INTRODUCTION

Old adults exhibit a decrease in both muscle force steadiness [1, 2] and visual capability [3] compared to young adults. Many studies investigating force steadiness have used a visual target as the stimulus for modulating muscle force [1, 2]. Since visual capability declines with age, and vision is used in most investigations of muscle force control with age, reduced muscle force control in older adults might be partially related to or explained by altered visual capacity. The purpose of this exploratory study was to compare the relationships between eye movement, as a component of visual steadiness, and quadriceps muscle force steadiness in young and old adults during isometric quadriceps contractions of constant and varying forces.

METHODS

19 healthy young adults (20.7±1.82yrs) and 18 healthy old adults (71.6±3.01yrs) participated in this study after providing written informed consent. Isometric quadriceps torque data were collected using an isokinetic dynamometer and used as a surrogate for muscle force. Horizontal and vertical eye movement data were collected using an eye-tracking system by recording motion of the pupil (Figure 1).

Visual feedback consisted of a cursor moving horizontally across the screen at a set speed and vertically in response to torque magnitude. The tasks consisted of three vision only tasks, two vision and torque tasks at a relative value of 40% MVC, and two vision and torque tasks at an absolute value of 54Nm. The vision only conditions consisted of a stationary cursor, the cursor moving across the middle of a blank screen, and the cursor moving across the middle of a screen on a straight white line. The torque conditions required the subject to bring the cursor up to a straight line in the middle of the screen and maintain the torque, or provide appropriate amounts of torque to increase and decrease the cursor on a parabola shaped target.

The middle 60% of each data set was plotted and a line of best fit was calculated. The horizontal and vertical vision and torque data were detrended before calculating measures of variance and central tendency. We used standard deviation to quantify steadiness for the vision and torque trials and Pearson Product Moment correlations to identify the relationships between steadiness in muscle torque and visual capacity.

RESULTS AND DISCUSSION

Torque data from the straight-line vision and force conditions were used to quantify muscle torque steadiness (Figure 3). There were no significant differences between age groups for torque steadiness in the absolute condition (p=0.19) with young displaying an average torque variability of 0.76±0.25Nm and old displaying an average torque variability of 0.84±0.29Nm. Statistical significance was detected for the relative torque condition (p<0.05); these results were contrary to our expectations, with old adults showing less torque variability averaging 0.79±0.36Nm compared to young adults with an average of 1.16±0.44Nm.

Both groups displayed similar visual capacity, as measured by the three vision-only conditions. The
static vision condition did not show a significant difference between the two groups for the horizontal (p=0.08) or vertical (p=0.28) visual components. The vision no-line and vision straight-line conditions did not show a significant difference between young and old adults for the vertical vision component, p=0.34 and p=0.47, respectively. A significant difference was observed in the horizontal component for the two conditions. Old adults showed decreased visual steadiness compared to young (p<0.05). Correlations performed between visual steadiness and muscle torque steadiness failed to show a statistically significant relationship for either condition in either age group using the following critical values for a two-tailed test at p<0.05: young adults (df=17) =0.456, old adults (df=16) =0.468 (Figure 2, Table 1).

Although decreased muscle force steadiness in old adults has been well documented [1, 2], our subjects failed to display this characteristic. The absence of a statistically significant difference in force steadiness is indicative of an extremely healthy, mobile, and capable old adult subject pool. The only differences between the two groups were age and maximal strength (young 209±68.44Nm, old 145±51.5Nm).

**CONCLUSIONS**

We were not able to identify any physiological relationship between muscle force steadiness and eye movement, as a component of visual steadiness.

It is possible that the relationship between force steadiness and visual feedback identified in previous research is due to decrements in visual processing capabilities and not due to a decline in visual steadiness. Regardless, present data support previous observations that reduced muscle force steadiness with age was in fact due to reduced neuromuscular capacity and not visual capacity.

**REFERENCES**


**Table 1:** Correlation coefficients for relative and absolute conditions *r value <> 0, p<0.05

<table>
<thead>
<tr>
<th></th>
<th>Relative (40% MVC)</th>
<th>Absolute (54Nm)</th>
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<tbody>
<tr>
<td></td>
<td>Young</td>
<td>Old</td>
</tr>
<tr>
<td>Straight-Line</td>
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<td>0.014</td>
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<tr>
<td>Parabola</td>
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<td>0.241</td>
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**Figure 2:** Correlations for absolute and relative parabola condition.

**Figure 3:** Representative torque data for one young and one old individual.