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PHASE TWO OF SPORTS REHABILITATION PROGRAM FOR POSTOPERATIVE ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION: CASE STUDY

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ABSTRACT

Background of study: ACL injury is a commonly concerning injury in sports. When an athlete suffers an ACL injury, it can prevent them from returning to their sport and even diminish their performance. Physiotherapists must follow a clear and structured rehabilitation program to track the progress of their patients. This study describes the second phase of an exercise rehabilitation program in one patient after ACL reconstruction surgery with a focus on increasing muscle strength and flexibility. **Methods:** This study presents a case report design of a female basketball player who suffered a grade 3 ACL tear. Patients were willing to provide informed consent for their data to be used in a 2-week research study that included 4 physiotherapy sessions. **Result:** After four session physiotherapy programs, the pain level of active knee movement decreased 20 mm also increase the range of motion of knee joint with 100 in flexion. The results of the muscle strength measurements also showed an increase in muscle strength and functional ability score with Knee Injury and Osteoarthritis Outcome Score (KOOS) was increase 30%. **Conclusion:** Implementation of phase two sports injury rehabilitation guidelines for post-ACL reconstruction conditions leads to positive patient outcomes, including reduced pain, increased range of motion, muscle strength, and functional ability

Keywords: Sports; Injury; Rehabilitation; Physiotherapy; ACL

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INTRODUCTION

The Anterior Cruciate Ligament (ACL) is one of the four main ligaments of the knee joint and functions as a stabilizer, preventing excessive forward movement of the tibia bone against the femur bone[1]. ACL injury is a commonly concerning injury in sports[2]. If the anterior cruciate ligament is injured, it causes instability in the knee joint[3]. When an athlete suffers an ACL injury, it can prevent them from returning to their sport and even diminish their performance [4]. ACL injuries can be classified into three grades 1. Grade one is that the ligament is pulled, grade two is that there is a partial tear of the ligament, and grade three is that there is a complete tear. If the ACL in the knee is completely torn, it will cause instability and require surgical repair [5].

Without surgery, the recovery process for an injury to the anterior cruciate ligament (ACL) is typically lengthy. This is due to the fact that the ACL is one of the intra-articular ligaments that has less blood supply, making it harder to heal naturally [6].

Operative management of ACL tear cases is generally carried out by ACL reconstruction 7. In the United States, an estimated 200,000 ACL reconstructions are performed each year 8. ACL reconstruction surgery typically uses tendon tissue to restore joint fixation and stabilization function 9. The tendons commonly used for grafting during ACL reconstruction include those from the hamstring, quadriceps, and patellar tendon. Following the procedure, various issues may arise pertaining to knee movement and function [10].

After surgery, patients may experience pain, swelling, limited joint motion, muscle weakness, movement disorders, reduced balance and endurance, as well as functional knee issues [11]. In the post-operative healing process, physiotherapy is essential to restore knee movement, function, and performance for athletes to return to sports[12]. Competent physiotherapists can provide modalities such as electrotherapy, manual therapy, active and passive exercise therapy and weight training [13].

Physiotherapists must follow a clear and structured rehabilitation program to track the progress of their patients. The program should have distinct phases, starting with pain reduction, followed by flexibility and muscle strength, recovery of muscle strength, endurance, and agility, and finally, the return to exercise. These stages help the physiotherapist and the patient determine the effectiveness of the rehabilitation program and ensure a successful recovery[14]. This study describes the second phase of an exercise rehabilitation program in one patient after ACL reconstruction surgery with a focus on increasing muscle strength and flexibility.

METHODOLOGY

This study presents a case report design of a young female basketball athlete who suffered a grade 3 ACL tear based on Magnetic Resonance Imaging result. Data was collected through patient interviews and hospital medical records, documenting previous illnesses and typical activities. Patients were willing to provide informed consent for their data to be used in a 2-week research study that included 4 physiotherapy sessions from March 16-26, 2021. The research was conducted at a hospital specializing in sports injuries (Hospital X) in the North Jakarta area.

Patient characteristics: The patient is a 15-year-old female basketball athlete. She weighs 48 kg and has a height of 155 cm. The patient is currently studying at a high school. In January 2020, while playing basketball, the patient suffered an injury due to an incorrect landing after jumping. The MRI results showed that the patient had a grade 3 ACL rupture in her right knee. This condition usually requires reconstructive surgery. However, due to the patient's young age and ongoing bone growth, the doctor postponed the surgery until January 2021. After undergoing reconstructive surgery, patients often experience a range of issues, such as pain, decreased muscle strength and range of motion (ROM), and limited ability to carry out daily activities. To address these challenges, the patient in question participated in a physiotherapy program at Hospital X. Within 3 weeks after surgery, the first phase of the physiotherapy program was carried out. Then proceed to the second phase described in this research.

Physiotherapy Examinations: Pain examination uses the Visual Analog Scale (VAS). This scale is used to determine the level of pain that patients experience after ACL reconstruction surgery 15. During the examination, the patient experienced pain when moving their knee. A goniometer was used to perform a Range of Motion (ROM) examination, followed by a muscle strength examination using a sphygmomanometer[16].The phygmomanometer is placed on a particular muscle and its strength can be measured after setting it to a pressure of 20 mmHg. When measuring muscle strength with a sphygmomanometer, muscles are indicated to be weak if the difference is 20 mmHg compared to healthy muscles. A Knee Injury and Osteoarthritis Outcome Score (KOOS) was performed to evaluate the functional ability 17. The KOOS Index is a knee injury outcome score designed to provide relevant outcomes for patients in the short and long term after experiencing a knee injury. The five dimensions of patient-relevant KOOS scoring instructions were evaluated separately.

Pain was assessed using nine items, symptoms with seven items, daily activities with 17 items, sports and recreational function with five items, and quality of life with four items. Each item had a five-point Likert scale response, ranging from zero (no problem) to four (extreme problem), and the scores for each of the five dimensions were calculated by adding up the scores for the included items. The score ranges from 0 to 100 and represents the total score that can be achieved. A lower score indicates decreased functional ability or problems, whereas a higher score indicates better functional ability. The results of pain examination, range of motion (ROM), muscle strength, and functional ability examination are presented in the following table.

Assessment Parameter		**Scale**
Active Knee Movement Pain		**VAS Scale**
	Right Knee Flexion	40 mm
	Right Knee Extension	20 mm
Active Knee Range of Motion		**ROM Degree**
	Right Knee Flexion	0°-135°
	Left Knee Flexion	0°-145°

Knee and Ankle Muscles Strength		Muscle Strength (mmHg)
	Right Quadriceps	74 mmHg
	Left Quadriceps	105 mmHg
	Right Hamstring	105 mmHg
	Left Hamstring	130 mmHg
	Right *Gastrocnemius*	120 mmHg
	Left *Gastrocnemius*	145 mmHg
Functional Ability Score		**KOOS Score (%)**
	KOOS	33 (30%)

Table 1. Assessment Result

Physiotherapy Intervention

The concept of post-surgery intervention for ACL reconstruction is a sports rehabilitation phase tailored to the patient's problems [14]. Based on theory, Kisner et al., (2017) proposed a four-phase rehabilitation program for athletes who have undergone ACL reconstruction surgery [18]. The program comprises specific targets to be achieved, which require intervention in the form of tailored physiotherapy modalities and exercises to address the patient's needs and problems. Below are the four intervention stages that need to be followed to achieve the rehabilitation goals.

Phase	Time Line	Objective	Intervention
First Phase	0-2 Weeks	The goals of this first phase are to reduce swelling, pain, increase muscle strength, increase ROM, improve mobilization, and stimulate proprioception.	• Protective racing, Rest, Ice, Compression, Elevasion (PRICE), • Ambulation training using crutches with minimal load or as tolerated • Passive and active exercises for the range of motion of the knee joint (extension and flexion) • Patella mobilization grade grade I and II. • Isometric exercises on the front, back and adductor thigh muscles • Straight Leg Raise (SLR) exercises in 4 directions with or without assistance or lifting the legs up, in a supine position. • Ankle pumps exercise
	2-4 Weeks	The first phase will continue for approximately the next 2 to 4 weeks, the program aims to accomplish the following objectives: reduce pain, enhance the full range of motion of joints, improve functional mobility, weight bearing, normal walking patterns without the aid of equipment, increase muscle strength, and expect	• Patella Mobilization • Wall slide exercise • Exercise with a ROM of 110° to 120° • Exercise increases weight bearing • SLR exercises in 4 directions with assistance or without assistance or lifting the legs up, in a supine position, • Progressive loading exercises and aerobic conditioning exercises on a stationary bike. • Trunk/pelvic stabilization exercises • Knee Close chain exercise

		patients to comply with the home exercise program.	
Phase Two	5-6 Weeks	The second phase aims to improve quadriceps activation, muscle hypertrophy, aerobic capacity, gait patterns, proprioception, muscle strength, and joint stability.	• Isometric exercises with various angles of motion. • Advanced strengthening exercises and endurance training, • Proprioceptive exercises such as box climbing and balance exercises, walking stabilization exercises with light resistance band, and advanced short-distance closed chain exercises.
Phase Three	7-10 Weeks	The third phase focuses on improving muscle strength, increasing neuromuscular control, restoring cardiopulmonary endurance and balance.	• Advanced close kinetic chain, advanced endurance training • Perform sport-specific exercises, including jogging, sprinting, running, and high-speed intervals. • Leg weight training with leg press and leg extension exercises.
Phase Four	11-24 Weeks	In the fourth phase, the program aims to enhance muscle strength using weights, improve neuromuscular control, restore cardiopulmonary endurance and balance, and facilitate the athlete's return to sport.	• Lower extremity stretching exercises, • Advanced closed-chain exercises • plyometric exercises such as hopping, skipping, hopping, and box jumping with a weather or two • Advanced proprioceptive training • Agility training in the form of zig-zag training with specific sports training patterns. • Practice sport-specific techniques. • Jog transition drills, sprint at full speed

Table 2. Rehabilitation Phase of ACL Injury after Reconstruction [18]

In conducting this case study, the physiotherapist implemented phase two, which focused on increasing muscle strength and improving functional movement. The following are the interventions that were carried out in practice Interventions are programmed and carried out by physiotherapists working in the hospital.

Time	**Intervention program and dosages**
16 March 2021	• Patella Mobilization based on the movement restrictions (5 repetitions, 2 sets) • Quadriceps setting exercise (10 repetitions, 3 sets) • Hamstring setting exercise (10 repetitions, 3 sets) • Ankle Pumping exercise (10 repetitions, 3 sets) • Static bike exercise (10 minutes, Moderate Resistance) • Calf raises (10 repetitions, 3 sets, hold 10 seconds and rest 10 second) • Lateral Walking with medium resistance band (10 repetitions, 3 sets) • Wall slide (10 step, 5 set)

18 March 2021	• Patella Mobilization based on the movement restrictions (5 repetitions, 2 sets) • Quadriceps setting exercise (10 repetitions, 3 sets) • Ankle Pumping exercise (10 repetitions, 3 sets) • Static bike (10 minutes, Moderate Resistance) • Calf raises exercise (10 repetitions, 3 sets, hold 10 seconds and rest 10 second) • Lateral Walking with medium resistance band (10 repetitions, 3 sets) • Wall Slide exercise (10 repetitions, 3 sets)
24 March 2021	• Quadriceps setting exercise (10 repetitions, 3 sets) • Hamstring setting exercise (10 repetitions, 3 sets) • Static Bike exercise (10 minutes, Moderate Resistance) • Calf raises exercise (10 repetitions, 3 sets, hold 10 seconds and rest 10 second) • Knee flexion and extension with adjustable pulley 7 Kg (10 repetitions, 3 sets) • Lateral Walking with medium resistance band (10 repetitions, 3 sets) • Single leg Romanian Dead Lift with 3 kg dumbbell (10 repetitions, 3 sets) • Wall squat exercise with 30° flexion (10 repetitions, 3 sets) • Step up and down forward (10 repetitions, 3 sets)
26 March 2021	• Static bike (10 minutes, Moderate Resistance) • Calf raises (10 repetitions, 3 sets, hold 10 seconds and rest 10 second) • Hamstring Stretching (10 seconds, 3 repetitons) • Wall squat (10 repetisi, 2 set) • Lateral Walking with medium resistance band (10 repetitions, 3 sets) • Step up and down forward and side to side (10 repetitions, 3 sets) • Knee flexion and extension with adjustable pulley 10 Kg (10 repetitions, 3 sets)

Table 3. The Implementation of Phase Two Rehabilitation Program

RESULT AND DISCUSSION

After conducting the intervention four times over a two-week period, the following table shows the obtained results.

Evaluation Parameter		**Scale**	
Active Knee Movement Pain		**VAS Scale**	
		Pre	**Post**
	Right Knee Flexion	40 mm	20 mm
	Right Knee Extension	20 mm	0 mm

Active Knee Range of Motion		**Active ROM Degree**	
		Pre	**Post**
	Right Knee Flexion	0°-135°	0°-145°
Knee and Ankle Muscles Strength		**Muscle Strength (mmHg)**	
		Pre	**Post**
	Right Quadriceps	74 mmHg	100 mmHg
	Right Hamstring	105 mmHg	120 mmHg
	Right *Gastrocnemius*	120 mmHg	130 mmHg
Knee Functional Ability Score		**Score (%)**	
		Pre	Post
	KOOS	33 (30%)	68 (60%)

Table 4. Evaluation Result

The table displays a reduction in active movement pain following therapy. At the start of the physiotherapy, the pain level during active movement in flexion was moderate, measuring at 40 mm. However, after four session physiotherapy, the pain level decreased to 20 mm, indicating mild pain. Therefore, there was a difference of 20 mm between the initial and final pain levels. At the beginning of physiotherapy session, for active extension movements, the patient should experience only mild pain (20 mm), which should decrease to no pain (0 mm) as therapy progresses.

Measurement of knee flexion ROM before exercise therapy showed results of 0-135°. After 4 treatments, there was an increase in flexion ROM by 10°. With this results, exercise therapy can increase ROM in patients because providing active and passive movement exercise therapy can help reduce pain and increase ROM. The results of the muscle strength measurements above showed an increase in muscle strength. At the beginning of the therapy, the quadriceps muscle strength was 75 mmHg. After four sessions, it increased by 25 mmHg. At the start of therapy, the strength of the hamstring muscles was 105 mmHg. After four session of physiotherapy, it increased by 15 mmHg. For the gastrocnemius muscle at the start of therapy, it was 120 mmHg, there was an increase to 10 mmHg after therapy. At the initial assessment, the patient's functional ability was only 30%. However, after four treatments, it increased to 60%.

In this study the results obtained are supported by previous theories which show that exercise therapy can reduce pain because exercise therapy can increase endorphin hormones which can reduce pain receptors in the brain so that the pain is reduced 19. Apart from that, exercise therapy allows the muscles to stretch optimally because the contraction and relaxation of the muscles makes the muscles more relaxed and make stretching easier, thus

reducing tension and pain in the muscles 20. The results of research conducted by Arundale et al. (2018) also supports this research where their research states that providing exercise therapy can help maintain muscle physiology thereby preventing joint stiffness and can increase ROM. [21].

Similarly, the research conducted Syafaat & Rosyida, (2020) provides further evidence to support the findings of this study. Exercise therapy with additional weights has been shown to increase muscle strength in patients with post-ACL reconstruction conditions. This is primarily due to an increase in the number of muscle fibers, such as actin and myosin filaments, which are essential for muscle contraction, as well as an increase in sarcomeres. These newly formed muscle fibers provide additional muscle strength[22]. In addition, exercise therapy can indirectly increase muscle strength by reducing pain[23]. Previous research by Amin et al., (2018), demonstrated that exercise therapy post-ACL reconstruction can improve functional ability in patients [24].

The study conducted was designed to apply the existing sports injury rehabilitation guidelines, which resulted in data collected from only one patient. Therefore, the findings of this research should be carefully considered before being applied to other individuals, as the results may vary from person to person. Future research is needed to determine the effectiveness of existing ACL reconstruction guidelines for sports injury rehabilitation.

CONCLUSION

Applying appropriate examinations, interventions, and evaluations after ACL reconstruction can lead to favorable outcomes for the patient's condition. Physiotherapists can easily develop ACL reconstruction rehab programs with the help of a sports rehabilitation guide. Implementation of phase two sports injury rehabilitation guidelines for post-ACL reconstruction conditions leads to positive patient outcomes, including reduced pain, increased range of motion, muscle strength, and functional ability.

Recommendation: Physiotherapists must develop and implement personalized sports injury rehabilitation programs based on the patient's specific needs and condition.

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REFERENCE

1. Madden CC, Putukian M, Young CC, McCarty EC. Netter's Sports Medicine. (1, ed.). Elsevier Inc; 2010.
2. Prodromos CC, Han Y, Rogowski J, Joyce B, Shi K. A meta-analysis of the incidence of anterior cruciate ligament tears as a function of gender, sport, and a knee injury-reduction regimen. Arthrosc J Arthrosc Relat Surg Off Publ Arthrosc Assoc North Am Int Arthrosc Assoc. 2007;23(12):1320-1325.e6. doi:10.1016/ j.a -rthro.2007.07.003
3. Yagi M, Wong EK, Kanamori A, Debski RE, Fu FH, Woo SLY. Biomechanical analysis of an anatomic anterior cruciate ligament

reconstruction. Am J Sports Med. 2002; 30(5):660-666.
4. Hyde TE, Gengenbach MS. Conservative Management of Sports Injuries. Lippincott Williams & Wilkins; 1997.
5. Tjong VK, Murnaghan ML, Nyhof-Young JM, Ogilvie-Harris DJ. A qualitative investigation of the decision to return to sport after anterior cruciate ligament reconstruction: To play or not to play. Am J Sports Med. 2014;42(2):336-342. doi:10.1177/0363546513508762
6. Hootman JM, Albohm MJ. Anterior cruciate ligament injury prevention and primary prevention of knee osteoarthritis. J Athl Train. 2012; 47(5):589-590. doi:10.4085/1062-6050-47.5.06.
7. Nyland J, Brand E, Fisher B. Update on rehabilitation following ACL reconstr-uction. Open Access J Sport Med. Published online 2010:151. doi:10.2147/oajsm.s9327
8. Paschos NK, Howell SM. Anterior cruciate ligament reconstruction: principles of treatment. EFORT open Rev. 2016; 1(11):398-408.
9. Bliss JP. Anterior Cruciate Ligament Injury, Reconstruction, and the Optimization of Outcome. Indian J Orthop. 2017;51(5):606-613. doi:10.4103/ortho.IJOrtho_237_17
10. Maralisa AD, Lesmana SI. Penatalaksanaan Fisioterapi pada Rekonstruksi ACL Knee Dextra Hamstring Graft. Indones J Physiother Res Educ. 2020;1(1).
11. Cho SH, Bae CH, Gak HB. Effects of closed kinetic chain exercises on proprioception and functional scores of the knee after anterior cruciate ligament reconstruction. J Phys Ther Sci. 2013;25(10):1239-1241. doi:10.1589/jpts.25.1239
12. Bulley C, Donaghy M. Sports physiotherapy competencies: The first step towards a common platform for specialist professional recognition. Phys Ther Sport. 2005;6(2):103-108. doi:10.1016/j.ptsp. 2005.02.002
13. Anggiat L. Early Stage Rehabilitation for Strain Hamstring : A case report. INSPIREE Indones Sport Innov Rev. 2021;2(2):138-145. doi:10.53905/inspiree.v2i2.43
14. Anggiat L. Sports Rehabilitation Phases: A Literature Review. Int J Med Exerc Sci. 2021;7(3):1097-1102.doi:10.36678/IJMAES.2021.V07I03.008
15. Coll AM, Ameen JRM, Mead D. Postoperative pain assessment tools in day surgery: literature review. J Adv Nurs. 2004;46(2):124-133.
16. Toohey LA, De Noronha M, Taylor C, Thomas J. Is a sphygmomanometer a valid and reliable tool to measure the isometric strength of hip muscles? A systematic review. Physiother Theory Pract. 2015;31(2):114-119.
17. Roos EM, Roos HP, Lohmander LS, Ekdahl C, Beynnon BD. Knee Injury and Osteoarthritis Outcome Score (KOOS)—development of a self-administered outcome measure. J Orthop Sport Phys Ther. 1998;28(2):88-96.
18. Kisner C, Colby LA, Borstad J. Therapeutic Exercise: Foundations and Techniques. Fa Davis; 2017.
19. Caparrós T, Pujol M, Salas C. General guidelines in the rehabilitation process for return to training after a sports injury. Apunt Med l'Esport. 2017;52(196):167-172. doi:10.1016/j.apunts.2017.02.002
20. Wyss JF, Patel AD. Therapeutic Programs for Musculoskeletal Disorders. Demos Medical Publishing; 2013. doi:10.1016/B978-0-323-39055-2.00012-7.
21. Arundale AJH, Bizzini M, Giordano A, et al. Exercise-based knee and anterior cruciate ligament injury prevention. J Orthop Sports

Phys Ther. 2018; 48(9): A1-A25. doi:10.2519/jospt.2018.0303.

22. Syafaat FA, Rosyida E. Upaya Pemulihan Pasien Pasca Rekonstruksi Anterior Cruciate Ligament (ACL) Dengan Latihan Beban. J Kesehat Olahraga. 2020;8(1):67-72.
23. Higgins M. Therapeutic Exercise: From Theory to Practice. FA Davis; 2011.
24. Amin AA, Amanati S, Novalanda W. Pengaruh terapi latihan, transcutaneous electrical nerve stimulation dan kinesiology taping pada post rekonstruksi anterior cruciatum ligamen. J Fisioter dan Rehabil. 2018;2(2):115-124.

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