The Correlation of Gait Velocity, Cadence and Gait Quality Parameter Using Points of Gait Quality Chart (GQC) Items in Hemiplegic Patients

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Abstract. [Purpose] We investigated the gait velocity and cadence using the gait quality chart (GQC), and verified the accuracy of the GQC which is often used by therapists in the evaluation. [Subjects] Participants who met the criteria for this study (n=30). [Methods] To evaluate the gait velocity, cadence and assessment by GQC in this study, the patients were asked to walk a distance of 13 m. Mean values were used in the analysis, and measurements were repeated three times. [Results] There was a significant, positive correlation between gait velocity and cadence, showing that cadence increased as the gait velocity increased. For the correlations between the gait velocity and the GQC items, and cadence and the GQC items, significant, positive correlations were found with the ankle, knee, and the trunk/arm items, but not with the hip/pelvic ratio, indicating that the gait quality was higher as the gait velocity increased. [Conclusion] The results show that the items that are observed at the hip/pelvis cannot be accurately observed because of the small angular joint movement and rapid motion, even though the general qualitative displacements of the GQC provide subjective data that can give results similar to those obtained by the scientific measurement tools.

Key words: Gait Quality Chart, Hemiplegic patients

INTRODUCTION

Ideal gait is translational motion in which the body moves stepwise in a certain direction with movement of the upper and lower extremities maintaining the needed velocity. It requires appropriate joint range of motion (ROM) for alternative movement, efficiency for minimizing fatigue, and stability to prevent falls, while the head, neck and trunk are maintained in normal alignment with each other1).

Motor disorder due to hemiplegia makes normal gait difficult. Hemiplegic patients use compensatory actions to cope with their situation and show asymmetrical gait2). Thus, they cannot keep normal balance, and inefficient energy consumption takes place3). For these reasons, the gait velocity of hemiplegic patients is poorly maintained, and their energy consumption is increased. Because of insufficient gait ability, hemiplegic patients choose a gait velocity that requires the least energy consumption, which serves as a factor that significantly reduces the stability of gait and the gait cycle, changing gait symmetry and weight distribution. Qualitative parameters of proven importance for the evaluation of the gait performance of hemiplegic patients have been derive from objective data, thanks to the development of technology. However, in addition to qualitative parameters, quantitative parameters are also important factors for gait assessment. The qualitative parameters are directly related with the ADL in hemiplegic patients, and they are important factors that are highly correlated with the quantitative parameters. Although the qualitative variables are evaluated using objective measuring equipment such as three-dimensional analysis, economical and spatial restrictions limit such measurements. The Gait Quality Chart (GQC) is one of the methods used for qualitative evaluation and it is an objective and highly reliable assessment tool with which a therapist can simply observe and assess a patient’s gait without special equipment or facilities4).

Therefore, in this study, we investigated the qualitative items at each joint that can affect the qualitative gait improvement of hemiplegic patients by studying the correlations among the qualitative evaluation items, the gait velocity and cadence using the Gait Quality Chart, in order to verify the accuracy of the Gait Quality Chart which is often used by therapists for evaluation.
SUBJECTS AND METHODS

The subjects were 20 males (66.7%) and 10 females (33.3%), and their average age was 55.66 ± 12.90 years, their average height was 163.93 ± 7.59 cm, and their average weight was 66.40 ± 9.29 kg. The cause of stroke was infarction for 14 subjects (46.7%) and hemorrhage for 16 (53.3%). Fifteen subjects (50%) had left hemiplegia, the other fifteen (50%) had right hemiplegia. The average gait level of the subjects was 3.20 ± 0.92 points by the Functional Ambulatory Category, and 3.46 ± 1.19 points by the Modified Motor Assessment Scale. The average gait velocity of the subjects was 0.46 ± 0.26 m/s, and their average cadence was 78.93 ± 18.49 steps/min. On the Gait Quality Chart, the average scores were 6.73 ± 2.91 for the ankle joint, 4.23 ± 1.61 for the knee joint, 1.26 ± 1.22 for the hip/pelvis, and 2.40 ± 1.30 for the trunk/arm. Informed consent indicating voluntary participation was received from each of the subjects.

To evaluate the gait velocity in this study, the patients were asked to walk a distance of 13 m, and the time taken to walk 10 m excluding the 1.5 m from the point of start and the point of arrival, was measured. The mean value of 3 trials was used in the analysis 3). To measure the cadence, we applied the modified 12-minute walking method. The cadence was calculated while walking for two minutes on flat ground. The mean value of 3 trials was used in the analysis 3).

The Gait Quality Chart assessment scores the movement of the ankle joint, knee joint, and hip joint on the affected side, and the ratio of the trunk movement to the arm sway during gait. This evaluation method shows a high reliability (r=0.87). Except the initial contact item (0–2 point), each of the items range from zero (strongly expressed) to three points (absent). The total number of items is 13 and the maximum score is 41 points, including 0–14 for the ankle joint, 0–9 for the knee joint, 0–12 for the hip/pelvic ratio, and 0–6 for the trunk/arm ratio 3). The detailed items of the assessment are shown in Appendix 1. To evaluate the objectification of Gait Quality Chart, the gait of the subjects was recorded on video clips and shown to 10 physical therapists so that they could evaluate it for the individual items. The mean values were used in the analysis.

The data obtained in this study was analyzed using SPSS 12.0 for Windows software, and the significance level α was chosen as 0.05. We recorded the general characteristics, medical history characteristics, the Function Ambulatory Category, and the Modified Motor Assessment Scale. For the gait velocity, cadence, and the Gait Quality Chart results, we calculated the frequency of the movement and the mean values. The correlations among the gait velocity, cadence and the gait quality items were analyzed using Pearson’s correlation coefficient.

RESULTS

There was a significant, positive correlation between the gait velocity and the cadence (p<0.05), showing that the cadence increased as the gait velocity increased. For the correlations between the gait velocity and the Gait Quality Chart items, significant, positive correlations were found with the ankle joint, knee joint, and the trunk/arm (p<0.05), but not with the hip joint/pelvic ratio, indicating that the gait quality was higher as the gait velocity increased. With respect to the correlations between the cadence and the Gait Quality Chart items, significant, positive correlations were found with the ankle joint, knee joint, and the trunk/arm (p<0.05), but not with the hip joint/pelvic ratio, indicating that the gait quality was higher as the cadence increased (Table 1).

DISCUSSION

This study assessed the correlations among the gait velocity, cadence and the Gait Quality Chart qualitative factors in the gait of hemiplegic patients. The results show that there were significant, positive correlation among the gait velocity, cadence and the Gait Quality Chart qualitative factors of the ankle joint, knee joint, and the trunk/arm (p<0.05), but not the hip joint/pelvic ratio, indicating that the quality of gait increased as the gait velocity and cadence increased. These results were consistent with the correlations between the quantitative gait parameters and the qualitative gait parameters found by Pizze et al. 7)

However, there was no correlation between the gait velocity or cadence and the qualitative measurers of the hip joint/pelvis, including pelvis retraction, hip extension during stance, weight acceptance, and circumduction during swing. This result was different from that of a previous study in which measurement equipment was employed 7). This result implies that items that show relatively small angular movement such as pelvis retraction are poorly evaluated by the visual judgment of therapists. Moreover, it indicates that the physical factors that are observed at the

| Table 1. Correlation of gait velocity, cadence and quality of gait |
|------------------|------|------|------|------|------|
|                  | GV   | Cd   | Ankle| Knee | Hip/Pelvis | Trunk/Arm |
| GV               | .710*| .719*| .708*| .152 | .678*      |
| Cd               | .615*|       | .663*| −.141| .627*      |
| Ankle            | .851*|       |      | −.114| .711*      |
| Knee             |      |       |      |      |            |
| Hip/Pelvis       |      |       |      |      | .103       |
| Trunk/Arm        |      |       |      |      |            |

p<0.05; GV : Gait Velocity; Cd : Cadence. NOTE: Each value is the Pearson’s correlation coefficient.
sole of a foot during gait including weight acceptance are poorly judged.

This result shows that the items that are observed at the hip joint/pelvis cannot be accurately observed because of the small angular joint movement and rapid motion, even though the general qualitative displacements of the Gait Quality Chart provide subjective data that can give the results that are similar to those obtained by scientific measurement tools. Therefore, require improvement to be of use in items of the Gait Quality Chart related to the hip joint/pelvis for the qualitative evaluation by therapists.

REFERENCES