The Effects The Type of Canes-Handle Affects in Recovering-Balance of Hemiplegic patients

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Purpose: We compared T-type and I-type canes on postural balance in 28 hemiplegic patients.

Methods: Subjects were allocated randomly into two groups: a T-shape cane group (n=14) and an I-shape cane group (n=14). Before the test, subjects were trained by a physical therapist to walk with a cane for 6 weeks. The Main Outcome Measures were measured as maximal sway velocity, sway path, sway area, and partial weight bearing using a Balance Performance Monitor (BPM) and ambulation velocity using a 'Timed up and go test'. We also measured the maximal ambulation velocity.

Results: The distribution of weight bearing on the affected side without the cane was 35% in the I-shape cane group and 36% in the T-shape cane group. After training, weight bearing on the affected side increased by 45% in the I-shape cane group and 40% in the T-shape cane group. With the cane held in the hand, weight bearing on the affected side in the T-shape cane group decreased by 3%.

Conclusion: The I-shaped cane increased static standing balance, including hemiplegic side weight bearing. Therefore, I-shape canes can improve the balance of hemiplegic patients.

Key Words: Cane, Hemiplegic patient, Rehabilitation, Weight bearing

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I. Introduction

Hemiplegia can lead to motor disturbances, including position asymmetry, poor body balance, defective weight transfer ability, and loss of specialized motor elements, used to perform delicate functions (Holt et al., 2000; Laufer, 2000; Rodriguez & Aruin, 2002). Hemiplegic patients have numerous problems with posture and balance in everyday life (Shumway-Cook & Woollacott, 2001). Maintaining balance is critical for most activities, and balance problems usually occur in patients with neurologic diseases or damage (Walker et al., 2000). Likewise, unstable standing in hemiplegic patients after a stroke also produces abnormal ambulation, and improving weight bearing on the affected
leg can improve standing stability (Arcan et al., 1977; Walker et al., 2000; Shumway-Cook et al., 1988). According to Bohannon and Larkin (1985), hemiplegic patients lean 80% of their weight on the unaffected side. This weight distribution increases asymmetry by controlling the lower limbs on the unaffected side. Weight movement training can improve symmetric posture and gait patterns, whereas asymmetric weight bearing reduces movement and patient function (Geurts et al., 2004; Bobath, 1990; Di Fabio & Badke, 1990; Vearrier et al., 2004).

A cane can assist patients during walking training. More than 25% of adult hemiplegic patients use a walking assistance implement that is similar to a cane (Yi & Kim, 1996). When deciding cane length, Dean & Ross (1993) asserted that education training should be involved. James et al. (2005) claimed that the weight bearing rate of lower limbs on the unaffected side decreases by about 25% when the patient uses a cane, reducing imbalance on the bilateral lower limbs. According to Enrique et al. (2005), the cane negatively affects weight bearing on the unaffected side and balance during static exercise. Cane use can reduce fatigue, increase arm strength, protect the lower limbs, and increase balance, as well as widening the supporting area. Expanding the supporting area improves problems such as pain, fatigue, labyrinthine sense, stability, and over-compensation of weight (Ragnarsson, 1988).

For the balance of weight, longer cane length decreases the elbow angle to raise tension in the Lumbodorsal fascia, as the back functional line (BFL) and front functional line (FFL). This moves the center of gravity toward the non-affected side, as occurs when a player serves a ball during a tennis match. In that case, the height of the rising hand and the ipsilateral iliac crest both rise, shifting weight to the affected side (Thomas, 2001). Similarly, weight bearing on the non-affected side should increase as the cane grip is raised.

II. Methods

1. Participants

We studied 28 hemiplegic patients who consented to this research. We provided patients with detailed information about the cane before the study. Patients were hemiplegic because of cerebral infarction or cerebral hemorrhage, able to walk with a cane, could understand and respond to instructions, and did not have orthopedic problems that could affect measurements. Subjects were allocated randomly into two groups based on handle shape: a T shape or an I shape. The T-shaped cane was a femur-high trochanter and the I shape cane was 1.5 m high, at the patients’ shoulder, and bar shaped. This custom cane shape was registered as a new design in Korea by Lee Sang-yoeol (2006). Participant characteristics are summarized in Table 1.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>I-shape cane group (Mean±SD)</th>
<th>T-shape cane group (Mean±SD)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of individuals(male/female)</td>
<td>10/4</td>
<td>8/6</td>
<td>0.732</td>
</tr>
<tr>
<td>Side of hemiparesis</td>
<td>Rt.: 2</td>
<td>Rt.:2</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>Lt.: 12</td>
<td>Lt.:12</td>
<td></td>
</tr>
<tr>
<td>Age (year)</td>
<td>53.42±7.65</td>
<td>47.42±6.13</td>
<td>0.132</td>
</tr>
<tr>
<td>Time since stroke (mon.)</td>
<td>11.85±2.54</td>
<td>12.00±2.16</td>
<td>0.912</td>
</tr>
<tr>
<td>BMI (kg/cm²)</td>
<td>21.37±1.68</td>
<td>21.44±2.58</td>
<td>0.952</td>
</tr>
</tbody>
</table>

* p<0.05

2. Measurement

Patient’s height and weight were measured before training (with or without cane), after training (6 weeks), and at follow up (7 weeks). All measurements were repeated 3 times and then averaged.

1) Standing balance

The reliability of Balance Performance Monitor (BPM) has already been reported by Hinman(1997) in a study using 31 healthy adult subjects. And the intra-rater reliability of BPM of measurements in poststroke adults were reported by Sackley et al (2005). Between-test reliability for sitting symmetry was high(ICC(1,1)=0.93) and for weight-shift activity was also high(ICC(1,1)=0.86). We used the BPM to measure static standing balance with feet spread 4 inches apart and sight fixed to the front at a height of 15 degrees(Kerr & Eng, 2002). We measured balance with and without the cane for the 30 seconds. We recommended the subjects to focus on the fore part point. Two canes at
the same angle were used to provide an equal base of support, but grip height was at scapula level for I-shaped canes, and at the level of the patient’s greater trochanter in the T-shape cane group.

Patients were instructed to use the canes during exercise time with their therapist, which involved walking and ascending stairs more than 2 hours a day for 6 weeks. We collected measurements of maximal sway velocity, sway path, sway area, and rate of weight bearing on the affected side after the 6-week training course.

2) Ambulation velocity
Timed up and Go test (TUG)
A chair with an armrest was put in the middle of the 4 x 6 m measurement area. The patient is seated in the chair with their feet in line on the floor in front of the chair. The patient needed to walk 3 m to a sign and back to the chair as fast as possible for the stand up and go test (Podsiadlo & Richardson, 1991).

Maximal ambulation velocity
The maximal ambulation velocity was measured with the most stabilized gait. Patients walked for 14 m, with the first and last 4 m excluded, and time measured from passing the start line to reaching the finish line (Steffen et al, 2002).

3. Data Analysis
Data analysis was performed with SPSS version 12.0. An independent T-test was performed to compare the I-shape and T-shape groups, with repeated-measure ANOVA used to test differences before training, after training (6 weeks), and at follow up (7 weeks), with Bonferroni post tests. Parameters with and without canes were analyzed by a paired T-test. The threshold of significance was set at the 0.05 level.

III. Results
1. Parameters with I- and T–shape canes before training
We measured postural balance between the I-and T-shape cane groups before training using maximum sway velocity, sway path, sway area, and weight bearing on the affected side. The maximum sway velocity, sway path sway area, and weight bearing on the affected side were not significantly different in the two groups. Similarly, the maximum ambulation velocity and TUG were not significantly different (Table 2).

Table 2. The comparison of the measurements without cane in before training

<table>
<thead>
<tr>
<th>Parameters</th>
<th>I-shape cane group (Mean±SD)</th>
<th>T-shape cane group (Mean±SD)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSV (mm/s)</td>
<td>54.00±13.07</td>
<td>59.00±13.26</td>
<td>0.491</td>
</tr>
<tr>
<td>SP (mm)</td>
<td>388.28±75.47</td>
<td>406.14±61.66</td>
<td>0.637</td>
</tr>
<tr>
<td>SA (mm²)</td>
<td>493.57±154.97</td>
<td>499.71±207.14</td>
<td>0.951</td>
</tr>
<tr>
<td>WB (%)</td>
<td>35.85±4.48</td>
<td>36.35±4.41</td>
<td>0.806</td>
</tr>
<tr>
<td>TUG (s)</td>
<td>31.94±1.87</td>
<td>31.48±3.02</td>
<td>0.739</td>
</tr>
<tr>
<td>MAV (m/s)</td>
<td>0.24±0.01</td>
<td>0.25±0.02</td>
<td>0.277</td>
</tr>
</tbody>
</table>

* p<0.05
MSV: maximal sway velocity, SP: sway path, SA: sway area, WB: weight bearing
TUG: Timed up and go test, MAV: maximal ambulation velocity

2. Parameters with or without canes before training
The maximum sway velocity, sway path, sway area, TUG, and maximum walking velocity were not significantly different regardless of the use of a cane. Weight bearing on the affected side in the T-shape group was not different (36.35%±4.4% versus 33.69%±4.40%), but was significantly
higher in the I-shape cane group (45.97%±1.36% vs 35.85%±3.48%) (Table 3).

Table 3. The comparison of the measurements with cane in before training

<table>
<thead>
<tr>
<th>Parameters</th>
<th>I-shape cane group (Mean±SD)</th>
<th>T-shape cane group (Mean±SD)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSV (mm/s)</td>
<td>44.42±9.57</td>
<td>46.85±8.68</td>
<td>0.983</td>
</tr>
<tr>
<td>SP (mm)</td>
<td>273.57±58.31</td>
<td>299.28±37.25</td>
<td>0.884</td>
</tr>
<tr>
<td>SA (mm²)</td>
<td>331.14±119.34</td>
<td>350.57±141.60</td>
<td>0.997</td>
</tr>
<tr>
<td>WB (%)</td>
<td>45.97±3.36</td>
<td>33.69±4.40</td>
<td>0.000*</td>
</tr>
<tr>
<td>TUG (sec)</td>
<td>34.32±1.79</td>
<td>33.37±2.83</td>
<td>0.210</td>
</tr>
<tr>
<td>MAV (m/s)</td>
<td>0.228±0.03</td>
<td>0.251±0.02</td>
<td>0.210</td>
</tr>
</tbody>
</table>

Values with different superscripts in the same column are significant at the 0.05 level.

3. Parameters with I- and T–shape canes after training

Static postural balance without a cane was measured after 6 weeks of training. There were significant differences between the I- and T-shape cane group for maximum sway velocity (I-shape cane group: 34.28±6.04 vs. T-shape cane group: 46.85±9.04), sway path (I: 215.57±35.68 vs. T: 302.57±38.99) and weight-bearing on the affected side (I: 45.77±1.82 vs. T: 40.88±1.73). However, sway area, TUG, and maximum ambulation velocity were not different (Table 4).

Table 4. The comparison of the I- and T-shape cane group after training

<table>
<thead>
<tr>
<th>Parameters</th>
<th>I-shape cane group (Mean±SD)</th>
<th>T-shape cane group (Mean±SD)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSV (mm/s)</td>
<td>34.28±6.04</td>
<td>46.85±9.04</td>
<td>0.018*</td>
</tr>
<tr>
<td>SP (mm)</td>
<td>215.57±35.68</td>
<td>302.57±38.99</td>
<td>0.002*</td>
</tr>
<tr>
<td>SA (mm²)</td>
<td>331.14±119.34</td>
<td>350.57±141.60</td>
<td>0.185</td>
</tr>
<tr>
<td>WB (%)</td>
<td>45.77±1.82</td>
<td>40.88±1.73</td>
<td>0.000*</td>
</tr>
<tr>
<td>TUG (sec)</td>
<td>19.36±2.58</td>
<td>22.10±3.69</td>
<td>0.070</td>
</tr>
<tr>
<td>MAV (m/s)</td>
<td>0.238±0.02</td>
<td>0.337±0.020</td>
<td>0.159</td>
</tr>
</tbody>
</table>

* p<0.05
MSV: maximal sway velocity, SP: sway path, SA: sway area, WB: weight bearing
TUG: Timed up and go test, MAV: maximal ambulation velocity

We measured maximum sway velocity, sway path, sway area, weight bearing on the affected side, TUG, and maximum ambulation velocity before training, after 6 weeks of training, and at 7 weeks (6 weeks using the cane and one more week without using the cane). These parameters were significantly different in the I-shape cane group at these times. (p<0.05). Although the T-shape cane group was significantly different on 3 occasions, there was no significant difference between 6 weeks of training at follow up (Table 5).
IV. Discussion

Most hemiplegic patients have problems standing and balancing that result from asymmetric weight-bearing and impaired equilibrium capacity (Geurts et al., 2004). Asymmetric and unstable standing balance, as well as abnormal gait patterns, can appear in hemiplegic patients after brain injury and are important considerations during rehabilitation. Decreased weight bearing on the affected side can impair motor function. Moreover, in hemiplegic patients, unstable standing position and abnormal gait patterns increase the risk of falling (Cheng et al., 2001, Eng & Chu, 1993).

The use of gait-assisting instruments can prevent falling and improve gait. Many (25%) hemiplegic patients use gait-assisting instruments such as a cane (Blunt, 1956). These instruments can improve speed, control, reduce fatigue, and increase balance and the support base (Bateni & Maki, 2005). Moreover, these instruments improve pain, fatigue, equilibrium, and safety by expanding the base of support. The use of a cane could improve both spatial and temporal factors as well as gait patterns in hemiplegic patients (Olsson et al., 1990). However, James (2005) and colleagues reported that the common T-shaped cane decreased weight-bearing on the affected side and reduced the applied force on the hip joint, which are important for orthopedic patients but not hemiplegic patients.

Here, a T-shaped cane decreased maximal sway velocity, sway path, and sway area during static balance, but biased weight bearing to the unaffected side. Thus, the use of a T-shaped cane may reduce uneasiness, but increase dependence on the unaffected side (Deathe et al., 1993). Alternatively, an I-shaped cane not only decreased maximal sway velocity, sway path, and sway area, but also decreased imbalances in weight bearing, especially after training, whereas training made no difference for the T-shaped cane. These results suggest that the use of an I-shaped cane during everyday life can help train patients to bear weight on the affected side.

In fact, hemiplegic patients can physically support weight-bearing on the affected side, but often do not because of the uneasiness of falling. The T-shaped cane decreased these feelings of uneasiness, but did not dramatically improve the balance of weight-bearing (Kuan et al., 1999).

Balanced weight-bearing is important to improve gait (Enrique et al. 2005). Patient training to improve weight balance could improve gait symmetry. However, the use of a cane also decreased gait velocity.

We found that both cane types improved postural sway immediately after use, which should increase their base of support and reduce falling risk, as indicated by Jeka (1997). However, after 6 weeks, both cane types decreased maximum sway velocity, sway path, and sway area, with the I-shaped cane more effective for postural sway, in agreement with weight-bearing studies of Sackley (1990) and Di Fabio (1990).

Patients indicated that the I-shaped cane made wheelchair use and navigating narrow passages difficult, but that group showed improved posture and reduced dependence on the unaffected side. Thus, the I-shaped cane seems to improve posture, but further studies are needed to verify this conclusion.

V. Conclusion

An I-shape cane increases static standing balance and improves weight bearing on the affected side. Therefore, an I-shape cane could improve the balance of hemiplegic patients.

Reference


