Case Report

Effect Of Knee Joint Strengthening Exercises Along With PNF Technique To Improve Balance In Person With Traumatic Brain Injury

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Abstract

Background: TBI is generally the brain dysfunction caused by an external force, usually a violent blow to the head. It is caused by an accidental or intentional beating of the head , motor vehicle accident, fall, or injury via some sport. **Objective:** The purpose of this study was to investigate the effect of the knee joint strengthening exercises using proprioceptive neuromuscular facilitation (PNF) on the clinical symptoms and the treatment effects in balance in patients with TBI. **Design:** A single case study. **Methodology:** A 12-year-old adolescent with paraplegia and knee joint control impairment participated in this five-week training intervention. The patient, diagnosed with TBI, was treated with knee joint strengthening exercises using PNF. In the first week, we focused on strengthening the body, relaxing the knee flexors and activating the knee extensor muscles in order to solve the patient's physical function and body structure. From the 2nd and 4th week, we progressed through the task-oriented method, and then weight-bearing training of the right lower extremity was preceded by kicking a football with the left lower extremity. **Result:** As a result of the study, the patient demonstrated improvements in the physical examination, which were evaluated before and after intervention and included the manual muscle testing, Berg balance scale, 5-time sit to stand test and 10 metre walk test. **Conclusion:** The results of this case suggest that a knee joint strengthening exercise program using PNF may improve knee control ability, balance and gait in a patient with TBI.

Key words: Traumatic brain injury, Proprioceptive neuromuscular facilitation, Gait

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Introduction

TBI also known as head injury or brain injury casually can also be medically called an intracranial injury or craniocerebral trauma is generally the brain dysfunction caused by an external force, usually a violent blow to the head. TBI is brought on by a blow to the head, either accidentally or on purpose, and can result from sports injuries, falls, or car accidents [1].

According to the Brain Injury Association of America, (1986), a "Traumatic brain injury (TBI) is an insult to the brain, not of a degenerative or congenital nature, but caused by an external physical force, that may produce a diminished or altered state of consciousness, which results in an impairment of cognition or physical functioning.

A little over 72% of these injuries are mild, 8% are serious, and 8% are severe. In India, it is believed that between 1.5 million and 2 million people suffer injuries each year, and 1 million people pass away.

Boys are more likely to sustain injuries than girls and frequently suffer from TBI in the adolescent years between the ages 15 and 19. Children with TBI face a variety of issues with their body's structure and function, including muscle development, paralysis, weakness, mobility issues, and spasticity owing to increased muscle tone. These issues can negatively impact how quickly they recover from typical activities and speak [2]. Children with TBI are reluctant to move due to the restrictions on activity and involvement, which increases the risk of physical strength and endurance deterioration. However, if treated with activities that the kid enjoys, it can help to enhance the level of physical strength [1].

Symptoms of impaired balance and altered coordination have been particularly troublesome in TBI patients, with as many as 30% of patients complaining of these problems after TBI. (Gurr, 2001; Mrazik et al., 2000; Cicerone, 1995)

Using simple methods, techniques, patterns, and philosophies to stimulate muscles and nerves, proprioceptive neuromuscular facilitation (PNF) can be utilized to increase both muscular and neural function as well as social and functional activities [3]. Many of the fundamental PNF techniques and procedures can be employed when the patient is standing or walking, and when resistance to posture and powerful gait movement occurs, the contralateral lower extremities and weakened trunk are stimulated for muscle contraction [3]. Although PNF has been used in numerous trials on patients with neuromuscular injury, no research has been done on PNF treatments in children who have suffered traumatic brain injuries.

Unfortunately, research in gait and balance rehabilitation for patients with traumatic brain injury (TBI) is not as advanced as research in these areas for patients with other neurologic disorders, such as stroke and cerebral palsy as reported by McFadyen et al., 2009.

Thus, the purpose of this study was to investigate the efficacy or effectiveness of strengthening exercise to improve balance and functional independence in TBI patient who was assumed to have the potential to ambulate independently.

Methodology

Subject

This study included a patient who was admitted and diagnosed with TBI at Chhatrapati Shivaji Subharti Hospital , was enrolled for the study for five weeks from September 7, 2022 to October 15, 2022. After learning the goal and specifics of the study, the caregiver of the subject voluntarily gave their consent. Onset of injury occurred in January 5, 2022. The 12-year old male patient had a height of 157 cm, weight of 50 kg, and no previous medical history. Although the patient's consciousness was clear, the patient's mini mental state examination (MMSE) result was 12, and although post-traumatic stress disorder (PTSD) was evident in the patient's comprehension and orientation issues, a psychiatric evaluation was also carried out. The Modified Barthel index, which measures everyday living activities, was 53 points.

Table 1. Demographic Details of Patient

Characteristic	Value
Gender	Male
Age	12 years
Onset	January 2022
BMI	20.3 kg/m^2
MSME	12
MBI	53

[MMSE: mini-mental state examination, MBI: modified Barthel index, BMI: body mass index]

Procedures

Physical examination

Table 2. Manual Muscle Testing (MMT)

Muscle tested	Left (Lower limb)	Right
Hip Flexors	3	2+
Hip Extensors	3	2+
Hip Abductors	2-	2+
Knee Flexors	3	3
Knee Extensors	2+	3
Ankle Dorsi - flexors	3	2-
Ankle Plantar – flexors	2+	3

Table 3. Scales / Test

Scales / Test	Scores
5 time sit – to stand test	32.91
10 metre walk test	30.56
BBS	11

[BBS: berg balance scale]

Treatment method

The participant with a TBI was subjected to proprioceptive neuromuscular stimulation using the following exercise technique.

Week 1

To address the patient's physical function and body structure, we concentrated on body strengthening, knee flexor relaxation, and extensor muscle activation throughout the first week of treatment. From the second and fourth weeks, we increased motivation using a task- oriented approach before refocusing on bodily function and structure. In order to strengthen the body's flexor muscles, the patient's strong left side was used in the initial exercise approach. Isotonic rolling motions were combined with the scapular anterior depression pattern and pelvic anterior elevation pattern.

In the second method, isotonic contraction relaxation technique was applied using bilateral lower extremity flexion along with a knee flexion pattern to bend the knee in order to increase the lower trunk muscle strength. This was done while the subject was lying on their backs and breathing normally.

In the third method, hip flexion, adduction with external rotation and knee flexion pattern in side-lying while using the contract-relax technique, and hip flexion, abduction and internal rotation with knee extension pattern with the combination of isotonic were used to increase the hip flexion range of motion and increase hip flexor muscle strength, respectively.

In the fourth technique, isotonic and stabilizing reversals were combined with the pelvic anterior elevation and pelvic posterior depression pattern to strengthen the muscles surrounding the hip joint.

2nd to 5th Week

After receiving treatment for a week, the patient's issue with motivation and endurance were resolved, and choosing an enjoyable sport, like football, was thought to be a more practical strategy.

The fifth technique, which is focused on exercise control and learning, involves breathing in a sitting position while doing the forward pelvic pattern, as well as applying stabilizing reversals to the scapula and pelvis while employing the forward and backward patterns.

The sixth technique involved using an isotonic hip joint combination based on exercise control and learning.

In order to highlight the exoskeleton of the hip joint, the seventh technique, this is based on the functional approach, which is the philosophy of PNF, combined isotonic exercises with realistic functional movements while being moved from a standing to a sitting position.

The eighth technique used a standing posture with a posterior tilted pelvis and a variety of isotonic exercises to stabilize the trunk and improve the lower limb's ability to bear weight. After completing enough weight support training, the left foot was shifted forward to enhance walking ability.

For the ninth technique, after shifting weight to the right, the exercise that involved regulating the movement of a ball forward and backward was carried out in order to encourage higher weight-bearing ability and motivation of the right foot using more realistic tasks, such as football.

The tenth method, which involved using a football, involved the therapist rolling the ball to the patient while the patient caught it. The patient then had to kick the ball into the goalpost, which was a useful job for enhancing the patient's right-side weight-bearing ability. Patient occasionally shown issues with endurance, so we used football, his favorite sport, to inspire him. Weight training to the right, training to the left, and gait training while manipulating the ball were all done last to increase walking ability.

Mobility was enhanced in the early stages of treatment based on exercise control and motor learning, and stability in the second and third mobility and stability at the same time. The patient was actively motivated to

conduct practical gait therapy in a real-world setting. The hip extensor and abductor muscles were constantly contracted with repeated extension and abduction movements from the low position to the actual gait training.

The fundamental PNF practices, methods, and philosophy were applied to each pose. The aforementioned 11 exercises as well as home workouts were carried out for 5 weeks, on alternate days, for 30 minutes twice a day, with the level of difficulty of the workouts increasing with time in accordance with the physical capabilities of the subject.

To address the patient's lack of endurance and motivation during the first week of the training session, the subject's favourite sport, such as football, was used as a participation approach. When the patient's motivation increased, he or she took a lower position once more to fix the structural and functional issue. For five weeks, the exercise was used in accordance with the patient's psychological state. Additionally, the right ankle joint, which is involved in dorsiflexion, received functional electrical stimulation (FES) for 15 minutes while the bike was ridden for 30 minutes in the gym. After that, a 30-minute session of upper extremity training was conducted in the occupational therapy room.

Data and statistical analysis

In this study, the results of the subject before and after the experiment using the mean values were compared at each stage to identify the changes in gait ability. This was done in order to investigate the changes in physical examination, sit to stand, and balance. Furthermore, the variation between the pre- and post-treatment periods was evaluated as a percent change (%improvement = (pre-treatment assessment-post treatment assessment/pre-treatment evaluation100).

Table4. Lower extremity changes (clinical test) prior to and following intervention

Lower extremity (Clinical test)	Left (Lower limb)		Right	
	Before	After	Before	After
Knee Extensors (MMT)	2-	3+	2+	4
Hip Abductors (MMT)	2-	3	2+	4
Knee Flexors (MAS)	1+	0	1	0
Hip Abductors (MAS)	1+	0	1	0

[MMT: manual muscle testing, MAS: modified Ashworth scale]

Results

Changes in physical examination

Changes in muscle strength

The following were the MMT results before and after the proprioceptive neuromuscular stimulation-based workout to strengthen the knee joint (Table 4). The strength test for the right knee extensor muscle improved from a 2 to a 3+, from a 2 to 3 for the hip abductor muscles, and from a 2+ to 4 for the left hip abductor muscle following the exercise. (Table 4).

5-time sit-to-stand test comparison

The five sit-to-stand tests yielded the following results: On the fifth test, scores increased from 32.91 to 10.81 seconds following intervention.

Comparison of the 10 meters walk test

The 10MWT results before and after interventions were as follows. The 10MWT scores improved from 30.56 seconds before intervention to 7.41 seconds after intervention.

Comparison of the Berg balance scale scores

After intervention, sit-to-stand scores increased from 1 to 4, standing without assistance increased from 3 to 4, and holding the sitting position without back support was rated at 4 both before and after intervention.

Following intervention, stand-to-sit ability increased from 1 to 4 and chair-to-chair movement increased from 1 to 4. After intervention, the number of people who could stand unaided and with their eyes closed increased from 1 to 4. After the intervention, the subject's capacity to stand with their feet together and their arms extended increased from 0 to 4 and 0 to 3, respectively.

The capacity to pick up objects from the floor increased from 0 to 3. Following intervention, the capacity to glance to the left and right and to rotate 360 degrees in position went from 0 to 4 and 0 to 3 points, respectively. Following intervention, there was an increase from 0 to 3 in the ability to stack one foot atop the other at an equivalent height.

Following intervention, the capacity to stand on one leg and on tandem feet grew from 0 to 3 and 0 to 1, respectively. From 11 to 48 points, the overall BBS score increased.

Table 5. Changes before and after intervention.

Scales / Test	Before Intervention	After intervention
5 time sit – to stand test	10.81	32.91
10 metre walk test	7.41	30.56
BBS	48	11

Discussion

The goal of this study was to examine the benefits of conducting PNF knee strengthening exercises in a patient with TBI, as well as the clinical characteristics and therapeutic effects related to balance. Children with TBI who exhibit motor impairment symptoms as delayed movement develop long-term impairments in their capacity to exercise [4] Asymmetrical posture, impaired balance reaction, and diminished walking ability may all contribute to the loss of exercise control necessary to accomplish delicate tasks [5].

Although weak knee muscles were seen in this study, using relaxation techniques on the knee flexors helped to reduce muscle tension and strengthen the hip abductor and knee flexor muscles. Since recent researches have revealed that patients with TBI may benefit from high-intensity training therapy

programmes, high-intensity training was carried out to evoke the potential of the patient during treatment [6,7]. The spontaneous movement of the affected limb of the subjects with brain injury improved, according to a study with 22 stroke patients and two brain surgery patients who received intense repetition of exercise with PNF [8]. The patient in this instance also shown issues with muscle strength and endurance and struggled with endurance during the activities. Complex issues can negatively affect cognitive ability, abilities, memory, language, and academic aptitude in children who have suffered serious brain injuries, necessitating substantial rehabilitation [9]. Children and adolescents who have suffered a severe TBI for four years have been reported to perform poorly in terms of their strength, agility, durability, and coordination, which may restrict their capacity to engage in sport and physical activity [10]. The atmosphere for therapeutic training must be enjoyable, demanding, and motivating for children [11], and sensory play groups, which can train in developmental skills, should be energizing and entertaining [12]. A football was employed during this trial to encourage walking and balance abilities and to generate active interest in the patient's therapy, despite the fact that the subject had grown tired, lost interest in the exercise, and shown endurance concerns. The international categorization of functioning, disability, and health model's therapy, activity, and participation section was used to try and solve the subject's structural and physical problems.

In this study, higher knee flexion and hip adductor muscle tension was associated with worse balance and coordination scores, while lower knee extensor and hip abductor muscle strength was associated with worse balance. Following the intervention, the tension in the knee flexor and hip adductor muscles decreased, and the strength of the knee extensor and hip abductor muscles rose, this had a good impact on balance and coordination. In addition, although it was discovered that the active PNF method of ankle strengthening improves strength, muscle tension, sensation, and coordination leading to an improvement in hip, knee, and ankle control ability, it was demonstrated in this study that the PNF method of knee strengthening produced a positive effect on the subject. The problem should be addressed on strengthening the knee joint utilizing the PNF approach in order to enhance knee joint control ability, balance, sitting up, and coordination. From a functional perspective, decreased knee joint control ability appears to be connected with balance. The study is restricted by the inclusion of a single TBI patient, and as the PNF approach was used in conjunction with several therapies, including occupation therapy, bicycling, and FES, it would be challenging to gauge the impact of the PNF method alone.

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