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ACCELERATED REHABILITATION FOR FOOTBALL PLAYERS FOLLOWING ACL RECONSTRUCTION

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Abstract

Athletes' rehabilitation programs after anterior cruciate ligament reconstruction (ACLR) are diverse. The purpose of this study was to compare the evolution of postoperative rehabilitation protocol (standard and accelerated) after anterior cruciate ligament reconstruction. The subjects were two athletes, (football players), 27 and 28yearsoldmales with anterior cruciate ligament reconstruction with a hamstrings autograft, after knee injury. The rehabilitation protocol of both subjects started the day after surgery, 2 sessions per day, 6 days per week, for 6 months where one player was administered the *standard protocol* and the other the *accelerated protocol*. The *standard protocol*is based on exercise for range of motion (ROM), flexibility, normalizing walking, balance strength and endurance muscle, proprioception and cardio respiratory fitness. *The accelerated protocol* is based on the same exercises as the standard protocol, with the addition of specific football exercises. Specific rehabilitation protocol for soccer players may lead to complete and accelerated functional recovery. The criteria for each phase progression were evaluated with the Lower Extremity Functional Scale (LEFS). The subject who followed the accelerated protocol reported a better (LEFS) score than the subject who followed the standard protocol. The results showed that range of motion, including hyperextension, flexion and balance improved faster and completely after accelerated protocol. This study concludes that organizing the rehabilitation protocol with specific football exercises is necessary to speed up recovery and minimizing risk of reinjure.

Keywords: Anterior cruciate ligament, accelerated rehabilitation, football players, specific football exercises, range of motion.

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1. Introduction

Anterior cruciate ligament rupture is considered a serious injury in elite soccer and has significant impact to the player-sport performance and quality of life. In the past, the conservative rehabilitation process after cross-ligament reconstruction included prolonged immobilization and slow progression in returning to sports activity. At present, the rehabilitation programs are more aggressive and support the return of athletes to sports activities faster. It is important to consider the goals of the patient throughout the rehabilitation process in order to incorporate specific functional and sport-specific activities as appropriate (Eckenrode, Carey, Sennett, & Zgonis, 2017). The previously crossed ligament along with the thigh muscles and the other ligaments are designed to provide the necessary stability in the knee joint. The knee stability depends on the passive and active stability of the joint which involve the geometry of the articular surfaces, ligaments, meniscus and fibrous capsule and active stability is exerted by the muscles surrounding the knee during contraction: quadriceps, hamstrings, sartorius, gracilis and gastrocnemius (Dvorak et al 2009). Understanding ACLR loading mechanisms and knowing risk factors for the injury and mean off time after ACLR are essential information for the coach, the medical staff, the elite soccer players, the insurance and team managers (Schiffner et al.,2018). Wilk (2015) recommends streamlining rehabilitation programs for individuals which can return them to their preinjury activity levels, including implementation of thorough functional testing to determine whether a patient is ready to return to sports or strenuous post-ACLR activities.

1.1. Causes and mechanisms of ACL injury

The cross-ligament rupture is a serious injury commonly encountered in the football game that occurs as a result of direct contact with an opponent or when the player runs with directional changes, pivots to hit the ball, accelerates or stops suddenly. The most common ACL injury mechanism in male elite players is pressing, where a player makes a side-step cut during a defensive playing situation. In addition, landing awkwardly on one leg after a heading duel is another established non-contact injury mechanism (Waldén et al., 2015). The injury is characterized by joint instability that leads to decreased sports activity, unsatisfactory knee function, and poor knee-related quality of life in the short term (Spindler et al., 2008). Dvorak et al (2009) in the "Football Medicine Manual" considers that the most common causes occur during tackling: in the first instance, the impact hits the lateral side of the knee, forcing the knee into valgus and the tibia into external rotation, causing a sequence of injuries with progressive severity and the second important cause in tackling is an impact hitting the medial side of the knee, forcingthe knee into varus and the tibia into internal rotation. Various studies demonstrate that anterior translation of the tibia relative to the femur is the most important mechanism of ACL loading. Increased anterior shear forces at the knee due to a small knee flexion angle and increased compression forces on a posterior tilted tibial plateau are primary causes of anterior translation of the tibia relative to the femur (Dai et al., 2014).The same author considers the risk factors for knee injuries to include joint laxity, muscle weakness and fatigue, inadequate rehabilitation after previous injury, poor fitness and foul play with tackle on the lateral or medial side of the knee. Soccer players are at greatest risk for ACL injury when defending, especially when tackling the opponent in an attempt to win possession of the ball (Brophy et al.,2015).In addition to describing a

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mechanism listed above, 85% of patients will feel a pop at the time of injury and most will have significant swelling within two to three hours of injury (Rehabilitation Guide 2017). Management after ACL injury may involve an operation to replace the torn ligament with a graft in an attempt to reduce excess anterior tibial movement in the sagittal plane, and it gives the patient the chance to return to sporting activities (Kvist, 2004).The factors that can affect rehabilitation after reconstructive ACL surgery include concomitant injuries, timing of surgery, graft selection, concomitant surgeries, quality of rehabilitation, and the goals and desire of the athlete (Malempati et al., 2015).Understanding ACL loading mechanisms and risk factors for the injury is critical for designing effective prevention programs (Dai, et al., 2014). The same author considers warm-up programs for ACL injury prevention necessary because of its short training duration and capability of being incorporated into regular training.

1.2. Postoperative Rehabilitation

The rehabilitation following the ACLR is crucial for the return of the player to the field at the same level as before the injury. Lai et al. (2017) in a systematic review and meta-analysis of five studies reported that postsurgery performance was unchanged (Erickson et al., 2013; Erikson et al., 2014) compared with preinjury performance, while other studies reported that performance deteriorated after surgery (Fabricant et al., 2015; Harris et al., 2013; Sikka et al., 2016).

Typical post-operative ACLR and rehabilitation protocols stages include: an early post-operative phase, which focuses on addressing knee range of motion (ROM) deficits, initiating knee strength and control, minimizing pain and effusion, and normalizing gait; a strengthening and neuromuscular control phase, which includes the progression of lower extremity functional strength, and enhancement of balance and neuromuscular control; an advanced strengthening phase, which progresses the patient into plyometrics, agility activities, running and early sport-specific training; and with a final phase focusing on continued strengthening and neuromuscular control with emphasis towards return to sport activities (Eckenrode et al., 2017).

The athletes' rehabilitation programs after ACLR follow three phases of progression: basic, intermediate and advanced. The first phase assumes the recovery to basic fundamental movement. The key to bridging the gap between rehabilitation and sports application is to return to basic fundamental movement skills and addresses the physiological responses of pain, swelling, range of motion and basic strength during the early phases of healing (Rehabilitation Guide 2017).

The second phase assumes recovery of biomotor patterns and continued improved range of motion (full extension and full flexion), proprioception, flexibility, gradual strengthening of the hamstring and quadriceps muscles, knee stabilization and cardiovascular fitness before advanced athletic movements can be achieved.

Phase three assumes specific training and reconditioning to return to sports competition, optimized plyometrics training, specific neuromuscular control, improved specific sport skills (speed, agility, coordination, strength) and specific conditioning, and returning gradually to sports practice (individual and team) with minimal risk of re-injury. The rehabilitation programs after ACLR are diverse and transforming. The options for rehabilitation include accelerated vs. conservative, closed vs. open kinetic chain and other techniques involving bracing, home-based rehabilitation, and neuromuscular training (Grant, 2013).

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Previously, conservative rehabilitation with limitation of range-of-motion (ROM), delayed weight bearing with full weight bearing at 8–10 weeks and returning to sports after 9–12 months has been the norm (Kvist, 2004). In contrast to this, Dvorak, et al. (2009) in the "Football Medicine Manual" claimed that with conservative treatment of isolated, partial or complete tears, the return to football training and matches may be quite fast if the ROM and muscular strength are restored and can be attempted after eight to 12 weeks. The accelerated protocols with immediate training of ROM and weight bearing allow the return to sports within 4–6 months (Kvist, 2004). Professional football needs accelerated protocols with immediate training of ROM, strength and muscle endurance and returning to the field as soon as possible. In the rehabilitation protocols, the full ROM, limb strength symmetry, and neuromuscular control are important for an athlete to safely and effectively return to sports (Malempati et al., 2015). *The accelerated protocol* is based on exercises for: ROM, flexibility, normalizing walking, balancing strength and muscle endurance, specific football proprioception, cardio respiratory fitness and specific football exercises, which may lead to safe and complete functional recovery.Rehabilitation of soccer players after ACLR is usually performed without sport-specific guidelines, and the final phases are often left to the team coaches (Della Villa, 2012).The complete improvement of the ROM from the immediate postoperative phase enables a complete and varied range of movements that help diversify the rehabilitation program and move faster to a new stage. In addition, accelerating rehabilitation involves restoring the strength of quadriceps and hamstring muscles both by general means and by means of proprioceptive exercises, plyometrics and agility drills. Proprioceptive and neuromuscular exercises are important for high-level football players as these contribute to regaining the dynamic joint and active stability. Wright et al., (2015) recommends initiated open chain quadriceps exercises from 6 weeks. Strength deficits are a common complication following ACLR and rehabilitation should focus on this; regaining strength throughout the entire post-operative course of care (Eckenrode, et al., 2017).The duration by which an athlete is able to advance in his or her programme is extremely variable and dependent on the extent of the injury, the time devoted for training and rehabilitation as well as constitutional variations, so time-based criteria are therefore questionable not only to define the time of the final comeback, but also to progress to the next level of rehabilitation (Petersen et al., 2017). Incomplete rehabilitation and rushing back to sports can result in additional knee injuries and graft rupture (Teodor, 2017). The review of rehabilitation interventions after ACLR suggests that both accelerated and home-based rehabilitation, neuromuscular training programs, hyaluronic acid injection, and single leg cycling may be beneficial (Grant, 2013).

1.3. Return to Sports

It is important to realize that return to sports is not based on a specific timeline; it is based on the individual athlete's ability to meet physical performance criteria, mental readiness, age, type of sport and the player position (Rehabilitation Guide, 2017). Return to sports includes return to football practice (individual and team) and full game with minimal risk of re-injury.

The return to sports should be based first of all on a series of intrinsic factors, that depend exclusively on the patient himself such as genetics, lesion type, anatomical features, rehabilitation protocols, motivation, psychological attitude and extrinsic factors type of graft, surgical technique, rehabilitation phases, biological support (Czuppon et al., 2014; Zaffagnini et al., 2015). Recent research has suggested

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that psychological factors may be important influences on returning to sports and recreation after athletic injury but cautioned that because there are few studies examining the relationship between psychological factors and returning to sports and recreation, more research is needed to facilitate more definitive conclusions (Ardern et al., 2014). Extrinsic factors are influenced by many personal and contextual factors and have been investigated by numerous studies (Engelman et al., 2014; Saka, 2014).

Tjong, et al. (2014) identified fear of reinjury and individual personality's priority as reasons for those athletes who do not choose to return to their pre-injury level of activity. Several psychological scales have been reported to predict the ability to return to sports; this is confirmed by evidence that the reason for abandoning sports may not be related to objective knee problems but rather to psychological issues such as fear of re-injury, family or personal problems, or other factors (Ardern et al., 2014). Rambaud et al. (2017) assume that many factors have been implicated in reinjury risk, including gender (Allen et al., 2016), age (Webster et al., 2014; Kamien et al., 2013), activity level (Borchers, Pedroza & Kaeding, 2009), graft type (Gifstad, 2014) or duration after surgery (Maletis et al., 2013). Clinical evidence indicates that the highest risk of ACL reruptures is within the first two years after reconstruction, especially in young high-level athletes (Nagelli & Hewett, 2017). The same authors assert that the incidence of ACL reruptures significantly decreases if athletes delayed their return to high-level activity until 2 years after ACLR. In an ample review, Kvist (2004) presented factors and criteria for safe returning to sports after ACLR, as presented in Table 1.

Table 01. Factors and criteria that influence a safe return to sports by Kvist (2004).

Rehabilitation	Surgery	Other factors
Muscle strength and performance Evaluated by isokinetic test and one leg hop test	**Static knee stability** Evaluated by: clinical examination and objective measures ex KT-1000	**Social** i.e. family, pregnancy, finished college, etc.
No pain or effusion full ROM (range of motion) Evaluated by: clinical examination	⟷	**Psychological factors** i.e. motivation, scholarship, fear of re-injury, etc.
Functional knee stability Evaluated by: clinical examination and objective measurements ex motion analysis		**Associated injuries** i.e. menisci, cartilage, other ligaments, etc.

For surgically-treated players, the period of prehabilitation prior to ACLR should be used to inform the player in detail about the procedure and to ensure that he has realistic expectations regarding the recovery of his knee function (Dvorak et al., 2009). First of all we must clarify what "return to sports" means because the term has different interpretations for different people. In patients aiming to return to sports, the rehabilitation program must continue until this is possible (Rambaud et al., 2017). To consider ACL rehabilitation successful, the patient should be able to return to the same level of sporting activity as before the injury (Lynch et al., 2015). For this purpose, the accelerated rehabilitation after surgery is necessary and helps the players to return to the football career at the same competitive level as prior to the injury. There is controversy about the optimal point of time to allow the athlete to return to sports especially on a competitive level. In most studies, a postoperative period of six months was suggested as to be sufficient where the athlete should refrain from her or his original activity (Barber-Westin et al., 2011). In football, most players return to training and matches after six to nine months or much earlier; 77 days after surgery (Roi et al., 2005). In a systematic review, Lai et al. (2017) identified four studies which mentions

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that on average, soccer players returned to sports between 6 and10.2 months postoperatively (Erickson et al. 2013); Howard et al. (2016); Zaffagnini et al. (2014). An analysis of Union of European Football Associations (UEFA) elite male soccer players showed a mean injury lay-off until return to unrestricted soccer practice of 202 ± 69 days for 43 European players and 203 ± 70 days for 20 Swedish players (Waldén et al., 2011). Schiffner et al. (2018) found a mean injury lay-off of 244 (range 118–604) days (8.1 months) until return to unrestricted soccer practice after total ACLR.

Van Grinsven et al. (2010) in a systematic review recommended the following criteria for return-to-sports in 6 months: full ROM, 85% or greater on strength (quadriceps and hamstrings) and single-leg hop tests compared with the opposite leg, less than 15% deficit on hamstring-quadriceps strength ratio, no pain or swelling with sport-specific activities, and a stable knee in active situations. In a soccer-specific rehabilitation program, it is important to know the physical demands of the football game and the performance level which the player needs to attain.

To attain this goal, close cooperation between the patient, physiotherapist, surgeon, coach and family athlete is necessary (Damian et al., 2018).

It is important to realize that return to sports is not based on a specific timeline, but on the individual athlete's ability to meet physical performance criteria, mental readiness, age, type of sports and the position he is playing (Rehabilitation Guide, 2017).

2. Research Questions

What is the difference in the evolution of postoperative rehabilitation protocols (standard and accelerated) after anterior cruciate ligament reconstruction?

3. Purpose of the Study

The purpose of this study was to compare the evolution of postoperative rehabilitation protocols (standard and accelerated) after anterior cruciate ligament reconstruction.

4. Research Methods

The subjects were two athletes, (football players), 27 and 28year old males with ACLR with a hamstrings autograft. The rehabilitation protocols of both subjects started a next day after surgery, comprising 2 sessions a day, 6 days a week, for 6 months. Each session lasted 90 minutes. The players were observed and evaluated periodically and the results were compared. *The protocol* (A) is based on goal and exercise for: range of motion (ROM), flexibility, normalizing walking, balance, strength and endurance muscle, proprioception and cardio respiratory fitness, while *protocol* (B) follows an accelerated rehabilitation, and is based on the same goal and exercises as the protocol A, and additional football specific exercises and training. Specific football rehabilitation took place outdoors on a grass field. The criteria for each phase progression was evaluated with Lower Extremity Functional Scale (LEFS) and are presented in the Table (2, 3). LEFS a valid tool for assessing change in functional status (Stratford, 2005). The LEFS consists of 20 items, each scored on a 5-point scale (0 to 4). Item scores are summed and total LEFS scores vary from 0 to 80, with higher values representing better functional status.

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Table 02. Summary of protocol(A)rehabilitation after ACL reconstruction

Stage	Goals	LEFS Score points
Weeks 0-4	Eliminate edema and pain; Restoring ROM (increase extension and flexion); Improve flexibility; Stability and walking re-education; Improve cardiovascular fitness;	15-39
Weeks 5-16	Improve range of motion (full extension and full flexion; Increase flexibility; Improve all strength muscle Improve knee stabilization; Improve cardiovascular fitness;	42-60
Weeks 17-28	Full range of motion (full extension and flexion; Improve specific neuromuscular control; Improve ligament stability; Agility workout, coordination and strength; Improve conditioning; Final rehabilitation of the player and return to the competition.	62-75

Table 03. Summary of protocol (B)rehabilitationafter ACL reconstruction

Stage	Goals	LEFS Score points
Weeks 0-4	Eliminate edema and pain; Restoring ROM (increase extension and flexion); Improve flexibility; Stability and walking re-education; Improve cardiovascular fitness;	15-39
Weeks 5-16	Improve range of motion (full extension and full flexion; Increase flexibility; Improve all strength muscle Improve knee stabilization; Improve cardiovascular fitness;	42-60
Weeks 17-24	Prepare the player for competitive football; Improve specific neuromuscular control; Improve football skills: speed agility, coordination strength; Improve specific football conditioning; Football practice: individual and team football exercises; Final rehabilitation of the player and return to the competition	63-80

The subject who followed the accelerated protocol realized a better (LEFS) score than the subject who followed the standard protocol and returned to competitive level after 6 months. The rehabilitation followed without complications; both players showed a strong determination to return to their football career at the same level as before the injury. The accelerated program supported the player to play first his game 6 months after surgery. The player who followed the standard program played the first match 7 months after surgery. Codorean, Codorean & Cojocaru (2016) argue that for an athlete to be competitive after ACLR, it is imperative to regain muscle strength and neuromuscular control of the affected lower limb, and maintain static stability of the joint. The muscular strength was improved with isometric, isotonic, and isokinetic training.

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Protocol (A) standard rehabilitation

(weeks 0-4)

Goals: eliminate edema and pain; improve ROM (full extension and partial flexion); improve flexibility, proprioception, stability and walking re-education; increase cardiovascular fitness;

To eliminate edema and pain, ice was applied for 20 minutes 3 times a day, on the raised leg with extension knee. Improvement of ROM was achieved by activating the quadriceps muscle with flexion and extension (flexion 3x20; extension 3x20), voluntary quadriceps contractions (3x20) and walking reductive exercises (3x20 meters).Stretching exercises are necessary for maintaining range of motion in all joints. They improve the muscle-tendon and ligament elasticity, reduce the risk of reactivation, and help improve postural stability and equilibrium. Some core exercises for the abdominal part, lower back and muscles, important for ensuring correct body posture and reeducation of walking were used in the rehabilitation program. Strong core body musculature is important in specific football motion. Codorean, et al. (2016) claim that core exercises is the foundation in daily life activities and in athletic movements. In first week, the LEFS score was 15 points. After 4 week of exercises comprising flexibility, stability and walking re-education, cardiovascular fitness, quadriceps activation, patellar mobilizations, the score increased to 39 points.

(weeks 5-16)

Goals: continued improvement of ROM (full extension and full flexion), proprioception, and flexibility, gradually increase the strength of the hamstring and quadriceps muscles, knee stabilization and cardiovascular fitness;

De Carlo (1992) asserts that patients who started weight bearing or gained range of motion earlier than advised had stronger, more functional knees at the completion of the rehabilitation. At this stage, we continued to improve the ROM through flexion and extension with weighs of 1kg each foot (flexion 3x20; extension 3x20) and the resistance band exercises (4x20 flexion-extension). Maintaining cardiorespiratory fitness through endurance training: bike (3x5 minutes 60% heart rate), stepper exercises (level 6) and band running (2x5 minutes) also helped to improve ROM and progress to a new stage. Improving muscle strength was accomplished with isotonic machines (leg extension, leg press, leg curl, adductors, abductors, gluteus and body weight exercises: squats, split squat, Bulgarian squat) in agreement with Codorean, et al. (2016) .Significant deficits in quadriceps strength are evident after ACLR (Kline, et al. 2015). According to Malempati et al. (2015) the quadriceps and hamstring musculature must be strengthened to achieve muscular balance in the affected extremity. Swimming exercises in the pool (crawl style) to develop the resistance of the quadriceps muscle and the muscle-tendon and ligament elasticity were done. Proprioception exercises and static balance exercises were done to improve the static balance. In week 5 the LEFS was 42 points. After 11 weeks of exercises: ROM (full extension and full flexion), flexibility, strength muscle, knee stabilization and cardiovascular fitness, the score increased 60 points.

(weeks 17-28)

Goals: full ROM (full extension and flexion, improve specific neuromuscular control, stability ligament, agility workout, coordination, strength and cardiovascular fitness;

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In week 17, the LEFS score was 62 points. After 11 weeks of exercises: continued improvement of ROM (full extension and flexion), improved specific neuromuscular control and stability ligament (proprioception and static balance exercises, bosu balance, semi-squads), agility workout, coordination, strength and cardiovascular fitness, the score increased to 75 points. This phase represents the final rehabilitation of the player and return to competition level sports. At this stage, we continued improvement of general muscle strength through isotonic machines exercises and pliometric exercises. According to Negrea, Negrea & Teodor (2010) pliometrics exercises are scheduled after warm-up. Cardio respiratory capacity was maintained through endurance exercises (bike 2x7 minutes 60% heart rate, aerobic run 2x20 minutes and aerobic-anaerobic run 12 minutes) and agility exercises (straight line, lateral, diagonal, forward: 4x4,6,8, 12 meters). The stretching and coordination exercises used were aimed to improve the stability, elasticity of the ligament and prevent the risk of recurrence.

Protocol (B) accelerated rehabilitation

(weeks 0-4)

Goals: eliminate edema and pain; improve ROM (quadriceps activation whit full extension and partial flexion); improve flexibility, stability and walking re-education; increase cardiovascular fitness;

The accelerated rehabilitation program, which allows patients to achieve full extension of the knee early in the postoperative period, is now a widely practiced rehabilitation program An KO (2017). In first week, the LEFS score was 14 points. After 4 week of exercises: quadriceps isometrics, bike pendulums, semi-squat (30°),flexibility, stability and walking reeducation, abduction/adduction exercises, core exercises, quadriceps activation, patellar mobilizations, the score increased to 38 points.

(weeks 5-16)

Goals: continued improvement of ROM (full extension and full flexion), flexibility, strength muscle, neuromuscular training, knee stabilization, cardiovascular fitness and specific football warm-up.

In this phase, isotonic machines (leg extension, isometric, eccentric, concentric), leg press (isometric, eccentric, concentric), leg curl, adductors, abductors, gluteus and body weight exercises: squats, split squat, Bulgarian squat, step up, lateral lunge walk, forward lunge walk, calf raises (concentric and eccentric single leg), intrarotators were applied (Codorean et al 2016). Malempati, et al.(2015) advised that neuromuscular training should continue to promote neuromuscular control and proprioception.Warm-up programs for ACL injury prevention have received great interest recently because of its short training duration and capability of being incorporated into regular training (Hewett et al. 1999).In week 5, LEFS score was 40 points. After 11 weeks of exercises: range of motion (full extension and full flexion), flexibility, strength muscle, knee stabilization and cardiovascular fitness, the score increased 61 points.

(weeks 17-24)

Goals: prepare the player for competitive football, optimize plyometrics training, specific neuromuscular control, improve football skills: speed agility, coordination, strength and specific football conditioning, return gradually to football practice (individual and team) and full game with minimal risk of re-injury.

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Specific neuromuscular training and football conditioning are important aspects of this phase. Hewett et al. (1999) investigated the effects of comprehensive neuromuscular training on non-contact ACL injury rates in high school soccer, volleyball, and basketball players. The study concluded that the training program significantly reduced the ACL injury rate. In week 17, the LEFS score was 63 points. After 7 weeks of exercises: plyometrics training, specific neuromuscular control, football skills (speed, agility, coordination, strength), specific football conditioning, football practice (individual and team football exercises: passing short distances, sub-maximal shooting, dribbling, running whit the ball), the score increased at 80 points. Proprioception continued the improvement with specific football exercises (forward and lateral hop and maintain stability for 3 seconds on landing). Risberg et al. (2009) concluded that the combination of strength training and neuromuscular exercises was required to achieve the best outcomes, including the patient's perception of knee function and knee performance on strength and hop tests. Cardiovascular fitness has training with specific football running with turns 90,180 and 360°, speed (running with change of direction 6x4,6,8,12 m, carioca,), and agility (lateral, diagonal, forward drills).The agility part of the program incorporates sport-specific activities that reinforce safe movement patterns and encourage the use of musculature that reinforces the anterior cruciate ligament (Dvorak et al., 2009). Agility was improved with agility training drills but also by improving the specific individual fitness elements of speed, balance, power and coordination. Negrea et al. (2015) believes that the development of force is necessary to perform the tasks specific to the game and to increase the performance of athletes to optimal level. Maintaining an optimal level of cardio respiratory fitness throughout the rehabilitation program has facilitated the achievement of the specific objectives of each stage and the faster passage to the specific training of the football game. This phase represents the final rehabilitation of the player and return to the competition.

Return to optimal level play should require an individualized progression through objective phases supervised by a kinetotherapist. Therefore patient-tailored rehabilitation protocol shave been developed, structured in progressive phases, and specific goals rather than temporal criteria must be met in order to progress from one phase to the next, involving on-field rehabilitation with sport-specific movements and actions (Della Villa et al., 2012). Zaffagnini et al. (2015) consider it relevant to apply patient-tailored rehabilitation protocols and return-to-sport criteria, based on individual characteristics.

5. Conclusion

The results of the study show that specific rehabilitation for football players, the accelerated protocol (B) may provide a complete and accelerated functional recovery. The player who underwent this protocol achieved better results after the accelerated rehabilitation program in contrast to the player who followed the standard protocol (A). To accelerate the rehabilitation program, we must be include general goals (range of motion, flexibility, normalizing walking, balance strength and endurance muscle, proprioception, cardio respiratory fitness) and specific goals (plyometrics training, specific neuromuscular control, improve football skills: speed, agility, coordination, strength and specific football conditioning, return to full football practice: individual and team football exercises). The specific football goals are necessary to speed up recovery and minimizing risk of reinjury. Maintaining an optimal level of cardio respiratory fitness throughout the rehabilitation program can facilitate the achievement of the specific objectives of each stage

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and the faster passage to the training specific to the sport practiced. Furthermore, the protocol rehabilitation must begin on the first day after surgery.

8. Implications

This study is important because it provides empirical evidence for a rehabilitation protocol after anterior cruciate ligament (ACL) reconstruction which can safely provide a complete and accelerated functional recovery. In sports performance, this aspect of recovery and rehabilitation is of utmost significance for the athlete and the sport he/she represents.

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References

Ardern, C.L., Taylor, N.F., Feller, J.A., & Webster, K. E. (2014). Fifty-five per cent return to competitive sport following anterior cruciate ligament reconstruction surgery: An updated systematic review and meta-analysis including aspects of physical functioning and contextual factors. *Br J Sports Med., 48*(21), 1543-52. http://dx.doi.org/10.1136/bjsports-2013-093398

Ardern, C.L., Österberg, A., Tagesson, S., Gauffin, H., Webster, K.E., & Kvist, J. (2014). The impact of psychological readiness to return to sport and recreational activities after anterior cruciate ligament reconstruction. *Br J Sports Med., 48,* 1613-1619. http://dx.doi.org/10.1136/bjsports-2014-093842.

Allen, M.M., Pareek, A., Krych, A.J., Hewett, E.T., Levy, B.A., Stuart M.J., & Dahm D.L. (2016). Are female soccer players at an increased risk of second anterior cruciate ligament injury compared with their athletic peers? *Am J Sports Med., 44,* 2492–8. doi:10.1177/0363546516648439.

Borchers, J.R., Pedroza, A., & Kaeding C. (2009). Activity level and graft type as risk factors for anterior cruciate ligament graft failure: a case-control study. *Am J Sports Med., 37*, 2362–7. doi:10.1177/0363546509340633.

Barber-Westin, S.D., & Noyes, F.R. (2011). Factors used to determine return to unrestricted sports activities after anterior cruciate ligament reconstruction. *Arthroscopy, 27*(12), 1697-705. doi: 10.1016/j.arthro.2011.09.009.

Brophy R.H., Stepan J.G., Silvers H.J.,& Mandelbaum B.R. (2015). Defending puts the anterior cruciate ligament at risk during soccer: a gender-based analysis. *Sports Health. 7*(3), 244-9. doi: 10.1177/1941738114535184.

Codorean, H., Codorean, B., & Cojocaru, V. (2016). Functional rehabilitation of the knee joint after cruciate ligament reconstruction in the football players – recovery in therapy room. *Journal of the Romanian Sports Medicine Society, XII* (2), 2792-2797.

Czuppon, S., Racette, B.A., Klein, S.E., & Harris-Hayes, M. (2014). Variables associated with return to sport following anterior cruciate ligament reconstruction: a systematic review. *Br J Sports Med., 48*(5), 356-64. doi: 10.1136/bjsports-2012-091786. Epub 2013 Oct 11.

Damian, C., & Damian, M. (2018). Futsal Player Rehabilitation after Anterior Cruciate Ligament (ACL) Reconstruction. *Revista RomaneascapentruEducatieMultidimensionala, [S.l.], 10* (1), 6270. http://lumenpublishing.com/journals/index.php/rrem/article/view/435>. Accessed 13/4/2018. doi:http://dx.doi.org/10.18662/rrem/18.

Boyi, D., Dewei, M., William E. Garrett, & Bing, Y. (2014). Anterior cruciate ligament injuries in soccer: Loading mechanisms, risk factors, and prevention programs. *J Sport Health Sci., 3*(4), 299306. https://doi.org/10.1016/j.jshs.2014.06.002.

DeCarlo, M.S., Shelbourne, K.D., McCarroll, J.R., & Rettig, A.C. (1992). Traditional versus accelerated

rehabilitation following ACL reconstruction: one-year follow-up. *Journal of Orthopaedic & Sports Physical Therapy*, *15*, 309–316. DOI:10.2519/jospt.1992.15.6.309

Della Villa, S., Boldrini, L., Ricci, M., Danelon, F., Snyder-Mackler, L., & Nanni, G. (2012). Clinical Outcomes and Return-to-Sports Participation of 50 Soccer Players after Anterior Cruciate Ligament Reconstruction through a Sport-Specific Rehabilitation Protocol. *Sports Health*, *4*(1), 17–24. doi:10.1177/1941738111417564.

Dvorak J, Ackerman K., Babwah T., Bahr R, Bangsbo J, Bizzini M… Fuller, C. (2009). F-MARC Football Medicine Manual 2nd Edition Fédération Internationale de Football Association, Official publication of the Fédération Internationale de Football Association (FIFA), www.FIFA.com.

Eckenrode, B.J., Carey, J.L., Sennett, B.J., & Zgonis, M.H. (2017). Prevention and Management of Post operative Complications Following ACL Reconstruction. *Current Reviews in Musculoskeletal Medicine*, *10*(3), 315–321. http://doi.org/10.1007/s12178-017-9427-2

Engelman, G.H., Carry, P.M., Hitt, K.G., Polousky, J.D. & Vidal, A.F. (2014). Comparison of allograft versus autograft anterior cruciate ligament reconstruction graft survival in an active adolescent cohort. *American Journal of Sports Medicine*, *10*, 2311–2318. http://dx.doi.org/10.1177/0363546514541935.

Erickson, B. J., Harris, J. D., Cole, B. J., Frank, R. M., Fillingham, Y. A., Ellman, M. B., … Bach, B. R. (2014). Performance and Return to Sport After Anterior Cruciate Ligament Reconstruction in National Hockey League Players. *Orthopaedic Journal of Sports Medicine*, *2*(9), 2325967114548831. http://doi.org/10.1177/2325967114548831

Erickson, B. J., Harris, J. D., Cvetanovich, G. L., Bach, B. R., Bush-Joseph, C. A., Abrams, G. D., … Cole, B. J. (2013). Performance and Return to Sport After Anterior Cruciate Ligament Reconstruction in Male Major League Soccer Players. *Orthopaedic Journal of Sports Medicine*, *1*(2), 2325967113497189. http://doi.org/10.1177/2325967113497189

Erickson, B.J., Harris, J.D., Heninger, J.R., Frank, R., Bush-Joseph, C.A., Verma, N.N., Cole, B.J., & Bach, B.R. (2014). Performance and return-to-sport after ACL reconstruction in NFL quarterbacks. *Orthopedics*, *37*(8), e728-34. doi: 10.3928/01477447-20140728-59.

Fabricant, P. D., Chin, C.S., Conte, S., Coleman, S.H., Pearle, A.D., & Dines, J.S. (2015). Return to play after anterior cruciate ligament reconstruction in major league baseball athletes. *Arthroscopy*, *31*, 896–900.

Gifstad, T., Foss, O.A., Engebretsen, L., Lind, M., Forssblad, M., Albrektsen, G., & Drogset, J.O. (2014). Lower risk of revision with patellar tendon autografts compared with hamstring autografts: a registry study based on 45,998 primary ACL reconstructions in Scandinavia. *Am J Sports Med.*, *42*(10), 2319-28. doi: 10.1177/0363546514548164.

Grant, J.A. (2013). Updating Recommendations for Rehabilitation after ACL Reconstruction: a Review. *Clin J Sport Med.*, *23*(6), 501-502. doi:10.1097/JSM.0000000000000044

Harris, J.D., Erickson, B.J., Bach, B.R., Abrams, G.D., Cvetanovich, G.L., Forsythe, B.,…Cole, B.J. (2013). Return-to-sport and performance after anterior cruciate ligament reconstruction in National Basketball Association players. *Sports Health*, *5*(6), 562-8. doi 10.1177/1941738113495788.

Hewett, T.E., Lindenfeld, T.N., Riccobene, J.V., & Noyes, F.R. (1999). The effect of neuromuscular training on the incidence of knee injury in female athletes. A prospective study. *Am J Sports Med.*, *27*, 699-706.

Howard, J.S., Lembach, M.L., Metzler, A.V., & Johnson DL (2016). Rates and determinants of return to play after anterior cruciate ligament reconstruction in National Collegiate Athletic Association division I soccer athletes: a study of the southeastern conference. *Am J Sports Med.*, *44*(2), 433-9. doi: 10.1177/0363546515614315.

Kvist, J. (2004). Rehabilitation following anterior cruciate ligament injury: Current recommendations for sports participation. *Sports Med.*, *34*, 269–80.

Kamien, P.M., Hydrick, J.M., Replogle, W.H., Go, L.T., & Barrett, G.R. (2013). Age, graft size, and Tegner activity level as predictors of failure in anterior cruciate ligament reconstruction with hamstring autograft. *Am J Sports Med.*, *41*(8), 1808-12. doi: 10.1177/0363546513493896.

Kline, P.W., Morgan, K.D., Johnson, D.L., Ireland, M.L., & Noehren, B. (2015). Impaired quadriceps rate of torque development and knee mechanics after anterior cruciate ligament reconstruction with

patellar tendon autograft. *Am J Sports Med., 43*(10), 2553-8. doi:10.1177/0363546515595834.

Keun, Ok An. (2017) Exercise Rehabilitation after Anterior Cruciate Ligament Reconstruction *Exerc Med., 1*, 1. doi: https://doi.org/10.26644/em.2017.001

Lai, CCH, Ardern, C.L., Feller, J.A., & Webster, K. E. (2017). Eighty-three per cent of elite athletes return to preinjury sport after anterior cruciate ligament reconstruction: a systematic review with meta- analysis of return to sport rates, graft rupture rates and performance outcomes. *Br J Sports Med.*, 0, 1–10. doi:10.1136/bjsports-2016-096836.

Lynch, A.D., Logerstedt, D.S., Grindem, H., Eitzen, I., Hicks, G. E., Axe, M. J… Mackler, L.,S. (2015). Consensus criteria for defining 'successful outcome' after ACL injury and reconstruction: a Delaware-Oslo ACL cohort investigation. *Br J Sports Med., 49*(5), 335–342. doi: 10.1136/bjsports-2013-092299

Malempati, C., Jurjans, J., Noehren, B., Ireland, M.L., & Johnson, D.L. (2015). Current rehabilitation concepts for anterior cruciate ligament surgery in athletes. *Orthopedics, 38*(11), 689-96. doi: 10.3928/01477447-20151016-07.

Maletis, G.B., Inacio, M.C., Desmond, J.L., & Funahashi, T.T. (2013). Reconstruction of the anterior cruciate ligament: association of graft choice with increased risk of early revision. *Bone Joint J., 95-B*(5), 623-8. doi: 10.1302/0301-620X.95B5.30872.

Negrea, V., Negrea, M., Teodor, D. (2010) Influence of physical training pliometrics exercises the fifth graders, Ovidius University Annals, Series Physical Education and Sport. *Science, Movement and Health,* X(2), 729-731. ISSN 1224-7359, [PDF] from analefefs.ro.

Negrea, V., & Musat, G. (2015). Contributions regarding the optimization of physical training in high school basketball. (Ovidius University Annals, Series Physical Education and Sport / Science, *Movement And Health, XV*(2), *suppl, 5*, 493-497. http://www.analefefs.ro/anale-fefs/2015/i2s/pe-autori/v2/41_v2.pdf

Nagelli, C.V., & Hewett T.E. (2017). Should return to sport be delayed until 2 years after anterior cruciate ligament reconstruction? Biological and functional considerations. *Sports Med., 47*(2), 221–232.

Petersen, W., Fink, C., & Kopf, S. (2017). Return to sports after ACL reconstruction: a paradigm shift from time to function. *Knee Surg Sports Traumatol Arthrosc., 25*(5), 1353-1355. https://doi.org/10.1007/s00167-017-4559-x.

Rambaud, A.J.M., Semay, B., Samozino, P., Morin, J.B., Testa, R., Philippot R…Edouard P. (2017). Criteria for Return to Sport after Anterior Cruciate Ligament reconstruction with lower reinjury risk (CR'STAL study): protocol for a prospective observational study in France. BMJ Open;7:e015087. doi:10.1136/ bmjopen-2016-015087.

Risberg, M.A. & Holm, I. (2009). The long-term effect of 2 postoperative rehabilitation programs after anterior cruciate ligament reconstruction: A randomized controlled clinical trial with 2 years of follow-up. *Am J Sports Med., 37*(10), 1958-66. doi: 10.1177/0363546509335196.

Roi, G.S., Creta, D., Nanni, G., Marcacci, M., Zaffagnini, S., & Snyder-Mackler, L. (2005). Return to official Italian First Division soccer games within 90 days after anterior cruciate ligament reconstruction: a case report. *J Orthop Sports Phys Ther., 35*(2), 52-61; discussion 61-6. doi:10.2519/jospt.2005.35.2.52

Saka, T., (2014). Principles of postoperative anterior cruciate ligament reconstruction. *World Journal of Orthopedics 4*, 450–459. http://dx.doi.org/10.5312/wjo. v5.i4.450.

Sikka, R., Kurtenbach, C., Steubs, J.T., Boyd, J.L., & Nelson, B.J. (2016). Anterior cruciate ligament injuries in professional hockey players. *Am J Sports Med, 44*, 378–83.

Stratford, P.W., Hart, D.L., Binkley, J.M., Kennedy, D.M., Alcock, G.K., & Hanna, S.E. (2005). Interpreting lower extremity functional status scores. *Physiotherapy Canada, 57*(2), 154-162. https://download.lww.com/wolterskluwer_vitalstream_com/PermaLink/JSM/A/JSM_2012_01_30_ROBBINS_200748_SDC1.pdf . 1

Schiffner, E., Latz, D., Grassmanna, J. P., Schek. A., Thelena, S., Windolf, J… Jungbluth P. (2018). Anterior cruciate ligament ruptures in German elite soccer players: Epidemiology, mechanisms, and return to play. *The Knee, 25*, 219–225; doi: https://doi.org/10.1016/j.knee.2018.01.010.

Spindler, K.P., & Wright, R.W. (2008). Anterior cruciate ligament tear. *N Engl J Med., 359*(20), 2135–2142. doi:10.1056/NEJMcp0804745

Teodor, D. (2017).When return to sport athletes after the anterior cruciate ligament (ACL) injury? *Science, Movement and Health, XVII*(2), (Supplement 2), 517-522. http://www.analefefs.ro/en/analefefs/2017/i2s/pe-autori/TEODOR%20Dragos-Florin%202.pdf

Tjong, V.K., Murnaghan, M.L., Nyhof-Young, J.M., & Ogilvie-Harris, D.J. (2014). 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. Feb; 42(2):336-42. *Am J Sports Med., 42*(2), 336-42. doi: 10.1177/0363546513508762.

van Grinsven, S., van Cingel, R.E., Holla, C.J., & van Loon, C.J. (2010). Evidence-based rehabilitation following anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc., 18*(8), 1128-44. doi: 10.1007/s00167-009-1027-2. Epub 2010 Jan 13.

Webster, K.E., Feller, J.A., Leigh, W.B., & Richmond, A.K. (2014). Younger patients are at increased risk for graft rupture and contralateral injury after anterior cruciate ligament reconstruction. *Am J Sports Med., 42*(3), 641-7. doi: 10.1177/0363546513517540. Epub 2014 Jan 22.

Wilk, K.E. (2015). Anterior Cruciate Ligament Injury Prevention and Rehabilitation: Let's Get It Right. *J Orthop Sports Phys Ther, 45*(10), 729-730. doi:10.2519/jospt.2015.0109

Waldén, M., Krosshaug, T., Bjørneboe, J., Andersen, T.E., Faul, O., & Hägglund, M. (2015). Three distinct mechanisms predominate in non-contact anterior cruciate ligament injuries in male professional football: a systematic video analysis of 39 cases. *Br J Sports Med., 49*(22), 1452-60. doi: 10.1136/bjsports-2014-094573.

Waldén, M., Hägglund, M., Magnusson, H., & Ekstrand, J. (2011) Anterior cruciate ligament injury in elite football: a prospective three-cohort study. *Knee Surg Sports Traumatol Arthrosc., 19*(1), 11-9. doi: 10.1007/s00167-010-1170-9. Epub 2010 Jun 9.

Wright, R.W., Haas, A.K., Anderson, J., Calabrese, G., Cavanaugh, J., Hewett T.E., … Williams, G. (2015). Anterior Cruciate Ligament Reconstruction Rehabilitation: MOON Guidelines. *Sports Health, 7*(3), 239-243. doi:10.1177/1941738113517855

Zaffagnini, S., Grassi, A., Marcheggiani Muccioli, G.M., Tsapralis, K., Ricci, M., Bragonzoni, L… Marcacci, M. (2014). Return to sport after anterior cruciate ligament reconstruction in professional soccer players. *Knee, 21*(3), 731-5. doi: 10.1016/j.knee.2014.02.005.

Zaffagnini, S., Grassi, A., Serra, M., & Marcacci, M. (2015). Return to sport after ACL reconstruction: how, when and why? A narrative review of current evidence. *Joints*, *3*(1), 25–30. PMID: 26151036