Effect of Foot Splint and Exercises Session on Foot Drop and Muscles Strengthening among Patients with Stroke

(1) Heba Abd El Reheem Abd El Reheem Abd El Reheem, (2) Wafaa Mohamed Elsayed Ahmed, (3) Nermen Abdelftah Mohamed, (4) Shaymaa Elsayed Mosaad Mohammed, (5) Mona Mohammed Abo El-elle Mohammed

(1) Lecturer in Medical-Surgical Nursing Department, Faculty of Nursing, Port-Said University
(2) Lecturer in Medical-Surgical Nursing, Misr University of Science and technology
(3) Lecturer in Medical-Surgical Nursing Department, Faculty of Nursing, Kafer elsheik University
(4) Lecturer in Medical Surgical Nursing, Faculty of Nursing, Mansoura University
(5) Lecturer in Medical-Surgical Nursing, Faculty of Nursing, South Valley University Qena Egypt

Abstract

Background: Foot-drop in stroke patients usually occurs because the muscles that lift the foot are weakened by the neural system impairment. Foot drop splints and physical exercise are important to manage foot drop patients after stroke for safe and efficient walking. **Aim**: This study was aimed to evaluate the effect of foot splint and exercises session on foot drop and muscle strengthening among patients with stroke. **Design:** Quasi-experimental research design was used in this study. **Setting**: The current study was conducted in the neurological department at Port said University Hospital. **Subjects**: A purposive sample of 100 ischemic stroke patients was recruited for the study, and was assigned into two groups, with 50 ischemic stroke patients in each group (the study and control groups). **Tools for data collection; Tool (1):** Patient's interview questionnaire; **Tool (2):** Foot and ankle disability index (FADI) (pre/post), and **Tool (3):** muscle strength assessment scale (pre/post). **Results:** The results revealed that (84%) of the study group and (88%) of the control group were of the same age from 40- ≤ 60 groups with a mean age (55.23 ± 7.02) (56.61 ± 4.45) respectively, (68%) were males. There was a statistically significant difference in the FADI scale total score among ischemic stroke patients within the study and control group post one month and three months post-implementation. There was a statistically significant difference in muscle strength scores among the study and control groups post one month and three months of implementation with an improvement in the level of muscle strength among the study group and then control group after implementation of foot splint and exercises. **Conclusion**: The application of a foot splint and exercises session has a positive effect on decreasing foot drop disability and improving muscle strengthening among patients with stroke. **Recommendation**: We recommend foot splints and exercises should be engaged in a rehabilitation program for patients with stroke to decrease disability associated with foot drop and improve muscle strengthening.

Keywords: Exercises, Foot Splint, Foot drop, Muscles strengthening, Patients with Stroke

Introduction:

Stroke was defined as an acute-onset focal neurologic deficit of vascular etiology, persisting for more than 24 hours of disability worldwide. It is classified into two types: ischemic stroke (IS) and hemorrhagic stroke (HS). Ischemic stroke is acute focal neurological dysfunction caused by focal infarction at single or multiple sites of the brain **(Lee, 2020).**

In comparison to other causes of Disability-adjusted life years (DALYs) in the world, stroke was the second-largest contributor after ischemic heart disease globally and in developing countries, and the third-largest contributor to DALYs in developed countries after ischemic heart disease and lower back and neck pain **(Katan & Luft, 2018).**

Stroke impairs motor and sensory functions, thus causing difficulties in postural control, leading to postural instability and difficulties in balance and gait. Functional impairment of the lower extremity affects balance and ambulation, and when the balance is disturbed, movement is reduced, thus limiting the activities of daily living **(Lioutas et al., 2021).**

It is the second leading cause of death and the third most common cause of long-term. In addition to spasticity and muscle weakness, foot drop due to plantar flexion stiffness and

dorsiflexion weakness is also a major cause of poor balance in patients with stroke. Foot drop occurs in 20% of stroke patients and results from a weakening of the dorsiflexors or spasticity of the plantar flexors, causing reduced gait velocity, inefficient gait, and increased risk of falling. Abnormal postural alignment in patients with stroke further increases asymmetry between the left and right sides of the body, thereby affecting balance, stability, and functional disability and resulting in decreased function **(de Moraes Bernal et al., 2020).**

Patients with stroke have difficulty controlling posture due to the motor and sensory function abnormalities, thereby affecting balance and walking. One of the most common sensorimotor problems is impaired gait, individuals with stroke experience difficulty in walking because of the insufficient muscular strength, and spasticity that affects joint motion **(Kararas et al., 2018).**

Foot drop describes the inability to raise the front part of the foot due to weakness or paralysis of the muscles that lift the foot. Foot drop is a symptom of an underlying problem and is either temporary or permanent, depending on the cause. Causes include neurodegenerative disorders of the brain that cause muscular problems, such as multiple sclerosis, stroke, and cerebral palsy; motor neuron disorders such as polio, some forms of spinal muscular atrophy, and amyotrophic lateral sclerosis **(Hwang., 2020).**

The prognosis for foot drop depends on the cause. Foot drop caused by trauma or nerve damage usually shows partial or even complete recovery. For progressive neurological disorders, foot drop will be a symptom that is likely to continue as a lifelong disability. People with foot drop are more likely to fall, and falls, particularly in the elderly, may result in increased morbidity **(Adigwe, 2021).**

Foot-drop in stroke patients usually occurs because the muscles that lift the foot are weakened by the neural system impairment. Foot drop is a frequent symptom in hemiplegic patients after stroke. It is known to occur due to difficulty in proper contraction of the tibialis anterior muscle during the swing phase in walking owing to the paralysis of the common peroneal nerve **(Kim, 2020).**

It is clinically important to manage foot drop symptoms in hemiplegic patients after stroke for safe and efficient walking. Methods for resolving foot drop symptoms in hemiplegic patients after stroke are largely divided into therapeutic or compensatory strategies. The therapeutic method aims to improve the actual walking function by supplementing the actual foot drop symptoms through methods, such as strengthening therapeutic exercises, electrical functional stimulation, and foot drop splints **(Dunning et al., 2015).**

Treatment depends on the specific cause of foot drop. The most common treatment is to support the foot with light-weight leg braces and shoe inserts, called ankle-foot orthotics. Exercise therapy to strengthen the muscles and maintain joint motion also helps to improve gait **(Kim, 2020).**

A splint is defined as "a rigid or flexible device that maintains in position a displaced or movable part; also used to keep in place and protect an injured part" or as "a rigid or flexible material used to protect, immobilize, or restrict motion in a part. Lower leg splints are prescribed to provide stability to the foot and ankle, as well as prevent foot drop **(Drake et al., 2021)**

The number of post-stroke patients who need rehabilitation exercises has been rapidly increasing mainly to improve the function of hemiplegic gait it was reported that single sessions of exercise can improve skill retention in post-stroke patients, which seems to improve motor recovery **(Elsner et al., 2021).**

Significance of the study:

Foot drop and physical activity in stroke patients who had foot drop; splints were successful in enhancing walking ability. Of the 795,000 new sufferers of stroke, 26% remain disabled in basic activities of daily living and 50% have reduced mobility due to hemiparesis **(Katan & Luft., 2018).**

Worldwide statistics found about 20% of stroke survivors have a persistent foot drop **(Bethoux et al., 2019).** By encouraging

patients to move and teaching them how to use foot splints, nurses play a critical role in the treatment and prevention of foot drop after an ischemic stroke. Hence, the researchers had done this study to evaluate the effect of foot splint and exercises session on foot drop and muscle strengthening among patients with stroke.

Aim of the study:

This study aimed to evaluate the effect of foot splint and exercises session on foot drop and muscle strengthening among patients with stroke through:

- Assessing foot and ankle conditions among patients with stroke.
- Assessing muscle strengthening among patients with stroke.
- Determine the effect of foot splint and exercises session on foot drop and muscle strengthening among patients with stroke**.**

Research hypothesis:

Ischemic stroke patients who apply exercises and wear foot splints will experience decreasing in foot drop disability than those who do not.

Subjects and Methods:

Research design:

A quasi-experimental research design was used to apply this study. It is used for establishing the cause-and-effect of the relation between the independent and dependent variables.

Setting:

The current study was conducted in the neurological department at Port-Said University Hospital. The department is located on the second floor and contains 4 rooms in each room 4 beds. This setting was selected due to the high prevalence of patients in the selected setting, and it serves the biggest region of the population.

Sample:

A purposive sample of 100 ischemic stroke patients was recruited for the study and was assigned into two groups, with 50 ischemic stroke patients in each group (the study and control groups).

The study group applies the exercises, and wear a foot splint, and the control group received routine care from the department. The ischemic stroke patients included in this study were selected according to the following:

Inclusion criteria were:

- Aged from 21–60 years old.
- Ischemic stroke patients with foot drop disability
- Agree to participate in the study

Exclusion criteria were:

- Unwillingness to participate
- History of chronic diseases such as heart disease, and acute respiratory disease

Sample size calculation:

The sample size was calculated based on considering the level of significance of power analysis of 0.95(β=1-0.95=0.5) at alpha .05 (one-sided) with a large effect size (0.5) was used as the significance, 0.001 was used as the high significance.

Tools of data collection:

Tool (I): Patient's interview questionnaire: It was designed and developed by the researchers based on current national and international literatures it included two parts:

Part (1): It included personal data of ischemic stroke patients such as age, gender, marital status, level of education, occupation, date of admission, date of discharge, and hospital stay length.

Part (2): Clinical data: It included items to assess the clinical data of the studied patient such as diagnosis, affected side of the body by stroke and previous stroke.

Tool (II): Foot and ankle disability index (FADI) (pre/post):

It was adapted from **Martin et al., (2005**). It aimed to assess functional limitations related to foot and ankle conditions. FADI is a region-specific self-report of function with 2

components FADI and FADI Sport It is a 34-item.

Scoring system:

The FADI Sport has eight pieces, while the FADI has 26. The FADI first scale, which was used in this investigation, comprises 26 items. It contained 22 entries linked to activity and 4 items related to pain. The 26 items are graded on a Likert scale of 0 (unable to do), 1 (extreme difficulty), 2 (moderate difficulty), 3 (slight difficulty), and 4 (very tough) (no difficulty at all). The FADI's four items measuring pain are graded from 0 (none) to 4. (unbearable). The FADI has a total point value of 104 points, each of which are scored separately and expressed as percentages, with 0 percent representing most of the disability. 100 percent, i.e., without any dysfunction or incapacity, An individual is diagnosed with FAI if their FADI score is lower than 90% (foot and ankle instability) (**Sabharwal and Singh, 2017).**

Tool (III): muscle strength assessment scale (pre/post).

It was adopted from **Williams, (1956) & Ciesla et al., (2011).** It is used to evaluate the complaint of weakness, often when there is a suspected neurologic disease or muscle imbalance/weakness (lower limb).

Scoring system:

0 from 5: no muscle contraction is seen or identified by palpation or paralysis (none). 1 from 5: muscle contraction is seen or identified by palpation but not sufficient to produce motion even with the elimination of gravity (trace). 2 from 5: muscle can move joint through a full range of motion only if the part is appropriately positioned so that the force of gravity is eliminated (poor). 3 from 5: muscle can move joint through a full range of motion against gravity but without any resistance (fair). 4 from 5: Muscles can move the joints through a full range of motion against moderate exercise (normal). 5 from 5: muscle can move joint through a full range of motion against gravity and full resistance (good).

Training booklet regarding foot splint and exercises:

The content of the booklet was developed in a simple Arabic language by the researcher based on patients' assessment needs, literature review, researcher experience, and opinion of the medical and nursing expertise to evaluate the effect of exercises session and foot splints on improving foot drop disability for ischemic stroke patients. It consists of three parts: -

Part I: Brief overview of foot drop definition, causes, signs and symptoms, diagnostic study, and treatment.

Part II: Stretching, flexibility, resistance, and range of motion exercises for foot and ankle joint:

Part III: Splinting: It was very important also in the prevention of contractures and ensuring the best possible functional gains for the stroke patient.

The procedure of data collection:

I- Preparatory Phase:

Administrative design:

Administrative permission was obtained through an issued letter from Port Said University Directors of the previously selected department to achieve this study.

Validity of the tools:

The content validity of the tools, their clarity, comprehensiveness, appropriateness, and relevance were reviewed by three experts: the – Medical-Surgical Nursing staff and the medical staff. Modifications were made according to the panel judgment to ensure sentence clarity and content appropriateness.

Reliability of the tools: *(*tool II):

In contrast to **Martin and Irrgang's (2007**) (0.84) correlation, the two scales for the involved ankles correlated (0.64), this came from an investigation of the matched unaffected extremities of healthy patients and CAI (chronic ankle instability) subjects. Between healthy subjects and subjects with CAI, there was a statistically significant association between the baseline FADI and FADI Sports scores (P.0005) (**Hale and Hertel, 2005).**

Reliability of tool III:

In post-stroke patients with chronic hemiparesis, objective muscular strength testing can be utilized with reliability in both the lower and upper extremities. Their dependability findings ranged from very low to high reliability (from 0.48 to 0.99) **Rabelo and others (2016**). Manual muscle testing (MMT) is a trustworthy method for evaluating strength longitudinally and thoroughly. With a median percent agreement and ICC of 96 and 0.98, respectively, MMT exhibits strong reproducibility. Between trainees and the reference rate, there was not clinically or statistically significant difference [96 (85-109) vs. 98 (83-107), P = 0.052]. 95 % confidence interval) for the overall, condensed, upper extremity, and lower extremity composites for all 19 pairs of trainee-reference raters (**Fan and others, 2010).**

Pilot study:

A pilot study on (10%) (10) Ischemic stroke patients were conducted in the study to test the clarity, relevancy, feasibility, and applicability of the tools. Ischemic stroke patients who were involved in the pilot study were included in the study.

Ethical considerations:

Before beginning the study, the researchers met with the directors of the selected setting to explain the aim of the study and gain their cooperation. First, the objectives of the study were explained to the Ischemic stroke patients and oral consent was obtained to obtain their cooperation. They were informed that participation in the study was voluntary, and they were free to withdraw from the study at any time, without giving any reason. The participants were told that their information would be kept confidential and used for research purposes only.

II-Implementation phase:

Data were collected within six months, from the beginning of July to the end of December 2021. The researcher started collecting data using the tool I after receiving approval from the director of the neurological department at Port-Said University to move forward with the proposed study and after verbally obtaining the patient's consent to participate voluntarily in the study. Patients in the study and control groups had their data collected on various days.

The neurological section conducted individual interviews with each participant in the study. For the study and control groups, the researcher evaluated the function of the ankle and foot using tool II. Patients in the control group received standard hospital treatment while those in the study group received a foot splint and exercise.

The implementation phase is performed through three sessions:

First session: the researcher explained to patients in the study group the following items: A brief overview of foot drop, definition, causes, treatment option for foot drop, foot drop splint definition, types, measures to maintain the splint, and how to apply it to the affected side. This session took about 15 minutes.

Second session: the researcher explained in detail: the importance of rehabilitation exercise to patients which helps to strengthen their lower limb muscles so that they can lift their feet normally again. The researcher demonstrated exercises that should be followed by the patient including each type of exercise, how to perform, how many times and time needed for each exercise to hold in position How to place the affected limb incorrect position at the time of rest Also the researcher taught patient how to apply foot splint. The patient demonstrated that the splint is intended for daily use, so it was designed to be comfortable to wear and not to cause any unnecessary distress or discomfort to the user.

Give the following instruction to the patient on how to apply the splint as follow:

1. Before wearing the splint, apply a cotton sock on the leg to protect the skin from scratches or cuts.
2. If the splint contains side straps, loosen the straps before use.
3. Insert the foot into the splint by bending the foot downward (toes pointing down).

4. Make sure the heel is back by looking along the sides and back of the foot.
5. Tighten the side straps tightly.
6. Shoes with a sole and a wide face can be worn over the splint.
7. The foot splint is worn during the day, considering that it is taken off every two hours to assess the condition of the foot and skin and to reduce sweating. There are types of splints that are used during sleep as well. This session took about 30 minutes.

The third session: after completing the first and second sessions, there were about 10-20 minutes for reexplaining and feedback.

To ensure the patient's understanding, encouragement and reinforcement were given as needed. To improve comprehension and aid in memory, each participant in the study group received a hard copy of the booklet of colored pictures. To assess and monitor patients' conditions one and three months after commencing their condition, patients were informed about the timetable for follow-up visits. This tool was used for both the study and control group three times before intervention, post one month, and after three months.

III- Evaluation phase:

Evaluation for both groups was conducted by interviewing patients at the outpatients' clinic post 1 month and three months after application by using the same tools (II & III) to evaluate the effect of foot splint and exercises session on foot drop and muscle strengthening among patients with stroke.

Statistical analysis:

The researcher entered data using a suitable personal computer. The statistical program for the social sciences (SPSS) version 25 software was used to enter and analyze all the data. The researcher examined, grouped, and then coded each tool's material. Standard deviation and mean are used to describe continuous variables (Mean, SD). To compare categorical variables, the chi-square test and the Fisher exact test are utilized. Statistical significance was defined as a two-tailed $p< 0.05$.

Results:

Table (I): Presents that (84%) of the study group and (88%) of the control group were of the same age from 40- ≤ 60 groups with a mean age (55.23 ± 7.02) (56.61 ± 4.45) respectively, (68%) were males in the study group compared to (64%) in the control group. While (100%) in both the study and control group ischemic stroke patients were married. As regards the level of education, (32% & 36%) of ischemic stroke patients in the study and control groups read and write. Finally, concerning occupation, (72%) of the study and control (76%) were working. There were no significant differences concerning demographic data in both the control and study groups ($p>0.05$).

Table (2) illustrates that (8%) of the ischemic stroke patients in the study group and (10%) of the control group had a previous history of stroke. Among the studied patients (58% and 54% respectively) were affected on the right side of the body by stroke.

Table (3): shows that there was no statistically significant difference between control and study group subjects after implementing a foot drop splint and exercise regarding ischemic stroke patient`s total knowledge. While the highly statistically significant difference was detected between both groups regarding satisfactory scores in total knowledge post one and post three months of implementing foot drop splint and exercise ($p\leq 0.001$).

Figure (1): Reveals that there was no statistically significant improvement in the control group regarding pre-total knowledge scores. While there was a highly statistically significant improvement among ischemic stroke patients in the study group regarding the total knowledge satisfactory scores pre-immediately post and post two months of implementing foot drop splint and exercise ($p\leq 0.001$**).

Table (4): Reveals that there was a statistically significant difference in FADI scale total score among ischemic stroke patients within-study and control group post one month with p-value 0.010 and three months with p-value <0.001 after implementing foot drop splint and exercises.

Table (5): Illustrates that there was a statistically significant difference in muscles strength scores among study and control groups post one month and three months with a p-value of 0.010 post one month and a p-value of 0.001 post three months with an improvement in the level of muscle strength among study group than the control group after implementing of foot splint and exercises.

Table (6): Clarifies that there was a significant positive correlation between FADI total score and muscle strength score among studied ischemic stroke patients in the study group after application of foot splint and exercises with a p-value <0.01.

Table (1): Percentage distribution of the studied ischemic stroke patients regarding their data in the study and control groups (N=100)

Personal data	Study (n=50)		Control (n=50)		Chi- square T test	p- value
	No	%	No	%		
Age (in years) 21-<40- 40- ≤ 60	 8 42	 16 84	 6 44	 12 88	0.263	0.779
(Mean ± SD)	55.23 ± 7.02		56.61 ± 4.45			
Gender Male Female	34 16	68 32	32 18	64 36	0.027	1.000
Marital status						
Single	0	0.0	0	0.0		
Married	50	100	50	100	1.754	0.627
Educational level Not read or write Read and Write High school University education	8 16 15 11	16 32 30 22	9 18 10 13	18 36 20 26	1.206	0.768
Occupation Worked Housewife Not work	36 9 5	72 18 10	38 11 6	76 22 12	1.575	0.667

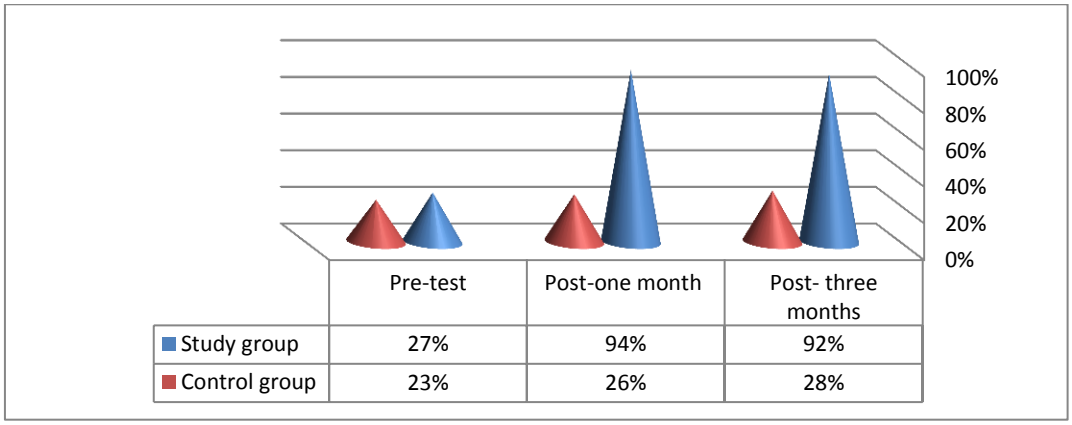
Table (2): Percentage distribution of the studied ischemic stroke patients regarding their clinical data in the study and control groups (N=100)

Items	Study (n=50)		Control (n=50)		Chi- square/ T test	p- value
	No	%	No	%		
Previous stroke: Yes No	4 46	8 92	5 45	10 90	1.542	0.203
The affected side of the body by stroke						
Right side	29	58	27	54	1.063	0.317
Left side	21	42	23	46		

Table (3): Comparison of mean score of patient's total knowledge among study and control group pre, post one month, and post three months regarding foot drop (N=100)

Items	Study group (n=50)	Control group (n=50)	T-stet	p-value
	Mean ± SD	Mean ± SD		
Total Knowledge	20.74 ± 7.86	22.83 ± 10.53	4.065	0.125
- Pre-test	78.04 ± 9.17	24.07 ± 10.36	23.882	<0.001**
- post-test - Post three months	74.67 ± 11.46	21.96 ± 10.96	20.643	<0.001**

*** Significant p ≤ 0.05 ** Highly Significant p ≤ 0.001 Not significant p > 0.05**



*** Significant (S) p ≤ 0.05 ** Highly Significant (HS) p ≤ 0.001**

Figure (1): Comparison between study & control groups regarding their total knowledge satisfactory scores pre, post month and post three months of implementing foot drop splint and exercise (N= 100).

Table (4): Comparison between study and control group regarding the total level of Foot and ankle disability index (FADI) scale pre and post-one months and three months after implementing foot drop splint and exercise (N= 100).

Variables	At admission				Post one Month				Post three Month			
	Study group		Control group		Study group		Control group		Study group		Control group	
	N	%	N	%	N	%	N	%	N	%	N	%
Least disability	0	0.0	0	0.0	0	0.0	0	0.0	5	10	0	0.0
Mild disability	0	0.0	0	0.0	2	4	4	8	35	70	5	10
Moderate disability	5	10	7	14	35	70	5	10	10	20	12	24
Most disability	45	90	43	86	13	26	41	82	0	0.0	33	66
P-value	**0.324**				***0.010**				**<*0.001**			

Chi-square test * Significant difference at p value < 0.05
**Statistically significant difference at p value < 0.001

Table (5): Comparison between study and control groups regarding muscle strength test assessment on the affected side at admission and post 1 month and three months of implementation of foot splint and foot exercises (N=100).

Variables	At admission				Post one Month				Post three Month			
	Study group		Control group		Study group		Control group		Study group		Control group	
	N	%	N	%	N	%	N	%	N	%	N	%
Foot dorsiflexion												
0/5 none	23	46	25	50.0	0	0.0	7	14	0	0.0	0	0.0
1/5 trace	11	22	12	24	8	16	26	52	0	0.0	3	6
2/5 poor	12	24	8	16	22	44	13	26	3	6	27	54
3/5 fair	4	8	5	10	15	30	4	8	4	8	17	34
4/5 good	0	0.0	0	0.0	5	10	0	0.0	14	28	3	6
5/5 normal	0	0.0	0	0.0	0	0.0	0	0.0	34	68	0	0.0
Foot plantar flexion												
0/5 none	23	46	25	50.0	0	0.0	6	12	0	0.0	0	0.0
1/5 trace	11	22	12	24	8	16	28	56	0	0.0	3	6
2/5 poor	12	24	8	16	21	42	13	26	2	4	26	52
3/5 fair	4	8	5	10	15	30	3	6	5	10	19	38
4/5 good	0	0.0	0	0.0	6	12	0	0.0	8	16	2	4
5/5 normal	0	0.0	0	0.0	0	0.0	0	0.0	35	70	0	0.0
P-value	**0.273**				***0.010**				**<*0.001**			

Chi-square test * significant difference at p value < 0.05 **Statistically significant difference at p value < 0.001

Table (6): Correlation between FADI total level and muscle strength scale score among ischemic stroke patients within study group after application of foot splint and exercises

Variables	Foot and ankle disability index (FADI)	
	Pearson r	P-value (2-tailed
level of muscle strength	0.224	<0.01

Correlation coefficient at p value < 0.01

Discussion:

Stroke is a medical condition that causes brain damage, leading to disability and mortality. In stroke, walking is more affected due to foot drop. Continuous regular physical therapy is essential to promote the improvement of the weakness and overall outcomes. In stroke; patients complain of foot drop at the affected side by hemiplegia because that leg muscle is weekend or contracted due to affection of motor supply to that limb or negligence and disuse of the affected side **(Knight et al ., 2019).**

Walking impairment is the most common problem in stroke survivors, occurring in 39 to 90 of all cases. Nursing staff can help by checking and correcting a patient's position and posture, undertaking active and passive joint mobilization exercises, as well as applying and providing education on how to use foot drop splints **(Islam et al., 2018).**

Regarding personal data of patients, the present study revealed that the mean age for ischemic stroke patients in the study group was (55.23 ± 7.02) years old and in the control group was Mean ±SD (56.61 ± 4.45) years old. In the researcher's opinion, this finding presented because stroke risk increased with increasing age which makes the patient more vulnerable and increasing risk of chronic disease and disability.

This result is supported by **Sylaja et al., (2018**) who studied " Ischemic stroke profile, risk factors, and outcomes in India: the Indo-US Collaborative Stroke Project " and mentioned that the mean age for the studied patients suffered from ischemic stroke was (58.3) years old.

Similar to the present study findings, the study conducted by **Hwang, (2020)** entitled "mention that means age for patients with ischemic stroke was (63.50) years old. According to **Go et al., (2018**) who reported in their study about "Association of the burden of atrial fibrillation with risk of ischemic stroke in adults with paroxysmal atrial fibrillation" the mean age for patients was (69.1) years old.

This result is congruent with that of a study performed by **Hendrix et al., (2019**) who conducted a study about "Risk factors for acute ischemic stroke caused by anterior large vessel occlusion "and reported that the mean age for patients was (67.7) years old.

The present study results revealed that there was a highly statistically significant difference and improvement among ischemic stroke patients detected between both groups regarding satisfactory scores total knowledge post one and post three months of implementing foot drop splint and exercise. From the researchers' point of view, this result is reflected in the positive effect of the intervention on improving ischemic stroke patients' knowledge regarding foot drop.

The findings of the present study revealed that there was a statistically significant difference in FADI scale total score among ischemic stroke patients within-study and control group post one month, and three months after implementing foot drop splint and exercises.

From the researchers' point of view, this reflects the importance and effectiveness of the intervention that is commonly associated with improving knowledge and a better understanding among the studied ischemic stroke patients and practices to help them learn and acquire good knowledge and apply it. This association is explained that when ischemic stroke patients had sufficient knowledge that can help them practice well which reflected positively on their health.

This finding is supported by **Fatmawati., (2018)** who studied " Penatalaksanaan Fisioterapi Pada Drop Foot Sinistra Dengan Modalitas Electrical Stimulation Dan

Strengthening Exercise " and stated that the benefits of providing strengthening exercise against drop foot obtained the evaluation result of increased muscle strength. There was an increase in the scope of joint range of motion. There was an increase in functional activity from FADI. It concluded that strengthening exercise can increase the range of motion and increase the functional activity of FADI.

This finding was in accordance with the study of **Choo & Chang., (2021**) entitled "Effectiveness of an ankle-foot orthosis on walking in patients with stroke" it revealed that a foot drop splint is considered beneficial in enhancing gait stability and ambulatory ability. They also found that foot splint uses can increase gait function, improve gait kinematic parameters, correct gait abnormalities by supporting dorsiflexion of the ankle and normalize gait patterns and maintain balance.

Similarly, **Kwon et al., (2019)** conducted a study about "A soft wearable robotic ankle-foot-orthosis for post-stroke patients" and found in their study that there was an improvement in both gait propulsion and foot-drop prevention after application of ankle-foot orthosis.

Also, this result is congruent with **Totah et al., (2019)** who studied " The impact of ankle-foot orthosis stiffness on gait: A systematic literature review. Gait & posture" and recommend that foot drop splints are commonly prescribed to provide ankle support during walking. Moreover, **Choo et al., (2021**) reported in their study" Machine learning analysis to predict the need for ankle-foot orthosis in patients with stroke" Patients with muscle strength scores less than 3 for the ankle dorsiflexor of the affected side were considered to require ankle-foot orthosis.

Results of the current study also come in agreement with **Chen et al., (2021**) who conducted a study about the " Effectiveness of a home-based exercise program among patients with lower limb spasticity post-stroke" and reported that there was significant improvement 6 months after initiation of rehabilitation exercises among patients in the interventional group compared with those in the control group in lower extremity motor performance with reduced spasticity. They also stated that strengthening exercise of the ankle joint can improve mobility in patients after stroke.

The findings of the present study revealed that there was a statistically significant difference in muscle strength scores among the study and control groups post one month and three months after implementing foot splint and exercises.

These findings are supported by the results obtained from a similar study conducted by **Han et al., (2017)** who studied " Effects of muscle-strengthening exercises using a thera band on lower limb function of hemiplegic stroke patients " and stated that muscle-strengthening exercises using a Thera-Band can be used as an effective nursing intervention to improve the function of the lower limb of hemiplegic stroke patients.

This result is matched with **Milton et al., (2018**) who conducted a study " A review of global surveillance on the muscle strengthening and balance elements of physical activity recommendations " and reported that undertaking strength training exercises is known to lead to increased muscle mass, improving muscle function and reducing functional impairment, disability, falls, and loss of independence.

Similarly, **Kim et al., (2019)** who studied "Effects of passive Bi-axial ankle stretching while walking on uneven terrains in older adults with chronic stroke" and found that stretching the ankle muscles helps people with stroke increase the ankle range of motion, decrease ankle joint stiffness and improve paretic walking performance on an even surface. It also increases the walking speed. Also, **Hou et al ., (2021)** recommended in their study about " Association between physical exercise and stroke recurrence among first-ever ischemic stroke " that stroke survivors should engage in low- to moderate-intensity aerobic activity and muscle-strengthening exercises at least 3 to 4 sessions per week of moderate to vigorous-intensity exercise.

Lui & Nguyen., (2018) told that most spontaneous stroke recovery occurs in the first three to six months after the acute neurological

event. Generally, patients make 70% of their recovery in the first 3 months after a stroke and rehabilitation aim to enhance and augment natural mechanisms of recovery. it is mandated to provide at least 3 hours of therapeutic rehabilitation exercises per day for a minimum of 5 days a week.

This study also revealed that was a significant positive correlation between FADI total score and muscle strength score among studied ischemic stroke patients in the study group after the application of foot splint and exercises. These results were similar to **Kramer et al., (2017)** who studied " How to prevent the detrimental effects of two months of bed-rest on muscle, bone, and cardiovascular system " and found that participants who did three minutes of light exercises (consisting of three series repeated six or seven times a week) maintained leg muscle strength, whereas control groups (who did not take part in the exercise) lost around two-fifths of their leg muscle strength. Similarly, **Yamamoto, et al., (2016)** revealed in their study about " Effects of resistance training on muscle strength, exercise capacity, and mobility in middle-aged and elderly patients with coronary artery disease " that resistance training exercises increased lower extremity muscle strength and improved mobility in the study compared with the control group.

From the researchers' point of view, this is reflected in the success of the intervention and its positive effects which supported the aim and hypothesis of the study. Foot drop splints assist patients in keeping their feet and legs in a neutral position, preventing floppy feet, helping them to walk, and preventing foot-dragging during the swing phase of walking. Additionally, workouts and training retain ankle mobility by keeping the foot and ankle muscles active as well as foot muscle strength and size. Applying a foot drop splint and doing exercises after a stroke is generally beneficial ways to keep your foot and ankle strong and lessen the disability that comes with foot drop in stroke patients.

Conclusion:

Based on the current study results, it was concluded that application of foot splint and exercises session has a positive effect on decreasing foot drop disability and improving muscle strengthening among patients with stroke. A statistically significant difference and improvement were found between the study and control group patients after the application of both splint and foot drop exercises.

Recommendation:

Based on the findings of the current study, the following recommendations are proposed:

- Foot splints and exercises should be engaged in a rehabilitation program for patients with stroke to decrease disability associated with foot drop and improve muscle strengthening.
- Replication of the current study with a larger sample of patients with stroke in different settings is required for generalizing the results.

References:

Adigwe G., (2021): Quality of life of stroke survivors in Nigeria (Low-income country). Can the outcome be predicted?. The Journal of Clinical Hypertension, Vol. (23), No.(8), P.p.1459.

Bethoux F., Rogers H., Nolan K., Abrams G., Annaswamy T., Brandstater M., & Kufta C., (2019): Long-term follow-up to a randomized controlled trial comparing peroneal nerve functional electrical stimulation to an ankle-foot orthosis for patients with chronic stroke. Neurorehabilitation and neural repair, vol. (29), no. (10), P.p. 911-922.

Chen S., Lv C., Wu J., Zhou C., Shui X., & Wang Y., (2021): Effectiveness of a home-based exercise program among patients with lower limb spasticity post-stroke: A randomized controlled trial. Asian Nursing Research, vol.(15), no. (1),P.p. 1-7.

Choo Y., & Chang M., (2021): Effectiveness of an ankle-foot orthosis on walking in patients with stroke: A systematic review and meta-analysis. Scientific reports, vol.(11), no. (1), P.p. 1-12.

Ciesla N., Dinglas V., Fan E., Kho M., Kuramoto J., & Needham D., (2011): Manual muscle testing: a method of measuring extremity muscle strength applied to critically ill

patients. JoVE (Journal of Visualized Experiments), vol (12), no. (50), P.p 2632.

De Moraes Bernal H., De Abreu L., Pinheiro Bezerra I., Adami F., Takasu J., Ji Young Suh J., & De Sousa Santos E., (2020): Incidence of hospitalization and mortality due to stroke in young adults, residents of developed regions in Brazil, plos one, Vol. (15), No. (11), P.p. 48.

Drake R., Parker K., Clifton K., Allen S., Adderson J., Mountain A., & Eskes G., (2021): Ankle-foot orthoses improve walking but do not reduce dual-task costs after stroke. Topics in Stroke Rehabilitation, vol. (28), no. (6), P.p. 463-473.

Dunning K., O'Dell M., Kluding P., & McBride K., (2015): Peroneal stimulation for foot drop after stroke: a systematic review. American Journal of Physical Medicine & Rehabilitation, vol.(94), no. (8), P.p. 649-664.

Elsner V., Trevizol L., De Leon I., Da Silva M., Weiss T., Braga M., & Boggio E., (2021): Therapeutic effectiveness of a single exercise session combined with WalkAide functional electrical stimulation in post-stroke patients: a crossover design study. Neural regeneration research, vol.(16), no. (5), P.p.805.

Fan E., Ciesla N., Truong A., Bhoopathi V., Zeger S., & Needham D., (2010): Interrater reliability of manual muscle strength testing in ICU survivors and simulated patients. Intensive care medicine, vol.(36), no. (6), P.p. 1038-1043.

Fatmawati S., Wijianto S., & Or M., (2018): Penatalaksanaan Fisioterapi Pada Drop Foot Sinistra Dengan Modalitas Electrical Stimulation Dan Strengthening Exercise Di RSUD Dr. Moewardi Surakarta (Doctoral dissertation, Universitas Muhammadiyah Surakarta).

Go A., Reynolds K., Yang J., Gupta N., Lenane J., Sung S., & Solomon M. (2018): Association of the burden of atrial fibrillation with risk of ischemic stroke in adults with paroxysmal atrial fibrillation: the KP-RHYTHM study. JAMA cardiology, vol.(3), no. (7), P.p. 601-608.

Hale S., & Hertel J., (2005): Reliability and sensitivity of the Foot and Ankle Disability Index in subjects with chronic ankle instability. Journal of athletic training, vol.(40), no. (1), P.p. 35.

Han S., Her J., & Kim Y. (2017): Effects of muscle-strengthening exercises using a thera band on lower limb function of hemiplegic stroke patients. Journal of Korean Academy of Nursing, vol.(37), no. (6), P.p. 844-854.

Hendrix P., Sofoluke N., Adams M., Kunaprayoon S., Zand R., Kolinovsky A., & Griessenauer C., (2019): Risk factors for acute ischemic stroke caused by anterior large vessel occlusion. Stroke, vol.(50) ,no. (5), P.p. 1074-1080.

Hou L., Li M., Wang J., Li Y., Zhang Q., Zhang L., & Zhu C., (2021): Association between physical exercise and stroke recurrence among first-ever ischemic stroke survivors, Scientific Reports, Vol: (11), no. (1), P.p. 1-9.

Hwang Y., (2020): Effects of an Elastic AFO on the Walking Patterns of Foot-drop Patients with Stroke. Korean Society of Physical Medicine, vol.(15), no. (1), P.p. 1-9.

Islam M., Kabir M., & Hossain Q., (2018): Design and implementation of automated ankle-foot orthosis for foot drop patients using gait cycle EMG analysis. International Journal on Advanced Science Engineering Information Technology, vol.(8), no. (6), P.p.2648-2653.

Kararas M., Cetin N., Bayramoglu M., Dilek A. (2018): Truck muscle strength concerning balance and functional disability in unihemispheric stroke patients. *Am. J. Phys. Med. Rehabil.* ;83:81–87. Doi: 10. 1097/ 01. PHM. 0000107486. 99756. C7. [PubMed] [CrossRef] [Google Scholar]

Katan M., & Luft, A., (2018): Global burden of stroke. In Seminars in neurology Thieme Medical Publishers, Vol. (38), No. (2), P.p. 208-211)

Kim H., Cho S., & Lee H., (2019): Effects of passive Bi-axial ankle stretching while walking on uneven terrains in older adults with chronic stroke. Journal of biomechanics, vol.(89), no. (2019), P.p. 57-64.

Kim J., (2020): Immediate Effect of Kinesiology Taping on Gait Function in Stroke Patients with Foot Drop. Journal of International Academy of Physical Therapy Research, vol.(11), no. (2), P.p. 2060-2064.

Knight J., Nigam Y., & Jones A., (2019): Effects of bed rest 5: the muscles, joints, and mobility. Nursing Times, vol. (115) ,no.(4),P.p. 54-57.

Kramer A., Gollhofer A., Armbrecht G., Felsenberg D., & Gruber, M., (2017): How to prevent the detrimental effects of two months of bed-rest on muscle, bone, and the cardiovascular system: an RCT. Scientific reports, vol.(7), no. (1), P.p. 1-10.

Kwon J., Park J., Ku S., Jeong Y., Paik N., & Park Y., (2019): A soft wearable robotic ankle-foot-orthosis for post-stroke patients. IEEE Robotics and Automation Letters, vol. (4), no. (3), P.p. 2547-2552.

Lee S., (2020): Stroke Revisited: Pathophysiology of Stroke: From Bench to Bedside.part (1), section (1), 1st ed ., Springer, Singapore, P.p.3-10.

Lioutas V., Ivan C., Himali J., Aparicio H., Leveille T., Romero J., & Seshadri S., (2021): Incidence of transient ischemic attack and association with long-term risk of stroke, JAMA, Vol. (325), No. (4), P.p. 373-381.

Lui SK., & Naguyen MH., (2018): Elderly Stroke Rehabilitation: Overcoming the Complications and Its Associated Challenges. Curr Gerontol Geriatr Res. Jun 27;2018:9853837. Doi: 10. 1155/ 2018/ 9853837.

Martin R., & Irrgang, J., (2007): A survey of self-reported outcome instruments for the foot and ankle. Journal of Orthopaedic & Sports Physical Therapy, vol.(37), no. (2), P.p. 72-84.

Martin R., Irrgang J., Burdett R., Conti S., & Swearingen J. (2005): Evidence of validity for the Foot and Ankle Ability Measure (FAAM). Foot & ankle international, vol.(26), no. (11), P.p. 968-983.

Milton K., Varela A., Strain T., Cavill N., Foster C., & Mutrie, N., (2018): A review of global surveillance on the muscle strengthening and balance elements of physical activity recommendations. Journal of Frailty, Sarcopenia, and Falls, vol.(3), no. (2), P.p. 114.

Rabelo M., Nunes G., da Costa Amante N., de Noronha M., & Fachin-Martins, E., (2016): Reliability of muscle strength assessment in chronic post-stroke hemiparesis: a systematic review and meta-analysis. Topics in stroke rehabilitation, vol.(23), no. (1), P.p. 26-35.

Sabharwal R., & Singh S., (2017): Prevalence of ankle instabilities and disabilities among female Kathak dancers, Physiotherapy. The Journal of Indian Association of Physiotherapists, vol.(11), no. (2), P.p. 45.

Sylaja P., Pandian J., Kaul S., Srivastava M., Khurana D., Schwamm L., & Singhal A., (2018): Ischemic stroke profile, risk factors, and outcomes in India: the Indo-US Collaborative Stroke Project. Stroke, vol.(49), no. (1), P.p. 219-222.

Totah D., Menon M., Jones-Hershinow C., Barton K., & Gates D., (2019): The impact of ankle-foot orthosis stiffness on gait: A systematic literature review. Gait & posture, vol. (69),no.(2019), P.p. 101-111.

Williams M., (1956): Manual muscle testing, development, and current use. Physical Therapy, vol: (36), no. (12), P.p. 797-805.

Yamamoto S., Hotta K., Ota E., Mori R., & Matsunaga A. (2016): Effects of resistance training on muscle strength, exercise capacity, and mobility in middle-aged and elderly patients with coronary artery disease: a meta-analysis. Journal of Cardiology, vol.(68), no.(2), P.p. 125-134