Original Article

The Use of Plastic Ankle-Foot Orthosis Prescribed for Patients with Foot Drop: The Application and Related Factors

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ABSTRACT

Objectives: To study the use patterns and factors related to the use of thermoplastic ankle-foot orthoses (AFO) by patients with foot drop to provide information and to help develop more efficient methods for making decisions regarding the prescription of AFOs.

Study design: Cross-sectional study.

Setting: Department of Rehabilitation Medicine, Maharat Nakhon Ratchasima Hospital.

Subjects: Patients with foot drop who had received thermoplastic AFOs between January 2021 and March 2022.

Methods: Demographics and clinical data were collected from the medical records of the patients. Frequency, duration, and other data related to AFO use were collected via phone interviews with the patients after the AFO had been prescribed for at least 3 months. Use of the AFO was defined as continuous use at least one day a week. Factors associated with compliance with recommended AFO use was analyzed using multivariable analysis.

Results: This study included 117 patients (77 men) with a mean age of 52 years. Of those patients, 59.8% reported continuous use of the AFO with a 95% confidence interval (CI) of 50.8-68.8. Patients who were unable to do ankle dorsiflexion, who wore clogs and who practiced walking with a physical therapist were more likely to use an AFO with adjusted prevalence ratios (95% CI) of 1.49 (1.04-2.14), 1.75 (1.05-2.93), and 1.45 (1.06-1.98), respectively..

Conclusions: Sixty percent of foot drop patients continued using an AFO after 3 months. Half of those patients used the AFO every day. Being unable to do ankle dorsiflexion, wearing clogs, and practicing walking with a physical therapist were all associated with good compliance with AFO use.

Keywords: foot orthoses, patient compliance, cross-sectional studies, stroke

ASEAN J Rehabil Med. 2023; 33(2): 81-86.

Introduction

Foot drop is presented as a reduction in dorsiflexion during heel strike and the swing phase of walking, resulting in poor foot clearance, increasing the risks of trips and falls.[1] Foot drop is a frequently occurring problem in stroke, spinal cord injury, and peripheral nerve injury. An ankle-foot orthosis (AFO) is commonly used to treat foot drop. The AFO limits the range of motion at the ankle, aids foot clearance,[2] assists walking by maintaining the ankle and foot alignment, prevents ankle-foot deformities, and increases speed and gait pattern while walking.[3-5]

Regarding the Prosthetic and Orthotic clinic's records from Maharat Nakhon Ratchasima Hospital, Thermoplastic AFO is commonly prescribed. The two common non-articulated thermoplastic AFOs are the posterior leaf spring and the solid ankle type. Each type of AFO prescription depends on the patient's status and preferences. There are differences in the use of AFOs for each disease. In stroke, spinal cord injury, and common peroneal neuropathy, the use of AFO in these patients was 61.3%,[6] 33.3%,[7], and 13.6%[8] respectively. Previous studies showed that many AFO users had discontinued their AFO usage.[7,8] The common reasons for discontinuation were difficulty walking and difficulty wearing.[9] Disadvantages of AFO consisted of weight and appearance of the orthoses[6,10] and pressure points, which are an insufficient adaptation to the foot and shoe shape, causing discomfort.[9] Refusal to wear an AFO leads to wasted healthcare resources.

Approximately 150 AFOs are prescribed in Maharat Nakhon Ratchasima Hospital each year, primarily thermoplastic AFOs. However, their use has not been followed up. There are few studies investigating the use of AFO in each disease group.[6-8] This study aimed to investigate the use of AFO in patients with foot drops, identify related factors to know the information, and develop the most efficient way to decide on an AFO prescription.

Method

Study design

This cross-sectional study was conducted at the Department of Rehabilitation Medicine, Maharat Nakhon Ratchasima Hospital.

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Received: November 26, 2022 Revised: January 28, 2023 Accepted: February 8, 2023

Participants

All patients who qualified for thermoplastic AFO from the Prosthetic and Orthotic Clinic from January 2021 to March 2022 had their data collected from the Hospital database. In addition, the author reviewed the electronic medical records of each patient. Inclusion criteria were as follows: ambulatory patients with unilateral or bilateral foot drop assessed by a Physiatrist and prescribed thermoplastic AFO at least three months ago, and age of 18 years or older. Patients with foot deformity and Charcot's foot were excluded. After the inclusion-exclusion screening, telephone informed consent to participate was obtained from all participants. Patients with cognitive impairment or an inability to communicate verbally were asked for information from their full-time caregivers. From previous studies of AFO use in stroke patients,[6] common peroneal neuropathy patients[8] and spinal cord injury patients[7] averaged 50.4%. According to this formula = $Z2\alpha/^2$ $P(1-P)/d^2$, the significance level was set to 0.05, and the estimation error of P was 0.1 indicating a minimum of 97 subjects were needed.

Procedure

Data were collected using case record forms from medical records and questionnaire forms from telephone interviews by the research author. In addition, patients' clinical manifestations and demographic characteristics were collected from medical records, composed of patients' age, gender, telephone number, diagnosis, underlying diseases, type of AFO, involved side of foot drop, and time since foot drop to a prescription of AFO.

The participants were interviewed to complete an AFO use questionnaire. The items in the questionnaire consisted of education level, the frequency and duration of using AFO, current ability to do ankle dorsiflexion, gait aid use, practice walking with a physical therapist after receiving an AFO, participation in decision-making before applying AFO, ability to independently don and doff AFO, walk with personal support and footwear use. We categorized footwear as sandals, trainers, or clogs (figure 1). Causes of discontinuing AFO were asked in patients not using AFO, and the benefits of AFO were asked in current users. The patients' feedback regarding facilitating AFO usage was also recorded. The newly designed questionnaire was tested for understandability with 10-foot drop patients, including AFO users and nonusers. Ethics approval was obtained from the Maharat Nakhon Ratchasima Institutional Review Board (049/2022).

Statistical methods

The data were analyzed using Stata version 11. Descriptive statistics were used to summarize patient characteristics, including frequency and percentage, mean, standard deviation, and median (IQR). AFO using rate was calculated as a percentage and 95%CI.

Patients were categorized as patients using and not using AFO. Patients using AFO were defined as continuously using AFO at least once a week by referring to Dajpratham et al. study.[6] The time since foot drop to a prescription of AFO was defined as two months because the recovery potential of neurapraxia after nerve injury is two months.[11] Univariate analysis was performed to evaluate the differences between patients using and not using AFO. The chi-square test was used to compare qualitative variables, including age more than 60 years, presence of co-morbid illnesses, diagnosis, type of AFO, involved side of foot drop, ability to do ankle dorsiflexion, use of gait aids, footwear using, practice walking with a physical therapist after prescribing an AFO, participation in decision-making before receiving AFO, ability to independently don and doff AFO, walk with personal support. Multivariable logistic regression analysis was then performed to determine which factors were significantly associated with patients using and not using AFO. Adjusted prevalence ratio and 95% CIs were estimated. A $p < 0.05$ was considered statistically significant.

Results

Thermoplastic AFOs were prescribed for 145-foot drop patients between January 2021 and March 2022. Of those, 25 patients cannot be contacted, two died, and one denied participating. The remaining 117 patients (77 men and 40 women, mean age 52 years) were included. Among these remaining patients, the causes of foot drop were stroke (40.2%), cauda equina syndrome (CES) or radiculopathy (27.4%), common peroneal neuropathy (13.7%), sciatic neuropathy (10.3%), traumatic brain injury (TBI) (3.4%), spastic spinal cord injury (SCI) (2.5%) and polyneuropathy (2.5%). 92.3% had unilateral, and 7.7% had bilateral foot drop (Table 1).

Three months or more after being prescribed thermoplastic AFO, 70 (59.8%) patients were using AFO (95% CI 50.8-68.8). Only 35 (29.9%) patients were using AFO every day. There were 13 from 32 cauda equina syndrome or radiculopathy patients (40.6%), 11 from 47 stroke patients (23.4%), 5 from 12 sciatic neuropathy patients (41.6%), 4 from 16 common peroneal neuropathy patients (25%), and

Figure 1. sandals trainers clogs

Table 1. Clinical characteristics of the patients (N=117)

Characteristics	Number (%)
Age (year)[1]	51.9 (15.4)
Male	77 (65.8)
Patients using AFO	70 (59.8)
Education	
High school or lower	88 (75.2)
Higher than high school	29 (24.8)
Diagnosis	
Stroke	47 (40.2)
TBI	4 (3.4)
Spastic SCI	3 (2.5)
Common peroneal neuropathy	16 (13.7)
Sciatic nerve neuropathy	12 (10.3)
CES or radiculopathy	32 (27.4)
Polyneuropathy	3 (2.5)
Involved side of foot drop	
Unilateral	108 (92.3)

[1]Mean (SD)
AFO, ankle-foot orthosis; TBI, traumatic brain injury; SCI, spinal cord injury; CES, cauda equina syndrome

Table 2. The proportion of the subjects and their frequency and duration of daily thermoplastic ankle-foot orthosis use after receiving a prescribed orthosis (N=117)

Frequency of use per week	Duration of use per day			Total No. (%)
	< 1 hour No. (%)	1-3 Hours No. (%)	> 3 Hours No. (%)	
Not at all				47 (40.2)
1-2 days	10 (8.5)	7 (6.0)	3 (2.6)	20 (17.1)
3-4 days	1 (0.9)	10 (8.5)	4 (3.4)	15 (12.8)
5-7 days	6 (5.1)	7 (6.0)	22 (18.8)	35 (29.9)

2 from 4 traumatic brain injury patients (50%). 47 (40.2%) patients had discontinued the use of the prescribed thermoplastic AFO (Table 2). We categorized the duration of use per day and frequency per week by referring to Dajpratham et al. study.[6] The benefits of wearing thermoplastic AFOs were reported by 70 patients using AFO. 42 (60%) patients reported improved foot clearance, 22 (31%) had better and more confidence in walking, and 6 (9%) reported other benefits. Causes of discontinuation were reported by 47 patients not

Table 3. General characteristic and patient variables comparing patients using and not using ankle-foot orthosis (AFO)

Variables	Patients using AFO (No. = 70) No. (%)	Patients not using AFO (No.= 47) No. (%)	*p*-value
Age (year)			
< 60	44 (62.9)	32 (68.1)	0.069
Presence of co-morbid illnesses	34 (48.6)	21 (44.7)	0.709
Diagnosis			0.483
Stroke	30 (42.7)	17 (36.2)	
TBI	3 (4.3)	1 (2.1)	
Spastic SCI	2 (2.9)	1 (2.1)	
Common peroneal neuropathy	9 (12.9)	7 (14.9)	
Sciatic neuropathy	6 (8.6)	6 (12.8)	
CES or radiculopathy	20 (28.6)	12 (25.5)	
Polyneuropathy	0 (0.0)	3 (6.4)	
Involved side of foot drop			0.481
Unilateral	66 (94.3)	42 (89.4)	
Ability to do ankle dorsiflexion	22 (31.4)	23 (48.9)	0.081
Time since foot drop to a prescription of AFO (months)			0.019
≥ 2 months	51 (72.9)	24 (51.1)	
Type of AFO			0.222
Solid ankle AFO	17 (24.3)	9 (19.1)	
Posterior leaf spring	53 (75.7)	36 (76.6)	
Articulated AFO	0 (0.0)	2 (4.3)	
Footwear			0.279
Unapplied	36 (51.4)	30 (63.8)	
Sandals	24 (34.3)	12(25.5)	
Trainers	2 (2.9)	3 (6.4)	
Clogs	8 (11.4)	2 (4.3)	
Participate in decision-making before receiving AFO	57 (81.4)	35 (74.5)	0.491
Practice walking with a physical therapist after receiving an AFO	44 (62.9)	20 (42.6)	0.038
Ability to independently don and doff	52 (74.3)	33 (70.2)	0.675
Use of gait aids of an assistive device	50 (71.4)	28 (59.6)	0.231
Walk with person support	10 (14.3)	4 (8.5)	0.399

AFO, ankle-foot orthosis; TBI, traumatic brain injury; SCI, spinal cord injury; CES, cauda equina syndrome

Table 4. Multivariate analysis of factors associated with patients using AFO

Factors	Prevalence ratio (95% CI)	APR (95% CI)	*p*-value
Unable to do ankle dorsiflexion	1.36 (0.97, 19.2)	1.49 (1.04, 2.14)	0.030
Onset to prescription ≥ 2 months	1.50 (1.04, 2.17)	1.40 (0.99, 1.97)	
Footwear			
Unapplied	1	1	0.057
Sandals	1.22 (0.89,1.68)	1.20 (0.90,1.61)	0.220
Trainers	0.73 (0.24, 2.20)	0.77 (0.23, 2.55)	0.665
Clogs	1.47 (1.00, 2.15)	1.75 (1.05, 2.93)	0.033
Practice walking with a physical therapist after receiving an AFO	1.40 (1.02, 1.93)	1.45 (1.06, 1.98)	0.019
Participation in decision-making before receiving AFO	1.19 (0.79, 1.80)	1.04 (0.72, 1.50)	0.839
Use of gait aids of an assistive device	1.11 (0.94, 1.33)	1.15 (0.96, 1.36)	0.122
Unable to independently don and doff	0.92 (0.65, 1.31)	0.72 (0.51, 1.02)	0.064
Walk with person support	1.23 (0.85, 1.78)	1.04 (0.69, 1.57)	0.838

AFO, ankle-foot orthosis

using AFO. 18 (38.3%) patients reported natural recovery, 17 (36.1%) patients reported difficulty walking, and 5 (10.6%) patients reported pressure sensations. The median duration of AFO use in patients who reported natural recovery was two months (IQR1,4). We found that recovery groups were 6 from 47 stroke patients (13%), 4 from 12 sciatic neuropathy patients (33%), 4 from 16 common peroneal neuropathy patients (25%), 3 from 32 CES or radiculopathy patients (9%) and 1 from 3 polyneuropathy patients (33%).

Univariate analysis revealed two statistically significant factors associated with AFO application. The two factors were the patient experiencing foot drop for more than two months (p = 0.019) and the patient practicing walking with a physical therapist after being prescribed an AFO (p = 0.038) (table 3). Other factors suspected to affect the use of AFO were analyzed in multivariable logistic regression analysis (table 4). These three factors, including patients unable to do ankle dorsiflexion, wearing clogs, and practicing walking with a physical therapist after applying an AFO, were shown. These factors were likely to increase the rate of using AFO with adjusted prevalence ratios (95%CI) of 1.49 (1.04, 2.14), 1.75 (1.05, 2.93), and 1.45 (1.06, 1.98), respectively.

Patient suggestions to increase the usage of AFO were that the material should be more durable from 7 patients' quotes. Moreover, 4 patients recommended that the AFO should be easy to don and doff. Finally, 4 patients suggested that the shape of the AFO should be improved. However, 81 patients had no suggestions.

Discussion

In this study, the percentage of AFO users after applying AFO for at least three months was 59.8%. Only 29.9% used their AFO almost every day. The patients using AFO reported that it helped increase foot clearance and made them walk more confidently, which was aligned with the previous studies.[12,13] Our findings also explained by the previous report that AFO can increase toe clearance significantly.[14]

Out of the 47 stroke patients in our study, it was found that 63.8% reported continuous use of AFO, which corresponds to Dajpratham et al. study,[6] which found 61.3% of chronic stroke patients continue using AFO after one year. Our study found that 23.4% of stroke patients use AFO every day, while Nakipoglu et al.[9] reported 59.4% of stroke patients used their lower extremity orthosis every day because Nakipoglu et al.[9] recruited stroke patients after discharge from inpatient rehabilitation who received practice walking with AFO. These results are consistent with the current study's findings that practicing walking with a physical therapist increased AFO usage. From our study, 40.6% of cauda equina syndrome or radiculopathy patients used AFO every day, whereas no spinal cord injury patients used AFO every day. This result differed from Koyuncu et al.'s study[7], which showed that 33.3% of spinal cord injury patients used AFO every day. While this study had only three spinal cord injury patients, those were too low to interpret.

AFOs are usually utilized with shoes.[15] Farmani et al. study[16] reported that wearing rocker shoes can lead to much more improved functional mobility and decreased energy expenditure than ankle-foot orthosis. However, finding a suitable shoe to use with AFO is difficult. The best-recommended shoes for AFO are the full-stretch or extra-depth shoes.[17] Clogs have a broad toe box and are flexible. Generally, clogs have a toe-only rocker bottom, and they can be easily purchased in the market and are suitable for Thailand's weather. Our study found that wearing clogs increased the rate of using AFO by about 80% when compared to AFO only. This high percentage is a crucial finding of this study because the likelihood of a patient following a prescription is nearly doubled for such a small cost.

Patients who practice walking with a physical therapist after applying an AFO could increase the rate of using AFO by about 40% compared to untrained people because the practice can help the patients get used to walking with AFO, which allows them to use AFO continuously. For example, Nakipoglu et al.[9]

reported that 59.4% of patients who practiced walking with a physical therapist while admitted to inpatient rehabilitation used AFO every day. Therefore, after being prescribed AFO, patients should practice walking with a physical therapist and have a follow-up to increase the AFO use rate.

Patients were unable to do ankle dorsiflexion use AFO 49% more than patients who were able to do the movement. Because these patients cannot control their ankles and feet, they use AFO more. Although patients could do ankle dorsiflexion, they could not do the full range of motion, so they still needed to use AFO. The previous study by Bruijn et al.[8] found that after follow-up with peroneal neuropathy patients, 40.9% of the patients who stopped using AFO stopped because they had an improvement in active dorsiflexion. This improvement came from the natural recovery of the peroneal nerve. Our study reported causes of discontinuation by patients not using AFO. 18 (38.3%) patients reported natural recovery, which includes 33% of sciatic neuropathy, 33.3% of polyneuropathy, and 25% of common peroneal neuropathy. Patients who recovered naturally were found to use AFO at a median of 2 months (IQR1,4). In this study, about sixty percent of foot drop patients still need to use AFO, and the benefit of using AFO they mostly reported AFO improved foot clearance and better walking. This finding corresponds to Aprile et al.,[18] which found patients still had 68% of patients walked with difficulty.

Some limitations of our study should be mentioned. Because it was cross-sectional, the time between AFO prescription and interview was not constant between each patient, which may affect the rate of using AFO. There was recall bias in asking about practicing walking with a physical therapist and participation in decision-making before applying an AFO. Due to the phone interview, we could not assess spasticity and the ability of ankle dorsiflexion in patients, which might affect the use of AFO. Prescribing AFO should be based on indication and necessity. Physiatrists should always check out AFO, advise for suitable shoes, and practice walking with a physical therapist. Finally, patient follow-up after applying AFO for benefits and cost-effectiveness is recommended.

Conclusions

This study showed that 59.8% of foot drop patients continued using AFO. Half of these patients use AFO every day. In addition, the patients who were unable to do ankle dorsiflexion, wear clogs, and practice walking with a physical therapist after receiving an AFO was associated with AFO use.

Disclosure

The author declares no conflict of interest.

Acknowledgments

The author would like to thank Dr. Kunyalak Narungsri for her help with statistical analysis. This research received funding from the Centre for Research and Service System Development, Maharat Nakhon Ratchasima Hospital.

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