CRITICALLY APPRAISED TOPIC

FOCUSED CLINICAL QUESTION

For a 21-year-old male professional American football running back post-primary bone-patellar tendon-bone (BPTB) ACL reconstruction (P), is there an increased risk for adverse knee-related outcomes (O) when an accelerated ACL rehabilitation protocol (I) is implemented that uses structured, progressive phases compared to a traditional ACL rehabilitation protocol which uses temporal criteria (C)?

AUTHOR

Prepared by	Gabe Dimock	**Date**	11/19/2019
Email address	gabriel_dimock@med.unc.edu		

CLINICAL SCENARIO

The patient is a 21-year old professional American football running back who tore his left anterior cruciate ligament (ACL) when decelerating from sprinting down the sideline during competition. The patient initially thought that the injury was minor but the MRI showed a tear of the ACL. The patient underwent bone-patellar-tendon-bone ACL reconstruction soon after the injury occurred. The patient would like to return to playing football as soon as possible while optimizing his performance abilities and future injury risk. In pursuit of helping this patient reach his goals, I would like to know whether an accelerated, phase-based rehabilitation protocol results in increased risk compared to a rehabilitation program that utilizes standard, temporal criteria.

SUMMARY OF SEARCH

[Best evidence appraised and key findings]

Eight studies met the inclusion and exclusion criteria including 2 systematic reviews, 2 RCTs, 2 cohort studies, 1 case-control study, and 1 current concepts paper.

- Objective criterion-based rehabilitation (OCBR) protocols may improve a patient's strength and laxity after ACL reconstruction compared to standard care[1]
- An accelerated protocol that has a loosely associated timeframe but is driven by the patient's ability to pass criteria at various phases of rehabilitation allows for return to sport as quickly and safely as possible[2]
- Impaired neuromuscular control is a risk factor for re-injury and is independent of time since surgery which indicates that strictly temporal criteria are not appropriate for making return to sport decisions[3,4]
- Due to both temporal and performance-based measures being correlated to increased injury risk post-ACL reconstruction, an OBCR rehabilitation can be implemented but patients should wait to return to sport until at least 9-months post-ACL reconstruction[5]

CLINICAL BOTTOM LINE

Athletes who have undergone ACL reconstruction and wish to return to sport quickly and safely should follow a rehabilitation protocol that has both criterion and temporal based components. The patient should meet various criteria to advance to the next phase of rehabilitation. This allows the patient to return to functional activity as quickly as their body indicates they are able. However, due to increased injury rates observed with return to sport in less than nine months, the patient should wait for this time marker to decrease the chances of re-injury upon return to sport.

This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor

The above information should fit onto the first page of your CAT

SEARCH STRATEGY

Terms used to guide the search strategy			
Patient/Client Group	**I**ntervention (or Assessment)	**C**omparison	**O**utcome(s)
Athlete*, American football, America football player, male, running back	ACL reconstruction, ACL surgery, ACL rehabilitation, ACL, anterior cruciate ligament surgery, anterior cruciate ligament reconstruction, anterior cruciate ligament rehabilitation, anterior cruciate ligament, ACLR	accelerated rehabilitation, criteri* based rehabilitation, accelerated therap*, criteri* based therap*	re-tear of ACL, failure of ACL, re-injury, adverse event, return to sport, follow up

Final search strategy (history):

Show your final search strategy (full history) from PubMed. Indicate which "line" you chose as the final search strategy.

PubMED

- ((((athlet*) OR american football) OR football player) OR male) OR running back (8462965 results)
- (((((((ACL) OR ACL reconstruction) OR ACL surgery) OR ACL rehabilitation) OR anterior cruciate ligament surgery) OR anterior cruciate ligament reconstruction) OR anterior cruciate ligament) OR anterior cruciate ligament rehabilitation) OR ACLR (25427 results)
- (((accelerated rehabilitation) OR criter* based rehabilitation) OR accelerated therap*) OR criteri* based therap* (1021 results)
- ((((((traditional rehabilitation) OR time based rehabilitation) OR temporal criteri*) OR standard rehabilitation) OR traditional therapy) OR time based therapy) OR standard therapy (622000 results)
- ((((((re-tear) OR failure) OR re-injury) OR revision) OR adverse) OR return to sport) OR follow up (3702737 results)
- (((((((((athlet*) OR american football) OR football player) OR male) OR running back)) AND (((((((((ACL) OR ACL reconstruction) OR ACL surgery) OR ACL rehabilitation) OR anterior cruciate ligament surgery) OR anterior cruciate ligament reconstruction) OR anterior cruciate ligament) OR anterior cruciate ligament rehabilitation) OR ACLR)) AND ((((accelerated rehabilitation) OR criter* based rehabilitation) OR accelerated therap*) OR criteri* based therap*)) AND (((((((traditional rehabilitation) OR time based rehabilitation) OR temporal criteri*) OR standard rehabilitation) OR traditional therapy) OR time based therapy) OR standard therapy)) AND (((((((re-tear) OR failure) OR re-injury) OR revision) OR adverse) OR return to sport) OR follow up) (0 results)
- Search (((((((((athlet*) OR american football) OR football player) OR male) OR running back)) AND (((((((((ACL) OR ACL reconstruction) OR ACL surgery) OR ACL rehabilitation) OR anterior cruciate ligament surgery) OR anterior cruciate ligament reconstruction) OR anterior cruciate ligament) OR anterior cruciate ligament rehabilitation) OR ACLR)) AND ((((accelerated rehabilitation) OR criter* based rehabilitation) OR accelerated therap*) OR criteri* based therap*)) AND (((((((traditional rehabilitation) OR time based rehabilitation) OR temporal criteri*) OR standard rehabilitation) OR traditional therapy) OR time based therapy) OR standard therapy)) AND (((((((re-tear) OR failure) OR re-injury) OR revision) OR adverse) OR return to sport) OR follow up) (0 results)
- ((((((((athlet*) OR american football) OR football player) OR male) OR running back)) AND (((((((((ACL) OR ACL reconstruction) OR ACL surgery) OR ACL rehabilitation) OR anterior cruciate ligament surgery) OR anterior cruciate ligament reconstruction) OR anterior cruciate ligament) OR anterior cruciate ligament rehabilitation) OR ACLR)) AND ((accelerated protocol) OR ((((accelerated rehabilitation) OR criter* based rehabilitation) OR accelerated therap*) OR criteri* based therap*))) AND (((((((re-tear) OR failure) OR re-injury) OR revision) OR adverse) OR return to sport) OR follow up) (20 results)
- (((((((((athlet*) OR american football) OR football player) OR male) OR running back)) AND (((((((((ACL) OR ACL reconstruction) OR ACL surgery) OR ACL rehabilitation) OR anterior cruciate ligament surgery) OR anterior cruciate ligament reconstruction) OR anterior cruciate ligament) OR anterior cruciate ligament rehabilitation) OR ACLR)) AND ((accelerated protocol) OR ((((accelerated rehabilitation) OR criter* based rehabilitation) OR accelerated therap*) OR criteri* based therap*))) AND (((((((traditional rehabilitation) OR time based rehabilitation) OR temporal criteri*) OR standard rehabilitation) OR traditional therapy) OR time based therapy) OR standard therapy)) AND (((((((re-tear) OR failure) OR re-injury) OR revision) OR adverse) OR return to sport) OR follow up) (4 results)
- **(((((((((ACL) OR ACL reconstruction) OR ACL surgery) OR ACL rehabilitation) OR anterior cruciate ligament surgery) OR anterior cruciate ligament reconstruction) OR anterior cruciate ligament) OR anterior cruciate ligament rehabilitation) OR ACLR)) AND ((accelerated protocol) OR ((((accelerated rehabilitation) OR criter* based rehabilitation) OR accelerated therap*) OR criteri* based therap*)))**

AND (((((((re-tear) OR failure) OR re-injury) OR revision) OR adverse) OR return to sport) OR follow up) (26 results)

- **(((((((((ACL) OR ACL reconstruction) OR ACL surgery) OR ACL rehabilitation) OR anterior cruciate ligament surgery) OR anterior cruciate ligament reconstruction) OR anterior cruciate ligament) OR anterior cruciate ligament rehabilitation) OR ACLR)) AND ((accelerated protocol) OR ((((accelerated rehabilitation) OR criter* based rehabilitation) OR accelerated therap*) OR criteri* based therap*))) AND (((((((traditional rehabilitation) OR time based rehabilitation) OR temporal criteri*) OR standard rehabilitation) OR traditional therapy) OR time based therapy) OR standard therapy)) AND (((((((re-tear) OR failure) OR re-injury) OR revision) OR adverse) OR return to sport) OR follow up) (5 results)**

SportDiscus

- (((((((((athlet*) OR american football) OR football player) OR male) OR running back)) AND (((((((((ACL) OR ACL reconstruction) OR ACL surgery) OR ACL rehabilitation) OR anterior cruciate ligament surgery) OR anterior cruciate ligament reconstruction) OR anterior cruciate ligament) OR anterior cruciate ligament rehabilitation) OR ACLR)) AND ((accelerated protocol) OR ((((accelerated rehabilitation) OR criter* based rehabilitation) OR accelerated therap*) OR criteri* based therap*))) AND (((((((traditional rehabilitation) OR time based rehabilitation) OR temporal criteri*) OR standard rehabilitation) OR traditional therapy) OR time based therapy) OR standard therapy)) AND (((((((re-tear) OR failure) OR re-injury) OR revision) OR adverse) OR return to sport) OR follow up) (0 results)
- (((((((((athlet*) OR american football) OR football player) OR male) OR running back)) AND (((((((((ACL) OR ACL reconstruction) OR ACL surgery) OR ACL rehabilitation) OR anterior cruciate ligament surgery) OR anterior cruciate ligament reconstruction) OR anterior cruciate ligament) OR anterior cruciate ligament rehabilitation) OR ACLR)) AND ((accelerated protocol) OR ((((accelerated rehabilitation) OR criter* based rehabilitation) OR accelerated therap*) OR criteri* based therap*))) AND (((((((re-tear) OR failure) OR re-injury) OR revision) OR adverse) OR return to sport) OR follow up) (18 results)
- (((((((((athlet*) OR american football) OR football player) OR male) OR running back)) AND (((((((((ACL) OR ACL reconstruction) OR ACL surgery) OR ACL rehabilitation) OR anterior cruciate ligament surgery) OR anterior cruciate ligament reconstruction) OR anterior cruciate ligament) OR anterior cruciate ligament rehabilitation) OR ACLR)) AND (((((((traditional rehabilitation) OR time based rehabilitation) OR temporal criteri*) OR standard rehabilitation) OR traditional therapy) OR time based therapy) OR standard therapy)) AND (((((((re-tear) OR failure) OR re-injury) OR revision) OR adverse) OR return to sport) OR follow up) (10 results)
- **(((((((((ACL) OR ACL reconstruction) OR ACL surgery) OR ACL rehabilitation) OR anterior cruciate ligament surgery) OR anterior cruciate ligament reconstruction) OR anterior cruciate ligament) OR anterior cruciate ligament rehabilitation) OR ACLR)) AND ((accelerated protocol) OR ((((accelerated rehabilitation) OR criter* based rehabilitation) OR accelerated therap*) OR criteri* based therap*))) AND (((((((traditional rehabilitation) OR time based rehabilitation) OR temporal criteri*) OR standard rehabilitation) OR traditional therapy) OR time based therapy) OR standard therapy)) AND (((((((re-tear) OR failure) OR re-injury) OR revision) OR adverse) OR return to sport) OR follow up) (3 results)**
- **(((((((((ACL) OR ACL reconstruction) OR ACL surgery) OR ACL rehabilitation) OR anterior cruciate ligament surgery) OR anterior cruciate ligament reconstruction) OR anterior cruciate ligament) OR anterior cruciate ligament rehabilitation) OR ACLR)) AND ((accelerated protocol) OR ((((accelerated rehabilitation) OR criter* based rehabilitation) OR accelerated therap*) OR criteri* based therap*))) AND (((((((re-tear) OR failure) OR re-injury) OR revision) OR adverse) OR return to sport) OR follow up) (47 results)**

PEDro

- **Abstract and Title: ACL rehabilitation outcome**
- **Body Part: Lower Leg or Knee**
  40 records

In the table below, show how many results you got from your search from each database you searched.

Databases and Sites Searched	Number of results	Limits applied, revised number of results (if applicable)
Databases and Sites Searched	**Number of results**	**Limits applied, revised number of results (if applicable)**
PubMed	**31 (last 2 searches combined)**	

Sport Discus	**50 (last 2 searches combined)**	
PEDro	**40**	

INCLUSION and EXCLUSION CRITERIA

Inclusion Criteria
- Patient population who has undergone ACL reconstruction surgery of any graft type - Any level of evidence - Patients in the study must be treated with either accelerated or standard ACL rehabilitation protocol. - Study must include at least 1 knee-related outcome measure
Exclusion Criteria
- Studies must be done on humans - Studies must be in English - Case series - Case studies - Studies with population electing for conservative treatment of ACL rehabilitation - Studies with a population that has undergone ACL repair vs reconstruction

RESULTS OF SEARCH

Summary of articles retrieved that met inclusion and exclusion criteria

For each article being considered for inclusion in the CAT, score for methodological quality on an appropriate scale, categorize the level of evidence, indicate whether the relevance of the study PICO to your PICO is high/mod/low, and note the study design (e.g., RCT, systematic review, case study).

Author (Year)	Risk of bias (quality score)*	Level of Evidence**	Relevance	Study design
Beynnon et al. (2005)[6]	**PEDro: 5/10**	**1b**	**Moderate**	**RCT**
Setuain et al. (2017)[1]	**PEDro: 5/10**	**1b**	**Low (Study is more relevant to hamstring graft)**	**RCT**
Grindem et al. (2016)[5]	**QUIPS – Rating of Risk of Bias:** **Study Participation: Low** **Study Attrition: Moderate** **Prognostic Factor Measurement: Low** **Outcome Measurement: Moderate**	**2b**	**High**	**Prospective Cohort Study**

	Study Confounding: High **Statistical Analysis and Reporting: Low** **Overall Risk of Bias: Low-Moderate**			
Myer et al. (2012)[3]	**RoBANS Risk of Bias:** **Selection of Participants: Unclear** **Confounding Variables: High** **Intervention (Exposure) Measurement: Low** **Blinding of Outcome Assessment: High** **Incomplete Outcome Data: Low** **Selective Outcome Reporting: Low** **Overall Risk of Bias: Moderate**	**3b**	**High**	**Case-Control Laboratory Study**
Andersson et al. (2009)[7]	**AMSTAR-2 Score: 5 yes items, 4 partial yes items, 4 no items, 3 no meta-analysis** **Rating of Overall Confidence of Findings: Moderate**	**1a**	**Moderate**	**Systematic Review of RCTs**
Decarlo et al. (1992)[8]	**QUIPS – Rating of Risk of Bias:** **Study Participation: Moderate** **Study Attrition: High** **Prognostic Factor Measurement: Moderate**	**2b**	**Moderate**	**Retrospective Cohort Study**

	Outcome Measurement: Moderate **Study Confounding: High** **Statistical Analysis and Reporting: Moderate** **Overall Risk of Bias: Moderate-High**			
Hewett et al. (2012)[4]	**High Risk of Bias Due to the Nature of an Expert Opinion Paper (No Methods Explained)**	**5**	**High**	**Current Concepts Article**
Van Grinsven et al. (2010)[2]	**AMSTAR-2 Score: 8 yes items, 5 no items, 3 no meta-analysis** **Overall Confidence of Findings: Moderate**	**1a**	**High**	**Systematic review of RCTs, rehabilitation programs, and reviews**

*Indicate tool name and score

**Use Portney & Watkins Table 16.1 (2009); if downgraded, indicate reason why

BEST EVIDENCE

The following 2 studies were identified as the 'best' evidence and selected for critical appraisal. Rationale for selecting these studies were:

- The 2016 prospective cohort study by Grindem et al. was chosen as the best available evidence for this specific clinical question due to the high clinical relevancy provided by the purpose of the study and the population.[5] The researchers aimed to assess the re-injury risk related to several variables in athletes including the timing of return to sport and knee function before return to sport. This allows clinical decisions to be made based on the patient's time since surgery and based on functional progress. Additionally, a large percentage of the athletes included in this study were football players which improves the generalizability of the results to my patient. The level of evidence is high (2a) and the risk of bias is low-moderate which can allow us to have more confidence in the results presented.

- The 2010 systematic review by Van Grinsven et al. was chosen as the second-best evidence available for the clinical question due to its being of the highest level of evidence.[2] However, among systematic reviews, this is a lower quality review because it reviews RCTs, published protocols, and background information. The authors justify the inclusion of lower-level evidence by stating that it was necessary to present an evidence-based protocol that fills a gap in the research. The presented protocol has phases that are loosely based on time-frames but are adjusted to the patient's progress as the patient does not progress to the next phase until the criteria in the current phase are met. Given that an evidence-based protocol is presented that is designed to optimize functional progress while minimizing the risk of injury, the evidence presented by Van Grinsven et al. is highly relevant to the clinical question.

SUMMARY OF BEST EVIDENCE

(1) Description and appraisal of (Simple decision rules can reduce reinjury risk by 84% after ACL reconstruction: the Delaware-Oslo ACL cohort study) by (Grindem et al., 2016)

Aim/Objective of the Study/Systematic Review:

The aims of the study by Grindem et al. were to determine whether there are correlations between the 2-year risk of re-injury post ACL reconstruction with a return to sport, timing of return to sport, and knee function when returning to sport.

Study Design

[e.g., systematic review, cohort, randomized controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]

Note: For systematic review, use headings 'search strategy', 'selection criteria', 'methods' etc. For qualitative studies, identify data collection/analyses methods.

This study by Grindem et al. is a prospective cohort study that consisted of 106 patients who underwent ACL reconstruction with either a bone-patellar-tendon-bone graft or a hamstring graft. The rehabilitation protocol differed between patients and was based on several factors including graft type and function. All patients received protocols that consisted of an acute phase, a rehabilitation phase, and a return to sport phase. Data regarding participation in sports was collected beginning at one-month post-surgery using an online survey. Knee re-injury was measured via the online survey as well as by clinical follow-ups at 6-months, 1-year, and 2-years after ACL reconstruction. The patients in the study completed a return to sport battery that included quadriceps strength testing, hop tests, the knee outcome survey-activities of daily living, and a global rating scale at baseline, 6-months, and 12-months. Data was extracted regarding knee function from the 6-month follow-up for 49 patients who returned to sport between 5- and 11-months post-surgery and from the 12-month follow-up for 20 patients who returned to sport between twelve and 23 months. The limb symmetry indexes (LSI) were calculated for quadriceps strength and hop testing and compared to the non-surgical leg. The passing of the return to sport criteria was defined as scoring greater than 90% on the LSI for all tests conducted. The study did include four patients who returned to sport in less than five months and were deemed to have not passed the return to sport criteria. The functional data collected at the return to sport could then be used to find any existing associations between the passing or failing of return to sport criteria and two-year re-injury rates. A Cox proportional hazards regression model was used to assess the re-injury rate of those who returned to sport vs those who did not as well as the rate of re-injury based on time of return to sport. The analyses were adjusted for age and the statistical significance was set at ≤ 0.05

Setting

[e.g., locations such as hospital, community; rural; metropolitan; country]

Rehabilitation and data collection occurred at the Norwegian Sports Medicine Clinic as part of the Delaware-Oslo ACL cohort study.

Participants

[N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]

Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article.

There were 106 participants included in the study who underwent ACL reconstruction. Eligibility criteria were unilateral ACL rupture that was confirmed with MRI and ≥ a 3 mm difference of anterior laxity compared to the contralateral knee as measured by the KT-1000. The ACL rupture must have occurred within 3-months of enrolment in the cohort, patients had to be between the ages of 13 and 60, and they must have participated in a sport involving jumping, pivoting, or cutting (level I) or level II sports at least twice per week before the injury. Patients with a previous injury to either knee, concurrent grade III knee ligament injury, fracture, cartilage pathology, and meniscal pathology (only if pain or swelling occurred during plyometric activity not resolved three months from injury) were excluded. The participants in the cohort were consecutively screened in the same clinic between 2007 and 2011. Of the initial 106 patients, 5 did not respond to the survey and 1 patient withdrew leaving the sample to equal 100 participants. There were 46 males and 56 females included, most of which (67%) underwent a hamstring graft while the rest of the sample received a bone-patellar-tendon-bone graft. When enrolling in the study the median subject was 4.8 months from the time of injury to surgery. A large percentage of the cohort had baseline concurrent injuries as 86 subjects had either meniscal, cartilage, MCL, LCL, or popliteus injury. Of the 83 subjects who participated in level I sports before injury, 53% played football, 30% played handball, 11% played floorball, and 6% played basketball. 74 of these 83 subjects returned to level I sports within 2-years of ACL reconstruction but only 69 subjects underwent functional testing before return to sport due to 1 patient missing all follow-ups and 4 patients returning to sport before 5-months post-surgery.

Intervention Investigated

[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided]

Control

This was an observational cohort study that was attempting to draw correlations between the independent variables of return to level I sport, knee function at return to sport, and timing of return to sport to the dependent variable of knee re-injury. Given that this study was primarily observational of patients with exposure to ACL reconstruction, no control group was used.

Experimental

As this study was an observational cohort study, there was no specific experimental group. However, all the subjects did receive 5 weeks of preoperative therapy and an individualized rehabilitation program after surgery that consisted of an acute phase, a rehabilitation phase, and a return to sport phase. The ACL reconstruction procedures were performed at seven hospitals using either a hamstring or a BPTB graft. The acute phase of the rehabilitation program focused on resolving swelling in the knee and range of motion deficits while minimizing atrophy. The goals of the rehabilitation phase were to improve neuromuscular control of the knee at full extension in functional, weight-bearing positions and to improve limb symmetry to ≥80% as shown on isokinetic strength and hop tests. The goals of the return to sport phase of the rehabilitation program were to improve limb symmetry to ≥90% as shown on isokinetic strength and hop tests and to begin sport-specific drills and movements with increasing frequency, intensity, and duration. No timeframes were used in the description of these rehabilitation phases suggesting that this rehabilitation program was strictly criterion based rather than time-based. While it is not explicitly stated in the paper, it is logical to assume that the site of the rehabilitation program was the same as the location of the screening which was the Norwegian Sports Medicine Clinic. It is also not indicated who the rehabilitation providers are or any of the exercise prescription parameters used.

Outcome Measures

[Give details of each measure, maximum possible score and range for each measure, administered by whom, where]

The independent variables of return to sport and timing of return to sport were measured through the monthly online survey while the knee function measures were conducted in the clinic at baseline, 6-months, and 12-months. These measures included isokinetic quadriceps strength testing, single-limb hop testing, the knee outcome survey-Activities of daily living (KOS-ADLS), and the global rating system (GRS). The isokinetic quadriceps strength testing was performed at 60 degrees per second using a Biodex 6000. While the strength value produced is continuous, the value was compared to the contralateral knee to calculate the limb symmetry index which ranges from 0-100%. The hop tests included single-limb hop for distance, crossover hop for distance, triple hop for distance, and a 6m timed hop. Similar to the strength testing, the results of the hop tests were measured continuously but were compared to the contralateral knee for a limb symmetry index that ranged from 0-100%. The KOS-ADLS is a self-report outcome measure that contains 14-items with a range from 0-100 with 100 being a better score. The GRS is also a self-report outcome measure that ranges from 0-100 based on the patient's perceived level of function with 100 being at pre-injury level of function. The authors determined that for a patient to meet the criteria for passing this return to sport battery, they must score >90 on all variables measured.

As stated above, the primary outcome measure utilized in this study was the presence or absence of knee re-injury within 2-years post ACL reconstruction. Knee re-injuries were reported through the monthly online survey or the follow-ups at 6,12, and 24 months. The injuries were diagnosed using the practice's standard clinical exam (2), using a combination of clinical exam and MRI (10), a combination of clinical exam and arthroscopic surgery (5), or a combination of clinical exam, MRI, and arthroscopic surgery (7). The diagnosis of re-injury was a dichotomous decision of yes or no.

Main Findings

[Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. You may summarize results in a table but you must explain the results with some narrative.]

Table 1. Return to Sport and Rate of Re-injury

	Return to level I sport	No return to level I sport
N	74	26
Re-injury	22	2
No re-injury	52	24
Age-adjusted relative risk RR (95% CI), p-value	4.32 (1.01-18.40), 0.048	

After adjusting for age, it was found that there is a significantly increased relative risk for re-injury within 2-years post ACL reconstruction of 4.32 times when returning to level I sport vs. no-return to level I sport.

Table 2. Average Time to Return to Level I Sport in Months

	n	Average Time to Return to Level I Sport in Months ± SD
Re-injury	22	7.2±2.7
No re-injury	52	10.7±4.3

Table 3. Timing of Return to Sport and Rate of Re-injury

	Returned to level I sport before 9 months	Returned to level I sport 9 months or later	Average Time to Return to Level I Sport in Months ± SD
N	38	36	
Re-injury	15	7	7.2±2.7
No re-injury	23	29	10.7±4.3
Age-adjusted Hazard Ratio (95% CI), p-value	0.49 (0.34-0.70), <0.001	0.75 (0.49-1.14), 0.18	

After adjusting for age, it was found that the subjects who returned to level I sport before 9-months after ACL surgery had a significantly greater incidence of reinjury than those who waited until 9-months to return to level I sport. During the first 9-months, each month that return to level I sport was delayed resulted in a 51% decrease in re-injury rate. After the first 9-months after ACL reconstruction, no significant association was seen between time to return to level I sport and re-injury rate.

Table 4. Return to Sport Criteria and Re-injury Rate

	Passed Return to Sport Criteria	Failed Return To Sport Criteria
N	18	55
Re-injury	1	21
No Re-injury	17	34
Age-adjusted HR (CI), p-value	0.16 (0.02-1.20), 0.08	

After adjusting for age, it was found that the subjects who passed the return to sport criteria before returning to sport demonstrated a decreased incidence of re-injury by 84%. However, these results only approached statistical significance as the p-value was 0.08.

Table 5. Return to Sport Battery Tests and Re-injury Rate

Test	Re-Injury (N, Score)	No Re-injury (N, Score ±SD)	Age-adjusted HR (CI), p-value
Quadriceps Strength	18, 75±16.7	51, 84.4±15.2	0.97 (0.94-0.99), 0.03
Single hop for distance, LSI	17, 91.0±11.7	48, 89.4±13.0	1.01 (0.96-1.05), 0.77
Triple Crossover Hop, LSI	16, 93.8±8.5	47, 90.7±11.8	1.04 (0.98-1.10), 0.22
Triple Hop, LSI	15, 93.5±10.8	47, 91.2±10.0	1.03 (0.96-1.10), 0.44
6 m Timed Hop	16, 92.4±6.2	47, 96.1±9.9	0.97 (0.93-1.02), 0.20
KOS-ADLS	18, 86.9±10.7	51, 89.2±9.6	0.98 (0.94-1.03), 0.43
Global Rating Scale	18, 77.7±16.1	51, 86.4±13.9	0.98, (0.95-1.01), 0.12

When analyzing the performance of subjects on individual components of the return to sport battery for correlation to re-injury rate, only the isokinetic quadriceps strength testing produced statistically significant results which indicate that this may be the most powerful test in the battery for determining readiness to return to sport. For each 1% increase in strength symmetry, there was a 3% reduction in injury rate.

Original Authors' Conclusions

[Paraphrase as required. If providing a direct quote, add page number]

Within 2-years post ACL reconstruction, a return to level I sports, returning to level I sports before 9 months post ACL reconstruction, and decreased isokinetic quadriceps strength when returning to level I sports are significantly associated with increased re-injury rates. Based on their findings the authors state on p. 5 that "strict time-based and functional return to sport criteria should be implemented."

Critical Appraisal

Validity

[Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.]

This prospective, level 2a study by Grindem et al. has a low-moderate overall risk of bias based on the QUIPS rating of risk of bias tool. One of the main strengths of this study relative to the focused clinical question is that a large percentage of the participants were football players of similar age to the patient in question. Additionally, all other participants were athletes. Because the factors leading to re-injury are likely different in athletes compared to the general population, the external generalizability of the results of this study are improved based on the subjects used. Another strength of the study is the frequent follow-up the researchers had with the participants which likely improved the accuracy of the data and decreased the amount of attrition. A weakness of the study was that exact exposure time was not measured due to return to level I sports being defined as any level of return. Therefore, further data such as volume or minutes of activity could not be compared to re-injury rates. The lack of a comparison group such as patients who were attending a different clinic for rehabilitation post ACL reconstruction is another weakness as the study design allows for some chance that the data was skewed by geographic location or a characteristic of the clinic attended by the participants. Another weakness of the study is that only one of the seven return to sport battery tests was significantly associated with increased re-injury rate. Therefore, a battery of tests with greater power may have better determined whether a patient was at increased risk for re-injury based on performance and self-report measures. Lastly, it is somewhat concerning that the authors chose to use the 84% reduction figure in the title of the paper when this was not a statistically significant finding which indicates that there may be some bias in the presentation of the data.

Interpretation of Results

[This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.]

The strongest evidence from the Grindem et al. study is related to the return to level I sports as well as the timing of the return to sports. A return to a level I sports within 2 years post ACL reconstruction significantly increases the rate of re-injury. While this is important to consider, the validity of this finding should continue to be researched as the p-value of 0.048 just reaches significance and the confidence interval is large at 1.01-18.40. The fact that the confidence interval approaches 1 also decreases the confidence in this finding. A stronger association is found when analyzing patients who returned to level I sports before 9-months as the p-value is <0.001, the confidence interval is narrower at 0.34-0.70, and the confidence interval does not closely approximate 1. The data obtained from the patients' functional and self-report testing approaches significance but does not achieve it. This may be due to 6 of the 7 tests in the return to sport battery failing to correlate significantly to increased re-injury rate. Based on the data from the study, the isokinetic quadriceps strength testing to establish a limb symmetry index was the most powerful tool in the return to sport battery for predicting re-injury.

Applicability of Study Results

[Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.]

This study is highly applicable to this clinical scenario as the population consists of level I athletes with a large percentage of them being football players who are likely to perform similar movements to those required of my patient. A third of the sample in this study received a BPTB graft which is the procedure the patient in this clinical scenario underwent. The aims of the study align with my clinical question as the researchers investigated both time-based and objective-based criteria for the safety of return to sport. One of the findings by the researchers was that a return to sport significantly increases the rate of re-injury compared to a lack of return. In the clinical scenario, the patient hopes to continue his professional football career so a decision not to return to sport to decrease the risk of re-injury is not feasible. The other significant findings in the study provide evidence that the patient may benefit from waiting until 9-months to return to sport as well as waiting until 90% LSI is achieved based on isokinetic quadriceps strength testing.

(2) **Description and appraisal of (Evidence-based rehabilitation following anterior cruciate ligament reconstruction) by (Van Grinsven et al., 2010)**

Aim/Objective of the Study/Systematic Review:

Van Grinsven et al. conducted a systematic review of RCTs, rehabilitation protocols, and reviews to develop an optimal rehabilitation protocol for patients post ACL reconstruction. The authors report a large amount of variability in the literature regarding rehabilitation protocols which has led to a lack of consensus. This systematic review aimed to provide clarity regarding best practices and fill a gap in the literature.

Study Design

[e.g., systematic review, cohort, randomized controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]

Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods.

This study is a systematic review of RCTs, rehabilitation protocols, and reviews.

Search Strategy: The authors used a search strategy that included the umbrella terms of anterior cruciate ligament, reconstruction, and physical therapy. Similar terms were used for each of these umbrella terms with “OR” in between to increase the sensitivity of the search. This search strategy yielded 1904 total results when combing the results from each database and eliminating duplicates.

Selection Criteria: RCTs and reviews that were relevant to ACL rehabilitation post BPTB or hamstring graft, as well as ACL rehabilitation protocols that were deemed by the authors to be based on “an extensive search of the literature” (p.1129) were included. Excluded physical therapy interventions were hydrotherapy, electrotherapy, and complementary therapies. Studies of poor quality were also excluded and the articles were limited by language to English, French, German, and Dutch. 32 of the initial 1904 results were included in the study with an additional 20 articles included to provide background information.

Methods: An online search was conducted using the Cochrane database, Pub Med, Embase, and PEDro to identify articles relevant to ACL rehabilitation between January of 1995 and December of 2006. Decisions regarding inclusion and exclusion were made upon screening of the title, abstract, and full-text screening as necessary. Reference lists of the studies included were searched to obtain any additional articles that were not yielded during the initial search. The quality of the RCTs and reviews were assessed using the Cochrane checklists which allowed the researchers to grade each article as either good, questionable, or good. From the articles included, data was extracted according to the research question, study participants, graft type/surgical

technique, intervention, outcome measure used, and results. Based on this data, the authors of this systematic review then made their conclusions and published an optimal rehabilitation protocol. The search strategy, study screening, quality assessment, and data abstraction were performed by two authors. Conflicts were resolved through consensus with a third researcher becoming involved when no consensus could be reached.

Setting

[e.g., locations such as hospital, community; rural; metropolitan; country]

The evidence included in this systematic review was obtained in several settings as the authors attempted to provide information at each stage of rehabilitation. The evidence presented in the post-surgical phase (week1) was more likely to be produced in the hospital setting compared to the evidence informing the later stages of rehab as these were more likely to be produced in an outpatient setting.

Participants

[N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]

Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article.

Of the 32 RCTs, protocols, or reviews that met the inclusion and exclusion criteria that were described above, 30 were written in English while 2 were written in German. Of the articles included for background, 17 were written in English while 1 was written in German. 15 of the 32 articles that met inclusion were reviews while the rest were either RCTs or meta-analyses. Categories of research topics that were addressed by the studies included accelerated vs conservative rehabilitation programs, BPTB graft vs hamstring graft, cryotherapy efficacy, early strength recovery, safety and efficacy of closed vs open chain exercises, and efficacy of neuromuscular training. 22 of the articles were assessed as good quality while the other studies were graded as questionable quality.

Intervention Investigated

[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided]

Control

When effusion was measured by Shaw et al., the contralateral knee was used as a control. Although not stated as a control group, the studies that compare accelerated rehabilitation to conservative rehabilitation are likely treating the conservative group as the control due to this being the standard care. Controls used in other RCTs were not described by the authors of the systematic review. However, common controls seen throughout ACL reconstruction literature that may be present in the studies included are the contralateral lower extremity, the use of matched-subjects without ACL reconstruction, or the use of ACL reconstructed patients with a different type of graft or surgical technique.

Experimental

Physical therapy interventions included in the systematic review were BPTB graft surgery, hamstring tendon graft surgery, accelerated rehabilitation program, conservative rehabilitation program, closed chain exercises, open chain exercises, cryotherapy, bracing, active ROM, active-assisted ROM, resisted ROM, gait education, balance exercises, proprioception training, and neuromuscular training.

Outcome Measures

[Give details of each measure, maximum possible score and range for each measure, administered by whom, where]

In appendix 2 of the systematic review, an overview of tests that are recommended as part of the optimal rehabilitation protocol is presented. These tests along with their scoring range are presented in the table below.

Table 6. Summary of Recommended Outcome Measures

Test	Scoring Range	Recommended Time of Administration
VAS pain Score	No pain – Unbearable Pain	Pre-surgery, day 2, end of weeks 8, 15, 22
Circumferential Knee Measurement	Continuous Measurement in mm	Pre-surgery, day 2, end of weeks 8, 15, 22
Knee Flexion/Extension ROM	Continuous Goniometric Measurement	Pre-surgery, day 2, end of weeks 8, 15, 22
IKDC Questionnaire	0-100	Pre-surgery, day 2, end of weeks 8, 15, 22
Hop Testing	0-100% of the uninvolved lower extremity, Limb Symmetry Index (LSI)	Pre-surgery, end of weeks 15, 22
Quadriceps and Hamstring Isokinetic Strength Testing	0-100% of the uninvolved lower extremity, Limb Symmetry Index (LSI)	Pre-surgery, end of weeks 15, 22

Main Findings

[Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. Use a table to summarize results if possible.]

In this systematic review, the authors summarize the methods and results of the included studies but do not utilize any statistics such as averages, treatment effects, confidence intervals, p-values, etc. When describing some of the results, they use the term “significant” which is often used with the alpha value of 0.05. However, this is not stated by the authors and therefore cannot be assumed. Overall, the main findings from the studies reviewed lack detail. The application of these findings to the authors’ construction of an optimal ACL rehabilitation protocol are presented in the table below.

Table 7. Evidence-based ACL Rehabilitation Protocol and Return to Sport Criteria

Phase	Goals	Projected Timeframe	Indicated Interventions	Contraindicated Interventions
Pre-Surgery	Pain, swelling, and inflammation control as well as full ROM and neuromuscular control before surgical intervention.	6-8 weeks from time of trauma	Patient Education regarding post-surgical exercises, use of assistive device, and the content of the rehabilitation program	None Stated
Phase I: Post-surgery	Pain, swelling, and inflammation control as well as knee ROM (emphasis on full extension and neuromuscular control recovery	Week 1	Medication, ROM exercises, compression wrap, elevation, cryotherapy, patellar mobilizations, isometric closed chain exercises (0-60 degrees), and isometric open-chain exercises (90-40 degrees)	No benefit to post-operative bracing, Avoid excess stress to the graft
Phase II	Continued improvement of pain, swelling, inflammation, ROM, strength, and neuromuscular control	Weeks 2-9	Cryotherapy, ROM exercises with a gradual increase in knee flexion, isotonic (closed chain: 0-60 degrees open chain: 90-40 degrees) and isokinetic	Avoid excess stress to the graft

			strengthening of quadriceps and hamstrings, neuromuscular training when able to walk without an assistive device, walking on a treadmill, swimming, cycling, stair-stepping, jogging	
Phase III	Maintain full ROM, monitor pain and swelling, increase knee strength, improve neuromuscular control	Week 9-16	Combination of closed and open chain exercises (no ROM restrictions), increased use of dynamic balance training and plyometrics, gait education when running, a gradual increase in exercise parameters	Agility and sport-specific training
Phase IV	Maximize strength and neuromuscular control of the knee, begin agility and sport-specific training	Week 16-22	Plyometric, agility, and sport-specific exercises	No return to sport before meeting criteria (see below)
Return to Sport Criteria	No pain or swelling, full ROM, quadriceps and hamstring strength > 85% of the contralateral side, Difference of hamstring/quadriceps ratio <15% of the contralateral side, hop tests > 85% compared to the contralateral side, tolerates maximal intensity sport-specific exercise	Week 22-return to sport	Continue with phase IV interventions	None Stated

Original Authors' Conclusions

[Paraphrase as required. If providing a direct quote, add page number]

The authors conclude that they have used the best available evidence to formulate an optimal accelerated, criterion-based ACL rehabilitation protocol. Their protocol focuses on the resolution of pain, swelling ROM, strength, neuromuscular control, and functional deficits. The authors argue that this protocol can provide a safe yet quick return to activity and function. During the first 2 phases of the protocol, the authors advocate for ROM restrictions based on the mode of exercise (closed vs. open) to protect the graft. The authors provide an accelerated timeline but allow for the timeline to be adjusted based on patient progression as the goals set for each phase should be reached before advancing to the next phase. Finally, a return to sport criteria is provided to guide clinicians in their recommendations for returning to sport.

Critical Appraisal

Validity

[Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.]

The AMSTAR-2 quality assessment of this systematic review indicates moderate confidence in the author's findings. A strength of the review is that it is of a higher level of evidence due to the systematic process undertaken with multiple researchers reviewing the evidence. However, the inclusion of the lower level of evidence such as protocols, reviews, and background evidence decreases the quality of evidence presented. The authors justify this inclusion as they state that they would be unable to formulate an evidence-based rehabilitation protocol without these additions. Another weakness of this review is that the latest included articles were from December of 2006. This leaves a 13-year gap in the evidence. More recent evidence has likely been published that may alter the construction of an optimal ACL rehabilitation program. Lastly, the authors do not present quantitative data from the included articles to support their applications to the rehabilitation protocol which may indicate some bias related to data reporting. Without knowing the effect sizes, confidence intervals, and p-values of the various interventions that were indicated from the systematic review, it is difficult to confirm the validity of the recommendations.

Interpretation of Results

[This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.]

The ACL rehabilitation protocol presented by the authors is based on varying levels of evidence but is highly applicable as they provide clear time-based and criterion-based recommendations designed to maximize the safety and efficacy of an ACL rehabilitation protocol. The lack of objective data presentation, the length of time that has passed since the latest inclusion indicated, and the inclusion of lower-level evidence decreases the validity of the results. The lack of objective data reporting is the most concerning factor in the evaluation of this study as this leads to a suspicion of bias among the authors. However, I do appreciate that the authors chose to sacrifice some of the quality of their evidence to provide a protocol that was comprehensive in a topic area that lacks consensus. Therefore, the results of this study should be loosely applied with the perspective that other evidence of higher quality may need to be prioritized when making clinical decisions.

Applicability of Study Results

[Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.]

The results of the systematic review are highly applicable to the clinical question at hand as Van Grinsven et al. aimed to produce a protocol that maximizes the safety and efficacy of ACL rehabilitation. The question of accelerated vs conservative rehabilitation protocol is addressed and the use of time-based and criterion-based ACL rehabilitation is implemented into the recommended rehabilitation protocol. The implementation of the recommended protocol is both practical and feasible as it can be performed in the standard physical therapy clinic and is detailed enough to provide the clinician clear parameters regarding patient progression through the phases and eventually to return to sport. As stated above, the authors sacrificed some quality of evidence to improve the applicability of the study as they attempted to fill a gap in the literature.

SYNTHESIS AND CLINICAL IMPLICATIONS

[Synthesize the results, quality/validity, and applicability of the two studies reviewed for the CAT. Future implications for research should be addressed briefly. Limit: 1 page.]

Overall, both studies included in this CAT indicate the use of a combination of time-based and criterion-based rehabilitation post ACL reconstruction. The first study included in the CAT by Grindem et al. is highly relevant to the clinical question as the study population consists only of athletes who underwent an accelerated, criterion-based protocol who are required to perform similar movements to the patient in this case. The prospective nature of this study is ideal for the question as we aim to identify factors such as rehabilitation characteristics that lead to increased rates of re-injury. The data from the Grindem et al. study shows that re-injury rates are increased within 2-years post ACL reconstruction with an attempt to return to level I sport to return, with a return to level I sport before 9-months, and with isokinetic quadriceps strength <90% of the contralateral lower extremity. The data indicates that both performance measures and time since surgery are important to consider when making recommendations regarding the design of a rehabilitation protocol and return to sport recommendations. Overall, the Grindem et al. study has a low-moderate risk of bias and can be readily applied as long as other relevant evidence is also considered. Future prospective studies that analyze the level of return to sport and volume of activity before re-injury may be helpful in better describing the factors that place the athlete at an increased risk for re-injury.

Van Grinsven et al. surveyed the available evidence to produce an evidence-based protocol that optimizes the post ACL reconstruction protocol, which is an area that has lacked consensus in the literature. The authors found that an accelerated protocol is safe and effective for patients after ACL rehabilitation when clear goals are set and reached before advancing to the next phase of rehabilitation. The proposed protocol has recommended timeframes but can be adjusted based on the patient's presentation on objective criteria such as pain, swelling, ROM, strength, or functional performance. A return to sport criteria is also presented which is criterion rather than time-based, although this is not recommended before the finishing of phase IV of the protocol which is predicted to occur at approximately 22 weeks post-surgery. The validity of the data is questionable as the authors included lower levels of evidence and did not report quantitative data such as effect sizes, confidence intervals, or p-values. Future systematic reviews similar to that of Van Grinsven et al. should be performed to update and improve upon the work presented in this study.

Based on the two studies described above, I conclude that both objective criteria and time since surgery should be considered in the design of a rehabilitation protocol. It appears that each month of delayed return up to 9 months post-surgery is beneficial in decreasing the risk of re-injury. However, the decreased performance also appears to be correlated to increased injury risk independent of time since surgery which indicates that this should also be considered. To provide the best advice to the patient in this case, I would recommend an accelerated protocol that progresses based on objective criteria but suspend return to sport until at least 9-months post ACL reconstruction.

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