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Comparing Functional Stabilization Training Vs Non Weight Bearing Exercise in PFPS Among Runners

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ABSTRACT

INTRODUCTION Running is a choice of sport for many,it is related with a risk of overuse injuries. Patellofemoral pain syndrome is recorded 18% [10]on overall complaints of adolescents and young adults below 35 years among middle and long distance runners.

OBJECTIVE Patellofemoral pain syndrome is a prequel to patellofemoral joint osteoarthritis. This study compares the effects of functional stabilization training and non weight bearing exercise in PFPS among runners.

METHODS A Comparative study of 30 marathon runners Age between 20-35 years with patellofemoral pain were included and randomized into NWB and FST groups. Pain, Functional activities are recorded using VAS, AKPS. The groups received treatment protocols for 8 weeks duration.

RESULT The recorded mean values of before and after intervention of VAS and AKPS for FST group are **8.27+_0.923 ,4.5 +_1.0** and **52.40+_16.01,92.93+_3.97** for NWB the pre and post values are**7.9+_0.737, 3.13+_0.767 and 68.33+_1.01,78.87+_6.24** both the groups shows significant difference in pain on comparing the functional activity score FST group showed significant difference.

CONCLUSION Non weight bearing knee exercises are focused to gain the quadriceps muscle strength which is the reason for lateral tracking of patella. Functional stabilization training engages both hip and knee muscle involvement as well in weight bearing which activates the co action multiple joint, and gain motor control and as well as stimulate proprioceptors. So FST considered as effective and higher in return to sport ,there may reduce the recurrence rate, keep the runners to be active in sport.

KEYWORDS Patellofemoral Pain Syndrome, Functional stabilization training, Non Weight Bearing exercise

ABREVATION: PFPS PATELLOFEMORAL PAIN SYNDROME

INTRODUCTION

Running is one of the most widely enjoyed athletic pursuits globally, and the number of participants has increased significantly in recent years. People pursuing a healthier way of living mostly adapt running, as this choice because of its cost effective, easily accessible. [1] . Despite the health benefits, running has been associated with high risk of non traumatic overuse injuries, having injury incidence of 6.8 to 59 per

1000 running hours.[2]patellofemoral pain syndrome with 6.3%among the lower extremity injury. Pain behind the patella (retropatelllar) and surrounding the patella (peripatellar) without any structural damage is known as PFPS. Running, and ascending stairs all create excessive demand on the knee extensor mechanism, which causes the pain over the patella femoral joint.[4] weakness of quadriceps muscle , a greater Q-angle, excessive knee soft tissue tightness, hip weakness, and changed foot kinematics are some of the causes of patellofemoral pain syndrome.

Employing improper methods, training inappropriately (including overtraining), and not using the proper equipmen(shoes) may leads to overuse syndrome. The nature of pain presented as dull throbbing discomfort. Another common sign is giving way from sport.[6] Patients with PFPS not only experience pain but also show reduced activation of the gluteus maximus and gluteus medius during functional tasks. This results in increased hip adduction, which raises dynamic valgus at the knees. Additionally, compared to normal individuals, PFPS patients have decreased activation of their quadriceps and hamstrings, which could lead to excessive knee flexion and increase the load on the knee joint[10]. Continuing in Sport act as pathogenic agent of PFPS.This going to precede patellofemoral joint osteoarthritis. The primary pathology is an increase in subchondral bone loading brought on by an increase in the patellofemoral joint reaction force[7].However, strength training is widely accepted and used as the primary treatment. Non-weight-bearing knee exercises are recommended to strengthen the quadriceps, which is thought to be the cause of the patella's lateral tracking[15].Several studies have discovered that PFPS patients' knee function and pain level are significantly improved by strength training their knee, hip, and core muscles. [32] Functional stabilization training focuses on Hip and knee strengthening exercises are more essential than non-weight-bearing exercise because they involve multiple joint movement to improve motor control, promote proprioceptor stimulation, and enhance functional movement for muscle activation[678910] Because weight bearing actions in the lower extremities require the cooperation of several muscle groups .There is evidence that the femur rotating medially beneath the patella on weight bearing, rather than the patella sliding laterally on the femur,which considered as abnormal lateral tracking is getting avoided in weight bearing. Because of these advantages, functional stabilization training are recommended for the rehabilitation of PFPS[11121332] in many studies.

METHODS

Comparative study among Recreational marathon runners engaged in sport activity for 3 times a week were selected ,and informed consent got approved from institutional ethics committee(EC/JCP/OCT/11/2025)was conducted under supervision of physiotherapist. The patients attended a baseline assessment, using VAS, AKPS**.** Thirty recreational runners between 18 and 30[3]years with PFP Were allotted to FST(N = 15) or NWB (N = 15). primary outcome measures were pain VAS and functional activity scale AKPS, measured at the end of the 8week intervention. Inclusion of Patients in this study is based on following criterias; patients with pain over anterior aspect of knee of 3 or higher on VAS scale and symptoms that worsened during any two of the following activities were included in the study: extended sitting, climbing or descending stairs, squatting, and kneeling. Patients with intra-articular disease, ligament damage, prior lower limb surgery, and persistent pain upon palpation of the patellar tendon or iliotibial band were eliminated.

OUTCOME MEASURES

VAS: visual analogue scale is 10 cm line of oriented horizontally, with one end indicating no pain other end indicating worst pain. The patient are asked to mark a point corresponding to their intensity of pain[29]

ANTERIOR KNEE PAIN SCALE: The measures from the AKPS is responsive to patellofemoral pain symptoms it supports screening the functional diagnosis.[41] The scoring system outlined by Kujala was used to evaluate the knee both subjectively and functionally. In order to assess pain during climbing stairs , difficulty in squat, on running, during jump, and sitting for prolonged duration with the knees flexed, and asses any limp present during walk, swelling over the knees, and subluxation over patella , noticeable quadriceps muscle atrophy and any ROM deficit during flexion of knee, and the need for assistance when walking, this 0- to 100-point scale—100 being the best score—was built primarily for patients with patellofemoral pain.[29)]

INTERVENTION

The FST(n=15) received exercise protocol with a warm and cool down exercise (hamstring self stretching) under observation for 8 weeks, 5 days/week with the duration of 40 minutes, including the rest period [321011]

FST[6]group received functional stabilization training with elastic band EB as follows

Weight bearing Knee extension from sitting position with elastic band,

Weight bearing Bilateral Hip flexion with elastic band around thigh

Standing Hip extension with Elastic band

Standing Hip abduction with Elastic Band

Lateral step down

NWB21 (n=15) received with Non weight bearing exercise protocol with warm up under stationary bicycle for 5 mins followed by exercise and end with cool down period for 8 weeks 5 sessions per week under supervision of therapist and progressed with added free weight cuffs .

NWB group received strengthening exercises concentrating on quadriceps muscle which can be performed as non weight bearing exercise.

Isometric quadriceps exercise

Seated knee extension

Stretching of hamstring

RESULT:

The recorded mean scores pre and post intervention of VAS and AKPS for FST group are **8.27+_0.923;4.5 +_1.0** and **52.40+_16.01;92.93+_3.97** and NWB has the pre and post values **7.9+_0.737;3.13+_0.767 and 68.33+_1.01,78.87+_6.24 .** Both the groups showed significant difference in pain and functional activities .On comparing patients in the FST group demonstrated greater improvements in functional activities .

Table 1 COMPARING VAS IN BETWEEN GROUPS

VAS	PRE TEST	POST TEST	t value	pvalue	
FST	Mean =8.27 SD=0.923	Mean =4.5 SD=1.06	10.3292	<0.0001	

NWB	Mean =7.9 SD=0.737	Mean =3.13 SD=0.767	18.846	<0.0001	

Table 2 COMPARING AKPS INBETWEEN GROUPS

AKPS	PRE TEST	POST TEST	t value	pvalue	
FST	Mean =52.40 SD=16.01	Mean =92.93 SD=3.97	4.9583	<0.0001	
NWB	Mean =68.33 SD=16.01	Mean =78.87 SD=6.24	9.3748	<0.0001	

Table 3 COMPARING POST VALUES OF BOTH GROUPS

	FST	NWB	t value	pvalue	
VAS POST	Mean =4.5 SD=1.06	Mean =3.13 SD=0.767	4.1411	0.0003	
AKPS POST	Mean =92.93 SD=3.97	Mean=78.87 SD=6.24	7.360	<0.0001	

DISCUSSION

Increased velocity, or the distance traveled in a given amount of time, and the existence of an airborne or float phase set running apart from walking.. Running is related to high risk of over injuries.[1] As per the data competitive runners who were involved in long distance runners≥ 800m≤ marathors highly predisposes to knee injury 28% and by location the injury rate is PFPS17% followed by Achilles tendinopathy10%.by this data PFPS is considered as the major injury rate in sports[3536]. Running has been shown to increase joint excursion with hip flexion, knee flexion, and ankle dorsiflexion. Running at a faster pace causes more joint excursion [3]. When sprinting, there is occasionally a higher degree of transverse plane motion. The thigh and leg muscles must exert more eccentric effort to regulate this motion.[9]Vertical ground reaction force may reach a magnitude of 2.2 times body weight after heel contact in running compared with 1.1 times body weight during walking. Joint motion, eccentric muscle contraction, and articular cartilage compression are factors that enable appropriate impact absorption [1617]. The force of impact at heel contact is dispersed by hip and knee flexion in addition to dorsiflexion at the ankle joint. Although knee flexion has a favorable effect as a shock absorber, it also has a negative effect because it increases the PFJR force. In a normal knee, this doesn't cause any discomfort, but occasionally these loads operate as supraphysiological loading and produce pain; this can also happen with overuse. The pathogenesis of PFP may be connected to patellar malalignment or maltracking[40]. When the knee is in a normal position, the patella should follow the center of the femur's trochlea during flexion and extension. When this path is not followed, the patellofemoral joint and surrounding tissues experience uneven stress, which results in PFP. During powered extension, the patella tendon is in line with the tibia (essentially vertical), and the quadriceps force works along the femoral axis (i.e., an oblique line from the anterior superior iliac spine [ASIS] to the apex of the patella). The deep lateral facet of the trochlea resists the lateral strain on the patella caused by this angle (the Q angle, which is

roughly 12° in males and 17° in females)[1027]. However, this resistance only occurs when the patella is engaged in the trochlea; otherwise, the distal, oblique part of the vastus medialis plays a crucial role in preventing this lateral pull and preserving appropriate patellar tracking. Atypical patella tracking is also believed to be caused by weak hip muscles. When compared to healthy controls, women with PFPS were found to be 26% weaker in hip abduction and 36% weaker in hip external rotation[22]. The valgus force vector at the knee and hip internal rotation may both increase as a result of this weakening, which could make lateral patella tracking even easier. The gluteus medius's temporal features in patients with and without PFPS revealed that patients with PFPS experienced a delay of gluteus medius activation during a stair-stepping activity. They came to the conclusion that variations in gluteus medius activation throughout time might be a factor in PFPS. The physiological patellofemoral contact surface might vary depending on the pathology, but generally speaking, reduced discomfort is linked to a decrease in the reaction force in the patellofemoral joint (PFJ). Exercise therapy for PFPS[20] may enhance functional ability, reduce discomfort in a way that is clinically significant, and promote long-term healing. This is accomplished by strengthening the hip and quadriceps muscles, which lessens strain on the PFJ and stops patella maltracking[19]. Restoring the patellofemoral joint's homeostasis[1518] is the aim of conservative treatment. If there is enough time between stress applications, repeated stresses applied below a structure's tensile limit result in positive remodeling.

The majority of muscular adaptations take place after eight weeks of training, and strength training indicates a sharp rise in neurological activation of the motor units during the early phases[37]gaining motor control.Weight bearing exercises are given between 0°-90° of knee flexion because at close kinematic movements the joint reaction is less up to 90° of knee flexion deep knee flexion is avoided where as the PFJRF is higher[21.] These exercises are considered as the long term effects on this condition as it gain femur abduction control which acts as the direct mechanism of PFPS. Strengthening of quadriceps along with hip abductors and external rotators helps in controlling the hip adduction [13]moment during stance phase of running where by activating the muscle at the required knee flexion angle and gaining control over the abnormal movement. There by functional stabilization training can reduce the abnormal movement of patella (decreasing the contact stress) and reducing the joint reaction force on patellar which eventually reduces pain and improving functional activities.

LIMITATION OF THE STUDY:

A Limited sample size had been taken. The duration of the study can be longer. Long term follow-up was not done .The study was done only with marathon runners does not include any other athletic activity.

RECOMMENDATIONS:

A Large sample size can be used. With long term follow up can be done. Future study can focus on assessing muscles activation through kinesiology EMG during functional activities.

AUTHOR CONTRIBUTION

Each author has committed to take responsibility for every part of the work after reviewing the final version that will be published. Design and concept by KM, SS, and data gathered, KM, and analysis or data interpretation by SS. The manuscript was drafted by KM. The manuscript is critically examined for significant intellectual content. Oversight by Dr. BC

CONCLUSION:

The study conducted 30 runners with PFPS in two groups,for a period of 8 weeks. FST who has received FUNCTIONAL STABILIZATION TRAINING protocol showed a significant improvement in pain reduction and improved functional activities in PATELLOFEMORAL PAIN SYNDROME. Hence when comparing the pre test and post test means the $p < 0.0001$ showed significant improvement which proves the effects of functional stabilization training has a holistic approach in managing PFPS and in improvement of patient outcomes

REFRENCES:

1. **J E Taunton, M B Ryan, D B Clement, D C McKenzie, D R Lloyd-Smith, BDZumbo:** A retrospective case-control analysis of 2002 running injuriesBr J Sports Med 2002;36:95–101
2. **Alexandre Dias Lopes, Luiz Carlos Hespanhol Junior, Simon S. Yeung and Leonardo Oliveira Pena Cost:** The Main Running-Related Musculoskeletal Injuries? A Systematic Review
3. **Nicolas Kakouris, Numan Yener, Daniel T.P. Fong2021** A systematic review of running-related musculoskeletal injuries in runners
4. Song K, Scattone Silva R, Hullfish TJ, Silbernagel KG, Baxter JR. Patellofemoral Joint Loading Progression Across 35 Weightbearing Rehabilitation Exercises and activities of Daily Living. Am J Sports Med. 2023;51:2110–9.
5. **Peter Francis , Chris Whatman , Kelly Sheerin , Patria Hume:** The Proportion of Lower Limb Running Injuries by Gender, Anatomical Location and Specific Pathology: A Systematic Review Journal of Sports Science and Medicine (2018) 18, 21-31
6. **Jehoon Lee, PT, PhD, Hwangjae Lee, PT, MSc, Wanhee Le, PT, PhD:** Effect of Weight-bearing Therapeutic Exercise on the Q-angle and Muscle Activity Onset Times of Elite Athletes with Patellofemoral Pain Syndrome: A Randomized Controlled Trial J. Phys. Ther. Sci.26: 989–992, 2014
7. Huo Z, Xu C, Li S, Niu Y, Wang F. The thickness change ratio and preservation ratio of the infrapatellar fat pad are related to anterior knee pain in patients following medial patellofemoral ligament reconstruction. J Orthop Surg Res. 2024;19:375.
8. Rabelo NDDA, Lucareli PRG. Do hip muscle weakness and dynamic knee valgus matter for the clinical evaluation and decision-making process in patients with patellofemoral pain? Braz J Phys Ther. 2018;22:105–9
9. **Wolf Petersen • Andree Ellermann • Andreas Go¨sele-Koppenburg • Raymond Best • Ingo Volker Rembitzki • Gerd-Peter Bru¨ggemann •**:Patellofemoral pain syndrome Knee Surg Sports Traumatol Arthrosc (2014)
10. **RODRIGO DE MARCHE BALDON, FÁBIO VIADANNA SERRÃ** Effects of Functional Stabilization Training on Pain, Function, and Lower Extremity Biomechanics in Women With Patellofemoral Pain: A Randomized Clinical Trial
11. **F. TEIXEIRA-SALMELA, PT, Phd RICARDO B. SOUZA,** Hip and Knee Strengthening Is More Effective Than Knee Strengthening Alone for Reducing Pain and Improving Activity in Individuals With Patellofemoral Pain: A Systematic Review With Meta-analysis Journal of Orthopaedic & Sports Physical Therapy

12. **Michelle C. Boling, MS, ATC, Lori A. Bolgla, PT, PhD, ATC, Carl G. Mattacola, PhD, ATC, Tim L. Uhl, PT, PhD, ATC, Robert G. Hosey, MD:** Outcomes of a Weight-Bearing Rehabilitation Program for Patients Diagnosed With Patellofemoral Pain Syndrome
13. **Thago Yukio Fukuda, PT, MSc • Flavio Marcondes Rossetto, PT• Eduardo Magalhães, PT Flavio Fernandes Bryk, PT • Paulo Roberto Garcia Lucareli, PT, PhD5 • Nilza Ap arecida de Almeida Carvalho, PT, MSc**:Short-Term Effects of Hip Abductors and Lateral Rotators Strengthening in Females With Patellofemoral Pain Syndrome: A Randomized Controlled Clinical Trial
14. **Marcelo Camargo Saada,b,, Rodrigo Antunes de Vasconcelosc, Letícia Villani de Oliveira** :Mancinellid, Matheus Soares de Barros Munnod, Rogério: Is hip strengthening the best treatment option for females with patellofemoral pain? A randomized controlled trial of three different types of exercises Brazilian Journal of Physical Therapy 2018;22(5):408---416
15. **van der Heijden RA, Lankhorst NE, van Linschoten R, Bierma-Zeinstra SMA, van Middelkoop M**:exercise for patellofemoral pain Cochrane review.
16. **Gregory R Waryasz and Ann Y McDermott** :Patellofemoral pain syndrome (PFPS): a systematic review of anatomy and potential risk factors
17. **Farzin Halabch Maryam Abolhasani Maryam Mirshahi Zahra Alizadeh:** Patellofemoral pain in athletes: clinical perspectives Sports Medicine Research Center,
18. **Reed Ferber, PhD; Karen D. Kendall,Lindsay:** Changes in Knee Biomechanics After a Hip-Abductor Strengthening Protocol for Runners With Patellofemoral Pain Syndrome
19. **Martin Whittingham, MSc Shea Palmer.PhD, Fiona Macmillan, PhD:** Effects of Taping on Pain and Function in Patellofemoral Pain Syndrome: A Randomized Controlled Trial
20. **Reed Ferber, PhD, Lori Bolgla, PhD, PT, ATC; Jennifer E. Earl-Boe** Strengthening of the Hip and Core Versus Knee Muscles for the Treatment of Patellofemoral Pain: A Multicenter Randomized Controlled Trial Journal of Athletic Training 2015.
21. **Lee Herrington, PT, MSc• Abdullah Al-Sherhi, PT, MSc:** A Controlled Trial of Weight-Bearing Versus Non–Weight-Bearing Exercises for Patellofemoral Pain
22. **Christian J Barton, Simon Lack, Peter Malliaras, Dylan Morrissey**: Gluteal muscle activity and patellofemoral pain syndrome: a systematic review Centre for Sports and Exercise
23. **CHRISTOPHER M. POWERS, PT, PhD, FACSM, FAPTA1 • KAI-YU HO, PT, PhD:**:Patellofemoral Joint Stress During Weight-Bearing and Non–Weight-Bearing Quadriceps Exercises J Orthop Sport
24. **Fredericson M, Yoon K:**Physical Examination and Patellofemoral Pain Syndrome
25. **Shane S. Schulthies, PhD, PT, ATC:** An Electromyographic Investigation of 4 Elastic-Tubing Closed Kinetic Chain Exercises After Anterior Cruciate Ligament Reconstructio Journal of Athletic Training 1998;33(4):328
26. **SAURABH P. MEHTA, PT, PhD ,ALLISON FULTON, MScPT • CEDRIC QUACH, MScPT:**Measurement Properties of the Lower Extremity Functional Sca A Systematic Review Journal of Orthopaedic & Sports Physical Therapy
27. **Kelly R. Sheerin*, Patria A. Hume, Chris Whatman:** Effects of a lower limb functional exercise programme aimed at minimising knee valgus angle on running kinematics in youth athletes
28. **Phil Page, PhD, PT, ATC, CSCS, FACSM:**Effectiveness of Elastic Resistance in Rehabilitation of Patients With Patellofemoral Pain Syndrome

29. **Kay M. Crossley, PhD, Kim L. Bennell, PhD, Sallie M. Cowan, PhD, Sally Green:** Analysis of Outcome Measures for Persons With Patellofemoral Pain: Which Are Reliable and Valid?
30. **POLLY E. BIJUR, PHD, WENDY SILVER, MA, E. JOHN GALLAGHER, MD :**Reliability of the Visual Analog Scale for Measurement of Acute Pain
31. **Bolling MC, Marshall SW, 2009.** A prospective investigation of biomechanical risk factors for patellofemoral pain syndrome. The joint undertaking to monitor and prevent ACL injury (JUMP-ACL) cohort. Am J Sports Med.
32. **Zheyu Xiong, Wei Zheng** Effects of functional strength training on pain, function, and lower extremity biomechanics in patients with patellofemoral pain syndrome: a randomized clinical trial
33. **M. Boling1, D. Padua2, S. Marshall2, K. Guskiewicz2** Gender differences in the incidence and prevalence of patellofemoral pain syndrome
34. **Ke Song,*y PhD** Patellofemoral Joint Loading Progression Across 35 Weightbearing Rehabilitation Exercises and Activities of Daily Living
35. **Peter Francis 1□, Chris Whatman 2**, The Proportion of Lower Limb Running Injuries by Gender, Anatomical Location and Specific Pathology:
36. Benjamin E. Smith1,2*, James Selfe3, Damian Thacker4 A Systematic Review Incidence and prevalence of patellofemoral pain: A systematic review and meta-analysis
37. Cameron N Fick, MD1, Rafael Jiménez-Silva, MPH1 Patellofemoral Kinematics in Patellofemoral Pain Syndrome: The Influence of Demographic Factors
38. Bas Van Hooren1 · Ivan Jukic2,3 · Maartje Cox1The Relationship Between Running Biomechanics and RunningEconomy: A Systematic Review and Meta-Analysis of Observational Studies
39. Shiqi Yu , Peng Yuan , Yilin Xu Effects of running technique characteristicson the patellofemoral joint load: A systematicreview and meta-analysis
40. Janice K. Loudon, PT, PhD biomechanics and pathomechanics of the patellofemoral joint
41. **Gregory D. Myer,Kim D. Barber Foss,et,al.,** Analysis of patient-reported anterior knee pain scale: implications for scale development in children and adolescents