Effectiveness of FES Assisted Gait Training on Pain, Patellar lateralization And Walking Speed in Patients with Patellofemoral Pain Syndrome :A Single Case Study

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Abstract*: Background: PFPS is one of the most frequent causes of anterior knee pain in adolescents and adults. PFPS is defined as pain behind or around the patella caused by stress in the patellofemoral joint that usually provoked by climbing stairs, squatting, and sitting with flexed knees for long periods of time. The typical clinical presentation in the patients with PFPS are Pain, patellar malalignment, mal-tracking, reduction in the gait speed. Functional electrostimulation (FES) is the application of an electrical stimulus at neuromuscular level to reproduce an impaired or lost function. Gait retraining in subjects with PFPS resulted in significant reductions in pain and improvements in function. This suggests that addressing the underlying mechanics associated with this injury will reduce pain. Aim of this literature is to summarize evidence regarding to gain patellar correction by use of FES in functional manner while walking and stair climbing. So, number of repetitions of Static quadriceps exercise and static glute exercise can be enhanced in multifold in functional manner rather than conventional therapy. Methodology: FES assisted Gait training along with the exercise program was given for 30 minutes per session, 2 sessions per day for 15 days. For the evaluation of pain, patellar lateralization and gait speed in PFPS patient, Pre and Post treatment outcome measures were taken using NPRS, Q-Angle and 10MWT. Results: It showed reduction of pain in terms of NPRS Scores from level 9 to level 1, decrease in the Q-Angle from 18 to 13 degree leading to correction of patellar lateralization, along with increase in the gait speed from 0.24m/s to 0.47m/s in patients with PFPS. Conclusion: FES based Gait training leads to reduction of pain, correction of the patellar lateralization along with the increase in the walking speed in the patients with Patellofemoral Pain Syndrome.

Keywords: Gait, Kneepain, PFPS, Speed.

INTRODUCTION

Patellofemoral pain syndrome (PFPS), also known as anterior knee pain, runner's knee, and chondromalacia patellae, is one of the most common knee problems among runners and individuals after injury or surgery around the knee. PFPS is multifactorial and the causes are unclear. However biomechanical studies described patellar mal-tracking and dynamic valgus in PFPS patients (functional malalignment). Causes for the dynamic valgus may be decreased strength of the hip abductors or abnormal rear-foot eversion with pes pronates valgus. PFPS is further associated with vastus medialis/vastus lateralis disbalance, hamstring tightness or iliotibial tract tightness [1]. PFPS, which is characterized by retro patellar (behind the kneecap) or peripatellar (around the kneecap) pain, is often referred to as anterior knee pain. The pain mostly occurs when load is put on the knee extensor mechanism when climbing stairs, squatting, running, cycling or sitting with flexed knees. Patients with PFPS usually exhibit a significant weakness of the lateral trunk flexors as well as the hip abductor, lateral rotator muscles and the knee extensor. Exercise programs based on strengthening the quadriceps and gluteal muscles have been shown to decrease pain and improve motor function and lower limb movement patterns. The etiology of PFPS is not completely understood, and is considered to be multifactorial [[2]]. The primary theory at the current time is that patellofemoral malalignment and mal-tracking result in PFPS. Suggested mechanisms causing PFPS are overload, patellar mal-tracking/malalignment and imbalances in muscle strength and contraction. It is common knowledge that these patients do not have

normal control of lower limb movements and exhibit deficient neuromuscular parameters, such as the activation time and electromyographic activity of the muscles. Therefore, combined knee and hip targeted exercises have been shown effective in reducing pain and improving function [3].

Patella tracking:
Recent studies, show that mal-tracking of patella probably plays a key role. Patients with a PFPS squat with increased lateralization and increased lateral tilt of the patella and hypermobile patella had a significant correlation with the incidence of patellofemoral pain**[3]**.
Wilson et al. used skin marker and an optoelectronic motion capture system to examine gliding of the patella inpatients with a PFPS in a standing position and while squatting. In this study, the patella of patients with PFPS had significantly increased lateral translation (mal-tracking), lateral patellar spin and a tendency towards increased lateral tilt compared to healthy subjects**[4]**.

Role of vastus medialis and lateralis:
'Patella mal-tracking' in patients with PFPS correlates with a delayed activation of the vastus medialis. An imbalance in the activation of the vastus medialis obliquus and vastus lateralis was also shown[5]. In patients with a PFPS, vastus lateralis was earlier activated than the vastus medialis obliquus when patients climbed downstairs and upstairs. Patients with patellofemoral problems exhibited atrophy of the vastus medialis obliquus[6].

Static or dynamic malalignment?
The role of the Q-angle (static measure) as predictor for PFPS is discussed controversially Some authors report that an increased Q-angle is associated with PFPS[7]. For example, Rauh et al. found that cross-country runners with increased Q-angle (>20*) are more prone to knee injury than athletes with normal Q-angle[8]. In contrast, Park et al. have shown that the Q-angle is not increased in PFPS patients. Other reports also do not show strong correlations between static measures such as the Q-angle to the onset of PFPS[9].

Hip muscle strength
Recent research has shown that functional malalignment does not arise in the knee joint but rather by internal rotation of the femur due to weakness of hip external rotators and abductors such as gluteus Medius and minimus[10].

Electrical stimulus at neuromuscular level
Functional electrostimulation (FES) is the application of an electrical stimulus at neuromuscular level to reproduce an impaired or lost function. The effects caused by FES at the muscle level include modifications in muscle fiber size, shape, and strength, increased muscle resistance due to decreased muscle fatigue, increased microcirculation, and selective activity on Type I and Type II muscle fibers[11].
Marcos G. Rosemffet et al did study on Effects of Functional Electrostimulation on Pain, Muscular Strength, and Functional Capacity in Patients with Osteoarthritis of the Knee which shows their experience which demonstrates that FES may prove to be a useful therapeutic alternative for patients with OA of the knee. The combination of FES and exercise could be more effective than the use of each treatment modality alone. Gait retraining in subjects with PFPS resulted in significant reductions in pain and improvements in function. This suggests that addressing the underlying mechanics associated with this injury will reduce pain[12].

AIM
Aim of this literature is to summarize evidence regarding to gain patellar correction by use of FES in functional manner while walking and stair climbing. So, number of repetitions of Static quadriceps exercise and static glute exercise can be enhanced in multifold in functional manner rather than conventional therapy.

LITERATURE REVIEW

For individuals with patellofemoral pain (PFP), altered muscle activity and pain are common during functional tasks. Clinicians often seek interventions to improve muscle activity and reduce impairments. Hence Aim of this literature review is to summarize evidence regarding the underlying pathology of PFPS and the best way to treat this condition through FES walk.

CASE PRESENTATION

This report details the case of Patellofemoral Pain Syndrome with the age of 47 years old female having occupation as an administrative work. The patient is

having chief complains as Pain around knee, difficulty in walking, climbing stairs and crossed leg sitting.

OBJECTIVE

To show the Effectiveness of Fes assisted Gait training on Pain, Patellar lateralization and Gait Speed in Patients with Patellofemoral Pain Syndrome.

DIAGNOSIS AND HISTORY

Diagnosis: Patellofemoral Pain Syndrome.
Date: June 2022
Present illness: A 47-year-old lady is having the history of sudden onset of pain in June, post Yoga and self-stretches, but ignored for about 2 months. During the course, Pain was again elicited while kicking the Activa, after which she consulted Orthopedic doctor, who advised to undergo investigative reports including X-RAY and MRI, which concluded patella lateralization with medial meniscal tear. So, Doctor prescribed medicines for pain relief and advised for bed rest, but there was no change in the pain level which increased, so patient visited to the Physiotherapy clinic in the month of October for the same.
Drug History: Pain and Anti-inflammatory drugs.
Rehabilitation History: Patient took home-based Pain-relieving therapy which includes icing.

SUBJECTIVE ASSESSMENT

- Pain Examination:
- Type of Pain: Dull Aching Pain.
- Site of Pain: Popliteal Fossa radiating to lateral aspect of Calf.
- Side of Pain: Right.
- Duration: Subacute.
- Numeric Pain Rating Scale: On Activity – 9, At Rest – 5.
- Aggravating Factor: Walking, Stair Climbing, Crossed Leg Sitting.
- Relieving Factor: Rest, Long Sitting position.

OBJECTIVE ASSESMENT

- ROM: Knee Extension – 120°
- MMT: Knee flexors, knee extensors - 4

Special tests:

- : Q – ANGLE: 18°
- : Patellar Compression test- Positive.
- : Lateral menisci: Apley's compression test – positive.
- : Mc Murray's test – Positive.

Gait Analysis:

- Type Of Gait: Waddling Gait.
- Gait Parameters: Reduced Cadence, Reduced gait speed.

CLINICAL PROCEDURE

The patient with the age of 47years, referred to us by an orthopedic surgeon with diagnosis of PFPS. The criteria for diagnosis of PFPS was: 1] Anterior knee pain, 2] Positive patellar compression test, 3] Dynamic valgus on one leg squat, 4] Increased Q-Angle, 5] Reduced Gait speed. Rehabilitation program for the patient followed the same physiotherapy program which included overground Gait training with FES along with the conventional therapy. Pre and Post treatment outcome measures were taken for Q-Angle and 10MWT while for pain, outcome measures were taken on 1st, 7th and 15th day of treatment session.

METHODOLOGY

Fes assisted Gait training along with the conventional therapy lasted for 15 days, for a total of 30 sessions. The treatment protocol was given as follows:

TREATMENT REGIME

It included following:
1.FUNCTIONAL TRAINING:
FES assisted overground walking was done to facilitate VMO contraction.

- Procedure: The patient was placed in a weight-bearing position with a comfortable amount of knee flexion. The parameters of FES were set, after which the patient had to walk along with FES.
- Duration of treatment:20 Minutes of FES walk / Session

FES SET-UP: On the basis of assessment FES was applied over the Left VMO muscle.

- Stimulation Of Muscle: Vastus medialis Obliques to correct patellar lateralization.
- Electrode Placement: To stimulate VMO, the proximal electrode was placed 4 cm superior to

the superomedial border of the patella, and the distal electrode 3 cm medial to this point.

- Intensity of stimulation: It was adjusted according to the patient's tolerance level which induced a contraction as close as to a maximum voluntary contraction around 30 mA but without patellofemoral pain.
- Parameters: The devices stimulated at 40Hz using asymmetrical biphasic waveform with pulse width up to 160 microseconds.

2.EXERCISE PROGRAM:

Strengthening of hip muscles including Gluteus Maximus and Medius muscles was done. Exercises: Hip Abduction with Extension and Clam shell exercise.

TREATMENT PARAMETERS:

- Duration of treatment:10 minutes / session
- Total treatment TIME: 30 minutes / session
- Total number of sessions: 2 sessions /day
- Total treatment period: 6 days/week
- Duration: 15 days

3.OUTCOME MESURES;

- NPRS
- Q-ANGLE
- 10METER WALK TEST

RADIOGRAPHIC CHANGES WITH ELECTRICAL STIMULATION ON PATELLAR LATERALIZTION

Standard Posterior-Anterior (PA) radiographs of both knees were performed.

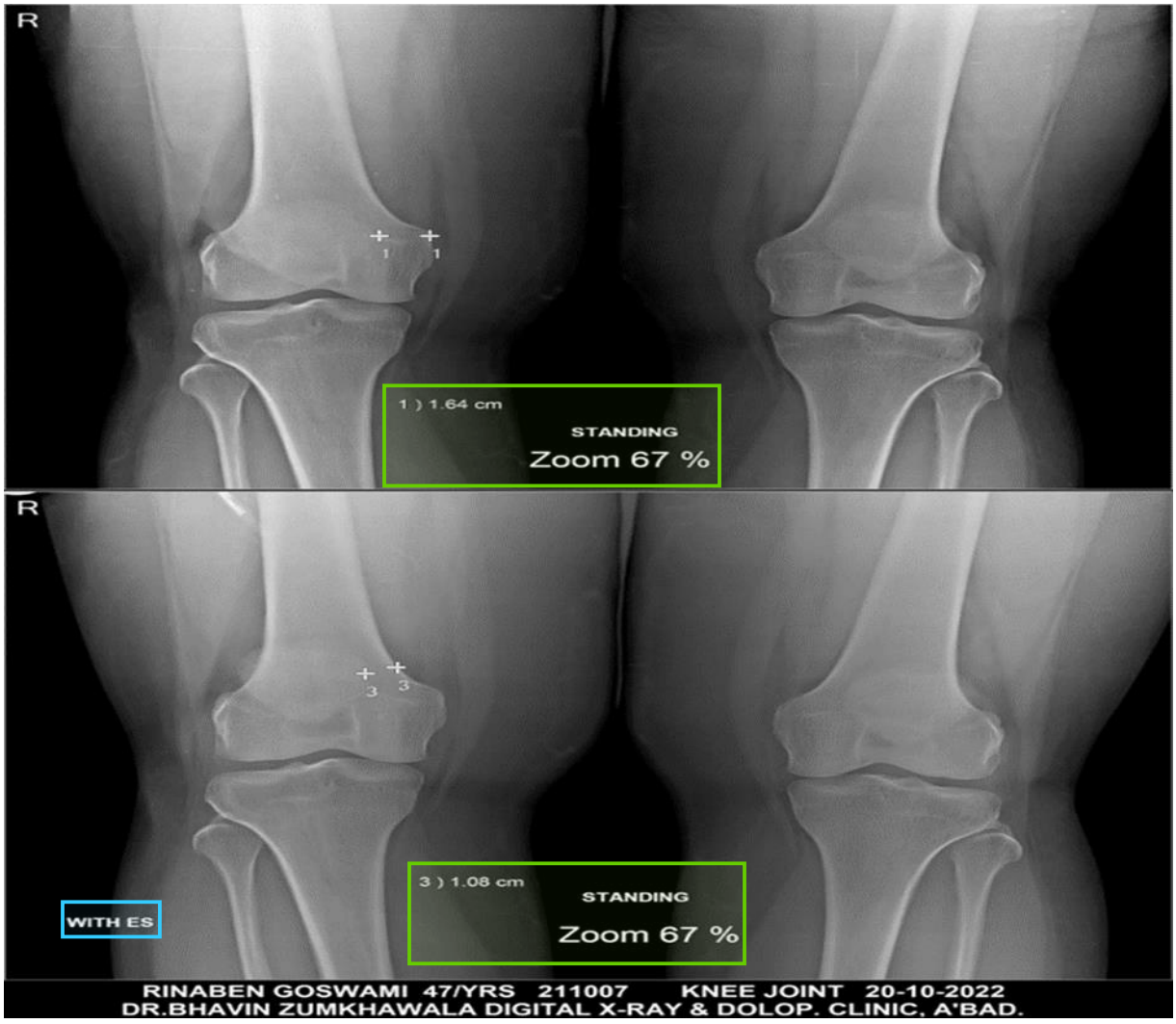


FIG. indicates the change in the patellar position before and after placement of the ELECTRICAL STIMULATION.

- X-RAY without ES: The distance of patella from medial femoral condyle without application of Electrical stimulation is 1.64cm which indicates patellar lateralization
- X-RAY with ES: The distance of patella from medial femoral condyle with application of Electrical stimulation is 1.08cm which indicates correction of the patellar position towards centrally.

RESULTS

1] Numeric Pain Rating Scale:

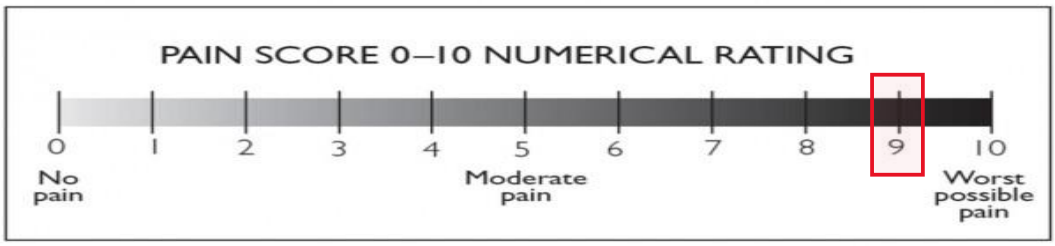
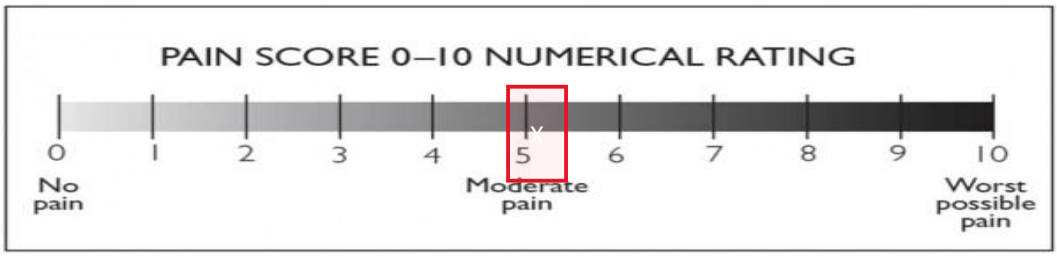
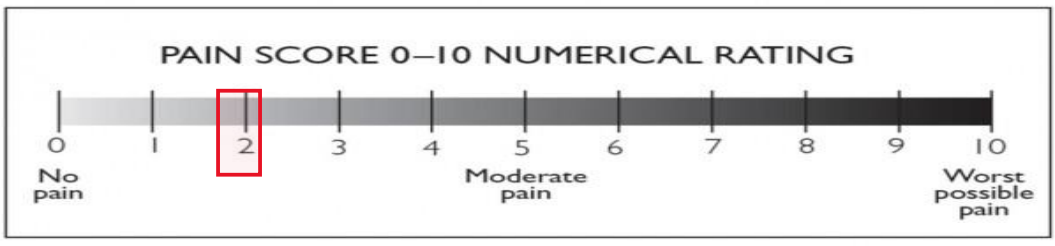
	NUMERICAL PAIN RATING SCORE
PRE–TREATMENT	
ON 7TH DAY OF TREATMENT	
POST–TREATMENT	

Table 1: Pre, 7th Day, Post Test Nprs.

(Table.1 shows change in the NPRS scores from level 9 to level 1, which indicates reduction of pain from worst pain towards the no pain in patients with PFPS.)

2] Q-ANGLE:

	Q-ANGLE (DEGREE)
PRE- TREATMENT	18°
POST-TREATTMENT	13°

TABLE 2: PRE AND POST TEST MEASURES OF Q- ANGLE

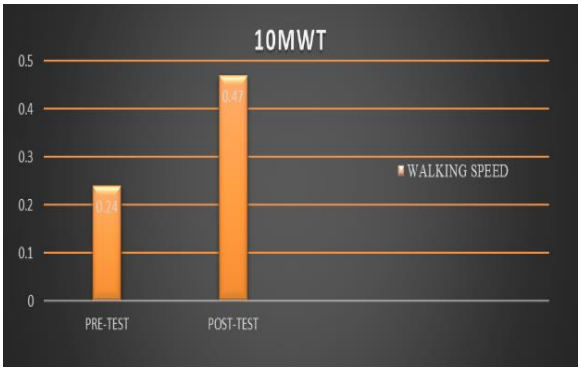
(Table 2, shows decrease in the Q-angle from 18° to 13°, which indicates correction of the position of the patella from lateral shift.)

3] 10 Meter Walk Test (10MWT)

10MWT	Pre-Test	Post-Test
Time Taken to Cover Distance	24.78 s	12.72 s
Walking Speed	0.24m/s	0.47m/s

TABLE 3, Pre and Post Test Measures for 10MWT

(Table 3, shows increase in the gait speed from 0.24m/s to 0.47m/s post intervention in patients with PFPS.)



GRAPH-1, Pre and Post Test Walking Speed

Graph 1, Shows increase in the walking speed of the patient with PFPS post intervention

DISCUSSION

The present study shows significant results in terms of reduction of pain, correction of patellar lateralization along with the increase in the gait speed in patients with PFPS while Just walking with Functional electrical stimulation in such short period of span. Generally conventional therapy takes time to achieve desired results in such a shorter period and strengthening muscle regime can take time and is very tedious process.

This study shows significant results for the NPRS scores, there was change in the level of pain from level 9 to 1, which shows reduction of pain from worst pain to no pain in patients with PFPS with just simple technique as walking with FES. A study done by Marcos G Rosemffet et al in 2004 on Effect of Functional Electrical Stimulation on Pain, Muscular strength, and Functional capacity in patients with O.A of the knee, which demonstrates that FES may prove to be a useful therapeutic alternative for pain and muscular strength[11].

Q- Angle results show decreased Q-angle from 18° to 13°, which shows significance of changes in the position of the patella. Stimulation of VMO during Gait training, leads to activation of the VMO muscle which helps to pull the patella towards centrally. Hence helps to resolve correction of the muscle imbalance between VMO and Vastus lateralis, there by helps to correct patellar malalignment and mal-tracking, leading to reduction of the Q-Angle[12]. There have been studies which supports Activation of Vastus Medialis Oblique and Vastus Lateralis in Sling-Based Exercises in Patients with Patellofemoral Pain Syndrome, which shows that activation of VMO muscle leads to correct positioning of patella. The VMO: VL ratio is critical because an appropriate ratio can correct patellar alignment and improve VMO strength[13].

10MWT shows increased in gait speed from 0.24m/s to 0.47m/s post intervention in patients with PFPS which is because of functional electrical stimulation assisted gait training. Similar results were found in the study done on effect of Kinesio taping on gait parameters in level gait in which the velocity and cadence significantly increased[14].

Hence, it was clear that FES assisted Gait training have a significant effect on reducing pain and correction of patellar lateralization thereby increased gait speed. We therefore hopefully would continue to work on strength and Endurance training of VMO through FES Walking so that patients with PFPS can walk on uneven surfaces Pain free and independently.

AUTHOR'S NOTE:

Improvement in all the selected parameters is significantly improved which shows that use of Functional Electrical Stimulation on muscles helps in gaining results faster with just walking. Walking requires no supervision plus number of repetitions of Static quadriceps exercise and static glute exercise can be enhanced in multifold in functional manner. The Functional Electrical Stimulation assists global stabilizers and stimulates prime movers in functional task like walking. There are two achievements doing function-oriented tasks

Patients becomes more confident and exercises can be done in required functional goal with the help of FES. So, by presenting this case study we wanted to open the path for new creative ideas which are easier for patient to understand and less complexed.

CONCLUSION

FES based Gait training leads to reduction of pain, correction of the patellar lateralization along with the increase in the walking speed in the patients with Patellofemoral Pain Syndrome.

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