



EFFECTIVENESS OF PILATES COMBINED WITH MFR IN REHABILITATION FOR PATIENTS WITH ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

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Abstract: Background- ACL ruptures accounts for more than 50% of knee injuries which significantly impact an individual's functional abilities and quality of life. The major goals of rehabilitation for post-operative ACL injuries are to retain strength, stability and dynamic control as well as to avoid reinjuring the ACL and surrounding tissue. Therefore, it has lately become crucial to include core stability exercises in the rehabilitation due to deficient trunk stability and compensation to other structures. Myofascial release potentially improves flexibility, range of motion and overall movement quality. The purpose of this study was to explore effect of Pilates along with myofascial release on balance, postural control and quality of life.

Methods- Study was conducted on 20 subjects both male and female with age group 20-40 years. 8 different Pilates exercises were performed five days a week for four months. Myofascial release was performed three days a week. Progression was made after every third week with change in frequency and mode of exercise. Clinical outcomes were evaluated using BESS (Balanced Error Scoring System), KOOS (Knee Injury and Osteoarthritis Outcome Score) and SEBT (Star Excursion Balance Test).

Results- Between-week comparison mostly results showed that scores significantly increased in the 3rd and 12th week. Reaching distance in SEBT was increased in the posterior ($P < 0.0001$), medial ($P < 0.0001$), posteromedial ($P < 0.0001$), and posterolateral ($P < 0.05$) directions. Decreased number of errors in BESS including ($P < 0.0001$), only between 3rd and 12th week. Improvement was also shown in KOOS scores for pain ($P < 0.0001$), symptoms ($P < 0.0001$), ADL ($P < 0.0001$), Sports ($P < 0.0001$), QOL ($P < 0.0001$) but not between 9th and 12th week.

Conclusion- The combination of MFR and Pilates may lead to synergistic benefits, including enhanced muscle strength, flexibility, proprioception and balance. While the initial results are promising, further research is required to validate the long-term efficacy and applicability into protocols.

Keywords- Pilates, ACL rehabilitation, balance, myofascial release

1. INTRODUCTION

The anterior cruciate ligament (ACL) is a wide, intraarticular, extra synovial ligament that attaches to the anterior intercondylar surface of the tibia and the postero-medial side of the lateral femoral condyle.¹ Most patients with ACL injuries present after suffering an acute, severe injury while participating in a sport or other activity. The ACL is particularly vulnerable to rotational stress, and pivoting, cutting, and landing motions frequently result in ACL rupture.²

While rehabilitation techniques have undergone significant modification, the objectives of ACLR protocols have remained mostly unchanged over time, placing a strong emphasis on minimizing losses in knee extension, regaining strength, and maintaining stability.³ Anterior cruciate ligament (ACL) injuries are thought to occur 200,000 times a year. As many patients want to return to competitive athletics, ACL reconstruction (ACLR) is a common treatment option for this injury. Approximately 80% of patients who undergo this sort of treatment return to sports of some kind, but only 65% do so at their pre-injury participation levels and just 55% do so in competitive sports.⁴

ACL injuries have a wide range of effects, including motor dysfunction, impaired neuromotor coordination, compromised muscular balance, and psychological discomfort. All of these arguments emphasize how crucial it is to have a thorough rehabilitation program strategy, both before and after surgery.⁵ The risk of re-injury following ACLR is more than 30%, and about 37% of those with ACLR do not resume their pre-injury activity level^{6,7}. There is a considerable risk of secondary injury given that the frequency of ACLR secondary injury has been predicted to be 1:4 in athletes returning to the sport⁸

Therefore, to optimize the results of conventional post-operative rehabilitation, there is a need to have tertiary prevention. Having a simple tertiary prevention program during the athlete's return to sport may reduce the risk of re-injury in athlete. To create a secure base for the extremities during functional tasks, core muscles contract before upper and lower extremity muscles does. Additionally, the power of the core muscles helps to control the movement of the lower limbs, especially the knees, and to lessen the strain on the joints^{9,10,11} The ACL may become re-injured as a result of compensatory behaviours and poor core muscle coordination.¹²

In the Pilates method, trunk and hip muscle activation can be obtained in variations of Pilates exercises with alterations of pelvic and trunk posture¹³ Joseph Pilates invented the Pilates physical fitness system, which bears his name, in the middle of the 20th century. "Contrology" is the name of Pilates' method.¹⁴ The Pilates method is a comprehensive body-moulding approach that is designed to improve a person's body and mind. Additionally, even when performed at a moderate intensity, Pilates exercises are proven to offer significant toning and strengthening benefits.¹⁵

A muscle that has been too contracted can be felt as a trigger point. Depending on the degree of the problem, pain may be induced at the trigger point and may refer to nearby muscle groups. Pain has a secondary impact on muscle activity, which in turn affects joint range of motion. Movement in various directions, muscular coordination, and muscle strength are all determined by how muscles work. Myofascial release helps to increase joint range of motion, increase muscle flexibility, and lessen pain. This demonstrates the significance of the Myofascial Release Technique as a major concern.¹⁶ This research will look at the impact of Pilates on

ACL rehabilitation and whether Myofascial Release has a significant role in addition to the technique or whether Pilates is sufficient on its own.

2. METHODOLOGY

This manuscript was a part of the study – “A comparative study to determine the effects of Pilates with or without myofascial release in patients with ACL reconstruction” for which protocol approval was approved by the Human research ethics committee at Geetanjali Medical College and Hospital, GU/HREC/2021/1982 and all participants were provided written informed consent prior to enrollment. This study was conducted on 20 subjects both male and females.

2.1 Inclusion criteria: Both male and female patients with age group of 20-40 years, unilateral ACL rupture confirmed by both clinical examination and MRI and reconstructed with hamstring graft and no concomitant injuries.

2.2 Exclusion criteria: other ligamentous injuries and a chondral defect or meniscal injuries, presence of any severe cardiovascular or musculoskeletal disease, knee flexion deformity, any other trunk or lower extremity injury.

2.3 Clinical outcome measures: BESS (Balanced Error Scoring System), KOOS (Knee Injury and Osteoarthritis Outcome Score) and SEBT (Star Excursion Balance Test).

2.4 Intervention: 8 different Pilates exercises were performed five days a week for 12 weeks. Progression was made after every third week with change in frequency and mode of exercise. Mode of exercise was changed with addition of TheraBand and Swiss Ball and frequency was changed from 10 repetitions to 15, 20, 25 consecutively every third week. Myofascial release was performed three days a week on bilateral IT band, contralateral Quadratus lumborum and planter fascia. Warm up and cool down of 10-15 minutes comprising of general body movements, breathing exercises, light stretching exercises were included before and after intervention respectively.

TABLE 1- Pilates intervention

Week 3	Week 6	Week 9	Week 12
Supine twist	Hundred	Side lying toe taps	Single leg stretches with TheraBand
Swan	SLR hold	Side lying rainbow	Toe taps with ball
Prone SLR	VMO	Side lying leg circles	Prone SLR with ball
Pelvic curl with adductor press	Toe taps in Supine	knee bending with Weight cuff	Sumo Squats
Single leg circle with knee bend	Side lying knee taps	Prone SLR with weight cuff	Squat with TheraBand
Clamshell	Knee taps to kick	Wall Squats	Side to side with TheraBand
Bird dog	Single leg stretches with TheraBand	Hip width apart squat	Swiss ball bridging
Roll Up	Knee fold with Swiss ball	Leg slides with stability ball and TheraBand	Pilates V squat

2.5 Statistical analysis: Data was analysed through graph pad prism software using Turkey Multiple Comparison Test.

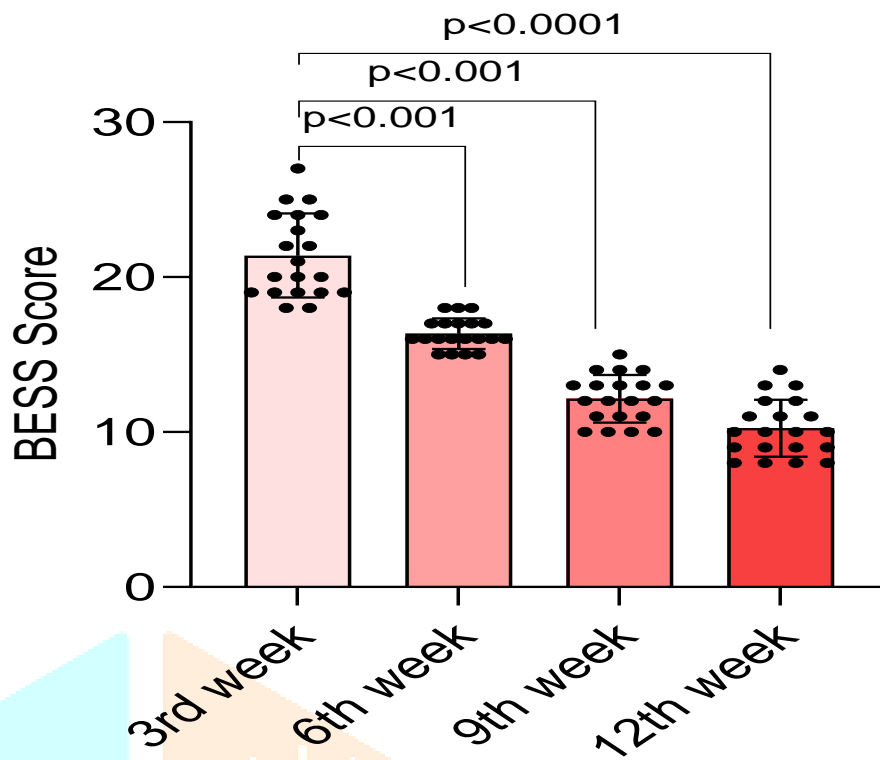
3. RESULTS-

Between-week comparison mostly results showed that scores significantly increased in the 3rd and 12th week. Reaching distance in SEBT was increased in the posterior ($P < 0.0001$), medial ($P < 0.0001$), posteromedial ($P < 0.0001$), and posterolateral ($P < 0.05$) directions. Decreased number of errors in BESS including ($P < 0.0001$), only between 3rd and 12th week. Improvement was also shown in KOOS scores for pain ($P < 0.0001$), symptoms ($P < 0.0001$), ADL ($P < 0.0001$), Sports ($P < 0.0001$), QOL ($P < 0.0001$) but not between 9th and 12th week.

TABLE 2- Statistical differences for BESS, SEBT and KOOS between 3rd and 12th week

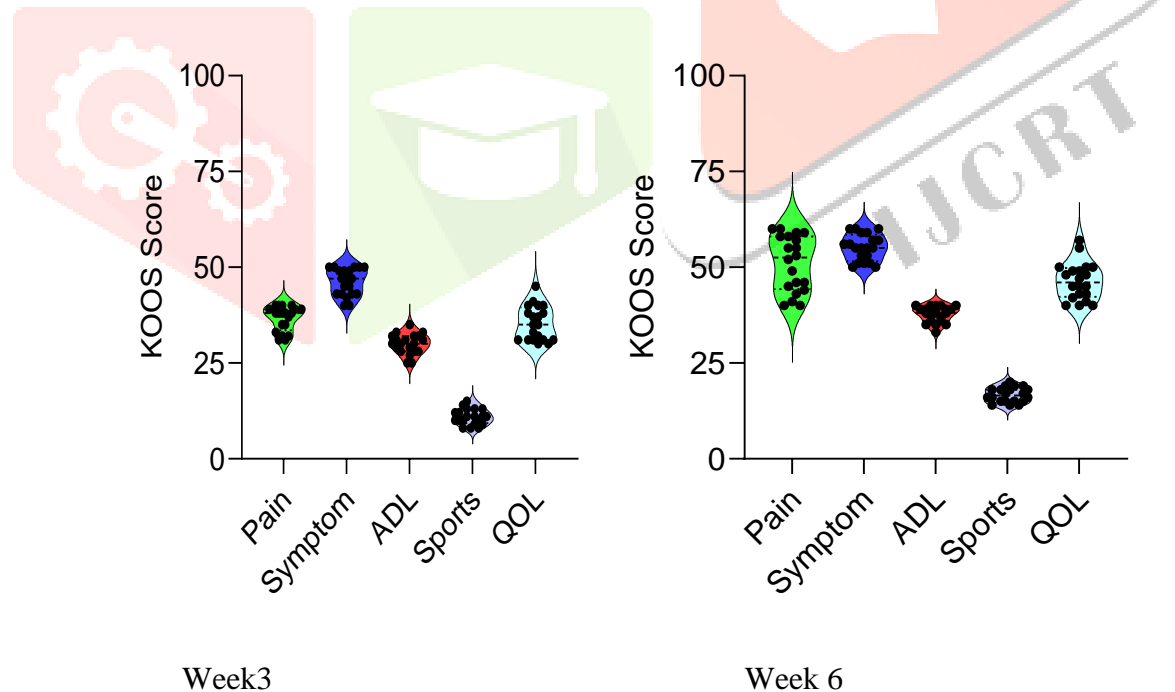
Parameters	Mean 1	Mean 2	Mean difference	95% CI	P Value
For BESS	21.4	10.25	11.15	9.597 to 12.70	<0.0001
For KOOS					
Pain	36.65	85.1	-48.45	-52.27 to -44.63	<0.0001
Symptom	46.1	86.7	-40.6	-43.82 to -37.38	<0.0001
ADL	29.95	68.5	-38.55	-41.90 to -35.20	<0.0001
Sports	10.9	36.75	-25.85	-28.38 to -23.32	<0.0001
QOL	35.3	68.05	-32.75	-36.00 to -29.50	<0.0001
For SEBT					
Anterior	61.98	65.45	-3.475	-9.809 to 2.859	0.478
Posterior	42.74	52.27	-9.526	-13.93 to -5.119	<0.0001
Medial	44.44	59.19	-14.75	-20.59 to -8.919	<0.0001
Lateral	60.92	59.03	1.888	-2.394 to 6.170	0.6549
Anterolateral	60.17	62.71	-2.547	-9.250 to 4.156	0.7509
Anteromedial	53.61	60.63	-7.021	-10.28 to -3.757	<0.0001
Posterolateral	58.29	61.44	-3.145	-6.006 to -0.2826	0.0256
Posteromedial	41.44	51.02	-9.582	-11.97 to -7.191	<0.0001

Figure 1- BESS scores between week 3 and week 12



BESS scores improved significantly between Weeks 3 and 6 and showed the most improvement by week 12.

Figure 2- KOOS scores between week 3 to week 12



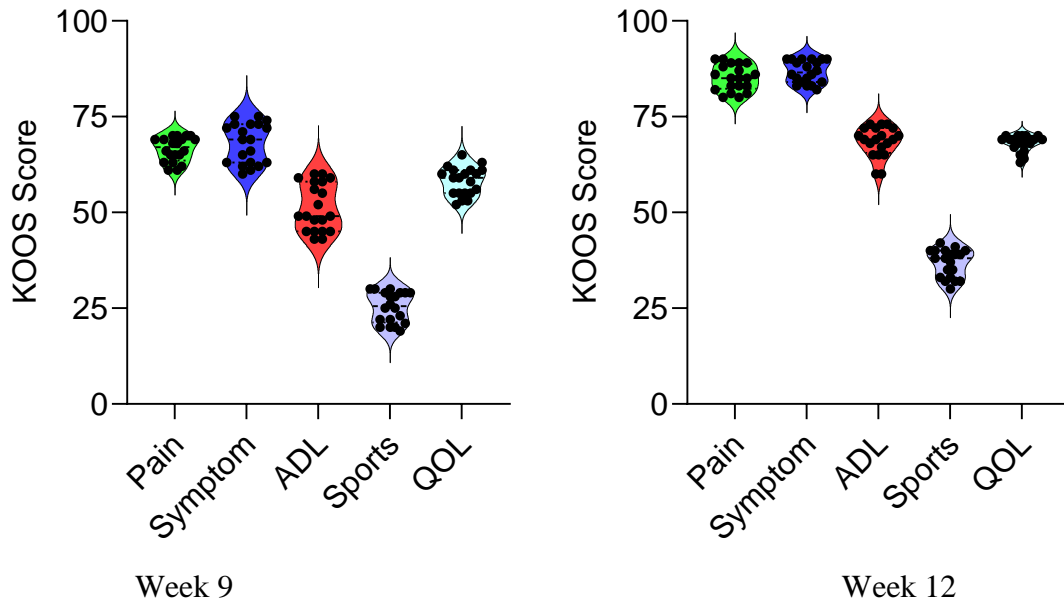
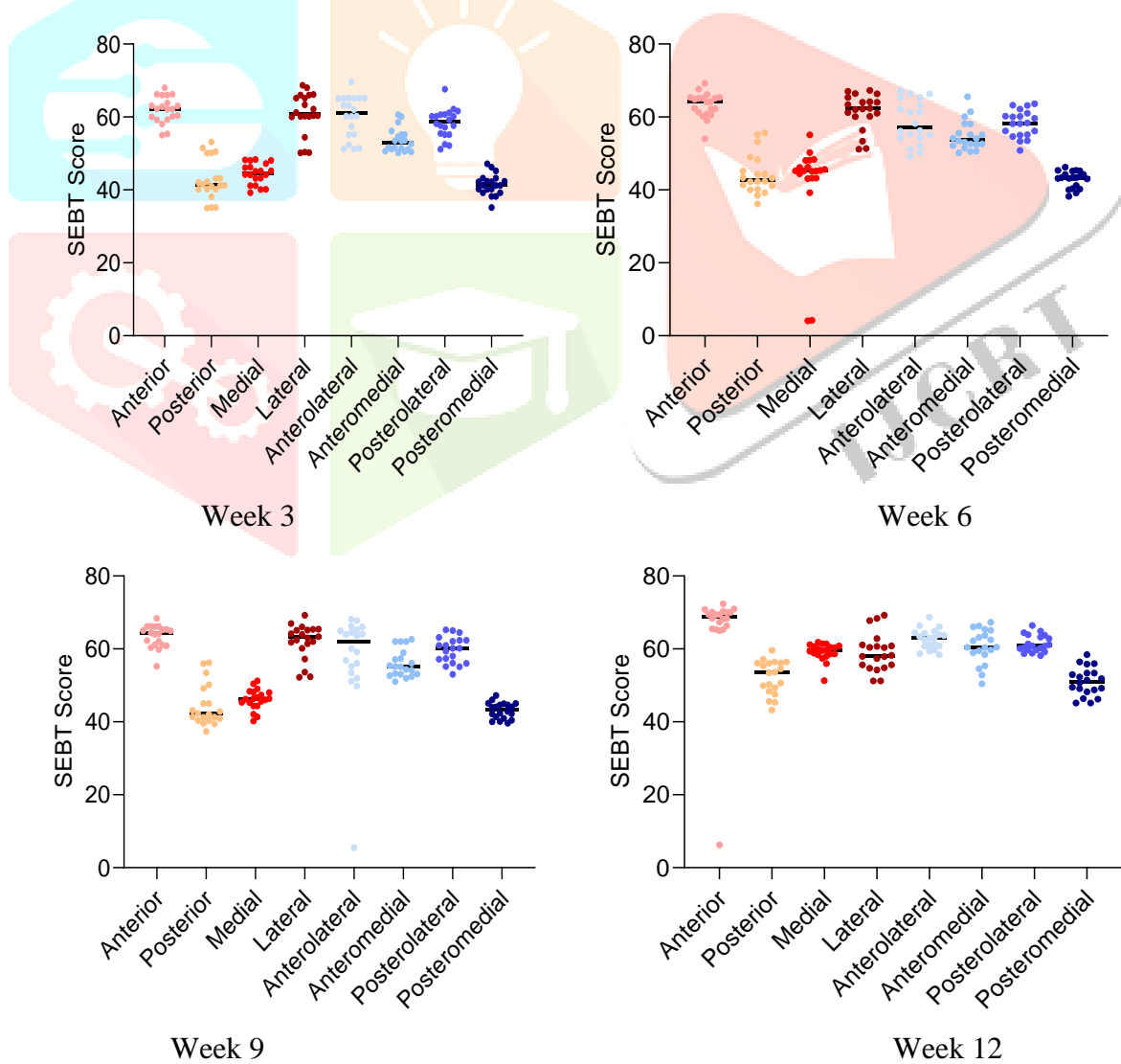


Figure 3- SEBT scores from week 3 to week 12



4. DISCUSSION

This study mainly aimed at neuromuscular control along with muscle strengthening in post ACL reconstruction patients. Goal was to achieve postural dynamic control and improve proprioception. 20 patients were taken for the study both male and female and Pilates intervention along with MFR was done for 12 weeks. Results obtained showed reduced error scores in BESS. Our study showed a significant reduction in pain levels and improvements in symptoms, activities of daily living, sports participation, and overall quality of life of KOOS scores. SEBT scores increased in distance posterior, medial, posteromedial, and posterolateral directions.

Pilates may provide clinicians a novel option when choosing a treatment for ACL rehabilitation. Deriya Celik et al 2017 conducted a study to examine Pilates effects in partial ACL injury patients. Mat Pilates was performed for 12 weeks. All patients were evaluated using the Lysholm Knee Scale, the Cincinnati Knee Rating System, and isokinetic quadriceps and hamstring strength. Patient satisfaction regarding improvement in knee stability was assessed using the Global Rating of Change scale. Results showed that Pilates is a superior management approach over a control treatment for increasing quadriceps strength in participants with partial ACL injury.¹⁷

Gustavo Telles et al 2018 conducted a study to conclude Exercises added with myofascial techniques showed better clinical effects than isolated exercises for patients with anterior knee pain. The addition of myofascial techniques should be considered to improve the functionality of the lower limbs and reduce pain in patients with anterior knee pain.¹⁸

This is favourable in ACL rehabilitation as previous studies have shown that proprioceptive feedback is important in both functional outcomes and ACL stability. The data obtained from the current study supports the positive impact of Pilates and MFR on balance, pain reduction, knee related outcomes and functional stability. These findings contribute to the growing body of evidence supporting the integration of Pilates and MFR in ACL rehabilitation intervention.

Clinical Implications: Incorporating Pilates exercises and MFR into rehabilitation programs can lead to improved balance and functional stability, not much research is available on the two parameters, and only knee joint strengthening is the main focus of rehabilitation.

Current limitations: The relatively small sample size and the lack of a control group restrict the generalizability of the findings. Additionally, the follow-up period was limited to 12 weeks; therefore, long-term effects beyond this period remain unknown.

5. CONCLUSION-

Integration of Pilates is advantageous, offering a secure and efficient way to regain knee function. It helps in core strengthening, balance, proprioception, and controlled movements that restore stability, improve joint alignment, and enhance overall body awareness and control. The combination of MFR and Pilates may lead to synergistic benefits, including enhanced muscle strength, flexibility, proprioception and balance. While the initial results are promising, further research is required to validate the long-term efficacy and applicability into protocols. As a non-invasive and adaptable exercise approach, Pilates and MFR has the potential to

enhance patient outcomes and improve the overall quality of life for individuals undergoing ACL rehabilitation.

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7. **CONFLICT OF INTEREST-** The authors declare no conflict of interest.

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