3D Motion Analysis Comparison of the Dominant Hand Wrist Flexion during Writing

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Abstract. [Purpose] The purpose of this study was to research the difference in wrist flexion of right-handed and left-handed persons during writing. [Subjects] This subjects were 25 persons (left handers 12/ right hander 13) and the study was conducted from 06/01/2011 to 10/31/2011. [Methods] A Motion analysis system (Zebris) was used to determine the degree of wrist flexion of right-handers and left-handers. The during writing data were analyzed using descriptive statistical analysis and the independent sample t-test. We used a statistical significance level of 0.5. [Results] Left-handers wrote with the wrist flexion of 2.92 (±9.42) degrees. Right-handers wrote with wrist extension of 8.42 (±2.80) degrees. The degree of wrist flexion during writing was significantly higher for left-handers than right-handers. [Conclusion] When a left-handed person writes, the degree of wrist flexion is greater than that of a right-handed person. To protect the wrist from excessive flexion and to maintain wrist stability, it is necessary to use an instrument that is designed for left-handed persons.

Key words: Ergonomics design, Hand function, Left-hander

INTRODUCTION

The dominant hand is the hand which becomes dexterous by using it more\textsuperscript{1). One of the characteristics which differentiates human beings from animals is the inherited right-handed tendency. In all cultures, more than 90% humans are uniformly right handed but other creatures do not show this bias\textsuperscript{2). The causes of hand dominance can largely be summarized as congenital inheritance, and environment and learning. In congenital inheritance, the dominant hand is decided according to the dominant side of brain, is predominant. That is, when the left brain is superior, a person becomes right-handed and when the right brain is superior, a person becomes left-handed\textsuperscript{3). Furthermore congenital inheritance is the predominant factor in deciding the dominant side.

Most of us manipulate tools and products using hands, and most products are designed for the right-handed. We can see this in many products, such as the location of elevator buttons, subway turnstiles, automatic ticketing machines, keyboards and mice of computers, digital cameras, volume controllers of mobile phones, etc\textsuperscript{4). Accordingly, a person with left hand dominance cannot help being slow at work and has lower right-hand strength.

Complex movements are made by the wrist joint: flexion, extension, turning upside down, turning over and circulation movements\textsuperscript{5). When the flexor muscles around the wrist control the wrist, if there is any disorder, extensor muscles are damaged, and this may be caused by repeated movements of strong flexion or extension of the wrist, or repeated use of these muscles in leisure activities or work. Excessive use of wrist extension and transportation of heavy things affects the wrists, weakening wrist muscular strength and stamina due to excessive tension of the wrist muscles\textsuperscript{6). Therefore, repeated flexion of the wrist may affect the health of the wrist, causing disability of the hand. Writing is an everyday activity which is typically performed by dominant hand\textsuperscript{7).} The purpose of this study was to investigate if there is any difference in flexion of the wrist joint according to the dominant side in writing. We seek to gain an understanding of the problems of wrist health of left-handed persons, and to provide basic data for subsequent research.

SUBJECTS AND METHODS

Twenty-five students (left-handed 12, right-handed 13) participated in this study. The population of this study was comprised of 12 men (48%), 13 women (52%), 12 left handed person (48%) and 13 right-handed persons (52%). Their average age was 21.72 (±1.65) years (Table 1). The subjects did not have any diseases related to the hands, fracture or past history, and they were normally healthy persons without neurologic disorders. Before the study, the principal investigator explained all procedures to the subjects in detail. All subjects signed an informed consent form, which was approved by Inje University College of Human Health Science Studies Committee.

To investigate the degree of wrist flexion, we used a
3-Dimension Motion Analyzer with Wimarm software Zebris Medical GmbH to analyze writing performed by the dominant hand. The writing items were the 7 sub-tests of the Jebsen-Taylor Hand Function Test to analyze writing performed by the dominant hand. The writing items were the 7 sub-tests of the Jebsen-Taylor Hand Function Test. The collected data were analyzed using SPSS for Windows for frequency, and the differences were examined using the independent t-test.

RESULTS

In writing with the dominant hand, the degree of wrist flexion was on average 2.92 (±9.42)° for the left-handed persons, and 8.42 (±2.80)° extension for right-handed persons. The significance level was 0.005, which was statistically significant. Regarding the times of writing activities by the dominant hand, left-handed persons took an average 11.71 (±2.36) sec, and right-handed persons took an average 10.98 (±1.32) sec. The significance level was 0.35, significant difference. Regarding gender differences in wrist flexion, men carried out the writing activities with an average wrist extension of 2.71 (±10.38)°, and women with an average wrist extension of 3.22 (±7.56)° in average. The significance level was 0.891, showing no significant statistical difference. Regarding gender differences in times by gender, men took an average 11.58 (±2.26) sec, while women averaged 11.10 (±1.53) sec. The significance level was 0.54, showing no statistically significant difference (Table 2).

DISCUSSION

Ninety percent of the population is the right-handed and most living environments are designed for the right-handed. Designs focused on the right-handed cause lots of difficulties for left-handed persons, but studies of this issue are rare. Accordingly, this study investigated the functional aspects of the left-handed through writing activities, the most distinct human characteristics. According to the results of the writing activities, the dominant hand affects wrist joint flexion irrespective of gender, but there was no time difference in the writing activities of the dominant hand. That is, when the left-handed carry out writing activities, they have greater wrist flexion than the right-handed.

For the writing task, we used the Jebsen-Taylor Hand Function Test, which is a standardized and much used upper limb performance test.

According to Chew et al., loads depend on position and movement of wrist. As static loads continue and the position is more related with reflection like flexing and grip, the more loads are received. In the study of King et al., subjects performed tasks wearing an orthotic device to prevent wrist flexion and reported that the orthotic device increased grip strength. Namely, if a left-handed person continues writing with wrist flexion, grip strength may be weakened. Many studies have reported that writing with the left hand increased wrist flexion and wrist load, posing a risk to the health of the upper limb.

This study had several limitations. First, although it was basic research of the potential risks for the normal left-handed, actual problems caused by the left-handedness were not confirmed. Second, this study provided uniform desks and chairs not considering the heights of the study subjects. The heights of the desk and chair could have affected the writing, but they were not considered in this study. Finally, the number of study subjects excluding the right-handed group was 12 persons, which is insufficient to represent the total population of the left-handed. Therefore, subsequent research should use larger numbers of study subjects and adjust the environment, e.g. the heights of desks and chairs, to individual characteristics. Future studies should also select subjects with diseases or problems arising from left hand use, as well as normally healthy subjects.

ACKNOWLEDGEMENT

This work was supported by grant from Inje University, 2011.

REFERENCES


Table 1. General characteristic

<table>
<thead>
<tr>
<th>Gender</th>
<th>Participants (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>12 (48%)</td>
</tr>
<tr>
<td>Female</td>
<td>13 (52%)</td>
</tr>
<tr>
<td>Dominant hand</td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>12 (48%)</td>
</tr>
<tr>
<td>Right</td>
<td>13 (52%)</td>
</tr>
<tr>
<td>Age</td>
<td>21.72 (±1.65)</td>
</tr>
</tbody>
</table>

Table 2. Wrist flexion and performance time

<table>
<thead>
<tr>
<th></th>
<th>Left (n=12)</th>
<th>Right (n=13)</th>
<th>Male (n=12)</th>
<th>Female (n=13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion (degree)</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
</tr>
<tr>
<td></td>
<td>2.92 ± 9.42*</td>
<td>–8.42 ± 2.80*</td>
<td>–2.71 ± 10.38</td>
<td>–3.22 ± 7.56</td>
</tr>
<tr>
<td>Time (sec)</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
</tr>
<tr>
<td></td>
<td>11.71 ± 2.36</td>
<td>10.98 ± 1.32</td>
<td>11.58 ± 2.26</td>
<td>11.10 ± 1.53</td>
</tr>
</tbody>
</table>

*Significant difference < 0.0