Model for Supracondylar Humerus Pediatric Fracture

Team Funny Bones Members

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Advisor

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Client

Dr. Pamela Lang

Overview

A model for repairing pediatric humerus fractures

Goal → Training orthopaedic resident surgeons
Current Status → Design Evaluation
Next Step → Fabrication
Future → Testing

Problem Statement

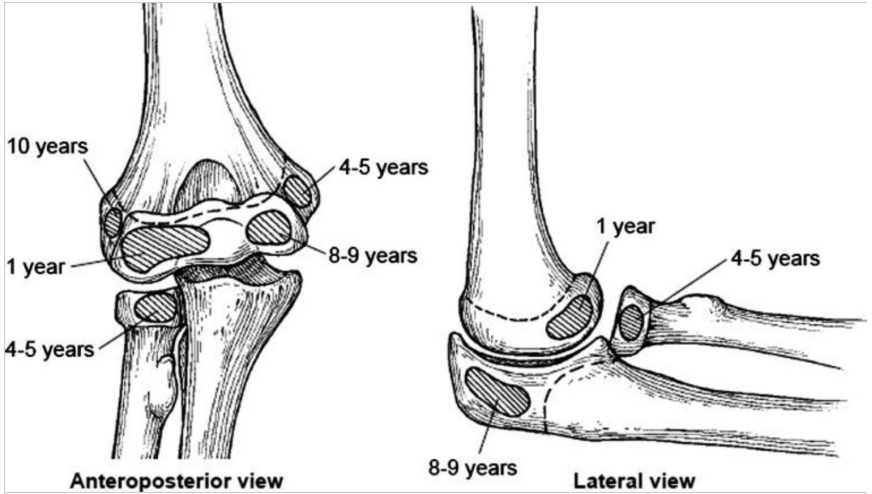
- One of the most **common** fracture in children[1]
- Don’t have a model to evaluate ability
- Residents need **practice** for the surgery
- If done incorrectly life long damage may occur

Product Design Specifications

- Client wants **realistic** design
- The surgery requires a certain feel
- Current models are not **reusable**
- Needs to be radiopaque
- Stepping stone for future models

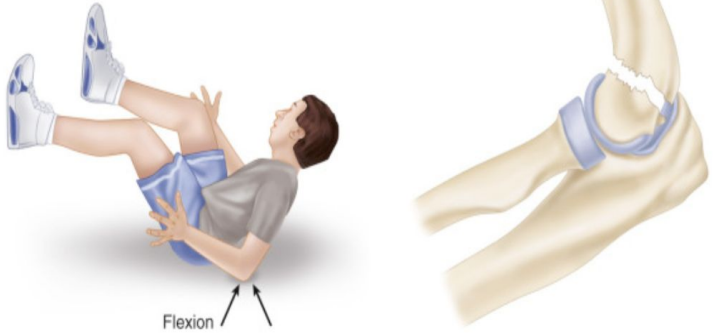
Pathoanatomy

- **Layout of the supracondylar area**[3]
  - Posteriorly: Olecranon fossa
  - Anteriorly: Coronoid fossa
  - Both sides: Supracondylar ridges
  - In proximity: Neurovasculature (ulna, median, radial)
- **Why does it happen more in children?**[3]
  - Ossification timing



https://www.ncbi.nlm.nih.gov/core/lw/2.0/html/tileshop_pmc/tileshop_pmc_inline.html?title=Click%20on%20image%20to%20zoom&p=PMC3&id=2682409_12178_2008_9027_Fig1_HTML.jpg

Pathoanatomy [2]



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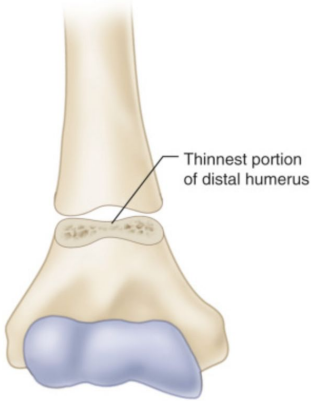

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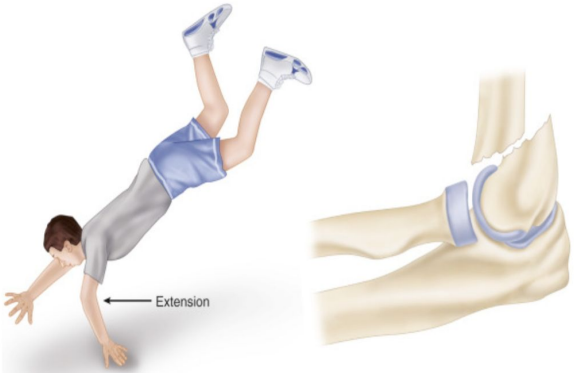

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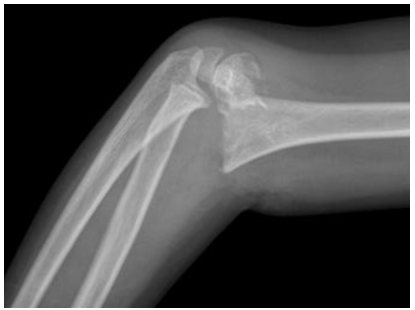
Types of injuries

Type I	Type II	Type III	Type IV
Non-displaced [1]	displaced, posterior context intact [1]	displaced, in 2 or 3 planes [1]	Complete periosteal disruption [1]

https://upload.orthobullets.com/4007/images/supracondylar%20type%20i%20ap.jpg

https://upload.orthobullets.com/topic/4007/images/lat_sch_2.jpg

https://upload.orthobullets.com/topic/4007/images/g3.jpg



https://upload.orthobullets.com/topic/4007/images/sche.jpg

Treatment : Closed Reduction and Percutaneous Pinning[3]

The steps of the surgical procedure are as follows:

- ➔ 1. Position the patient face up
- ➔ 2. Place the affected extremity under a fluoroscopy detector
- ➔ 3. Perform the closed reduction
  - ◆ Apply traction with the elbow at 30 degrees of flexion
  - ◆ **Correct displacement then correct misalignment**
  - ◆ Maintain traction and flex the elbow
  - ◆ **Assess reduction using fluoroscope**
  - ◆ **Place pins laterally (2 for Type II) (3 for Type III)**
  - ◆ Assess stability then cut pins
  - ◆ Apply cast

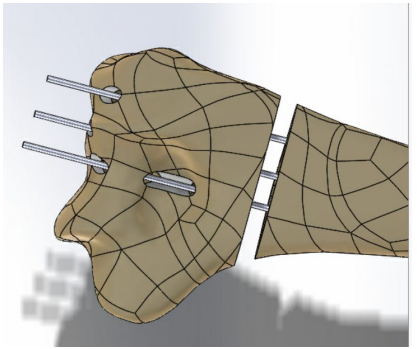
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5296534/bin/jcdr-10-RE01-g004.jpg

Design Alternatives Considered

- Modifying Sawbones Model
  - Tissue Envelope
  - Radiopaque Bones
- Third Party Manufacturer
  - Printing in Silicone
- 3d Printing at The Makerspace
  - For Bone - Tough PLA
  - Tissue - Elastic Resin

https://www.sawbones.com/arm-right-pediatric-soft-tissue-envelope-for-bone-assemblies-1530-13-1.html

https://www.sawbones.com/elbow-right-pediatric-solid-foam-radiopaque-1024-63.html



Design Criteria (Weight)	Modified Sawbones		MakerSpace 3D print		Third-party 3D print	
Reusability (25)	4/5	**20**	3/5	**15**	3.5/5	**17.5**
Functionality (25)	4/5	**20**	2.5/5	**12.5**	3.5/5	**17.5**
Ease of Fabrication (20)	4.5/5	**18**	2.5/5	**10**	3.5/5	**14**
Cost (15)	5/5	**15**	4/5	**12**	3/5	**9**
Appearance (10)	4/5	**8**	2.5/5	**5**	4.5/5	**9**
Safety (5)	5/5	**5**	3.5/5	**3.5**	3.5/5	**3.5**
Total	**82**		**70**		**77.5**	

Modifying the Model

Evaluation:

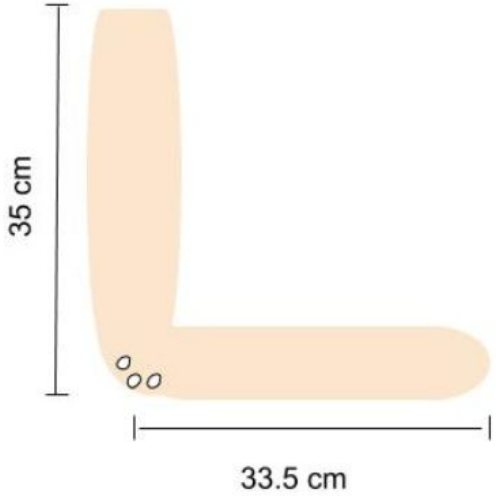
- ➔ Instructors must be able to evaluate students performance-
  - ◆ Drilling location
  - ◆ Pin angles
  - ◆ Hazards
- ➔ Envelope must be **removable**
  - ◆ Options considered
  - ◆ Final decision- zipper attachment

Modifying the Model

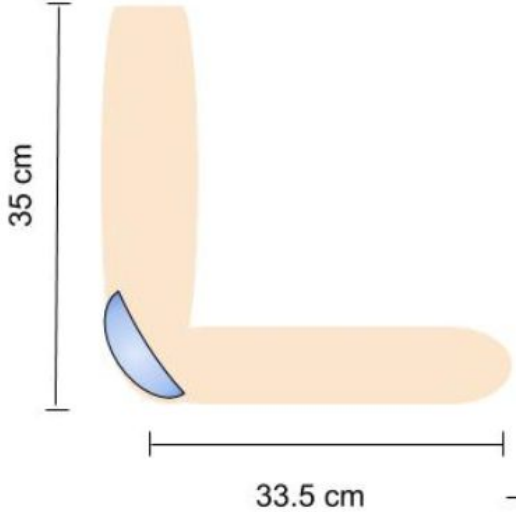
Reusability:

- ➔ Model will be used many times by students
- ➔ Challenges:
  - ◆ Withstanding many drill holes
  - ◆ Maintain functionality
  - ◆ Starting with a “clean slate” everytime
- ➔ Design matrix

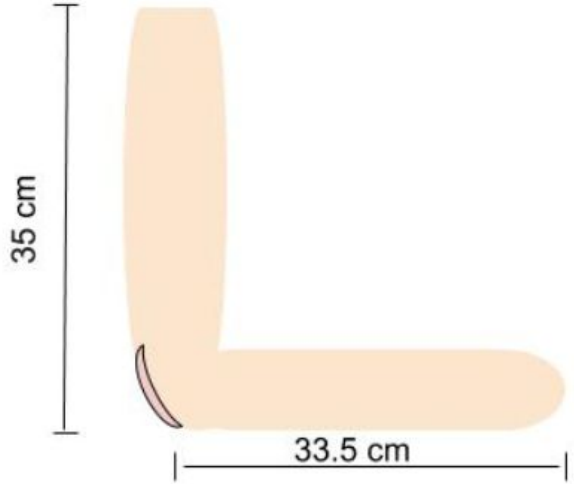
Visuals



Unfilled Holes



Styrofoam Patch

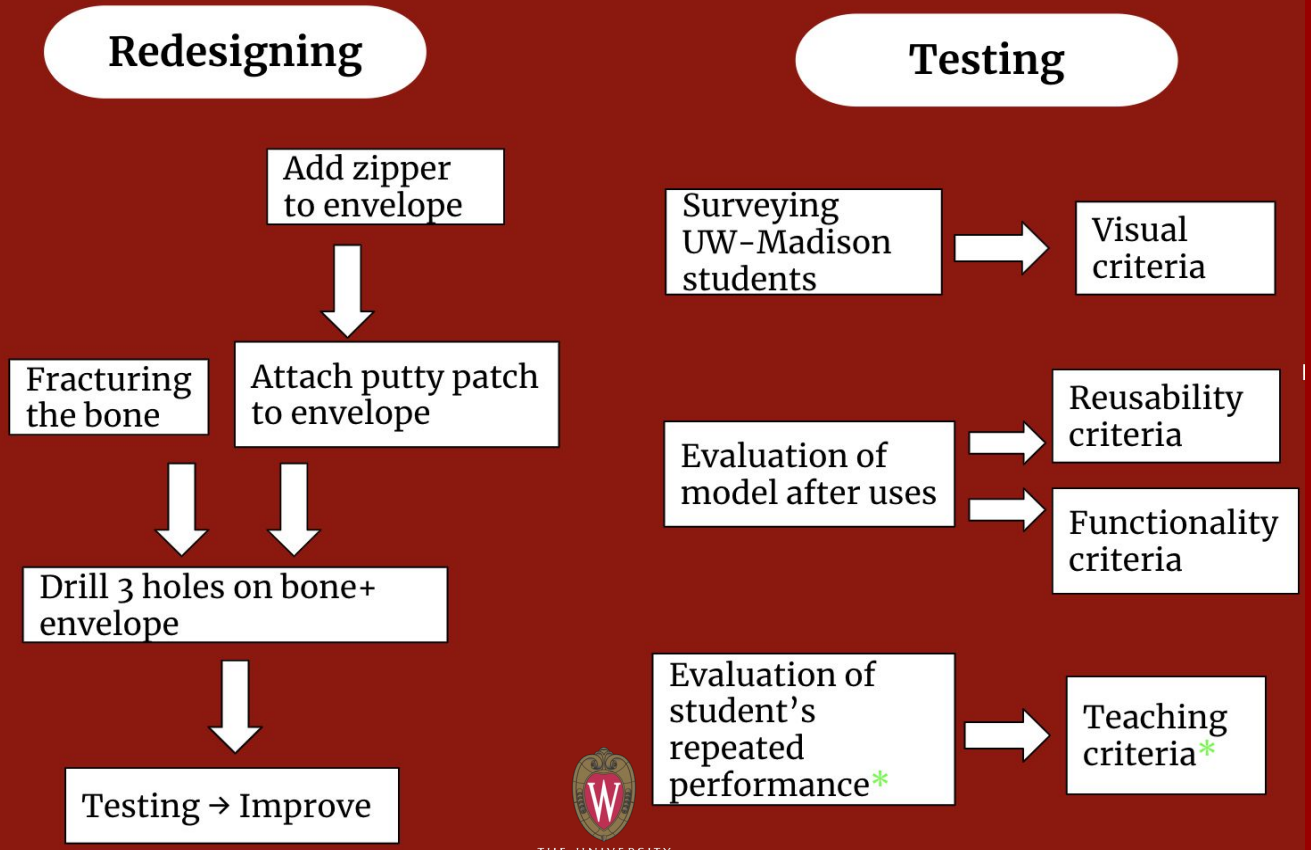


Silly Putty Patch

Modifying the Model

Design Criteria (Weight)	Unfilled Holes		Styrofoam Patch		Silly Putty Patch	
Reusability (25)	2/5	**10**	3/5	**15**	4/5	**20**
Functionality (25)	3/5	**15**	4/5	**20**	4/5	**20**
Cost (15)	5/5	**15**	3/5	**9**	4/5	**12**
Appearance (15)	4/5	**12**	2/5	**6**	3.5/5	**10.5**
Ease of Fabrication (15)	5/5	**15**	3/5	**9**	4/5	**12**
Safety (5)	5/5	**5**	5/5	**5**	5/5	**5**
Total	**72**		**64**		**79.5**	

Future Work: **Humerus Model Process Plan**



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*tentative

Acknowledgements

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References

[1] Woon, Colin et. al. “Supracondylar Fracture - Pediatric.” *Orthobullets*, 2019. https://www.orthobullets.com/pediatrics/4007/supracondylar-fracture--pediatric.

[2]Stans, Anthony “Humeral Supracondylar Fracture” *Humeral Supracondylar Fracture - an Overview | ScienceDirect Topics*, 2018. https://www.sciencedirect.com/topics/medicine-and-dentistry/humeral-supracondylar-fracture.

[3] V. Kumar, “Fracture Supracondylar Humerus: A Review,” *Journal Of Clinical And Diagnostic Research*, 2016. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5296534/