Research Article

Effectiveness Of Swiss Ball Exercises Versus Progressive Resisted Exercises During Early Rehabilitation (3–6 Weeks) Following Acl Reconstruction In Athletes)

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Abstract

Background: Rehabilitation after anterior cruciate ligament (ACL) surgery is crucial for reinstating knee stability, enhancing muscular strength, improving range of motion, and optimizing functional performance. Swiss ball workouts offer an unstable training platform that could improve proprioception and neuromuscular coordination, while progressive resisted exercises (PRE) mainly aim to bolster muscle strength.

Objective: To compare the effectiveness of Swiss ball exercises and progressive resisted exercises on pain, knee range of motion (ROM), and functional outcome in patients following ACL reconstruction.

Methods: An experimental randomized controlled study was conducted involving 40 participants, divided into two groups of 20 participants each. Group A received Swiss ball exercises, whereas Group B received progressive resisted exercises. The intervention was administered during the early post-operative rehabilitation phase, specifically from the 3rd to the 6th week following ACL reconstruction. Both groups received supervised rehabilitation five times per week for six weeks, with each session lasting approximately 45 minutes. Pain was assessed using the Visual Analogue Scale (VAS), knee ROM using a universal goniometer, and functional performance using the Lysholm Knee Score. Between-group comparisons were performed using unpaired t-tests.

Results: Both Group A (Swiss Ball Exercises) and Group B (Progressive Resisted Exercises) showed statistically significant improvement in pain, range of motion and functional knee performance following treatment ($p<0.001$). However, Group A and Group B both demonstrated significantly greater improvement, but Group A have highly significant than Group B. Between-group analysis revealed highly significant differences in post-test VAS, ROM, and Lysholm Knee Score values ($p<0.001$), favoring Group A.

Conclusion: Both interventions demonstrated improvements in postoperative ACL rehabilitation outcomes. However, Swiss ball exercises showed greater improvements in pain, knee ROM, and functional performance compared with progressive resisted exercises.

Keywords: Anterior cruciate ligament reconstruction, Swiss ball exercises, progressive resisted exercises, pain, knee range of motion, Lysholm Knee Score, rehabilitation.

INTRODUCTION

The knee joint is an intricate synovial and modified hinge joint that allows for flexion, extension, and a restricted degree of rotation while ensuring stability (Standring, 2016). The anterior cruciate ligament (ACL) is crucial for regulating anterior tibial movement and ensuring stability in the knee joint. It stretches from the lateral femoral condyle to the anterior intercondylar area of the tibia (Moore et al., 2018).

Injuries to the anterior cruciate ligament are prevalent among athletes and anyone who engage in vigorous activities. ACL restoration is a frequently executed surgical intervention aimed at reinstating knee stability and promoting functional rehabilitation. Postoperative therapy is crucial for restoring knee mobility, enhancing muscular strength, improving proprioception, and optimizing functional performance.

Swiss ball exercises are often integrated into rehabilitation programs as they offer an unstable surface that tests balance, coordination, and neuromuscular control. These activities could enhance proprioceptive feedback and engage various muscle groups concurrently (Hernandez et al., 2008).

Progressive resistance exercises (PRE) are a significant feature of postoperative recovery. They involve gradually increasing resistance to improve muscular strength, motor coordination, and functional capacity. Strengthening the quadriceps, hamstrings, and surrounding hip muscles is essential for restoring knee function after ACL surgery.

Both approaches may offer advantages in postoperative recovery. However, comparing their effectiveness may

assist find a suitable exercise approach for reducing pain, knee ROM, and functional results.
Therefore, the present study was conducted to assess the efficiency of Swiss ball exercises vs progressive resisted workouts in patients undergoing ACL surgery.

NEED OF THE STUDY

Anterior cruciate ligament reconstruction is a frequently executed surgical intervention for athletics. Postoperative therapy is crucial for reinstating knee stability, strength, mobility, and functional capability.
A range of physiotherapeutic approaches exists for the rehabilitation of postoperative ACL patients. Swiss ball workouts and progressively resisted exercises are often employed methods.
Swiss ball workouts predominantly test proprioception, equilibrium, coordination, and dynamic joint stability, while progressive resistance training emphasizes enhancing muscular strength and motor control.
It is essential to evaluate these interventions to ascertain if instability-focused training offers supplementary advantages compared to traditional progressive resistance workouts.
Consequently, this research was conducted to determine the most efficacious rehabilitation strategy for enhancing pain, knee range of motion, and functional results post-ACL reconstruction.

AIM OF THE STUDY

To compare the effectiveness of Swiss ball exercises versus progressive resisted exercises on pain, range of motion, and functional outcome in patients following postoperative anterior cruciate ligament reconstruction.

OBJECTIVES

1. To assess pain before and after intervention using the Visual Analogue Scale.
2. To evaluate knee range of motion using a universal goniometer.
3. To assess functional knee performance using the Lysholm Knee Score.
4. To compare the effectiveness of Swiss ball exercises and progressive resisted exercises on the selected outcome measures.

REVIEW OF LITERATURE

Mohammad Daher et al. (2024) investigated the effects of hip-focused strengthening programmes following total knee arthroplasty. Their findings suggested improvements in balance, particularly single-leg stance performance, following hip strengthening exercises.
Gokeler et al. (2020) investigated neuromuscular deficits and movement quality following ACL reconstruction. Their findings highlighted the persistence of altered movement patterns, including knee valgus and changes in landing mechanics. The authors emphasized the importance of task-specific and neuromuscular training.
Adams et al. (2012) developed a criterion-based rehabilitation progression following ACL reconstruction. Their rehabilitation approach emphasized gradual strengthening, restoration of knee extension, functional training, and progression towards advanced neuromuscular activities.
Palmieri-Smith et al. (2008) investigated quadriceps strength deficits following ACL injury and reconstruction. Their findings highlighted persistent muscle weakness and altered neuromuscular activation as important factors contributing to functional limitations.

MATERIALS AND METHODS

Study Design

The study employed an experimental comparative design in which participants were randomly allocated into two intervention groups to compare the effectiveness of two different physiotherapy interventions.

Source of Subjects

Outpatient Department, Dasmesh College of Physiotherapy, Faridkot.

Sampling Technique

Convenience sampling was used to recruit eligible participants who fulfilled the inclusion and exclusion criteria and were available to participate in the study.

Sample Size

A total of 40 participants were included and divided into two groups:

- Group A: 20 participants receiving Swiss ball exercises.
- Group B: 20 participants receiving progressive resisted exercises.

Inclusion Criteria

Age group: 20–45 years , Patients who had undergone ACL reconstruction using hamstring tendon autograft , Both male and female participant athletes , Patients in the early postoperative rehabilitation phase , Patients with reduced knee ROM, pain, or functional limitation following ACL reconstruction , Patients able to follow verbal instructions and actively participate in exercise sessions , Patients without major postoperative complications interfering with rehabilitation , Patients without neurological deficits or previous surgery on the same knee.

Exclusion Criteria

Clinically diagnosed multiple ligament knee injuries , Revision ACL reconstruction surgery , Congenital deformities of the lower limb affecting gait or knee mechanics , Lower-limb fractures involving the femur, tibia, or patella , Balance disorders or vestibular dysfunction , Severe musculoskeletal conditions , Significant chondral defects or meniscal repair requiring delayed weight-bearing , Individuals without a history of regular athletic or sports participation were excluded from the study , Patients unable or unwilling to comply with the rehabilitation protocol or follow-up assessment.

OUTCOME MEASURES

Visual Analogue Scale (VAS)

The Visual Analog Scale (VAS) is an extensively employed subjective measurement tool for assessing pain intensity. It consists of a 100-mm horizontal line, with one end representing “no pain” (0 mm) and the other end denoting “worst imaginable pain” (100 mm). Participants are asked to place a mark on the line that most accurately reflects their perceived pain level. The distance from the zero point to the participant's mark is measured in millimeters, yielding a score that ranges from 0 to 100. Higher scores indicate increased pain intensity. The VAS is a straightforward, sensitive, and reliable instrument for evaluating fluctuations in pain intensity and tracking treatment outcomes (Huskisson, 1974).

Universal Goniometer

A universal goniometer was employed to assess the range of motion in the knee joint in degrees. It comprises a fulcrum, a stationary arm, and a movable arm. To measure knee flexion and extension, the participant is correctly positioned, with the fulcrum situated over the lateral epicondyle of the femur, the stationary arm directed toward the greater trochanter, and the movable arm oriented toward the lateral malleolus. (Gogia et al. 1987, Brosseau et al. 2001).

Lysholm Knee Score

The Lysholm Knee Scoring Scale is a patient-reported outcome tool utilized to evaluate knee functionality, especially after ligament damage and ACL surgery.

It comprises eight elements: Limp, Requirement for assistance, Locking, Instability, Discomfort, Edema, Ascending stairs, and Squatting.

The cumulative score varies from 0 to 100, with elevated scores signifying superior knee performance.

Functional grading: Excellent: 95–100, Good: 84–94, Fair: 65–83, Poor: Below 65(Briggs et al. 2009).

PROCEDURE

A total of 40 participants were randomly allocated into two groups, with 20 participants in each group.

Both groups received their respective supervised exercise programmes five times per week for six weeks. Each session lasted approximately 45 minutes.

Group A: Swiss Ball Exercise Protocol

Participants in Group A received a structured Swiss ball exercise programme.

Weeks 3–5 following ACL reconstruction

S. No.	Exercise	Dosage
1	Knee flexion using Swiss ball	10 repetitions, 3 sets; 10-second hold and 10-second relaxation
2	Bridging exercises	10 repetitions, 3 sets; 10-second hold and 10-second relaxation
3	Closed kinetic-chain strengthening	10 repetitions, 3 sets

Weeks 5–6 following ACL reconstruction

S. No.	Exercise	Dosage
1	Swiss ball alternating leg raise (gait simulation)	10 repetitions, 3 sets; 10-second hold and 5-second relaxation
2	Figurehead exercise (closed kinetic-chain exercise)	10 repetitions, 3 sets; 10-second hold and 5-second relaxation
3	Dynamic sitting and stepping activities on Swiss ball	10 repetitions, 3 sets; 10-second hold and 5-second relaxation

Group B: Progressive Resisted Exercise Protocol

Participants in Group B received progressive resisted exercises focusing on strengthening the muscles surrounding the knee and hip.

Weeks 3–6 following ACL reconstruction

S. No.	Exercise	Dosage
1	Quadriceps progressive resistance training	10 repetitions, 3 sets
2	Hamstring progressive resistance training	10 repetitions, 3 sets
3	Resisted hip flexion	10 repetitions, 3 sets
4	Resisted hip abduction	10 repetitions, 3 sets
5	Resisted hip adduction	10 repetitions, 3 sets
6	Resisted hip extension	10 repetitions, 3 sets

The exercise programme also included isometric quadriceps and hamstring exercises and ankle/toe pumps, as described in the presentation.

RESULTS

The present study was conducted to compare the effectiveness of Swiss ball exercises and progressive resisted exercises in patients following ACL reconstruction.

A total of 40 participants were included, with 20 participants in Group A (Swiss ball exercises) and 20 participants in Group B (progressive resisted exercises).

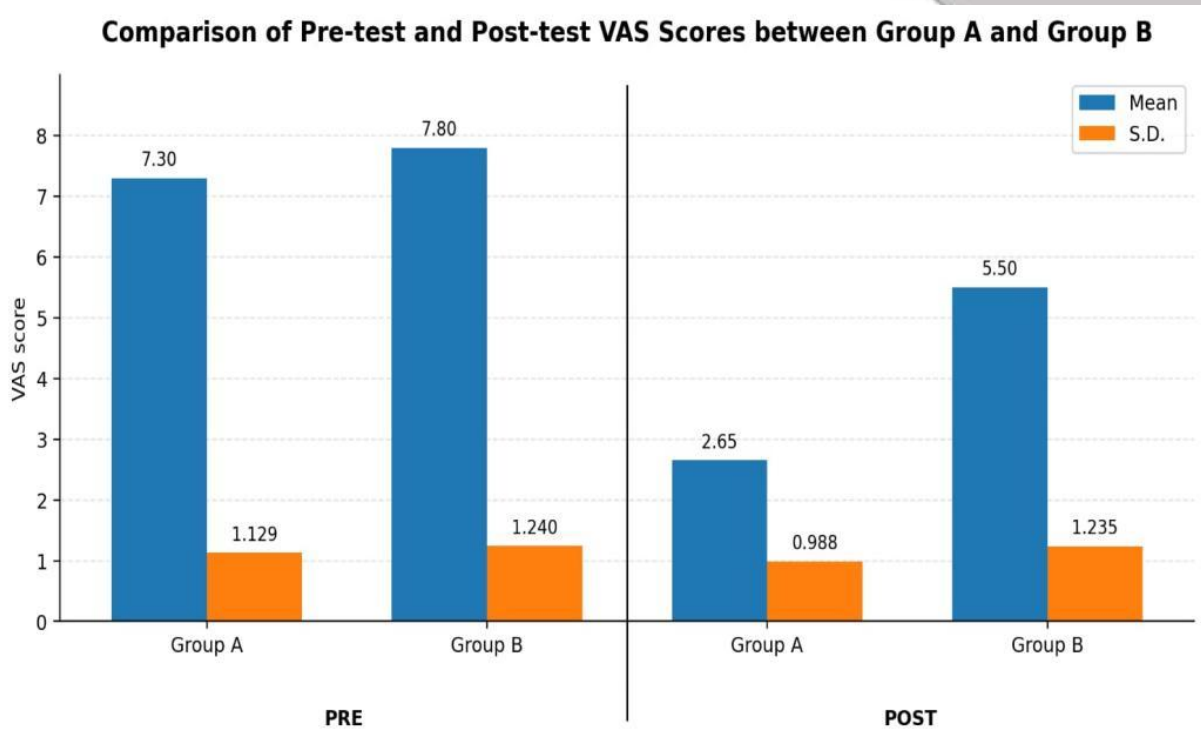
The results demonstrated improvements in pain, knee ROM, and functional performance in both groups following the intervention.

Between-group analysis revealed no statistically significant differences in baseline scores. However, statistically significant differences were observed in post-intervention scores for all three outcome measures ($p < 0.001$), favoring Group A.

Comparison of Pre-test and Post-test VAS Scores

Table 1. Comparison of VAS scores between Group A and Group B

Parameter	Group A Pre	Group B Pre	Group A Post	Group B Post
Mean	7.30	7.80	2.65	5.50
SD	1.129	1.240	0.988	1.235



Sample size	20	20	20	20

Between-group statistical comparison

Statistical parameter	Pre-test	Post-test
Mean difference	0.50	2.85
Unpaired t-value	1.334	8.057
p-value	0.1902	<0.001
Critical t-value	2.02	2.02
Result	Not significant	Significant

The mean VAS score decreased from 7.30 to 2.65 in Group A and from 7.80 to 5.50 in Group B. The post-intervention comparison demonstrated a statistically significant difference favouring Group A ($p < 0.001$).

Figure 1. Comparison of pre-test and post-test VAS scores between Group A and Group B

Comparison of Pre-test and Post-test Knee Range of Motion

Table 2. Comparison of knee ROM between Group A and Group B

Parameter	Group A Pre	Group B Pre	Group A Post	Group B Post
Mean (degrees)	82.80	90.70	132.00	104.55
SD	16.143	11.819	6.283	13.113

Sample size	20	20	20	20

Between-group statistical comparison

Statistical parameter	Pre-test	Post-test
Mean difference	7.90	27.45
Unpaired t-value	1.766	8.443
p-value	0.0855	<0.001
Critical t-value	2.02	2.02
Result	Not significant	Significant

The mean knee ROM increased from 82.80° to 132.00° in Group A and from 90.70° to 104.55° in Group B. The post-intervention comparison demonstrated a statistically significant improvement in Group A compared with Group B ($p < 0.001$).

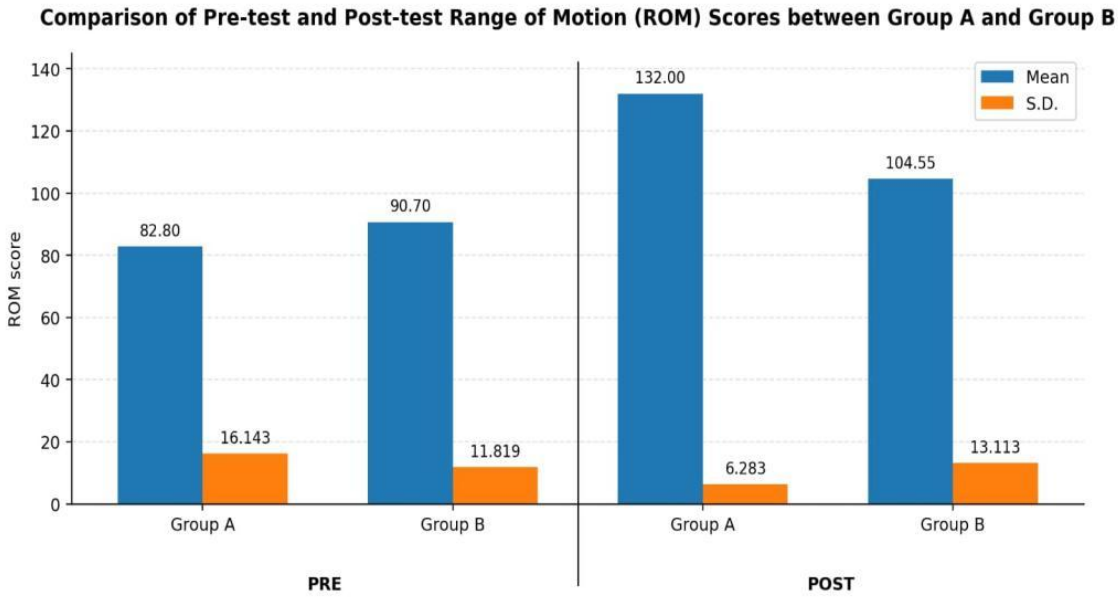


Figure 2. Comparison of pre-test and post-test knee ROM between Group A and Group B.

Comparison of Pre-test and Post-test Lysholm Knee Scores

Table 3. Comparison of Lysholm Knee Scores between Group A and Group B

Parameter	Group A Pre	Group B Pre	Group A Post	Group B Post
Mean	54.20	51.80	88.10	69.30
SD	6.271	6.887	3.810	8.718

Sample size	20	20	20	20

Between-group statistical comparison

Statistical parameter	Pre-test	Post-test
Mean difference	2.40	18.80
Unpaired t-value	1.152	8.837
p-value	0.2564	<0.001
Critical t-value	2.02	2.02
Result	Not significant	Significant

The mean Lysholm Knee Score increased from 54.20 to 88.10 in Group A and from 51.80 to 69.30 in Group B. The post-intervention comparison demonstrated a statistically significant difference favouring Group A ($p < 0.001$).

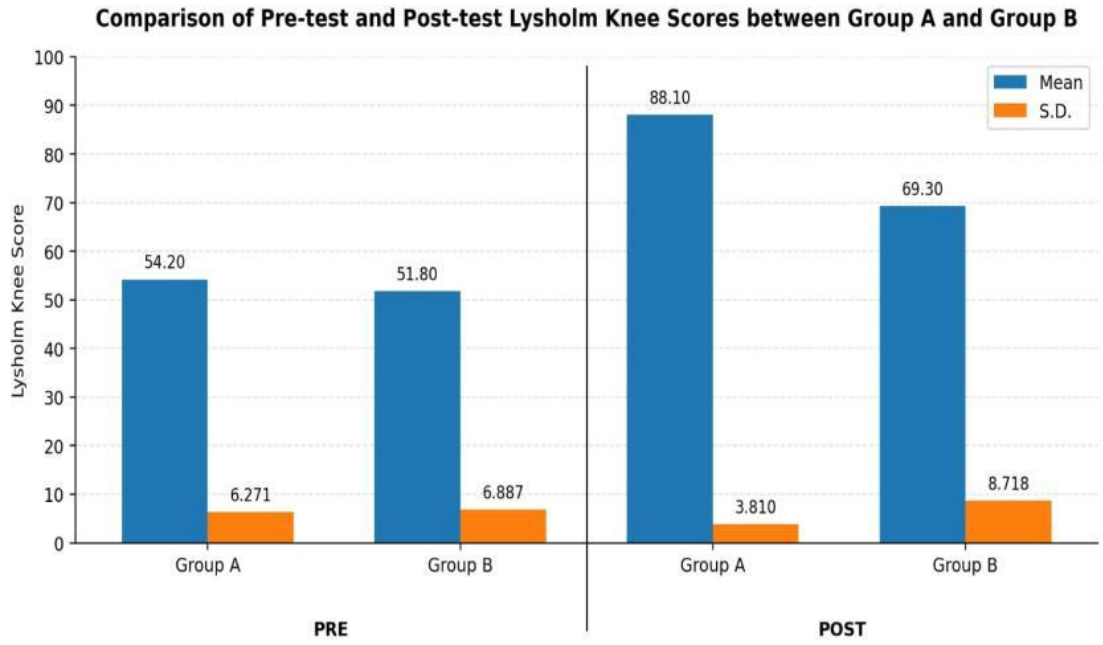


Figure 3. Comparison of pre-test and post-test Lysholm Knee Scores between Group A and Group B.

Overall Summary of Results

The findings demonstrated that both groups improved following the intervention. However, Group A showed greater improvements in all three outcome measures.

Outcome measure	Group A post-test	Group B post-test	p-value
VAS	2.65 ± 0.988	5.50 ± 1.235	<0.001
Knee ROM	132.00 ± 6.283°	104.55 ± 13.113°	<0.001
Lysholm Knee Score	88.10 ± 3.810	69.30 ± 8.718	<0.001

DISCUSSION

The current research evaluated the efficacy of Swiss ball workouts against progressive resisted activities in individuals recovering from ACL surgery.

A total of 40 individuals were segregated into two factions. Group A was assigned Swiss ball workouts, whereas Group B was given progressive resistance training. The results were evaluated by VAS, knee range of motion, and the Lysholm Knee Score.

The results indicated notable statistical enhancements in both cohorts after the intervention. Nonetheless, the comparison following the intervention revealed more significant enhancements in Group A across all three outcome metrics.

In Group A, the average VAS score diminished from 7.30 ± 1.129 to 2.65 ± 0.988, signifying a substantial alleviation of pain. In contrast, Group B exhibited a decline from 7.80 ± 1.240 to 5.50 ± 1.235. The results indicate that Swiss ball workouts resulted in more significant pain alleviation compared to progressive resistive activities in this study.

Concerning knee range of motion, Group A exhibited an enhancement from 82.80 ± 16.143° to 132.00 ± 6.283°, while Group B progressed from 90.70 ± 11.819° to 104.55 ± 13.113°. This signifies enhanced knee mobility in those undertaking Swiss ball exercises.

In a comparable manner, functional performance enhanced in both cohorts, as evidenced by the Lysholm Knee Score. Group A exhibited an enhancement from 54.20 ± 6.271 to 88.10 ± 3.810, while Group B progressed from 51.80 ± 6.887 to 69.30 ± 8.718.

The significant enhancement noted in Group A could be linked to the neuromuscular requirements of Swiss ball activities. Engaging in training on an uneven surface tests postural stability, proprioceptive abilities, balance, and coordination. These activities might promote synchronized engagement of the quadriceps, hamstrings, hip muscles, and core stabilizers.

Behm and Colado (2012) examined the efficacy of instability-focused resistance training in both rehabilitation and athletic

performance. Lephart et al. (2002) also emphasized the significance of proprioception in the treatment and recovery of sports-related injuries.

Adams et al. (2012) highlighted the significance of criterion-oriented rehabilitation, incremental strengthening, and neuromuscular training post-ACL reconstruction.

The results of the current research align with the significance of integrating neuromuscular and functional training into ACL rehabilitation following surgery.

The findings indicate that Swiss ball workouts could offer supplementary advantages than progressive resisted exercises just in enhancing pain, knee range of motion, and functional performance.

LIMITATIONS OF THE STUDY

1. The study included a relatively small sample size of 40 participants.
2. The study was conducted at a single institution.
3. Long-term follow-up was not reported.
4. The study did not assess return-to-sport performance.
5. Participant-level data were not available for independent statistical verification.
6. Detailed information regarding allocation concealment and assessor blinding was not provided.

CONCLUSION

The current research evaluated the efficacy of Swiss ball workouts against progressive resisted activities in individuals post-ACL reconstruction.

The findings indicated that both treatments were linked to enhancements in pain, knee mobility, and functional performance of the knee.

Nevertheless, Swiss ball exercises demonstrated superior enhancements across all three result metrics in comparison to progressive resisted activities. Group A exhibited a more significant decrease in discomfort, enhanced knee range of motion, and superior Lysholm Knee Scores compared to Group B. These results indicate that Swiss ball workouts could serve as a valuable element in postoperative ACL rehabilitation by enhancing neuromuscular control, balance, coordination, and functional stability. Consequently, Swiss ball exercises might be regarded as a supplementary rehabilitation method in conjunction with standard postoperative physiotherapy.

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