THE INFLUENCE OF GLOVE AND HAND POSITION ON PRESSURE OVER THE ULNAR NERVE DURING CYCLING

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INTRODUCTION

Sensory and motor impairments of the hand are common among both amateur and experienced bicyclists [1,2]. This condition, termed Cyclist’s Palsy, most often presents as paresthesia in the fifth and ulnar aspect of the fourth finger, sometimes accompanied with weakness in the abductors or adductors [3]. Chronic ulnar nerve compression is believed to be the primary cause of Cyclist’s Palsy. Guyon’s Canal, the location where the ulnar nerve enters the hand, is located relatively superficially, making the ulnar nerve susceptible to compression when pressure is placed over the hypothenar region of the hand [1]. Suggestions for preventing Cyclist’s Palsy include wearing padded gloves, frequently changing hand positions and riding a properly fit bicycle. However, the relative effectiveness of these interventions has yet to be substantiated [3].

The purpose of this study was to evaluate the effects of hand position and glove padding on pressure over the ulnar nerve. Specifically, we considered three different hand positions typically used on road bicycles and one position used on mountain/hybrid bicycles. We also compared gloves that were padded with either gel or foam materials located over the hypothenar eminence, thenar eminence and/or metacarpals. We hypothesized that (1) the greatest pressure over the hypothenar region would be found with the hands in the drops position; (2) the largest pressure reduction would be achieved using compliant padding over the hypothenar eminence.

METHODS

Thirty-six healthy adults (18 male, 18 female) were tested (38.9±13 yrs, 74.2±13.9 kg and 174±9 cm). An adjustable stationary cycle was adjusted to match the dimensions of each subject’s personal road bicycle. Subjects performed a series of trials in which glove padding (Fig. 1a) and hand position (Fig. 1c) were randomly varied while power and cadence levels were kept consistent. A pressure sensitive mat (229 sensors, 4.4 mm per side, Novel gmbh) was used to record pressure distribution over the hypothenar region of the subject’s dominant hand (Fig. 1b), while a motion capture system (PhoeniX Technologies Inc.) was used to record upper extremity kinematics. Data collected from each pressure sensor were interpolated at 100 evenly spaced intervals over full pedal strokes using piecewise cubic splines. Cyclic pressure curves from twelve consecutive pedal strokes were then averaged together. We then quantified both the pressure distributions and peak pressure over the hypothenar eminence for each condition.

Three-dimensional images of the subject’s hand with and without the pressure mat attached were obtained using a laser scanner (Shape-Grabber Inc). These laser scans allowed for the creation of
subject-specific pressure images that related pressure distribution to the underlying anatomy (Fig. 2). The compressive stiffness of the gel and foam padding inserts were measured separately with a materials testing machine (Instron 1000, 100-lb capacity load cell, 15 mm circular indenter).

RESULTS AND DISCUSSION

Analysis of the pressure distributions revealed that the most substantial pressure concentrations nearest Guyon’s Canal were observed with the hands in the drops and hoods positions (Fig. 2). Pressure magnitudes were greatest with the hands in the drops and straight bar positions (Table 1), which were each significantly higher than that seen in the tops and hoods positions ($p < 0.05$). Hypotenar pressure did not significantly vary between male and female cyclists.

Padding in the hypothenar region of the glove reduced peak pressures seen in the no glove condition from 21-28%, with the highest pressure reduction achieved using foam. There was no significant pressure reduction achieved when using 5 mm padding over 3 mm. The foam padding/glove system was found to be ~50% less stiff than the gel, suggesting that pressure reduction was achieved using a more compliant interface. The drops hand position induced the greatest amount of wrist extension (~54°), which could exacerbate nerve compression [2].

Table 1: Average (SD) peak pressure (kPa) for all combinations of glove and hand positions

<table>
<thead>
<tr>
<th>Glove</th>
<th>Padding</th>
<th>Thickness (mm)</th>
<th>Stiffness (kN/m)</th>
<th>Tops 1,2</th>
<th>Drops 1,3</th>
<th>Hoods 1,3</th>
<th>Straight Bar 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>None</td>
<td>---</td>
<td>---</td>
<td>137 (12)</td>
<td>165 (12)</td>
<td>134 (12)</td>
<td>152 (12)</td>
</tr>
<tr>
<td>1</td>
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<td>---</td>
<td>---</td>
<td>129 (11)</td>
<td>160 (13)</td>
<td>125 (11)</td>
<td>155 (15)</td>
</tr>
<tr>
<td>2</td>
<td>Gel</td>
<td>3-3-3</td>
<td>22</td>
<td>123 (11)</td>
<td>147 (13)</td>
<td>114 (10)</td>
<td>123 (12)</td>
</tr>
<tr>
<td>3</td>
<td>Gel</td>
<td>5-5-3</td>
<td>17</td>
<td>113 (11)</td>
<td>142 (13)</td>
<td>103 (8)</td>
<td>127 (13)</td>
</tr>
<tr>
<td>4</td>
<td>Foam</td>
<td>3-3-3</td>
<td>10</td>
<td>108 (9)</td>
<td>133 (11)</td>
<td>104 (8)</td>
<td>121 (10)</td>
</tr>
<tr>
<td>5</td>
<td>Foam</td>
<td>5-5-3</td>
<td>8</td>
<td>113 (9)</td>
<td>128 (10)</td>
<td>96 (8)</td>
<td>116 (10)</td>
</tr>
</tbody>
</table>

1No Glove vs. Padded Glove, $p < 0.05$ 2Glove 4 vs. Glove 2, $p < 0.05$ 3Glove 5 vs. Glove 2, $p < 0.05$

CONCLUSIONS

The results demonstrate that pressure over the ulnar nerve can be reduced with cycling gloves that include relatively thin, compliant padding in the hypothenar region. Pressure distributions varied substantially between hand positions, such that appropriate pad placement is dependent on riding style. Further research is needed to quantitatively relate hypothenar pressure magnitudes and durations to risk for ulnar nerve damage.

REFERENCES


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