

# Analysis of Factors Affecting Return to Sports after Anterior Cruciate Ligament Reconstruction: A Prospective Clinical Investigation

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## Abstract

**Introduction:** Anterior cruciate ligament (ACL) is the most common ligament injury around the knee. The purpose of ACL reconstruction (ACLR) among sports person is to return athletes to their pre-injury activity level. Even after successful reconstruction, a good number of patients are not able to return to preinjury status. Hence, it is important to understand the variables influencing return to sports (RTSs). The purpose of this study was to report on the variables proposed to be associated with RTSs following ACLR.

**Methods:** A total of 100 patients were included in the study. The inclusion criteria were unilateral ACL injury, age between 15 and 45 years, and pre-injury Tegner activity score of 5 or more. Patients with Grade III-IV chondral damage and significant associated ligament injury were excluded from the study. ACLR was done with quadruple hamstring graft. The final results were evaluated by using different knee scores and Tampa Scale for Kinesophobia (TSK) after 1 year.

**Results:** There was a significant improvement shown by all knee scores. Nearly, 55% were able to return to their pre-injury sports at the same level, 35% shifted to a lower activity level, while the remaining 10% were unable to return to their previous sports activities. Marx scale and the TSK demonstrated a significant difference ( $P < 0.001$ ) between patients who "returned" and those who "did not return" to their previous sports.

**Conclusion:** This study shows that fear of re-injury is a major factor of not returning to pre-injury sports activity. Further study is needed in this aspect.

**Key words:** Anterior cruciate ligament, Instability, Kinesophobia

## INTRODUCTION

Anterior cruciate ligament (ACL) tears are the most commonly reported knee injury in athletes. In the United States, nearly, 300,000 ACL reconstructions (ACLRs) are performed yearly.<sup>1</sup> About 98% of the orthopedic surgeons recommend surgery if patients wish to return to sports (RTSs). However, unfortunately, not all patients RTSs in the same efficacy following ACLR.<sup>2</sup> Most individuals elect to undergo surgical reconstruction following injury to

restore knee function and facilitate RTSs participation.<sup>3,4</sup> The aim of ACLR is to provide the athletes with the best opportunity to return to pre-injury levels of sports participation.<sup>2,5-10</sup> Recently, it has been reported that between 8% and 50% of those with ACLR did not return to the same sports after surgery, even with follow-up times of up to 5 years.<sup>11</sup> It is also reported that 70% of the individuals previously involved in contact sports were unable to return to the same sports after surgery.<sup>12</sup> Among those who did return to their prior sports, up to 21% were reported to have returned with major functional limitations that contributed to a reduced level of performance.<sup>13</sup> In a study conducted among the soccer players of the National Football League, it was found that almost 80% returned to competition after ACL injury. However, the performance of players measured by power ratings was reduced by one-third.<sup>14</sup> Similarly, 22% of the athletes in the National Basketball Association did not RTSs after surgery. In those

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who did return, 44% experienced a decrease in efficiency ratings.<sup>15</sup> It has been suggested that the high incidence of poor RTSs outcomes following ACLR may be due to a lack of standardized RTSs guidelines and incomplete resolution of physical and psychological impairments.<sup>3,16-18</sup>

From different literatures, it is evident that more than 50% of the sports person were not able to perform their pre-injury sports activity. This leads to an urgency of improved understanding of variables influencing patients' ability to RTSs. Several factors were published in literature as contributors to post-operative self-reported disability following ACLR. These were the number of injured knee structures,<sup>19</sup> quadriceps strength,<sup>16,20,21</sup> knee pain intensity,<sup>16,21</sup> knee flexion range of motion,<sup>15</sup> single-leg hop performance,<sup>19,21</sup> and pain-related fear of movement/re-injury.<sup>15</sup> It is unclear that whether self-reported knee function influences return to pre-injury levels of sports participation following ACLR. Furthermore, the relative importance of these factors is unknown.

In this prospective investigation, we examine the differences in clinical variables between those who return to pre-injury level of sports participation and those who do not following ACLR 1 year post-surgery. Based on different literatures, we hypothesized that a combination of demographic, knee impairment, functional, and psychosocial measures would differ and discriminate between those who did and did not RTSs.

## METHODS

This is an institutional-based, observational, prospective study carried out from February 2013 to March 2015, in our institution, after getting permission from the Ethical Committee. All the patients have been counseled about the advantages and disadvantages and complication of the study, and the written consent has been taken. All the patients with Grade III ACL injury of less than 1 year duration were included in this study. The inclusion criteria were unilateral ACL injury, age between 15 and 45 years, and pre-injury Tegner activity score of 5 or more. This age group with a pre-injury Tegner activity level of at least 5 was chosen to include individuals most likely to be involved in sports-related activities. Patients with bilateral knee injury, prior knee ligament injury and/or surgery, and concomitant ligamentous injury greater than Grade I were excluded from the study. The other exclusion criteria were Grade III-IV chondral damage and significant associated ligament injury requiring reconstruction articular cartilage repair procedure performed in conjunction with ACLR. All surgeries were performed by the senior surgeon by quadruple semimembranosus graft with aperture fixation

by interference screw. The rehabilitation was conducted for 6 months in our hospital.

## Evaluation

To document the progression of the patients' recovery, clinical evaluations were conducted by several knee scores. Subjective and objective assessment was conducted using the International Knee Documentation Committee (IKDC) form. It has been used across a broad range of knee pathologies, including ACL injury and ACLR. It has provided a valid and reliable measurement (intraclass correlation coefficient [ICC] = 0.94). The IKDC contains 10 items related to knee symptoms and physical function. Scores range from 0 to 100, with higher scores indicating less disability. The Tegner activity-level scale has been used to rate their current level of sports participation as well as to recall their pre-injury level of sports participation. The scale has demonstrated an acceptable test-retest reliability (ICC = 0.80) after ACLR. This is an 11-point grading scale. Level 5 was used as a standard in our study as it indicates participation in sports-related activities at the lowest recreational level. Further evaluations were carried out using the Lysholm and Noyes scales. A knee activity rating scale (Marx scale) was also used preoperatively and at final follow-up to measure the patients' activities.

Knee ligament laxity was measured at 30° flexion by OSI CA 4000 arthrometer. OSI CA 4000 arthrometer has been shown to provide valid and reliable measurements of anterior knee joint laxity (ICC = 0.91-0.93). The amount of difference of anterior displacement of the tibia in comparison with nonsurgical sides was the anterior knee joint laxity difference.

Isokinetic strength testing was a reliable method of quadriceps strength testing (ICC = 0.81-0.97). The test was performed with isokinetic dynamometer (Biodex Multi-joint system) at speeds of 60, 180, and 300°/s. The maximum peak torque in flexion and extension and total work and hamstring/quadriceps ratio were calculated. The test was performed at 3, 6, and 12 months after the surgery.

The patient's psychological profile was measured with the shortened version of the Tampa Scale for Kinesophobia (TSK-11). Scores on the TSK-11 range from 11 to 44 points. The higher scores indicate greater pain-related fear of movement/re-injury. The TSK-11 is a psychometrically stable instrument to assess the fear of movement/re-injury following ACLR as it has good test-retest reliability (ICC = 0.81).

Data were obtained preoperatively and at subsequent follow-ups at 3, 6, and 12 months following the knee reconstruction. Statistical analysis of data obtained was

performed using non-parametric technique with the Mann–Whitney U-test (Wilcoxon rank-sum test) due to the different variables measured between the two groups.

## RESULTS

A total of 130 patients (sports person) were included in the study. Among them, 100 patients met all the inclusion criteria (60 men, 40 women; mean  $\pm$  standard deviation age,  $22.4 \pm 8.6$  years). Distribution of different pre-injury sports activity is shown in Table 1. About 90 patients (90%) reported that they had returned to some form of sports or recreational activity since their surgery; however, only 55 (55%) reported returning to pre-injury levels of sports participation, and these were included in the yes RTSs (Y-RTS) group. About 45 patients (45%) reported that they had not returned to their pre-injury level of sports participation and were included in the no RTSs (N-RTS) group. Demographic information for these patients is shown in Table 2. Of those patients reporting in the N-RTS group, 55.56% (25/45) reported fear of re-injury/lack of confidence as a primary reason for not returning to pre-injury levels of sports participation, and knee joint symptoms (pain, swelling, instability, and muscle weakness) collectively accounted for an additional 44.44% (20/45). Pain (7/45 [15.6%]) and muscle weakness (5/45 [11.1%]) were the most frequently reported knee joint symptoms. The distributions of primary reasons for not returning to pre-injury sports participation are shown in Table 3.

### Knee Scores

Objective IKDC knee scores of normal or near-normal obtained among the 100 patients treated demonstrated a significant improvement ( $P < 0.05$ ) from the pre-operative value of 33-97% at the final follow-up.

Mean Tegner activity score from 100 patients reviewed demonstrated statistically significant difference ( $P < 0.05$ ) from mean 7.2 points pre-injury to 5.5 points on the final follow-up. Mean subjective knee score of 47 points preoperatively improved to 85 points at the final follow-up among the 100 patients treated using the IKDC evaluation form which compared the investigated knee to the patient's uninjured contralateral knee. Mean Noyes and Lysholm scores, on the other hand, improved from 45 and 50 preoperatively to 88 and 90 on the final follow-up (Figure 1). These improvements in the Noyes and Lysholm scales were noted to be statistically significant ( $P < 0.05$ ).

Comparing the scores obtained by those who “RTSs” against those who “did not return at the same level of sports activity” revealed no significant differences. In the same way, patients who completely ceased participation

**Table 1: Sports activities among patients**

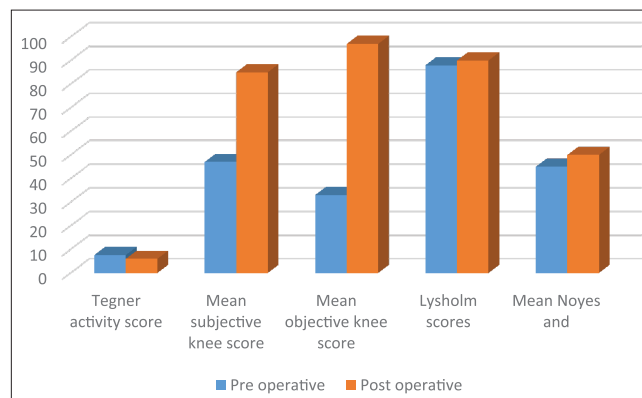
Sports activity	Number of patients
Soccer	31
Running	15
Cycling	5
Volleyball	9
Swimming	15
Karate	12
Kabaddi	13

**Table 2: Demographic variable means and distributions for Y-RTS and N-RTS groups**

Parameters	Y-RTS (n=55)	N-RTS (n=45)	P value
Age (years)	20.9 $\pm$ 8.3	24.2 $\pm$ 8.8	0.066
Concomitant injuries	0.9 $\pm$ 0.8	0.8 $\pm$ 0.9	0.533
Injury to surgery (days)	72.6 $\pm$ 57.6	82.4 $\pm$ 68.5	0.43
Pre-injury Tegner score	8.6 $\pm$ 1.4	8.2 $\pm$ 1.6	0.74
Post-surgical Tegner score	8.5 $\pm$ 1.6	6.6 $\pm$ 1.4	<0.001
Surgery to follow-up (weeks)	50.9 $\pm$ 3.0	48.5 $\pm$ 5.7	0.17

**Table 3: Distribution of self-reported primary reasons for not returning to pre-injury levels of sports participation**

Primary reason	N-RTS	Percentage
Pain	7	15.6
Swelling	4	8.87
Fear of injury or lack of confidence	25	55.56
Knee instability	4	8.87
Muscle weakness	5	11.1



**Figure 1: Pre- and post-operative distribution of knee score**

in sports activity demonstrated no statistically significant difference with those who “RTSs at a lower level” (objective IKDC [ $P = 0.35$ ]; subjective IKDC [ $P = 0.20$ ]; lysholm [ $P = 0.38$ ]; Noyes [ $P = 0.054$ ]; and Tegner [ $P = 0.93$ ]).

### Isokinetic Tests and Computed Analysis

Isokinetic tests conducted at  $60^\circ/s$  3 months following surgery demonstrated a decreased quadriceps strength in the Y-RTS group (23% deficit in total extensor work

versus 7.3% deficit in total flexor work) and decreased hamstring strength in the N-RTS group (21.3% deficit in total extensor work versus 22.4% deficit in total flexor work). Tests conducted at 60, 180, and 300°/s in extension 1 year postoperatively demonstrated no statistically significant difference between the Y-RTS and N-RTS groups.

Anterior laxity tests performed with computed analysis (OSI) carried out at 3 months, 1 and 2 years from knee reconstruction demonstrated 90% of the 100 patients treated to have less than 3 mm side-to-side difference, 8% with 3-5 mm difference, and 2% to have more than 5 mm difference; no statistically significant difference was noted among the groups (Figure 2).

**RTSs**

On the final follow-up, 55% of the 100 patients were able to return to their pre-injury sports at the same level, 35% shifted to a lower activity level, while the remaining 10% were unable to return to their previous sports activities (Figure 3). Among the patients who were unable to RTSs, five feared re-injury to their reconstructed knee, another two had pain related to

chondropathy, one had extension deficit, while two had pain at tibial fixation site (Table 4).

**Knee Activity Rating Scale (Marx Scale)**

In the final follow-up, 35 of the 45 patients who “did not RTSs” had a mean score of 6.71 points (0-16) with only 6.67% (3) obtaining a score ≥15 points. This group of patients reported some difficulty in resuming running, cutting, decelerating, and pivoting activities.

On the other hand, a mean score of 14.03 points (9-16) was documented among 55 patients who “RTSs.” In this group, 54.55% (30) scored ≥15 points as they did not encounter any difficulty doing the same activities. Statistical analysis carried out using the Mann–Whitney U-test demonstrated a significant difference ( $P < 0.001$ ) between patients who “returned” and those who “did not return” to their previous sports (Figure 4).

**Psychological Profile**

Data from the psychological questionnaire administered before the surgery demonstrated that 68.9% (31) of the athletes who “did not RTSs” scored ≥40 points. On the other hand, 85.5% (47) of the athletes who “RTSs,” scored ≤15 points. Statistical analysis using the Mann–Whitney U-test revealed a significant difference ( $P < 0.001$ ) between these two groups (Figure 5). Athletes who were able to return to previous sports had a mean score of 14.07 while those who changed or completely stopped any sports activity had an average mean score of 38.46 points.

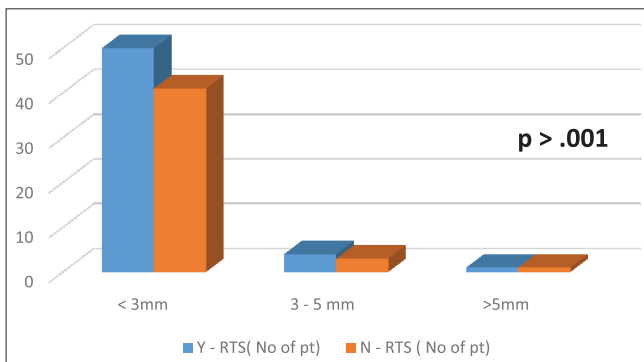


Figure 2: Comparison of arthrometry

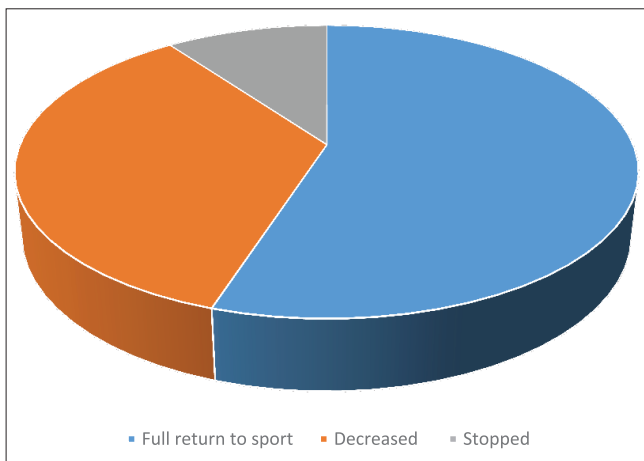


Figure 3: Outcome following anterior cruciate ligament reconstruction

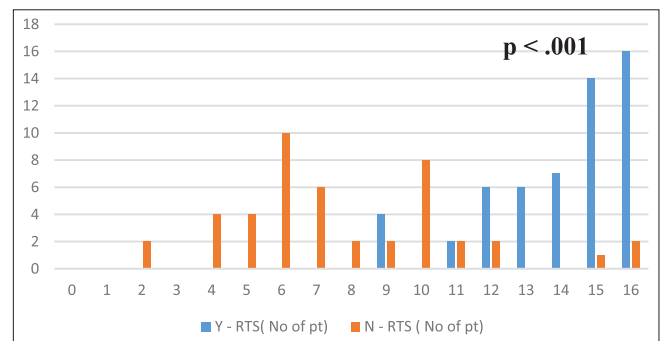


Figure 4: Knee activity rating scale (Marx scale)

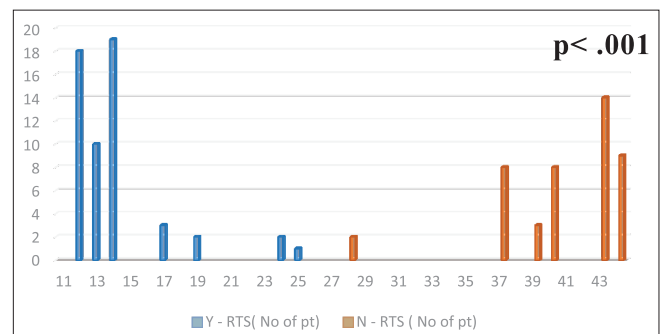


Figure 5: Comparison of Tampa Scale for Kinesophobia

**Table 4: Distribution of factors of unable to RTSs**

Parameters	Number of points
Fear of re-injury	5
Pain due to chondropathy	2
Extension deficit	1
Pain at tibial fixation site	2

RTS: Return to sport

### Subsequent Surgeries

Two patients presented with persistent clicking and catching during the 1<sup>st</sup> year post-ACLR. On the second-look arthroscopy, a medial meniscal tear was demonstrated in one case while the other case had a Grade II chondral pathology at the area of the medial femoral condyle. Partial meniscectomy and chondroplasty were done, respectively. At the final follow-up, both patients were able to return to their previous sports.

## DISCUSSION

When the ACL is injured, ACLR is usually considered the gold standard of treatment, especially in young active patients. However, it is also necessary to consider various interconnected aspects (anatomy, biomechanics, and psychology) relating to the patients' athlete, as these can contribute to determine the outcome of the ACLR, which can range from successful to disastrous. For athletes with ACL tear, the outcome of reconstruction becomes more important as expectations of returning to pre-injury activity levels are usually higher. Unfortunately, even with the present techniques in knee reconstruction, successful RTSs cannot be guaranteed. ACLR in athletes is carried out to achieve a stable knee that can enable them to return to their desired activities. Restoration of mechanical restraints is the initial step in achieving knee functional recovery, but factors including the patients' motivation and willingness to complete the prescribed rehabilitation program may also play a role in influencing the outcome.

The results of our study using the IKDC (objective and subjective), Noyes, and Lysholm demonstrated a significant overall improvement in all the patients. Commonly utilized knee evaluation scales remain as good indicators in evaluating the results of ACLR. However, in certain cases, return to the same level of previous sports after ACLR is not achieved.<sup>22-25</sup> To identify the possible factors responsible for preventing successful return to previous sports, two additional scales were utilized for this study: The knee activity rating scale (Marx scale) and the TSK.

The Marx scale demonstrated a significant difference ( $P < 0.001$ ) between athletes who were able to return to previous sports and those who "did not return to

any sports." In this scale, patients were asked about the components of physical function common to different sporting activities, putting more focus in measuring activity rather than health status.

The TSK, on the other hand, focused on factors which included the patients' commitment, willingness, and interest in resuming pre-injury activity levels. Valuable information extracted from these additional scales can provide the data necessary to go beyond the objective measures available with the standard knee scales. The importance of using these two questionnaires cannot be undermined, especially in cases where good results with IKDC, Lysholm, Tegner, and Noyes scales are obtained and yet the athlete remains unable to resume the previous activity levels.

This investigation demonstrated that only 55% of the athletes were able to resume the same sports activity at the same level following ACLR while the remaining 45% for various reasons decreased their level of activity (35%) or completely ceased sports participation (10%). Further evaluation revealed that 2/10 had persistent pain related to chondropathy and 2/10 at the area of tibial fixation site and the other factors such as fear for new injury 5/10 and strength deficit 1/10 (Table 3). A previous study conducted by Aglietti demonstrated similar results comparable to our findings.<sup>26</sup> Järvinen *et al.* found in their studies that 53% and 40%, respectively, "RTSs" following knee reconstruction.<sup>27</sup> On the other hand, Nakayama reported a 92% incidence of RTSs among 50 young athletes reviewed.<sup>9</sup> However, in all these studies mentioned, the main focus was on the technique utilized for reconstruction (patellar tendon vs. hamstring tendon) followed by the analysis of outcome using standard knee rating scales. In cases where less satisfactory results were obtained, possible contributory factors were enumerated, but not thoroughly discussed.

Our study emphasizes that ACLR with hamstring graft and restoration of joint stability is just one of the several factors required to facilitate return of athletes to sports. The other important factors include patient selection, pain, patellofemoral dysfunction, and change in lifestyle, rehabilitation as well as concomitant injuries to the joint.<sup>22,28-30</sup> Some studies emphasized the importance of early recovery of knee function as a significant determinant of the long-term outcome of reconstructed knees.<sup>22-24</sup> ACL is rich in nerve supply which is completely lost in reconstructed knee. Hence, proprioception and neuromuscular control is an important determinant that influences the outcome.<sup>31-35</sup> As a result, a progressive neuromuscular control rehabilitation program should be made mandatory to minimize the risk of injury and to promote the greater chance of successful return to competition.<sup>29,36-40</sup>

The most important observation of our study is that the kinesophobia of patients exerts a certain degree of influence in the final outcome of treatment. Morrey *et al.* demonstrated that significant mood changes throughout rehabilitation may be a contributing factor to poor psychological and physical outcomes.<sup>41</sup> Furthermore, Pantano *et al.* emphasized that a variety of psychosocial factors including motivation influence the level of activity following surgical procedures.<sup>42</sup> The recognition of the variety of factors influencing outcome following ACLR is important, especially when developing a sports-specific post-operative rehabilitation program focused in facilitating the full return of athletes to the previous levels of activity. Although certain weaknesses are evident in this investigation including the relatively low number of patients included per group and the medium term follow-up achieved, the data obtained can be very important in analyzing the rationale behind some athletes inability to RTSs following ACLR.

## CONCLUSION

Standard knee scales such as IKDC, Lysholm, Noyes, and Tegner remain a valuable tool for evaluating the progression of knee recovery following ACLR. However, we believe that the additional use of the Marx knee activity rating scale and the TSK provide additional data on the patients' functional capabilities and psychological profile which could be useful in determining the capacity of athletes to resume pre-injury activity level.

This study provides further insight into clinical variables that empirically discriminate between individuals in RTSs groups. Results suggest that the ongoing knee symptoms following ACLR are associated with individuals returning to pre-injury sports participation levels. These potentially modifiable factors represent important targets for rehabilitation. Findings from this study should be considered. In future, longitudinal studies aimed at the development of return-to-sports rehabilitation guidelines and participation criteria are needed.

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