

Various Definitions of Failure Are Used in Studies of Patients Who Underwent Anterior Cruciate Ligament Reconstruction



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Purpose: To conduct a literature review to assess the definitions of anterior cruciate ligament reconstruction (ACLR) failure used throughout the orthopaedic literature. **Methods:** A systematic search of Embase, Ovid Medline, SPORT-Discus, and Web of Science was conducted by a university librarian to identify level I-IV clinical studies on ACLR failure. Inclusion criteria consisted of patients who underwent ACLR and included a definition of failure of ACLR. Patients who underwent anterior cruciate ligament (ACL) repairs, animal/cadaver studies, review studies, non-English language articles, and non-full text articles were excluded. Failure data were extracted from each study and categorized. Other data that were extracted included follow-up time after ACLR, failure reoperation rate, and failure reoperation procedure. Descriptive statistics was used to analyze the data. **Results:** Out of 2,775 studies, 104 (3.75%) met inclusion criteria and were analyzed in this review. The most common definition of ACLR failure included the use of a physical examination, specifically Lachman's test (21/104 [20.2%]), anterior laxity assessment, or a Pivot-Shift test (24/104 [35.2%]) or undergoing or requiring revision ACLR (39/104 [37.5%]). Although some studies used quantitative tests or imaging to help define "failure," others simply defined it as graft rupture that was otherwise not defined (22/104 [22.5%]). Other common definitions included: the use of imaging (magnetic resonance imaging/radiographs) to confirm graft re-rupture (37/104 [35.6%]), patient-reported outcomes (recurrent instability)/patient reported outcomes measures (International Knee Documentation Committee [IKDC], Knee injury and Osteoarthritis Outcome Score [KOOS], Tegner) (18/104 [17.3%]), and the use of an arthrometer (KT-1000/2000, Rollimeter, or Kneelax) (17/104 [16.3%]). The least common definitions included graft failure or rupture confirmed by arthroscopy (13/104 [12.5%]) and nonrevision surgery (2/104 [1.0%]). The failure rate of this procedure ranged from 0% to 100% depending on the definition of "failure." **Conclusion:** In this study, we found that a variety of definitions of failure are used among studies published in the orthopaedic literature. The most common criteria for failure of ACLR were the results of physical examination tests (35%), the need for undergoing a revision ACLR (36%), and the use of imaging to diagnose the failure (34%). About 17% of studies included in this review used patient-reported outcomes, specifically recurrent instability, or PROMs (IKDC, KOOS, Tegner) in their assessment of failure of ACLR. The least used definitions of "failure" of ACLR included nonrevision ACLR surgery (2%). Although some studies used similar tests or categories in their definition of failure, there were a variety of score and grade cutoff points between them. **Level of Evidence:** Level IV, systematic review of Level II-IV studies.

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Anterior cruciate ligament (ACL) reconstruction (ACLR) is a common procedure performed by orthopaedic surgeons.¹ ACL injuries are increasing in incidence because of an increase in youth participating in athletic activities, resulting in an increase of ACLR procedures.^{2,3} Although the procedure has been presented as being quite effective, with 70% to 90% of patients reporting a successful outcome, around 10% to 15% of these patients will require a revision procedure.^{4,5} ACL tears continue to carry a substantial lifetime healthcare cost burden of \$7.6 billion annually in the United States according to a 2013 study, impacting the financial lives of patients.⁶ Furthermore, numerous long-term complications associated with ACLR procedures have been recorded throughout the literature.⁷⁻¹⁰

Although ACLR successes, complications, and failure outcomes are found in numerous articles, many authors neglect to provide a definition for a “failed” procedure. Without a clear definition for the failure of an ACLR, analysis and interpretation of the procedure’s effectiveness becomes complicated. Some authors define failure as requiring a revision ACLR or identification of a complete graft rupture verified by magnetic resonance imaging (MRI), whereas others define it as a 2+ Lachman result, positive pivot shift, and 5 mm difference or more on KT-1000 arthrometer measurement.^{11,12}

By completing a thorough investigation of the various definitions of “failure” relating to ACLR, clinical recognition and effectiveness will be enhanced. The purpose of this study was to conduct a literature review to assess the definitions of ACLR failure used throughout orthopaedic literature. We hypothesize that studies of patients who underwent ACLR will have differing definitions of “failure.”

Methods

Literature Search

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines were used to complete this systematic review, and approval from the institutional review board was obtained. To identify studies for inclusion, a search was conducted using Embase, Ovid Medline, SPORTDiscus, and Web of Science using the search terms “anterior cruciate ligament,” “anterior cruciate ligament reconstruction,” “fail,” “failure,” “treatment failure,” “definition,” “follow-up,” “post-operative,” and “pain.” The full search strategy is shown in [Appendix 1](#).

Study Eligibility

Inclusion criteria consisted of human studies, written in the English language, published between January 1, 2016, and July 11, 2021, evaluating ACLR outcomes

that have a definition of ACLR “failure.” Studies with a level of evidence I-IV were included. Animal or cadaver studies, review studies, case reports, and studies including definitions of ACL repair or revision ACLR failure were excluded.

Study Selection and Data Extraction

A university librarian pulled all the studies from the databases listed above. Two research team members then screened the articles based on title before moving onto abstract screening. If there were disagreements on inclusions, both team members would review the article again separately before meeting to discuss their reasoning. If there was still disagreement, a senior team member made a final decision. This was followed by full-text review of articles and re-evaluation for eligibility. Once article inclusion was finalized, 2 team members split the articles and extracted the data.

Failure data were extracted from each study and divided into the following categories: imaging (failure confirmed by), arthroscopy (failure confirmed by), physical examination (Lachman’s test, anterior laxity, pivot shift test), arthrometer (KT-1000/2000, Rollimeter, Kneelax), revision ACLR, need for additional surgery (nonrevision ACLR), graft rerupture (not otherwise defined), patient-reported outcomes (PROs; recurrent instability)/patient-reported outcomes measures (PROMs; International Knee Document Committee [IKDC] score, Knee injury and Osteoarthritis Outcome Score [KOOS], and Tegner score). Other data that were extracted included follow-up time after ACLR, failure reoperation rate, and failure reoperation procedure. Descriptive statistics was used to analyze the data.

Results

A total of 2,775 studies were identified in the initial database search, of which 104 (3.75%) met inclusion criteria ([Fig 1](#)). The characteristics of these studies are included in [Table 1](#). Definitions of failure used on these studies can be seen in [Figure 2](#).

Some studies that incorporated PROs in their definition of ACLR “failure” used subjective measures, such as Wang et al.¹³ including “patient-reported knee instability that affected daily living or sport activities” in their definition whereas Naik et al.¹⁴ defined it as “instability, stiffness, or persistent pain.” The use of imaging (MRI or radiography) to confirm graft rerupture was used in 35.6% of included studies (37/104). Patients undergoing or requiring revision ACLR were used in 37.5% of included studies (39/104). The least common definitions included graft failure or rerupture confirmed by arthroscopy (13/104 [12.5%]) and non-revision surgery (2/104 [1.90%]). Cutoff for IKDC scores to be included in the definition of “failure” of an ACLR were an overall grade of C or D in all 5 studies

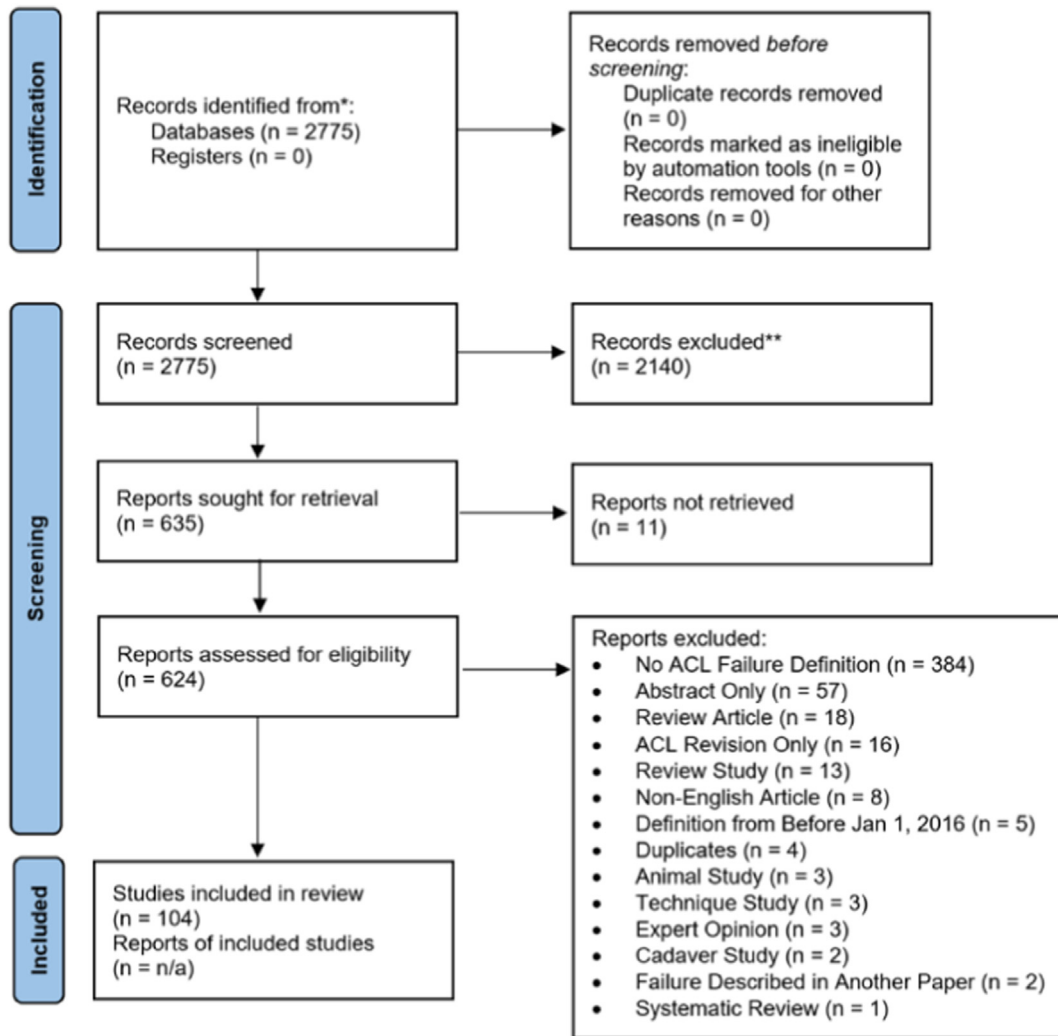


Fig 1. Preferred reporting items for systematic reviews and meta-analyses 2020 flow diagram of articles included in the definitions of failure in anterior cruciate ligament reconstructions.

(5/104 [4.8%]) that include it in their definition of “failure.”¹⁵⁻¹⁹ Three studies (3/104 [2.9%]) used a KOOS quality of life cutoff of <44 whereas one study (1/104 [1.0%]) used a score of \leq 20th percentile.²⁰⁻²³ Studies that used an arthrometer also had different cutoffs for the definition of “failure” in ACLR. In 5 studies (5/104 [4.8%]), “failure” was indicated by a side-to-side difference of >3 mm.^{13,19,24-26} 16 studies (16/104, 15.4%) definition of failure included a side-to-side difference of >5mm.^{16-18,27-39} Failure rates for the >3 mm side-to-side group ranged from a mean of 3.4% to 15.4% (Table 1). Failure rates for the >5 mm side-to-side difference group ranged from a mean of 0% to 100% (Table 1). The Lachman’s test was used in 21 studies (21/104 [20.2%]) with the cutoff ranging from \geq 2 (5-10 mm translation) (7/21 [33%]), a grade of \geq 3 (>10 mm translation) (1/21 [4.8%]), a soft or loss of endpoint on the physical exam (4/21 [19%]), or any positive Lachman test (9/21 [42.9%]) for an ACLR to

be considered a “failure.”^{13,19,25,30,32,35,40-54} The Pivot-Shift test cutoff ranged from a grade of \geq 1 (1/104 [1.0%]), \geq 2 (10/104 [9.6%]), and \geq 3 (3/104 [2.9%]), whereas others simply stated a “positive” Pivot-Shift constituted a “failure” of ACLR (10/104 [9.6%]).^{13,19,25,27,29-32,35,41-45,47,49-51,53,55-60} Many articles used more than 1 category, with only 1 needing to be fulfilled to be defined as a “failure” of ACLR (50/104 [48.1%]) (Table 1).

Discussion

The most important finding of this study is that there remain a variety of definitions currently used to define “failure” of ACLR, with the most common criteria consisting of physical examination tests (38/108 [35.2%]), the need for or undergoing a revision ACLR (39/108 [36.1%]), and the use of imaging to diagnose the failure (37/108 [34.3%]). Only 18/108 (16.7%) studies included in this review used PROs, specifically

Table 1. Study Characteristics and Failure Data

First Author	Year of Publication	Study Design	Level of Evidence	Total Participants	Females	Males	Mean Age \pm SD (y)	Age Range (y)	Mean Follow-Up \pm SD (m)	Failure Rate (%)	Definition of Failure
Akoto et al. ²⁴	2019	Retrospective cohort	na	64	0	64	28.5 \pm 10.5	na	13.85	7.3-9.8	Graft failure was indicated by a side-to-side difference of more than 3 mm in the instrumental measurement
Akoto et al. ²⁷	2020	Case series	IV	6	6	14	27.8 \pm 8.6	18-49	30.5 \pm 9.3	0	Postoperative failure was defined as a side-to-side difference of \geq 5 mm in the Rolimeter test and a pivot-shift grade of 2 or 3
Alentorn-Geli et al. ⁶⁵	2019	Retrospective cohort	III	548	100	448	21.5 \pm 6.7	na	8	5.7	A failure was considered only the presence of persistent instability (by physical examination and MRI obtained during the follow-up) requiring revision ACL reconstruction or leading to sports abandon in a patient who elected not to have further surgery
Antosh et al. ⁶⁶	2018	Retrospective cohort	III	470	41	429	28.5	18.8-48.6	na	13.6	Failure of the ACL graft as defined by radiographic tear confirmed by clinical examination
Attia et al. ⁶⁷	2020	Cohort	III	413	10	403	31.54	na	44.27	8	Failure was defined as having a revision ACLR of the index knee, persistent or recurrent instability, or MRI evidence of rupture of the graft
Batailler et al. ⁴⁰	2018	Case control	III	82	21	61	30.5	15-74	13	2.4-4.9	Reconstruction failure was defined by clinical anterior laxity (soft endpoint on Lachman–Trillat test) and/or instability reported by the patient
Benner et al. ²⁸	2016	Cohort	II	553	na	na	23.4 \pm 9.2	na	49.2 \pm 13.2	6.9-9.8	Graft failure was defined as a KT-1000 manual maximum difference between knees of >5 mm
Britt et al. ⁶⁸	2020	Case series	IV	90	90	0	15.4 \pm 1.3	na	40.8	11.3	Failure was defined as a ACL graft retear
Burton et al. ⁶⁹	2021	Prospective case series	IV	35	14	21	32.2 \pm 7.2	19-47	2.8 \pm 0.9	6.9	Clinical failure was defined as ACL rerupture requiring revision ACL reconstruction

(continued)

Table 1. Continued

First Author	Year of Publication	Study Design	Level of Evidence	Total Participants	Females	Males	Mean Age ± SD (y)	Age Range (y)	Mean Follow-Up ± SD (m)	Failure Rate (%)	Definition of Failure
Castoldi et al. ⁴¹	2020	Randomized control trial	II	57	31	26	na	15-59	232.8	21	Graft failure was defined by the presence of at least 1 of the following criteria: subsequent revision ACLR, recurrent instability (>1 episode), a difference in anterior knee laxity (TELOS) >10 mm, a soft endpoint in the Lachman test, or a 3+pivot-shift test (gross pivot shift) on physical examination
Chen et al. ¹⁵	2017	Cohort	II	111	19	92	27.6 ± 9.3	17-54	121.85	7.9-8.2	Notably, an endpoint event was set as a graft rupture or clinical failure (overall IKDC grade C or D), which was recently generalized as cumulative failure
Clatworthy et al. ⁷⁰	2019	Prospective comparative	II	1480	na	na	32.2	na	24	5.1-6.9	ACL failure was determined by clinical failure and MRI confirmation with or without subsequent ACL revision surgery.
Cristiani et al. ¹⁶	2019	Retrospective cohort	III	191	na	na	21.7 ± 7.1	na	na	8.4	“Surgical failure” was defined as a STS difference greater than 5 mm (IKDC grade C and D).
Cristiani et al. ¹⁷	2019	Cohort	III	5462	2412	3050	28.45	na	na	2.4-4.3	“Surgical failure” was defined as a STS difference > 5 mm (IKDC grades C and D)
Cristiani et al. ¹⁸	2018	Retrospective cohort	III	4497	2102	2395	27.18	na	6	3.2-9.1	“Surgical failure,” for the purposes of this study, was defined as a side-to-side difference >5 mm in accordance with the IKDC knee examination form
Cruz et al. ⁷¹	2020	Retrospective cohort	na	102	26	76	26.15	na	29.3	7.7	The primary outcome was ACL graft failure requiring revision surgery
Darnley et al. ⁷²	2016	Cohort	III	54	20	34	20.9 ± 7.0	na	24	7.4-18.5	Graft failure was defined as the performance of a revision ACL reconstruction, which likely underestimates the true failure risk as some patients who suffered graft failure may not seek revision surgery

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Table 1. Continued

First Author	Year of Publication	Study Design	Level of Evidence	Total Participants	Females	Males	Mean Age \pm SD (y)	Age Range (y)	Mean Follow-Up \pm SD (m)	Failure Rate (%)	Definition of Failure
Dekker et al. ⁷³	2017	Cohort	Therapeutic IV	85	51	34	13.9 \pm 2.1	6-17	48.3 \pm 15.3	31.8	Failure was defined as a secondary ACL injury to either knee
Di Benedetto et al. ⁷⁴	2020	na	na	11	1	10	41	24-49	36	100	All the eleven patients were treated due to the failure (rupture) of the LARS-ACL reconstruction determining clinical instability
Eysturoy et al. ⁷⁵	2018	Cohort	III	13200	na	na	na	na	na	2.1	Failure was measured in terms of the revision rate, defined as revision of primary ACL reconstruction
Ferretti et al. ²⁹	2016	Retrospective comparative	III	71	20	51	27.3	18-50	125	11.2	Considering as a failure a presence of a side-to-side maximum manual difference of more than 5 mm using KT-1000 arthrometer or a pivot shift test as ++/++++, any giving way episode during follow-up period
Franciozi et al. ⁷⁶	2021	Prospective comparative	II	144	31	113	30.45	na	30.2	4-9	Failure, also a secondary outcome, was defined as the indication of a revision surgery due to complaints of instability after the first surgery or new trauma
Gagliardi et al. ⁷⁷	2020	Case series	IV	81	39	42	15.9 \pm 1.7	10-18	37.2	1.2	Failure was defined as a ACL graft re- tear
Gagliardi et al. ⁷⁸	2019	Cohort	III	179	92	87	14.8	na	35.4	4.7	Failure was defined as the need for revision surgery or as an MRI-confirmed reruptured ACL
Getgood et al. ⁵⁵	2020	Randomized control trial	I	618	321	297	18.9	14-25	na	25-40	The primary outcome was ACLR clinical failure, a composite measure of rotatory laxity defined as 1 or more of a persistent (detected at 2 visits) mild asymmetric pivot shift (grade 1), a moderate or severe (grade 2 or 3) asymmetric pivot shift at any follow-up visit, or a graft rupture. Graft rupture was defined as a tear of the graft confirmed by either MRI or arthroscopic examination

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Table 1. Continued

First Author	Year of Publication	Study Design	Level of Evidence	Total Participants	Females	Males	Mean Age \pm SD (y)	Age Range (y)	Mean Follow-Up \pm SD (m)	Failure Rate (%)	Definition of Failure
Grassi et al. ⁷⁹	2021	Case series	IV	267	62	205	30.7 \pm 10.6	na	10.1 \pm 0.6	3	The most used and universally accepted criterion is probably the failure rate, defined as the need for revision surgery
Guo et al. ⁸⁰	2016	Case control	III	51	12	39	26.7 \pm 4.9	na	53.5	7.8	Attenuation of ACL was defined as failure of ACL without clear injury history and diagnosed by second-look arthroscopy
Gupta et al. ⁸¹	2021	Prospective cohort	III	367	28	339	24.8	na	48.5 \pm 15.9	1.6-6.5	Failure was defined as ACL graft rerupture
Gupta et al. ⁸²	2018	na	III	249	22	227	24	16-46	61.8 \pm 25.9	1.2-7.1	Failure was defined as ACL graft rerupture
Hamrin Senorski et al. ²⁰	2018	Cohort	III	6889	3461	3428	na	13-49	24	24.9	Failure was defined as a KOOS \leq 20th percentile
Helito et al. ⁴²	2019	Case Control	III	90	49	41	28.5	na	28.9	3.3-21.7	New ruptures were defined based on clinical ACL failure criteria (physical examination showing laxity with no clear end point for Lachman and Anterior drawer tests (at least 2+/3+) or pivot-shift positivity (at least 2+/3+) associated with instability complaints) and when imaging showed a new graft rupture
Ho et al. ⁸³	2019	Case control	III	561	264	297	15.4	5-19	na	9.6	Graft failures were confirmed both with clinical examination and MRI or the patient had to have undergone a revision ACL reconstruction
Hunnicutt et al. ⁸⁴	2018	Retrospective case series	IV	100	48	52	22.6 \pm 8.0	na	42.2 \pm 21.2	11	Graft failures were defined as rupture of the graft, as selfreported by patient at time of follow-up, or the need for subsequent revision surgery, as reported in the patient's medical chart

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Table 1. Continued

First Author	Year of Publication	Study Design	Level of Evidence	Total Participants	Females	Males	Mean Age \pm SD (y)	Age Range (y)	Mean Follow-Up \pm SD (m)	Failure Rate (%)	Definition of Failure
Hurt et al. ³⁰	2021	Case series	IV	480	204	276	17.8	na	24.4	9.7-10.2	Failure rates for each group were calculated as a percentage of the total of the group, and a failure was identified as a 2+ \dagger Lachman (no end point), 1+ or greater pivot shift, or a KT-1000 arthrometer difference of five or more
Inacio et al. ⁶¹	2017	na	na	6985	2328	4657	28 \pm 11	na	2.8 \pm 1.8	1.5	Revision surgery in this study was defined as the aseptic failure of the primary ACL graft that required removal and replacement of the original graft
Jacobs et al. ⁴³	2016	Retrospective cohort	na	88	44	44	14.8	na	39	11.9-28.3	For the current analysis, "graft failure" was operationally defined as patient-reported instability that affected the patient's ability to perform activities of daily living or sporting activities, pathological laxity during the physical examination (positive Lachman test, marked anterior laxity, or a positive pivot-shift test compared
Jacobs et al. ⁴⁴	2017	Cohort	III	288	106	182	38.2	na	44.4	2.2-2.7	In addition to the need for revision ACLR, we also included evidence of a failed graft on MRI, or pathological laxity during the physical examination (positive Lachman test, marked anterior laxity, or a positive pivot shift best compared to the healthy knee), or patient-reported instability that affected the patient's ability to perform activities of daily living or sporting activities, in our definition of a failed graft

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Table 1. Continued

First Author	Year of Publication	Study Design	Level of Evidence	Total Participants	Females	Males	Mean Age \pm SD (y)	Age Range (y)	Mean Follow-Up \pm SD (m)	Failure Rate (%)	Definition of Failure
Jaecker et al. ⁴⁵	2017	Retrospective cohort	na	101	35	66	25.8	12-47	na	100	Inclusion criteria included having undergone previous primary ACL reconstruction with either the TT or AM technique for femoral tunnel placement and having experienced traumatic or non-traumatic ACL reconstruction failure as evidenced by clinical symptoms of recurrent instability and objective knee laxity, defined as a positive pivot shift and Lachman test with side-to-side difference on arthrometer testing greater than 4 mm
Jia et al. ³¹	2017	na	na	91	30	61	36 \pm 11	20-64	91 \pm 19	4.4	ACL failure is defined as either ACL graft re-rupture diagnosis by MRI or a pivot shift test greater than grade 2, KT-1000 side-to-side difference of >5mm and extension >5 and flexion deficit >15° according to the contralateral side
Kane et al. ⁸⁵	2017	na	na	216	99	117	20.2	na	24	6	Additionally, graft failure was defined by the rate of ACL revision and not by reinjury
Kim et al. ³²	2016	na	III	120	19	101	30.2	na	501	25.8	Failure was defined as greater than 2 laxity on the Lachman or pivot shift test or greater than 5mm anterior translation on stress radiography postoperative
Kimura et al. ⁸⁶	2020	Retrospective cohort	IV	518	269	249	24.5 \pm 11.3	11-66	42.4 \pm 30.2	7.1-10	ACL graft rerupture and revision ACL reconstruction are obvious failures of ACL reconstruction
Koch et al. ²⁵	2020	Case series	IV	12	2	10	12.1	10.4-13.4	54	16.7	A side-to-side difference in KT-1000 rating of >3 mm, whereby in two knees a positive Lachman test and pivot-shift test was detectable, suggestive of graft failure

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Table 1. Continued

First Author	Year of Publication	Study Design	Level of Evidence	Total Participants	Females	Males	Mean Age \pm SD (y)	Age Range (y)	Mean Follow-Up \pm SD (m)	Failure Rate (%)	Definition of Failure
Kosters et al. ²⁶	2016	Retrospective cohort	IV	85	29	56	28.2	na	24	12.5-16.3	Clinical failure was defined as delta-Anterior Tibial Translation >3 mm in combination with subjective instability
Larson et al. ³³	2020	Randomized control trial	I	183	102	81	26.9	12-69	72	11.5	A clinical failure was defined as ACL graft rupture or KT-1000 measurement greater than 5 mm side-to-side difference
Lazarides et al. ⁸⁷	2017	Case control	III	168	62	106	21.8	na	18	4.2	Failure was defined as presence of symptomatic laxity or graft insufficiency
Lian et al. ⁸⁸	2018	Cohort	III	304	136	168	23.5	na	na	8.9	Failure was defined as an ACL graft reter
Lind et al. ⁶²	2020	Prospective cohort	III	16579	6134	10445	28.2	16-70	12	1.5-4.7	The primary outcome was failure of the ACLR expressed as need for revision
Maletis et al. ⁸⁹	2020	na	III	5586	1803	3783	23.8	17.9-33.2	24	1.9-3.6	Aseptic revision was the endpoint of the study, which was defined as any noninfectious failure of primary ACLR that required revision surgery
Maletis et al. ⁹⁰	2017	Cohort	II	14015	5091	8924	28.1 \pm 11.1	na	21.6	1.9-2.3	Aseptic revision was the endpoint of the study, which was defined as any noninfectious failure of primary ACLR that required revision surgery
Mantell et al. ⁴⁶	2017	Cohort	II	50	22	28	31.3	18-54	24	23.5	Failure was defined as need for revision ACL reconstruction based on subjective symptoms, objective physical findings of laxity on Lachman examination, and evidence of reter on MRI
Melugin et al. ⁹¹	2019	na	na	60	12	48	26.4	13-47	57.3	10	Failure was defined as an ACL graft reter

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Table 1. Continued

First Author	Year of Publication	Study Design	Level of Evidence	Total Participants	Females	Males	Mean Age \pm SD (y)	Age Range (y)	Mean Follow-Up \pm SD (m)	Failure Rate (%)	Definition of Failure
Mengdi et al. ¹⁹	2018	Cohort	III	185	50	135	31.5	13-57	86.4	11.4	Overall IKDC grade C or D, such as an overall IKDC objective score of C or D, Pivot-Shift test \geq 2+, Lachman test or Kneelax3 > 5 mm, limited range of motion (ROM) (ie extension deficit >5 degrees or flexion deficit >15 degrees), was regarded as clinical failure
Mohtadi et al. ⁴⁷	2021	Retrospective case series	IV	315	137	178	28.6	na	60	4-10	Complete traumatic reruptures were defined as a consequence of an acute traumatic event resulting in an obvious change in static stability (definite loss of end point on Lachman testing, increased anterior translation [$>$ 3 mm], and pivot shift grade of \geq 2) and confirmed by MRI or diagnostic arthroscopy. Revision ACL reconstruction was recommended for all patients with a complete traumatic rerupture. Partial traumatic tears were defined as a consequence of an acute traumatic event resulting in a suspected meniscal injury or graft tear, without the clinical characteristics of a complete rerupture, as defined above. A partial traumatic tear was confirmed by MRI or diagnostic arthroscopy. Revision ACL reconstruction was not recommended or required. Atraumatic graft failures were defined in the absence of an acute traumatic event, but with a pivot shift grade of \geq 2
Murgier et al. ⁹²	2019	Randomized control trial	Therapeutic I	992	na	na	\leq 20	na	38	5.2	Failure was defined as an ACL graft re- tear

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Table 1. Continued

First Author	Year of Publication	Study Design	Level of Evidence	Total Participants	Females	Males	Mean Age \pm SD (y)	Age Range (y)	Mean Follow-Up \pm SD (m)	Failure Rate (%)	Definition of Failure
Murray et al. ⁴⁸	2016	na	III	20	14	6	24.4	18.1-34.6	3	0	The outcomes measures included postoperative pain, muscle atrophy, loss of joint range of motion, and implant failure (designated by an International Knee Documentation Committee grade C or D Lachman test and/or an absence of continuous ACL tissue on MRI)
Nagai et al. ⁹³	2016	Cohort	II	35	17	18	19.5	na	26.4	14.3	Graft failure on postoperative examination (i.e., excessive side-to-side difference on KT-1000) or imaging
Nagaraj et al. ⁹⁴	2019	Retrospective cohort	IV	1318	na	na	29.9	20-30	62.4	5.9	Failure was defined as a knee that demonstrates recurrent pathologic laxity that was present before surgery, or a stable knee that has a range of motion from 10° to 120° of flexion that is stiff and painful even with activities of daily living
Naik et al. ¹⁴	2019	Retrospective cohort	na	32	na	na	na	na	na	0	Failure was defined as instability, stiffness or persistent pain
Nissen et al. ⁹⁵	2018	Cohort	III	200	89	111	28.5	na	12	5.4-12.7	Failure was defined as a new revision ACLR procedure
Niu et al. ³⁴	2016	Cohort	III	101	49	52	26.5	na	41.5	4-17.6	Ruptures and side-to-side changes >5 mm as measured with the KT1000 instrument were considered graft failures
O'Brien et al. ⁴⁹	2019	Case Series	IV	8	2	6	13.8	12.6-15.6	21.1	13	ACL retear was defined as a failure of the reconstruction, by physical examination (revealing a 3B Lachman and/or frank pivot shift), confirmed by MRI
Parkes et al. ⁹⁶	2021	Retrospective comparative	IV	108	33	75	25.1	13-54	26.1	3-6	ACLR failure was defined as graft rupture or revision reconstruction procedures

(continued)

Table 1. Continued

First Author	Year of Publication	Study Design	Level of Evidence	Total Participants	Females	Males	Mean Age \pm SD (y)	Age Range (y)	Mean Follow-Up \pm SD (m)	Failure Rate (%)	Definition of Failure
Parkinson et al. ⁵⁶	2017	Case control	III	124	30	94	27	16-65	26	16.1	Failure of the ACL was defined to be 1 or more of the following criteria: (1) patient-reported symptoms of rotational instability, (2) a positive pivot-shift test, (3) MRI or arthroscopy showing ACL graft rupture
Patel et al. ⁹⁷	2019	Retrospective cohort	III	1056	535	521	15.1 \pm 2.4	na	26.2 \pm 3.3	10-10.8	Graft failure was considered a rupture of the prior ACL graft confirmed by MRI
Pennock et al. ⁹⁸	2016	Cohort	III	40	24	16	15.7	12-18	36	5-30	Graft failures were confirmed with both clinical examination and MRI, or the patient had to have undergone a revision ACL reconstruction for a discontinuous graft that was confirmed at the time of arthroscopy
Pennock et al. ⁵⁰	2019	Cohort	III	83	21	62	14.8 \pm 1.4	na	33.6 \pm 10.8	4-21	Graft failure and contralateral ACL tears were confirmed when both the patient's physical examination findings (positive Lachman and pivot-shift test results) and the MRI findings were consistent with a complete rupture of the native ACL or graft
Perelli et al. ⁹⁹	2019	Case series	IV	76	na	na	32.8	16-51	85	2.6	An endpoint event was set as a graft rupture or clinical failure defined as a feeling of giving-way as reported by the patient. The sum of both was generalized as cumulative failure
Perez et al. ¹⁰⁰	2019	Cohort	III	50	14	36	22.4	15-38	33.2	0-3.6	Graft failure was defined as a graft re-tear confirmed on MRI

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Table 1. Continued

First Author	Year of Publication	Study Design	Level of Evidence	Total Participants	Females	Males	Mean Age \pm SD (y)	Age Range (y)	Mean Follow-Up \pm SD (m)	Failure Rate (%)	Definition of Failure
Perkins et al. ¹⁰¹	2019	Cohort	III	354	197	157	15.3	10-19	26	14	Graft failure was defined as those patients who had revision ACL reconstruction performed within our hospital system, MRI evidence of complete graft rupture, or self-reported revision ACL reconstruction by an outside surgeon
Rao et al. ¹⁰²	2021	Case control comparative	III	139	72	67	22.9	na	50.64	15.8	Conditional logistic regression was used to account for the matched nature of the data to assess the association between revision ACL (failure) and group (standard ACL vs augmented ACL) controlling for the effect of initial graft size
Redler et al. ³⁵	2018	Case series	III	118	26	92	34 \pm 8	23-44	10.6	7.6	Failure included episodes of giving way with sports or daily activities, recurrent knee laxity on examination, or MRI finding of a graft tear. Knee laxity was defined as either a positive (2+) Lachman test, positive (2+ or 3+) pivot shift test, or side-to-side difference >5 mm at maximal manual force on the KT-1000 arthrometer
Rose et al. ¹⁰³	2016	Prospective cohort	IV	98	36	62	35.9	na	10	4-6.3	The primary outcomes of the study were differences in graft failure rate (re-rupture)
Rugg et al. ¹⁰⁴	2020	Case series	IV	32	17	15	15.8	na	29.5	9.4	Failure was defined as an ACL graft re-tear
Sadeghpour et al. ⁵¹	2017	Prospective cohort	IV	50	na	na	28.8 \pm 3.4	22-37	0.5	16-28	Positive pivot shift and Lachman test were considered clinical signs and symptoms of treatment failure. The absence of the ACL or transverse ACL rather than the posterior oblique ligament is an MRI finding that indicates treatment failure

(continued)

Table 1. Continued

First Author	Year of Publication	Study Design	Level of Evidence	Total Participants	Females	Males	Mean Age \pm SD (y)	Age Range (y)	Mean Follow-Up \pm SD (m)	Failure Rate (%)	Definition of Failure
Sadoni et al. ⁵²	2017	Prospective cohort	na	101	8	93	31.2	18-45	3	5-13.9	The outcome of ACL tear surgery is assessed by anterior drawer and Lachman tests where positive scores indicate the failure of the surgery
Sajovic et al. ¹⁰⁵	2018	Randomized control trial	na	48	20	28	44	na	17	6.3-9.4	Failure was defined as an ACL graft re-tear
Saltzman et al. ¹⁰⁶	2017	Case series	IV	40	19	21	30.3 \pm 9.6	16-54	5.7 \pm 3.2	20	Clinical failures were defined as an additional ACLR procedure, revision MAT, or conversion to unicompartmental or tricompartmental total knee arthroplasty
Sanders et al. ¹⁰⁷	2017	Retrospective case series	IV	1355	535	820	26.6 \pm 9.9	na	120 \pm 76.8	5-5.5	Graft failure was defined as MRI or arthroscopic evidence of complete graft failure or the need for revision ACLR
Sauer et al. ³⁶	2018	Cohort	na	104	31	73	29	na	12	1	A post-ACL reconstruction anterior tibial translation (KT-1000 measured) of more than 5 mm was defined as an ACL failure
Sauer et al. ¹⁰⁸	2018	Cohort	na	108	44	64	na	na	12	50	Failures by means of clinical failure and MRI with or without subsequent ACL revision surgery. Clinical failure was defined as ACL graft rupture or insufficiency with consecutive subjective instability and abnormal laxity upon clinical examination.
Schilaty et al. ¹⁰⁹	2017	Descriptive Epidemiological Study	na	1019	438	581	29.4 \pm 11.7	na	97.2 \pm 44.4	6.4	Failure was defined as an ACL graft re-tear
Schneider et al. ¹¹⁰	2019	Cohort	III	35	11	24	39 \pm 9	na	10 \pm 5.2	8.6	Patients requiring revision osteotomy or arthroplasty were considered failures, as were patients with ACL graft rupture or revision ACL reconstruction

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Table 1. Continued

First Author	Year of Publication	Study Design	Level of Evidence	Total Participants	Females	Males	Mean Age \pm SD (y)	Age Range (y)	Mean Follow-Up \pm SD (m)	Failure Rate (%)	Definition of Failure
Shakked et al. ³⁷	2016	Retrospective cohort	III	65	65	0	19.2	15-25	21	2.7-21.4	Arthrometric failure was defined as a manual maximum side-to-side difference of greater than 5 mm. Criteria for graft failure was defined as either arthrometric failure or revision ACL surgery during the follow-up period
Sherchan et al. ⁵³	2020	Cohort	na	239	73	166	30	na	na	16.8-17.6	We defined the Lachman test of Grade 2 or grade 3 with the presence of the Pivot-shift test as a clinical failure
Snoj et al. ¹¹¹	2017	Cohort	na	50	23	27	29.2	na	na	12	Graft failure was evaluated as ACL graft being ruptured or preserved. A graft was considered ruptured when no intact fibers were seen and fluid signal was interposed between the ends of graft fibers
Sobrado et al. ¹¹²	2020	Cohort	II	182	28	154	29.2	17-47	34.9	1.4-10.2	Ligament tears were defined on the basis of clinical ACL failure criteria and MRI scans showing new graft rupture
Soreide et al. ²¹	2016	Cohort	III	7822	3132	4361	na	na	33.6	9.6	On the basis of these findings, we defined a KOOS Quality of Life score <44 at 2-year follow-up as equivalent to graft failure
Spragg et al. ¹¹³	2016	Case control	III	491	232	259	17.6	na	1.5	25.3	Revision, therefore, was used as a marker for graft failure in our study
Spragg et al. ¹¹⁴	2019	Cohort	III	6593	2558	4035	na	na	29.6	3.4	Revision was defined as the aseptic failure of the primary ACLR graft where removal and replacement of the original graft was required

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Table 1. Continued

First Author	Year of Publication	Study Design	Level of Evidence	Total Participants	Females	Males	Mean Age \pm SD (y)	Age Range (y)	Mean Follow-Up \pm SD (m)	Failure Rate (%)	Definition of Failure
Tanaka et al. ¹¹⁵	2018	Cohort	III	358	na	na	36.4	na	na	0-17.7	A failed graft was defined as one that was invisible or partially invisible between the notch roof and the apex of the tibial eminence, whereas an intact graft appeared thick throughout the entire graft. Throughout this study, graft failure was judged only by morphological characteristics of the grafts
Tang et al. ⁵⁴	2020	na	na	394	67	327	27.3 \pm 8.1	na	na	5.1	Graft failure was defined as symptomatic patients with positive anterior drawer and Lachmann test supported with either compatible MRI or arthroscopic findings
Tejwani et al. ¹¹⁶	2018	Cohort	II	19059	7264	11795	28.9 \pm 11.5	na	27.6	3.1	Revision was defined as the aseptic failure of the primary ACLR graft where removal and replacement of the original graft were required
Tomihara et al. ⁵⁷	2017	Retrospective cohort	III	66	21	45	22.8	16-39	30.9	20.5-27.3	Failure was defined as symptomatic rotatory knee instability with a positive pivot shift test graded as 2 or 3.
Tulloch et al. ³⁸	2019	Cohort study	III	55	23	32	36	19-58	93.6	33.3	Clinical evidence of failure occurred with the clinical testing (side-to-side difference in KT-1000 > 5 mm)
Volpi et al. ¹¹⁷	2019	Retrospective cohort	na	71	13	58	29.7 \pm 7.8	na	95.4 \pm 21.9	2.8	Failures were defined as Tegner-Lysholm score \leq 65 points, and were confirmed with MRI
von Essen et al. ²²	2020	na	I	68	na	na	na	na	24	17-23	Treatment failure was defined as the Knee Osteoarthritis Outcome Score subscale quality of life of <44

(continued)

Table 1. Continued

First Author	Year of Publication	Study Design	Level of Evidence	Total Participants	Females	Males	Mean Age \pm SD (y)	Age Range (y)	Mean Follow-Up \pm SD (m)	Failure Rate (%)	Definition of Failure
Wang et al. ¹³	2018	Retrospective comparative	III	57	38	19	32.7	na	40.6	3.4-14.3	Graft failure was defined as patient reported knee instability that affected daily living or sport activities, pathologic laxity detected when the surgeon performed the physical examination (positive Lachman test, positive pivot-shift test, or a KT-1000 side-to-side difference >3 mm), or MRI evidence
Wilson et al. ¹¹⁸	2019	Case series	IV	57	21	36	13	11-16	38.5	5.3	Graft failure was defined as recurrent instability with the need for a revision procedure or recurrent injury with radiographic or surgical confirmation of a graft injury
Winkler et al. ³⁹	2021	Retrospective cohort	III	102	49	53	na	na	12	100	ACL graft failure was defined as (1) the need for revision ACLR because of symptomatic instability, pain, or severe impairment in daily activities, (2) complete ACL graft disruption confirmed by MRI or arthroscopy, or (3) attenuated or partially ruptured graft confirmed by MRI plus side-to-side difference > 5 mm for anterior tibial translation based on KT-1000 (MEDmetric) arthrometry
Witonski et al. ²³	2016	na	na	101	30	71	30	15-62	16.8	29	Treatment failure was defined as the Knee Osteoarthritis Outcome Score subscale quality of life <44
Yoon et al. ⁵⁹	2019	Cohort	III	377	58	319	29.5	na	101.2	2.7-5.2	Failure was defined as the need for revision ACL reconstruction (1) for complete tear of ACL graft, specifically including complete tear of ACL graft seen on MRI, and (2) for instability with pivot shift test grade 2 or 3 results compatible with the failure of graft

(continued)

Table 1. Continued

First Author	Year of Publication	Study Design	Level of Evidence	Total Participants	Females	Males	Mean Age ± SD (y)	Age Range (y)	Mean Follow-Up ± SD (m)	Failure Rate (%)	Definition of Failure
Yoon et al. ⁶⁰	2020	Retrospective comparative trial	III	232	49	183	28.2 ± 8.9	na	11.5	4.7-16.1	Graft failure after ACL reconstruction was defined as (1) revision ACL reconstruction, (2) complete tear of the ACL graft as observed on MRI, or (3) instability with pivot shift test grade 3, considered as graft failure results in previous study
Zheng et al. ¹¹⁹	2019	na	na	60	17	43	29.6	na	20.3	8.3	Graft failure was defined as a failure in the completion of the ligamentization process, leading to an atonic, disorganized, and nonviable graft
Ziegler et al. ¹²⁰	2021	Retrospective cohort	na	199	102	97	33.7	15-71	15	0	ACL graft failure was defined as recurrent subjective instability requiring additional surgery that was objectively verified on patient clinical history, physical examination, and MRI

ACL, anterior cruciate ligament; ACLR, anterior cruciate ligament reconstruction; IKDC, International Knee Documentation Committee; KOOS, Knee injury and Osteoarthritis Outcome Score; m, months; MAT, meniscal allograft transplantation; MRI, magnetic resonance imaging; na, nonapplicable, SD, standard deviation; y, years.

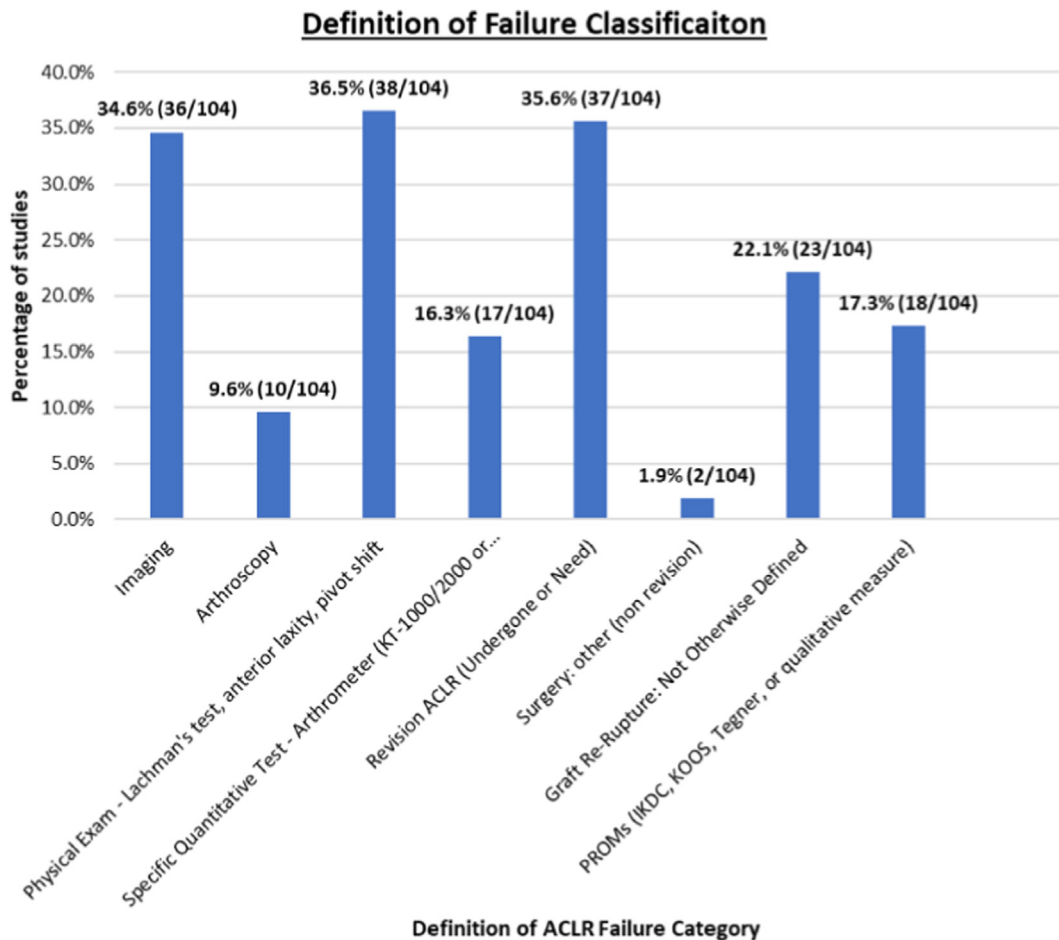


Fig 2. Percentage of each classification of definitions of failure in anterior cruciate ligament reconstruction.

recurrent instability, or PROMs (IKDC, KOOS, Tegner) in their assessment of “failure” of ACLR. The least used definitions of “failure” of ACLR included nonrevision ACLR surgery (2/108 [1.9%]). Although some studies used similar tests or categories in their definition of failure, there were a variety of score and grade cutoff points between them. This lack of standardization leads to difficulty in comparison of results. These differing cutoff scores and grades complicate the comparison of failure rates between studies. A study by Inacio et al.⁶¹ found a 0% to 1.5% failure rate depending on the graft used in ACLR using the following narrow definition of failure: Revision surgery in this study was defined as the aseptic failure of the primary ACL graft that required removal and replacement of the original graft. In contrast, a study conducted by Winkler et al.³⁹ found a failure rate of 57% using the following more encompassing definition of ACLR failure: (1) the need for revision ACLR due to symptomatic instability, pain, or severe impairment in daily activities, (2) complete ACL graft disruption confirmed by MRI or arthroscopy, or (3) attenuated or partially ruptured graft confirmed by MRI plus side-to-side difference > 5 mm for anterior

tibial translation based on KT-1000 (MEDmetric, San Diego, CA) arthrometry. Using a broader definition of failure of ACLR may allow physicians to identify and treat more ACLR failures than those who use a more limited definition. Furthermore, although studies may use the same categories to define failure, an example being the use of an arthrometer, differing cutoff points make the comparison of said studies more difficult for both physicians and patients alike. We believe a definition of “failure” of ACLR should include objective measures such as graft rupture, as well as subjective measures of patient outcomes. If a patient requires additional surgery or revision surgery or has a subjectively inadequate outcome, that is a failure of the surgery.

Many studies cite the requirement of undergoing of revision ACLR (39/108 [36.1%]) in their definition of ACLR “failure.” However, revision ACLR is not a perfect outcome measure and may underestimate true failure rate if no other criteria are added to the definition of “failure”. This can be due to a patient accepting an insufficient restoration of knee stability after ACLR or patients who do not wish to undergo revision ACLR

for any reason.⁶² This problem is not exclusive to using revision ACLR as a sole outcome but to any criteria using one outcome to define “failure.”⁶³ It is important to have a thoroughly defined definition of “failure” of ACLR to encompass different patient presentations.

Although many studies rely on imaging or quantitative findings to define “failure” of ACLR, others consist only of PROs. Naik et al.¹⁴ used “instability, stiffness or persistent pain” to define “failure” of ACLR. This definition is promising in that it captures whether the surgery achieves its goal of restoring patient function. The lack of studies using nonrevision surgery (1.9%) is unsurprising because of the rarity of those surgeries. It may be beneficial for researchers to consider whether “failure” of ACLR should be defined as quantifiable failure, such as rerupture confirmed by MRI, or a subjective failure, such as PROs with or without physical examination or imaging findings supportive of when choosing how to define “failure” of ACLR. We suggest a collective definition to include one or more of the common definitions: patient-reported instability or failure or physical confirmation with manual assessment and a visual confirmation via imaging, similar to that of Winkler et al.³⁹ This sentiment is shared by Svantesson et al.⁶⁴ in their ACL Consensus Meeting Panther Symposium finding that outcomes of an ACLR should include the following 4 categories: early adverse events, PROs, ACL graft failure/recurrent ligament disruption, and clinical measures of knee function and structure. Further agreement on what defines “failure” along with specific examination grade or score cutoffs will enhance the clarity of future ACLR failure research and outcomes.

In this review, only definitions of ACLR “failure” were searched for, whereas definitions of revision ACLR “failure” were excluded. We believed that there were more articles defining failure of ACLR failure compared to revision ACLR failure and thus focused on that procedure. However, it would be beneficial to compare the definitions “failure” of ACLR to revision ACLR definitions of “failure” to determine whether different definitions should be required for both procedures or if a singular definition would be sufficient for both. Although 0.43% (12/2,775) of the articles were found to be revision ACLR cases only, not all may have possessed a definition of failure, and our search terms were not specified for revision ACLR. A future study could be done to determine the differences between the definition of ACLR “failure” and those of revision ACLR “failure” with adapted search terms.

Limitations

This study is not without limitations. We chose to include only studies published after January 1, 2016. This choice was made to limit our review to only current definitions of “failure” of ACLR used in recent

scientific literature. Failure of ACLR has most likely been defined differently throughout the past decades and the researchers wanted to focus on the most recent definition used in the current literature. Another limitation of the study was the inclusion of studies that used cohorts largely or entirely of failed patients, thus having incredibly large failure rates, such as Winkler et al.³⁹ and Jaecker et al.⁴⁵

Conclusion

In this study, we found that a variety of definitions of failure are used among studies published in the orthopaedic literature. The most common criteria for failure of ACLR were the results of physical examination tests (35%), the need for or undergoing a revision ACLR (36%), and the use of imaging to diagnose the failure (34%). About 17% of studies included in this review used PROs, specifically recurrent instability, or PROMs (IKDC, KOOS, Tegner) in their assessment of failure of ACLR. The least-used definitions of “failure” of ACLR included nonrevision ACLR surgery (2%). Although some studies used similar tests or categories in their definition of failure, there were a variety of score and grade cutoff points between them.

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Appendix 1

FULL SEARCH STRATEGY FOR ALL DATABASES USED IN THE SYSTEMATIC REVIEW

[SportDiscus](#)

[Web of Science](#)

[Ovid Medline](#)

SportDiscus

((DE "ANTERIOR cruciate ligament surgery") OR (acl n5 reconstr*) OR (anterior n5 reconstr*)) AND (post-operative OR post operative OR post-surgery OR post-surgical) AND ((TI fail*) OR (AB fail*) OR (KW fail*))

Web of Science

acl near/3 reconstr* (Topic) OR 'anterior cruciate' near/3 reconstr* (Topic) and Failure (Search within all fields)

Ovid Medline

1

exp Anterior Cruciate Ligament Reconstruction/ or Anterior Cruciate Ligament Reconstruction.mp.

2

(Anterior Cruciate Ligament Injuries or Anterior Cruciate Ligament).mp. or (Anterior Cruciate Ligament Injuries/ or Anterior Cruciate Ligament/)

3

exp Pain, Postoperative/ or Pain, Postoperative.mp. or (exp Postoperative Care/ or Postoperative Care.mp.) or (exp Postoperative Complications/ or Postoperative Complications.mp.) or (exp Postoperative Period/ or Postoperative Period.mp.) or (acute post operative pain or acute post-operative pain or acute postoperative pain or chronic post operative pain or chronic post surgical pain or chronic post-operative pain or chronic post-surgical pain or chronic postoperative pain or chronic postsurgical pain or chronic postsurgical pains or pain, acute post-operative or pain, acute postoperative or pain, chronic post-operative or pain, chronic post-surgical or pain, chronic postoperative or pain, chronic postsurgical or pain, persistent postsurgical or pain, post operative or pain, post-operative or pain, post-surgical or pain, postoperative or pain, postsurgical or persistent postsurgical pain or post operative pain or post operative pain, acute or post operative pain, chronic or post surgical pain or post-operative pain or post-operative pain, acute or post-operative pain, chronic or post-operative pains or post-surgical pain or postoperative pain, acute or postoperative pain, chronic or postsurgical pain or postsurgical pain, chronic or postsurgical pain, persistent).mp. or (care,

postoperative or postoperative care or postoperative procedure or postoperative procedures or procedure, postoperative or procedures, postoperative).mp.

4

1 or 2

5

3 and 4

6

*Treatment Failure/ or Treatment Failure.mp. or Follow-Up Studies/ or (follow up studies or follow-up studies or follow-up study or followup studies or followup study or studies, follow-up or studies, followup or study, follow-up or study, followup).mp. or complications.fs. or adverse effects.fs.

7

5 and 6

Embase

Query("postoperative complications" OR "post-operative period" OR "acute post operative pain" OR "acute post-operative pain" OR "acute postoperative pain" OR "chronic post operative pain" OR "chronic post surgical pain" OR "chronic post-operative pain" OR "chronic post-surgical pain" OR "chronic postoperative pain" OR "chronic postsurgical pain" OR "chronic postsurgical pains" OR "pain, acute post-operative" OR "pain, acute postoperative" OR "pain, chronic post-operative" OR "pain, chronic post-surgical" OR "pain, chronic postoperative" OR "pain, chronic postsurgical" OR "pain, persistent postsurgical" OR "pain, post operative" OR "pain, post-operative" OR "pain, post-surgical" OR "pain, postoperative" OR "pain, post-surgical" OR "persistent postsurgical pain" OR "post operative pain" OR "post operative pain, acute" OR "post operative pain, chronic" OR "post surgical pain" OR "post-operative pain" OR "post-operative pain, acute" OR "post-operative pain, chronic" OR "post-operative pains" OR "post-surgical pain" OR "post-surgical pain, chronic" OR "postoperative pain" OR "postoperative pain, acute" OR "postoperative pain, chronic" OR "postsurgical pain" OR "postsurgical pain, chronic" OR "postsurgical pain, persistent" OR "care, postoperative" OR "postoperative care" OR "post-operative procedure" OR "postoperative procedures" OR "procedure, postoperative" OR "procedures, post-operative" OR "postoperative complication"/exp OR "postoperative period"/exp) AND ("anterior cruciate ligament reconstruction"/exp OR ((acl OR "anterior cruciate") NEAR/4 reconstr*)) AND ("treatment failure"/exp OR fail:ti,ab,kw OR fail*:ti,ab,kw OR "follow up studies":ti,ab,kw OR "follow-up studies":ti,ab,kw OR "follow-up study":ti,ab,kw OR "followup studies":ti,ab,kw OR "followup study":ti,ab,kw)