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Difference in gait recovery rate of hemiparetic stroke patients according to paralyzed side

A cross-sectional study based on a retrospective chart review

Cheol-Hyun Kim, MD(KMD), PhD[a], Hongmin Chu, MD(KMD)[a], Geon-Hui Kang, MD(KMD)[b], Kang-Keyng Sung, MD(KMD), PhD[a,c], Dae Gill Kang, PhD[d], Ho Sub Lee, MD(KMD), PhD[d], Sangkwan Lee, MD(KMD), PhD[a,b,d,*]

Abstract

In *Donguibogam*, a representative encyclopedic source of knowledge on traditional Korean medicine, left-sided hemiparesis due to stroke is called "Tan" as a sort of "Heyol-Byeong," while right-sided hemiparesis due to stroke is called "Tan" as a sort of "Gi-Byeong." According to the theory of *Donguibogam*, diseases on the left or right side of the human body must be treated differently. Clinically, the symptoms caused by left and right hemisphere lesions in stroke patients differ, as the functions of the left and right hemispheres differ. Considering these facts, when treating patients in clinical practice, it may be useful to distinguish between diseases on the left or right side according to *Donguibogam*. This study set out to confirm whether side-dependent gait rehabilitation could be used to treat hemiparetic stroke patients. Gait was selected for analysis, as it is the most important factor in returning stroke patients to daily life.

This study conducted a retrospective chart review of stroke patients who satisfied the following criteria: outpatient or inpatient at the Wonkwang University Korean Medicine Hospital in Gwangju (WKUGH) with hemiparesis due to stroke; aged between 19 and 85 years old; with a stroke onset within the past 6 months; having undergone gait analysis (GAITRite) more than twice between September 1, 2017 and June 30, 2018 at the WKUGH, with a minimum 2-week interval between the first and next gait analysis; right-handed stroke patient; able to walk unaided. The spatio-temporal parameters for analysis included the FAP, walking velocity, step length, stance time, and swing time as obtained with GAITRite.

In the initial gait analysis, there was no significant difference between the 2 groups in all spatio-temporal parameters. However, in the follow-up gait analysis, the left hemiparesis group showed a significantly higher FAP and faster walking velocity than the right hemiparesis group.

This study found a difference in the recovery rate between the left and right hemiparesis groups. Based on this, we suggest that a different treatment strategy for gait rehabilitation can be used according to the paralyzed side.

This study was approved by the Institutional Review Board (IRB) of the Wonkwang University Korean Medicine Hospital in Gwangju (WKUGH), Republic of Korea (WKIRB 2018 – 25, November 28, 2018). This trial was registered with the Clinical Research Information Service (CRIS) of the Korea National Institute of Health (NIH), Republic of Korea (KCT0002984).

Abbreviations: CRIS = Clinical Research Information Service, FAC = functional ambulation category classification, FAP = functional ambulation profile, IQR = interquartile range, IRB = Institutional Review Board, MMT = manual muscle testing, NIH = National Institute of Health, S-W test = Shapiro-Wilk test, TKM = traditional Korean medicine, WKUGH = Wonkwang University Korean Medicine Hospital in Gwangju.

Keywords: gait analysis, stroke, traditional Korean medicine

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[a] Department of Internal Medicine and Neuroscience, College of Korean Medicine, Wonkwang University, Iksan, Jeonbuk, [b] Clinical Trial Center, Wonkwang University Gwangju Hospital, Gwangju, [c] Internal Medicine and Neuroscience, Jangheung Integrative Medical Hospital, Wonkwang University, Jangheung, Jeonnam, [d] Hanbang Cardio-Renal Syndrome Research Center, College of Oriental Medicine, Wonkwang University, Iksan, Jeonbuk, Republic of Korea.

[*] Correspondence: Sangkwan Lee, Department of Internal Medicine and Neuroscience, College of Korean Medicine, Wonkwang University, Iksan, Jeonbuk 54538, Republic of Korea (e-mail: sklee@wku.ac.kr).

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1. Introduction

Despite the development of acute care and rehabilitation for stroke, 70% to 80% of post-stroke patients today have a chronic dysfunction.[1] This lowers the quality of life not only of stroke patients, but also of the family members who support them, placing a great burden on the nation.[1] Therefore, there is a constant need for new treatment strategies to minimize stroke sequelae.

In traditional Korean medicine (TKM), stroke is called Jung-pung.[2] In the Wind Chapter of *Donguibogam* about TKM, left hemiparesis due to stroke is called "Tan" or "Hyeol-Byeong" while right hemiparesis due to stroke is called "Tan" or "Gi-Byeong", and it is emphasized that treatment should differ according to the side of the paralysis.[2]

In modern times, it is well known that the functions of the left and right hemispheres of the brain differ, and that symptoms also differ depending on which hemisphere has a lesion.[3,4] For example, aphasia is mostly caused by left hemisphere lesions, as 90% of right handers' dominant language area is in the left hemisphere.[3] Meanwhile, hemineglect is a symptom related to the dysfunction of the right hemisphere. Therefore, it mostly appears as left hemineglect.[4] The recovery prognosis may also differ depending on which hemisphere the lesion is in. The transfer effect is one example[5]: it is a strategy to induce function acquisition in the other side limb though functional training of the limb on one side, and is reported to be more prominent in left handers than in right handers.[5] These previous findings suggest that the concept of distinction between left and right disease within the same disease can be applied to the treatment of modern diseases.

The aim of this study was to investigate whether the concept of distinguishing between left and right disease could be applied to stroke rehabilitation therapy for post-stroke patients. Gait was selected for analysis as it is the most important factor in returning post-stroke patients to daily life.[6] Although some studies have observed the gait recovery progress of post-stroke patients[7,8] and have compared the gait of normal subjects with that of post-stroke patients,[9,10] none have considered the gait recovery prognosis of post-stroke patients according to the paralyzed side. One study[11] reported that the motor function recovery prognosis did not differ between left and right hemiparesis due to stroke. However, that study[11] only assessed whether maximal, moderate, or minimal assistance was needed during gait; it did not perform a precise analysis using spatio-temporal parameters. If our study finds a difference between the gait recovery prognosis of post-stroke patients with left and right hemiparesis, it may provide grounds for distinguishing between left and right disease in the actual gait rehabilitation of post-stroke patients. We report our findings, as our gait analysis of post-stroke patients using spatio-temporal parameters yielded meaningful results.

2. Materials and methods

2.1. Subjects

At the Wonkwang University Korean Medicine Hospital in Gwangju (WKUGH), gait analysis is included as part of the regular treatment process to improve the gait of post-stroke patients. This study conducted a retrospective chart review of the gait analysis results of subjects who satisfied the inclusion criteria listed below. This study was approved by the Institutional Review Board (IRB) of the WKUGH (WKIRB 2018 – 25, November 28, 2018) and was registered with the Clinical Research Information Service (CRIS) of the Korea National Institute of Health (NIH), Republic of Korea (KCT0002984).

2.2. Sample size

As this study was a retrospective chart review, all subjects who satisfied the inclusion and exclusion criteria were included.

2.2.1. Inclusion criteria. The gait analysis results of patients who received TKM and rehabilitation treatment between 1 September 2017 and 30 June 2018 and who met the following criteria were included in the analysis.

(1) Patients diagnosed with cerebral infarction or cerebral hemorrhage through radiological imaging at a medical institution and who had hemiparesis
(2) Patients aged 19 to 85
(3) Patients whose stroke onset was not older than 6 months
(4) Patients who undertook 2 or more gait analyses at the WKUGH, with a minimum interval of 2 weeks between them
(5) Right-handed patients
(6) Patients able to walk unaided; functional ambulation category classification (FAC)[12] 3 to 4

2.2.2. Exclusion criteria. Patients with difficulty walking due to other diseases, such as musculoskeletal diseases.

2.3. Gait analysis system – GAITRite (CIR system Inc.)[13] (Fig. 1)

GAITRite is a device that can obtain spatio-temporal parameters using a 6m-long mat with pressure-sensitive sensors during walking (Fig. 1A). When a subject walks on the GAITRite mat, the mechanical pressure applied activates the sensor within the mat. The activated sensor stores each footfall as an electronic recording. The records stored through the sensor are transferred to the GAITRite computer software (version 4.8.5), and spatio-temporal parameters such as the functional ambulation profile (FAP), walking velocity, step length, swing time, and stance time are calculated based on this (Fig. 2, Table 1).

2.4. Gait analysis process

The subject walked on the 6m-long GAITRite mat at his/her preferred speed, that is, at the speed at which he/she felt most comfortable walking. The preferred speed was determined by the gait training performed as part of the subjects' rehabilitation therapy. The spatio-temporal parameters during walking were obtained through the above process. The procedure was carried out by 2 skilled Korean medical doctors and was repeated twice to improve the quality of the measurements. A follow-up gait analysis was performed at least 2 weeks after the initial one to assess the changes in the spatio-temporal parameters. The same procedure as above was used for the follow-up gait analysis (Fig. 3).

2.5. Statistical analysis

The subjects were divided into 2 groups according to the paralyzed side: a right hemiparesis group and a left hemiparesis group. The data obtained from the subjects were analyzed with

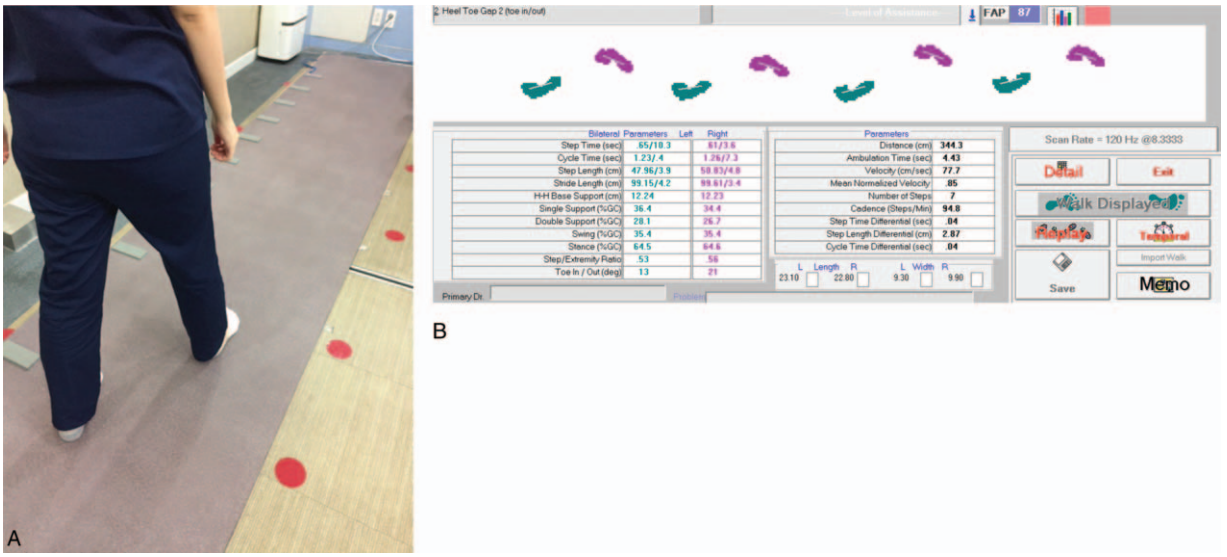

Figure 1. Gait Analysis System - GAITRite (A) Subjects were instructed to walk barefoot at a preferred speed on a 6-m GAITRite mat (B) Result of gait analysis using GAITRite.

the SPSS for Windows (ver20.0) statistical package program after coding.

In reference to Patterson's study,[10] for data coding, the step length, stance time, and swing time were entered in the form of a left and right ratio for ease of interpretation. The ratio was obtained by dividing the variable on the paralyzed side by the variable on the normal side. For example, if the stance time ratio was 0.5, this meant that the stance time was twice longer on the normal side than on the paralyzed side.

To check the normality of the coded data, a frequency analysis was performed for non-continuous variables and a Shapiro-Wilk test (S-W test) was performed for continuous variables. To

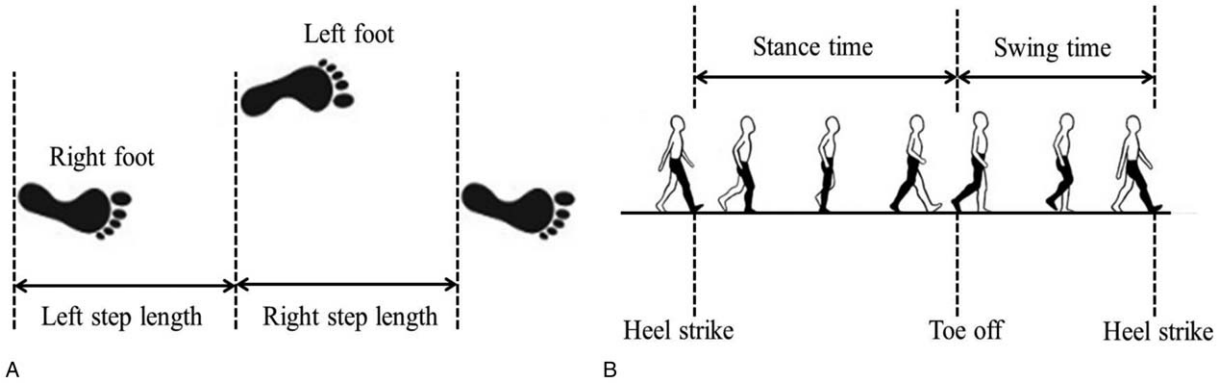

Figure 2. (A) Step length between heels of successive right and left foot (B) Stance time and swing time of the gait cycle.

Table 1

Parameters obtained by GAITRite: Functional ambulation profile (FAP), walking velocity, step length, swing time, and stance time.

Parameter	Explanation
Functional ambulation profile (FAP)	The FAP score (0-100) is calculated from walkway data such as step length/leg length (SL/LL) ratio, step time and degree of asymmetry, etc. FAP is a sensitive measure in the characterization of dissimilar patients with hemiparesis due to stroke. Stroke patients have significantly lower FAP scores than healthy subjects.[14]
Walking velocity	The walking velocity is an important factor reflecting the improvement of walking ability of the stroke patients. An increase in walking velocity in stroke patients, results in better function and quality of life.[15]
Step length (SL) Swing time (SWT) Stance time (STT)	Step length, swing time and stance time are most common gait parameters.[10] Step length is the distance measured from the heel print of one foot to the heel print of the other foot. The swing time is the period of time when one foot is in the air. The stance time is the period of time when one foot is in contact with the ground.[16] The closer the ratio of left and right step length, swing time and stance time are to 1, the better the walking.[10]

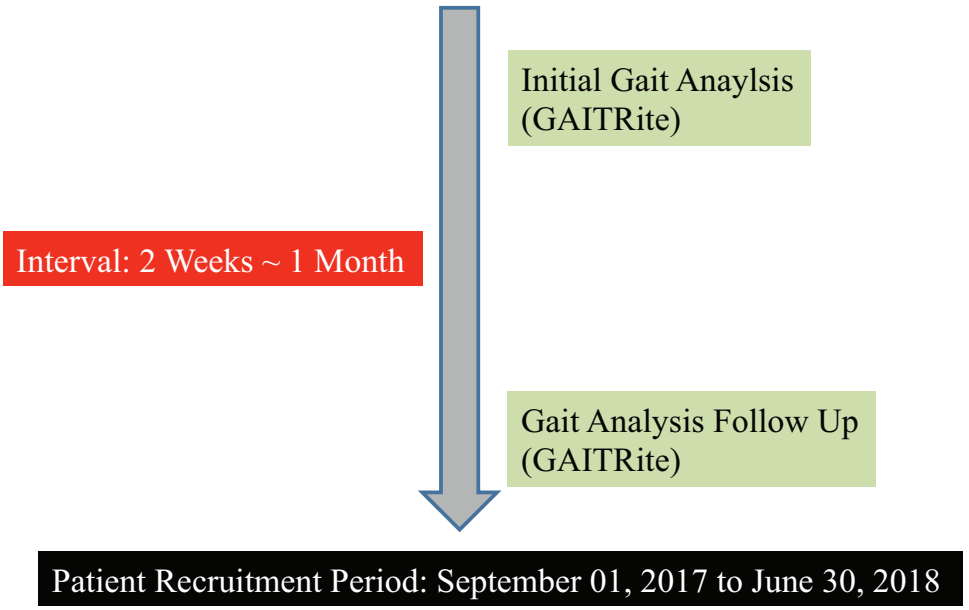

Figure 3. Time schedule of gait analysis gait analysis is a routine examination performed on stroke patients in Wonkwang University Korean Medicine Hospitals in Gwangju (WKUGH). Among the stroke patients who performed the gait analysis more than 2 times during the period from September 01, 2017 to June 30, 2018 in WKUGH, those who satisfies the inclusion criteria becomes the subjects.

confirm the differences in the individual subjects' characteristics between the two groups, independent *t* tests or Mann–Whitney *U* tests were performed for the gender, age, type of stroke, muscle strength class in the manual muscle testing (MMT), number of days elapsed since the stroke onset, and gait analysis interval. Paired *t* tests or Wilcoxon signed-rank tests (Wilcoxon tests) were used to compare the variables between the initial gait analysis and the follow-up gait analysis within the same group. Independent *t* tests or Mann–Whitney *U* tests were used to compare the variables from the initial and follow-up gait analyses between the 2 groups. A Pearson correlation was applied to the variables obtained from the initial and follow-up gait analyses to determine the relationships between the variables. All of the analysis results were expressed as a mean ± SEM when the normality was satisfied, or as a median and interquartile range (IQR) when the normality was not satisfied. A significance level (*P*) under .05 was considered significant.

3. Results

3.1. General features of left and right hemiparesis groups

This study retrospectively analyzed the data from 39 subjects (20 in the left hemiparesis group and 19 in the right hemiparesis group). The general characteristics, including the gender, age, type of stroke, muscle strength class in the MMT, elapsed days from stroke onset, and gait analysis interval did not show a significant difference between the 2 groups (Table 2). No specific

Table 2

General characteristics of subjects: general characteristics of subjects values are presented as mean (standard deviation) and number (%).

		Left hemiparesis group	Right hemiparesis group	*P* value
Gender (number (%))	Male	11 (55%)	10 (52.63%)	.88
	Female	9 (45%)	9 (47.37%)	
Age (mean (SD)) (min, max, median)		62.70 (9.33) (52, 79, 61.5)	66.79 (13.63) (44, 85, 69)	.29
Types of stroke (number (%))	Infarction	15 (75%)	16 (84.21%)	.48
	Hemorrhage	5 (25%)	3 (15.79%)	
Stroke lesion location (number (%))	Carotid circulation*	16 (80%)	16 (84.21%)	.45
	Posterior circulation†	4 (20%)	3 (15.79%)	
MMT (median (IQR))	Upper limb	4 (0)	4 (3–4)	.17
	Lower limb	4 (0)	4 (0)	.96
Days since stroke onset (mean (SD))		46.00 (30.65)	52.42 (43.22)	.59
Gait analysis interval (mean (SD))		19.55 (3.93)	20.42 (4.65)	.53

* carotid circulation (anterior circulation): anterior cerebral artery (ACA), middle cerebral artery (MCA).
† posterior circulation: posterior cerebral artery (PCA), vertebral artery (VA), basilar artery (BA).

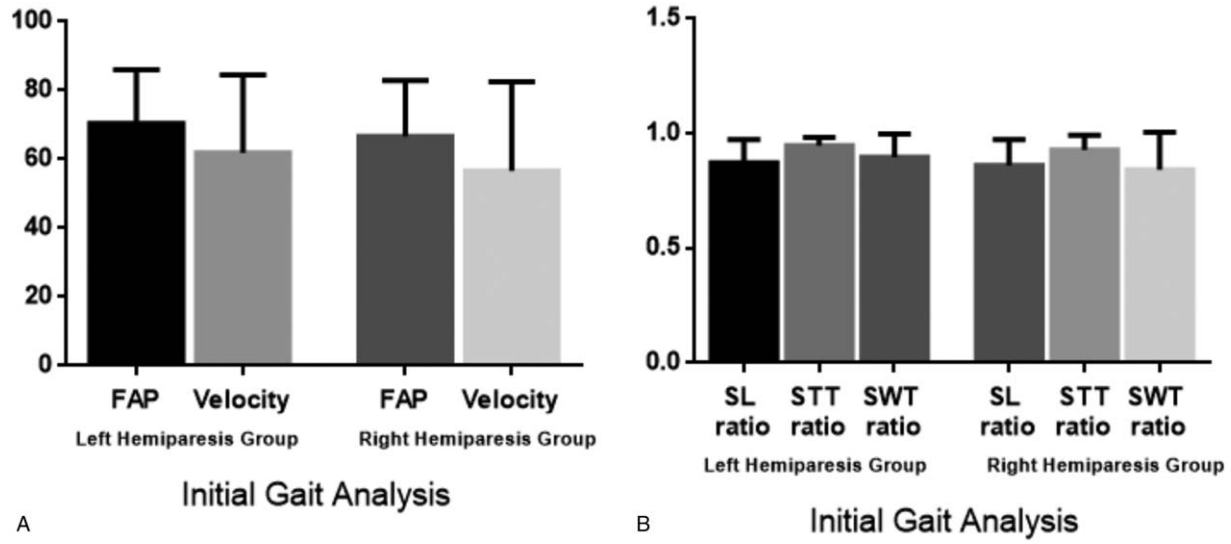

Figure 4. Comparison of parameters obtained by GAITRite between left and right hemiparesis groups in initial gait analysis (A) FAP ($P = .47$) and walking velocity ($P = .50$) of left and right hemiparesis groups, respectively. (B) SL ratio ($P = .74$), STT ratio ($P = .22$) and SWT ratio ($P = .21$) of left and right hemiparesis groups, respectively. SL ratio = step length ratio, STT ratio = stance time ratio, SWT ratio = swing time ratio.

adverse event was reported during the study. Actual *P* values rather than thresholds were described and were expressed to 2 digits for *P* values lower than or equal to .01, according to medicine standards.

3.2. Gait analysis results using GAITRite

3.2.1. Differences in initial gait analysis variables between the 2 groups. As both groups satisfied the normality in the S-W test, an independent t test was performed. No significant difference was found in the FAP, walking velocity, step length ratio, stance time ratio, and swing time ratio of the 2 groups (Fig. 4).

3.2.2. Differences in follow-up gait analysis variables between the 2 groups. As both groups satisfied the normality in the S-W test, an independent *t* test was performed. The FAP and walking velocity values were significantly higher in the left than in the right hemiparesis group. There was no significant difference between the 2 groups in the step length ratio, stance time ratio, and swing time ratio (Fig. 5).

3.2.3. Differences in variables between initial gait analysis and follow-up gait analysis. As both groups satisfied the normality in the S-W test, paired t tests were performed. In the left hemiparesis group, the FAP, walking velocity, and step length

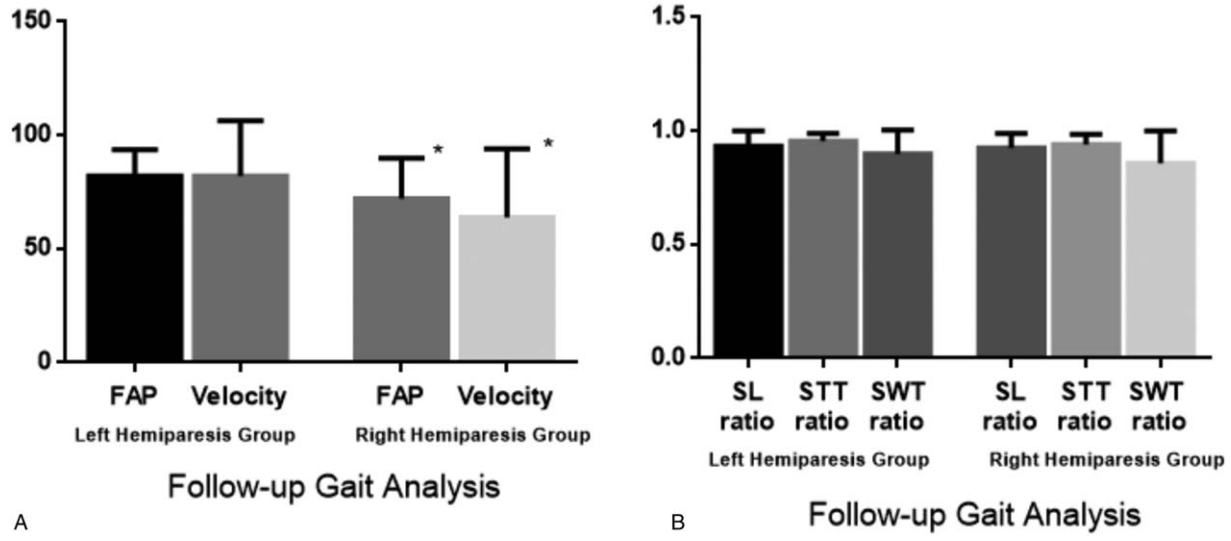

Figure 5. Comparison of parameters obtained by GAITRite between left and right hemiparesis groups in follow-up gait analysis (A) FAP($t_{1,37} = 2.064$, $P = .04$) and walking velocity($t_{1,37} = 2.092$, $P = .04$) of left and right hemiparesis groups, respectively. (B) SL ratio ($P = .73$), STT ratio ($P = .22$) and SWT ratio ($P = .29$) of left and right hemiparesis groups, respectively. SL ratio = step length ratio, STT ratio = stance time ratio, SWT ratio = swing time ratio. *$P < .05$, compared to corresponding values of left hemiparesis group.

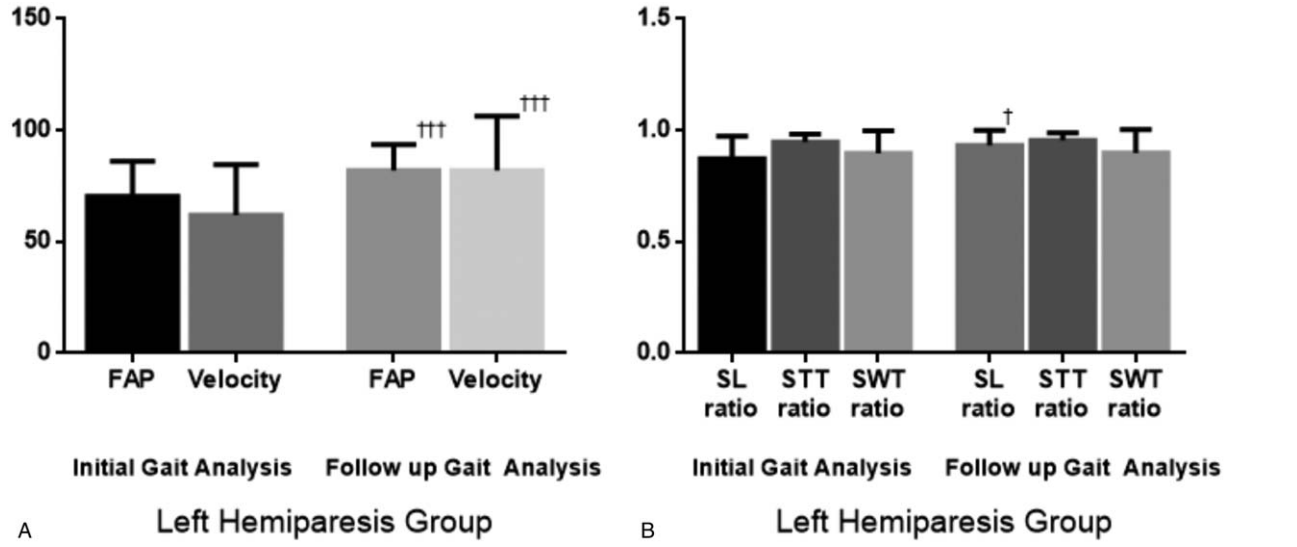

Figure 6. Comparison of parameters obtained by GAITRite between initial and follow-up gait analysis in left hemiparesis group (A) FAP($t_{1,19}=7.551$, $P<.001$) and walking velocity ($t_{1,19}=11.846$, $P<.001$) (B) SL ratio ($t_{1,19}=2.616$, $P=.02$), STT ratio ($P=.40$) and SWT ratio ($P=.74$) of initial and follow-up gait analysis, respectively. $^{\dagger}P<.05$, $^{\dagger\dagger\dagger}P<.001$, compared to corresponding values of initial gait analysis, respectively. SL ratio = step length ratio, STT ratio = stance time ratio, SWT ratio = swing time ratio.

ratio were significantly higher in the follow-up analysis than in the initial gait analysis. There was no significant difference in the stance time ratio and swing time ratio of the left hemiparesis group between the initial and follow-up gait analyses (Fig. 6). In the right hemiparesis group, the FAP, walking velocity, and step length ratio were significantly higher in the follow-up than in the initial gait analysis. Like in the left hemiparesis group, there was no significant difference in the stance time ratio and swing time ratio of the right hemiparesis group between the initial and follow-up gait analyses (Fig. 7).

3.2.4. Relevance between variables from initial gait analysis. In the left hemiparesis group, the Pearson correlation analysis showed a significant positive linear relationship between the FAP and the walking velocity, between the FAP and the step length ratio, between the FAP and the swing time ratio, between the walking velocity and the step length ratio, between the walking velocity and the swing time ratio, between the step length ratio and the swing time ratio, and between the stance time ratio and the swing time ratio. Although there was a positive linear relationship between the FAP and the stance time ratio, between

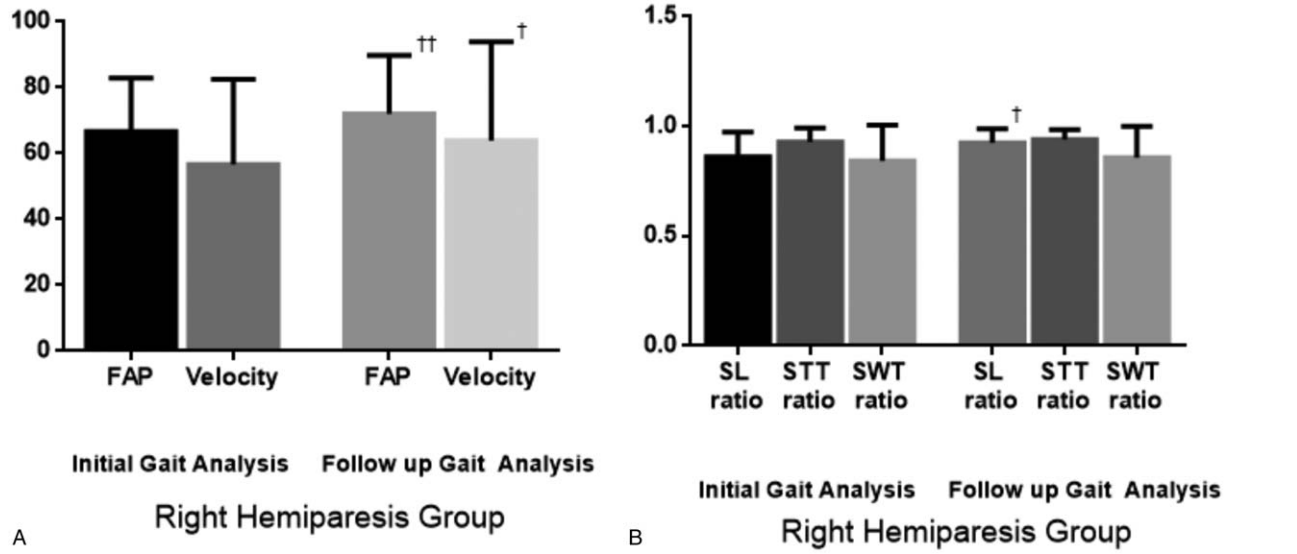

Figure 7. Comparison of parameters obtained by GAITRite between initial and follow-up gait analysis in right hemiparesis group (A) FAP ($t_{1,18}=4.224$, $P<.01$) and walking velocity ($t_{1,18}=2.883$, $P<.01$) (B) SL ratio ($t_{1,18}=2.402$, $P=.03$), STT ratio ($P=.26$) and SWT ratio ($P=.64$) of initial and follow-up gait analysis, respectively. $^{\dagger}P<.05$, $^{\dagger\dagger}P<.01$, compared to corresponding values of initial gait analysis, respectively. SL ratio = step length ratio, STT ratio = stance time ratio, SWT ratio = swing time ratio.

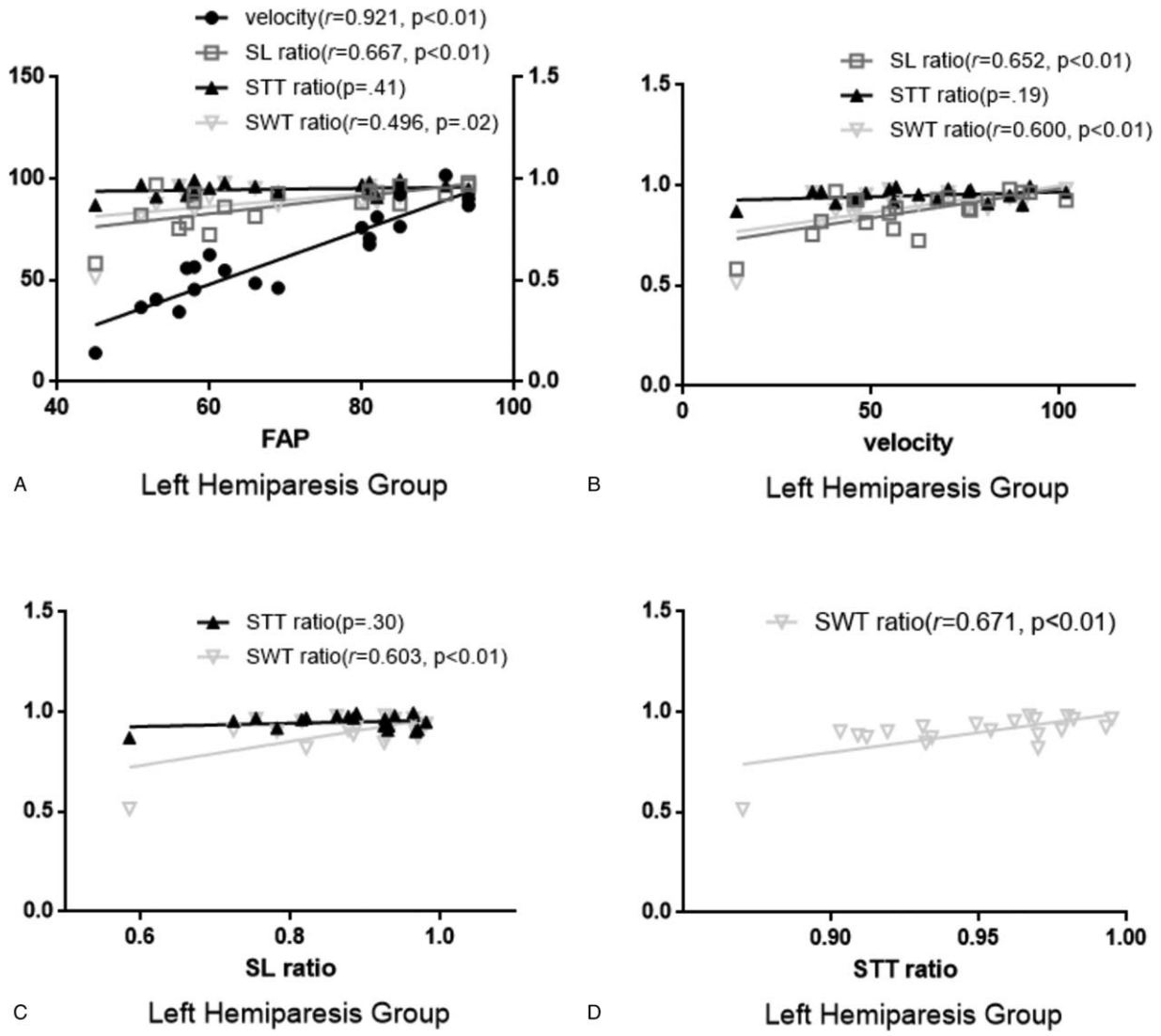

Figure 8. Pearson's correlation analysis results between GAITRite parameters obtained by initial gait analysis in left hemiparesis group (A) *X*-axis: FAP, *Y*-axis: walking velocity ($r = 0.921$, $P < .01$), SL ratio ($r = 0.667$, $P < .01$), STT ratio ($P = .41$) and SWT ratio ($r = 0.496$, $P = .02$) (B) *X*-axis: walking velocity, *Y*-axis: SL ratio ($r = 0.652$, $P < .01$), STT ratio ($P = .19$) and SWT ratio ($r = 0.600$, $P < .01$) (C) *X*-axis: SL ratio, *Y*-axis: STT ratio ($P = .30$) and SWT ratio ($r = 0.603$, $P < .01$) (D) *X*-axis: STT ratio, *Y*-axis: SWT ratio ($r = 0.671$, $P < .01$). SL ratio = step length ratio, STT ratio = stance time ratio, SWT ratio = swing time ratio.

the walking velocity and the stance time ratio, and between the step length ratio and the stance time ratio, these were not significant (Fig. 8).

In the right hemiparesis group, there was a significant positive linear relationship between the FAP and the walking velocity, between the FAP and the step length ratio, between the FAP and the stance time ratio, between the FAP and the swing time ratio, between the walking velocity and the stance time ratio, between the walking velocity and the swing time ratio, and between the stance time ratio and the swing time ratio. Although there was a positive linear relationship between the walking velocity and the step length ratio, between the step length ratio and the stance time ratio, and between the step length ratio and the swing time ratio, these were not significant (Fig. 9).

3.2.5. Relevance between variables from follow-up gait analysis. In the left hemiparesis group, the Pearson correlation analysis showed a significant positive linear relationship between the FAP and the walking velocity, between the walking velocity and the stance time ratio, between the walking velocity and the swing time ratio, and between the stance time ratio and the swing time ratio. Although there was a positive linear relationship between the FAP and the step length ratio, between the FAP and the stance time ratio, between the FAP and the swing time ratio, between the walking velocity and the step length ratio, between the step length ratio and the stance time ratio, and between the step length ratio and the swing time ratio, these were not significant. (Fig. 10).

In the right hemiparesis group, there was a significant positive linear relationship between the FAP and the walking velocity, between the FAP and the step length ratio, between the FAP and the stance time ratio, between the FAP and the swing time ratio, between the walking velocity and the stance time ratio, between the walking velocity and the swing time ratio, and between the stance time ratio and the swing time ratio. Although there was a positive linear relationship between the walking velocity and the

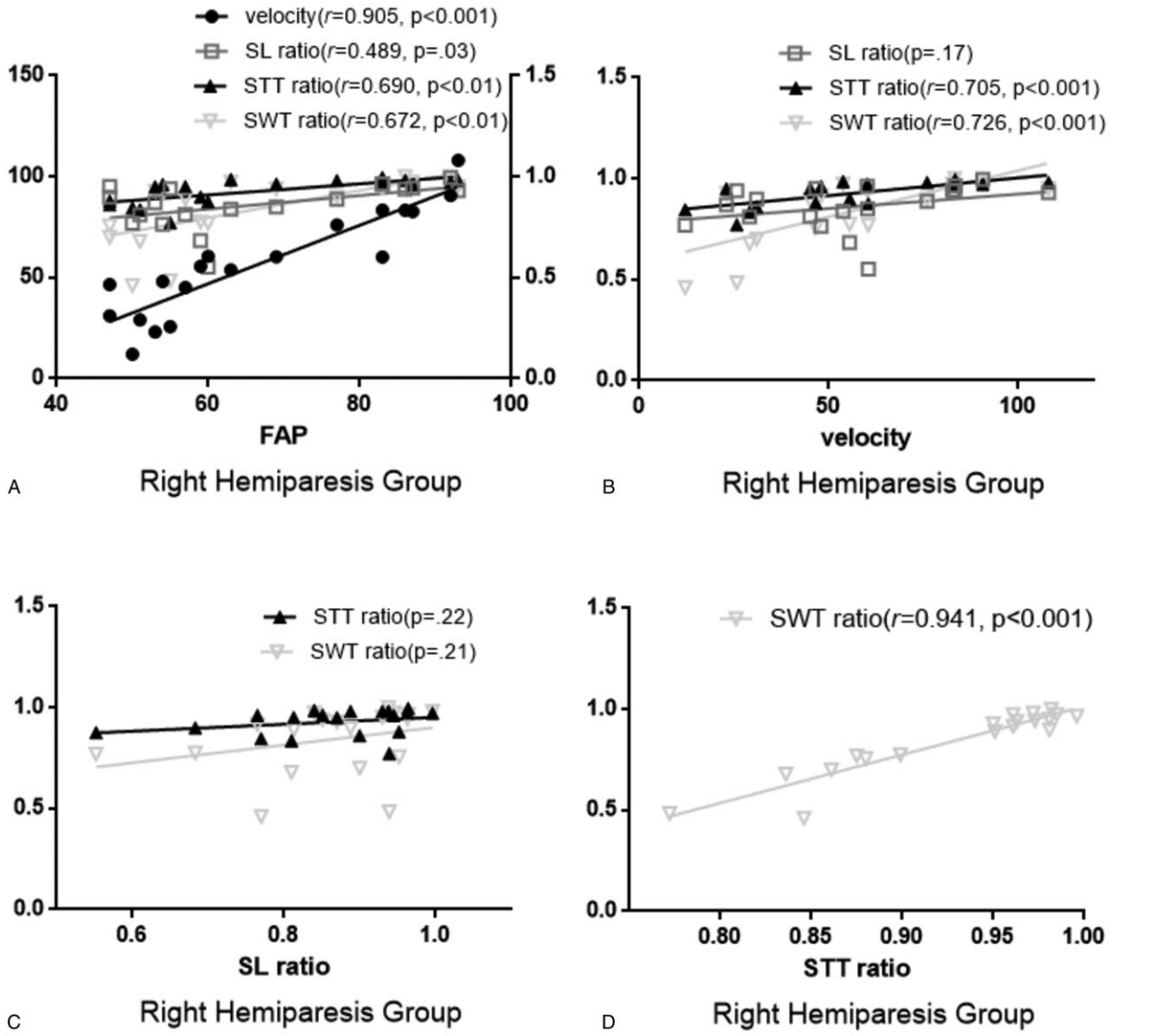

Figure 9. Pearson's correlation analysis results between GAITRite parameters obtained by initial gait analysis in right hemiparesis group (A) *X*-axis: FAP, *Y*-axis: walking velocity ($r = 0.905$, $P < .001$), SL ratio ($r = 0.489$, $P = .03$), STT ratio ($r = 0.690$, $P < .01$) and SWT ratio ($r = 0.672$, $P < .01$) (B) *X*-axis: velocity, *Y*-axis: SL ratio ($P = .17$), STT ratio ($r = 0.705$, $P < .001$) and SWT ratio ($r = 0.726$, $P < .001$) (C) *X*-axis: SL ratio, *Y*-axis: STT ratio ($P = .22$) and SWT ratio ($P = .21$) (D) *X*-axis: STT ratio, *Y*-axis: SWT ratio ($r = 0.941$, $P < .001$). SL ratio = step length ratio, STT ratio = stance time ratio, SWT ratio = swing time ratio.

step length ratio, between the step length ratio and the stance time ratio, and between the step length ratio and the swing time ratio, these were not significant (Fig. 11).

4. Discussion and conclusion

This study retrospectively analyzed the data of post-stroke patients who underwent gait analysis at the WKUGH to assess the possibility of using different treatment strategies for post-stroke patients' rehabilitation therapy according to the paralyzed side. The following results were obtained.

In the gait analysis using GAITRite, both groups showed a significant improvement in the FAP and walking velocity between the first and follow-up gait analyses. In the first gait analysis, there was no significant difference between the 2 groups. However, in the follow-up gait analysis, the FAP and walking velocity of the left hemiparesis group was significantly higher than that of the right hemiparesis group.

The FAP is a variable that assesses the gait of post-stroke patients with hemiparesis, who have significantly lower FAP values than normal subjects.[14] The walking velocity is an important variable that reflects the gait ability of post-stroke patients. A study reported that the faster the walking velocity of post-stroke patients, the higher their quality of daily life.[15] In addition, a Canadian study[17] reported that to improve walking in post-stroke patients, a strategy is needed to identify the factors that are most relevant to the walking velocity and to train this area intensively.

Therefore, the results of this study suggest that over the same period, the degree of improvement in walking was significantly greater in the left hemiparesis group than in the right hemiparesis group.

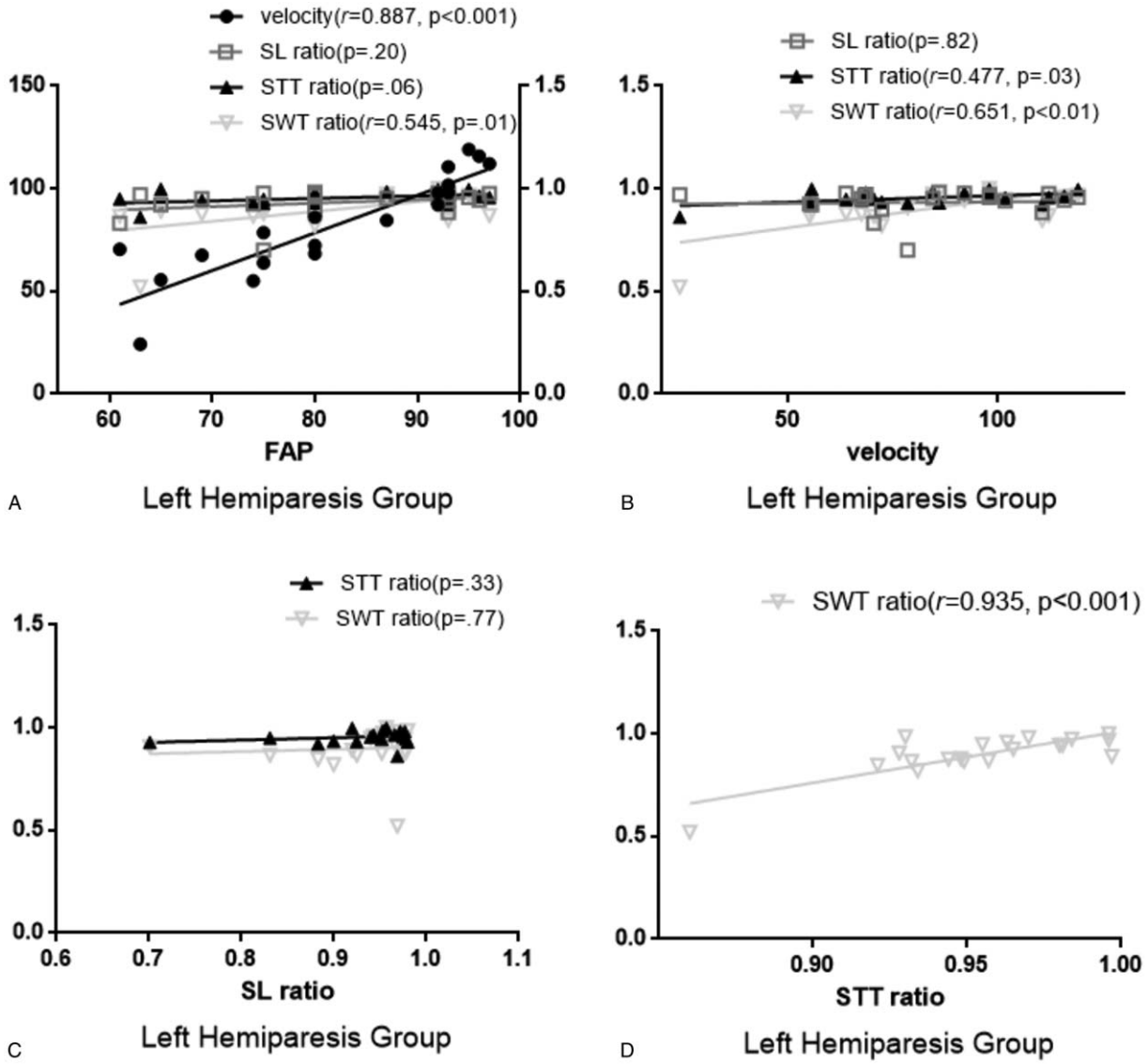

Figure 10. Pearson's correlation analysis results between GAITRite parameters obtained by follow-up gait analysis in left hemiparesis group (A) *X*-axis: FAP, *Y*-axis: walking velocity ($r = 0.887$, $P < .001$), SL ratio ($P = .20$), STT ratio ($P = .06$) and SWT ratio ($r = 0.545$, $P = .01$) (B) *X*-axis: velocity, *Y*-axis: SL ratio ($P = .82$), STT ratio ($r = 0.477$, $P = .03$) and SWT ratio ($r = 0.651$, $P < .01$) (C) *X*-axis: SL ratio, *Y*-axis: STT ratio ($P = .33$) and SWT ratio ($P = .77$) (D) *X*-axis: STT ratio, *Y*-axis: SWT ratio ($r = 0.935$, $P < .001$). SL ratio = step length ratio, STT ratio = stance time ratio, SWT ratio = swing time ratio.

De Haart et al[18] and Dettmann et al[19] reported that compensatory treatment strategies such as shifting the center of pressure to the non-paretic side rather than restoring the function of the paretic lower limb are more important factors in the improvement of post-stroke patients' gait. In addition, Mahon et al[20] reported that in post-stroke patients' gait, the propulsive force to move forward is determined by the force of the non-paretic lower limbs to support the body while walking. Therefore, based on previous studies,[18–20] we assume that the gait recovery was faster in the left hemiparesis group than in the right hemiparesis group as it is easier to implement a compensatory strategy to shift the center of pressure to the right side than to the left side, and the right lower limb provides higher body safety during walking in right-handed post-stroke patients.

This study had the following limitations. First, there were 39 patients, which was insufficient to reflect the characteristics of all stroke patients, and the subjects were intentionally selected. However, the reliability of the results is not expected to be low, since the results are also significant within small numbers and are consistent with the results of previous studies. Second, it is possible that the age of the subjects influenced the gait. However, there was no statistically significant difference in age between 2 groups, and only minor differences in minimum, maximum, and median age were found. Therefore, the possibility that the age of the subjects contributed to the difference between the 2 groups is expected to be low. Third, the subjects were all right-handed, and left-handed post-stroke patients may show different prognosis of gait recovery than those found in this study. However, considering that only 4.8 of Koreans are left-handed,[21] the results of this study do not have a small relevance. Fourth, the subjects' rehabilitation therapy was not controlled for uniformity. However, the major framework in which all subjects received

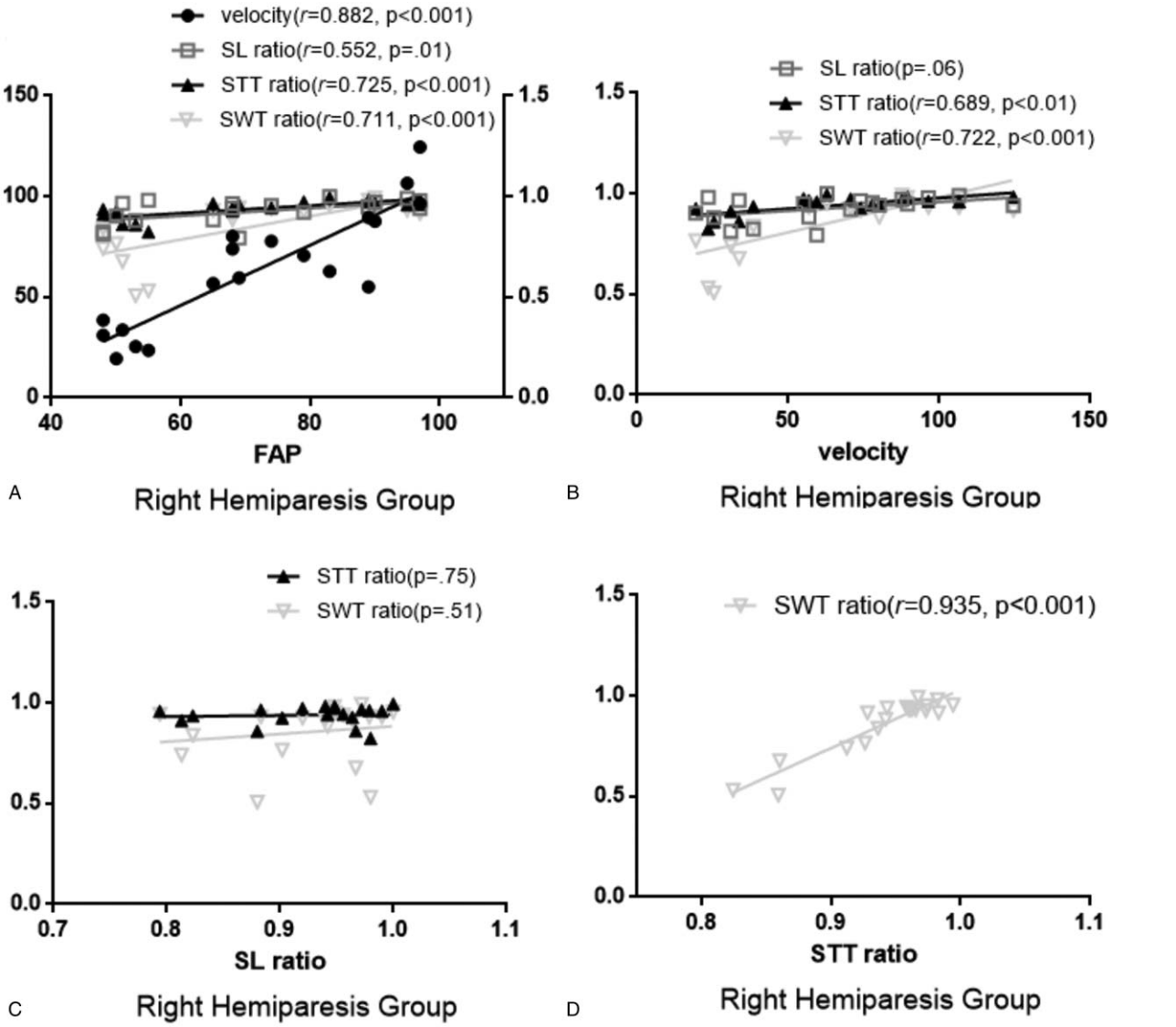

Figure 11. Pearson's correlation analysis results between GAITRite parameters obtained by follow-up gait analysis in right hemiparesis group (A) *X*-axis: FAP, *Y*-axis: walking velocity ($r = 0.882$, $P < .001$), SL ratio ($r = 0.552$, $P = .01$), STT ratio ($r = 0.725$, $P < 0.001$) and SWT ratio ($r = 0.711$, $P < .001$) (B) *X*-axis: walking velocity, *Y*-axis: SL ratio ($P = .06$), STT ratio ($r = 0.689$, $P < .01$) and SWT ratio ($r = 0.722$, $P < .001$) (C) *X*-axis: SL ratio, *Y*-axis: STT ratio ($P = .75$) and SWT ratio ($P = .51$) (D) *X*-axis: STT ratio, *Y*-axis: SWT ratio ($r = 0.935$, $P < .001$). SL ratio = step length ratio, STT ratio = stance time ratio, SWT ratio = swing time ratio.

cooperative treatment between western and Korean medicine was the same, and the purpose of this study was to observe the changes in gait, not to confirm the effects of treatments. Fifth, there was a possibility that the subject's upper limb function affected the gait. However, the comparison of the subjects' basic characteristics showed no significant difference between the 2 groups' upper extremity muscle strength.

Despite these limitations, this study retrospectively analyzed the gait analysis results of 39 post-stroke patients and found a significant difference between the gate recovery rate of the left and right hemiparesis groups. These results suggest that it is not meaningless to distinguish between left and right hemiparesis, according to what is described in *Donguibogam*. No studies have investigated the way spatio-temporal parameters may improve according to gait rehabilitation therapy strategies based on distinction between left and right hemiparesis. Therefore, if such studies are conducted in the future, it may be possible to provide more effective treatment for post-stroke patients.

Author contributions

Investigation: Dae Gill Kang.
Methodology: Kang-Keyng Sung.
Resources: Hongmin Chu, Geon-Hui Kang.
Software: Hongmin Chu, Geon-Hui Kang.
Supervision: Ho Sub Lee, Sangkwan Lee.
Visualization: Hongmin Chu.
Writing – original draft: Cheol-Hyun Kim.
Writing – review & editing: Sangkwan Lee.

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