Prosthetic Ear Attachment Anchor

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Abstract

Prosthetic ears are provided to thousands of people every year who have lost their ears due to trauma, cancer, or congenital disorders. Prosthetic ears are often secured to the skull via a surgically implanted metal abutment. A magnet is chemically bonded to the silicone prosthesis and attaches to the metal abutment. The chemical bond between the magnet and silicone is unreliable and leads to an unpredictable lifespan of prosthetic ears using this technique. Medical Art Prosthetics is seeking a method to mechanically attach the magnet to the silicone ear, providing a longer, more reliable lifespan for the prosthesis. Testing shows that a polycarbonate anchor can successfully increase the retention of a magnet inside of a silicone ear.

Background

- Microtia affects about 1 in 6,000 newborns
- Silicone ear prostheses are made for individuals who are missing all, or a portion of their ear
- Medical Art Prosthetics delivers about 20 prosthetic ears per year
- Ear prostheses have inconsistent lifespans
- Unreliable chemical bonding of magnet to silicone
- Magnets cannot be reattached to silicone

Design Specifications

- Attachment must:
  - Secure magnet in silicone ear
  - Fit differently sized magnets
  - Be 0.5 mm thick
  - Be inconspicuous
  - Withstand 200°F
  - Improve silicone ear lifespan to a minimum of two years

Problem Statement

- Medical Art Prosthetics is seeking to increase the lifespan of their ear prostheses
- Current methods for molding magnets into silicone prostheses are unreliable
- A magnet anchor is necessary to retain the magnet in the prosthesis
- A fabrication procedure that can be used by Medical Art Prosthetics must accompany the design
- Anchor should be versatile to fit ear prostheses of different sizes

Testing and Validation

Testing Methods:

- Fatigue Testing
  - Pulled magnet with silicone on and off the abutment 730 times, or until the magnet came out of the silicone.
- MTS Machine
  - Tension Test

<table>
<thead>
<tr>
<th>Magnet</th>
<th>Results</th>
<th>Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without anchor</td>
<td>Fatigue testing: Mean- 3 trials 95% CI [2-4 trials] MTS testing: Too weak to test* &lt;13 N (Breakaway force of magnet)</td>
<td>Not effective retention when tension applied</td>
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<tr>
<td>With anchor</td>
<td>Fatigue testing: Mean- &gt;730 trials MTS testing: Mean- 44 N 95% CI [29-59 N]</td>
<td>The anchor greatly increases retention strength and durability</td>
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</tbody>
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Results:

- Magnet with attachment has a mean breakaway force of 44N
- Magnet without attachment has a breakaway force of <13 N
- The magnet with an anchor stayed in the ear for all of the fatigue testing
- The magnet without the attachment came out of the silicone after 4 tries

Conclusions

- Polycarbonate anchors are effective in preventing auricular magnets from stripping out of silicone prostheses
- Compression molding is an effective method to create thin anchors around auricular magnets
- It is unsure whether the anchor is inconspicuous inside silicone ears

Future Work

- Use high flow material to optimize molding process
- Fabricate molds for differently sized magnets
- Perform mechanical testing on magnets with silicone primer and compare to acquired data
- Test how inconspicuous the anchor makes the magnet in a prosthetic ear

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References