



Original Research

Usage Frequency, Barriers, And Effectiveness of Functional Electrical Stimulation as An Intervention for Stroke Patients

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ABSTRACT

Objective: To determine the frequency of Functional Electrical Stimulation (FES) use in stroke rehabilitation and to identify the barriers and effectiveness of its usage as an intervention for stroke patients.

Materials & Methods: This prospective observational study was performed in different clinics and hospitals in Hyderabad. Physical therapists actively practicing in healthcare facilities within Hyderabad, with a minimum of one year of clinical experience in stroke rehabilitation of either gender were included. A questionnaire was structured to collect data on the usage frequency, perceived barriers, and effectiveness related to the utilization of FES in stroke rehabilitation.

Results: Most of the participants were using FES frequently and sometimes for shoulder subluxation, improving arm function, enhancing walking function, improving muscle strength and endurance, addressing hypertonia and spasticity, and improving sensation. Respondents when asked about having sufficient time to apply FES, lack of evidence justifying FES use, and regards to workplace support most of the cases >50% agreed strongly agreed, while <50% of study subjects' believed that does not provide advantages for individuals having a chronic stroke. FES utilization among healthcare professionals in stroke patient rehabilitation, highlighting its potential benefits in improving arm function, shoulder subluxation, walking performance, and hemiplegic shoulder pain. However, there were no significant barriers identified.

Conclusion: There was a significant use of FES by physical therapists in Hyderabad to address various aspects of stroke rehabilitation. The study overall highlights its potential for improving arm function, preventing shoulder subluxation, enhancing walking, and reducing hemiplegic shoulder pain, without significant identified barriers.

Keywords: Stroke, Physical Therapists, FES, Usage, Effectiveness.

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INTRODUCTION

Stroke is a leading contributor to disability, with an estimated 70% of patients experiencing dysfunction in their upper limbs (UL) following a stroke.^{1,2} Over half of these individuals face moderate to severe dysfunction, leaving 40% with a non-functional arm, significantly impacting their quality of life.^{1,3} Only a small percentage, ranging from 5% to 20%, achieve complete recovery of upper limb function.^{1,4} These complications have a considerable influence on the overall well-being of patients and hinder their ability to reintegrate into society.⁵⁻⁷ Various rehabilitation technologies have been studied to enhance the management of disabilities resulting from strokes. FES has been successful in enhancing the standing balance and walking capacity of individuals who have experienced a stroke.⁸ It is a subset of NMES where stimulation facilitates effective and determined movement.⁹ This is achieved through the activation of electrical impulses that, when contracted, produce movements that can be activated.⁹ FES is an intervention that produces consistent and timely muscle contraction for functional activities.¹⁰ This stimulus is achieved by bringing low-energy energy through electrodes to the skin to activate motoneurons that cause muscle contraction. FES has been employed among people with stroke to enhance strength, and upper and lower extremity function and prevent hemiplegic shoulder subluxation. FES is recommended for stroke rehabilitation, but physical therapists may not use it regularly in their clinical activities because the devices are not available at the clinic.¹¹ FES can also be divided into three classes such as operations, sensory functions restoration, skeleton motor function restoration, and independent functions restorations. In recent years, there has been an increasing interest in functional electrical stimulation. This device creates the start of new advanced area

rehabilitation called FES. It delivers contraction of the muscles and functionally valuable movement with artificial stimulation, which has been lost due to loss of nervous control in injury. FES requires electrical current to excite the contraction of muscles to improve functioning. As FES works to stimulate existing nerves, nerve fibers in the middle of the spinal cord and muscles should not be damaged. Doing this can give each person the ability to walk, even for just a few meters, with a cane or a stick. Encouraging electricity to repair a reduced foot produces a normal mobility pattern. It enables people to move faster with reduced effort and also reduces the danger of falling leading people to self-confidence and independence in their travels. FES can be used for people with difficulty in affecting their limbs due to impairment to their brain or spine as it appears in stroke or multiple sclerosis.¹² Sensory stimulus occurs when the current flow of the sensor is elevated membrane potential overhead edge. As stroke leads to sensorimotor impairments that significantly reduce the ability to engage in daily life activities and constrain functional tasks, it has been established through various studies that Functional Electrical Stimulation (FES) proves effective in enhancing motor recovery and improving functional tasks among stroke patients.⁹ FES is a treatment modality that induces muscle contractions, thus aiding in the enhancement of motor outcomes post-stroke.⁹ Specifically, it stimulates muscle contractions during activities to enhance the performance of those activities.¹² Consequently, our research has observed the utilization of FES by physical therapists for stroke patients. This study aims to explore the level of usage, barriers, and effectiveness of FES according to physical therapists. By doing so, we aim to identify the deficiencies that lead to the limited application of FES in clinical practice.

MATERIAL AND METHODS

Study Design and Setting

This prospective cross-sectional study was done at combined Isra University, LUMHS, Maa Jee Hospital, and Jee Jal Maa Hospitals, Hyderabad. The study was completed over three months after taking ethical approval from Isra University Hospital Hyderabad.

Inclusion Criteria

All the licensed physical therapists actively practicing in healthcare facilities within Hyderabad, with a minimum of one year of clinical experience in stroke rehabilitation of either gender were included.

Exclusion Criteria

All the physical therapists with controversial clinical experience in stroke rehabilitation were excluded as they may not have sufficient exposure to FES, and those who did not provide informed consent for participation were not included in the study.

Data Collection

The study used convenience sampling to select participants. Physical therapists practicing in various healthcare facilities in Hyderabad were invited to participate in the survey. A list of eligible participants meeting the inclusion criteria was compiled through collaboration with healthcare institutions and professional associations. A questionnaire was structured to collect data on the usage frequency, perceived barriers, and effectiveness related to the utilization of FES in stroke rehabilitation. The survey questionnaire was distributed to eligible participants through both online and paper-based methods. Physical therapists were given a choice to complete the survey electronically or in print, depending on their preference. Study subjects were briefed on the study's objectives, methods, and possible hazards, and they had to give informed consent before their involvement. They were also assured that all

collected data would be kept confidential, and their anonymity would be preserved.

Data analysis

All the collected information was entered and analyzed by using SPSS version 26.

RESULTS

Gender and Work Experience

This study interviewed 100 physiotherapists regarding the usage frequency, barriers, and effectiveness of FES as an intervention for stroke patients. Out of them, 31% were male, and 69% were female. In terms of work experience, 79% had <5 years of experience, 13% had 5-10 years, and 8% had over 10 years of experience in this field. Table 1.

Table. 1. Gender and work experience with stroke patients of study subjects n=100.

Variables		Frequency	Percent
Gender	Male	31	31.0
	Female	69	69.0
Working experience with stroke patients	<5 years	79	79.0
	5-10 years	13	13.0
	>10 years	8	8.0

Usage of FES Among Stroke Patients

Regarding FES usage, 19% often used it for reducing shoulder subluxation, while 27% used it frequently. For improving arm function, 34% used it frequently, and 24% used it occasionally. Similarly, for enhancing walking function, 34% used FES frequently, and 24% used it sometimes. In terms of muscle strength/endurance, 44% used FES frequently, and 21% used it occasionally. To address hypertonia/spasticity, 27% used FES frequently, and 19% used it sometimes. Lastly, for improving sensation, 31% frequently used FES, and 20% used it occasionally. The remaining cases used it either most of the time, rarely, or never as shown in the table 2.

Barriers to FES Usage Among Stroke Patients

Patients were requested to assess their level of agreement with different statements. When asked about having sufficient time to apply FES, 56% agreed 8% strongly agreed, while 14% strongly disagreed and 5% disagreed. Regarding the lack of evidence justifying FES use, 52% agreed, and 11% strongly agreed, with 5% strongly disagreeing and 11% disagreeing. For those who had tried using FES with limited success, 29% disagreed, 10% strongly agreed, 13% strongly disagreed and 27% neither agreed nor disagreed. Concerning client access to FES devices for home use, 33% agreed, and 12% strongly agreed, with 16% strongly disagreeing and 18% disagreeing. The belief that FES does not provide advantages for individuals suffering from chronic stroke saw 27% agreeing and 12% strongly agreeing, while 12% strongly disagreed and 24% disagreed. Lastly, concerning workplace support, 58% agreed 5% strongly agreed, 14% strongly disagreed, and 23% neither agreed nor disagreed. These findings offer insights into the perceived barriers to FES utilization among healthcare professionals in stroke patient rehabilitation, covering factors such as time constraints, evidence, client concerns, and workplace support. Table 3.

Effectiveness of FES Usage Among Stroke Patients

Table 2: Usage of FES among stroke patients according to study participants n=100.

		Frequency	Percent
How frequently do you use FES to reduce shoulder subluxation	Usually	19	19.0
	Frequently	27	27.0
	Sometimes	9	9.0
	Occasionally	14	14.0
	Rarely	14	14.0
	Never	17	17.0
How often do you utilize FES to enhance arm function, specifically reach and grasp abilities?	Usually	14	14.0
	Frequently	34	34.0
	Sometimes	24	24.0
	Occasionally	18	18.0
	Rarely	2	2.0
	Never	8	8.0
How frequently do you use FES to improve walking function?	Usually	18	18.0
	Frequently	34	34.0
	Sometimes	24	24.0
	Occasionally	17	17.0
	Never	7	7.0
How frequently do you use FES to improve muscle strength/endurance	Usually	16	16.0
	Frequently	44	44.0
	Sometimes	21	21.0
	Occasionally	12	12.0
	Rarely	3	3.0
	Most of the time	4	4.0
How frequently do you use FES to Reduce hypertonia/spasticity?	Usually	15	15.0
	Frequently	27	27.0
	Sometimes	19	19.0
	Occasionally	18	18.0
	Rarely	5	5.0
	Usually	18	18.0
How frequently do you use FES to improve sensation	Frequently	31	31.0
	Sometimes	20	20.0
	Occasionally	15	15.0
	Rarely	11	11.0
	Never	5	5.0

Usually = >80%, **Frequently** = 60-70%, **Sometimes** = 41-59%,
Occasionally = 21-40%, **Rarely** = 1-20%, **Never**= 0%

In terms of experiences with FES across various aspects. The findings offer insights into the perceived effectiveness of FES utilization among healthcare professionals in stroke patient rehabilitation, highlighting its potential benefits in improving arm function, preventing shoulder subluxation, enhancing walking performance, and

reducing hemiplegic shoulder pain, results shown in the table 4.

Table 3: Barriers to FES usage among stroke patients according to study participants n=100.

		Frequency	Percent
I have sufficient time to apply for FES	Strongly Disagree	14	14.0
	Disagree	5	5.0
	Neither Agree nor Disagree	17	17.0
	Agree	56	56.0
	Strongly Agree	8	8.0
There is insufficient evidence to support the utilization of FES in stroke patients	Strongly Disagree	5	5.0
	Disagree	11	11.0
	Neither Agree nor Disagree	21	21.0
	Agree	52	52.0
	Strongly Agree	11	11.0
My stroke clients are hesitant to use FES	Strongly Disagree	11	11.0
	Disagree	3	3.0
	Neither Agree nor Disagree	42	42.0
	Agree	38	38.0
	Strongly Agree	6	6.0
My stroke clients have the opportunity to use an FES device at home	Strongly Disagree	16	16.0
	Disagree	18	18.0
	Neither Agree nor Disagree	21	21.0
	Agree	33	33.0
	Strongly Agree	12	12.0
FES does not provide advantages for individuals with chronic stroke (occurring more than one-year post-stroke)	Strongly Disagree	12	12.0
	Disagree	24	24.0
	Neither Agree nor Disagree	25	25.0
	Agree	27	27.0
	Strongly Agree	12	12.0
My workplace or supervisor encourages the utilization of FES as a form of treatment.	Strongly Disagree	14	14.0
	Disagree	--	--
	Neither Agree nor Disagree	23	23.0
	Agree	58	58.0
	Strongly Agree	5	5.0

Table 4: Effectiveness of FES usage among stroke patients according to study subjects n=100.

		Frequency	Percent
I attempted to incorporate FES into my practice but did not achieve significant success with it.	Strongly Disagree	13	13.0
	Disagree	29	29.0
	Neither Agree nor Disagree	27	27.0
	Agree	21	21.0
	Strongly Agree	10	10.0
Improve arm function poststroke	Strongly Disagree	7	7.0
	Disagree	1	1.0
	Neither Agree nor Disagree	24	24.0
	Agree	60	60.0
	Strongly Agree	8	8.0
Prevent shoulder subluxation poststroke	Strongly Disagree	7	7.0

	Disagree	1	1.0
	Neither Agree nor Disagree	24	24.0
	Agree	60	60.0
	Strongly Agree	8	8.0
	Strongly Disagree	3	3.0
Prevent shoulder subluxation poststroke	Disagree	20	20.0
	Neither Agree nor Disagree	24	24.0
	Agree	45	45.0
	Strongly Agree	8	8.0
	Strongly Disagree	8	8.0
Improve walking performance poststroke	Disagree	7	7.0
	Neither Agree nor Disagree	19	19.0
	Agree	63	63.0
	Strongly Agree	3	3.0
	Strongly Disagree	4	4.0
Reduce hemiplegic shoulder pain	Disagree	7	7.0
	Neither Agree nor Disagree	26	26.0
	Agree	58	58.0
	Strongly Agree	5	5.0

DISCUSSION

Functional Electrical Stimulation has found extensive application in the treatment of individuals with central nervous system injuries, aiming to enhance motor control.¹³ It elevates the cerebral sensory-motor cortex activity among patients with stroke, influencing functional movement, facilitating motor learning, and enhancing the efficacy of treatment.^{13,14} FES devices may not be accessible in all clinical settings and not included in the curriculum.⁹ Current study has been conducted among 100 physical therapists in Hyderabad to evaluate the frequency of Functional Electrical Stimulation (FES) use in stroke rehabilitation and to identify the barriers and effectiveness of its usage as an intervention for stroke patients. In this study according to FES usage, 19% often used it for reducing shoulder subluxation, while 27% used it frequently, for improving arm function, 34% used it frequently, and 24% used it occasionally, similarly, for enhancing walking function, 34% used FES frequently, and 24% used it sometimes, in terms of muscle strength/endurance, 44% used FES frequently, and 21% used it occasionally, followed by to address hypertonia/spasticity, 27% used FES

frequently, and 19% used it sometimes and in improving the sensation, 31% frequently used FES, and 20% used it occasionally. In the Comparison of this study, Auchstaetter et al,¹⁵ reported that utilization of FES for stroke patients across all assessed therapeutic objectives (enhancing walking, improving arm function, increasing muscle strength and endurance, enhancing sensation, preventing shoulder subluxation, and reducing spasticity) was limited.¹⁵ In this study no significant barriers were found, while few physical therapists found barriers in terms of insufficient time, lack of evidence to justify the use of Fes, clients apprehensive, and fewer benefits for chronic stroke. On the other hand, Tedesco Triccas et al,¹⁶ found barriers to the utilization of FES encompassed constraints related to staff availability, training, financial considerations, and equipment accessibility. Among those who had not used FES, 63% expressed an inclination to consider its use in the future if given the chance. Brown et al,¹⁷ found challenges in the adoption process, including restricted FES availability, clinician confidence issues, and the necessity for a tiered education approach accompanied by continuous support. Although professional organizations acknowledge the effectiveness of

FES and there is an expanding body of evidence supporting it, the process of implementing FES services has been sluggish.^{18,19} This delay may be attributed to the absence of detailed guidance regarding the provision of FES services.¹⁸ On the other hand, it was mentioned that the focus lies in identifying and addressing barriers that can be reduced or eliminated through the application of FES in patients with diverse neurological conditions, including traumatic brain injury (TBI), cerebral palsy (CP), and multiple sclerosis (MS), as long as the primary obstacles are identified.²⁰ In this study offers insights into the perceived effectiveness of FES utilization among healthcare professionals in stroke patient rehabilitation, highlighting its potential benefits in improving arm function, preventing shoulder subluxation, enhancing walking performance, and reducing hemiplegic shoulder pain. These were supported by Vafadar et al,²¹ Tan et al²², and Eraifej et al.²³ Differences in barriers were observed following various studies and this may be because different studies on the use of Functional Electrical Stimulation (FES) in stroke patients may have employed varying methodologies, sample sizes, and patient populations. These differences can lead to variations in the barriers identified. It can also be because stroke is a complex neurological condition, and patients can present with a wide range of symptoms and comorbidities. The nature and severity of these symptoms can differ among stroke patients, which can lead to variations in the barriers they encounter when using FES. The effectiveness of FES and the specific barriers faced by stroke patients can also be influenced by contextual factors, such as healthcare systems, rehabilitation protocols, and patient demographics. These contextual differences can result in varying outcomes and identified barriers.

CONCLUSION

It has been revealed that physical therapists significantly utilize FES for addressing shoulder

subluxation, improving arm function, enhancing walking function, increasing muscle strength and endurance, managing hypertonia and spasticity, and enhancing sensation. 39% of participants believed that FES was not beneficial in clients with chronic stroke, 36% were in favor and 25% had no idea. However overall, the study underscores the promising potential of FES in stroke patient rehabilitation for improving arm function, preventing shoulder subluxation, enhancing walking performance, and reducing hemiplegic shoulder pain, with no significant identified barriers. Further large-scale studies should be conducted to evaluate the use of FES in stroke rehabilitation and other conditions. Additionally, there is a need for more opportunities for continuing education in FES and the development of affordable and simple devices.

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AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Fouzia Baloch	1. Study design and methodology.
2.	Mehreen Niaz	2. Paper writing.
3.	Asma Bilal	3. Data collection and calculations.
4.	Prem Sagar	4. Analysis of data and interpretation of results.
5.	Nadeem Ahmed Memon	5. Literature review and referencing.