Reaching Aid for Spinal Fusion Recipients

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Opportunity & Significance
- 500,000 spinal fusion operations are performed annually in the United States [1]
- Post-operative patients should avoid B.L.T.'s (Bending, Lifting, & Twisting) [2]
- Bending is permanently restricted & requires lifestyle change
- Market Analysis:
  - Current reaching aids provide negligible support to the user’s wrist
  - 61% of mobility and 4.4% of non-mobility device users have difficulty bending [3]

Innovation Mission
Spinal fusion recipients require a means to increase ability to perform activities of daily living that require lumbar flexion, while minimizing bending torque and compressive stresses acting on the spine. Patients with osteoporosis must take further caution to prevent bone fractures elsewhere in the body.

Technical Approach & Design Accomplishments
- Choice of initial final design
  - Wrist brace, full grip handle, telescoping body, dual grabber
- Addition of locking mechanism
- Preliminary CAD model created
- Design confirmation post design review
- Finite element analysis and static analysis
- 3D printing of handle and components
- CAD model adjustments
- Body alterations and bench testing
- Final prototype assembly

Verification Results
- Finite Element Analysis
  - Device held 7kg with maximum stress of 51.3 MPa
- Tensile Testing on Cable
  - Ultimate stress of 0.668 MPa
  - Failure at 35.665 lbs
- Dwell Testing on Cable
  - 76.4 N (17.2 lbs) load after 10 min
- Spring Testing
  - 23 N required to close grabbers
- Failure Testing on Body
  - Held 24 lbs without reaching failure
  - Only elastic deformation to body
- User Trials
  - Optional medium size suction cups

Validation Matrix

<table>
<thead>
<tr>
<th>User Needs</th>
<th>Design Input</th>
<th>Validation</th>
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<tbody>
<tr>
<td>Force to operate handle</td>
<td>180 N</td>
<td>23 N</td>
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<tr>
<td>Weight of device &lt; 1 kg</td>
<td>Prototype at 1.23 kg</td>
<td></td>
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<tr>
<td>Bending moment on spine &lt; 5 Nm</td>
<td>No bending of spine needed for 95th male while standing</td>
<td></td>
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<tr>
<td>Device can lift object up to 2.2 kg</td>
<td>Can lift objects up to a safety factor of 3</td>
<td></td>
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<tr>
<td>Water resistant</td>
<td>Materials used are water resistant</td>
<td></td>
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<tr>
<td>Portable</td>
<td>Shortest length of 26.5&quot;</td>
<td></td>
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<tr>
<td>Lifetime of at least 10 years</td>
<td>Fatigue limit of all materials prove lifetime of at least 10 years</td>
<td></td>
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<tr>
<td>Optimized to perform variety of tasks</td>
<td>User trials prove variety in size and shape of retrievable objects</td>
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References

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