Assiut Scientific Nursing Journal
http://asnj.journals.ekb.eg
http://www.arabimpactfactor.com
http://olddrji.lbp.world/indexedJournals.aspx
DOI: 10.21608/ASNJ.2022.127347.1342

Impact of Foot Splint and Exercises on Foot Drop among Ischemic Stroke Patients

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Abstract
Background: Foot drop after stroke is a common lower extremity motor dysfunction. Physical exercise and foot drop splints were effective in improving walking performance in stroke patients affected by foot drop. **Aim:** To evaluate the impact of application of foot splint and exercises on foot drop among ischemic stroke patients. **Research design:** A quasi-experimental (study and control) research design was utilized. **Setting:** The study was conducted in neurological department at Assiut University Hospitals. **Sample:** (80) adult patients diagnosed with ischemic stroke. **Tools: Tool (I):** Patient's assessment sheet, **Tool (II):** Ankle and foot assessment which included **Foot** and ankle disability index (FADI) and muscle strength assessment. **Results:** mean age in control group was (60.52± 6.02) years old and study group was (58.30± 9.14) years old, more than half of patient were male (57.5 %, 65.0%) respectively and affected with left side hemiplegia (57.5%, 55.0%) respectively in both control and study group. Achilles tendon score, muscle strength was improved and level of disability on FADI was decreased after applying foot splint and exercises. **Conclusion:** There was a statistically significance difference between study and control group patients regarding ankle and foot assessment after application of both splint and foot drop exercises. **Recommendation:** Stroke patient should engage in rehabilitation exercise for foot and ankle and apply foot drop splint to decrease disability associated with foot drop.

Keywords: Exercises, Foot drop, Foot Splint & Ischemic Stroke.

Introduction
Stroke was defined as an acute-onset focal neurologic deficit of vascular etiology, persisting for more than 24 hours **(Lioutas et al., 2021)** is the second leading cause of death and the third most common cause of long-term disability worldwide **(Adigwe., 2021).** It is classified into two types: ischemic stroke (IS) and hemorrhagic stroke (HS) **(de Moraes Bernal et al., 2020)**

Ischemic stroke is acute focal neurological dysfunction caused by focal infarction at single or multiple sites of the brain **(Lee, 2020).**

From the 795,000 new sufferers of stroke, 26% remain disabled in basic activities of daily living and 50% have reduced mobility due to hemiparesis. 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).**

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. Foot-drop in stroke patients usually occurs because the muscles that lift the foot are weakened by the neural system impairment **(Hwang, 2020)**

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).**

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 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 in order to improve the function of hemiplegic gait it was reported that single sessions of exercise are able to improve skill retention in post-stroke patients, which seems to improve motor recovery **(Elsner et al ., 2021).**

Significance of the study:

Worldwide statistic found about 20% of stroke survivors have a persistent foot drop **(Bethoux et al., 2015).** From the researcher's experience during 2 years of training period in neurological department at Assiut University Hospital it has been observed that ischemic stroke patient may suffer from foot drop as result of lower limb muscle weakness and muscles disuse which account about 1612 in 2019 , **(Assiut University hospital records**., **2019)**. So nurse play a significant role in care and prevention of foot drop following ischemic stroke through helping patient to perform exercise and educate them how to apply foot splint.

The aim of this study were:

To evaluate the impact of foot splint and exercises on foot drop among ischemic stroke patients.

Research hypotheses:

Foot drop disability will be decreased in ischemic stroke patients who will apply exercises and wear foot splint than patients whom receive routine hospital care.

Patients and Methods

Research design:

Quasi experimental (study and control) research design was utilized.

Study variable:

The independent variable in this study was the foot splint and exercises while the dependent variable was foot drop in stroke patients.

Sample and Sample size:

A sample size of (80) patients diagnosed with ischemic stroke and their age ranged from 20 to 65 was needed for study by knowing that there were about (1612) case of stroke admitted to hospital through 2019 **(Assiut University hospital records**., **2019)** using **Steven K. Thompson** equation.

$$n = \frac{N \times p(1-p)}{\left[\left[N-1 \times \left(d^2 \div z^2\right)\right] + p(1-p)\right]}$$

N = total number of population (patient admitted to neurology department at Assuit University Hospitals = (1612) through 2019. Z = confidence level is 0.95. D =the error ratio is =0.05. P = the property availability ratio and neutral =0.05.

Patients were divided into two equal groups study and control , 40 patients for each group , study group was applied foot splint and participated in foot and ankle exercises and the control group was received the routine care. Both groups were matched as much as possible as regard to age, sex, level of education, occupation -------ect.

Setting:

The study was conducted in neurological department at Assuit University Hospitals.

Tools for data collection:

Two tools were used to achieve the aims of the study:

Tool I: Patient's assessment sheet:

It was designed and developed by the researchers based on current national and international literatures it included two parts:

Part (1): Personal data: this part included: patient name, age, gender, marital status, level of education, occupation, telephone number, date of admission, date of discharge and length of hospital stay.

Part (2): Clinical data: This part aimed to assess the clinical data of studied patient included the following : diagnosis , past medical history of chronic disease (heart disease, hypertension, diabetes) present medical history which include which side of body affected by stroke (Rt / Lt) and previous stroke .

Tool II: Ankle and foot assessment: which included 2 parts.

Part (1):- Foot and ankle disability index (FADI): adopted from Martin et al., (2005). (pre / post)

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 has 26 items, and the FADI Sport has 8. First scale which utilized in this study FADI has 26 items. Contains 4 pain related items and 22 activity related items. Each of the 26 items is scored on a 5-point Likert scale from 0 (unable to do), 1 (Extreme difficulty) 2 , (Moderate difficulty) , 3(Slight difficulty) to 4 (no difficulty at all). The 4 pain items of the FADI are scored 0 (none) to 4 (unbearable). The FADI has a total point value of 104 points are scored separately as percentages, with 0% represent most disability 100% which representing no dysfunction or disability, A score of ≤90% on the FADI indicates that a subject has FAI (foot and ankle instability). **Sabharwal & Singh, (2017).** This tool used for both study and control group three times before intervention , post one month and six months.

Part (2):-Muscle strength assessment scale, adopted from Williams, (1956) & Ciesla et al., (2011). (Pre / post).

The aim of muscle strength testing is to evaluate the complaint of weakness, often when there is a suspected neurologic disease or muscle imbalance/weakness. In this study the part of scale which pertain to lower limb was utilized. This tool used for both study and control group three times before intervention , post one month and six months.

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 elimination of gravity **(trace).**

2 from 5: muscle cane move joint through full range of motion only if part is appropriately positioned so that the force of gravity is eliminated **(poor)**.

3 from 5: muscle can move joint through full range of motion against gravity but without any resistance **(fair).**

4 from 5: muscle can move the joint through full range of motion against moderate exercise **(normal).**

5 from 5: muscle can move joint through full range of motion against gravity and against full resistance **(good) .**

Rehabilitation exercises and training on splinting (colored picture booklet):

The content of 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 effect of rehabilitation exercises and foot splint on improving ankle joint function for ischemic stroke patients. It consists of three parts:-

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

Part II: Stretching, Flexibility, Resistance and Range of Motion Exercises for foot and ankle joint:

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

Procedure

This study was carried out in the following phases:

Phase (1) (preparatory phase):-

Tools development:

A review of current, past, local and international related literature in the various aspects using books, articles, periodicals magazines and references were done.

Content validity and reliability:

Content validity was checked by 3 experts from Medical-Surgical Nursing staff and Medical staff who reviewed the tools for clarity, relevance, and comprehensiveness.

Reliability of tool II part one:

The correlation for the two scales for the involved ankles was (0.64). Contrary to (0.84) **Martin & Irrgang ., (2007).** which resulted from a combined analysis of the uninvolved extremities of CAI (chronic ankle instability) subjects with the matched extremities of healthy subjects .The correlation between the baseline FADI and FADI Sport scores was statistically significant (P <.0005) among healthy subjects and subjects with CAI. **Hale & Hertel., (2005).**

Reliability of tool II part two:

Objective muscle strength assessment can be reliably used in lower and upper extremities in post-stroke patients with chronic hemiparesis. Their reliability results varying from low to very high reliability (ICCs from 0.48 to 0.99). **Rabelo et al., (2016).**

MMT (manual muscle testing) is reliable for longitudinal and comprehensive assessment of strength. MMT has substantial reproducibility with a median percent agreement and ICC of 96% and 0.98, respectively. There was no clinically or statistically significant difference between trainees versus reference rater [96 (85–109) vs. 98 (83–107), P = 0.052]. Across all 19 trainee-reference rater pairs, the ICC (95% CI) for the overall, abbreviated, upper extremity, and lower extremity composite. **Fan et al ., (2010).**

Pilot study:

A pilot study on (10%) (8) patients were conducted during May , (2021) in order to test the clarity, relevancy ,feasibility and applicability of the tools. Those patients who were involved in the pilot study were also included in the study.

Ethical considerations:

Research proposal was approved from Ethical Committee in the Faculty of Nursing Assiut University. There is no risk for study subject during application of the research. Oral consent was obtained from patient or guidance that is willing to participate in the study, after explaining the nature and purpose of the study. Confidentiality and anonymity was assured. Patients have the right to refuse to participate and or withdraw from the study without any rational any time. Patients privacy was considered during collection of data.

Phase (2) Implementation phase:-

Once the permission was granted from head of neurological department at psychiatric and neurological disease hospital at Assuit University to proceed with the proposed study and after taking the patient's oral agreement for voluntary participation in the study the researcher initiated data collection using **tool I**. Data were collected form patients (study and control groups) on different days , data collection was carried out during morning and afternoon shifts.

Each patient involved in the study was interviewed individually at neurological department. The researcher assessed ankle and foot function by using tool **II** for study and control groups. Studied patients were applied foot splint and exercise where patients in control group were received routine hospital care.
Implementation phase performed through three sessions**;**
1st session the researcher explained for patients in study group the following items in the explanation : **(part I):** brief overview about 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.
2nd session; the researcher explained in details **(part II):** importance of rehabilitation exercise to patients which help to strengthen their lower limb muscles so that they can lift their foot up 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 theaffected limb incorrect position at time of rest Also the researcher taught patient how to apply foot splint. The patient is demonstrated that 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 for patient on how to apply splint

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, taking into account 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.
3rd session; after completing the first and second session, there were about 10-20 minutes for re-explaining and feedback. Reinforcement and encouragement was performed according to patient's needs to ensure their understanding.
Each patient in study group obtained a hard copy of the colored picture booklet to enhance patient's understanding and help them to retain the learned material. Patients were discussed about schedule for follow up to asses and monitor patient condition at one and six month from starting patient's condition.
Phase (3) (Evaluation phase)
The researcher performed foot and ankle assessment post 1 month and 6 month after intervention. The collection of data lasted (8) months through the period from (1st June 2021) to (31th January 2022).
Patients were assessed for muscles strength and reflexes at outpatient clinic when they come for follow up appointments and they have been asked to complete foot and ankle disability index questionnaire using tool II part one and part two.
The technique for assessing muscle strength Proper technique must be employed during testing to ensure valid results. Tight or restrictive clothing should be removed so that the researcher can visualize the muscles being tested and observe for muscle twitch. The researcher should also stabilize the joint and ensure that other muscles do not provide assistance. Muscles should first be tested with gravity eliminated by positioning the patient, so that muscle contraction is perpendicular to gravity, such as along an examining table or bed. If the patient is unable to engage the muscle with gravity eliminated, the researcher should place a hand on the muscle and ask the patient to contract his or her muscles again. This allows the researcher to feel for a muscle twitch, even if a twitch is not visible. This observation would differentiate a score of 0 from a score of 1. When the patient demonstrates the full range of motion with gravity eliminated, the test should be repeated against gravity for the full range of motion. If this is successful, the patient should be challenged by the addition of a small degree of resistance, then maximal resistance by the researcher. The unaffected or less affected side should be tested first to gauge contralateral strength for comparison.
Patient were given the following instruction when completing FADI scale "please answer the following question with one response that closely describe your condition " subject rate the activity as no difficulty at all (4piont) ,slight difficulty (3 point) , moderate difficulty (2 point) , extreme difficulty (1 point) and unable to do (0 point) then the FADI reported as percentage of 104 point.
Statistical analysis:
Data entry was done using compatible personal computer by the researcher. All data was entered into statistical packages for the social sciences (SPSS) version 25 software for analysis. The content of each tool was analysed, categorized and then coded by the researcher. Continuous variables described by mean and standard deviation (Mean, SD). Chi-square test and fisher exact test used to compare between categorical variables. A two-tailed $p < 0.05$ was considered statistically significant.

Results

Table (1): Distribution of demographic characteristics of the studied patients (n= 80).

Variables	Study group		Control group		P. value
	(n=40)	%	(n=40)	%	
Age					
Mean ±SD(range)	58.30± 9.14(20-65)yrs		60.52± 6.02(20-65)yrs		0.203
Sex					
Male	26	65.0	23	57.5	0.647
Female	14	35.0	17	42.5	
Marital status					
Single	2	5.0	0	0.0	0.336
Married	36	90.0	38	95.0	
Widow	1	2.5	2	5	
Divorced	1	2.5	0	0.0	
Educational level					
Illiterate	15	37.5	14	35.0	0.636
Read and write	18	45.0	22	55.0	
primary school	1	2.5	0	0.0	
Secondary school	5	12.5	4	10	
High education	1	2.5	0	0.0	
Occupation					
Non-working	12	30.0	16	40.0	0.350
Farmer	24	60.0	19	47.5	
Machinery work	1	2.5	0	0.0	
Office work	2	5.0	5	12.5	
Professional	1	2.5	0	0.0	
Residence					
Urban	13	32.5	13	32.5	1.000
Rural	27	67.5	27	67.5	

chi-square test *Ns = Non significant difference p > 0.05*

Table (2): Relation between study and control groups according to Deep tendon reflexes (Achilles tendon) assessment at affected side at admission and post 1 month and 6 month of implementing of foot splint and foot exercises (N = 80).

Variables	At admission					1 Month					6 Month				
	Study group		Control group		P. value	Study group		Control group		P. value	Study group		Control group		P. value
	N. 40	%	N. 40	%		N. 40	%	N. 40	%		N. 40	%	N. 40	%	
Absent	36	90.0	35	87.5	1.000	1	2.5	16	40.0	*0.010	0	0.0	0	0.0	*0.001
Present but diminished	4	10.0	5	12.5		32	80.0	23	57.5		1	2.5	24	60.0	
Normal	0	0.0	0	0.0		7	17.5	1	2.5		39	97.5	16	40.0	
Increased	0	0.0	0	0.0		0	0.0	0	0.0		0	0.0	0	0.0	
Hyperactive	0	0.0	0	0.0		0	0.0	0	0.0		0	0.0	0	0.0	

chi-square test ** significant difference at p value <0.05*

***statistically significant difference at p value < 0.01*

Table (3): Relation between study and control groups according to muscle strength test assessment at affected side at admission and post 1 month and 6 month of implementing of foot splint and foot exercises (N. 80).

Variables	At admission					1 Month					6 Month				
	study group		control group		P. value	study group		control group		P. value	study group		control group		P. value
	N. 40	%	N. 40	%		N. 40	%	N. 40	%		N. 40	%	N. 40	%	
Foot dorsiflexion															
0/5 none	16	40.0	24	60.0	0.284	0	0.0	6	15.0	*0.010	0	0.0	0	0.0	*****0.001
1/5 trace	11	27.5	9	22.5		7	17.5	21	52.5		0	0.0	3	7.5	
2/5 poor	10	25.0	6	15.0		18	45.0	11	27.5		1	2.5	21	52.5	
3/5 fair	3	7.5	1	2.5		12	30.0	2	5.0		3	7.5	15	37.5	
4/5 good	0	0.0	0	0.0		3	7.5	0	0.0		8	20.0	1	2.5	
5/5 normal	0	0.0	0	0.0		0	0.0	0	0.0		28	70.0	0	0.0	
Foot plantar flexion															
0/5 none	16	40.0	24	60.0	0.284	0	0.0	5	12.5	*0.010	0	0.0	0	0.0	*****0.001
1/5 trace	11	27.5	9	22.5		7	17.5	22	55.0		0	0.0	3	7.5	
2/5 poor	10	25.0	6	15.0		16	40.0	11	27.5		1	2.5	20	50.0	
3/5 fair	3	7.5	1	2.5		12	30.0	2	5.0		4	10.0	16	40.0	
4/5 good	0	0.0	0	0.0		5	12.5	0	0.0		6	15.0	1	2.5	
5/5normal	0	0.0	0	0.0		0	0.0	0	0.0		29	72.5	0	0.0	

Chi-square test ** significant difference at p value <0.05*
***statistically significant difference at p value < 0.01*

Table (4): Relation between study and control group regarding total level of FADI scale pre and post one month and six month after implementing foot drop splint and exercise N= 80 .

Variables	At admission					1 Month					6 Month				
	Study group		Control group		P. value	Study group		Control group		P. value	Study group		Control group		P. value
	N. 40	%	N. 40	%		N. 40	%	N. 40	%		N. 40	%	N. 40	%	
Least disability	0	0.0	0	0.0	0.104	0	0.0	0	0.0	*****0.010	3	7.5	0	0.0	*0.001
Mild disability	0	0.0	0	0.0		1	2.5	1	2.5		28	70.0	1	2.5	
Moderate disability	8	20.0	4	10.0		29	72.5	3	7.5		9	22.5	10	25.0	
Most disability	32	80.0	36	90.0		10	25.0	36	90.0		0	0.0	29	67.5	

Chi-square test ** Significant difference at p value <0.05*
***Statistically significant difference at p value < 0.01*

Table (5): Relation between FADI total level and Achilles tendon score among patients within study group and control group after implementing foot splint and exercise.

Variable	Achilles tendon score																			
	At admission						P. value	1 month						P. value	6 months						P. value
	Absent		Present		Normal			Absent		Present		Normal			Absent		Present		normal		
FADI total level	N40	%	N40	%	N40	%		N40	%	N40	%	N40	%		N40	%	N40	%	N40	%	
Study group																					
Most disability	29	72.5	3	7.5	0	0.0		1	2.5	9	22.5	0	0.0		0	0.0	0	0.0	0	0.0	
Moderate disability	7	17.5	1	2.5	0	0.0		0	0.0	23	57.5	6	15		0	0.0	1	2.5	8	20	0.107
Mild disability	0	0.0	0	0.0	0	0.0	0.607	0	0.0	0	0.0	1	2.5	* 0.009	0	0.0	0	0.0	28	70	
Least disability	0	0.0	0	0.0	0	0.0		0	0.0	0	0.0	0	0.0		0	0.0	0	0.0	3	7.5	
Control group																					
Most disability	33	82.5	3	7.5	0	0.0		15	37.5	21	52.5	1	2.5		0	0.0	18	45.0	10	25.0	
Moderate disability	2	5.0	1	2.5	0	0.0		1	2.5	2	5.0	0	0.0		0	0.0	5	12.5	5	12.5	
Mild disability	0	0.0	0	0.0	0	0.0	0.284	0	0.0	0	0.0	0	0.0	0.889	0	0.0	0	0.0	1	2.5	0.194
Least disability	0	0.0	0	0.0	0	0.0		0	0.0	0	0.0	0	0.0		0	0.0	0	0.0	0	0.0	

*Chi-square test * Significant difference at p value <0.05 **Statistically significant difference at p value < 0.01*

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

Variable	FADI total score of disability																			
	At admission						P. value	1month						P. value	6 month						P. value
	Most		Moderate		Mild			Most		Moderate		Mild			Moderate		Mild		Least		
Muscle strength scale	N40	%	N40	%	N40	%		N40	%	N40	%	N40	%		N40	%	N40	%	N40	%	
Foot dorsiflexion																					
0/5 none	15	37.5	1	2.5	0	0.0		0	0.0	0	0.0	0	0.0		0	0.0	0	0.0	0	0.0	
1/5 trace	8	20.0	3	7.5	0	0.0		5	12.5	2	5.0	0	0.0		0	0.0	0	0.0	0	0.0	
2/5 poor	6	15.0	4	10.0	0	0.0		3	7.5	14	35.0	1	2.5		1	2.5	0	0.0	0	0.0	
3/5 fair	3	7.5	0	0.0	0	0.0	0.230	2	5.0	10	25.0	0	0.0	*0.031	1	2.5	1	2.5	1	2.5	0.150
4/5 good	0	0.0	0	0.0	0	0.0		0	0.0	3	7.5	0	0.0		3	7.5	5	12.5	0	0.0	
5/5normal	0	0.0	0	0.0	0	0.0		0	0.0	0	0.0	0	0.0		4	10.0	22	55.0	2	5.0	
Foot planter flexion																					
0/5 none	15	37.5	1	2.5	0	0.0		0	0.0	0	0.0	0	0.0		0	0.0	0	0.0	0	0.0	
1/5 trace	8	20.0	3	7.5	0	0.0		5	12.5	2	5.0	0	0.0		0	0.0	0	0.0	0	0.0	
2/5 poor	6	15.0	4	10.0	0	0.0		3	7.5	12	30.0	1	2.5		1	2.5	0	0.0	0	0.0	
3/5 fair	3	7.5	0	0.0	0	0.0	0.138	1	2.5	11	27.5	0	0.0	*0.052	2	5.0	1	2.5	1	2.5	0.087
4/5 good	0	0.0	0	0.0	0	0.0		1	2.5	4	10	0	0.0		2	5.0	4	10.0	0	0.0	
5/5normal	0	0.0	0	0.0	0	0.0		0	0.0	0	0.0	0	0.0		4	10.0	23	75.5	2	5.0	

*Chi-square test * Significant difference at p value <0.05 **Statistically significant difference at p value < 0.01*

Table (1): Mentions that as regard to demographic data the mean age in control group was (60.52± 6.02) years old and study group was (58.30± 9.14) years old. More than half of patient were male in both control and study group (57.5 %, 65.0%) respectively. The majority of patients in both group were married (95.0% , 90.0%) respectively. as regard to education about half of patient were able to read and write (55.0%, 45.0 %) respectively. Table also show that highest percentage of patient were farmer in each group (47.5%, 60.0%) respectively and rural residence (67.5, 67.5) respectively in both group. No significant difference as regard to demographic data in both control and study group with (p>0.05).

Table (2): Shows that there is statistically significant difference regarding Achilles tendon score among study and control group post one month and six months with p. value 0.001 with an increasing in Achilles tendon score in study group post implementing foot splint and exercises.

Table (3): Illustrate that there is statistically significant difference regarding muscles strength score among study and control group post one month and six months with p. value 0.010 post one month and p. value 0.001 post six months with an improvement in the level of muscle strength among study group than control group after implementing of foot splint and exercises.

Table (4): Reveals that there is statistically significant difference regarding FADI scale total score among patients within study and control group post one month with p. value 0.010 and six months with p .value 0.001 after implementing foot drop splint and exercises .

Table (5): Explain that there is significant relation between FADI total score and Achilles tendon score among patients in study group at follow after one month of implementing of foot splint and exercises at p value 0.009 mention also that there is no significant relation between FADI total score and Achilles tendon score among patients in control group post one and six months at p value > 0.05.

Table (6): Clarifies that there is significant relation between FADI total score and muscle strength score among studied patients in study group at follow up after one month as regard foot dorsiflexion with p. value 0.031 and foot planter flexion with p. value .052 .

Discussion

Stroke is a medical condition that causes brain damage, leading to disability and mortality. Walking impairment are the most common problems in stroke survivors, occurring in 39 to 90 of all cases. 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. 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) & Knight et al., (2019).**

Regarding to demographic characteristics of patients**,** the present study revealed that the mean age for patients in study group was (58.30± 9.14) yrs old and in control group was Mean ±SD (60.52± 6.02) yrs old this result supported by **Sylaja et al ., (2018)** who mentioned in his study that the mean age for the studied patients suffered from ischemic stroke was (58.3) yrs old and **Hwang ., (2020)** who mention that mean age for patients with ischemic stroke was (63.50) yrs old.

According to **Go et al ., (2018)** who reported in the study of "Association of burden of atrial fibrillation with risk of ischemic stroke in adults with paroxysmal atrial fibrillation" that the mean age for patients was (69.1) yrs old and **Hendrix et al., (2019)** that also reported that the mean age for patients was (67.7) yrs old.

From researcher opinion this finding presented because stroke risk increased with increasing age which make patient more vulnerable and increasing risk of chronic disease and disability.

Regarding the impact of foot splint and practicing foot rehabilitation exercises on foot drop. The result of present study revealed that there was statistically significant difference among patients in study and control group regarding foot and ankle assessment post implementing foot splint and exercises.

This finding was in accordance with study of Choo **& Chang., (2021)** entitled as "Effectiveness of an ankle–foot orthosis on walking in patients with stroke" it revealed that 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, corrects gait abnormalities by supporting dorsiflexion of the ankle and normalize gait patterns and maintain balance.

In this respect, **Kwon et al., (2019)** mentioned in their study that the results showed improvement in both gait propulsion and foot-drop prevention after application of ankle foot orthosis. In

another study recommend that foot drop splint are commonly prescribed to provide ankle support during walking **Totah et al ., (2019) .**

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 score less than 3 for the ankle dorsiflexor of the affected side were considered to require ankle foot orthosis.

Results of current study also come in agreement with **Chen et al., (2021)** who reported that there is 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.

Also **Han et al., (2017)** 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.

Likewise **Milton et al., (2018)** reported that undertaking strength training exercise is known to lead to increasing muscle mass , improving muscle function and reducing functional impairment, disability, falls, and loss of independence.

Kim et al., (2019) reported that stretching the ankle muscles help 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.

More over **Hou et al ., (2021)** recommended 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 of the 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 aims to enhance and augment natural mechanisms of recovery. it is mandated to provide at least 3 hours of therapeutic rehabilitation exercises per day for minimum 5 days in a week .

The current study revealed that there was statistically significant difference regarding total score of Foot And Ankle Disability index (FADI) scale among patients in study and control group with p. value = 0.001 post six months after application of foot splint and exercises .

This finding supported by **Fatmawati., (2018)** who stated that the benefits of providing strengthening exercise against drop foot obtained the evaluation result of increased muscle strength from value 1 to 2. There was an increase in the scope of joint range of motion .There was an increase in functional activity from FADI 96 to 104. Its conclude that strengthening exercise can increase the muscle strength, increased range of motion, and increase functional activity of FADI.

The present study revealed statistically significant difference among patients in study and control group regarding assessment of Achilles tendon reflex post one and six months after application of foot splint and practicing foot rehabilitation exercises with p .value = 0.001. The current study revealed that was a significant relation between Achilles tendon total score and FADI total score in subjects in study group at one month follow up.

These come in agreement with **Shao et al., (2019)** who stated in their study that there is evidence that rehabilitation via physiotherapy and exercises in motor dysfunction can substantially improve the daily activity and quality of life in post stroke patients and reduce their medical burden on the family and society, this study also clarifies that there is a change in Achilles tendon characteristics after implementing rehabilitation exercise for lower limb with motor dysfunction in stroke patients .

Moreover, the present study revealed statistically significant difference among subjects in control and study group regarding assessment of muscle strength of lower limb post one and six months after application of foot splint and exercises. This study also revealed that was a significant relation between muscle strength score and FADI total score in subjects in study group at (one) month follow up

This results was similar to **Kramer et al., (2017)** who reported 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 40% of their leg muscle strength.

Yamamoto et al., (2016) revealed that resistance training exercises increased lower extremity muscle strength and improved mobility in study compared with the control group.

In stroke; patients complain from 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.

In researcher opinion, foot drop splint help patient to maintain leg and foot in norm grade position, preventing foot from being floppy, assisting patient during walking and preventing foot dragging during swing phase of walking . Also exercises training help to reduce muscle fiber atrophy, preserve ankle mobility by maintaining foot and ankle muscle active, conserve foot muscle strength and size.

Generally, applying foot drop splint and practicing exercises post stroke is helpful method to maintain foot and ankle strength and reducing disability associated with foot drop in stroke patients.

Conclusion

The result of the present study concluded that; there was highly statistical significance difference between study and control group patients regarding ankle and foot assessment after application of foot drop splint and exercise, Achilles tendon score , muscle strength and level of disability on FADI scale was improved after applying foot splint and exercise

Recommendations

- Stroke patients should engage in rehabilitation exercise for foot and ankle and apply foot drop splint to decrease disability associated with foot drop.
- Colored picture booklet should be available for each patient in simplified term and containing simple pictures and distributed among ischemic stroke patients to provide them with information regarding application of foot drop splint and exercises.
- Application of research on larger sample.

Limitations of the study:

Some patients at first refuse to use foot drop splint for social and financial affairs.

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