Original Article

The Effect of Rocker Bar Ankle Foot Orthosis on Functional Mobility in Post-Stroke Hemiplegic Patients

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Objectives: Ankle Foot Orthoses (AFOs) are widely utilized to improve walking ability in hemiplegic patients. The present study aimed to evaluate the effect of Rocker bar Ankle Foot Orthosis (RAFO) on functional mobility in post-stroke hemiplegic patients.

Methods: Fifteen hemiplegic patients (men and women) who were at least 6-months post-stroke and able to walk without assistive device for at least 10 meters voluntarily participated in this study. The patients were examined with and without RAFO. Their functional mobility was evaluated through 10-meter walk test and Timed Up and Go (TUG) test. Also, paired t-test was used to analyze obtained data.

Results: When patients used RAFO, their gait speed significantly increased ($p<0.05$). Also, the time of performing TUG test experienced a significant decrease using RAFO compared with utilizing shoe only ($p<0.05$).

Discussion: RAFO led to a significant improvement in functional mobility in hemiplegic patient's secondary to stroke. It seems that, it has been due to the positive effect of rocker modification on improving push off and transferring weight during stance phase of gait.

Keywords: Rocker bar Ankle Foot Orthosis, functional mobility, hemiplegic patients

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Introduction

Hemiplegia secondary to stroke contribute to problems in standing and walking. Hemiplegic patients suffer from poor balance, slow walking and weak muscles. Also, lower limb is often accompanied with an equinovarus deformity in ankle-foot complex (1-3). Ankle Foot Orthoses (AFOs) are widely prescribed for hemiplegia to improve balance and facilitate gait. Various studies have reported positive effectiveness of AFOs on walking ability in hemiplegic patients (4,5). AFOs help patients in both stance and swing phases of gait through stabilizing ankle-foot complex and preventing abrupt foot drop (6,7).

For hemiplegic patients, gait speed is a key factor which can directly affect their activity daily living. Therefore, enhancing walking speed is an important goal regarding prescribing AFO for individuals with hemiplegia (8). Preferred walking speed in healthy subjects is 1.18 m/s for men above 64 and 0.96 m/s for women above 60. Although Solid AFO (SAFO) enhances walking speed in hemiplegic patients, acquired speed is far less than that of healthy subjects (9). Thus, some efforts have been done to increase gait velocity more than that with common Solid AFO (7,10-12). Considering the positive effect of rocker bar modification added to orthoses on

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walking velocity reported in previous studies (13-5), we hypothesized that adding rocker bar to an SAFO could potentially improve walking speed in hemiplegic patients. On the other hand, since Timed Up and Go test (TUG) is a valid and reliable test which could evaluate several tasks concurrently, and consequently, examines acquired functional ability in patients (16-18), we used that to investigate the effectiveness of RAFO on functional mobility in hemiplegic patients, in addition to using 10-meter walk test to investigate gait speed (19-21). Thus, the aim of this study was to evaluate the effect of Rocker bar AFO (RAFO) on functional mobility in post-stroke hemiplegic patients.

Methods

Fifteen post-stroke hemiplegic patients including ten men and five women voluntarily participated in this study. Inclusion criteria were being at the age between 40 to 70, having the ability to walk without assistive device for at least ten meters and having maximum spasticity of 3 according to Modified Ashworth Scale. Exclusion criteria were having deformity in spine or lower limbs (except for equinovarus in ankle join in paretic side), having history of surgery in spine or lower limbs, having severe cardiovascular, respiratory or cognitive problems. Table (1) indicates demographic characteristics of the patients.

Table 1. Demographic characteristics of the patients (N=15)

Gender	Age mean ((year) mean ± SD)	Weight ((kg) mean ± SD)	Paretic side	Months after stroke (mean ± SD)
Male: 10 Female: 5	54.23 ± 9.65	66.95 ± 11	Left: 11 Right: 4	22.13 ± 14

Patients were provided with a custom made SAFO and RAFO. In order to provide RAFO, SAFO was modified with a rocker sole added bellow the footplate. Rocker modification had 2 cm height. Rocker bar started slightly proximal to metatarsal heads and its angle was 15 degrees. Orthoses were prepared and fitted to the patients' limb by an expert orthotics. All the patients were examined in three conditions including shoe only, with SAFO and with RAFO in random sequences. Also, all the participants used the same shoes.

Measure by Preferred Gait Speed (PGS): The participants were instructed to walk for 10 meters at their self-selected speed. The time of doing task was recorded and divided into passed distance to obtain gait speed (m/s).Timed Up and Go test: The patients were asked stand up from a standard chair, walk for 3 meters, turn, walk back to the chair and sit down again. The time of task was recorded in second. All the measurements were done three times and their average data was considered for final analysis. Means and standard deviation of the performed measurements were recorded. All participants signed informed consent prior to performing the tests. Furthermore, the current study was received ethical approval from Medical Ethics Board at the University of Social Welfare and Rehabilitation Sciences.

The Repeated measures analysis of variance test (ANOVA) was used to analyze the differences among measurements. Tukey Honestly Significance Difference (THSD) post hoc tests were used to identify specific difference between two groups. We utilized SPSS statistical software version 16.0 (SPSS Inc., Chicago, IL) to analyze obtained data. The level of α=0.05 was considered statistically significant.

Results

Regarding functional test parameters including Preferred Walking Speed and Timed Up and Go test in three conditions table (2) shows the data in shoes only, with SAFO and with RAFO. There were significant differences between shoes only condition and using SAFO or RAFO ($p<0.05$). Both SAFO and RAFO led to faster gait speed and less timed TUG test compared with shoes only condition. Also, RAFO significantly resulted in higher gait speed and less time in doing TUG compared to SAFO ($p<0.05$).

Table 2. The Mean ± SD of functional mobility parameters in three conditions: Shoes only, with SAFO and with RAFO

	Shoes only	SAFO	RAFO	P1	P2	P3
PGS (m/s)	0.36 ± 0.11	0.54 ± 0.26	0.73 ± 0.24	0.033	0.018	0.029
TUG (s)	28.06 ± 4.06	23.18 ± 3.55	20.36 ± 3.81	0.021	0.006	0.045

P1: Comparison between shoes only condition and SAFO

P2: Comparison between Shoes only condition and RAFO

P3: Comparison between SAFO and RAFO

SAFO: Solid Ankle Foot Orthosis, RAFO: Rocker bar Ankle Foot Orthosis, PGS: Preferred Gait Speed, Timed Up and Go: TUG, m: meter, s: second, $p<0.05$.

Discussion

The aim of the present study was to investigate the effect of RAFO on functional mobility parameters including gait speed and TUG in post-stroke hemiplegic patients compared with SAFO. The results of this study showed that SAFO led to significant improvement in functional mobility which was consistent with previous research. That is, SAFO resulted in increased gait speed and decreased TUG time compared to shoes only condition. Also, RAFO contributed to further more improved functional mobility in patients. Comparing RAFO to SAFO, there were significant differences in both gait speed and the time of performing TUG test.

According to Perry and Burnfield (22), normal function of the foot consists of three sequential rockers: heel rocker (first rocker), ankle rocker (second rocker) and third rocker (forefoot rocker). Research have indicated that SAFO enhances gait speed through improving first and second rockers while it has no positive effect on third rocker (23-5). In some cases, it has been shown that AFO disturbs forefoot rocker in late stance (25,26). On the other hand, it is proved that rocker bar could improve weight progression on foot and change kinetic and kinematic function of the ankle-foot complex (15,27). Therefore, it has been suggested to be used in cases which ankle-foot complex has been immobilized such as utilizing orthoses (15). It seems that in the current study, modifying AFO in forefoot part resulted in improving forefoot rocker and therefore, push-off and body weight transferring in late stance. This finding was consistent with previous research which showed that rocker modification changes biomechanical function of the foot and ankle during walking (14,15). Similarly, it was recorded that lower limb orthoses modified with forefoot rocker increase gait speed in other neurologically disabled patients (13). However, evaluating the precise mechanism of this improvement seems to be required in another study.

The limitation of the present study was investigating kinematic and kinetic characteristics of the participants' gait which is highly suggested to be done in the future. Also, evaluation of the RAFO effectiveness is suggested for further research. Also, short sample size was another limitation of the current study.

Conclusion

Finding of this study suggests that RAFO could potentially improve gait ability compared to SAFO or shoes only condition in post-stroke hemiplegic patients. Examining the effect of RAFO on hemiplegic gait in a study with larger sample size could further prove obtained results.

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Conflict of interest - The authors of the present study report no conflict of interest.

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