

Temporal Utilization of Physical Therapy Visits After Anterior Cruciate Ligament Reconstruction

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Background: Physical therapy (PT) rehabilitation is critical to successful outcomes after anterior cruciate ligament reconstruction (ACLR). Later-stage rehabilitation, including sport-specific exercises, is increasingly recognized for restoring high-level knee function. However, supervised PT visits have historically been concentrated during the early stages of recovery after ACLR.

Purpose/Hypothesis: To assess the number and temporal utilization of PT visits after ACLR in a national cohort. We hypothesized that PT visits would be concentrated early in the postoperative period.

Study Design: Descriptive epidemiological study.

Methods: The Humana PearlDiver database was searched to identify patients who underwent ACLR between 2007 and 2017. Patients with additional structures treated were excluded. The mean \pm SD, median and interquartile range (IQR), and range of number of PT visits for each patient were determined for the 52 weeks after ACLR. PT visits over time were also assessed in relation to patient age and sex.

Results: In total, 11,518 patients who underwent ACLR met the inclusion criteria; the mean age was 32.62 ± 13.70 years, and 42.7% were female patients. Of this study cohort, 10,381 (90.4%) had documented PT postoperatively; the range of PT visits was 0 to 121. On average, patients had 16.90 ± 10.60 PT visits (median [IQR], 16 [9-22]) after ACLR. Patients completed a mean of 52% of their PT visits in the first 6 weeks, 75% in the first 10 weeks, and 90% in the first 16 weeks after surgery. Patients aged 10 to 19 years had the highest number of PT visits (mean \pm SD, 19.67 ± 12.09 ; median [IQR], 18 [12-25]), significantly greater than other age groups ($P < .001$).

Conclusion: PT after ACLR is concentrated in the early postoperative period. Physicians, therapists, and patients may consider adjusting the limited access to PT to optimize patient recovery.

Clinical Relevance: As supervised PT visits may be limited, the appropriate temporal utilization of supervised PT visits must be maximized. Strategies to ensure sessions for later neuromuscular and activity-specific rehabilitation are needed.

Keywords: anterior cruciate ligament; physical therapy; return to sport; rehabilitation

It is estimated that as many as 350,000 anterior cruciate ligament (ACL) reconstructions (ACLRs) are performed every year in the United States.^{7,12,18,37,44} Successful recovery after ACLR is based on several factors, including patient age, graft ligamentization, functional level before surgery, and participation in rehabilitation to restore knee strength and functional control.^{12,25}

Knee rehabilitation after ACLR can occur under the supervision of the physical therapist,² as a home-rehabilitation program,^{14,25} or via telehealth options.¹⁰ Historically, post-ACL rehabilitation guidelines recommended early, accelerated courses of rehabilitation with patients

generally cleared to return to unrestricted sports within 6 months.^{19,36} However, with improved understanding of the entire biological and biomechanical recovery process after ACLR, this critical return-to-sport timepoint has been questioned.¹² Recently, the time to return to unrestricted sport has been proposed to take much longer, with times ranging from 9 months¹⁶ to 2 years.^{5,9}

Justification for this delay comes from evidence that the biomechanical aspects of recovery, such as normalization of knee joint mechanics, proprioception, and strength, are critical to the biological process of graft ligamentization during this time and are known to continue to improve for at least the first 2 years after reconstruction.^{1,13,20,32,42} Delaying return to sport has been shown to reduce ACL reinjury rates, with studies^{9,18} demonstrating that ACL

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reinjury rates decrease by 51% each month for up to 9 months after ACLR.

With increased attention paid to the restoration of the biomechanical function of the surgical leg, the importance of an appropriate postoperative rehabilitation program necessarily follows. While there is currently no consensus regarding some of the rehabilitation specifics,¹² there are evidence-based guidelines regarding the goals of each phase as well as the measurements and assessments that may be applied to determine progression.⁴⁰

The early phase of rehabilitation aims to aid in the recovery from the impairments of surgery, namely, reducing pain and effusion while restoring range of motion and quadriceps activation.¹² The middle phase of rehabilitation focuses on the restoration of function of the lower extremity, including strengthening and balance exercises, with the inclusion of sport-specific exercises when appropriate.^{2,12,34,40,41} Finally, the late phase involves neuromuscular training and optimization of movement patterns and strength, with the goal of minimizing the risk of reinjury upon return to Level I activities. Functional assessments to guide progression between phases generally include tests of quadriceps and hamstring strength, hop tests, and the limb symmetric index.^{4,11,12,19,27,40} These later aspects of rehabilitation have received greater attention over time and are associated with better patient-reported outcomes.^{2,31,41}

The issue with focusing physical therapy (PT) visits in the early postoperative portion of ACLR rehabilitation is that the number of PT visits is often limited by insurance company protocols.³³ Thus, there is concern regarding “using up” PT visits early in the recovery process and not having them available to patients during the important later rehabilitation phases of ACLR care.

The present study sought to determine the temporal utilization of postoperative PT in the 52 weeks after ACLR. It is hypothesized that the majority of supervised PT visits after ACLR would be in the earlier part of the postoperative course and not as focused on the later phases, which are of greater recent emphasis.

METHODS

Patient Cohort

PearlDiver, the large Humana insurance claims database, was utilized in this study. This database contains data on

~55 million patients. No specific institutional review board approval was required for this study, as the database contains only deidentified patient data. The database was queried to identify patients who underwent arthroscopic ACLR using the Current Procedural Terminology (CPT) code 29888 between 2007 and 2017. Patients who had additional structures repaired were excluded.

PT Visits

The PT visits for each patient were then identified using the following CPT codes: 97001, 97005, 97006, 97010, 97014, 97016, 97022, 97032, 97035, 97110, 97112, 97113, 97116, 97124, 97140, 97150, 97161, 97162, 97163, 97164, 97530, and 97750. The total number of visits associated with these PT codes was then tallied for each week after ACLR, for a total of 52 weeks.

The mean and median number of PT visits per patient as well as the range of the number of PT visits for each of the 52 weeks after surgery were calculated. The total number of PT visits as well as the temporal utilization of PT were analyzed by age and sex.

Statistical Analysis

Individual patient records are not accessible within PearlDiver to protect patient privacy. However, PearlDiver does provide descriptive statistics, including the number of patients, mean, median, range, and interquartile range (IQR), for the study population under analysis. For the current study, a calculation of the mean and standard error of the mean of PT visits by week was accomplished using organic PearlDiver analytical tools. The standard error of the mean was included in this study as it represents how close the mean number of PT visits of the large population studied is expected to be relative to the true population mean.

The distribution of PT visits in the overall study population, as well as among men, women, and various age groups, was assessed for normality using the Shapiro-Wilk normality test. The Kruskal-Wallis test was used to detect statistical differences between the number of PT visits among all patients when stratified by age group. The Mann-Whitney-Wilcoxon test was used to detect differences in the mean number of PT visits between female and male patients. Statistical significance was set at $P < .05$.

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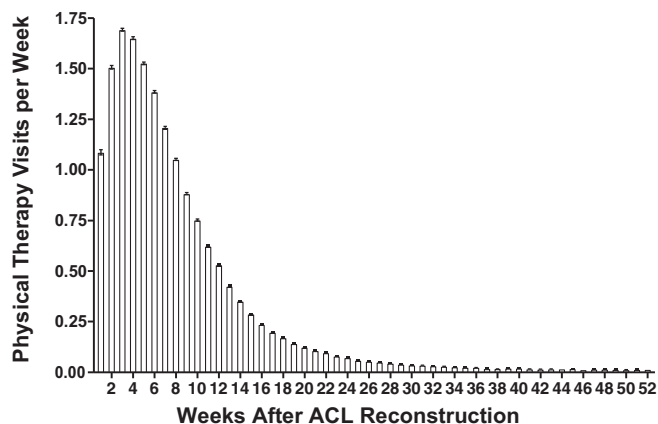


Figure 1. The mean number of physical therapy visits each week in the 52 weeks after arthroscopic anterior cruciate ligament (ACL) reconstruction (N = 10,411). Bars represent the mean number of visits per patient, and error bars represent SEM.

TABLE 1
Difference in Physical Therapy Visits Between Female and Male Patients^a

	Median (IQR)	Mean ± SD	P (t test)
Physical therapy visits			<.001
Male patients (n = 5876)	15.0 (9.0-21.0)	15.9 ± 10.1	
Female patients (n = 4505)	17.0 (10.0-23.0)	17.9 ± 11.1	

^aIQR, interquartile range.

RESULTS

In total, 11,518 patients who underwent arthroscopic ACLR and met inclusion criteria were identified from the PearlDiver Humana Orthopaedic data set. The mean age was 32.6 ± 13.7 years (mean ± SD), and 43.3% were female.

Of the study cohort, 10,381 patients (90.1%) were documented to have participated in PT in the year after surgery. The mean number of PT visits was 16.90 ± 10.60 visits per patient (range, 0-121 visits). The median number of PT visits was 16, and the IQR was 9 to 22. Of these PT visits, 52% occurred in the first 6 weeks after surgery, 75% in the first 10 weeks, and 90% in the first 16 weeks (Figure 1). Shapiro-Wilk normality tests performed on the overall study population as well as cohorts defined as male, female, and by patient age showed that the number of PT visits were not normally distributed in each group. Rather, they demonstrated a positive skew due to the influence of a small number of patients with a high number of PT visits. As a result, the mean, median, and IQR of PT visits are reported where appropriate.

Female patients (n = 4505) attended more PT (median [IQR]) visits than male patients (n = 5,876) (17 [10-23] vs 15 [9-21]; P < .001) (Table 1).

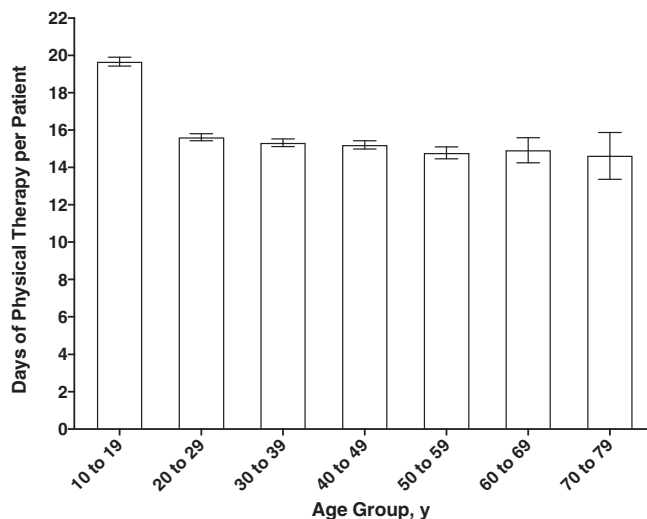


Figure 2. Mean number of physical therapy (PT) visits in the 52 weeks after arthroscopic anterior cruciate ligament reconstruction. Patients aged 10 to 19 years had significantly more PT visits than other studied age groups (P < .001). The number of PT visits did not vary significantly among patients aged 20 to 79 years (P = .097). Error bars represent SEM.

The distribution of PT visits is shown in Figure 2 after separating the study population into 10-year age groups. Patients aged 10 to 19 years had a significantly higher number of PT visits (mean, 19.67 ± 12.09 years; median, 18 years; IQR, 12-25 years) than all other age groups studied (P < .001). The number of PT visits was not significantly different when comparing patient age groups between 20 and 79 years (P = .097).

DISCUSSION

The current study found that, after arthroscopic ACLR, the mean number of PT visits was 16.90 ± 10.60 per patient. The median number of PT visits was 16 (IQR, 9-22 visits). More than 50% of those visits occurred in the first 6 weeks after surgery, 75% in the first 10 weeks, and 90% in the first 16 weeks (4 months).

There is consensus in contemporary sports medicine literature that the optimal rehabilitation protocol progresses through phases defined by functional goals.^{2,8,11,16,18,40,41} The above-noted findings indicate that patients are receiving the majority of their PT in the early postoperative period after ACLR, when the primary goals of rehabilitation include increasing range of motion, decreasing knee effusion, and quadriceps activation exercises.^{2,17,30,39} Based on typical rehabilitation guidelines, and data from previous studies^{2,12,41} detailing rehabilitation after ACLR, this distribution of PT visits suggests that later-stage therapy goals (sports-specific training) may not be sufficiently addressed.

Historically, the most common return to sport timeline has been 6 months^{9,19}; however, recent literature^{18,21,40} has

suggested that the majority of patients do not “pass” functional testing at 6 months, and thus, timelines of greater than 6 months will decrease reinjury rates. Herbst et al²¹ compared age-matched controls with patients who underwent ACLR with a functional testing protocol and found that the majority of patients who underwent ACLR have measurable functional deficits 8 months after surgery. These results are consistent with studies demonstrating benefits to patient-reported outcomes when rehabilitation extends from 6 to 12 months³; and that ACL reinjury rates decreased until 9 months after ACLR.^{17,18} The results of the current study suggest that patients receive only 10% of their total PT (~1-2 visits) between 4 and 12 months after surgery. Therefore, patients may not have access to PT late in the rehabilitation timeline when return-to-sport clearance is expected.

The factors contributing to reinjury after ACLR, a devastating complication in this population, are complex and multifactorial.^{4,17,23,34,35,38,40,43} Effective PT aims to reduce reinjury by addressing modifiable factors, such as neuromuscular control of the lower extremity. There is evidence that faulty movement patterns developed during recovery from ACLR may lead to increased rates of reinjury to both the surgical knee and the contralateral ACL.^{23,29,38} These undesirable biomechanical changes can be corrected in PT, suggesting the value a physical therapist can have during the later phases of rehabilitation.²²

Ideally, all patients would have as many supervised PT sessions as they need to completely recover all motion, strength, and return to prior level of function after an ACLR. However, as a result of multiple factors, patients are often limited in their access to PT. Therefore, the temporal use of PT sessions should be optimized when possible.

A review of recent literature^{6,14,15,24,25} on rehabilitation after ACLR demonstrates that home-based rehabilitation can be effective for motivated patients in achieving rehabilitation goals for range of motion and strength. In addition, telerehabilitation and similar digital health interventions have shown patient acceptance and promising results for ACL rehabilitation.¹⁰ These methods have been successfully used after total knee arthroplasty and treatment of acute hip fracture.^{10,26,28} By taking advantage of other rehabilitation methods, patients may be able to preserve access to supervised PT until they are performing complex, high-intensity neuromuscular retraining that can be observed and optimized by physical therapists.

There are some limitations associated with this study, including those inherent with the PearlDiver database and the retrospective nature of this study. When using PearlDiver, the ability to extract data for analysis is limited to the queries designed by the research team and the original patient data that were entered into the medical record. Moreover, in order to protect patient privacy, granular data from individual patient records cannot be accessed, which can limit the types of statistical analyses performed. In addition, the method of reconstruction and particular technique used by each surgeon is not specified with CPT codes and therefore was not used to further stratify or analyze our study population. Furthermore, the data came from a single insurance provider, Humana, so selection bias may

exist, and the study population may not accurately represent the US population. However, the database contains records on nearly 55 million individuals, and it is thought to represent a broad spectrum of patients. Finally, we do not know whether patients had additional sources for PT, such as team trainers, and we cannot state the specific reason for discharge because we cannot ascertain the actual milestones met by patients at the completion of formal PT.

CONCLUSION

The current study describes the temporal utilization of PT after ACLR with a goal of helping orthopaedic surgeons, physical therapists, and patients maximize recovery after surgery. The current study determined that the majority of the PT visits occur in the first 6 weeks after ACLR. Armed with this information, those involved in these treatment pathways may reconsider the temporal use of formal PT and potentially employ nontraditional therapy methods to ensure access to the expertise of a physical therapist during the critical later stages of rehabilitation.

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