Methodologies:

The custom-made orthotics tested in this project have to be made from a ‘rigid’ or ‘semi-rigid’ material and must have a non-compressible heel post. The orthotics were tested before they have been dispensed to the patient for wearing. A total of 100 orthotics will be tested.

Teasing is performed by two independent testers with the 3rd member of the team performing statistical analysis.

The teasing procedure for each orthotic is as follows:

- The orthotic material is recorded, and the following measurements are made prior to teasing: 1) the maximum medial arch height, 2) the maximum lateral arch height, 3) the width of the orthotic in the center, 4) the thickness of the orthotic, and 5) the length of the orthotic from the anterior heel post to front clamp.

- The orthotic is clamped to a solid table with the heel post set flat on the table surface and the anterior edge hanging off the edge of the table. A clamp is attached to the front edge of the orthotic that has a 7/16” bolt head aligned with the center line of the orthotic. A digital angle finder is laid to the top of the clamp and set to 0° when the orthotics is at rest.

- A plate captive wrench is fastened to the orthotic, and the torque is increased by 5 in·lb at each torque increment.

- The first glance reads the angle of the forefoot clamp and the angle of the rearfoot clamp. The angle of the forefoot is then read from the digital angle finder.

- The test is then repeated in the eversion direction until the wrench has failed at a given angle increment of torque.

- A graph showing the average resistance of the polypropylene and the acrylic orthotic to forefoot inversion torque is shown in Figure 6.

Table 1

<table>
<thead>
<tr>
<th>Material</th>
<th>Length (cm)</th>
<th>Width (cm)</th>
<th>Cross sectional area (cm²)</th>
<th>Polar moment of inertia (cm⁴)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polypropylene</td>
<td>260</td>
<td>70</td>
<td>3.77e⁻²</td>
<td>271</td>
</tr>
<tr>
<td>Acrylic</td>
<td>260</td>
<td>70</td>
<td>2.32e⁻²</td>
<td>160</td>
</tr>
</tbody>
</table>

Table 2

<table>
<thead>
<tr>
<th>Material</th>
<th>G. Exserhan</th>
<th>G. Exserhan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polypropylene</td>
<td>12/12</td>
<td>1342</td>
</tr>
<tr>
<td>Acrylic</td>
<td>18/16</td>
<td>20/20</td>
</tr>
</tbody>
</table>

Discussion:

I have long been recognized that for the plantigrade foot, all of the metatarsal heads touch the ground. Figure 8 shows a classic forefoot pronation foot. In this foot, the rearfoot is revealed to be pronated, and the number of degrees that the rearfoot is everted from perpendicular is the pronation foot. An orthotic, therefore, that is toes to control the rearfoot from evertting from perpendicular, must prevent the foot from inverting to the rearfoot. If this lacks this resistance, then the patient will continue to invert the orthotic, which will cause the foot to feel uncomfortable. The more an orthotic tries to evert the forefoot against the rearfoot, the more likely it will be able to resist the patient’s rearfoot pronation.

While Table 2 shows that the cross sectional areas of the two orthotics are almost identical, the acrylic orthotic has a smaller polar moment of inertia which would decrease G. Assuming that the material is linear, we arrive at the values in Table 2.

As can be seen in Table 2, the acrylic orthotic is about 15% more resistant to the torque that tries to invert the foot against the rearfoot. On the other hand, it is about 53% more resistant to the torque that tries to invert the foot against the rearfoot. This suggests that the acrylic orthotic will mildly resist rearfoot pronation more than the polypropylene. This project is still in its early stages of data collection. Additional analysis will be performed to better understand how medial and lateral arch height increases or decreases the stiffness of the orthotic.

With additional data, it is should be possible for practitioners to optimize the selection of orthotic materials for the wide variety of foot morphologies and kinematics they encounter.

References:


