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Comparing The Effect Of Fes And Pnf Exercises To Help Stroke Patients Walk More Easily

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ABSTRACT

Background: Those who have had a stroke may find it difficult to walk, which makes getting about and being independent more challenging. This study investigated the effectiveness of Proprioceptive Neuromuscular Facilitation (PNF) and Functional Electrical Stimulation (FES) exercises in assisting stroke survivors with walking and performing other tasks.

Methodology: 120 stroke patients with limited gait were part of a randomised controlled study. The groups for the participants were either the FES or the PNF ones. While FES targeted important muscle groups involved in gait, PNF focused on gait training, balance exercises, and muscular strengthening. Interventions ran for eight weeks, three times a week.

Results: Gait qualities, muscular strength, balance, and functional mobility were assessed both before and after the intervention. Efficacy of PNF and FES statistically matched.

Conclusion: This study guides doctors in selecting suitable therapies by comparing the efficacy of FES and PNF in improving gait and functional outcomes, thereby supporting stroke rehabilitation.

Keywords: *stroke, gait disruption, rehabilitation, functional Electrical Stimulus (FES), proprioceptive Neuromuscular Facilitation (PNF), randomised controlled trial, muscle strength, balance, functional mobility*

1. INTRODUCTION

Stroke, a cerebral event in which blood flow to the brain stops suddenly, is the main cause of death and long-term disability around the world. Ischaemic strokes happen when a blood vessel that brings blood to the brain gets blocked or occluded. Hemorrhagic strokes happen when a blood vessel breaks and blood flows inside or around the brain. Depending on where and how bad the brain damage is, these events can lead to a number of neurological problems, such as problems with movement, senses, thinking, and perception.

Ischaemic strokes are usually caused by thrombotic or embolic blockages in the brain's arteries. High blood pressure, diabetes, high cholesterol, smoking, being overweight, and atrial fibrillation are some of the things that can cause these. Ischaemic strokes are more likely to happen in people with atrial fibrillation because it makes atherosclerosis, clotting, and

cardioembolic events more likely. Even though they happen less often, anticoagulant drugs, arteriovenous malformations (AVMs), brain aneurysms, and high blood pressure have all been linked to hemorrhagic strokes.

The symptoms of a stroke vary on which parts of the brain are damaged. But it usually comes on quickly and includes things like hemiparesis, hemiplegia, sensory problems, aphasia, dysarthria, eye disturbances, and changes in awareness. To reduce brain damage and improve results, it is important to quickly recognise and treat stroke signs. "FAST" stands for "Facial drooping, Arm weakness, Speech difficulties, and Time to call emergency services." It is often used to make people more aware of the problem and help people act quickly.

2. TYPES OF STROKE

Ischemic Stroke: An ischemic stroke occurs when a blood clot or thrombus blocks a blood vessel supplying the brain, resulting in a reduction or cessation of blood flow and oxygen delivery to the affected brain tissue. Ischemic strokes account for approximately 87% of all stroke cases and are

Further classified into several subtypes:

Thrombotic Stroke: This type of ischemic stroke occurs when a blood clot (thrombus) forms within a cerebral artery or one of its branches, usually in association with atherosclerosis or plaque buildup in the vessel walls. **Embolic Stroke:** Embolic strokes result from the embolisation of a blood clot or other debris from a distant site, such as the heart or large arteries, which travels through the bloodstream and lodges in a smaller cerebral artery, causing occlusion.

Lacunar Stroke: Lacunar strokes involve the occlusion of small penetrating arteries within the brain's deep structures, leading to small, discrete infarcts. They are often associated with hypertension and diabetes and may manifest as pure motor or sensory deficits.

Cryptogenic Stroke: Cryptogenic strokes refer to cases where the underlying cause of ischemic stroke remains undetermined despite comprehensive evaluation, including cardiac, vascular, and laboratory investigations.

Ischemic strokes present with sudden-onset focal neurological deficits, such as hemiparesis, hemiplegia, sensory loss, aphasia, or visual disturbances, corresponding to the affected brain region. Prompt recognition and management, including thrombolytic therapy with tissue plasminogen activator (tPA) and mechanical thrombectomy, are crucial for salvaging brain tissue and optimising outcomes in eligible patients.

Hemorrhagic Stroke: Hemorrhagic stroke occurs when a blood vessel within the brain ruptures, leading to bleeding into or around the brain tissue. Although less common than ischemic stroke, hemorrhagic strokes are associated with higher morbidity and mortality rates. Hemorrhagic strokes are primarily classified into two types.

Subtypes:

Intracerebral Hemorrhage (ICH): Intracerebral hemorrhage involves bleeding directly into the brain parenchyma, typically due to the rupture of small vessels damaged by hypertension or cerebral amyloid angiopathy. ICH commonly presents with a sudden-onset severe headache, altered consciousness, focal neurological deficits, and signs of increased intracranial pressure.

Subarachnoid Hemorrhage (SAH): Subarachnoid hemorrhage results from bleeding into the subarachnoid space, usually secondary to the rupture of an intracranial aneurysm or, less commonly, arteriovenous malformation (AVM). SAH presents with a thunderclap headache, often described as the worst headache of one's life, along with nausea, vomiting, meningeal signs, and altered mental status.

3. TREATMENT

Treatment of stroke depends on the type of stroke (ischemic or hemorrhagic) and the time since symptom onset. Here's an overview of the treatment approaches:

Ischemic Stroke:

Thrombolytic Therapy:

Thrombolytic therapy involves giving tissue plasminogen activator (tPA) through an IV within 4.5 hours of the start of sym ptoms in order to break up blood clots and get blood flowing again.

Mechanical Thrombectomy:

Mechanical Thrombectomy is an endovascular technique used to remove big blood clots from blocked brain arteries. It is u sually done within 6 hours, but can happen up to 24 hours after the first sign of a problem.
Medications like aspirin and clopidogrel can help stop the formation of more thrombi.
In cases of a cardioembolic stroke, like atrial fibrillation, anticoagulants, like warfarin or direct oral anticoagulants (DOAC s), can be used to stop the blood clot from getting bigger.

Antiplatelet Therapy: In cases of intracerebral haemorrhage (ICH), surgical evacuation of the hematoma helps reduce pressure on the brain. In cases of subarachnoid haemorrhage (SAH), coiling or embolisation of aneurysms helps prevent rebleeds. Managing hypertension helps to control blood pressure such that re-bleeding and other damage are avoided. Surveillance in intensive care units, control of intracranial pressure, and reduction of effects like cerebral oedema and seizures constitute supportive care.

Hemorrhagic Stroke: Stroke rehabilitation consists of multidisciplinary programs combining occupational therapy, physiotherapy, speech therapy, and cognitive treatment to improve recovery and maximise functional results. Problems, including spasticity, pain, depression, and dysphagia, could be addressed with pharmaceuticals.

Rehabilitation: Utilizing mobility aids, orthoses, and adaptive equipment enables individuals to increase autonomy in daily life tasks. Modification of lifestyle: Encouragement of healthful behaviours such as physical activity, nutrition, smoking cessation, and control of cardiovascular risk factors to diminish the likelihood of recurrent stroke.

Secondary Prevention: control of diabetes, hyperlipidaemia, hypertension, and smoking cessation. Antiplatelet or anticoagulant treatment: depending on the aetiology and risk of recurrent stroke. In certain cases, surgical procedures to remove plaque accumulation or widen restricted carotid arteries are known as a carotid endarterectomy or stenting. Adopting a good diet, consistent exercise, weight control, and limiting alcohol intake to reduce the risk of recurrent stroke helps one change their lifestyle.

Mechanism of Action of Functional Electrical Stimulation (FES) Functional electrical stimulation (FES) is the application of electrical currents to muscles or peripheral nerves, thereby producing muscular contraction and stimulation of movement. It increases neuroplasticity, directly stimulates muscle fibres, and avoids damaged brain circuits.

Muscle Re-Education: Functional Electrical Stimulus (FES) can activate weakened or paralysed muscles, therefore enabling muscular re-education and motor function recovery. Functional Electrical Stimulation (FES) can be used to target specific muscle groups associated with ambulation, including the quadriceps, hamstrings, and dorsiflexors, thereby enhancing walking competency and gait symmetry. FES can enable people to reach, grasp, and lift objects—essential functional tasks—by strengthening muscles and improving coordination.

FES helps patients with stroke-related weakness, lower muscular atrophy, and boosts muscle strength. Through the induction of muscle contraction, FES can enhance motor control and coordination, thereby promoting more fluid and efficient movement patterns. For stroke survivors, FES-assisted activities can enhance functional independence, quality of life, and performance in daily living tasks.

Things to consider:

FES settings - Changing the intensity, frequency, and length of FES calls for careful thought about the patient's preferences and pragmatic goals. Monitoring safety and security: Frequent assessments of muscle response and skin condition assist to avoid unwanted consequences such muscular tiredness or skin irritation.

Applications in Stroke Recovery: To enhance their treatment, many patients mix functional electrical stimulation (FES) with other means of healing, like traditional therapy or robotic-assisted training. Often used in conjunction with other types of rehabilitation, like robotic-assisted training or traditional treatment, functional electrical stimulation (FES) maximises the healing process. Using ideas of motor learning and neuromuscular facilitation, functional electrical stimulation (FES) is a rehabilitation method including proprioceptive neuromuscular facilitation (PNF). Emphasising hand skills, sensory inputs, and diagonal movement patterns helps muscles in becoming active and improving functional movement patterns.

PNF procedures using rhythmic start and resistance patterns can help stroke sufferers with weak or spastic muscles. PNF workouts concentrate on changing your weight and using different body motions. This helps you to build your gait and improves your rhythm and balance when walking. Treatments include PNF stretching can assist stroke sufferers with tight muscles or contractures become more flexible and move their bodies in a greater variety of ways. PNF improves among other things proprioception, sensory input, balance, and muscle learning and control. Better motions follow from this. By using circular and vertical movement patterns, PNF treatments assist your muscles work at their optimum and hence increase your endurance. PNF workouts focus on including movement patterns into normal tasks, like standing, reaching, and lifting, thereby enhancing general functional ability.

Gait Training: PNF exercises concentrate on dynamic movement patterns and weight shifting, thereby helping to train gait and improve coordination and balance when walking.

Range of Motion: For individuals with muscular tension or contractures following a stroke, PNF stretching treatment can help to improve flexibility and range of motion.

Benefits are :

PNF improves motor learning and control by working proprioception, sensory input, and balance. This generates better movement patterns. PNF methods maximise your muscles by use of circular and diagonal movement patterns, therefore

improving your endurance and strength. PNF workouts concentrate on including movement patterns into daily actions, like standing, reaching, and lifting, so improving general functional ability.

Considerations :

For PNF treatments to be effective, they must be applied correctly and safely, and a trained provider should supervise them. As long as you don't overexert yourself or become tired, PNF workouts should become progressively more challenging over time, allowing you to continue improving and adapting. The benefits of PNF treatment depend on active involvement; therefore, it's essential for patients to be motivated and have considerable patience. "To evaluate the efficacy and practicality of Functional Electrical Stimulus (FES) compared to Proprioceptive Neuromuscular Facilitation (PNF) exercises in enhancing gait and functional outcomes in stroke survivors," the study says.

4. RESEARCH METHODOLOGY

This study employed a randomised controlled trial design. **Study Population**: The study population includes stroke patients with gait impairment. **Sampling**: Participants were recruited via convenience sampling from rehabilitation clinics and hospitals.

Sample Size Calculation: A total of 120 individuals (60 per group) were selected using power analysis to detect a clinically relevant difference in gait characteristics, achieving 80% power and a significance level of 0.05. By computer-generated randomisation, participants were randomly assigned to the Functional Electrical Stimulus (FES) group or the Proprioceptive Neuromuscular Facilitation (PNF) exercise group. Participants in the FES Group had FES treatment targeting the quadriceps, hamstrings, and dorsiflexors—key muscle regions related to gait. For eight weeks, three times weekly FES sessions were scheduled. Participants undertake a methodical PNF exercise program that emphasises gait training, balance exercises, and lower limb muscular development. PNF workouts ran three times a week for eight weeks.

Performance Measures:

Before and after the intervention period, a computerised gait analysis system assessed primary outcomes including walking speed, stride length, cadence, and symmetry. Using standardised evaluation tools, including the Berg Balance Scale, Timed Up and Go Test, and Muscle Strength Testing, secondary outcomes such as muscle strength, balance, and functional mobility were measured. Data compilation: Trained assessors collected data to minimise bias, remaining blinded to the group allocation of the subjects. Using appropriate parametric or non-parametric approaches, statistical analysis was conducted to assess the effectiveness of FES in improving gait performance and functional outcomes in stroke patients over the course of physical therapy (PT) sessions. The study adhered to ethical standards, and before enrollment, informed consent was obtained from each participant or their legal guardian. Participant data were kept confidential throughout the study.

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