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Supervised physiotherapy leads to a better return to physical activity after anterior cruciate ligament reconstruction.

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ABSTRACT

BACKGROUND: The main goal of rehabilitation after anterior cruciate ligament reconstruction (ACLR) is to return to functional and sports activity at a preinjury level. The aim of this study was to assess the influence of supervised (SU) versus non-supervised (NS) rehabilitation protocols after ACLR on the return to sports activity and quality of life of amateur athletes.

METHODS: The study included a total of 50 patients after ACLR, with 25 in the SU group and 25 in the NS group. No significant differences were observed between the two groups with regard to age, sex, or BMI. Two different ACLR techniques were used: hamstring graft and bone patellar tendon bone. The patients were examined preoperatively and 12 months postoperatively. Outcomes were evaluated utilizing the Kujala scale, Tegner scale, the Knee injury and Osteoarthritis Outcome Score (KOOS), the Functional Movement Screen (FMS), and range of motion. Patients from the SU group participated in rehabilitation sessions with a physiotherapist with an average of 48 meetings. Those in the NS attended six meetings with the physiotherapist.

RESULTS: At final follow up, patients from both groups demonstrated a higher level of functional and sports activity and had a better quality of life 12 months after ACLR. Patients from the supervised group returned to a significantly higher level of sports activity (Tegner scale: SU=6, NS=5, $p=0.003$) and reported significantly better quality of life 12 months after ACLR (KOOS QOL: SU=90, NS=74; $p < 0.001$).

CONSLUSIONS: Supervised, controlled physiotherapy results in higher activity levels and better quality of life in amateur athletes 12 months after ACLR.

Key words: knee injury, knee surgery, ligament reconstruction, return to sport, non-supervised physiotherapy.

Introduction

Following anterior cruciate ligament reconstruction (ACLR), rehabilitation can take place under the supervision of a physiotherapist (SU) or by following a non-supervised or home-based (NS) regimen. The most common approach is the supervised protocol, which provides individualized training programs tailored to the current abilities of the patient and a wider range of exercises: neuromuscular training, closed and open kinetic chain exercise, strength training, proprioception, postural control and feedback technique. [1, 2, 3, 4] In contrast, NS rehabilitation protocols may serve as an option for those who live far from a physical therapist. [3] However, it was reported that supervised physiotherapy can result with better functional outcomes and improve limb symmetry, some authors claim that SU and NS protocols give equally effective results. [5, 6, 7, 8, 9, 10, 11, 12] SU is also commonly reported to be beneficial for older people, patients with comorbidities and might also result in a quicker return to activity. [13]

The main goal of a rehabilitation program is to return a patient to the same level of activity as before the injury. [3, 14, 15] An important issue is the time needed to return to training after ACLR. [16, 17, 18] Several studies indicate that a period of 12 months seems to be adequate following surgery [14, 17]; however, others have shown that functional condition should be the predominant factor in clearing a patient for full activity after ACLR rather than time, and to this end, many functional tests can be performed to determine the possible return to sports activity. [19, 20, 21] In contrast, Rabuck et al. found that the progress of graft healing might play an important role in individualized rehabilitation and return to sport, magnetic resonance imaging being an effective tool to evaluate the degree of ligament healing. [22]

Studies have found the main reasons for not returning to sport after ACLR to be functional problems such as ongoing pain, instability, stiffness, weakness and poor proprioception. [14]

However, large numbers of patients do not return to their preinjury level of sports even though they may achieve normal knee function. [23] One of the non-functional factors affecting the return to sport of post-ACLR patients is their mental condition and the fear of re-rupture, as well as their personality, lifestyle and preinjury sport level. Of these, fear is one of the most commonly-experienced factors and it has been shown that not only fear of re-injury plays a significant role, but also fear of pain, being debilitated and the consequent financial burden, as well as the need to undergo surgery and subsequent rehabilitation. [14, 18, 24, 25] The mental state and motivation of the patient appear to be important in achieving full activity and satisfaction following ACL rehabilitation. [15, 26, 27]

The knee joint injury may result from dysfunction not only of the knee itself but also of the nearest joints or the other limb. Additionally, it may have influence on whole body activity. The functional tests should have a holistic approach. The FMS score is designed to assess the quality of a variety of functional movements patterns and identify an individual's asymmetries and limitations. [28] Although some authors have raised a question if FMS is a proper tool for assessing knee function, it has been commonly used in numerous studies focused on reporting the outcomes of knee surgical treatment. [29, 30, 31, 32,33, 34, 35]

The aim of the present study is to determine whether supervised physiotherapy leads to superior outcomes with regard to physical activity. Despite previous studies, there continues to remain debate whether supervised rehabilitation protocol leads to the higher return of physical activity as determined by patient reported outcomes.

Materials and methods

This is a prospective study of 50 consecutive patients (37 male and 13 female) who underwent ACLR between 2012 and 2015. The age of the patients was 30.5 (26;37) years. For 32 (64%) patients, ACLR was performed in the dominant limb. All patients were amateur athletes.

Each patient was operated on by the same orthopedic surgeon (MS). However, two different types of grafts were used: hamstring autograft (HS) was used for 39 patients and the middle part of the patellar tendon autograft (BTB) for 11 patients. For each patient, anatomic ACLR was performed with an independent AM portal for femoral drilling, and outside-in drilling from a separate skin incision on the tibia. Titanium interference screws were used as a fixation method for both the femoral and tibial tunnel. The decision regarding the choice of graft was made by the orthopedic surgeon in consultation with the patient.

The inclusion criteria were as follows: 1) age 18 to 55 years old, 2) at least six months from injury, 3) no pre-operation physiotherapy, 4) unilateral ACL reconstruction. The following exclusion criteria were used: 1) professional athletes, 2) concomitant knee injuries (including collateral ligaments, PCL and meniscal injuries), 3) previous surgical treatment, 4) previous operation of damaged limb and 5) patients with contralateral knee injuries. All patients met the criteria and gave their written consent to take part in the study. The protocol of the study was accepted by the Bioethics Committee of the Medical University of Lodz (resolution RNN/43/13/KE dated 12 March 2013).

A clinical diagnosis of chronic instability caused by ACL deficiency was given on the basis of a clinical examination by an orthopedic surgeon (positive Lachman and pivot shift test), as well as magnetic resonance imaging. The subjects were then divided into two groups of 25: the first group was supervised by a physiotherapist while the second followed a non-supervised/home-based program. The decision of which type of rehabilitation protocol was used was made by the

patient. The study protocol was designed by the first author, supervised by senior author and qualified statistician.

Each patient received an original rehabilitation protocol designed by the first author (KP). The protocol consisted of four stages, presented in Table I. (Table I)

The SU group attended individual visits with the PT, with each appointment lasting approximately 1.5 hours. The PT assessed the functional condition of the patient and provided adjusted exercises. The second group were given the rehabilitation protocol and allowed to exercise at home without any supervision by the PT. These patients met the PT only at the beginning of every stage to obtain the new guidelines. The number of meetings is shown in Table II.

All measurements and clinical examinations were performed approximately one week before the operation, during a pre-operative visit with the PT and then twelve months postoperatively. Data was collected during an interview and clinical examination by the first author. A demographic profile comprising age, sex, diagnosis, type of injury, time from the injury to the operation and chronic diseases (locomotor system, nervous system, cardiovascular diseases) was obtained from the interview. Three scales were used to objectify the patients' reported outcomes: Kujal's Scoring Questionnaire, which evaluates subjective anterior knee pain, the Tegner scale, which assesses activity level and was used to define the return to sport level, and the Knee injury and Osteoarthritis Outcome Score (KOOS), which was used for knee function assessment. [36, 37, 38] Physical examination included the range of motion of the knee (SFTR scale: S - sagittal, F – frontal, T - transverse, R – rotation) and its movement pattern (FMS test – Functional Movement Screen). [39] The clinical evaluation was performed by a physiotherapist (KP).

Statistical analysis was performed using STATISTICA 10 (Stat Soft Poland, JPZP601E504326AR-9). For all tests, the level of significance was taken as p=0.05. Quantitative variables (measurables) are presented both as the number of observations (N) and percentages (%). The Shapiro-Wilk test was used to confirm the normality of the measured data. Most variables were found to have a non-normal distribution, and in these cases, non-parametric tests were used: Wilcoxon's test for consecutive pairs for comparing two dependent samples, and the Mann-Whitney U-test for two independent samples. For descriptive statistics we used median (ME) and interquartile range.

Results

Patient demographics are provided in Table III.

We analyzed sport and recreational activity. The level of activity as measured by the Tegner scale increased from 5(3;6) before the operation to 6(5;7) at the final follow-up in the SU group. There was no increase in NS group (before operation 5(4;6) and after operation 5 (4;5) p=0.79). A statistically significant increase was observed only in the SU group ($p < 0.001$).). Although the groups did not differ in terms of physical activity before the operation (p=0.52), a significant difference was found between them after 12 months (p=0.003).

The level of activity, as determined by the KOOS scale, rose from 60(35;80) before the operation to 100(100;100) one year later in the SU group, and from 70(30;80) to 85(80;95) in the NS group. In both groups, the change was statistically significant: $p<0.001$ in the SU group and p=0.008 in the NS group. Although the groups did not differ in terms of activity before the operation (p=0.91), a significant difference between them was found after 12 months ($p<0.001$).

Secondly, we took care of the quality of life. The quality of life increased significantly from 44(25;56) to 94(88;100) after ACLR in patients in the SU group, and from 44(25;75) to

75(69;81) in the NS group. In both groups, the change was statistically significant: $p<0.001$ in the SU group and $p<0.001$ in the NS group. While the two groups did not differ in terms of quality of life before the operation ($p=0.91$), statistically significant differences were seen between them after twelve months ($p<0.001$).

Finally, we investigated the return to functional activity. Both groups demonstrated improvements in KOOS Symptoms after twelve months. The score rose from 80(86;96) to 100(93;100) following the operation in the SU group, and from 89(71;96) to 93(86;96) in the NS group. In both groups, the change was statistically significant: $p=0.002$ in the SU group and $p=0.048$ in the NS group. Again, while the groups were similar before the operation ($p=0.52$), statistically significant differences were seen between the groups afterwards ($p=0.009$).

Movement patterns were analyzed by the FMS test. The mean test scores rose from 14(13;15) points before the operation to 18(17;18) points postoperatively in the SU group ($p<0.001$), and from 14(15;15) points to 15(14;17) points in the NS group ($p<0.001$). The difference between the SU and NS groups is statistically significant.

A comparison of the inter-group differences in the range of motion (ROM) of the operated knee is shown in Table IV. Both groups demonstrated significant differences in ROM in both the operated and non-operated knees between the period before the operation and one year later. However, clinically speaking, the change was too small to consider these results. An analysis of sex and type of surgery was run, but there were no statistically significant differences between the groups. (Table V)

Discussion

Our most important finding is that the use of a rehabilitation protocol supervised by a physiotherapist is more effective at returning an amateur athlete to preinjury level of sports.

We believe that one of the reasons that supervised rehabilitation might be beneficial for some patients is expected higher compliancy. That problem was studied by Han et al, who reported that if patient is compliant with the supervised rehabilitation program, then it predicts greater likelihood of return to sports and functional outcome scores after one-year post operation. [2] In a study of the influence of extended rehabilitation on return to activity, Frosch et al. note that patients from EAP (Extended Ambulatory Physiotherapy) returned to higher levels of activity measured by Tegner scale 11.1 months after ACLR ($p<0.05$). [40]

In contrast to our study, many reports indicate no differences in outcome between supervised and home-based rehabilitation protocols. [6, 7, 11, 12, 41] This may result from the use of small groups (10 patients), an insufficient final follow-up time of six months and the use of too few functional tests and quality of life scales to assess recovery. Feller et al. report similar sports activity levels 12 months after ACLR in a group of patients undergoing minimal physiotherapy (ME was two visits in the first six months) and another group undergoing regular physiotherapy (ME 23 visits in the first six months). [41] Similarly, Hohmann et al. found no significant difference in the results of the Tegner scale, functional tests or strength tests between a supervised and an unsupervised group; however, a difference in functional tests was observed between the limbs 12 months after ACLR. The operated leg still performed worse than the non-operated leg in the single-leg hop, timed hop and vertical jump tests. [6] This is confirmed in our present findings, which indicate that differences still existed in the range of motion between the operated and non-operated legs 12 months after ACLR. Additionally, supervised rehabilitation was found to lead to a more successful return to the preinjury level of sports in amateur sports patients:

preoperatively, both groups of patients were at the same level of physical activity, as measured by the Tegner scale (p=0.52) and KOOS sport/rec scale (p=0.91); however, significant differences were observed between the groups after one year of rehabilitation, with patients from the supervised group exhibiting a higher level of physical activity (Tegner scale p=0.003, KOOS sport/rec p<0.001).

Furthermore, supervised rehabilitation directed by a physiotherapist was found to be associated with improved patient quality of life. Although all patients were found to have similar QOL before operation (p=0.91), after one year, patients from the control group did not have confidence in the operated limb, still avoided dangerous knee activity, did not return to perform all preoperative activities and reported more frequent complaints from the operated limb (p < 0.001). Similar findings were reported by Fibay et al. who showed that those who did not return to their preinjury level of sport reported a worse quality of life five to 20 years after ACLR. [42] Additionally, Christiano et al. report that those who return to sports activity have significantly greater self-esteem that those who did not, and it was not connected with knee stability and time since surgery. [43] In contrast, Grant et al. found that patients from a home-based rehabilitation protocol presented better outcomes in the ACL-QOL questionnaire three years after ACLR (80.0 ±16.2 vs 69.9±22.0, p=0.02). [5, 7]

The fundamental goal of every course of physiotherapy following ALCR is to restore correct functional activity. In addition, we sought to investigate this thesis with reference to movement patterns of the whole body and not only the leg through a functional movement screen. [44] Patients from both groups returned to preinjury level of functional activity, as measured by KOOS symptoms and the FMS test. But after 12 months, statistically significant differences existed between the groups despite having similar preoperative scores. An FMS value of 14 or below

suggests an elevated risk of injury. [35, 45] Additional value is possibility to assess asymmetry in movement patterns and limb loading, which is reported to incorporate estimating the right time of rupturing to sport activity. [34] Patients from both groups were awarded a score of less than 14 after ACLR, but patients from the SU group achieved better results. In contrast, Schenck et al. found no difference in functional or subjective outcomes between two postoperative rehabilitation protocols. [7] These findings were also confirmed by Hohmann et al. [6] Despite this, more precise studies are required to assess patients according to both static and dynamic tests and regarding the activity/movement patterns they want to return to after surgery.

This study is not without limitations. The observation groups have a low number of patients; however, other studies in the literature are also based on similar sized groups. Nevertheless, incorporating more patients in the study would strengthen the results. In addition, there was a difference in age between the two groups. However, previous studies have shown that both younger and older age groups can have excellent reported outcomes after ACL reconstruction. [46] Location and financial status may have an influence on the choice of rehabilitation protocol by the patient and subsequent attendance, as noted by Feller at al. and Papilla et al. [7, 41] The lack of randomization is a weakness. In addition, two different grafts were utilized in these cohorts, although studies have shown no differences in return to sport between the two [27]. Additionally, although motivation may play an important role in recovery after ACL reconstruction, we did not utilize any specific testing method to assess for our patients' motivation levels. We are also aware that FMS is not a perfect tool to fully evaluate post-operative knee function. However, it is easy to apply and analyze, well described and commonly used in other studies test. [30,47] Finally, our follow-up time was only 12 months. Future studies are needed

with longer follow up time to see what differences may exists at two years and longer follow up. [3, 19, 20, 21, 24, 48, 49]

Although many studies have evaluated rehabilitation after ACL and its effect on return to sport and physical activity, no consensus exists as to whether a supervised or non-supervised protocol is needed after ACLR for recreational athletes.

However, a web-based intervention protocols has been recently investigated, a paper-printed guideline remains a worldwide standard. It is easy and reproducible way of supporting physiotherapy especially in areas with the poor internet access. [50, 51]

Conclusions

Supervised, controlled physiotherapy is associated with better results than non-supervised physiotherapy with regard to return to preinjury level of sports in recreational athletes 12 months after ACLR. Also, patients undergoing supervised physical therapy report better quality of life one year out from ACLR.

Both rehabilitation protocols have similar results in returning to functional activity level 12 months after ACLR.

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NOTES

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Table I. The stages of the physiotherapy protocol and their main purposes.

Number of stage/ Time after ACLR	The purpose
First / 0-2 weeks after ACLR	- restore correct range of motion (firstly the extension of the knee), - control effusion and pain in the knee joint, - prevent postsurgical adhesions, - maintain neuromuscular control, - teach correct movement patterns, - learn about correct weight bearing (with crutches).
Second / 2-6 weeks after ACLR	- restore normal range of motion (full extension, flexion under 90 degrees after four weeks) - restore a normal gait pattern, - restore correct muscle strength, - return to daily activities.
Third / 6-12 weeks after ACLR	- achieve full range of motion of the knee, - return to work and full activity in daily life, - introduce eccentric, proprioceptive, central stabilization and neuromuscular control exercises
Fourth / 12 weeks 12 months after ACLR	- return to recreational sport activity, - prevent disorders in the patellofemoral joint

Table II. A comparison of the number of meetings between the groups.

	First group (Supervised)	**Second group (Non-supervised)**
Before ACLR	1 meeting	1 meeting
First stage	4 meetings	1 meeting
Second stage	12 meetings	1 meeting
Third stage	18 meetings	1 meeting
Fourth stage	12 meetings	1 meeting
12 months after ACLR	1 meeting	1 meeting

Table III. A comparison of age, sex and BMI between the groups [ME(interquartile range)].

	Supervised Group	**Non Supervised**	**P (<0.05)**

		Group	
Age	34(28;41)	27(25;34)	0.04
Sex	18 M, 7 F	19 M, 6 F	0.82
BMI pre-op	25.5(22;27)	24.8(23;26)	0.74

Table IV. A comparison of ROM of the operated knee between the groups [ME(interquartile range)].

	SU group	**NS group**
Knee extension before operation	-1(-2;0)	0(0;0)
Knee extension one year after ACLR	-2(-3;0)	0(-1;0)
Knee flexion before operation	130(120;140)	130(120;130)
Knee flexion one year after ACLR	135(130;140)	130(125;130)

Table V. A comparison of sex and type of surgery according to the Tegner scale, KOOS QOL, KOOS sport and KOOS symptoms before and 12 months after ACLR [ME (interquartile range)].

	Female	***Male***	***p***	***HS***	***BTB***	***p***
KOOS QOL						
Before ACLR	38(25;63)	50(31;69)	0.394482	44(25;63)	44(31;69)	0.817447
12 months after ACLR	88(75;94)	81(75;94)	0.634415	88(69;94)	81(75;88)	0.760783
Tegner scale						
Before ACLR	4(3;5)	5(4;6)	0.111285	5(4;5)	6(4;6)	0.122182
12 months after ACLR	5(4;5)	5(5;6)	0.064777	5(5;6)	6(5;6)	0.527715
KOOS Sport						
Before ACLR	45(35;75)	70(30;80)	0.514104	60(30;85)	70(30;75)	0.764077
12 months after ACLR	100(80;100)	95(85;100)	0.982354	100(80;100)	95(85;100)	0.743008
KOOS Symptoms						
Before ACLR	86(75;93)	89(75;96)	0.650257	89(75;96)	86(71;93)	0.308324
12 months after ACLR	96(93;96)	96(86;100)	0.799226	96(86;100)	96(83;100)	0.796705