Ergonomic Syringe Adaptor For Office-Based Injection Procedures

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Abstract

- Design ergonomic syringe adaptor to relieve physician discomfort during prolotherapy
- Previous designs attempted to address the issue
- Developed three designs to increase stability and surface area
- Testing done by surveying prolotherapists about the designs at a local conference
- Justified those results with hand biomechanics concepts
- Future work will consist of mechanical testing, patenting, and production of the device in mass quantities

Project Motivation

- Prolotherapy is a regenerative form of chronic pain management
- Gaining popularity in clinical use and service applications
- UW-Madison is the center for prolotherapy education and research
- Physicians experience discomfort in their hands and wrists, causing fatigue and injury to develop

Background

- Repetitive injections lead to hand fatigue and increase the risk of soft tissue damage
- Fatigue in the hand creates instability
- De Quervain’s tenosynovitis and tenosynovitis of the finger flexors at the wrist, beneath the flexor retinaculum, may result from repeated thumb motion and a pinch-like grip
- The pinch grip fails to disperse forces across the fingers and places more strain on the tendon pulley

Testing

- Survey was designed for physicians attending Hackett Hemwall Patterson Prolotherapy Conference
- Survey included three designs above as well as a thicker versions of each design
- Survey included five categories...
  1. Comfort
  2. Stability
  3. Control
  4. Compatibility
  5. Reliability

Future Work

- The group is working with WARP to develop a patent for the slanted adaptor
- More testing is required to further justify the effectiveness of this device, including maximum force capabilities and actual tendon stress
- Mass manufacturing capabilities will be evaluated, including gathering investments to purchase a design mold
- Material choices will be considered, acknowledging potential ethical issues

Discussion

- Individuals who gave a more comprehensive review of all designs favored the slanted design over those who did not fully complete the survey
- Qualitative feedback from phototherapy experts supported this opinion
- An increase in contact area is directly associated with greater force distribution
- With greater force distribution, tendons and ligaments can function longer before fatigue sets in
- Greater force distribution leads to decreased amounts of pain and discomfort
- Survey and biomechanical results, as well as the power grip model, support the development of the slanted design

Preliminary Design Selection

- Comfort, safety, and sterilizability were most important criteria
- Slanted design scored highest in design matrix
- All three designs were used for survey based testing

Table 1. Average fully-filled (FF) out survey scores (n=13) of each design with respect to each of the five criteria measured on a scale of 3 to 5. Error bars represent standard error within each group.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Horizontal Grip</th>
<th>Elevated Horizontal Grip</th>
<th>Slanted Grip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comfort (35)</td>
<td>3/5</td>
<td>4/5</td>
<td>28/5</td>
</tr>
<tr>
<td>Safety (25)</td>
<td>5/5</td>
<td>5/5</td>
<td>5/5</td>
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<tr>
<td>Sterilizability (20)</td>
<td>5/5</td>
<td>5/5</td>
<td>20/5</td>
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<td>Manufacturability (10)</td>
<td>5/5</td>
<td>10/5</td>
<td>5/5</td>
</tr>
<tr>
<td>Cost (5)</td>
<td>5/5</td>
<td>5/5</td>
<td>3/5</td>
</tr>
<tr>
<td>Aesthetic (5)</td>
<td>5/5</td>
<td>5/5</td>
<td>5/5</td>
</tr>
<tr>
<td>Total</td>
<td>86/5</td>
<td>87/5</td>
<td>91/5</td>
</tr>
</tbody>
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Surface Area Analysis

- Contacting surface area of basic syringe is 0.302 in², via ImageJ analysis
- With an adapter, surface area increases to 1.248 in²
- This 313% increase in surface area leads to a 75.8% decrease in stress throughout the contacting surfaces

References