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Effectiveness of Pilates in rehabilitation for reconstructed anterior cruciate ligament

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Abstract
Background and Purpose: Anterior cruciate ligament 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 anterior cruciate ligament injuries are to retain strength, stability and dynamic control as well as to avoid reinjuring the ligament 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. The purpose of this study was to explore effect of Pilates on balance, postural control and quality of life.
Methodology: 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. 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: Results showed that with each week of exercise progression, reaching distance in star excursion balance test was increased significantly (p<0.05), knee injury and osteoarthritis outcome score scale scores (p<0.0001) and decrease in errors mainly in single leg stance and tandem stance position (p<0.0001).
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 restores stability, improves joint alignment and enhancing overall body awareness and control. Furthermore, more research is required on a large sample size.

Keywords: Pilates, anterior cruciate ligament rehabilitation, balance, stability and proprioception

1. Introduction
The ACL is the primary restraint to anterior translation of the tibia and a secondary restraint to tibial rotation and to varus and valgus stress [1]. ACL ruptures accounts for more than 50% of knee injuries which significantly impact an individual's functional abilities and quality of life [2]. The incidence of ACL ruptures is estimated to range from 30 to 78 per 100,000 person-years. After ACL reconstruction, 61% to 89% of athletes successfully return to sports [3]. Though surgical approaches and rehabilitation has evolved dramatically since few decades but still patient have functional deficits which persists and my increase risk of reinjury, post traumatic osteoarthritis and quality of life [4].
Deficits in neuromuscular control of the body's core may lead to uncontrolled trunk displacement during movement, which in turn may place the lower extremity in a valgus position, thereby increasing knee abduction motion and torque and resulting in increased knee ligament strain and ACL injury [5].
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 [6]. Pilates has been proven to improve core strength and function connected with breathing [7]. The purpose of this study was to explore effect of Pilates on balance, postural control and quality of life.

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 Thera Band and Swiss Ball and frequency was changed from 10 repetitions to 15, 20, 25 consecutively every third week. 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 Thera Band
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 Thera Band
Clamshell	Knee taps to kick	Wall Squats	Side to side with Thera Band
Bird dog	Single leg stretches with Thera Band	Hip width apart squat	Swiss ball bridging
Roll Up	Knee fold with Swiss ball	Leg slides with stability ball and Thera Band	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 results showed that scores significantly increased in the 3rd and 12th weeks. Reaching distance in SEBT was increased in the anterior (P=0.002), posterior (P=0.006), medial (p<0.0001), anteromedial (p<0.0001), posteromedial (p<0.0001), and posterolateral (P=0.025), but no improvements were shown for lateral (P =0.65) and anterolateral (P= 0.40) 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, KOOS and SEBT scores

Between 3rd and 12th week					
Parameters	**Mean 1**	**Mean 2**	**Mean difference**	**95% CI**	**P Value**
For BESS	21.4	14.75	6.65	3.091 to 10.21	<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	53.15	-23.2	-27.25 to -19.5	<0.0001
Sports	10.3	19.95	-9.65	-11.65 to -7.652	<0.0001
QOL	35.3	58.8	-23.5	-26.72 to -20.8	<0.0001
For SEBT					
Anterior	61.98	65.88	-3.899	-6.721 to -1.076	0.0028
Posterior	42.74	49.04	-6.292	-11.21 to -1.376	0.0065
Medial	44.44	54.72	-10.28	-13.75 to -6.811	<0.0001
Lateral	60.92	59.01	1.904	-2.390 to 6.198	0.6508
Anterolateral	60.17	62.71	-2.547	-6.839 to 1.745	0.4081
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

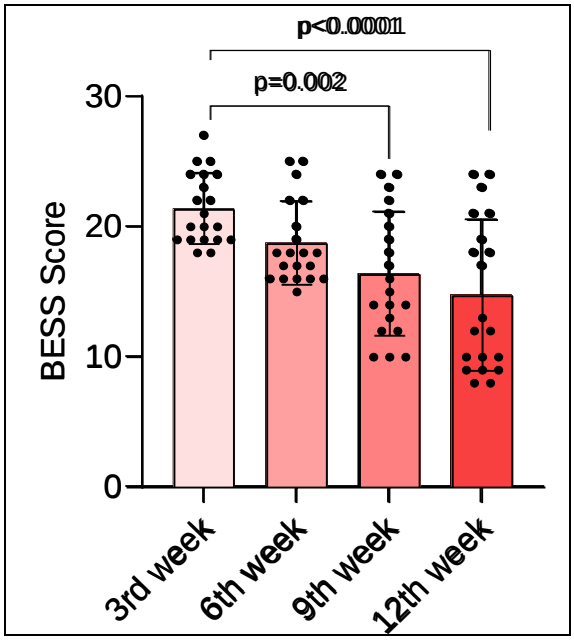
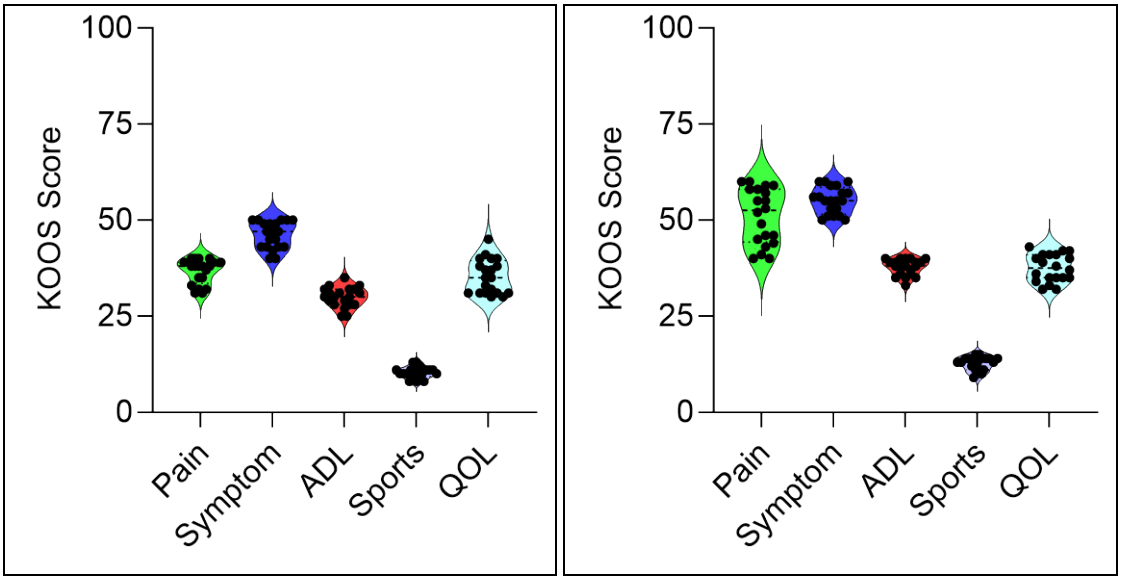
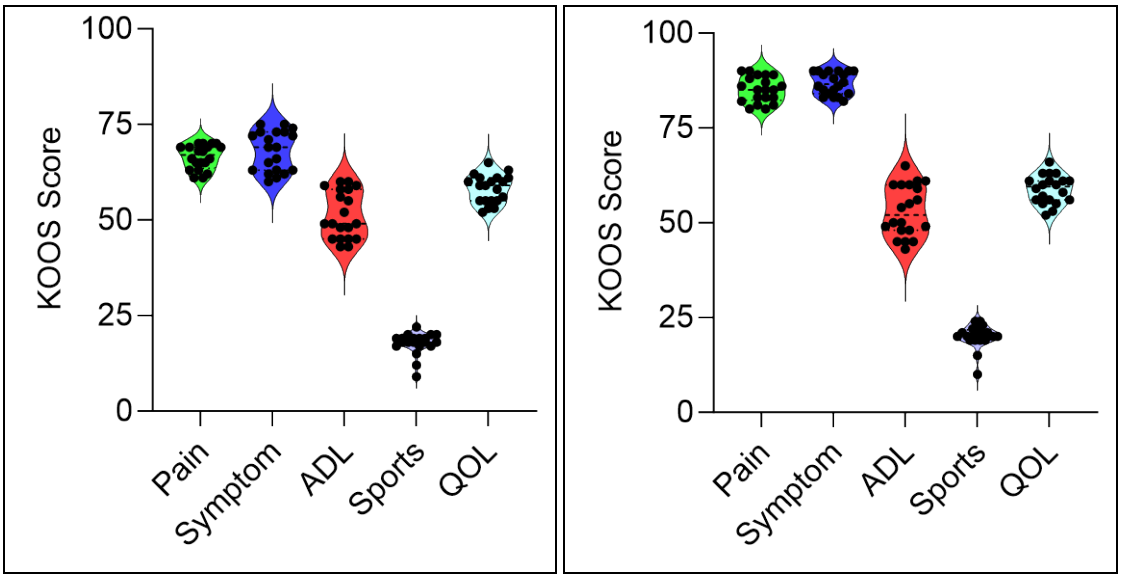


Fig 1: BESS scores from week 3 to week 12



Week 3 Week 6



Week 9 Week 12

Fig 2: KOOS scores from week 3 to week 12

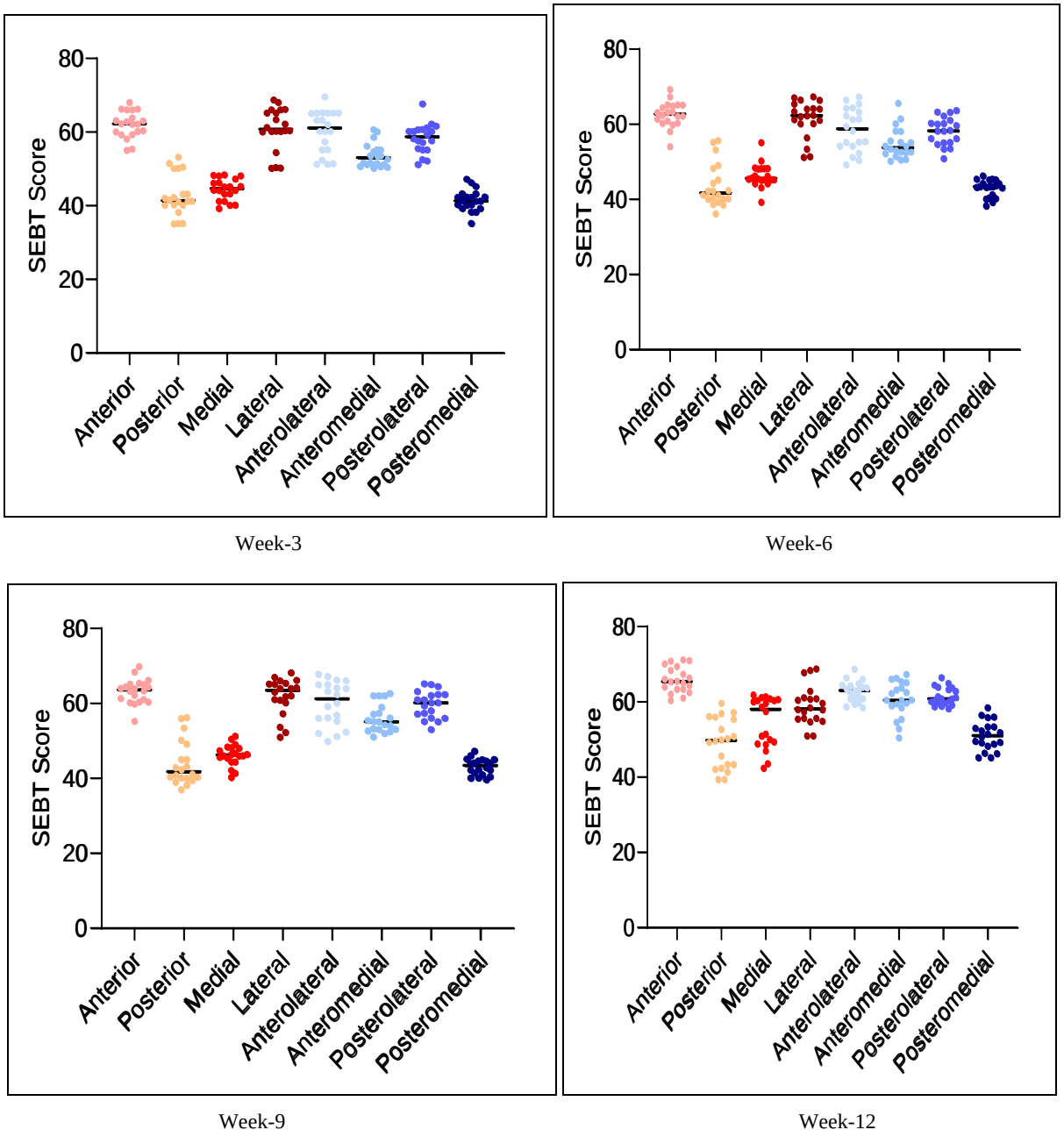


Fig 3: SEBT scores from week 3 to week 12

4. Discussion

The purpose of our study was to investigate the effects of 12 weeks intervention of Pilates for the patients who have undergone ACL reconstruction on both male and female with age group of 20-40 years. The findings suggested that there was a significant increase in SEBT distances in all directions except for lateral and anterolateral. KOOS scores improvement was also seen indicating improving pain and quality of life. BESS scores were decreased indicating improvement in balance and proprioception. But major changes were achieved by ninth week as observed during in between week analysis.

According on previous studies, strong core provides maximum force distribution and generation, with minimal compressive, translational, and shearing forces in the joints of the kinetic chain, as well as optimal control of movements and proper absorption of shock forces [8].

Given that a decreased knee flexion and a larger valgus angle are connected to an increased risk of ACL injuries, strengthening the endurance of the core muscles can reduce the risk of ACL injuries by regulating the lower limb kinematics [9].

Pilates showed significant improvements in the quadriceps extensor strength in the intervention groups at follow up. This is important as strong quadriceps are an essential muscle group for ACL rehabilitation and in the prevention of further ACL injury [10].

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 [11].

Attar *et al*. (2022) in a systematic review and meta-analysis study, investigated the effects of injury prevention programs that include core stability exercises on knee and ACL injuries. They found that exercise programs that included core stability exercises reduced the incidence of knee injuries by 46% in men and 65% in women [12].

4.1 Clinical Implications: Incorporating Pilates exercises 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.

4.2 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. In conclusion, our research indicates that Pilates is an effective intervention in the rehabilitation of patients with reconstructed ACL. The data support the positive impact of Pilates on balance, pain reduction, knee-related outcomes, and functional stability. As a non-invasive and adaptable exercise approach, Pilates has the potential to enhance patient outcomes and improve the overall quality of life for individuals undergoing ACL rehabilitation.

6. Acknowledgement

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7. References

1. Clinical Orthopedic Rehabilitation S.Brent Brotzman, Kevin E. Wilk II edition; p. 266-276.
2. Gans I, Retzky JS, Jones LC, Tanaka MJ. Epidemiology of Recurrent Anterior Cruciate Ligament Injuries in National Collegiate Athletic Association Sports: The Injury Surveillance Program, 2004-2014. Orthop J Sports Med. 2018 Jun 13;6(6):2325967118777823.
3. Sayampanathan AA, Howe BK, Bin Abd Razak HR, Chi CH, Tan AH. Epidemiology of surgically managed anterior cruciate ligament ruptures in a sports surgery practice. J Orthop Surg (Hong Kong). 2017 Jan;25(1):2309499016684289.
4. Biggs A, Jenkins WL, Urch SE, Shelbourne KD. Rehabilitation for Patients Following ACL Reconstruction: A Knee Symmetry Model. N Am J Sports Phys Ther. 2009 Feb;4(1):2-12.
5. Patterson BE, Barton CJ, Culvenor AG, Cooper RL, Crossley KM. Exercise-therapy and education for individuals one year after anterior cruciate ligament reconstruction: a pilot randomised controlled trial. BMC Musculoskelet Disord. 2021 Jan 11;22(1):64.
6. Bliss LS, Teeple P. Core stability: the centerpiece of any training program. Curr Sports Med Rep. 2005 Jun;4(3):179-83.
7. Hewett TE, Zazulak BT, Myer GD, Ford KR. A review of electromyographic activation levels, timing differences, and increased anterior cruciate ligament injury incidence in female athletes. Br J Sports Med. 2005 Jun;39(6):347-50.
8. Comerford MJ, Mottram SL. Movement and stability dysfunction–contemporary developments. Man. Ther. 2001;6(1):15-26.
9. Saki, Farzane, Shafiee, Hossein, Tahayori, Behdad, *et al*. The effects of core stabilization exercises on the neuromuscular function of athletes with ACL reconstruction. Scientific Reports; c2023. 13. 10.1038/s41598-023-29126-6
10. Bodor M. Quadriceps protects the anterior cruciate ligament. J Orthop Res. 2001;19(4):629-633. DOI: 10.1016/S0736-0266(01)00050-X
11. Leetun DT, *et al*. Core stability measures as risk factors for lower extremity injury in athletes. Med. Sci. Sports Exerc. 2004;36(6):926-934.
12. Al Attar, WSA, *et al*. The effectiveness of injury prevention programs that include core stability exercises in reducing the incidence of knee injury among soccer players: A systematic review and meta-analysis. Isokinet. Exerc. Sci. (Preprint); c2022. p. 1-11.