Model of Pediatric Supracondylar Humerus Fracture

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Abstract

The supracondylar humerus fracture is a common elbow fracture in children. There is a need to practice “Closed Reduction and Percutaneous Pinning,” which is the appropriate procedure for this fracture. The team created a teaching model for this complex procedure by modifying off-the-shelf models. The bone was fractured, holes for pinning were pre-drilled, the envelope was shaved down, and a patch was placed to obscure the holes. To test the model, the team received qualitative evaluations of the simulation from orthopedic residents. Overall the model is a good first prototype, but requires future work to make it more reusable and realistic.

Background and Motivation

Background
- In children the supracondylar area is predisposed to fracture [2]
- The common way to fix Type II & III fractures is the surgical method of closed reduction and percutaneous pinning (CRPP)[3]

Motivation
- Supracondylar humerus fractures represent 18% of all pediatric fractures [1]
- Residents need a realistic and reusable model to practice the CRPP surgery

Design Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Functionality</td>
<td>Anatomically accurate</td>
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<tr>
<td>Reusability</td>
<td>Maintains functionality up to 5 years</td>
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<tr>
<td>Appearance</td>
<td>Looks realistic</td>
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<tr>
<td>Ease of Fabrication</td>
<td>Methods are doable under time constraints</td>
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<tr>
<td>Materials</td>
<td>Easily accessible</td>
</tr>
<tr>
<td>Cost</td>
<td>Within $250 budget</td>
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<tr>
<td>Safety</td>
<td>Non-flammable</td>
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Fabrication & Development

Materials
- Sawbones pediatric humerus model: Strong, radiopaque
- Sawbones pediatric tissue envelope
- Band-aid*: cheap, replaceable patching method to cover the drilling site
  *The team also considered using putty

Methods
- Fracturing the bone
- Coping Saw was used for accurate ridge formation
- Drilling pilot holes for proper pin placement
- Cutting patch in the envelope for proper assessment of skill
- Shaving of material in envelope to give model more realistic feel

Design Achievements:
- Excellent fluoroscopic visibility
- Great functionality of bone
- Good teaching method for closed reduction
- Low-cost and reusable

Design Evaluation:
- Senior medical staff were more generous in their scoring of the model
- The client is overall satisfied with this first prototype

Discussion

Model Issues:
- Rubber peristeme was too weak
- Elbow joint was too stiff
- Foam was too thick
- Fracture location was too high

Future Work

Tissue Envelope
- Utilize self healing material for patch site
- Increase flexibility of the elbow joint and add neurovascular anatomical details

Bone
- Add sensor in model to prevent damage to the bone
- Move fracture site proximal to the elbow

Design Process
- Increase sample size and duration of testing
- Consider 3D printing options

Acknowledgements

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References