

# Physiotherapy rehabilitation management on phase IV of post-operative anterior cruciate ligament reconstruction with medial meniscus repair : a case report

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## ABSTRACT

**Background:** Sports injuries are injuries that arise as a result of sporting activities or activities. 60% of sports-related injuries occur in the lower limbs, including the knee's anterior cruciate ligament (ACL). This study aims to evaluate the physiotherapy interventions to improve ROM, balance, and knee function following ACLR with medial meniscus repair phase IV.

**Case Description:** The patient complained of pain and stiffness in the popliteal area. The pain was felt when driving a car and squatting. The injury occurred when playing futsal, and the patient made a zigzag while trying to win the ball. The patient took the wrong footing. Namely, the body turned while the left leg was left behind, and the knee joint suddenly rotated or twisted. Before surgery, the patient had carried out physiotherapy for six meetings. The operation was carried out on 11 May 2022 at the Royal Progress Hospital with three-day hospitalisation. The patient has been doing physiotherapy since the first day after surgery. Currently, the patient has entered week 19 (Phase IV).

**Conclusion:** The physiotherapy rehabilitation process, in this case, focuses on maintaining and increasing the strength of the core muscles and lower extremities, preparing the patient to jog, and training the patient's brain coordination through agility training. Returning to futsal is the ultimate goal of physiotherapy rehabilitation in this case.

**Keywords:** ACLR, medial meniscus, phase iv, physiotherapy, rehabilitation.

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## Introduction

The knee joint is one of the hinge joints in the lower extremity. It is vital in generating movement in the limbs and supporting the body, especially when sitting, standing, walking, running and jumping. The knee joint primarily facilitates flexion and extension movements. The anatomical function of the knee joint and its stability capabilities depend on other body tissues around the knee joint, such as muscles, bones, ligaments, cartilage and synovial tissues. The anterior cruciate ligament (ACL), medial collateral ligament (MCL), posterior cruciate ligament (PCL), and lateral collateral ligament (LCL) are four ligaments that help stabilize the knee joint. The main muscles that help active movement in the knee are the quadriceps and hamstrings muscle groups, and there is also a role for the sartorius and popliteal muscles in knee joint movement.<sup>1</sup> In addition to ligaments and muscles, there are two fibrocartilages on the medial and lateral sides between the femur and tibia bones, namely the medial and

lateral meniscus, which play a role in reducing the pressure on the two bones and static stabilization.<sup>2</sup>

Ligament tears are prevalent in the knee, with an incidence rate of 16%.<sup>3</sup> One of the most commonly injured ligaments in the knee is the Anterior Cruciate Ligament (ACL). The Anterior Cruciate Ligament (ACL) is one of the most critical ligaments. It plays a role in maintaining and stabilizing the knee, which works statically and dynamically with the coordination of the joints in the knee. The ACL has the primary function of preventing displacement of the tibia anterior to the femur. ACL rupture injuries often occur in individuals who engage in physical activity, especially sports. As sporting activities increase, the likelihood of injury also increases, which can result from sudden deceleration or hyperextension. Individuals with ACL injuries may experience recurrent periods of pain, loss of function, movement instability, and decreased function after the injury, resulting in limitations of daily activities and loss of productivity.<sup>4</sup>

Regarding causal origin, ACL tears can be caused by two main risk factors, 1) internal risk factors, including age, anthropometric conditions, specific variations in intercondylar notch structure, neuromuscular control in posture defence reflex mechanisms, gender with variations in hormonal status between women and men, and body mass index that can put the tibiofemoral joint at risk as an axial load, 2) external risk factors, including physical equipment, field conditions, and training programs.<sup>5</sup> There are two types of how ACL injuries occur: contact and non-contact. This is caused by a sudden deceleration or sudden change in knee direction. Just like the non-contact type, it is likely to occur due to hyperextension or impact where there is compression towards the varus or valgus in the form of translational movement. Sport-specific injury patterns are associated with specific injury mechanisms common to field manoeuvres.<sup>6</sup>

ACL injuries are divided into 3 degrees of severity. Grade 1 means stretching the tissue without a tear, characterized by slight swelling and pain, a partial tear of the ligament tissue indicates grade 2, and ligament rupture is accompanied by severe or even painless pain but accompanied by swelling and muscle weakness around the knee joint.<sup>7</sup> ACL diagnoses can be made with examinations such as the Lachman, anterior drawer, Lelli, and pivot shift tests.<sup>8</sup> Additionally, supporting examinations such as MRI are standardized to identify what tissues around the knee joint are damaged apart from the ligaments. Based on research conducted by Zhao et al., 2020 states that MRI has a sensitivity value of 95.45%, specificity of 91.67%, and accuracy of 94.87%.<sup>9</sup>

ACL injuries often occur when the knee is flexed with the joint capsule and ligament relaxed while the femur can rotate against the tibia. This results in pressure from the femur, causing compression of the tibia resulting in pressure that causes serious injury to the ligament. When an individual or patient injures a ligament in the knee, they usually hear a "cracking" or popping sound when the pressure is applied. The clinical manifestations of the ACL depend on how big a tear is created in the ligament, whether it is partial or total. While total or complete ACL tears are sometimes painful, partial ACL tears can create severe and unbearable pain. Aggravation of a partial tear will cause swelling due to retained bleeding inside the joint capsule. In contrast, in a complete tear, the bleeding diffuses through the tear gap in the joint capsule.<sup>2</sup> The increased participation of young athletes in competitive sports has increased the incidence of ACL injuries in the Indonesian population.<sup>10</sup> Of the ACL injuries that occurred, nearly 150,000 injuries underwent surgery or reconstruction.<sup>11</sup>

ACL reconstruction replaces the anterior cruciate ligament with a tissue graft to restore function. This surgery is usually performed with the aid of arthroscopy.<sup>12</sup> Current surgical techniques for reconstruction involve a combination of skin incision, tissue dissection, muscle separation, bone drilling and graft fixation.<sup>13</sup> ACL reconstruction usually takes grafts from the hamstring tendon or patellofemoral tendon.<sup>12</sup> ACL reconstruction is one of the most frequently performed surgical procedures in sports and aims to restore knee stability and avoid further injury to the meniscus and

cartilage.<sup>14</sup> Graft maturation affects patients who have the goal of returning to sport. 100% graft maturation occurs

at 12 to 16 months postoperatively, and return to sport participation in some protocols occurs at six months (if function and isokinetic tests meet the criteria). The graft maturation process starts at implantation and lasts for the next 1 to 2 years. The autograft is strongest at the time of implantation. The implanted graft undergoes a process of functional adaptation (ligamentisation) with gradual biological transformation. Tendon grafts undergo four stages of maturation: necrosis, revascularisation, cell proliferation and collagen maturation.<sup>15</sup>

The patellar tendon intrinsic graft cell necrosis occurs within the first three weeks after implantation. The graft consists of collagen tissue that, until recently, relied on a blood supply. As this blood supply is interrupted, the graft undergoes a process of necrosis. Necrosis starts immediately and generally lasts for two weeks. Bone plugs are inserted into the respective bone tunnels for 12 weeks but are felt to be almost complete around the sixth postoperative week. Tendon-bone healing begins as a fibrovascular interface develops between the bone and tendon. Bone ingrowth occurs in this interface, extending into the outer tendon tissue—re-establishing continuity. Collagen fibres between the bone and tendon occur gradually, and the attachment's strength increases as the collagen fibres' continuity improves. This ACL autograft is approximately 30% to 50% of normal ACL strength 1 to 2 years postoperatively.

There are 5 phases of ACL reconstruction rehabilitation. In phase 1 (0-2 weeks), the primary goals are to increase joint range of motion (prioritising knee extension), activate quadriceps muscle, maintain tissue healing, and control pain and swelling. Phase 2 (2-6 weeks) continues to improve knee joint range of motion and muscle strength and starts walking exercises (full weight bearing) in week four if the patient also has a meniscus injury according to tissue healing. Phase 3 (6-12 weeks) aims to maximise knee joint range of motion and continue lower extremity muscle strengthening exercises. In phase 4 (12-24 weeks), the aim is to achieve single-leg muscle strengthening abilities and to prepare for jogging and agility training at the end of the phase. Phase 5 (12-24 weeks) aims to maintain maximal joint range of motion and muscle strength and continue agility training to return to each individual's sport.<sup>7</sup>

The meniscus is a fibrocartilage cushion attached to the inner and outer sides of the tibial plateau. This meniscus covers 50% of the tibial plateau. The meniscus is a cartilage tissue in the knee joint that functions as a cushion and stabilisation of the knee joint. The meniscus is divided into two: the thigh and shin bones do not rub against each other when there is movement in the knee joint. A Meniscus tear is a tear in the cushion or cartilage tissue in the knee joint caused by traumatic or degenerative causes.<sup>16</sup>

Meniscus injury is one of the most common knee injuries found in orthopaedics which is a condition where there is a tear or rupture of the cartilage that functions as a cushion or pressure reducer in the knee joint.<sup>17</sup> This injury often occurs in sports that involve rotating movements and excessive squat/flexion of the knee joint, such as in

basketball, football or badminton.<sup>18</sup> Meniscus tears are common musculoskeletal injuries across all ages and functional groups, with incidental radiographic pathological changes occurring in asymptomatic populations.

Acute traumatic tears are most common in the athlete population (football, basketball, skiing and baseball). The underlying mechanism of meniscus injury usually involves twisting, cutting, hyperextension, or doing something with great force. Most patients report sharp pain after twisting with the knee flexed and the ankle in a position of resistance or no movement. Meniscus tears can result in a variety of disorders (pain, joint locking, and erosion) and can lead to early degeneration of the knee joint.<sup>19</sup> Meniscus injuries are usually associated with anterior cruciate ligament injuries.<sup>20</sup> There are specialised tests to detect meniscus injuries, such as the Apley grind, McMurray and Thesally tests which provoke pain by applying pressure on the knee.<sup>21</sup>

Accuracy in providing physiotherapy programs will be important in preventing failure in recovery.<sup>22</sup> So, the purpose of writing this article is to provide information reporting regarding appropriate physiotherapy training programs in Phase IV Anterior Cruciate with medial meniscus repair.

### Case report

A 22-year-old university student complained of pain and stiffness in the popliteal area. The pain was felt when driving a car and squatting. The injury occurred when the patient played futsal and made zigzag movements while trying to win the ball. The patient took the wrong foot, namely the body turned while the left leg was left behind, and then suddenly, the knee joint rotated and twisted. Before surgery, the patient had carried out physiotherapy for six meetings. The operation was carried out on 11 May 2022 at the Royal Progress Hospital with three-day hospitalisation. The patient has been doing physiotherapy since the first day after surgery. Currently, the patient has entered week 19 (Phase IV).

### Measurements

Measurements were taken twice, before the intervention on 9 September 2022 (**Table 1**) and after the intervention on 21 September 2022 (**Table 5**). Measurements taken for evaluation include segment circumference, ROM, muscle strength, balance, and knee functionality. Before performing the intervention, vital signs and anthropometry were checked. The results of the patient's vital signs are in the normal category, namely Heart Rate 86x/min, Respiration Rate 15x/min, Blood Pressure 110/70 mmHg, Temperature 36.6 ° centigrade, Oxygen Saturation 95%. The patient's weight is 64 kg, height is 172 cm, with a body mass index of 21,639, indicating the patient's nutritional status is in the normal category.

Initial measurements for essential motion function examination (PFGD) and ROM using a goniometer. This measurement aims to determine the scope of motion of the patient's joints. Patients are asked to move actively, measured, then passively, and isometrically in the upper and lower extremity regions. The actual motion function

examination results show that the patient can perform active knee flexion movements (full ROM) without pain, passive knee flexion without pain, and a soft end feel. The patient can perform full ROM knee extension without pain and brutal end feeling. Specific examinations performed include an Anterior Drawer test with negative results (-) and confirmed with the Lachman test with negative results (-).

Measure segment circumference using a midline to compare the size of the affected side (left) and the healthy side (extra). The measured segment circumference includes mid patella, 5 cm above the patella, 10 cm above the patella, 20 cm above the patella, 10 cm bellows the patella, and 20 cm bellows the patella. The results of the measurement circumference obtained before the intervention were 1.1 cm above the patella and mid-patella. They decreased the difference to 0.7 cm at 10 cm above the patella, mid-patella, and 10 cm bellows the patella.

Muscle strength measurements were made with a sphygmomanometer. The evaluation results were the difference in muscle strength between the healthy and diseased side at the beginning of 20 mmHg in quadriceps, 15 mmHg in the hamstring and ten mmHg in hamstring gastrocnemius muscles to 0 mmHg in quadriceps muscles, 20 mmHg in hamstring muscles and 10 mm Hg in gastrocnemius. The measurement evaluation results for the gastrocnemius, hamstring and quadriceps muscle strength showed increased muscle strength.

Balance was measured by one leg standing on the floor and bosu with eyes open and closed. A comparison of evaluation results after and before intervention showed that the patient's balance was good, but only the closed eyes on bosu were still not good. Knee functional measurements using the KOOS (Knee Injury and Osteoarthritis Outcome Score) and IKDC (International Knee Documentation Committee) questionnaires aimed at assessing the patient's level of independence. The Barthel Index has ten assessment items on which the patient is dependent. There was a functional improvement of the knee, as seen from the increase in the KOOS score from 78.65 to 81.52 and the IKDC score from 66.6 to 79.31.

**Table 1.** Measurements 1

Measurement		Results		
Segmental circumference (mitline)	Positions	Dextra/Rig ht	Sinistra / Left	Difference
	20 cm above the patella	50.5 cm	50 cm	0.5 cm
	10 cm above the patella	41.3 cm	41 cm	0.3 cm
	5 cm above the patella	36.2 cm	37.1 cm	1.1 cm
	Mid-patella	35.2 cm	36.3 cm	1.1 cm
	10 cm below the patella	32.5 cm	32.7 cm	0.2 cm
	20 cm below the patella	31 cm	31.6 cm	0.6 cm
ROM (Goniometer)	Join		Active ROM	Passive ROM
	Right Knee	Flexion (°)	145°	150°



**Figure 1.** Physiotherapy intervention, A. Hip Abduction, B. Single leg squat, C. Lunges, D. Ladder Agility, and E. Box jump.

**Table 5.** Measurement II (Evaluation)

Measurement		Results		
Segmental circumference (supine sleep) (Metline)	Positions	Dextra/Right	Sinistra/Left	Difference
	20 cm above the patella	51.8 cm	51.8 cm	0 cm
	10 cm above the patella	43.8 cm	43.1 cm	0.7 cm
	5 cm above the patella	38.1 cm	38.5 cm	0.4 cm
	Mid-patella	36.7 cm	37.4 cm	0.7 cm
	10 cm below the patella	32.4 cm	33.1 cm	0.7 cm
	20 cm below the patella	33.7 cm	34.1 cm	0.4 cm
	Join		Active ROM	Passive ROM
	Right Knee	Flexion (°)	150°	153°
		Extension (°)	0°	2°
Left Knee	Flexion (°)	145°	150°	
	Extension (°)	0°	5°	
Pain (VAS)	<i>Silent pain (0-10)</i>	<i>Motion pain (0-10)</i>	<i>Tenderness (0-10)</i>	
	0	0	0	
Muscle Strength (Sphygmomano meter)	muscle	dextra	Sinistrs	Difference
	<i>Quadriceps</i>	75 mmHg	75 mmHg	0 mmHg
	<i>Hamstring</i>	140 mmHg	120 mmHg	20 mmHg
	<i>Gastrocne mius</i>	130 mmHg	140 mmHg	10 mmHg
Balance (One leg stance)		Dextra	Sinistra	
	<b>On floor</b>			
	Open eyes	2 minutes 3 seconds	1 minute 45 seconds	
	Close eyes	56 seconds	44 seconds	
	<b>On Bosu</b>			
	Open eyes	1 minute 3 seconds	1 minute 3 seconds	
Close eyes	7 seconds	5 seconds		
<i>Functional Knee</i>		Score 81.52 (there is an increase in score)	Score 79.31 (there is an increase in score)	

		Extension (°)	0°	0°
Left Knee		Flexion (°)	140°	145°
		Extension (°)	0°	0°
Pain (VAS)	<i>Silent pain (0-10)</i>	<i>Motion pain (0-10)</i>	<i>Tenderness (0-10)</i>	
	0	0	0	
Muscle Strength (Sphygmomano meter)	muscle	dextra	Sinistrs	Difference
	<i>Quadriceps</i>	80 mmHg	60 mmHg	20 mmHg
	<i>Hamstring</i>	95 mmHg	110 mmHg	15 mmHg
	<i>Gastrocnemius</i>	130 mmHg	120 mmHg	10 mmHg
Balance (One leg stance)		Dextra	Sinistra	
	<b>On floor</b>			
	Open eyes	2 minutes	1min 30sec	
	Close eyes	44 seconds	34 seconds	
	<b>On Bosu</b>			
	Open eyes	1 minute 9 seconds	47 seconds	
Close eyes	2 seconds	2 seconds		
<i>Functional Knee</i>		Score 78.65	Score 66.6	

## Intervention

Physiotherapy management in this case aims to maintain and improve lower limb muscle strength, prepare for progressive activities such as jogging, maintain and improve core muscles, maintain and improve endurance and VO2Max, restore agility, train brain coordination, and prepare patients to return to futsal sports. Interventions carried out on patients are in accordance with the protocol used at the Royal Sports Medicine Center Jakarta and added with several interventions based on published journals. The intervention was carried out for 4 meetings and the evaluation was carried out at the last meeting on 21 September 2022 (Table 2).

Education, in this case, aims to provide psychological support and information on what activities can be carried out to reduce the possibility of rehospitalization. The details of the operation are in Table 2.

The home Program, in this case, aims to speed up the healing process details of the home program are in Table 2.

## Evaluation

Evaluation Evaluation after the intervention showed positive exercise results for four meetings. The results of flexion ROM and balance measurements have improved, but close eyes on bosu still need improvement. The functional knee also improved, as seen from the increase in KOOS score from 78.65 increased to 81.52 and IKDC score from 66.6 increased to 79.31. Details of the improvement are shown in Table 5.

**Table 2. Interventions**

Intervention I (Friday, 9 September 2022, Week 18)			
Intervention	Method Implementation	Dose	Evidence Based
static Bikes	The patient requested An up stationary bike, Then a pedal bicycle per specified time. Pay attention to the patient's feet moment pedal. No, can there is internal rotation laterally or abduction.	Resistance 3, 10 minutes	Escamilla et al., 2012
Double and Single Calf Raises	The patient requested to climb the box as high as 20 cm while carrying one burden weighing 7.5 kg. The patient requested they stand a half foot on the edge of the box and do heels raise heel drop. The patient does by which command is given. The first patient does double calf raises, then does singles calf raises.	Weight 7.5 kg 3 set 12 reps Singles 3:1 sets of 12 reps	Bucknill, 2020
Step up forward, lateral, Diagonal	The patient requested to climb the box as high as 40 cm with the grasp of two dumbbells weighing 7.5 kg. The patient up box separately forward, lateral, And diagonal with feet flat straight, knees parallel forward, view straight forward, and the body is not bowed. Forward start begins with feet behind the box, lateral start begins with feet next to the box, and the tart diagonal begins with feet beside behind box.	Weight 7.5 kg 3 set 12 reps	Akbari et al., 2016
Romanians Deadlifts (RDL) Butterfly	Patient with position beginning stand. Then instruct patient To lift One limb with knee bend, then the patient requested To swing One limb the to direction behind until the knee was straight. This movement varied with existing horizontal abduction from both shoulders with burden moment One that limb lifted Already straightened out to back.	3:1 sets of 12 reps	Morencos et al., 2022
Medicine Ball Series	The patient requested a squat position ( standing with second feet shoulder-width apart, flexed knee and hip flexion with butt back off back and trunk straight without kyphosis lumbar ), then second-hand patient hold medicine ball weighing 3 kg. The patient was instructed for up and down squats in place or in a static manner.	Ball Weight 3kg 2 set 10 reps	Buckthorpe, Tamisari and villas, 2020
Squats	The patient requested a position stand with feet shoulder-width apart. Knees flexed and hip flexion with butt back off backwards and straight trunk without kyphosis lumbar. Then the second-hand patient is in front of the chest. The patient was instructed to walk with position squats forward And laterally ( sideways ).	Weight 7.5 kg backwards	Buckthorpe, Tamisari and villas, 2020
Single Legs Bridging	The patient requested For soup above the mattress. Then one leg flexes hip and knee flexion by 90° and the feet another hip extension, knee And ankles dorsiflexion. Then dumbbells 7.5 kg are placed on the stomach, and the patient holds the load. No fall. The patient requested a pelvis lift, with no may tilt or Still. A little hip and leg flexion extension must be lifted parallel with the knee flexion.	Weight 7.5 kg 3:1 sets of 10 reps	Tobey et al., 2017
stretching Lower Extremities	The patient Sleep supine in condition relax. The therapist does stretching on the region of the lower extremity patient, Which activates muscle - large muscles, like the gluteus, quadriceps, hamstrings, vastus medial And lateral, And gastrocnemius.	2 sets of 8 holds	Jean, et al., 2022

Intervention II (Thursday, 15 September 2022 , Sunday 18th)			
Intervention	Method Implementation	Dose	Evidence Based
static Bikes	The patient requested An up stationary bike, Then a pedal bicycle per specified time. _ Pay attention to the patient's feet moment pedal. No, can there is internal rotation laterally or abduction	Resistances 3, 10 minute	Escamilla et al., 2012
Diagonal step up	The patient requested to climb the box as high as 40 cm with grasp two dumbbells weighing 7.5 kg. The patient up box in a manner diagonal with feet flat straight, knees parallel forward, view straight forward, and body with No bow. Start started with feet is at beside behind box..	Weight 7.5 kg 3:1 sets of 12 reps	Akbari et al., 2016
static lunges	The patient is instructed For brought wrong One limbs to behind with pedestal fingers foot so that palm pointing feet to back , Then instruct patient For lower her body with still maintain posture upright . Correct movement patient when posture body towards the front.	Weight 7.5 kg 3 set 12 reps	Escamilla et al., 2012
Single leg bridging	he patient requested soup above the mattress. Then one leg flexes hip and knee flexion by 90° and another hip extension, knee And ankles dorsiflexion. Then dumbbells 7.5 kg are	Weight 7.5 kg 3:1 set, 12 reps	Tobey et al., 2017

Single leg squats with box (sit to stands)	placed on the stomach, and the patient holds the load. No fall. The patient requested To lift the pelvis. No one can make it crooked or Still. There is Slight hip flexion, and the extended leg should be lifted in line with the flexed knee. The patient requested to sit on the edge of the high box 80cm with body position strapping, second-hand cross in front of the chest. Wrong foot bend >90° and the other leg straight, view forward. The patient requested To sit down to stand with straight legs and No touch surface floor. On moment stand patient too requested For strapping, No tilt to One which side bump, the knee must be neutral No can There is movement translation toward medial nor laterally. Movement done repeated by order Which given.	2:1 set, 12 reps	Buckthorpe, Tamisari and villas, 2020
sumo squats	The patient requested To do a position that stood with the second foot leading to the outside and opened wider from the shoulder, flexed knees and hip flexion with butt back off backwards and straight trunk without kyphosis lumbar. Then the second-hand patient is in front of the chest.	3 set, 12 reps	Buckthorpe, Tamisari and villas, 2020
Romanians deadlift (single legs)	Patient position beginning stand. Then, the patient was instructed to lift One limb with a knee bend, and then the patient requested To swing One limb in the direction behind until the knee was straight. This movement varied with existing horizontal abduction from both shoulders with burden moment One that limb lifted Already straightened out to back.	Weight 2.5 kg 3:1 set, 10 reps	Morencos et al., 2022
nordic hamstrings	The patient is in position, beginning to kneel on the mat with the body upright. The physiotherapist detained both legs patient, and the patient was instructed To cross their second hand on the chest and start to drop her body in the direction front with slowly until it reaches 45 degrees.	3 sets 10 seconds	Bregenhof et al., 2018
Reverse nordic hamstrings	The patient is beginning to kneel on the mat with their body upright. The physiotherapist detained both legs patient, and the patient was instructed To cross the second hand on the chest and drop her body direction behind slowly until it reached 45 degrees.	3 sets 10 seconds	Bregenhof et al., 2018
Squats on boss	Patient in position beginning standing above bosu ( side average) and instructed To do movement squats ( flex knee and flex hip ) with maintain posture body so no hyperlordosis and bring butt to back. Every move set is done with a count second	3 sets, 30 seconds	Buckthorpe, Tamisari and villas, 2020
leg press	The patient requested to sit on the tool's second leg and press the hand beside hold on on the backup hand. The patient's feet pushed the tool until full knee extension. The patient requested To lower the excellent leg ( right ) and plant it on the ground floor. Meanwhile, the leg that hurts (left) bends the knee and pushes the tool in a manner repeated. Feet at the moment push No can until full extension, only need	Weight 61 kgs (double) & 52 kg (single) 3 set, 10 reps	Bucknill, 2020
leg curls	The patient's Sleep stomach adapts to tool leg curls. Instruct patient To lift burden leg curl tool with bend knee.	Weight 23 kgs (double) & 14 kg (single) 3 set, 10 reps	fleck and Kraemer, 2014

### Intervention III (Monday, 19 September 2022 , Sunday 19th)

Intervention	Implementation Method	Dose	Evidence Based
Double and Single Calf Raises	The patient requested For alert box as high as 20 cm while bringing one burden as heavy as 7,5 kg. The patient requested to stand a half foot in the edge box And do heels raise and heels drop. The patient does this by the order given. The first patient does a double calf raise, then a single calf raise.	Weight 7.5 kg 3 sets of 12 reps Singles 3:2 set 12 reps	Bucknill, 2020
Body Weight Trainers Diagonal Step up	The patient requested For up body weight tool trainers, then walked with by step right. A patient asked to patient asked for climb the box as high as 40 cm, grasping two dumbbells weighing 7.5 kg. the patient up box diagonally with feet flat straight, knees parallel forward, view straight forward, and the body is not bowed. for a diagonal start, start with feet beside the back of the box.	BB: 64 kg Levels 5, 10 minute Weight 7.5 kg 3:2 set 12 reps	Escamilla al., 2012 Akbari et al., 2016
Static Lunges	Patients are asked to stand with one leg forward while legs others back off to the back, and both hands grasp the burden weighing 2.5 kg. Both legs are given a vast distance with	Weights 2.5 kg 3:2 sets of 12 reps	Escamilla et al., 2012

	notice of straight ankle position aligned. The patient was instructed To bend his knees down or bring burden her body down, Then return to a neutral position. Movement done repeated by given dose		
Progressive Single Leg Squat with box/single sit to stand	The patient requested to sit on the edge of the box with a height of 80cm, upright body position, and second-hand cross in front of the chest. One leg bends > 90° and the other straight, view forward. The patient requested to sit down to stand with straight legs and No touch surface floor. At the moment stand patient is also requested. The knee must be neutral for strapping, not tilted to One the supporting side. No, I can. There is movement translation in a medial or lateral direction. The movement is repeated according to the command given.	2:1 sets of 12 reps	Buckthorpe , Tamisari and Villas, 2020
Romanian Deadlift (RDL) Butterfly	Patient position beginning stand. Then instructed, the patient To lift One limb with a knee bend, and then the patient requested To swing One limb in the direction behind until the knee was straight. This movement varied with horizontal abduction from both shoulders with burden moment One raised leg _ Already straightened out to back.	Weight 2.5 kg 3:1 sets of 10 reps	Morencos et al., 2022
Pulleys 2 Ways	The patient was instructed For a pair of pulley straps on the ankle, and then the patient requested For attractive rope associated with a load of 23 kg individually many times. When pulling the burden body patient should have straight legs straight and not bend, and one hand leaning on a pole—the attractive patient rope toward abduction and adduction.	Weight 23 kg 3 sets of 12 reps	Werstine and Manip Ther, 2009)
Single Leg Presses	The patient requested to sit back on the second leg, press the hand beside, and hold on to the backrest patient's hands and feet to push the tool to full knee extension. The patient requested To lower the healthy leg ( right ) and step on the surface floor. Meanwhile, the leg that hurts ( left ) bends the knee and pushes the tool in a manner repeated. Feet at the moment push No can until full extension. You only need semi-flexion.	Weight 52-61 kg 3 sets of 10 reps	Bucknill, 2020
Single Leg Curls	The patient's Sleep stomach adapts to the leg curl tool. Instruct patient To lift burden leg curl tool with bend knee.	Weight 14 kg 3 sets of 12 reps	Fleck and Kraemer, 2014
Double Jump on Minibox	The patient was instructed to squat and jump above the box as high as 20 cm, with the position end. Still, in the last squat state, stand with strapping. When jumping, knee No can toward the outside or exists tibial translation, body moment starting and landing position must be straight and not There is too much burden anchor to One side.	2 sets of 10 reps *Appropriate tolerance patient	Buckthorpe, Tamisari and Villa, 2020
Treadmills	The patient requested For up treadmill, then in a manner progressive walk Relax until jogging is appropriate that time is given.	Kph: 7 10 minutes	Buckthorpe, Tamisari and Villa, 2020

### Intervention IV (Wednesday, 21 September 2022, Week 19)

Intervention	Implementation Method	Dose	Evidence Based
Treadmills	The patient is asked to get on the treadmill and then progressively stroll until jogging in the allotted time.	Minute I : 3 kph II: 5 kph III: 7 kph 8 minutes	Buckthorpe, Tamisari and Villa, 2020
Double and Single Calf Raises	The patient is asked to climb a 20 cm high box while carrying one weight weighing 7.5 kg. Then the patient is asked to stand half a foot on the edge of the box and perform heel-lifting and heel-lowering movements. The patient performs according to the instructions given. First, the patient performs a double calf raises. Then the next performs a single calf raise.	Weight 7.5 kg 3 sets of 12 reps Single 3:2 sets of 12 reps	Bucknill, 2020
Diagonal Step Up	The patient is asked to climb a 40 cm high box by holding two dumbbells weighing 7.5 kg. Then the patient climbs the box diagonally with flat feet, straight knees parallel to the front, straight forward gaze, and the body does not bend. For a diagonal start, start with the foot next to the back of the box.	Weight 7.5 kg 3:2 sets of 12 reps	Akbari et al ., 2016
Static Lunges	The patient is asked to stand with one foot forward while the other foot goes backwards, and both hands hold a 2.5 kg weight. The feet are spaced wide apart, with the ankles aligned straight. The patient is instructed to bend their knees or lower the weight downwards and then return to a neutral position. The movement is repeated according to the dose given.	Weights 2.5 kg 3:2 sets of 12 reps	Escamilla et al., 2012
Single Leg Bridging	The patient is asked to lie on the mat, then one leg hip flexion and knee flexion 90 ° and the other leg hip extension, knee and ankle dorsiflexion. Then 7.5 kg dumbbells are placed on	Weight 7.5 kg 3:1 sets of 10 reps	Tobey et al ., 2017

Progressive Single Leg Squat with box/single sit to	the abdomen, and the patient holds the weight so as not to fall. The patient is asked to lift the pelvis, it should not be tilted, or there should still be a slight hip flexion, and the extended leg should be lifted parallel to the bent knee. The patient is asked to sit on the edge of a box with a height of 80cm and an upright body position, and both hands are crossed in front of the chest. One leg is bent >90° and the other is straight. Gaze forward. The patient is asked to sit up to stand with straight legs that should not touch the floor surface. When standing, the patient is also asked to be upright, not tilting to one side of the support. The knee must be neutral. There should be no translation of movement in the medial or lateral direction. The movement is performed repeatedly according to the instructions given.	2:1 sets of 12 reps	Buckthorpe, Tamisari and Villa, 2020
Pulleys 2 Ways	The patient is instructed to attach a pulley rope to the ankle. Then the patient is asked to pull the rope associated with a 23 kg weight individually many times. When pulling the weight, the patient's body is upright, the legs are straight and do not bend, and one hand rests on the pole. The patient pulls the rope in the direction of abduction and adduction.	Weight 23kg 3 sets of 12 reps	Werstine and Manip Ther, 2009)
Double and Single Leg Presses	The patient is asked to sit leaning on the second leg, press the hand at the side holding on to the armrest, and the patient's foot pushes the device to full knee extension. Double: the patient is asked to bend and push the weight. Single: the patient is asked to lower the healthy leg (right) and step on the floor surface. Meanwhile, the affected leg (left) bends the knee and repetitively pushes the device. The leg at the time of pushing should not be in full extension. Only spring flexion is required.	Weight 52-61 kg 3 sets of 12 reps  Doubles: Set I: Weight 70 kg 1 set of 12 reps Set II: Weight 79kg 1 set of 12 reps	Bucknill, 2020
Single Leg Curls	The patient sleeps on their stomach, adapting to the leg curl device. Instruct the patient to lift the weight of the leg curl device by bending the knees.	Weight 14 kg 3 sets of 10 reps	Fleck and Kraemer, 2014
Agility Ladder	Set up the agility ladder, instruct The patient is to pass each ladder separately quickly. Vary the form of passing each ladder sideways for lateral agility ladders and or diagonally for diagonal agility ladders. Ensure that each patient's steps are correct and that no one passes more than one stair. Movements include forward, cross, single run, and side-to-side.	Each movement 3 sets, accordingly with ability patient .	Buckthorpe, Tamisari and Villa, 2020

#### EDUCATION AND HOME PROGRAMME

Education	Provide psychological support and education related to targets for the current phase. The patient is not allowed to do activities such as playing futsal and running first. The patient is asked to do the exercises at home. As often as possible to help accelerate better progress and be able to enter the return to sports phase.	Ucar, Mehmet et al. 2014. Evaluation of Open and Closed Kinetic Chain Exercises in Rehabilitation Following Anterior Cruciate Ligament Reconstruction. Turkey: J. Phys. Ther. Sci
Home programme	Patients are instructed to continue doing the exercises given at home according to the exercises given by the therapist, such as diagonal step-ups, single leg bridging, jogging, and calf raises. Apply ice packs to relax the muscles after exercise or if there is pain.	Ucar, Mehmet et al. 2014. Evaluation of Open and Closed Kinetic Chain Exercises in Rehabilitation Following Anterior Cruciate Ligament Reconstruction. Turkey: J. Phys. Ther. Sci

#### Discussion

In phase 4 (12-24 weeks), the goals were to avoid femoral patella pain, achieve single-leg muscle strengthening ability, achieve adequate ROM and strength to start jogging and plyometric exercises and prepare for jogging and agility training at the end of the phase. After providing the intervention four times, the evaluation results obtained were the different values of muscle strength between the healthy and diseased sides, initially 20 mmHg in the quadriceps, 15 mmHg in the hamstring and ten mmHg in the gastrocnemius muscle to 0 mmHg in the quadriceps muscle, 20 mmHg in the

hamstring muscle and ten mmHg in the gastrocnemius which was included in the excellent category. The results of the evaluation of segment circumference measurements were initially a difference of 0 cm at 20 cm above the patella, 0.7 cm at 10 cm above the patella, and 0.4 cm at 5cm above the patella. The difference of 0.7 cm at the middle patella, 0.7 cm at 10 cm below the patella, and 0.4 cm at 20 cm below the patella became a difference of 0 cm at 20 cm above the patella, 0.7 cm at 10 cm above the patella, and 0.4 at 5 cm above the patella. Difference of 0.4 at the middle patella, 0.7 at 10 cm below the patella, and 0.4 cm at 20 cm below the patella, which is included in the excellent category. These



measurements show positive exercise evaluation results for three meetings. The results of measuring ROM flexion and balance have improved, but close eyes on bosu still need improvement. The functional knee also improved, as seen from the increase in the KOOS score from 78.65 increased to 81.52 and IKDC score from 66.6 increased to 79.3. The improvement in muscle strength, balance and knee functional ability occurred because the patient had done the recommended exercises for ACL phase IV, according to the protocol, including static bike, double and single calf raise, step up, Romanian deadlift, medicine ball series, squats, single leg bridging, lower extremity stretching, static lunges, sumo squats, nordic hamstring, reverse nordic hamstring, leg press, leg curl, bodyweight trainer, treadmill, pulley exercise, agility ladder.

### Conclusion

Through the exercise program provided, there is an increase in the measurement of left knee flexion ROM, balance, and knee functionality. Knee functional improvement is seen from the increase in KOOS score from 78.65 to 81.52 and IKDC score from 66.6 to 79.31 after four interventions. Hopefully, this case can be used as a reference for providing exercise interventions in patients with ACL postoperative conditions, especially phase IV. Further research with a larger group of patients and with a long-term evaluation is needed to evaluate the safety and efficiency of the exercise program in this case.

### Conflict of interest

This research has no conflict of interest.

### Acknowledgment

The patient had permitted the authors to publish her case in a scholarly journal without disclosing any personal information for scholarly purposes

### Author's contribution

I NPSN conducted the research, was responsible for the research plan, compiled the findings of the draft manuscript and literature review. Data for this research was collected with the help of PRKV, RCH and IKS..

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