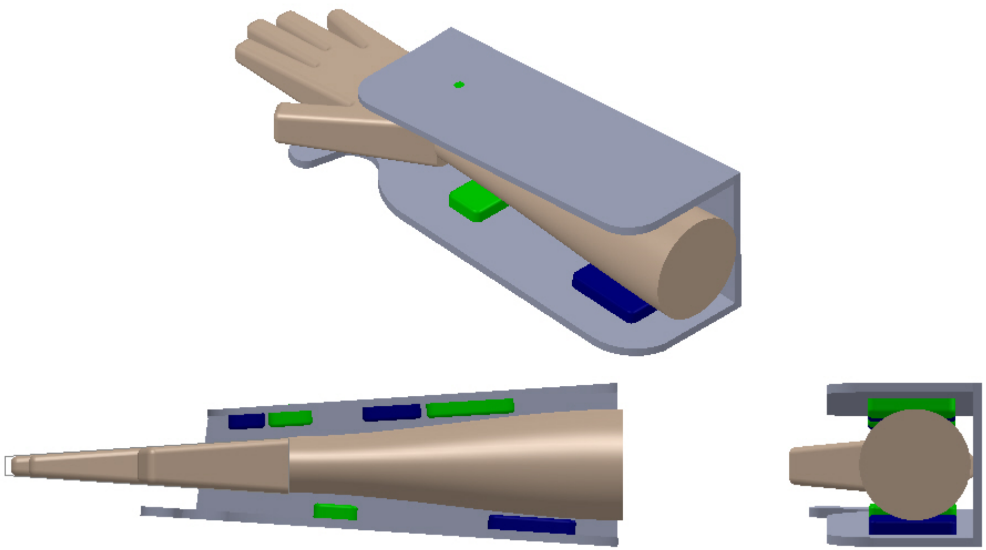
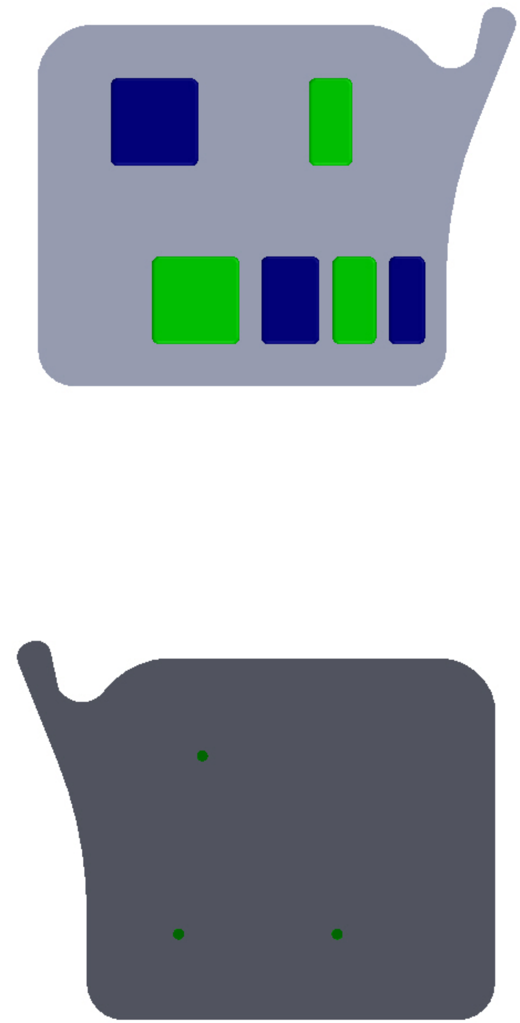


Figure 4: The three loading point locations are shown in relation to the break.

Design





- 3 individual inflation parts (green) to apply 3-point loading
- 3 non-inflatable pads (blue) to help with stabilization

Testing

• FlexiForce Piezoelectric Sensors

• Resistance related to force from calibration curves

•Pressure is force by area of sensor

Figure 5 : This is the FlexiForce Sensor used.

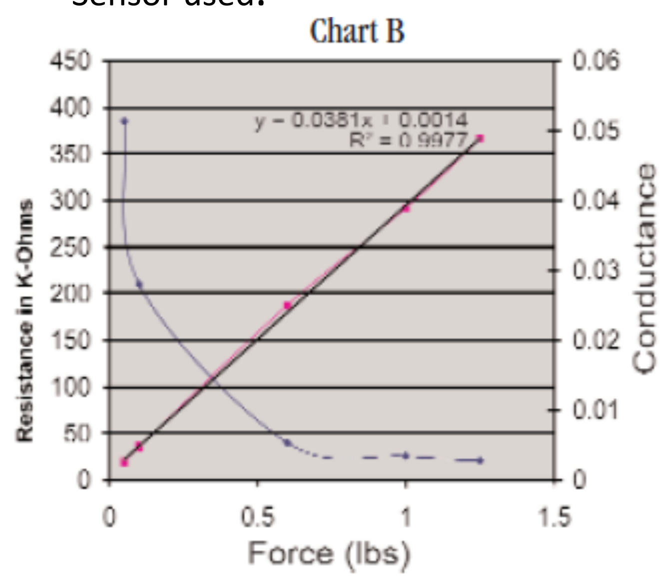


Figure 6 : Calibration curves are used to determine the force from resistance

Testing – Casting Pressures

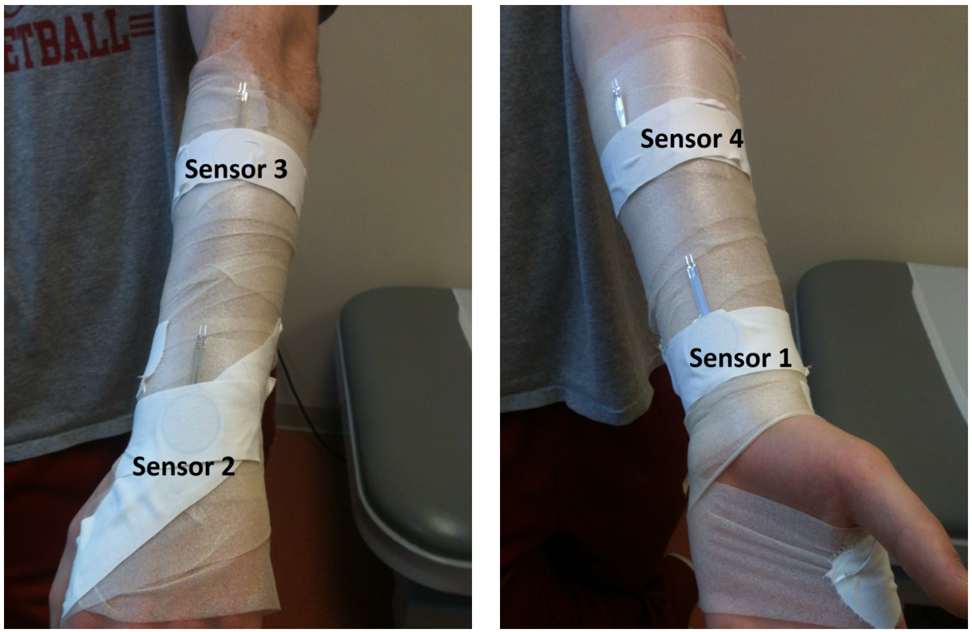


Figure 7: Sensors placed in the areas of three point loading.

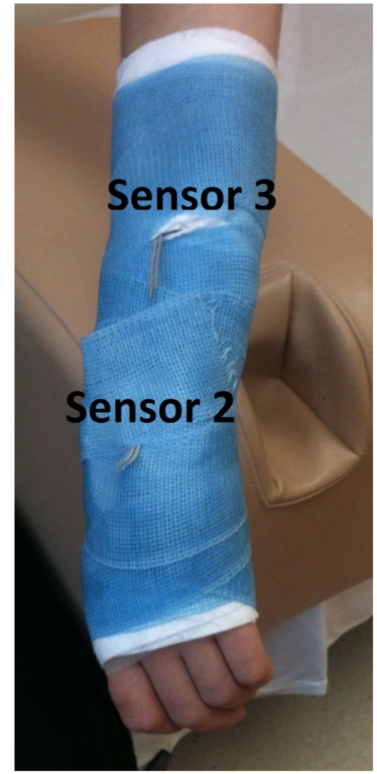


Figure 8: Dr. Halanski casted over sensors with leads exposed.

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Testing – Inflatable Pads

Figure 9 : Using the splint to test the inflatable pads' pressures.

Results

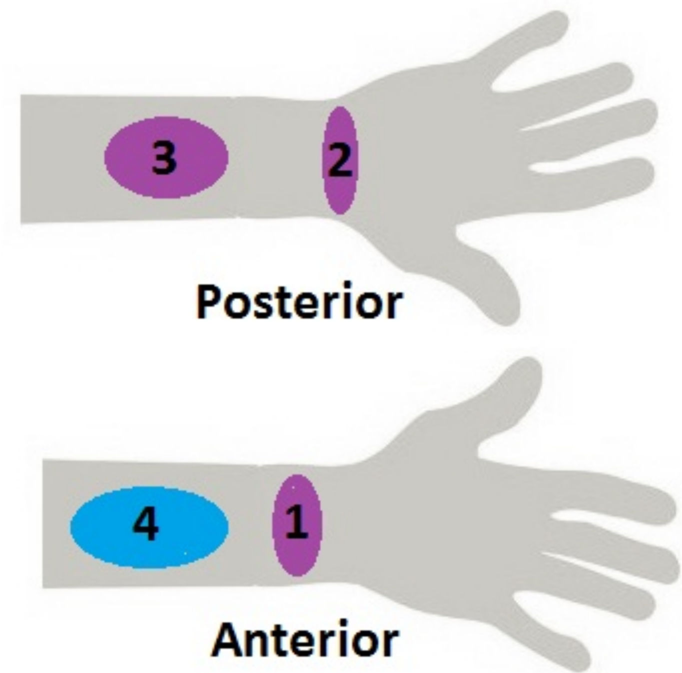


Figure 10: The areas are highlighted in relation to the pressures.

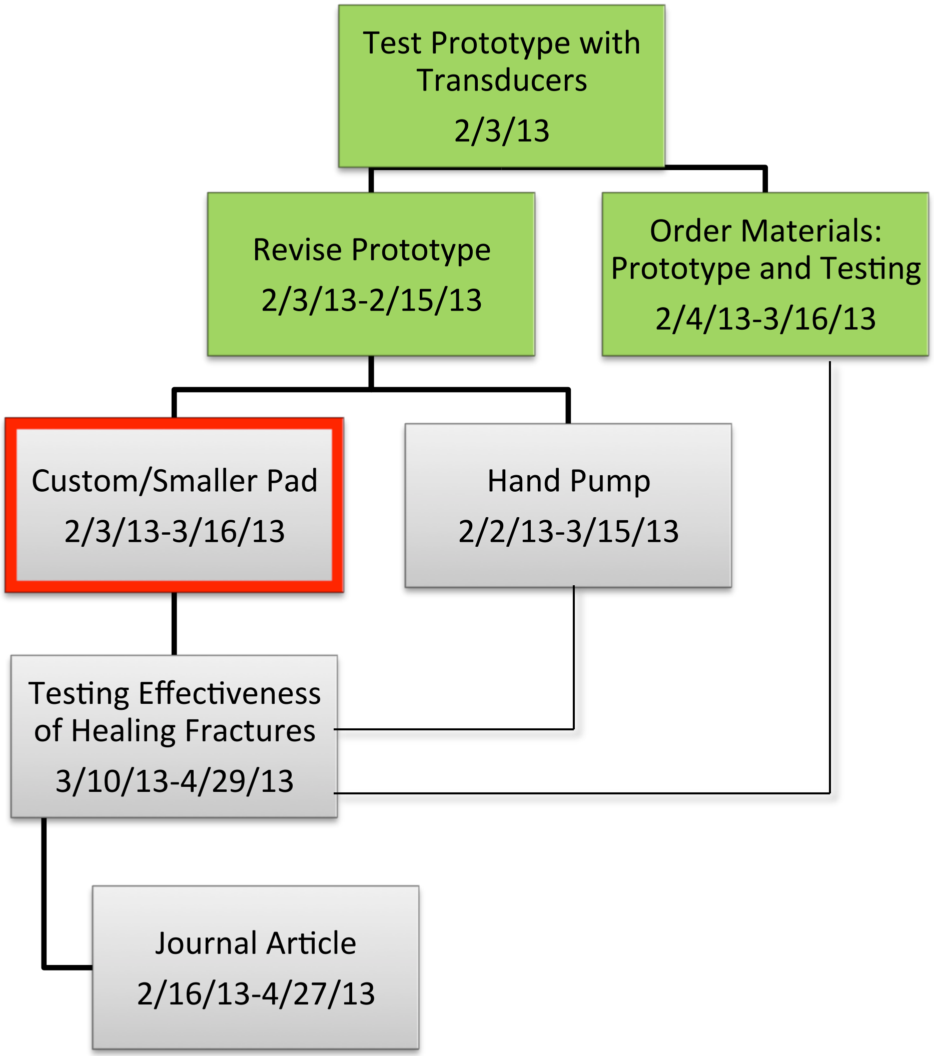
Area	Casting Pressure (psi)	Inflatable Pads Pressure (psi)
1	4.58	4.71
2	4.76	5.61
3	4.28	4.50
4	3.77	3.64

Table 1: The pressures from the inflatable pads produce similar pressures as casting.

Goals for the Semester

- Construct/obtain dynamic airbladders with a needle-hole for inflation
- 2 Functional Adult Prototypes
- Perform testing on the prototype
- Journal Article

Timeline


Test Prototype with Transducers
2/3/13
Revise Prototype
2/3/13-2/15/13
Order Materials: Prototype and Testing
2/4/13-3/16/13
Custom/Smaller Pad
2/3/13-3/16/13
Hand Pump
2/2/13-3/15/13
Testing Effectiveness of Healing Fractures
3/10/13-4/29/13
Journal Article
2/16/13-4/27/13

Design Improvements

- Must create/obtain airbladders with the needle-hole and correct pressures
- Pads too thick, reduce from 2 cm to 1 cm
- Create custom pump that easily displays pressure of the bladder

Figure 11: The hand pump for StabilAir with a pressure indicator.

Customized Inflatable Pads

- Looking for a company to do rotational molding
- Making our own pads

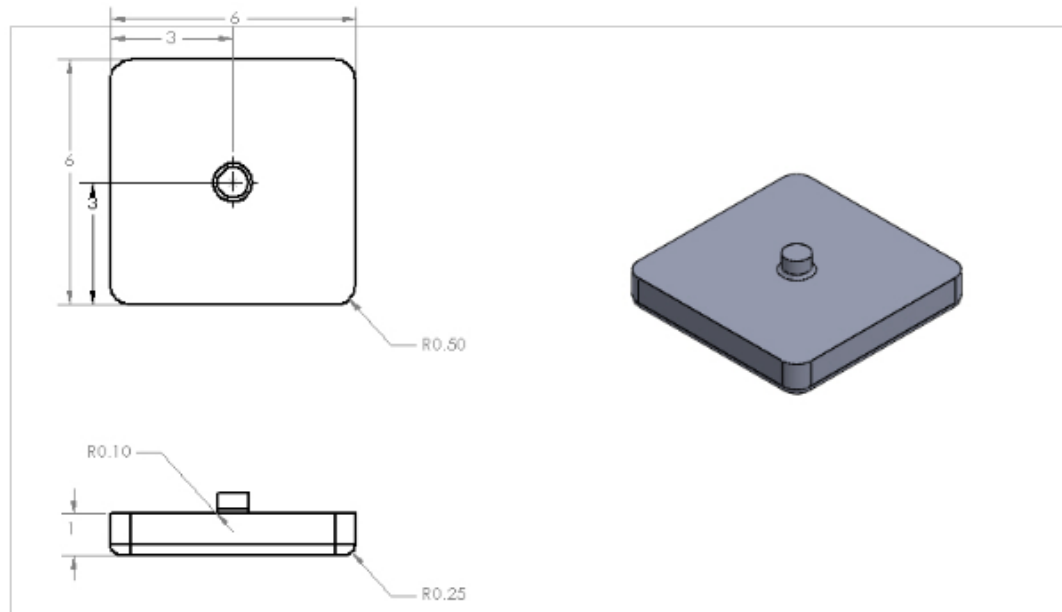


Figure 12 : A SolidWorks drawing of one of the inflatable pads.

Future Testing

- More casting pressure measurements
  - Different doctors
  - More samples
- Prototype Testing
  - Two Week Test
  - Casting Model Test
    - Upper Extremity Fracture Model Design Team

Figure 13: The multimeter is used to measure the resistance of the sensors.

Other Information

- Manual on proper air pad pressure for both doctor and patient
- Design Schematics for Pediatric Splint
- Children designs

Budget

Item	Cost
Force Senors	$113.00
Pads Long	$81.90
Pad 1	$64.37
Pad 2	$39.37
Pad 3	$12.53
4 Pad sets	$0.00
Aircast	$171.98
Sleeve	$24.98
Total	**$508.13**

Table 2: Costs spend last semester.

Item	Cost
Hard Splint Cover	$0.00
Sleeve	$24.98
Custom Pads	$150 to $400
Total	**$174.98 to $424.98**

Table 3: Projection of custom pad splint.

Item	Cost
Hard Splint Cover	$0.00
Sleeve	$24.98
Plastic Materials	$5.00
Adhesives	$15.00
Total	**$44.98**

Table 4: Projection of creating our own pads.

Special Thanks to:

- Dr. Matthew Halanski
- Dr. Paul Thompson
- Sarah Sund
- Gloria Brown
- Upper Extremity Fracture Design Team

Sources

- Slide 1: Image from: www.pubmed.com
- Slide 4:Image from: http://www.betterbraces.com/aircast-stabilair-wrist-braceImage from: Hargrave, D.C., & Prais, E. “Fracture Brace.” Patent No. 7,942,840 B2. 11 May 2011. “Care of Casts and Splints.” April 2011. American Academy of Orthopaedic Surgeons. <http://orthoinfo.aaos.org>. Boyd, A.S., Benjamin, H.J., & Asplund, C. “Splints and Casts: Indications and Methods.” Am Fam Physician. 2009;80(5):491- 499.
- Slide 5: Images from: www.whatsupfamilies.com & www.rehabmd.com
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- Slide 7: Image from: www.summitmedicalgroup.com
- Slide 9: Images from: Tekscan. *FlexiForce® Sensors.* N.p., n.d. Web. 10 Dec. 2012. < http://www.tekscan.com/flexible-force-sensors>
- Slide 15: Images from: http://www.betterbraces.com/aircast-parts-accessories