

## [ Orthopaedic Surgery ]

# Results After Anterior Cruciate Ligament Reconstruction in Patients Older Than 40 Years: How Do They Compare With Younger Patients? A Systematic Review and Comparison With Younger Populations

Nathan A. Mall, MD,<sup>†</sup> Rachel M. Frank, MD,<sup>‡</sup> Bryan M. Saltzman, MD,<sup>§</sup> Brian J. Cole, MD, MBA,<sup>‡</sup> and Bernard R. Bach Jr, MD\*<sup>‡</sup>

**Context:** Anterior cruciate ligament (ACL) reconstruction in older patients is a controversial topic among orthopaedic surgeons.

**Objective:** To determine the outcomes, failure, and morbidity associated with ACL reconstruction in patients older than 40 years and to compare it with nonoperative treatment as well as results of ACL reconstruction in a younger patient population.

**Data Sources:** A systematic review of the literature from 1970 to 2015 was conducted utilizing MEDLINE, CINAHL, and the Cochrane Central Register databases using PRISMA guidelines.

**Study Selection:** Inclusion criteria were studies with longer than 2-year follow-up of primary ACL reconstruction and minimum age of patients older than 40 years, inclusive of any graft type or source and of any concomitant meniscal pathology.

**Study Design:** Systematic review.

**Level of Evidence:** Level 4.

**Data Extraction:** Two independent reviewers collected demographic, preoperative, intraoperative, and postoperative data.

**Results:** Twelve studies with a total of 452 patients were included. The mean patient age was 47.8 years (range, 40-66 years) with a mean follow-up of 53.3 months (minimum, 24 months). Lysholm scores improved from 53.9 to 90.5 in the 11 operative studies. The only nonoperative study reported a mean Lysholm score of 82 after rehabilitation. International Knee Documentation Committee (IKDC) scores of A or B were found in 81%. Tegner activity scores averaged 4.7 preinjury, fell to 2.9 preoperatively, and returned to 4.7 postoperatively. The reported failure rate was 2.3%. There were few complications, and failure rate was similar in younger patients.

**Conclusion:** The data confirm that ACL reconstruction can be recommended to patients older than 40 years who wish to maintain an active lifestyle or have symptomatic instability with daily activities. Patient-based outcomes scores were better in the operative studies compared with the single nonoperative study in this patient population.

**Keywords:** ACL; reconstruction; anterior cruciate ligament; revision; older patient

From <sup>†</sup>St Louis Center for Cartilage Restoration and Repair, Regeneration Orthopedics, St Louis, Missouri, <sup>‡</sup>Division of Sports Medicine, Rush University Medical Center, Chicago, Illinois, and <sup>§</sup>Department of Orthopaedic Surgery, Rush University Medical Center, Chicago, Illinois

\*Address correspondence to Bernard R. Bach Jr, MD, Rush University Medical Center, 1611 West Harrison Street, Suite 300, Chicago, IL 60612 (email: brbachmd1952@gmail.com).

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Anterior cruciate ligament (ACL) injuries are common in the active population. While an ACL is not always needed to perform activities of daily living or even straight-ahead running, patients without a competent ACL may be more dissatisfied in competitive sports activities that require pivoting.<sup>6,15</sup>

Anterior cruciate ligament reconstruction in older patients is a controversial topic among orthopaedic surgeons. If arthritis is present in an ACL-deficient knee, it may be a relative contraindication to ACL reconstruction.<sup>1,21</sup> Older individuals have a greater likelihood of developing arthrofibrosis.<sup>11,13,31</sup> However, active patients are not satisfied with activity restraint.<sup>24</sup> A systematic review of the literature as it relates to this population is appropriate to address the patient demographic. The goal of this study was to determine the outcomes, failure, and morbidity associated with ACL reconstruction in patients older than 40 years and to compare it with reports of nonoperative treatment in this patient population as well as results published in the literature of ACL reconstruction in a younger patient population.

## METHODS

A broad literature search utilizing the following databases was employed using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines: MEDLINE, CINAHL (Cumulative Index to Nursing and Allied Health Literature), and the Cochrane Central Register of Controlled Trials. All databases were searched for all literature published from January 1970 to October 2015 using the following key search terms: *ACL reconstruction, elderly, over 40, middle aged, conservative, knee, anterior cruciate ligament, and ACL*. Case reports, expert opinions, as well as data only presented as abstracts were excluded. Inclusion criteria were studies with longer than 2-year follow-up and minimum age of patients more than 40 years. Exclusion criteria were studies with less than 2-year follow-up and age of patients less than 40 years. Patient demographic information, ACL tear characteristics, operative technical details, objective and subjective outcome measurements, and complications were extracted from the studies.

Abstracts of studies obtained during the search were reviewed in duplicate by 2 of the authors to determine appropriateness for inclusion in the study, with full-text review performed when questions existed as to whether the study should be included in analysis. There were 12 studies<sup>1-7,12,17,23,24,29</sup> that met the final criteria and were included in the final data analysis (Figure 1). These studies had their reference lists reviewed for additional papers appropriate for inclusion, with no additional studies selected. Data collected included patient demographics, preoperative data, intraoperative data, and postoperative data (Table 1 in the Appendix, available at <http://sph.sagepub.com/content/by/supplemental-data>).

No statistical comparisons were performed as part of this qualitative systematic review. Inconsistencies between reviewers

were resolved by joint review of the involved studies. When applicable, weighted averages were utilized when grouping data.

## RESULTS

### Demographic Data

The weighted mean age for all included studies was 47.8 years. The inclusion criteria required a minimum age of 40 years in 8 of 12 (66%) studies,<sup>2,3,5,6,12,17,24,29</sup> 50 years in 3 (25%) studies,<sup>4,7,23</sup> and 55 years in 1 study.<sup>1</sup> The majority (55%) of patients were men. Several studies reported patients having undergone prior meniscectomies before ACL reconstruction, either as a result of the ACL tear (partial meniscectomy with the ACL untreated) or earlier in life from prior injuries.<sup>2,5,6</sup>

### Physical Examination

Collated physical examination results from the included studies are presented in Table 2 in the Appendix (available at <http://sph.sagepub.com/content/by/supplemental-data>).

### Outcomes Scores

Weighted Lysholm, International Knee Documentation Committee (IKDC), and Cincinnati scores are available in Table 3 in the Appendix (available at <http://sph.sagepub.com/content/by/supplemental-data>). Preoperatively, 60 of 75 knees had pain and swelling, and postoperatively, only 3 knees had these complaints.<sup>24</sup> Fifty-five of 75 had giving way symptoms preoperatively, which was resolved in all patients postoperatively. In this group, 52 knees (69%) had an excellent result, 21 (28%) had a good result, and 2 (3%) had a fair result. In the lone nonoperative study of patients over 40 with 2-year follow-up, 83% were satisfied with their treatment, while 17% stated that if current operative techniques had been available at the time of initial injury they "might have requested operative treatment"; none desired surgery for the current condition of their knee.<sup>6</sup> Forty percent of patients noted slight, intermittent pain after strenuous exertion, and 10% noted pain during moderate exertion.<sup>6</sup>

### Activity Level

Preinjury UCLA (University of California, Los Angeles) scores were 8.5 (range, 4-10), preoperative scores averaged 4.3 (range, 3-6), and postoperative scores at final follow-up averaged 8.3 (range, 4-10) (Table 3 in the Appendix).<sup>7</sup> In the nonoperative population, there was a return to sports in 73%, but the authors did mention that more than half of the patients returning to high-level sports noticed a subjective difference in their ability to perform at their preinjury level.<sup>6</sup>

### Graft Source

In all, 173 of 352 (49%) patients had bone-patellar tendon-bone (BPTB) autografts used to reconstruct their ACLs. The next most frequent graft source was BPTB allograft (20%), followed by Achilles allograft (12%), allograft fascia lata (11%), and hamstrings autograft (7%). Only 51% of allografts used radiation,

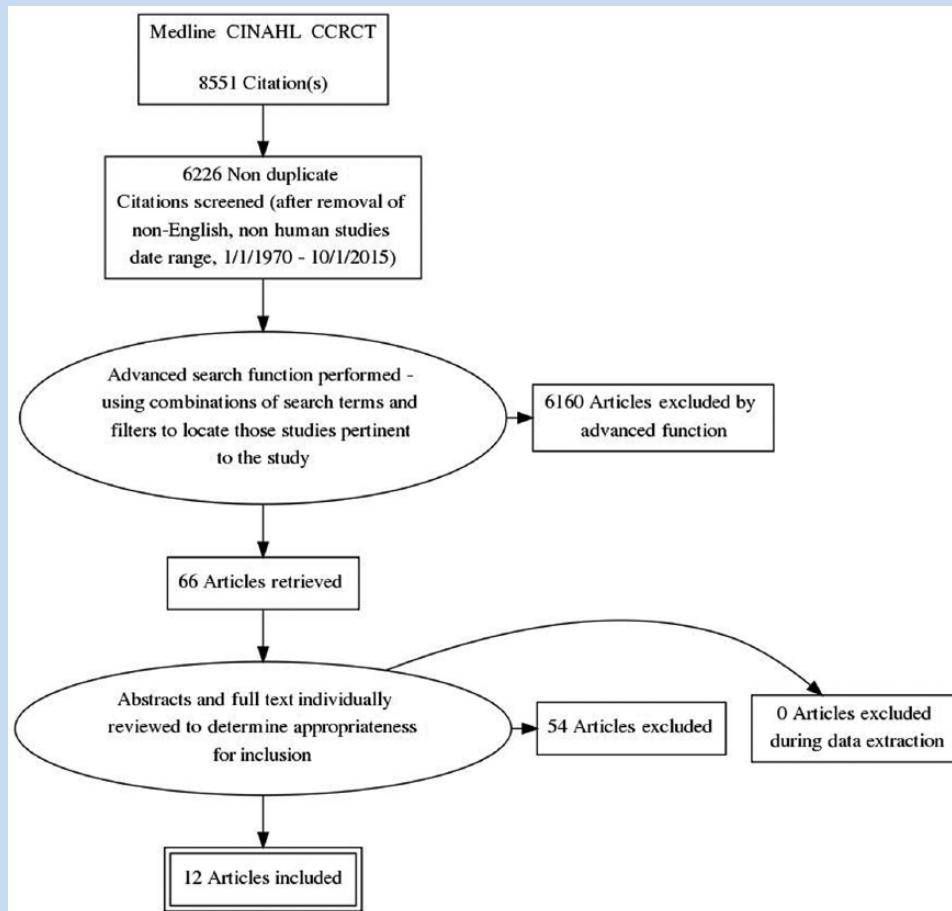


Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of study inclusion. CCRCT, Cochrane Central Register of Controlled Trials; CINAHL, Cumulative Index to Nursing and Allied Health Literature.

with 45 of 79 (57%) being low-dose irradiated (range, 12-18 kGy) and the other 38 (43%) being nonirradiated.

### Mechanism of Injury

Of studies reporting mechanism of injury by the individual sport 101 of 246 (41%) injuries occurred while skiing. The next most common sport was tennis, with 34 (14%) patients.

### Articular Cartilage and Meniscal Pathology Noted at Surgery

The condition of cartilage diminished with increased time from injury to reconstruction ( $P = 0.02$ ) and correlated with lower IKDC ( $P = 0.02$ ) (Table 4 in the Appendix, available at <http://sph.sagepub.com/content/by/supplemental-data>).<sup>4</sup> Most studies treated cartilage lesions with simple debridement or lavage; however, 1 study performed microfracture to all grade 3 and 4 lesions.<sup>23</sup>

### Development of Arthritis

Seven studies did not report radiographic results.<sup>1-3,5,23,24,29</sup> Overall, radiographic changes at final follow-up were rarely

severe. In the nonoperative study, only 2 patients (7%) had progression from their initial radiographs.<sup>6</sup> The majority of patients in each of the ACL reconstruction studies had minimal or no radiographic degenerative changes.<sup>4,7,12,17</sup>

### Time to Reconstruction

Mean times from injury to reconstruction surgery were: 2.8 months (range, 2.4-3.3 months),<sup>23</sup> 24 months (range, 1-156 months),<sup>7</sup> 25.9 months (range, 5 days-26.6 years),<sup>3</sup> 36 months (range, 6-360 months),<sup>5</sup> 48 months (range, 2 days-1196 weeks),<sup>24</sup> and 88 months (range, 2-396 months).<sup>4</sup>

### Failure/Complications

After nonoperative treatment, 4 patients (7.7%) underwent meniscal surgery after the diagnosis of ACL tear.<sup>6</sup> Complications included 2 superficial infections,<sup>17</sup> excessive bleeding in 2 patients,<sup>5</sup> and 1 urinary tract infection (see Table 5 in the Appendix, available at <http://sph.sagepub.com/content/by/supplemental-data>).<sup>1</sup>

## Group Comparison

A comparison of the over 40 population to a group younger than 40 years was conducted and found no difference in Lysholm, IKDC, or Cincinnati scores.<sup>2</sup> In another study, the older group was found to be significantly more pleased with their result than the younger group, with no difference in standardized outcomes scores.<sup>5</sup> This study showed a slightly higher activity level at follow-up in their younger patient population (6 vs 5 in the older group). In another study, 12 (60%) patients in the over-50 group versus 18 (90%) in the under-30 group returned to their preinjury level of activity. The mean Lysholm score in the nonoperative study (82) was lower than the 90.5 weighted average in the operative studies.

## Comparison With Prior Literature

Thirteen studies<sup>8,9,14,16,18-20,22,25-27,30,32</sup> with prospective data and greater than 2-year follow-up using modern techniques were pooled for data comparison (Table 6 in the Appendix, available at <http://sph.sagepub.com/content/by/supplemental-data>). The mean patient age in these studies was 26.7 years compared with 47.8 in the studies in this systematic review. The rerupture rate was 3.5% in the younger population compared with 2.3% in the older population. Tegner activity scores were higher in the younger patients, yet Lysholm and IKDC scores were similar between the 2 populations.

## Bias

The quality of this review was limited by the fact that these studies were all level 3 or level 4 evidence. Many of the included studies had relatively small numbers. None of the included studies performed a power analysis, thus all nonsignificant differences must be questioned. Additionally, many of these studies occurred over a number of years, and thus, surgical techniques and even preferred graft choices changed during the study period.

## DISCUSSION

The principal finding of this study is that the outcomes after ACL reconstruction in the population older than 40 years are similar to those in younger patient populations. The number of patients and the length of time patients are continuing active lifestyles continues to rise. Thus, the number of ACL injuries that occur in an older patient population is likely to increase.

The interval from injury to surgery has an adverse effect on outcomes.<sup>10</sup> Five of the 6 studies reporting mean time from injury to reconstruction had a mean delay of over 2 years. Also, several studies reported patients having undergone prior meniscectomies before ACL reconstruction. These would all be considered factors that may cause a reduction in the overall outcome after ACL reconstruction, yet these patients had similar results to younger patients.

This study cannot prove that ACL reconstruction is better than nonoperative treatment as there were no direct comparative studies in this age group. The only nonoperative study in

patients older than 40 years reported good results<sup>6</sup> but did place restrictions on patients in terms of activities. These restrictions may be considered unacceptable for many patients wanting to remain active as they age. Decision analysis recently demonstrated that operative treatment was more cost-effective and should be the treatment of choice for ACL tears in this population.<sup>28</sup> There is still a role for nonoperative treatment in patients who are willing to accept the limitations that this may cause, including refraining from sports or activities that require cutting and pivoting. However, there is a subset of patients that may have instability symptoms during activities of daily living.

The younger patients had a greater mean decrease in activity, despite the final follow-up number being statistically significantly higher in the younger patients. This, along with all other outcomes scores being similar, indicates that the difference in activity scores between these populations may be clinically insignificant because the population older than 40 years is not as active preinjury or is willing to modify their activities somewhat to prevent future injury.

## CONCLUSION

Anterior cruciate ligament reconstruction can be recommended to patients older than 40 years who wish to maintain an active lifestyle or have symptomatic instability with daily activities. Complication rates were low in this population, and the outcomes are similar to those in younger patients. Patient-based outcomes scores were better in the operative studies compared with the single nonoperative study in this patient population.

## REFERENCES

1. Arbutnot JE, Brink RB. The role of anterior cruciate ligament reconstruction in the older patients, 55 years or above. *Knee Surg Sports Traumatol Arthrosc.* 2010;18:73-78.
2. Barber FA, Aziz-Jacobo J, Oro FB. Anterior cruciate ligament reconstruction using patellar tendon allograft: an age-dependent outcome evaluation. *Arthroscopy.* 2010;26:488-493.
3. Barrett G, Stokes D, White M. Anterior cruciate ligament reconstruction in patients older than 40 years: allograft versus autograft patellar tendon. *Am J Sports Med.* 2005;33:1505-1512.
4. Blyth MJ, Gosal HS, Peake WM, Bartlett RJ. Anterior cruciate ligament reconstruction in patients over the age of 50 years: 2- to 8-year follow-up. *Knee Surg Sports Traumatol Arthrosc.* 2003;11:204-211.
5. Brandsson S, Kartus J, Larsson J, Eriksson BI, Karlsson J. A comparison of results in middle-aged and young patients after anterior cruciate ligament reconstruction. *Arthroscopy.* 2000;16:178-182.
6. Ciccotti MG, Lombardo SJ, Nonweiler B, Pink M. Non-operative treatment of ruptures of the anterior cruciate ligament in middle-aged patients. Results after long-term follow-up. *J Bone Joint Surg Am.* 1994;76:1315-1321.
7. Dahm DL, Wulf CA, Dajani KA, Dobbs RE, Levy BA, Stuart MA. Reconstruction of the anterior cruciate ligament in patients over 50 years. *J Bone Joint Surg Br.* 2008;90:1446-1450.
8. Ejerhed L, Kartus J, Semert N, Kohler K, Larsson J. Patellar tendon or semitendinosus tendon autografts for anterior cruciate ligament reconstruction? A prospective randomized study with a two-year follow-up. *Am J Sports Med.* 2003;31:19-25.
9. Eriksson K, Anderberg P, Hamberg P, et al. A comparison of quadruple semitendinosus and patellar tendon grafts in reconstruction of the anterior cruciate ligament. *J Bone Joint Surg Br.* 2001;83:348-354.
10. Goradia VK, Grana WA. A comparison of outcomes at 2 to 6 years after acute and chronic anterior cruciate ligament reconstructions using hamstring tendon grafts. *Arthroscopy.* 2001;17:383-392.
11. Harner CD, Irrgang JJ, Paul J, Dearwater S, Fu FH. Loss of motion after anterior cruciate ligament reconstruction. *Am J Sports Med.* 1992;20:499-506.

12. Heier KA, Mack DR, Moseley JB, Paine R, Bocell JR. An analysis of anterior cruciate ligament reconstruction in middle-aged patients. *Am J Sports Med.* 1997;25:527-532.
13. Hughston JC. Complications of anterior cruciate ligament surgery. *Orthop Clin North Am.* 1985;16:237-240.
14. Ibrahim SA, Al-Kussary IM, Al-Misfer AR, Al-Mutairi HQ, Ghafar SA, El Noor TA. Clinical evaluation of arthroscopically assisted anterior cruciate ligament reconstruction: patellar tendon versus gracilis and semitendinosus autograft. *Arthroscopy.* 2005;21:412-417.
15. Kannus P, Jarvinen M. Conservatively treated tears of the anterior cruciate ligament. Long-term results. *J Bone Joint Surg Am.* 1987;69:1007-1012.
16. Kleipool AE, Zijl JA, Willems WJ. Arthroscopic anterior cruciate ligament reconstruction with bone-patellar tendon-bone allograft or autograft. A prospective study with an average follow up of 4 years. *Knee Surg Sports Traumatol Arthrosc.* 1998;6:224-230.
17. Kuechle DK, Pearson SE, Beach WR, et al. Allograft anterior cruciate ligament reconstruction in patients over 40 years of age. *Arthroscopy.* 2002;18:845-853.
18. Laxdal G, Kartus J, Hansson L, Heidvall M, Ejerhed L, Karlsson J. A prospective randomized comparison of bone-patellar tendon-bone and hamstring grafts for anterior cruciate ligament reconstruction. *Arthroscopy.* 2005;21:34-42.
19. Liden M, Ejerhed L, Sernert N, Laxdal G, Kartus J. Patellar tendon or semitendinosus tendon autografts for anterior cruciate ligament reconstruction: a prospective, randomized study with a 7-year follow-up. *Am J Sports Med.* 2007;35:740-748.
20. Maletis GB, Cameron SL, Tengan JJ, Burchette RJ. A prospective randomized study of anterior cruciate ligament reconstruction: a comparison of patellar tendon and quadruple-strand semitendinosus/gracilis tendons fixed with bioabsorbable interference screws. *Am J Sports Med.* 2007;35:384-394.
21. Marx RG, Jones EC, Angel M, Wickiewicz TL, Warren RF. Beliefs and attitudes of members of the American Academy of Orthopaedic Surgeons regarding the treatment of anterior cruciate ligament injury. *Arthroscopy.* 2003;19:762-770.
22. O'Neill DB. Arthroscopically assisted reconstruction of the anterior cruciate ligament. A follow-up report. *J Bone Joint Surg Am.* 2001;83-A:1329-1332.
23. Osti L, Papalia R, Del Buono A, Leonardi F, Denaro V, Maffulli N. Surgery for ACL deficiency in patients over 50. *Knee Surg Sports Traumatol Arthrosc.* 2011;19:412-417.
24. Plancher KD, Steadman JR, Briggs KK, Hutton KS. Reconstruction of the anterior cruciate ligament in patients who are at least forty years old. A long-term follow-up and outcome study. *J Bone Joint Surg Am.* 1998;80:184-197.
25. Roe J, Pinczewski LA, Russell VJ, Salmon LJ, Kawamata T, Chew M. A 7-year follow-up of patellar tendon and hamstring tendon grafts for arthroscopic anterior cruciate ligament reconstruction: differences and similarities. *Am J Sports Med.* 2005;33:1337-1345.
26. Ropke M, Becker R, Urbach D, Nebelung W. Semitendinosus tendon vs. patellar ligament. Results of a prospective randomized study after anterior cruciate ligament reconstruction [in German]. *Unfallchirurg.* 2001;104:312-316.
27. Sajovic M, Vengust V, Komadina R, Tavcar R, Skaza K. A prospective, randomized comparison of semitendinosus and gracilis tendon versus patellar tendon autografts for anterior cruciate ligament reconstruction: five-year follow-up. *Am J Sports Med.* 2006;34:1933-1940.
28. Seng K, Appleby D, Lubowitz JH. Operative versus nonoperative treatment of anterior cruciate ligament rupture in patients aged 40 years or older: an expected-value decision analysis. *Arthroscopy.* 2008;24:914-920.
29. Shah AA, McCulloch PC, Lowe WR. Failure rate of Achilles tendon allograft in primary anterior cruciate ligament reconstruction. *Arthroscopy.* 2010;26:667-674.
30. Shaieb MD, Kan DM, Chang SK, Marumoto JM, Richardson AB. A prospective randomized comparison of patellar tendon versus semitendinosus and gracilis tendon autografts for anterior cruciate ligament reconstruction. *Am J Sports Med.* 2002;30:214-220.
31. Strum GM, Friedman MJ, Fox JM, et al. Acute anterior cruciate ligament reconstruction. Analysis of complications. *Clin Orthop Relat Res.* 1990;(253):184-189.
32. Zaffagnini S, Marcacci M, Lo Presti M, Giordano G, Iacono F, Neri MP. Prospective and randomized evaluation of ACL reconstruction with three techniques: a clinical and radiographic evaluation at 5 years follow-up. *Knee Surg Sports Traumatol Arthrosc.* 2006;14:1060-1069.

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