Walking Cycle after Stroke

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Recent studies on quantitative gait analyses of hemiparetic patients have indicated that temporal-distance parameters are clinically useful indicator for assessment of their gait performance and monitoring of functional recovery (Knutsson and Richards 1979; Wall and Ashburn 1979; Glasser 1986; Holden et al. 1986; Wall and Turnbull 1986). However, in most of the reports the data were gathered from patients who had suffered stroke more than 3 months previously. Since walking speed of stroke patients improves over the first 12 weeks and there is little consistent improvement after 3 months (Wade et al. 1987), it is important for making physical therapy program to analyze what changes are taking place in gait parameters during early recovery phase (Mizrahi et al. 1982; Brandstater et al. 1983). This study records improvement of gait parameters in the first 8 weeks after starting gait training in post-stroke patients.

Ten hemiparetic patients, four males and six females aged from 44 to 70 years, participated in the study. The duration from the onset of stroke to the start of gait training was 2.1 (range : 1.2–4.5) months. The method used to examine gait parameters, maximum walking speed, walking rate and stride length, was previously reported (Nakamura et al. 1985). The measurements were performed prior to the start (0 week), in the middle (4 weeks), and at the end (8 weeks) of ordinary physical therapy program with gait training. Also the stage of motor recovery of...
the affected lower limb was assessed at each measurement using the method of Brunnstrom (1970).

Table 1 presents means and standard deviations of the gait parameters. There was a significant difference in each variable between the three measurements ($p < 0.01$). Correlations of walking speed with walking rate and stride length were statistically significant in each measurement ($p < 0.05$). Demographic variables such as age, sex, body weight, height, duration of illness and stage of motor recovery, that might influence the gait parameters were examined using stepwise regression analysis. Both at 0 and 8 weeks, a consistent relationship was noted between each of the gait parameters and duration of illness with the exception of stride length at 0 week. At 4 weeks walking speed and stride length depended primarily upon the stage of motor recovery, but walking rate depended upon duration of illness. These results confirmed previous reports that improvement of gait performance took place rather rapidly during early recovery phase (Wade et al. 1987) and was coupled with recovery of muscle strength of paretic limb (Nakamura et al. 1985; Bohannon 1986), and that the longer a patient took to start walking the less he was to regain normal gait performance (Wade et al. 1987).

Fig. 1 shows the relation of walking rate and stride length to walking speed. The slope of regression equation between walking speed and walking rate is rather steep when walking speed is less than 20 m/min, i.e., walking rate less than 90 steps/min, whereas relation of walking speed to stride length is simple. Since walking speed = walking rate $\times$ stride length by definition, correlation coefficient of increase in these variables between the measurements were calculated. The increase of walking speed correlated significantly with that of walking rate between 0 and 4 weeks ($p < 0.05$), but not between 4 and 8 weeks. On the contrary, the increase of walking speed was definitely related to that of stride length between 0 and 4, and 4 and 8 weeks ($p < 0.01$). There was no significant correlation between the increases of walking rate and of stride length. It seems that the
increases of walking rate and of stride length contribute to the increase of walking speed within 4 weeks after starting of gait training, but the increase of walking speed is mainly acquired by the increase of stride length after 4 weeks. However, as shown in Fig. 1 the extent of increase in walking rate depends upon the walking speed, a further analysis is necessary to obtain a definite conclusion. After dividing the data into two groups based on walking speed, one with walking speed less than and the other greater than 20 m/min (n = 11 and 9, respectively), correlation coefficients between the increments of each variable were calculated. In the group with walking speed less than 20 m/min, all the correlations of increase in walking speed with those in walking rate and with stride length were significant (p < 0.01), while the correlation between walking rate and stride length was not. Both walking rate and stride length appeared to be a variable that determined independently walking speed in these patients. In the group with walking speed greater than 20 m/min, the correlation was significant only between the increase of walking speed and that of stride length (p < 0.01). These results indicate that a limiting factor of walking speed in hemiparetic patients with walking speed greater than 20 m/min is the decreased stride length.

References


