



The Timing of Rehabilitation Commencement After Reconstruction of the Anterior Cruciate Ligament

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Abstract

One of the most common injuries of the knee joint is a rupture of the anterior cruciate ligament (ACL). Most authors believe that early rehabilitation of patients after ACL reconstruction promotes better treatment outcomes. Less is known about the influence of the time that passes from injury to surgical reconstruction. Therefore, the goal of this study was to assess the dependence of treatment outcomes of ACL on injury-to-reconstruction and reconstruction-to-rehabilitation time lags. The study included 30 patients of the mean age 34 ± 7 years with trauma-related rupture of ACL and its surgical reconstruction. The time range from ligament rupture to its reconstruction was 120–180 days and from reconstruction to rehabilitation was 1–120 days. Postsurgical rehabilitation outcomes were assessed with the Lysholm knee scale and the IKDC 2000 subjective knee evaluation form. The scales were applied before and after

rehabilitation. We found distinct improvements in all physical symptoms in the damaged knee joint, regardless of the time elapsed from trauma to ACL reconstruction and from ACL reconstruction to rehabilitation. The beneficial outcomes of rehabilitation were significantly inversely associated with the time elapsing from reconstruction to rehabilitation commencement but failed to depend on the time from ACL rupture to reconstruction. We conclude that rehabilitation should start as early as possible after ACL reconstruction to optimize the beneficial outcomes in terms of functional physical recovery, whereas the injury-to-reconstruction delay is less meaningful to this end.

Keywords

Anterior cruciate ligament · Knee joint · Reconstruction · Rehabilitation · Treatment outcome

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1 Introduction

The anterior cruciate ligament (ACL) is the most frequently damaged anatomical structure in the knee joint (Anderson et al. 2016; Saka 2014). There are several possible mechanisms of ACL damage. Most often, the injury is caused by crooked or deforming torsional forces acting about the knee joint while the foot is stabilized or by sideward pressure exerted on the loaded limb, with a slight flexion of the knee joint. Young people, actively practicing sport, are most often exposed to ACL injury. Treatment of a ruptured ACL consists of its reconstruction, followed by a comprehensive patient-tailored rehabilitative process, taking into account exercise intensity and pace, extended over several months (Paschos and Howell 2016; Kruse et al. 2012). Rehabilitation programs in individuals with ACL-deficient knees should include proprioceptive and balance exercises, which helps improve outcomes and a return to a full range of knee joint motions (Cooper et al. 2005). A selection of a rehabilitation program depends, to an extent, on coexisting injuries, age, type of activity, and a physical condition of the patient. Studies suggest that post-reconstruction rehabilitation of a patient with ACL injury ought to begin as early as feasible, with the optimum delay of 2–3 days depending on the patient's condition (Grindem et al. 2015; Beynnon et al. 2005). Differences in the effectiveness of rehabilitation have been noticed, depending on the time of its onset after surgical reconstruction (Kochański et al. 2013; Pasierbiński and Jarzabek 2002), but the exact impact of a delayed start of rehabilitative procedures on recovery performance of patients with an ACL injury and their return to full physical activity is unsettled. In this study, we addressed this issue by examining the dependency on the injury-to-ligament reconstruction and reconstruction-to-rehabilitation time delays of the expected beneficial outcomes of rehabilitation after repair of ACL injury. We found that a shortening of the former, but not the latter, associates with outcomes.

2 Methods

This study gained ethical approval from the Human Research Ethics Committee of the College of Rehabilitation in Warsaw, Poland. The study involved 30 patients (20 men and 10 women) of the mean age 34 ± 7 years who suffered unilateral anterior ACL ruptures, followed by arthroscopically assisted reconstruction. The reconstruction consisted of inserting hamstring autographs made with the semitendinosus and gracilis tendons, a double-bundle (STG-DB) technique (Zaffagnini et al. 2006; Fu et al. 2000). Exclusion criteria were previous knee ligament surgery, additional knee injuries, or leg bone fractures. The time range from ligament rupture to surgical reconstruction was from 120 to 180 days (mean 146 ± 96 days) and from reconstruction to rehabilitation was from 1 to 120 days (mean 66 ± 41 days). Rehabilitation was based on cryotherapy and passive and active kinesiotherapy which had all of the patients. In addition, other forms of physiotherapy treatment, such as laser therapy, magnetotherapy, electrotherapy, or patella mobilization, were variably used in some patients. The patients were assessed twice after surgery, before and after rehabilitation using the Tegner Lysholm Knee Scale-Orthopedic Scores and the 2000 International Subjective Knee Evaluation Form (IKDC 2000). The former is a 100-point scale providing information on how the patient's symptoms affect his daily life activities. The scale consists of the following domains: pain (25 points), knee instability (25 points), locking (15 points), swelling (10 points), limping (5 points), stair climbing (10 points), squatting (5 points), and requirement for support (5 points) (Lysholm and Gillquist 1982). The main parts of the latter consisted of patient-reported current health assessment (general ailments) form and sports activities evaluation form (Irrgang et al. 2001). The score for the individual items was summed and then transformed to a scale that ranges from 0 to 100. For both scales, the greater is the score, the fewer symptoms and the better outcome.

Data were displayed as means \pm SD and 95% confidence intervals. Differences in the surveyed knee symptoms before and after rehabilitation

treatment were assessed with a two-tailed paired *t*-test. Dependence of the treatment outcome on injury-to-reconstruction time and reconstruction-to-rehabilitation time was assessed with Pearson's correlation coefficients. A *p*-value <0.05 defined statistically significant differences taking place from before to after rehabilitation. The analysis was conducted using a commercial SPSS Statistics software package (IBM Corp.; Armonk, NY).

3 Results and Discussion

In the main, we noticed that the postsurgical rehabilitation had a highly beneficial effect in patients with reconstructed ACL. There were distinct across-the-board improvements in all physical symptoms depicted in both scales used for the assessment of the damaged knee joint, regardless of the time elapsed from trauma to ACL reconstruction and from ACL reconstruction to rehabilitation. Notably, the Lysholm scale shows a 6.5-fold lessening of pain perception, with the tremendous improvement in the ability to climb stairs and disappearing of knee locking symptoms (Table 1). Likewise, the 2000 IKDC scale confirms the improvement in knee joint damage-related declines in muscle strength and endurance and in general physical health, which is most probably related to increased performance of sports activities (Table 2). All these positive changes were substantial as judged from highly significant increases in the scoring of both surveys.

Our present findings confirm those of other recent studies pointing to the importance of physical rehabilitation, in terms of knee function recovery, in patients after ACL reconstruction (Villa et al. 2016; Imoto et al. 2011; Wright et al. 2008; Frańczuk et al. 2004). The main purpose of postoperative rehabilitation is to relieve pain, restore the full function of the knee and the entire limb, and return to a variety of activities as early as feasible (Kochański et al. 2013).

Uncertainty, however, exists about the influence on the effectiveness of rehabilitation of the time scale between the ligament rupture and reconstructive surgery and between the surgery and rehabilitation commencement. In the present study, we attempted to address this issue by seeking the possible association between the two time scales outlined above and the rehabilitation results assessed by the Lysholm and IKDC 2000 scores. We took advantage of the heterogeneity of patients, each having a different circumstance of the ACL injury, health condition, and health care provided thereafter. A dissimilar timeline of treatment procedures enabled the correlation of outcome benefits with the ligament injury-to-reconstruction and reconstruction-to-rehabilitation time lags. We found that all domains of both Lysholm, except knee joint swelling, and IKDC 2000 scales were significantly inversely associated with the time elapsing from reconstructive surgery to rehabilitation commencement, meaning the shorter the delay to

Table 1 Lysholm scale applied in patients before and after rehabilitation of postsurgically reconstructed anterior cruciate ligament (ACL)

Domains	Before rehabilitation	After rehabilitation	<i>p</i> <
Pain	2.3 ± 2.9	15.0 ± 8.5	0.001
Knee instability or buckling	6.5 ± 5.1	17.3 ± 4.1	0.001
Knee locking or catching	0.3 ± 0.8	3.3 ± 3.0	0.001
Swelling	1.5 ± 2.0	5.9 ± 1.7	0.001
Limping	0.7 ± 1.3	2.6 ± 1.9	0.001
Stair climbing	0.4 ± 1.1	5.6 ± 3.7	0.001
Squatting	1.1 ± 1.1	3.9 ± 1.9	0.001
Elbow crutches	0.0 ± 0.0	2.7 ± 1.8	0.001
Total score	12.9 ± 9.6	56.1 ± 22.9	0.001

Data are means ±SD

Table 2 The 2000 international subjective knee evaluation form (IKDC 2000) applied in patients before and after rehabilitation of postsurgically reconstructed anterior cruciate ligament

Domains	Before rehabilitation	After rehabilitation	p <
General ailments	11.9 ± 5.5	25.2 ± 10.5	0.001
Sports activities	16.0 ± 6.8	36.9 ± 12.0	0.001
Total score	27.9 ± 11.0	62.2 ± 21.7	0.001

Data are means ±SD

Table 3 Correlation between the surgery-to-rehabilitation time and the results of rehabilitation assessed with the Lysholm and IKDC 2000 scales in patients with injured anterior cruciate ligament (ACL)

Lysholm scale domains	r	p
Pain	-0.418	0.022
Knee instability or buckling	-0.511	0.004
Knee locking or catching	-0.622	<0.001
Swelling	-0.183	0.334
Limping	-0.579	0.001
Stair climbing	-0.837	<0.001
Squatting	-0.694	<0.001
Elbow crutches	-0.406	0.026
Total scale	0.742	<0.001
IKDC 2000 scale domains		
General ailments	-0.486	0.006
Sports activities	-0.790	<0.001
Total scale	-0.723	<0.001

r, Pearson's correlation coefficient.

rehabilitation, the better overall physical health outcomes and faster resuming sports activities (Table 3). However, there was no appreciable association between the time elapsing from ACL rupture to reconstructive surgery and the rehabilitation outcomes (Table 4).

In conclusion, we believe we have demonstrated that postoperative rehabilitation should start as early as possible after surgical ACL reconstruction to minimize the effects of injury that caused the ligament rupture. Thus, the present findings lend support to the notion expressed in a recent review of rehabilitation interventions after ACL reconstruction that accelerated rehabilitation may optimize the functional recovery (Grant 2013). On the other hand, we show that a time lag between the injury and undertaking surgical reconstruction is of lesser importance in terms of improved outcome of subsequent rehabilitation. Nonetheless, aggressive rehabilitation does not always bring the intended

Table 4 Correlation between the injury-to-surgery time and the results of rehabilitation assessed with the Lysholm and IKDC 2000 scales in patients with injured anterior cruciate ligament (ACL)

Lysholm scale domains	r	p
Pain	+0.055	0.773
Knee instability or buckling	+0.050	0.793
Knee locking or catching	+0.259	0.166
Swelling	-0.074	0.697
Limping	-0.101	0.597
Stair climbing	-0.103	0.587
Squatting	-0.055	0.773
Elbow crutches	+0.108	0.571
Total scale	-0.097	0.611
IKDC 2000 scale domains		
General ailments	-0.097	0.611
Sports activities	-0.004	0.983
Total scale	-0.050	0.792

r, Pearson's correlation coefficient.

results. ACL is a sensitive ligament, and too early loading of it can lead to a re-injury (Stańczak et al. 2014). Individually targeted rehabilitation process in different patients, taking into account specific patient-oriented rehabilitation factors, may play a key role in maximizing the expected postsurgical outcomes.

Conflicts of Interest The authors declare no conflicts of interest in relation to this article.

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