Rehabilitation Program and Functional Outcomes for Anterior Cruciate Ligament Reconstruction

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ABSTRACT

Objective: *To investigate the effectiveness of pre and post-operative vs. only post-operative accelerated rehabilitation physical therapy program for athletes with anterior cruciate ligament (ACL) injury referred for physiotherapy pre and post-reconstruction surgery in terms of pain, instability and knee dysfunction.* ***Methods:*** *Thirty six male Zagazig University top performance athletes with a mean age of 21.8 ±4.3 years old BMI 23.8±3.2 with acute anterior cruciate ligament rupture of 28.9 ±16.2 days participated in this study. Participants were randomly divided into two groups. Group (1): 18 subjects received intensive physical therapy settings pre-operative plus post-operative 2 months accelerated rehabilitation program. Group (2): received only 2 months of accelerated rehabilitation program. Both groups were subjected for a single-incision arthroscopic ACL reconstruction using bone-patellar tendon-bone autograft (BPTB) technique and followed up for 12, 16, 24 weeks. Outcome measures: Knee range of motion (ROM), heel height difference (HHD), Patient's subjective satisfaction, patients was then evaluated performing a series of hop tests. RESULTS: Both study groups showed a significant improvement in all variables measured in the 24 week functional performance assessments. There was dramatic early significant improvement in mostly all variables during follow-up assessments. Athletes in the group 1 showed a significant difference in the subjective satisfaction which was maintained through out the study. Mostly all improvements were maintained at the 6 month follow up assessments.* ***Conclusions:*** *Accelerated rehabilitation physical therapy program, either as a pre-and post-operative treatment or only postoperative is an effective intervention for patients with ACLR. Although all patients had improvement, pre-and post-operative physical therapy group was superior to post-operative program group alone for the functional performance at 16 week evaluation. These results indicate that patients who choose to attend a pre-operative physiotherapy program before ACLR can achieve satisfactory, if not better, outcomes than patients who attend only post-operative physiotherapy.*

Key wards: *Anterior cruciate ligament injury, rehabilitation program, Bone-Patellar Tendon-Bone autograft, functional assessment.*

INTRODUCTION

It is well documented that the anterior cruciate ligament (ACL) plays an important role in maintaining anterior stability of the knee. ACL laxity is a prelude to mechanical instability and degeneration of the joint. Integrity of the ACL is particularly crucial for athletes whose sports activities include running and jumping sports[37]. Its rupture is a common injury during both sports and leisure time activities[19], as it is the most commonly reconstructed ligament of the knee[3]. Athletes often find it difficult to return to full function after injury to the ACL, and surgery is frequently indicated[9]. Gray et al. (1999)[15] reported that the ACL not only serves a mechanical role by limiting passive

knee mobility but also serves a sensory role through the mechanoreceptors deep in its tissue, which communicate with the neuromuscular system to provide proprio-ceptive feedback during training and competition.

The primary goal of arthroscopic surgical ACL reconstruction (ACLR) in professional athletes is to restore the physiological functions of the injured knee and to allow the patients to return to pre-injury sports activities and competitions. For professional soccer players, the pressure to return to pre-injury competitive levels is immense and the goal of the surgical and rehabilitation sports teams is the fastest possible safe return to competitions of their patients. This pressure has accelerated research in the orthopedic and rehabilitation fields, so actually there are several surgical techniques giving the possibility of an accelerated rehabilitation that seems to not adversely affect the functional recovery[30]. Shelbourne and Nitz (1992)[33] introduced the concept of accelerated rehabilitation with return to sports activities within 4–6 months. Physiotherapy based rehabilitation programs are often used after ACLR surgery[10,12]. In general, these programs are designed to maximize function by restoring range of motion, strength, and neuromuscular coordination[11].

The purpose of this study was to determine the relationships among the aforementioned clinical outcome measures in patients who underwent arthroscopically assisted ACLR and pre-and postoperative rehabilitation.

SUBJECTS AND METHOD

Thirty Six male Zagazig University top performance athletes with a mean age of 21.8 ±4.3 years old BMI 23.8±3.2 with acute ACL rupture of 28.9 ±16.2 days participated in this study. All subjects were referred from the outpatient department by orthopedic surgery Zagazig University student hospital. Subject recruitment began on July 1, 2007 till end of April 2008. The minimum acceptable time periods between injury and operation was 10 days. Participants were randomly assigned into two groups. Group (1): 18 subjects received intensive daily physical therapy sessions for two weeks pre-operative plus three times a week for 2 months post-operative accelerated rehabilitation program. Group (2): received only 2 months of the same rehabilitation program, both groups were followed up for 12, 16 and 24 weeks.

Exclusion criteria included significant concomitant injury such as a collateral ligament injury greater than a sprain, a meniscal tear requiring repair rather than resection or no treatment, a full thickness chondral lesion, or a PCL injury, signs of infection, reduced general condition, and prior reconstruction. All of the patients chose to undergo ACLR surgery because of pain, soreness, giving way, and an inability to perform sports activities.

All the patients tested were healthy and active. Clinical assessments were made before operation and after surgery at 12, 16, and 24 weeks. All surgeries were performed using a single-incision arthroscopic ACLR on ipsilateral knee. Patients were hospitalized an average of 1.3 days. Informed consent to participate in the study was obtained from all participants.

Rehabilitation

Rehabilitation after ACLR must first strive to achieve full symmetrical knee ROM before aggressive strengthening can begin. The pre-operative rehabilitation starts at the time of injury and includes aggressive swelling

reduction, hyperextension exercises, gait training, and mental preparation. The goals of the accelerated rehabilitation protocol was to decrease postoperative complications without jeopardizing the long term stability of the ACL reconstructed knee, and control swelling while regaining full knee ROM. All patients followed the same postoperative rehabilitation protocol according to Time et al. (2004)[34].

Gradual full weight-bearing with full knee extension was allowed from the first day post-surgery as tolerated and emphasis was placed on obtaining early full hyperextension. Continuous passive motion (CPM) was performed using a motorized CPM device. Analgesic treatment was applied when necessary in combination with local cooling. From the 5th day the CPM device was used to obtain up to 90° flexion and full extension of the knee. Knee protection was provided by a knee brace that was fitted and worn until week 6 postoperative without limitation of extension or flexion. By the 2nd postoperative week, the patients with a 100^0 ROM participated in a guided exercise and strengthening program. The second phase started from weeks 4 to 8 and comprised of the open and closed kinetic chain exercises such as mini squats, toe raises, training of the hip and knee extensors on a leg press machine, isometric quadriceps contraction, ROM exercises, and straight leg raising. By the 4th week, patients were permitted unlimited activities of daily living and were allowed to return to light sports activities as early as the 8th week if the functional performance scores of the involved extremity exceeded 70% of the scores of the noninvolved extremity and the patient had completed a sport-specific functional program. Through weeks 12, 16, to 24 added proprioceptive, balance, and gait training. Additional exercises were of the hip adductors and abductors and knee flexors. Endurance training of the leg muscles was allowed in both groups using a stationary bicycle. The third phase varied depending on the subjects' needs. This included running, stair climbing, and bicycling programs combined with progressive resistive exercises. Successful completion of the aforementioned phase qualified the patient for the fourth and final phase which involves a safe return to sports.

Patellar tendon graft

The reconstructive procedure was performed arthroscopically in all patients by one experienced surgeon, using a patellar tendon (BPTB) autograft according to Tim et al. (2004)[34]. A standard arthroscopic one-incision technique using the single-channel method and Arthrex guides for tunnel placement was used in all patients. The central third of the patellar tendon and a bone block (length 2.5 cm) were harvested from the patella and tibia, respectively, through a longitudinal incision. The width of the graft was 8–10 mm, depending on the size of the patellar tendon. A small notch plasty was performed to avoid graft impingement. The graft was placed in approximately the 10.30 (right knee) or 1.30 (left knee) position in the posterior intercondylar notch. The fixation was performed using bioresorbable interference screws (Arthrex), Cannuflex silk screws 20 mm from at both ends, 7 mm diameter in femur and 7–9 mm in tibia (Acufex Ltd, Naples, FL, USA).

Functional Outcomes

Functional outcomes are what determine the success or failure of the surgical intervention. Knee flexion evaluated by ROM as measured by a goniometer. Functional performance was also evaluated using the one-leg hop test. Heel height differences (HHD) in

the prone position measured to the nearest centimeter.

The Series of Hop Tests

The single hop for distance was performed as outlined by Andrea et al (2007)2 within the 12th week following ACLR. Subjects stood on the leg to be tested, hopped, and landed on the same limb. The distance hopped (measured at the level of the great toe) was measured and recorded to the nearest centimeter from a standard tape measure. It was performed 3 times with each leg and the best distance was recorded and used as the dependent score. The timed 6-m hop was performed as the subjects were instructed to perform large one-legged hops in series over the total distance. A standard stopwatch was used to record time. Measure the triple hop for distance was performed as the subjects were instructed to stand on one leg and perform 3 consecutive hops as far as possible, landing on the same leg. The total distance for 3 consecutive hops was recorded. Finally, the crossover hop for distance was performed over a 15-cm strip on the floor. The subjects hopped forward 3 times while alternately crossing over a marking. The total distance hopped forward was recorded. For each set of tests, the subjects were instructed to begin with the nonoperative limb. Use of arm swing was not discouraged, as subjects were asked to perform with maximal effort. The testing procedures were identical on each test occasion and were administered by the same investigator. Single-leg hop-for-distance scores are commonly expressed as a limb symmetry index (LSI), which is calculated as outlined by Carl et al (2002)9 as the mean score of the involved limb divided by the mean score of the uninvolved limb, with the result multiplied by 100. Overall combination of Hops was expressed as the mean summation of limb symmetry index of all tests.

Range of motion

ROM was recorded on both sides pre-operatively and at each follow-up. A standard hand-held goniometer was used. The flexion measurements were measured when the patient slid his heel as close to the buttocks as possible without any arms help.

Subjective Assessment

Subjective patient satisfaction was evaluated using several methods as outlined by James et al (2001)17. Patients were asked to respond with a simple yes or no if they would consider having the procedure performed on the opposite knee if faced with similar circumstances. They were asked to categorize their satisfaction level as completely, mostly, or somewhat satisfied, or dissatisfied.

Statistical Methods

SPSS for Windows software was used for data management and statistical analysis. To compare the groups concerning demographic measurements, ANOVA tests were used in group analyses. The repeated measure analysis of variance (ANOVA) was used to compare the study groups on nominal variables, and paired t test was used to test the changes from baseline. The level of significance was set at 0.05 for all statistical tests.

RESULTS

All patients in both groups completed their participation in the study. There were no differences between the two groups in terms of demographic data (Table 1). The right knee represented the injured knee in 14 of the 36 knees (39%) and the dominant knee in 32

subjects (89%). Thirty three (92%) patients were injured during sports participation and three (8%) during work or other activities. The patients were evaluated pre-operatively at 12, 16 and 24 weeks postoperative. Subjects in both rehabilitation programs reported similar incidences of immediate postoperative joint effusion, hemarthrosis, soft tissue swelling, flexion and extension limits of the knee, use of pain medications, and time of stay in the hospital. No postoperative complications were recorded. All patients performed the four functional tests without complaints of pain or giving way.

There were no significant differences among the 4 parameters for mean symmetry index

Table (1): Characteristics of all subjects of the study.

Variables	Mean	SD±	Range
Age	21.8	4.3	19-27 Y
Height (cm)	176.2	7.6	
Weight (kg)	74.8	7.6	58.9-88.2
BMI	23.8	3.2	-27.7 24.6
O l (R/L)	14/22	-	-
D L (R/L)	32/4	-	-
TOT (days)	28.9 d	16.2	14-45

M: Mean, BMI: body mass index, OL: Operative limb, DL: Dominant limb, TOT: Time of trauma

Percentage difference between sides at 24 weeks (P>0 .05). The mean symmetry index percentage difference for the single-leg hop was 88.4±10.2 % for group 1 and 87.8±9.4 % for group 2. The mean symmetry index percentage difference for the timed 6-m hop at 24 weeks for group1 was 89.6±9.7% and 88.7±9.6% for group 2. The mean symmetry index percentage difference for the triple hop for distance at 24 weeks was 87.6±10.7% for group 1 and 86.2±11.4% for group 2. The mean symmetry index percentage difference for the crossover hop for distance at 24 weeks was 82.9±10.4 % for group 1 and 82.3±11.6%for group 2.

The overall combination of Hops showed a significant difference for both group at the 24 weeks evaluation (P<0.05), while there was no statistically significant difference between both groups at the end of study (P>0 .05).

The range of flexion was significantly reduced post-operatively in both groups. The trend for improvement was evident throughout the period of follow-up, and both groups showed significant difference (120±9° vs115±12°) (P<0.05), although the differences between both groups were most apparent during the first evaluation (P<0.05). At the 24 weeks follow-up the mean ROM in both groups was nearly the same with no significant difference 135±7° for group 1 vs. 134±8° for group 2 (P>0 .05) (Table 2).

Mean prone heel height difference (HHD) at 24 weeks for group 2 was significantly higher by statistical means at 1.3±0.6 cm versus 0.9±0.4 cm for group 1 (P>0.05) (Table 2).

Subjective Satisfaction

Ninety-six percent of group (1) and 78% of group (2) would have had the surgery over again given similar circumstances (P>0 .05).

For the 24 weeks evaluation, 69% of group1 patients were completely satisfied, 29% were mostly satisfied, 2% were somewhat satisfied, and no patients were dissatisfied. For group (2), 60% were completely satisfied, 33% were mostly satisfied, 5% were somewhat satisfied, and 2% were dissatisfied. Significant differences were noted between both groups in the percentage of patients with completely, mostly, somewhat, or dissatisfied responses (P>0.05) for group 1.

Table (2): The post operative measurements of both treatment groups.

Test	Group	12 Weeks				16 Weeks				24 Weeks				L.S.D 0.05	
		G1		G2		G1		G2		G1		G2		G2	G2
		M	SD±	M	SD±	M	SD±	M	SD±	M	SD±	M	SD±		
Single hop	OL (cm)	28.3	12.9	24.4	14.4	42.3*	12.3	39.4*	12.7	52.8*	12.5	50.3*	12.6	8.46	8.93
	NOL(cm)	34.6	6.2	30.3	8.7	51.4*	10.3	47.9*	10.9	59.7*	9.8	57.2*	10.3	6.03	6.74
	SI (%)	81.9	8.6	80.4	9.2	82.3	12.5	82.2	11.4	88.4	10.2	87.8	11.4	7.11	7.22
6-m timed hop	OL (cm)	3.4	1.9	3.7	2.5	2.9	1.2	3.1	1.1	2.6	0.9	2.8	0.8	0.94	1.11
	NOL(cm)	2.5	0.8	2.7	0.7	2.3	0.5	2.5	0.6	2.3	0.6	2.5	0.5	0.43	0.41
	SI (%)	81.6	16.3	78.9	16.2	83.2	12.9	82.4	11.8	89.6	9.7	88.7	9.6	8.92	8.64
Triple hop	OL (cm)	66.3	39.7	59.4	40.2	110.5*	36.1	104.6*	34.5	159.4*	87.3	152.4*	38.7	39.84	25.50
	NOL(cm)	80.3	36.4	74.8	37.8	134.6*	34.7	128.8*	29.3	182*	85.1	176.8*	36.7	38.43	23.44
	SI (%)	82.6	13.5	79.4	12.8	82.1	12.7	81.2	13.8	87.6	10.7	86.2	11.4	8.32	8.55
Crossover hop	OL (cm)	87.7	32.9	78.8	38.3	126.9*	32.6	118.5*	37.6	162.9*	39.5	159.8*	37.6	23.66	25.48
	NOL(cm)	107.8	26.3	99.8	28.4	150.7*	34.7	143.4*	38.4	191.5*	31.2	190.6*	33.2	20.82	22.61
	SI (%)	81.3	13.2	78.9	13.6	84.2	13.4	82.7	15.7	85.1	10.4	84.1	11.6	8.36	9.25
OCH%		81.8	13.3	79.4	13.8	82.7	10.9	82.5	12.2	87.6	7.9	86.7	9.4	7.36	8.04
ROM		120	9	115	12	128*	11	121*	13	135*	7	134*	8	6.16	7.55
HHD(cm)		2.3	0.9	3.8	1.3	1.2*	0.8	3.2	1.2	0.9*	0.4	1.3*	0.6	0.49	0.73
Subjective Satisfaction %	Cs	32	3.4	25	2.4	55*	5.2	42*	3.9	69*	6.3	60*	5.4	3.44	2.75
	Ms	57	5.9	39	3.8	37*	3.5	45*	4.2	29*	2.5	33*	2.9	2.84	2.47
	Ss	9	1.2	29	2.7	6*	0.71	7*	0.88	2*	0.31	5*	0.51	0.56	1.12
	Ds	2	0.32	7	0.99	2	0.23	6*	0.74	00.0*	0	2*	0.23	0.15	0.49

IPO: Immediate preoperative, O L: Operative limb, NOL: Nonoperative limb, SI (%): Symmetry index (%), QMS: quadriceps muscle strength, HHD: Heel height difference. OCH%: Overall combination of Hops: limb symmetry index(%), (SS: Subjective satisfaction, Cs: completely satisfied, Ms: mostly satisfied, Ss: somewhat satisfied, Ds

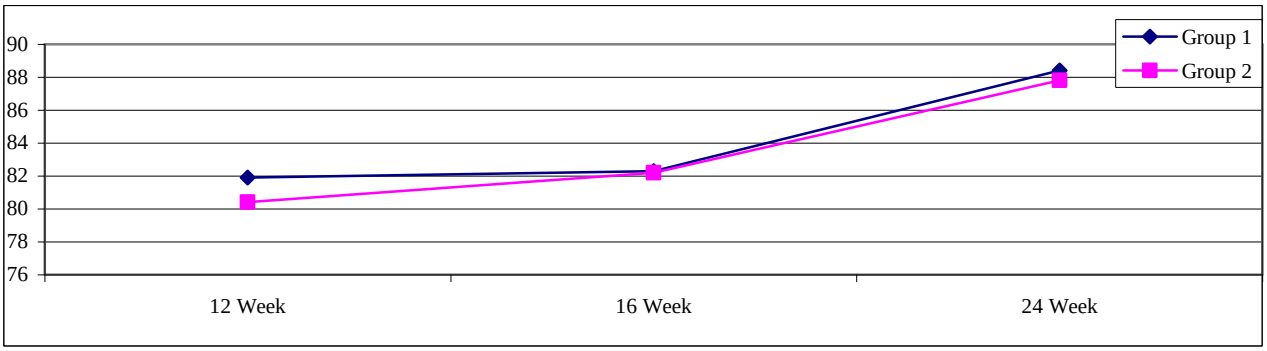

Fig. (1): Mean Symmetry index (%) of single hop for both groups.

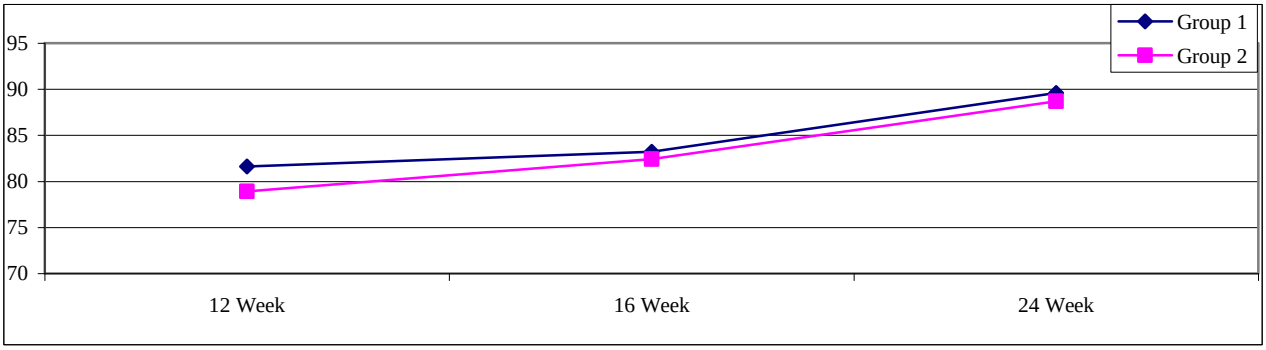

Fig. (2): Mean Symmetry index (%) of 6 m timed hop for both groups.

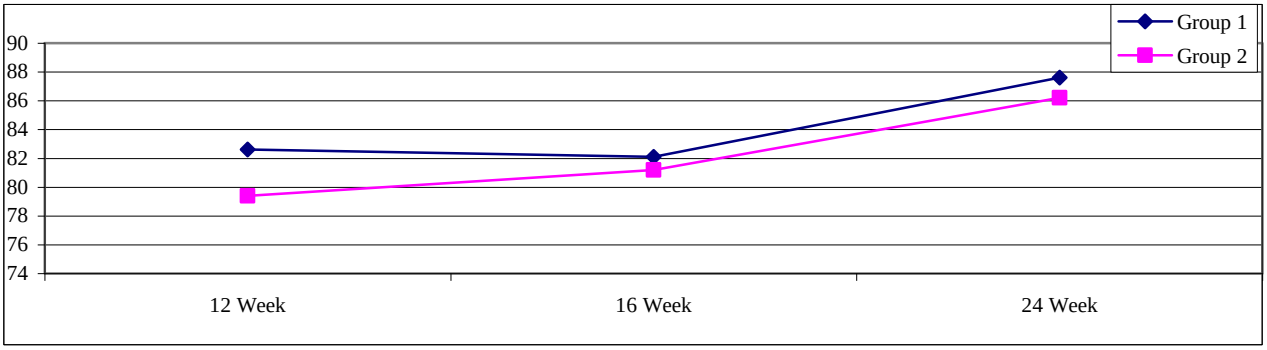

Fig. (3): Mean Symmetry index (%) of triple hop for both groups.

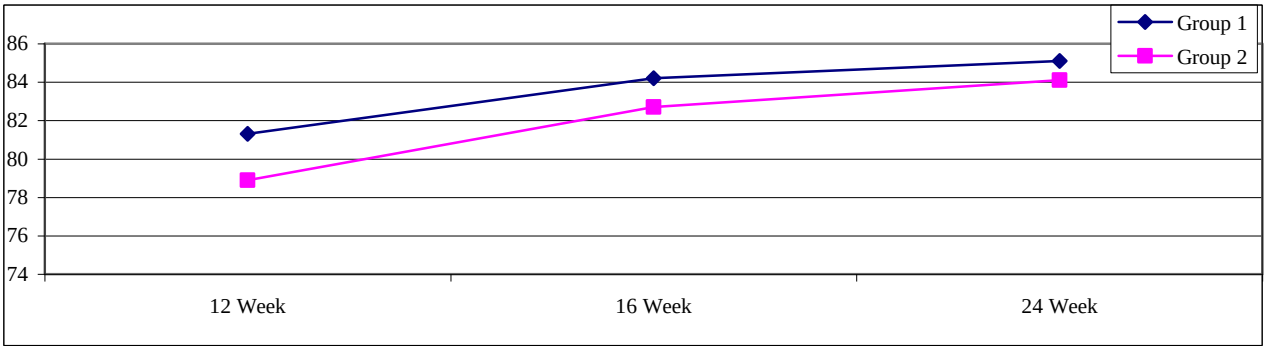

Fig. (4): Mean Symmetry index (%) of crossover hops for both groups.

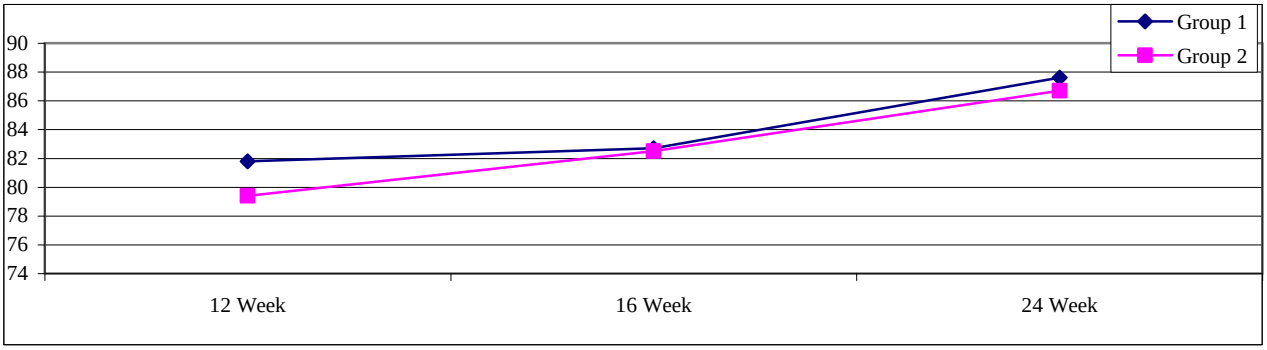

Fig. (5): Mean Symmetry index (%) of overall combination of hops for both groups.

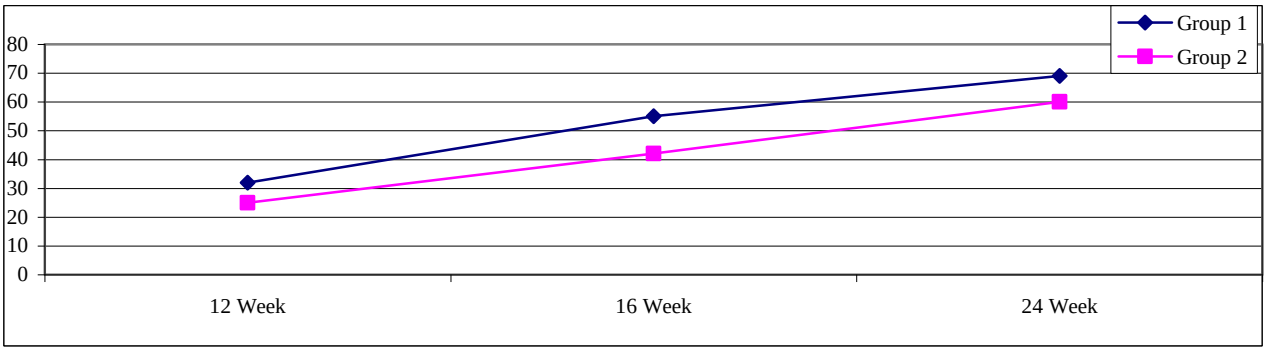

Fig. (6): Mean subjective satisfaction (%) of both groups.

DISCUSSION

The overall results of the present study revealed a significant improvements for the 12 weeks assessments for the group 1 followed by significant improvements in both groups in functional performance and patient's subjective satisfaction at 24 weeks evaluation this may be explained by the effect of the pre-operative rehabilitation program and the increased patient satisfaction of the group 1, this was confirmed by Feller et al. (2004)[11] who also observed a significant improvement in clinical outcome and patient satisfaction following ACLR after a pre-and post-operative rehabilitation program which is designed to maximize function by restoring ROM, strength, and neuromuscular coordination. Beynnon and Johnson (1996)[6] reported that Postoperative rehabilitation is a major factor in the success of an ACLR procedure. Results of the present study is consistent and explained by the work of Bruce et al. (2002)[8] who reported that rehabilitation that incorporates early joint motion is beneficial for reducing pain, minimizing capsular contructures, decreasing scar formation that can limit joint motion, and is beneficial for articular cartilage. They also added that there is evidence derived from randomized controlled trials that immediately after ACLR, weightbearing is possible without producing an increase of anterior knee laxity and is beneficial because it lowers the incidence of patellofemoral pain.

Accelerated rehabilitation program applied during the present study accompanied with the application of bone-patellar tendon-bone autograft technique for both groups were in parallel with the principles of accelerated rehabilitation that were described by

Shelbourne and Nitz (1992)[33] and were further modified by Muneta et al. (1998)[27], their results have been considered accelerated rehabilitation program as uniformly good, especially in patients operated on using BPTB autograft and more effective than traditional program in reducing limitations of motion. Benoit et al. (2008)[5] concluded that arthroscopic ACLR using BPTB autograft resulted in high patient satisfaction levels and good clinical results after 10 years. Moreover, a high percentage of patients remained involved in sports activities, and ACLR protected their meniscus from a secondary tear. Shelbourne and Klotz (2006)[32] reported that the patellar tendon autograft fixed with buttons provides tight bone-to-bone placement of the graft and quick bony healing, which allows accelerated rehabilitation to obtain full range of motion and strength. Zaidi et al. (2008)[37] reported that ACLR with the patella ligament (PL) provides good outcome based on physical and functional evaluation. Although there are recent advances in ACLR using hamstring tendon graft, allograft or other synthetic materials, reconstruction with BPTB in still considered the gold standard.

The immediate weightbearing advised in this study are in consistence with MacDonald et al (1995)[21] and Tyler et al. (1998)[35] who favored an accelerated postoperative treatment program with full weight-bearing following ACLR surgery. In addition, they favored immediate, full range of motion coupled with wearing a knee brace for a maximum of 2 weeks. A return to sports activity was allowed after 4 (most sports) or 6 months (sports that involve pivoting) without any increase in complications or morbidity. Also Bruce et al. (2002)[8] reported that immediate weightbearing did not affect AP knee laxity (evaluated by clinical examination and KT-1000), as it does not seem to produce excessive loads across a healing graft that permanently deform the graft or its fixation and resulted in a decreased incidence of patellofemoral pain compared with rehabilitation with a 2-week delay of weightbearing. They added also that immobilization of the knee or limited motion without muscle activity, results in an unwanted outcome for the structure that surround the knee, as early joint motion after ACLR certainly is beneficial; in reducing pain, lessens adverse changes in articular cartilage, and helps prevent the formation of scar and capsular contractions that have the potential to limit joint motion. They also added that studies of tendon repairs have revealed that controlled loading can enhance the quality and rate of healing. For example, matrix collagen and repair cells become aligned with the axis of load applied to a healing tendon repair, whereas in the absence of load the matrix and repair cells become disorganized.

Tim et al. (2004)[34] reported that 64% of patients (n=72) operated with BPTB autograft had returned to their previous level of activity within a follow-up period of at least 24 months postoperative (range 24-40 months). O'Neill (1996)[29] found that patients in the LP group returned to a higher level of activity than patients in the semitendinosus tendon treatment (SG) group. Feller et al (2004)[11] observed a higher activity level in the BPTP group despite a lower IKDC score and a greater pain in general in BPTP group 4 months postoperatively. This conclusion was underscored by the Yunes et al. (2001)[36] meta-analysis which indicated a significant return to activity advantage for patients in the LP groups at a minimum follow-up of 2 years. Conflicting findings obtained by Ropke et al. (2001)[31] and Aglietti et al (1996)[1] who suggested improved functional results in patients who had received (SG) compared with

those who underwent LP treatment after follow-up of up to 24 months.

Jonas et al. (2006)[19] reported that recovery of knee joint function and the patient's ability to perform pre-injury activities are decisive factors in assessing surgical outcome. Hiemstra et al. (2000)[16] stated that strength and stiffness of the graft are important components. However, functional outcomes are what determine the success or failure of the surgical intervention. The ability to perform functional tests of the lower extremity within normal values is regarded as an important criterion. The return to levels of activity equal to or higher than preinjury levels at 24 weeks was attained by 58% of our patients. Our results do not completely confirm these prior findings these is explained by all of our patients were top performance athletes while patients of the previous studies were mostly active and some were athletes, BPTB technique was applied for all the participants while others used different techniques and our study used pre-operative physical therapy program followed by immediate post-operative accelerated rehabilitation program for group 1 while the others were interested only in post-operative rehabilitation program. Mologne and Friedman (2000)[26] reported that regardless of the technique, the goal of ACLR surgery is to eliminate the pivot shift phenomenon (the anterior subluxation of the tibia), restore normal knee kinematics, regain as much pain-free movement as possible, and resume optimal function. We found no difference in postoperative patellofemoral problems or donor-site morbidity between both groups.

In the present study series of hop tests were chosen according to Andrea et al (2007)[2] who consider it as an objective functional test, practical, performance based outcome measure that would provide stress to the knee joint while also allowing us to evaluate strength, as it correlates positively with muscular strength and confidence in the tested extremity, and requires minimal equipment and time to administer and provide a reliable and valid performance-based outcome measure for patients undergoing rehabilitation following ACLR. Barber et al. (1999)[4] and Noyes et al. (1991)[28] mentioned that the tests incorporate a variety of movement principles (ie, direction change, speed, acceleration-deceleration, and rebound) that mimic the demands of dynamic knee stability during sporting activities and are suggested to prepare the patient for return to such activities.

Fitzgerald et al. (2001)[13] suggested that hopping may be appropriate for use as a predictive tool for identifying patients who may have future problems as a result of knee injury or pathology and as an evaluative tool to reflect change in patient status in response to treatment. Jesper et al. (2004)[18] mentioned that a ratio of limb symmetry known as the limb symmetry index (LSI) has been the most frequently reported criterion for assessing whether a hop test is normal or abnormal. The LSI is used to calculate the difference in hop length between the injured and uninjured sides, help to differentiate individuals with and without dynamic knee stability and to compare different rehabilitation strategies following ACLR. An LSI of 15% difference between limbs is often regarded as satisfactory for single-leg hop tests. However, it should be noted that these values were empirically established by noting that 90% of subjects without a history of ACL injury had LSI's greater than or equal to 85%. This finding is in line with the observation of Jesper et al. (2004)[18] who noted that hop-symmetry scores of 90% for the single-leg hop test in healthy subjects. Moreover, it has been reported that in individuals with ACL-deficient knees only those performing at more than 90% of knee

function (including the single-leg hop test) compared with the uninjured side were able successfully to return to pre-injury levels of activity.

In the present study 58% of the patients included in this study exhibited limb symmetry of 85% or greater when all the four tests were averaged (Fig. 1, 2, 3, 4, 5) Carl et al (2002)[9] claimed the decreased percentage of limb symmetry index to the strength deficits of 5% to 34% after ACLR with the BPTP procedure and subsequent rehabilitation. These results also show no statistically significant difference between the two treatment groups in the 24 weeks evaluation for the series of hop tests, one explanation for the lack of significant concerns the time and the accelerated program for both groups as evidenced by high hop tests scores.

The patients subjective satisfaction showed a significant difference for group 1 through the follow up evaluations ($P<0.05$) (Fig. 6). This may explain the high hop scores of the group 1 at the 12 weeks assessments and explained by the pre-operative physical therapy program.

The mean HHD was significantly greater in group 2 compared with group 1 ($P<0.05$). Furthermore, group 1 constituted a significantly greater percentage of patients with HHD one or less cm ($P<0.05$). These results are in agreement with James et al. (2001)[17] who find a significant difference in HHD between women with a pre-and post-operative rehabilitation program and men with only post-operative program.

Regarding the ACLR timing Marcacci et al. (1995)[22] reported that patients who undergo early ACLR (≤15days after injury) can return to sports activity earlier and show better clinical results and higher knee joint stability than patients who undergo delayed reconstruction. Our clinical results did not confirm the findings of Marcacci et al. (1995)[22]. The main reason for the difference could be the different definition of acute trauma (14 days vs. 6 weeks). Foulk and Shelbourne (1995)[14] found a delayed return of quadriceps strength in patients who elected to have an early reconstruction and a slower progress to sport-specific rehabilitation exercises. An increased incidence of arthrofibrosis was also reported if the reconstruction was carried out within one week of injury. They therefore recommended that surgery be delayed by at least three weeks, and suggested introducing an accelerated postoperative rehabilitation programme to reduce knee stiffness. Karlsson et al. (1999)[20] found that reconstruction between two and 12 weeks after injury resulted in a higher activity level for competitive athletes. There was also a decrease in meniscal damage when compared with delayed surgery. Meighan (2003)[23] reported that postoperative stiffness of the knee is a well-recognised complication of ACLR. In particular, early reconstruction after tears of the ACL has been associated with an increased incidence of stiffness and prolonged rehabilitation. A delay in surgical reconstruction also has a potential morbidity, such as inability to return to employment or sporting activities because of instability of the knee. Currently, many surgeons prefer to treat injuries of the ACL with an initial period of rehabilitation followed by reconstruction two months or more after the injury.

It appears that as time increases, the patients gaining confidence and felt well regarding their overall knee functions. Additionally, there appears to be a relationship between the time, progress in rehabilitation program and all four hop tests. With constant patient evaluation and follow-up, clinically successful results have been achieved.

A knee brace can prevent uncontrolled anterior-to-posterior and torsional movement while the intra-articular proprioception remains impaired. With these techniques in mind, all of the patients in this study wore a knee brace during the first 6 weeks after surgery and participated in similar training programs under the supervision of a physical therapist. More recently, two prospective, randomized studies are consistent with ours Brandesson et al. (2001)[7] and Moller et al. (2001)[25] were reported that compared rehabilitation with and without the use of a brace during the first 3 weeks after surgery resulted in fewer problems with swelling, a lower prevalence of hemarthrosis and wound leakage, and less pain throughout the early recovery period in comparison with rehabilitation without the use of a brace.

The application of combined program of open and closed kinetic chain in our study are in agreement with Mikkelsen et al. (2000)[24] prospective, randomized study that compared closed kinetic chain versus combined closed and open kinetic chain rehabilitation initiated 6 weeks after ACLR with six- month follow-up revealed that the addition of open kinetic chain exercises produced a significant improvement in quadriceps strength, an earlier return to sport at the preinjury level, and did not effect KT-1000 arthrometer measurements of AP knee laxity.

Conclusion

A return to pain-free function of the knee joint is of major importance to patients who undergo ACLR. This function is best achieved via use of the surgical method that causes the least trauma as possible and allows the fastest possible rehabilitation. It appears to be safe and satisfactory, to start early as the onset of trauma with aggressive swelling reduction, hyperextension exercises, gait training, and mental preparation followed by immediate post ACLR, accelerated rehabilitation program.

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الملخص العربي

المخرجات الوظيفية لبرنامج من العلاج الطبيعي التأهيلي السريع قبل وبعد جراحات استعادة الرباط الصليبي الأمامي

لدراسة فعالية برنامج من العلاج الطبيعي التأهيلي السريع قبل وبعد الجراحة لحالات استعادة الرباط الصليبي الأمامي للرياضيين . اشتملت الدراسة علي ستة وثلاثين لاعب من لاعبي المستويات العالية بجامعة الزقازيق ممن يعانون من إصابة تمزق الرباط الصليبي الأمامي لفترة 28.9 ± 16.2 يوم وكان متوسط عمرهم 21.8 ±4.3 عام ومعدل مؤشر حجم الجسم 23.8 ±3.2. تم تقسيم الحالات عشوائيا إلي مجموعتان، المجموعة الأولي: 18 مصاب تلقوا برنامج مكون من العلاج الطبيعي قبل الجراحة لفترة أسبوعان لتقليل الألم وعلاج التورم واستعادة المدى الحركي للركبة إضافة إلي برنامج التأهيل السريع عقب التدخل الجراحي مباشرة لفترة ثمانية أسابيع بينما تلقت المجموعة الثانية المكونة من 18 مصاب برنامج مكون من التأهيل السريع فقط لمدة ثمانية أسابيع مباشرة عقب التدخل الجراحي. واستمرت متابعة الحالات لمدة أربعة وعشرون أسبوعا عقب التدخل الجراحي لكلتا المجموعتان. وقد تم اختيار قياس المدى الحركي لمفصل الركبة وكذا اختبارات القفز المتعددة لتقييم البرنامج. وقد أظهرت نتائج هذه الدراسة تحسنا ذو دلالة إحصائية لكلتا المجموعتان في قياس الأسبوع الرابع والعشرون ولم تظهر الدراسة أي فروق ذات دلالة إحصائية بين المجموعتان لهذا القياس بينما أظهرت الدراسة وجود فروق ذات دلالة إحصائية لقياس الأسبوع السادس عشر بين المجموعتين لصالح المجموعة الأولي ، وكذا أظهرت الدراسة وجود تحسن ذو دلالة إحصائية لقياس الرضا الذاتي لصالح المجموعة الأولي منذ بدء الدراسة وحتى نهايتها . وقد أظهرت هذه الدراسة إلي أن برنامج العلاج الطبيعي التأهيلي السريع سوءا كان قبل أو عقب التدخل الجراحي فقط لحالات تمزق الرباط الصليبي الأمامي للرياضيين ذو فائدة مرتفعة للمخرجات الوظيفية للركبة لكلا المجموعتين. وعلي الرغم من تحسن كافة المشاركين بالبرنامج عند قياس الأسبوع الرابع والعشرون فإن نتائج المجموعة الأولي أظهرت تحسن ذو دلالة إحصائية عند قياس الأسبوع الثاني عشر وارتفاع نسبة الرضا الذاتي لحالات المجموعة الأولي عن المجموعة الثانية وحتى نهاية البرنامج . وقد خلصت هذه الدراسة إلي أن المصابين الذين ينتظمون ببرنامج للعلاج الطبيعي قبل التدخل الجراحي لإصلاح الرباط الصليبي الأمامي يحصلون علي معدلات مرتفعة من التحسن الوظيفي المبكر والذي بدوره يؤثر علي الرضا الذاتي للمصاب عن الذين يشاركون في برامج من التأهيل السريع عقب التدخل الجراحي فقط .