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Physiotherapy rehabilitation management on phase III of post-operative anterior cruciate ligament reconstruction with partial lateral meniscectomy: a case report

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ABSTRACT

Background: ACL reconstruction (ACLR) is a surgical procedure to graft the ACL using tendon tissue to restore joint fixation and stabilization functions. Rehabilitation management is performed by physiotherapy in ACLR phase III patients to increase strength, balance, and functional motion control of patients with rehabilitation and exercise adaptation interventions.

Case Description: On June 09, 2022, the patient was playing basketball, when the patient heard his leg "pop" due to sudden stopping and turning movements while playing basketball. The patient took the initiative to go to the hospital because his leg was painful and was advised to do an MRI, the results of the MRI examination stated that the patient had an ACL and Meniscus rupture. The patient has undergone ACL reconstruction surgery and partial lateral meniscectomy on July 20, 2022, the patient has been doing physiotherapy since the first postoperative day until now entering the 10th week, the patient still feels something is stuck in the knee, and feels that left leg is stiff and weak when moved.

Conclusion: There is an increase in ROM measurement results, muscle strength, segment circumference, hamstring and trunk flexibility, functional knee, and decreased pain scale. It is hoped that this case can be used as a reference for providing exercise interventions in patients with ACL postoperative conditions, especially phase III with other comorbidities.

Keywords: ACLR, Meniscus Tear, Phase III, Rehabilitation, Sports Injury.

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Introduction

The incidence of lower extremity injuries during sports activities reaches 40-60% worldwide and 16% of them cause injuries to the ACL ligament, where the ACL ligament is stretched to rupture, ACL injuries can occur due to trauma mechanisms, where the knee position is rotational, and hyperextension or due to sudden contraction of the quadricep femoris muscle.[1] Injuries to the ACL and meniscus tears can lead to an impaired range of motion that can interfere with daily activities.[2]

ACL reconstruction (ACLR) is a surgical procedure to graft the ACL using tendon tissue to restore joint fixation and stabilization functions. Tendons taken for ACL grafts come from the hamstring, quadriceps, patellar tendons, or other lower extremity muscle tendons that are considered strong and long, In conditions of meniscus tears, meniscectomy can be performed. Partial meniscectomy involves removing the torn portion of the meniscus and is usually done for tears that have a very low chance of healing after repair. This procedure will remove a piece of the torn meniscus so that the knee can function normally again.[3]

Rehabilitation management performed by physiotherapy in ACLR phase III patients to improve strength, balance, and functional motion control of patients with rehabilitation and exercise adaptation interventions. This management aims to prevent injury, restore optimal function, and contribute to improving the sports performance of athletes or players of all ages and abilities by ensuring high professional standards.

The knee joint is one of the largest joints in the human body, the movements in this joint consist of flexion, extension, lateral rotation, and medial rotation.[4] The bones that make up the knee joint are the femur, tibia, fibula, and patella. In addition, the knee is also composed of meniscus,

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ligaments, and muscles. So that it forms a unit called the knee joint. In the tibiofemoral joint, there is an anterior cruciate ligament (ACL) for stabilization of the tibia against anterior forces, posterior cruciate ligament (PCL) for stabilization against posterior forces, medial collateral ligament (MCL) for stabilization against valgus forces and lateral collateral ligament (LCL) as stabilization against varus forces.[5] The muscles that assist the movement of the knee joint are the active movement of the knee, namely the quadriceps and hamstrings muscle groups, there is also a role for the sartorius and popliteal muscles in knee joint movement.[4]

The ACL is one of the knee ligaments, which runs from the anterior intercondyloid fossa of the os.tibia the superior, posterior, to the lateral on the medial condyles of the femur. The ACL acts as a passive stabilizer that preserves and prevents the tibia from sliding anteriorly, and resists tibia exorotation during knee flexion, and knee hyperextension.[6] The ACL is the main stabilizer of the knee joint, contributing about 85% of knee stabilization. The ACL gets its blood supply from the genicular artery, which has two bundles namely, the anteromedial and posterolateral ACL has 2 bundles namely, the anteromedial bundle (AM) and the posterolateral bundle (PL), which are named after where they are attached to the tibia. The anteromedial (AM) bundle tightens during flexion, the posterolateral bundle tightens during extension. When the extension movement, both bundles will align, the knee joint movement. when flexion of the posterolateral bundle moves anteriorly, the two bundles cross, the anteromedial bundle tightens and the posterolateral bundle relaxes so that when the knee extension is performed Lachmans Test, the provoked is the posterolateral bundle. When the knee is flexed, resistance to anterior translation of the tibia, the anterior drawer test, is performed by the medial anterior bundle.[7]

The majority of ACL injuries occur through non-contact mechanisms such as kneeing, rotations, incomplete landings, zigzag movements, and sudden changes in direction such as in soccer, basketball, and futsal movements. As sporting activity increases, 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 following injury; which may result in limitations in daily activities and loss of productivity.[8]

Risk factors for ACL injury can include several influencing factors, namely internal factors and external factors. Internal factors of ACL injury can occur due to age, strength, gender, neuromuscular control, fatigue, and, skill. When viewed from external factors, ACL injuries can occur due to inadequate sports equipment, position during play, type of sport, and field conditions.

The mechanism of ACL injury can be divided into 2, namely direct and indirect contact. Direct contact ACL injury occurs with a trauma mechanism such as a blow or blow directly on the lateral part of the knee, this is caused by sudden deceleration or sudden change in knee direction. It may occur due to hyperextension, or impact where compression in the varus or valgus direction occurs in the form of translational movement. As for indirect ACL injury mechanisms, these non-contact mechanisms account for 60%-70% of all ACL injuries, with indirect contact injuries typically occurring in sports that involve zigzagging, changes in direction of motion, and sudden changes in speed (acceleration). In particular, moments of rapid deceleration, including engaging the injured leg's proprioceptive to cut and change direction rapidly can lead to ACL injury.[9]

When a person sustains an injury to a ligament in the knee, specifically the ACL. Usually, the patient will hear a "pop" or popping sound when the injury occurs. The clinical manifestations depend on the severity of the injury. The clinical manifestations of the ACL depend on how big a tear is created in the ligament, be it partial or total. In a complete or total ACL tear, there is sometimes no pain, whereas a partial ACL tear can create severe pain that is unbearable.[10]

Anterior cruciate ligament rupture can be classified into 3 degrees, the first degree is that the ligament fibers are stretched but no tear is found, and there is mild pain. Does not increase weakness and there is an end feel. The second degree is that the ligament fibers are partially torn or completely torn with bleeding. There is a loss of function, the joint feels unstable during activity. The third degree is that the ligament fibers are completely torn (ruptured). There is tenderness, there may be slight swelling, signs of inflammation, and knee instability.[11]

Diagnosis of ACL injury can be done through supporting examination (MRI) and physical examination (anterior drawer test, lachman test, pivot shift test, and lelli test). There are two options for the proper management of ACL injuries, namely conservative management (non-operative) and reconstructive surgery (operative). Non-operative management is recommended for patients with good knee stability when performing daily activities or sports activities (no functional limitations), while reconstructive surgery is recommended for patients with unstable knee conditions or those with total rupture.[10] In medical management of ACL tear cases, ACL reconstruction will be performed, which is a surgical procedure to graft the ACL using tendon tissue to restore joint fixation and stabilization functions. ACL reconstruction usually takes grafts from the hamstring, quadriceps, and patellar tendons. In ACL reconstruction, graft selection is considered based on bone surface integration and risk of failure.

ACLR should be performed immediately, considering the occurrence of the meniscus and chondral injuries if ACL reconstruction is delayed. In addition, it can lead to the risk of arthrofibrosis associated with early ACL reconstruction, and loss of muscle strength because the muscles around the injured area are not active in sports activities due to delayed reconstruction surgery. The impact that arises after ACL reconstruction will usually cause problems such as postoperative stiffness (decreased ROM), pain, swelling, and decreased muscle strength (muscle atrophy). As a result of these problems, postoperative rehabilitation requires a long period time to return to normal activities, usually it will take about 6 months.[13]

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After surgery, there will be a grafting healing process, where the process is divided into 3 phases: early phase, proliferation phase, and maturation phase. The early healing phase starting from the day of surgery until 4 weeks, this phase is characterized by graft necrosis and hypocellularity without significant changes and graft cell death, and no blood vessels invading the graft tissue, the initial cellular response after surgical implantation of the tendon graft involves the accumulation of host inflammatory cells. After graft implantation, neutrophils and macrophages are recruited to the peripheral area of the implanted graft and, various cytokines such as interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-a), and transforming growth factor-beta (TGF-b) are released. Each of these growth factors has its role in the inflammatory process. For example, Platelet-Derived Growth Factor and Transforming Growth Factor-B act to attract immune system cells around the injury site to stimulate proliferation; Vascular Endothelial Growth Factor acts to stimulate the formation of new blood vessels around the injury site; Fibroblast Growth Factor acts to support new cell growth, especially collagen and cartilage growth. Immune cells such as neutrophils, monocytes, and other immune cells that have been stimulated by the presence of growth factors that migrate to the injury site will eat and remove debris and dead cells. Within the first 3 weeks after implantation, necrosis of the patellar tendon intrinsic graft cells occurs. 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 2 weeks. The original cells of the patellar tendon (graft) are reduced, and replacement cells may appear in the first week. Cellular repopulation occurs before revascularization. These cells are thought to arise from extrinsic sources (i.e. synovial cells, mesenchymal stem cells, bone marrow, blood, ACL stump) and intrinsic sources (i.e. surviving graft cells). Graft necrosis allows the metamorphosis of the graft from a tendon to a ligamentous process. Graft necrosis is characterized by granulation tissue formation and inflammation. Bone blood supply and synovial fluid nourish the graft by synovial diffusion.[14]

Furthermore, the proliferation phase starts at week 4 to week 12, this phase is characterized by immune cells releasing various growth factors and cytokines. This release stimulates fibroblast proliferation to reshape the injured ligament. The tissue that forms from this process appears as disorganized tissue. It contains more blood vessels, fat cells, fibroblasts, and inflammatory cells compared to normal ligament tissue. Over the next few weeks, fibroblast cells form different types of collagen, proteoglycans, glycoproteins, and other proteins in the matrix. Revascularization occurs in the first 6 to 8 weeks after implantation. At this time the graft is revascularized through the fat pad, synovium, and endosteum, and the inflammatory response should be under control.[14]

The healing process continues into the maturation phase which is characterized by the tightening of the preformed collagen fibers and increased maturation of the collagen matrix that continues for several months to years.[15] The ACL autograft is approximately 30% to 50% of normal ACL strength 1 to 2 years postoperatively. Cell proliferation and collagen formation take place as a continuous process throughout the maturation process.[14]

In addition to the ACL, the meniscus is also susceptible to damage and injury, which can generally be categorized as occurring during sports activities (soccer, basketball, badminton, rugby), non-sports activities (squats), or non-activity.[16] Meniscus injuries can result from activities that involve twisting, cutting movements, excessive application of force or motion to the knee joint (hyperextension/hyperflexion), impact with great force, and activities that require rapid acceleration and deceleration.[17] Meniscus injuries are usually associated with anterior cruciate ligament injuries.[18] There are some specific examinations to detect meniscus injuries namely the McMurray test, Apley's compression test, and Thesally which provoke pain by applying pressure on the knee.[19]

There are 5 phases of ACL reconstruction rehabilitation where in the first phase (0-2 weeks) the main goal is to increase joint range of motion (prioritizing knee extension), quadriceps muscle activation, maintain tissue healing, and control pain and swelling.[20] Phase 2 (2-6 weeks) continues to improve knee joint range of motion and muscle strength and starts walking exercises (full weight bearing).[21] Phase 3 (6-12 weeks) has the goal of maximizing knee joint range of motion and continuing lower extremity muscle strengthening exercises. In phase 4 (12-24 weeks), the goal is to achieve single-leg muscle strengthening, balance, and preparation for jogging and agility training at the end of the phase.[22] Phase 5 (6-12 months) aims to maintain maximum joint range of motion, muscle strength, and continue agility training to return to each individual's sport.[23]

Case report

A private employee who joined a basketball club had pain and instability in the left knee. On June 09, 2022, the patient played basketball, then the patient heard his leg make a "pop" sound due to sudden stopping and turning movements while playing basketball. The patient took the initiative to go to the hospital because his leg was painful and was advised to do an MRI, the results of the MRI examination stated that the patient had an ACL and Meniscus rupture. The patient has undergone ACL reconstruction surgery and partial lateral meniscectomy on July 20, 2022, the patient has been doing physiotherapy since the first postoperative day until now entering week 10, the patient still feels something is stuck in the knee, and feels his left leg is stiff and weak when moved.

Measurements

A vital signs examination was carried out before the intervention was given on September 28, 2022, to determine the patient's condition. The results of the patient's vital signs are in the normal category, namely Heart Rate 65x/min, Respiration Rate 20x/min, Blood Pressure 132/77 mmHg,

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Temperature 36.5oC, and Oxygen Saturation 98%. The patient's weight is 102 kg, height is 170 cm, with a body mass index of 35.29 which indicates the patient's nutritional status is in the obese category.

Initial measurements for basic motion function examination (PFGD) and ROM using a goniometer, this measurement aims to determine the patient's joint range of motion. the patient is asked to move actively first and then measured, then done passively and actively in the lower extremity region. Through the results of the basic motion function examination, it is known that the AROM of flexion of the knee dextra is 120 °, AROM Flexi knee sinistra 110 °, PROM flexion of the knee dextra 120 ° with soft end feel, and PROM flexion knee sinistra 120 °. The patient can perform full ROM knee extension without pain and hard end feel. The specific examination performed was the anterior drawer test with negative results (-) and confirmed with the Lachman test with negative results (-).

Measurement of segment circumference using a midline to compare the size of the affected side (sinistra) and the healthy side (dextra). The measured segment circumference includes mid the patella, 5 cm above patella, 10 cm above the patella, 20 cm above the patella, 10 cm bellows patella, and 20 cm bellows patella (table 1).

In measuring the pain scale using VAS which aims to determine the degree of pain felt by the patient at this time. VAS has a range of values from 1-10, where the higher the value, the more severe the degree of pain felt. At this time the patient feels motion and tenderness 3 out of 10 (table 1).

In measuring hamstring and trunk flexibility using the Sit and Reach Test which aims to determine the flexibility of the hamstring, and trunk. The Sit and Reach Test has a range of values from < -20 which is very bad to > 27 very good for men, while in women from < - 15 very bad to > 30 very good. In this patient, the result was -9.5 (table 1).

Muscle strength is measured using a sphygmomanometer which aims to determine the strength of the quadriceps, hamstring and gastrocnemius muscles which are assessed from the measurement results when the patient presses the cuff according to the direction of physiotherapy, the results obtained are in the dextra part of the dextra quadriceps muscle strength (50 mmHg) sinistra (35 mmHg), dextra hamstring muscle strength (160 mmHg) sinistra (90 mmHg) and dextra gastrocnemius muscle strength (130 mmHg) sinistra (120 mmHg).

In the functional assessment of the knee using the International Knee Documentation Committee (IKDC) questionnaire with a rate <70 = poor, 70-79 = fair, 80-89 = good, ≥ 90 = excellent, and the Lysholm Knee Scoring System (LKSS) with a rate < 65 = poor, 65-83 = intermediate, 84-90 = good, > 90 = very good. IKDC and LKSS aim to assess the level of functional ability of the patient's knee. The IKDC score was 59.7 and the LKSS score was 71.

Intervention

Physiotherapy management in this case aims to reduce pain and discomfort in the knee, increase ROM, increase strength and muscle mass, and restore the functional ability of the knee so that it can return to basketball. Interventions performed on patients by following per under the protocols 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 October 12, 2022 (Table 3).

Evaluation

Evaluation after intervention showed positive exercise results for 4 meetings, where there was an increase in ROM, muscle strength, anthropometry, hamstring and trunk flexibility, IKDC score, Lysholm score, and decreased pain. Increased flexion ROM on the dextra side there was an increase of 10 ° and sinistra as much as 15 °, quadriceps muscle strength 10 points dextra, and 25 points sinistra, hamstring muscle decreased 20 points dextra and 10 points sinistra increase, anthropometric improvement of 0.3-0.9 cm in each measurement segment, decreased pain 1 point in motion pain when walking, increased hamstring and trunk flexibility 2 cm, increased IKDC score 13.8 points and increased Lysholm score 10 points.

Table 1. Measurement I

Measurement I (Wednesday, September 28th 2022)					
Measurement	Measurement Tools		Results		
Segmental circumference (supine/ supine sleep)	Midline		Dextra	Sinistra	Difference
		20 cm	63,5 cm	62,5 cm	1 cm
		10 cm	52,5 cm	51,9 cm	0,4 cm
		5 cm	47 cm	48,2 cm	1,2 cm
		Mid patella	42,5 cm	43,5 cm	1 cm
		10 cm	42 cm	42 cm	0 cm
		20 cm	38,6 cm	37,6 cm	1 cm
		Interpretation: The largest difference is 1.2 cm above the patella			
ROM	Goniometer	Joint	Active	Passive	Interpretation
		Knee Dextra	S : 0^0-0^0-120^0	S : 0^0-0^0-120^0	There is limited ROM during flexion of the

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		Knee Sinistra	S : 0^0-0^0-110^0	S : 0^0-0^0-120^0	sinistra knee.
Pain	VAS	Before Training: ● Silent Pain: 0 ● Motion Pain: 3 (cross-legged position) ● Pressure Pain: 3 Interpretation: Still feeling mild pain in the left leg			
Muscle Strength	*Sphygmomanometer*		Dextra	Sinistra	Difference
		Quadriceps	50 mmHg	35 mmHg	15 mmHg
		Hamstring	160 mmHg	90 mmHg	70 mmHg
		Gastrocnemius	130 mmHg	120 mmHg	10 mmHg
		Interpretation: The largest difference in hamstring muscle is 70 mmHg			
Hamstring and Trunk Flexibility	*Sit and Reach*	Score (- 9,5 cm) = Poor Interpretation: Has poor hamstring and trunk flexibility.			
Functional Knee	IKDC	Score 59,7 = Poor Interpretation: The functional ability of the patient's knee is still not fully recovered			
	Lysholm	Score 71 = Medium Interpretation: The patient's knee functional ability is good.			

Table 2. Evaluation after interventions

Measurement 2 (Wednesday , October 12th 2022)

Measurement	Measurement Tools		Results		
Segmental circumference (supine/ supine sleep)	Midline		Dextra	Sinistra	Difference
		20 cm	63,5 cm	63,3 cm	0,2 cm
		10 cm	53,4 cm	53,3 cm	0,1 cm
		5 cm	46,8 cm	48 cm	1,2 cm
		Mid patella	42,3 cm	43,3 cm	1 cm
		10 cm	42,1 cm	42,1 cm	0 cm
		20 cm	39 cm	38,9 cm	0.1 cm
		Interpretation: The largest difference is 1.2 cm mid patella True Leg Length Dexstra: 86 cm Sinistra: 83 cm Aperance Length Dexstra: 98 cm Sinistra: 98 cm Interpretation: There is a 3 cm difference in the true leg lenght.			
ROM	Goniometer	Joint	Active	Passive	Interpretation
		Knee Dextra	S : 0^0-0^0-130^0	S : 0^0-0^0-140^0	There is limited ROM during flexion of the sinistra knee.
		Knee Sinistra	S : 0^0-0^0-125^0	S : 0^0-0^0-135^0	
Pain	VAS	Before Training: ● Silent Pain: 0 ● Motion Pain: 2 (cross-legged position) ● Pressure Pain: 2			

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		Interpretation: Still feeling mild pain in the left leg
Muscle Strength	*Sphygmomanometer*	Dextra / Sinistra / Difference *Quadriceps*: 60 mmHg / 60 mmHg / 0 mmHg *Hamstring*: 140 mmHg / 100 mmHg / 40 mmHg *Gastrocnemius*: 130 mmHg / 130 mmHg / 0 mmHg Interpretation: The largest difference in hamstring muscle is 40 mmHg.
Hamstring and Trunk Flexibility	*Sit and Reach*	Score (- 7,5 cm) = regular Interpretation: Has poor hamstring and trunk flexibility but has improved.
Functional Knee	IKDC	Score 73,5 = fair Interpretation: The patient's knee functional ability has improved with slight limitations
	Lysholm	Score 80 = Medium Interpretation: The functional ability of the patient's knee is close to normal

Table 3. Intervention

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No	Intervention	Implementation Method	Goal
1	*Static Bike*	The patient is asked to ride a stationary bike, then pedal the bike according to the specified time. Pay attention to the patient's feet while pedaling, there should be no internal rotation laterally or abduction. Resistance = 3 Time = 10 minutes	Exercising the patient's active knee ROM and warm-up before the main exercise.
	3-way Pulley	The patient is instructed to attach the pulley rope to the ankle, then the patient is asked to pull the rope that has been associated with the load repeatedly. When pulling the weight, the patient's body is upright, legs are straight and do not bend, 1 hand rests on the pole. The patient pulls the rope towards flexion, abduction and adduction. Weight = 18 kg Set = 3	Increase strength and endurance of lower limb abduction, adduction and extension muscles
2		Reps = 10	
	Extension Conic Pulley	The patient is instructed to sleep supine on the mat under the pulley machine, then the patient is asked to flex one leg 90 degrees and the pulley strap is attached to the ankle. Then the patient is instructed to do hip extension with a slight knee extension repeatedly and at the end of the repetition held for several counts. Weight = 14kg Set = 3 Repetition = 10	Increase the muscle mass and strength of the patient's hamstring muscles
3	Double calf raise	The patient is positioned standing on a 20 cm box, and holds something as a support, then raises both toes and then lowers them. Set = 3 Reps = 10	Activates and increases calf muscle strength
4	Single calf raise	The patient is positioned standing on a 20 cm box, and holding something as a support, one leg is lifted up then raise one toe and then lower it. Set = 3:1 Reps = 10	Activates and increases calf muscle strength
5	Squat	The patient is asked to perform a standing position with both feet pointing outward and opened wider than the shoulders, knee flexion and hip flexion with the buttocks backward and straight trunk without lumbar kyphosis. Then the patient's hands are in front of the chest Set = 3 Reps = 6 Hold = 6	Improves lower extremity muscle strength and postural muscles
6	Step-Up	The patient stands upright, carrying a weight ball weighing 6 kg in both hands, the patient is instructed to climb a 40 cm high box from the forward, diagonal and lateral directions, with the affected leg going up the box and the healthy leg going down the box. Weight = 6 kg Set = 3 Reps = 10	Improve patient's coordination, balance and muscle strength

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7	Double Leg Press	The patient is asked to sit leaning on the leg press tool, both hands next to holding on to the armrest, both legs of the patient pushing the tool to full knee extension. Then the patient bends the knee and pushes the tool repeatedly. Legs at the time of pushing should not reach full extension. and back flexion. Weight = 52 kg Set = 3 Reps = 10	Increases lower extremity muscle strength and mass
8	Single leg press	The patient is asked to sit leaning on the leg press tool, both hands on the side holding on to the armrest, both legs of the patient pushing the tool to full knee extension. Then the patient is asked to lower the healthy leg (right) and tread on the floor surface. Meanwhile, the affected leg (left) bends the knee and pushes the tool repeatedly. The leg at the time of pushing should not reach full extension, and return to flexion. Weight = 29.5 kg Set = 3 Reps = 10	Increases lower extremity muscle strength and mass
9	Double leg curl	The patient sleeps prone on the flywheel-leg-curl machine with a knee extension position of 0° and then both knees are moved towards 30°-120° flexion and back to the 30°-0° extension position. Weight = 18 kg Set = 3 Reps = 10	Increase strength and increase endurance of hamstring muscle strength
10	Single leg curl	The patient sleeps prone on the flywheel-leg-curl machine with a knee extension position of 0° and then the reconstructed leg performs a knee flexion movement of 30°-120° and returns to an extension position of 30°-0°. Weight = 5 kg Set = 3 Reps = 10	Increase strength and increase endurance of hamstring muscle strength.
11	Cobra Pose	The patient lies in a prone position, the position of the legs is shoulder-width apart and the palms of the hands are next to the chest, the ankle is in the plantar flexion position and then the hands push up followed by head and spine movements, the patient holds this movement until the specified time. Set = 3 Hold = 6 sec	Improves flexibility and increases spine ROM
12	Dynamic Squat	Patients are asked to stand upright with feet shoulder-width apart, knee and hip flexion with buttocks backward and straight trunk without lumbar kyphosis. Then the patient is instructed to hold a 3 kg ball, and walk in a squat position forward and laterally. Weight = 3 kg Frek = 2 sets Miniband gray (2)	Improve coordination ability, lower extremity muscle strength and postural muscles
13	Romanian Deadlift (RDL) Assisted with Box	The patient stands in an upright position near the box and is instructed to lift one leg with the knee straight, then the patient is asked to swing one leg backwards until the knee is straight with both arms against the box. Set = 2 Reps = 8	Improves hamstring muscle flexibility

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14	Ultrasound	Ultrasound therapy was applied to the antero posterior medial part of the knee to stimulate fingertip repair. The patient slept on the bed with a 90° knee flexion position (sore leg) and then the gel was applied to the area to be treated, the tranducer was moved in the transverse direction. Time = 5 minutes Intensity = 1.5 W/cm2 Frequency = 3Mhz Duty Factor = 100%	Improves tissue around the knee area
15	Stretching	Instruct the patient to sleep on their back then ask the patient to lift the injured leg slowly, then contract the hamstrings muscle until they feel the stretch, 10 seconds each hold.	Improves muscle elasticity
16	Cold Compress	The patient is positioned sleeping on his back on the bed, then the therapist takes a cold pack and places it on the anterior and posterior knee. Cold pack is given a base (tissue) to prevent ice burn. Time = 10 minutes	Reduce and prevent post-workout pain

Tabel 4. Education

Education
- Patients are not yet allowed to do activities such as running, jumping, and basketball. - Patients are asked to do home exercises as often as possible to help accelerate better progress and can enter the return to sport phase.

Table 5. Home Program

Home Program
- Patients are instructed to continue doing the exercises that have been given at home according to the exercises that have been given by the therapist such as a. *Step up diagonal* 3set 12 reps b. *Double calf raises* 3 set 12 reps c. *Single calf raises* 3:1 3 set 10 reps d. *Squat* with tabata timer : work = 10 sec, rest = 5 sec, ciycle : 8 sec, rest between set : 20 sec e. *Cobra pose* 3 times hold 6 -8 sec - Apply ice packs to relax the muscles after exercise or if there is pain.

Discussion

In phase 3 (6-12 weeks), the goals to be achieved are to reduce patient pain, increase lower extremity muscle mass, strength, and endurance, increase hamstring muscle flexibility, increase knee ROM, improve the symmetry between the right and left legs and improve the patient's knee functional abilities.

After providing the intervention 4 times, the evaluation results obtained, namely in basic motion functions, it is known that the AROM of knee flexion dextra 120 ° (pre-intervention) increased to 130 ° (post-intervention), AROM flexion knee sinistra 110 ° (pre-intervention) increased to 125 ° (post-intervention), PROM flexion knee dextra 120 ° (pre-intervention) increased to 140 ° (post-intervention) with soft end feel and PROM flexion knee sinistra 120 ° (pre-intervention) increased to 135 ° (post-intervention). Patients can perform full ROM knee extension without pain and hard end feel. The difference in segment circumference measurements at mid patella dextra and sinistra did not change before and after the intervention, which was 1 cm, 5 cm above the patella had a difference of 1.2 cm in pre- and post-intervention, while at 10 cm above the patella decreased from 0.4 cm (pre-intervention) to 0, 1 (post-intervention), 20 cm above the patella decreased from 1 cm (pre-intervention) to 0.2 cm (post-intervention), 10 cm below the patella had no difference in pre and post-intervention, 20 cm below the patella decreased from 1 cm (pre-intervention) to 0.1 cm (post-intervention). The pain scale obtained a motion pain value of 3 (pre-intervention) decreased to 2 (post-intervention), and tenderness 3 (pre-intervention) decreased to 2 (post-intervention). In measuring hamstring and trunk flexibility using the Sit and Reach Test, the results obtained were -9.5 (pre-intervention) increased to -7.5 (post-intervention). In muscle strength, a value of 50 mmHg was obtained in the strength of the dextra quadriceps (pre-intervention) increasing to 60 mmHg (post-intervention), while in the sinistra from 35 mmHg (pre-

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intervention) increased to 60 mmHg (post-intervention). For hamstring muscle strength in the dextra part from 160 mmHg (pre-intervention) decreased to 140 mmHg (post-intervention), while in the sinistra part from 90 mmHg (pre-intervention) increased to 100 mmHg (post-intervention). For dextra gastrocnemius muscle strength, it was 130 mmHg (pre-intervention) and settled at 130 mmHg (post-intervention), while in the sinistra from 120 mmHg (pre-intervention) increased to 130 mmHg (post-intervention). There was an increase in the results of the IKDC value, which from a value of 59.7 (pre-intervention) increased to 73.5 (post-intervention), and the results of the LKSS value from 71 (pre-intervention) increased to 80 (post-intervention). The increase occurred because the patient performed the recommended exercises for ACL phase III according to the protocol, namely static bike, single and double calf raise, step-up, squat, Romanian deadlift assisted, hip exercise with pulley, leg press, leg curl, and cobra pose.

Conclusion

Through the exercise program provided, it can be concluded that there is an increase in ROM measurement results, muscle strength, segment circumference, hamstring and trunk flexibility, functional knee, and decreased pain scale. It is hoped that this case can be used as a reference for providing exercise interventions in patients with ACL postoperative conditions, especially phase III with other comorbidities. Further research with a larger group of patients and with long-term evaluation is needed to evaluate the safety and efficiency of the exercise program in this case.

Conflict of interest

The author declares no conflict of interest in making this case report.

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Author's contribution

AGDM carried out the study, was in charge of the research plan, and compiled the findings. Drafts of the manuscript and literature study were completed by IMEAP, and NWSW.

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