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POST-OPERATIVE REHABILITATION PROGRAM AFTER SURGERY ACL RECONSTRUCTION

1. INTRODUCTION

The anterior cruciate ligament (ACL) is one of the four major ligaments that provide stability and minimize stress across the knee joint. An increased level of terrestrial physical activity places excessive loading on the knee joint and ACL and consequently increases the risk of injury. The risk of suffering an anterior cruciate ligament injury (ACLI) is considerably higher in athletes (Hewett, Griffin, 2007). ACLI is associated with abnormal loading of the knee caused by unsuccessful postural adjustments to rapid changes in the external environment (Besier, Lloyd, Cochran&Ackland, 2001), with approximately 70% of ACLI being noncontact in nature (McNair, Marshall&Matheson, 1990). ACLI rates vary between sports, with athletes involved in game-based team sports being particularly susceptible to this type of injury as they are constantly exposed to potentially damaging forces while performing numerous repetitions of cutting, landing, and jumping in both practice and competition (Agel, Arendt&Bershadsy, 2005;Mihata, Beutler&Boden,2006; Prodrornos, Han, Rogowski, Joyce&Shi,2007). ACL injuries are a problem in many team sports, particularly among women (Engstrom et al., 1991.; Lindenfeld et al.,1994.;Hippe et al.,1993). The risk of rupturing the ACL is five times higher among women than among men, and the gender difference is even higher at the elite level than in lower divisions (Myklebust et al, 1997, 1998). It is reported incidence of 1.6 injuries per 1,000 player-hours for elite female players during matches, in handball (Myklebust, 1998). An ACLI can be devastating to an athlete, as this type of injury is accompanied by long disability time and high economic cost as compared with other common athletic injuries (Gottlob&Baker,2000). Operative treatment is widely performed in the athletic environment (Meuffels et al., 2009).

The main goals of ACL ruptures operative treatment are to restore knee stability, limit loss of function in the knee, and limit risk or onset of degenerative changes to other knee structures. It has been reported that such treatment, although highly improved in past 20 years, has a success rate of around 75% (Kamath, Redfern, Greis, & Burks, 2011), which leaves a substantial number of patients with unsatisfactory results. Finally, the athlete who undergoes surgery is at significantly greater risk of developing secondary injury and knee osteoarthritis in the long term (Lohmander, Englund, Dahl, & Roos, 2007).

Sport practitioners constantly seek information regarding the effectiveness of training regimens for performance enhancement, injury prevention and rehabilitation. Therefore, the purpose of this article is to provide a model of training program aimed to post op period. The surgical procedure is one aspect of a successful outcome after

ACL reconstruction; however, a scientifically based and well-designed rehabilitation program also plays a vital role.

2. METHODS

This research is made as case study, with one subject.

Subject was female professional handball player (pivot) 28 years old with 13 year playing carrier (International/National team player), and previously with ACL injury of another knee (surgery treatment 10 years ago).

Detailed analyses of 9 week training protocol in rehabilitation after ACL surgery was done.

The program started exactly 3 month after surgery and subject till then didn't have serious rehabilitation program, except of hospital and physio treatment. Body mass, percentage of body fat, and maximal oxygen uptake (VO_{2max}) were measured at the beginning and at the 5th week of training program, as control data for program efficacy.

3. RESULTS

Results are presented in two tables, with training program protocols. First period (5 week) was conducted under coach supervision, and second period (4 week) was conducted with according written individual program in club. Some explanations about training programs were done.

T – training

EMS – training + electrical muscle stimulation. Program of EMS was performed with COMPEX mi sport (Medical SA - All rights reserved - 07/06 - Art. 885,616 - V.2 model). Treatments were from 24 to 50 min duration. Following muscle group were under EMS program: m. quadriceps femoris, hamstring muscle, soleus muscle on both legs.

(SWP) – training in swimming pool (at the beginning exercise which consists swimming, running in deep water, in combination with handball movement exercise, during the time, were substitute with same exercise in shallow water). Thera-band equipment and medicine ball were mostly used. Duration of training were usually around 90 min.

(H&H) - Hoff and Helgerund (Hoff et al., 2002) method of specific aerobic endurance training was used on ergo cycle at the beginning and later in running, to improve aerobic capacity. Interval method was similar to handball game.

Jump training – step box (10-20cm)

ROM – range of motion (ROM activities for hyperextension and flexion four times per day)

Table 1. Training protocol for 5 week (training program)

	Days	Training 1	Training 2	Exercise type	EMS (compex)
week 1	1	T (test)	T (H&H)+EMS	strength + ergo cycle +ROM	Hypertrophy/Recovery
	2	T	T+EMS	strength + ergo cycle +ROM	Hypertrophy/Recovery
	3	free	free		
	4	T+EMS	T	strength + ergo cycle +ROM	Hypertrophy/Recovery
	5	T (SWP)	T+EMS	swimming + running (swp)	Hypertrophy/Recovery
	6	T (H&H)	free	ergo cycle + running in place +ROM	
	7	free	free		
week 2	1	T	T (H&H)+EMS	strength + ergo cycle +ROM	Hypertrophy/Strength
	2	T (SWP)	T+EMS	swimming + running (24min) +ROM	Hypertrophy/Strength
	3	T (SWP)	free	swimming + running (swp) +ROM	
	4	T	T+EMS	strength + ergo cycle + ROM	Hypertrophy/Strength
	5	T (SWP)	T+EMS	swimming + running (H&H) +ROM	Hypertrophy/Strength
	6	T	free	strength + running (60min) +ROM	
	7	free	free		
week 3	1	free	free		
	2	T	T+EMS	strength + ergo cycle (H&H) +ROM	Fartlek
	3	free	T+EMS	stepper exercise + running +ROM	Fartlek
	4	T	T+EMS	strength proprioceptive + running	Strength
	5	T	T+EMS	strength proprioceptive + running	Cross training
	6	T+EMS	free	running (H&H)	Cross endurance
	7	free	free		
week 4	1	test	free		
	2	free	free		
	3	free	T+EMS	running (3*10min)	Hypertrophy/Strength
	4	T (SWP)	T+EMS	swimming + handball (proprioceptive)	Hypertrophy/Strength
	5	T+EMS	T	handball exercise (proprioceptive)	Hypertrophy/Strength
	6	EMS	free		Hypertrophy/Strength
	7	free	free		
week 5	1	free	T+EMS	jump training	Explosive strength/Plyometry
	2	T (jumps)	T+EMS	jump training + running (H&H)	Explosive strength/Plyometry
	3	free	T+EMS	handball + running	Explosive strength/Plyometry
	4	T (jumps)	T+EMS	handball	Explosive strength/Plyometry
	5	free			
	6	free			
	7	test			

Table 2. Training protocol for 4 week (training program in club)

	Days	Training 1	Training 2	Exercise type
week 6	1	free	T	running (50min)
	2	T (strength)	T	jump training
	3	T (strength)	T	running (H&H)
	4	free	T	speed training
	5	T (strength)	T	running (24min - interval training)
	6	free	T	running (50min)
	7	free	free	
week 7	1	T (strength)	T	jump training
	2	T (strength)	T	running (25min - interval training)
	3	free	T	speed training
	4	T (strength)	T	running (H&H)
	5	T (strength)	T	jump training
	6	free	T	running (50min)
	7	free	free	
week 8	1	T (strength)	T	jump training
	2	T (strength)	T	running (24min - interval training)
	3	free	T	speed training
	4	T (strength)	T	running (H&H)
	5	T (strength)	T	jump training
	6	free	T	running (30min)
	7	free	free	
week 9	1		T (handball)	
	2			
	3			
	4		T (H&H)	
	5			
	6	GAME		

Effect of the Training Program

The Astrand - Rhyming test (1960) on ergo cycle was done at beginning and at the end of the 5th week of program. Body composition measurement was also done at the beginning and at the end of the 5th week. Results are shown in following table. Athlete increase her functional ability, and increase muscle mass, with reducing of fat mass.

Table 3. Functional and morphological data

	VO ₂ max	Body weight	Body fat %
Initial measurement	51.33 ml/kg/min	68.7 kg	17.7
Final measurement	55.07 ml/kg/min	69.8 kg	15.6

4. DISCUSSION

Current rehabilitation programs following ACL reconstruction are more aggressive than those utilized in the 1980s. 3 different rehabilitation programs are utilized for patients with an isolated ACL reconstruction: 1) accelerated program 2) regular program for patellar tendon reconstruction 3) separate protocol for hamstring reconstruction. The accelerated approach is utilized for the young and/or athletic patient. The

main differences between the 2 programs are the rate of progression through the various phases of rehabilitation and the recovery time necessary prior to running and a full return to athletic activities (Wilk et al., 2012). This program is more adequate for older athletes. With following characteristics: **ACL Rehabilitation Exercises for week 1-2:** prepare for training, isometric exercise, ergo cycle, swimming pool exercise (running), light jogging, ROM, EMS; **week 3-4:** ergo cycle (higher intensity), running (forward – backward), proprioception training; **week 5-6:** Running (higher intensity), handball training (proprioceptive), jump training (plyometric); **week 7-8:** Running (high intensity), lateral movement, handball training, jump training (40cm); **week 9:** Handball training, running (high intensity), jump training, game.

Program is in relation with programs of Mayo Foundation for Medical Education and Research (2007). Decision about return into sport training and playing was made according functional progression, Graft type (it was not taken from a donor) and a Surgeon preference (Beynon et al., 2005). Bracing we used only in critical moments of training program (beginning of jump training, lateral movement, etc.), because studies have shown no benefit in preventing re-injury to the ACL (Beynon et al., 2005). According some research, which found an increased risk of ACL injury during the ovulatory phase (Wojtys et al, 1998), intensity and volume of training were decreased in menstrual period, and few days before and after.

A study (Myklebust et al., 2003) incorporated a multicomponent training intervention, consisted of stretching, proprioception, strengthening, and plyometric and agility drills, as it was implemented in this program. The most effective and efficient programs appear to require a combination of components, and the effects of these components are likely additive.

Current rehabilitation programs focus not only on strengthening exercises but also on proprioceptive and neuromuscular control drills to provide a neurological stimulus so that the athlete can regain the dynamic stability that is needed in athletic competition. Goal in the rehabilitation program following ACL surgery is to restore full, unrestricted function and to assist the patient to return to 100% of the pre injury level while achieving excellent long-term out-comes.

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ACL (anterior cruciate ligament) are small ligaments inside the knee capsule that connect the femur tibia, main function is to prevent movement of the femur in front of tibia and to provide stability, it also helps in controlling the movement of the knee, in direction back-forward. Injuries of ACL appear in an increasing number of athletes. Per year, from 100,000 people who have an injury of the knee joint, 30% have the reconstruction surgery of ACL. ACL injury accounts about 40% of all sports injuries. The greatest number of injuries just happens in the most popular sports, such as: basketball, football and handball, often in female athlete. After the injury, about 25% of athletes fail to return to the sport. Recovery time after surgery is usually 6-12 months, depending on individual characteristics, as well as technical and tactical

demands of specific sports activities. Choosing an appropriate and efficient rehabilitation protocols, and training is of great importance. The aim of this paper is to present training protocol of 60 days, 3 months after ACL reconstruction surgery, of top handball female athletes. In the first 30 days, a total of 74 training sessions were done, 39 trainings and 21 EMS (Electrical Muscle Stimulation) treatments, at the end of each workout. Functional abilities and morphological status were measured at the beginning and end of the treatment program. After the training protocol athlete got individual exercise program of 26 days (30 training sessions). After 20 days began with normal training, the 26th day of the first game played. The applied protocol has proven successful, as the third competition season there is no problem with an injury.

Key words: ACL rehabilitation, post-operative rehabilitation.

„Dan“, 21. mart 2013.

У СУСРЕТ НАУЧНИМ СКУПОВИМА ЦРНОГОРСКЕ СПОРТСКЕ АКАДЕМИЈЕ

Организатори већ спремни

Иако је до почетка научних скупова Црногорске спортске академије, који ће се од 4. до 6. априла први пут одржати у Подгорици остало још двије недјеље, организатори су саопштили да су у потпуности спремни да дочекају преко 200 учесника из 13 земаља свијета. Пријављено је преко 120 радова, а на списку од 91. до 100 налазе се: 91. Милан Чох, Милан Жван, Стојан Бурник (Факултет за спорт у Љубљани): „Биомониторинг еластичне снаге код елитних скакача трскока“, 92. Бујар Турјака, Азиз Дујака (Факултет за физичко васпитање и спорт у Приштини), Жарко Костовски (Факултет за физичку културу Универзитета „Св. Ћирила и Методија“ у Скопљу), Висар Ганиу, Шпреса Мемини (Факултет за физичку културу Државног универзитета у Тетову): „Ситуациони биомеханички параметри на слалом карвинг скијама код врхунских скијача“, 93. Горан Вучковић, Раша Димитријевић (Криминалистичко-полицијска академија у Београду): „Дискриминативни модел одређених моторичких показатеља фудбалера као селекциони критеријум позиције у екипи“, 94. Др Мустафа Левент Инице, ванредни професор (Средњеевропски технички универзитет, Одејек за спорт и физичку културу - Анкара): „Професионални развој настав-

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Т.Б.