

# Psychological Readiness to Return to Sport (RTS) and RTS Rates Are Similar in Patients After Either Bilateral or Unilateral Anterior Cruciate Ligament Reconstruction



Michael Buldo-Licciardi, B.S., Nicole D. Rynecki, M.D., Naina Rao, B.S., Jordan Eskenazi, B.S., Samuel R. Montgomery Jr., M.D., Zachary I. Li, B.A., Michael Moore, M.D., Michael J. Alaia, M.D., Eric J. Strauss, M.D., Laith M. Jazrawi, M.D., and Kirk A. Campbell, M.D.

**Purpose:** To compare psychological readiness to return to sport (RTS), RTS rate, level of return, and time to return between patients who underwent bilateral anterior cruciate ligament reconstruction (ACLR) and those who underwent unilateral ACLR. **Methods:** The electronic medical record at a single academic medical center was queried for patients who underwent ACLR from January 2012 to May 2020. The inclusion criteria were skeletally mature patients who underwent either single or sequential bilateral ACLR and who had undergone either the primary ACLR or second contralateral ACLR at least 2 years earlier. Bilateral ACLRs were matched 1:3 to unilateral reconstructions based on age, sex, and body mass index. Psychological readiness to RTS was assessed using the validated ACL Return to Sport After Injury (ACL-RSI) scale. This, along with time to return and level of RTS, was compared between the 2 cohorts. **Results:** In total, 170 patients were included, of whom 44 underwent bilateral ACLR and 132 underwent unilateral ACLR. At the time of the first surgical procedure, patients in the unilateral cohort were aged  $28.8 \pm 9.4$  years and those in the bilateral cohort were aged  $25.7 \pm 9.8$  years ( $P = .06$ ). The average time difference between the first and second surgical procedures was  $28.4 \pm 22.3$  months. There was no difference in psychological readiness to RTS (50.5 in bilateral cohort vs 48.1 in unilateral cohort,  $P = .66$ ), RTS rate (78.0% in unilateral cohort vs 65.9% in bilateral cohort,  $P = .16$ ), percentage of return to preinjury sport level (61.2% in unilateral cohort vs 69.0% in bilateral cohort,  $P = .21$ ), or time to return ( $41.2 \pm 29.3$  weeks in unilateral cohort vs  $35.2 \pm 23.7$  weeks in bilateral cohort,  $P = .31$ ) between the 2 cohorts. **Conclusions:** Compared with patients who undergo unilateral ACLR, patients who undergo bilateral ACLR are equally as psychologically ready to RTS, showing equal rates of RTS, time to return, and level of return. **Level of Evidence:** Level III, retrospective cohort study.

Appropriate expectation setting prior to orthopaedic surgery positively influences patient-reported outcomes.<sup>1-3</sup> This is particularly important in patients sustaining anterior cruciate ligament (ACL) injuries

because they are typically active and engage in sports.<sup>4</sup> For primary ACL reconstruction (ACLR), return to sport (RTS) and psychological readiness to return (most commonly measured by the validated ACL Return to Sport After Injury [ACL-RSI] scale) have been studied.<sup>5,6</sup> This research has been critical in the creation of both physical and psychological rehabilitation protocols.<sup>7-9</sup> Aizawa et al.<sup>10</sup> reported an association between ACL-RSI scores and physical function scores, with ACL-RSI scores of 60 or greater being associated with greater knee flexion strength, an increased hamstring-to-quadriceps ratio, and a higher limb symmetry index. This emphasizes the close intertwinement of both the psychological and physical readiness components of RTS.

From the Department of Orthopedic Surgery, New York University School of Medicine, New York, New York, U.S.A.

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Address correspondence to Michael Buldo-Licciardi, B.S., NYU Langone Orthopedic Hospital, 333 E 38th St, Fourth Floor, New York, NY 10003, U.S.A. E-mail: [Michael.buldo-licciardi@nyulangone.org](mailto:Michael.buldo-licciardi@nyulangone.org)

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There is a sparsity of existing studies, however, exploring the applicability of these data in patients after sustaining a subsequent second ACL rupture, an injury increasing in frequency.<sup>11</sup> Approximately 12% of patients who undergo primary ACLR sustain a contralateral ACL injury within 5 years.<sup>12</sup> Paterno et al.<sup>13</sup> reported a 15 times greater incidence of re-tear or contralateral ACL injury within the first 12 months after ACLR and subsequent RTS. Regarding physical function, Koca et al.<sup>14</sup> found no difference in return to activity level between patients who underwent bilateral ACLR and those who underwent unilateral ACLR.

After a second ACL injury, patients likely expect their experience perioperatively and postoperatively to mirror their experience with the first ACL injury. However, despite the same injury occurring twice, unbeknownst to patients, a repeated ACL injury with a demanding postoperative rehabilitation may impose an unexpected, increased psychological stress on them. Webster et al.<sup>15</sup> reported that only 40% of athletes with bilateral ACLR returned to their preinjury level of sport and that psychological readiness, namely fear of reinjury, was one of the most commonly cited barriers to return, rather than physical deficiencies.<sup>14</sup> Similarly, McPherson et al.<sup>16</sup> studied 329 patients who returned to sport after ACLR and found that patients who sustained a second contralateral ACL injury had lower psychological readiness scores at 12 months postoperatively, but the difference was not statistically significant.

Therefore, to aid surgeons in optimizing postoperative physical and psychological rehabilitation protocols and counsel patients appropriately, it is important to evaluate differences in psychological readiness and RTS of patients undergoing bilateral ACLR versus unilateral ACLR. The purpose of our investigation was to compare psychological readiness to RTS, RTS rate, level of return, and time to return between patients who underwent bilateral ACLR and those who underwent unilateral ACLR. Our hypothesis was that patients undergoing bilateral ACL surgery would be less psychologically ready to RTS, would return at lower rates, would return at a lower level, and would require a longer time to return.

## Methods

### Selection Criteria

Study activities were commenced after institutional review board approval was obtained. The electronic medical record at a single academic medical center was queried for patients who underwent ACLR from January 2012 to May 2020. The inclusion criteria were skeletally mature patients who underwent either single or sequential bilateral ACLR and who had undergone either the primary ACLR or second contralateral ACLR

at least 2 years earlier. Patients who underwent surgery with any graft type were included, as were those with concomitant meniscal injuries (e.g., meniscal tears and sprains). Patients were excluded if they underwent a concomitant ligament repair or reconstruction, osteotomy, cartilage procedure, or revision ACLR; they had incomplete patient-reported outcomes at final follow-up; and/or they did not report playing a sport prior to the first surgical procedure. Bilateral ACLR patients were excluded if they no longer played a sport after the first ACLR.

### Study Design

Demographic data including sex, age at the time of surgery, and body mass index (BMI) at the time of surgery were obtained from the electronic medical record. For the bilateral ACLR cohort, age and BMI at the time of the second surgical procedure were used. After informed consent for participation was obtained, patients were retrospectively administered the ACL-RSI survey via e-mail to assess psychological readiness to RTS. The ACL-RSI scale is a 12-item questionnaire developed to examine athletes' emotions, confidence, and risk appraisal when returning to sport after ACLR. Scores for each item are summed, with higher scores indicating greater psychological readiness. The questionnaire has good internal consistency and has shown construct validity and test-retest reliability.<sup>8</sup> Patients answered additional questions assessing their type and level of sport preoperatively and postoperatively. Sports were classified as pivoting versus non-pivoting and high impact versus low impact based on published literature with categorizations. Pivoting sports included football, soccer, and tennis. High-impact sports included running, football, and basketball.<sup>17,18</sup>

### Statistical Analysis

Patients who underwent unilateral ACLR were matched 1:3 to those who underwent bilateral ACLR based on age, sex, and BMI by use of a propensity score analysis. The Shapiro-Wilk test was used to assess continuous variables for normality. Normally distributed variables were compared using the independent-samples *t* test. The Mann-Whitney *U* test was used for non-normally distributed variables. Categorical and binomial variables were compared by  $\chi^2$  analysis. The level of statistical significance for all analyses was set at  $\alpha < .05$ . All statistical analysis was performed using R statistical software (version 4.2.1; R Foundation for Statistical Computing, Vienna, Austria).

We conducted an a priori power analysis for the rate of return and ACL-RSI score. Using a simulated 2-sample Student *t* test for ACL-RSI score and  $\chi^2$  test for rate of return, assuming a standard deviation of 15.0 based on values published by Webster et al.,<sup>15</sup> a desired statistical significance level of .05, and a desired

statistical power of 0.80, we determined that the minimum sample size necessary to detect a clinically significant difference in rate of return and ACL-RSI score was 82 patients between the 2 cohorts.

## Results

Between March 2011 and May 2022, 3,016 patients underwent ACLR at our institution. Within this cohort, 78 patients underwent bilateral ACLR. After removal of patients who met the exclusion criteria, 44 patients were included in our final analysis. Two hundred patients who underwent unilateral ACLR were selected from the original query by random selection of the first 20 patients listed by date from each year. After removal of patients who met the exclusion criteria, there were 132 unilateral ACLR patients (Fig 1). There was a 75% response rate.

Patients were successfully matched 1:3 based on age, sex, and BMI. Both cohorts were equally composed of male and female patients, with 69 female patients (50.0%) in the unilateral ACLR cohort and 22 female patients (50%) in the bilateral ACLR cohort ( $P > .999$ ). Patients undergoing unilateral ACLR were aged, on average,  $28.8 \pm 9.4$  years, and patients undergoing bilateral ACLR were aged  $25.7 \pm 9.8$  years at the time of their first surgical procedure ( $P = .06$ ). There was no difference in BMI between the 2 cohorts, with a mean BMI of  $25.9 \pm 4.7$  in the unilateral cohort and  $25.1 \pm 4.5$  in the bilateral cohort ( $P = .30$ ). Average final follow-up was greater than 5 years in both cohorts ( $5.8 \pm 2.8$  years for unilateral and  $5.1 \pm 2.1$  for bilateral,  $P = .13$ ). The average time difference between the first and second surgical procedures was  $28.4 \pm 22.3$  months for bilateral cohort patients. In the bilateral ACLR cohort, 15 patients (34.1%) underwent concomitant meniscal repair, 9 (20.5%) underwent concomitant meniscectomy, and 20 (40.5%) underwent no other concomitant meniscal surgery. In the unilateral ACLR cohort, 57 patients (43.2%) underwent concomitant meniscal repair, 9 (6.8%) underwent concomitant meniscectomy, and 69 (52.3%) underwent no other concomitant meniscal surgery. On  $\chi^2$  analysis, no significant difference was found between cohorts with respect to the presence of concomitant meniscal surgery ( $P = .861$ ). Regarding graft type, 13 patients (29.5%) in the unilateral cohort received an allograft whereas 31 (70.5%) received an autograft. In the bilateral cohort, 30 patients (26.1%) received an allograft whereas 85 (73.9%) received an autograft. There was no significant difference between cohorts with respect to choice of allograft versus autograft ( $P = .811$ ).

There was no significant difference between cohorts with respect to the preoperative sports activity level ( $P = .277$ ) (Table 1). Furthermore, analysis with a generalized linear model of all patients included in the study revealed that after adjusting for age, sex, and

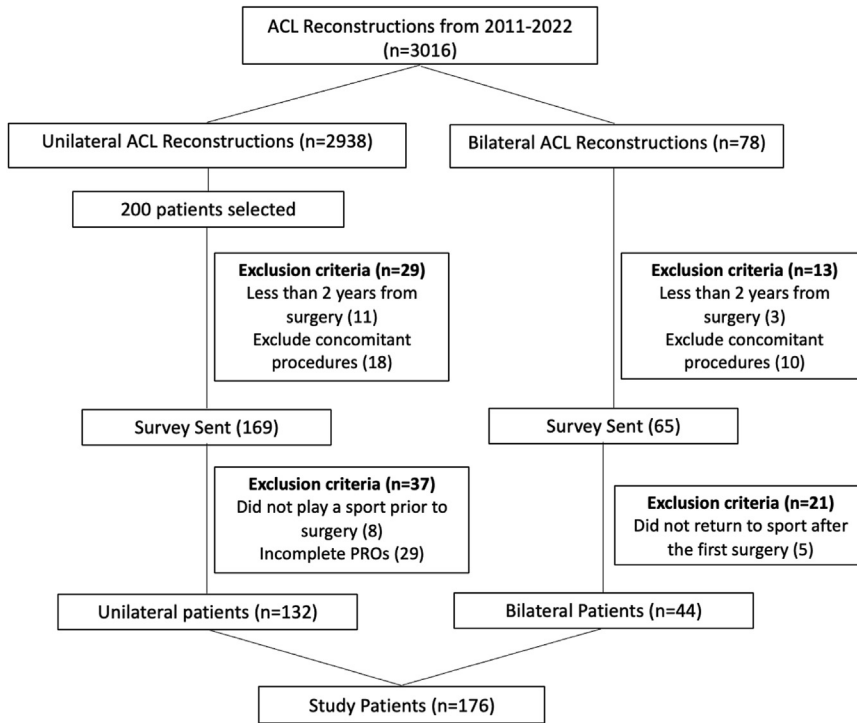
BMI, there was no association between preoperative Tegner sports activity level and ACL-RSI score ( $P = .147$ ).

## Psychological Readiness and RTS

There was no difference in ACL-RSI scores between patients who underwent unilateral ACLR and those who underwent bilateral ACLR (48.1 vs 50.5,  $P = .66$ ). However, there was a significant difference between the unilateral and bilateral cohorts with respect to the answers to the ACL-RSI questions regarding confidence that the “knee will not give way” (56.9% and 40.9%, respectively;  $P = .01$ ) and “thoughts of having to go through surgery and rehabilitation” (62.5% and 50.4%, respectively;  $P = .03$ ) (Fig 2). There was no difference in the RTS rates between the unilateral and bilateral cohorts (78.0% and 65.9%, respectively;  $P = .16$ ) or in the percentage of patients who returned to the same level or a greater level (61.2% and 69.0%, respectively;  $P = .21$ ). Furthermore, there was no difference in the time to RTS ( $41.2 \pm 29.3$  weeks in unilateral cohort vs  $35.2 \pm 23.7$  weeks in bilateral cohort,  $P = .31$ ).

Among patients who received autografts, there was no difference between the unilateral and bilateral ACLR cohorts in ACL-RSI score (53.7 and 53.3, respectively;  $P = .93$ ), rate of RTS at the preinjury level or a greater level (55.6% and 65.0%, respectively;  $P = .62$ ), or time to return ( $39.4 \pm 23.1$  weeks and  $35.7 \pm 26.5$  weeks, respectively;  $P = .54$ ). Similarly, among those who received allografts, there was no difference between the unilateral and bilateral ACLR cohorts in ACL-RSI score (51.8% and 44.9%, respectively;  $P = .49$ ), rate of RTS at the preinjury level or a greater level (66.7% and 75.0%, respectively;  $P > .999$ ), or time to return ( $34.9 \pm 30.2$  weeks and  $32.3 \pm 14.5$  weeks, respectively;  $P = .54$ ).

Within the unilateral ACLR cohort, the most common graft was bone-tendon-bone (BTB) autograft (53%), followed by BTB allograft (21%) (Fig 3A). The same graft breakdown was present in the bilateral ACLR cohort (BTB autograft, 62%; BTB allograft, 21%) (Fig 3B). Across both cohorts, there was a significant difference in age between patients who received autografts and those who received allografts ( $28.0 \pm 9.5$  years and  $40.0 \pm 11.7$  years, respectively;  $P < .001$ ). There was no difference in psychological readiness to RTS between those who received autografts and those who received allografts (54.1 and 53.4, respectively;  $P = .84$ ). Consistently, there was no difference in rate of RTS (78.0% with autograft vs 78.7% with allograft,  $P = .75$ ) or time to RTS ( $39.3 \pm 24.8$  weeks with autograft vs  $36.6 \pm 30.5$  weeks with allograft,  $P = .67$ ). Patients participating in pivoting sports more often received autografts (69.1% for pivoting vs 52.0% for non-pivoting,  $P = .02$ ), as did patients participating in



**Fig 1.** Patients meeting inclusion criteria, divided into 2 cohorts based on unilateral or bilateral anterior cruciate ligament (ACL) reconstruction surgical history. (PROs, patient-reported outcomes.)

high-impact sports (72.1% for high impact vs 54.7% for low impact,  $P = .015$ ).

### Bilateral ACLR Cohort Subanalysis

Significant differences within the bilateral ACLR group were found with respect to both sex and age. Male patients had significantly higher ACL-RSI scores than female patients (60.2 vs 42.1,  $P = .02$ ); likewise, patients younger than 30 years had significantly higher scores than those aged 30 years or older (59.0 vs 39.5,

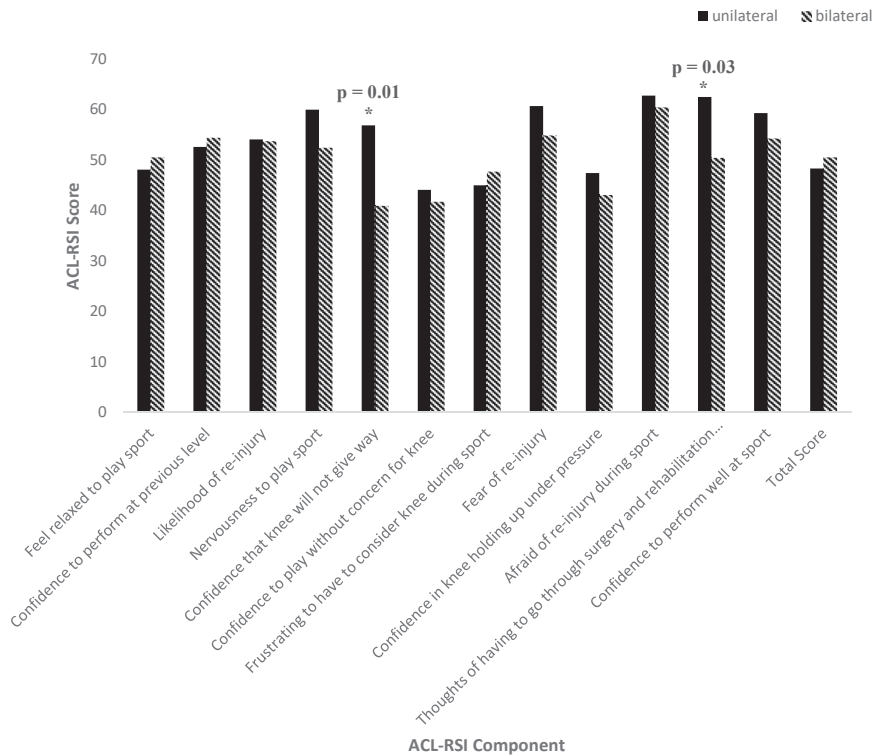
$P = .01$ ) (Fig 4). There was a significant decrease in the RTS rate for patients aged 30 years or older ( $P = .05$ ). These differences regarding sex and age were not found in the unilateral ACLR cohort. There was a 22.8% decrease in the rate of RTS for patients who participated in high-impact activities (84.6% for low impact vs 61.8% for high impact,  $P = .25$ ) and an 11.7% decrease in the rate of RTS for patients participating in pivoting sports (75.0% for non-pivoting vs 63.3% for pivoting,  $P = .64$ ), but neither of these differences met the level

**Table 1.** Preoperative Tegner Sports Activity Level in Unilateral ACLR Cohort Versus Bilateral ACLR Cohort

Preoperative Tegner Sports Activity Level	Unilateral Cohort (n = 114), n (%)	Bilateral Cohort (n = 41), n (%)
Level 1: Sedentary work (secretarial and so on)	0 (0)	1 (2.4)
Level 2: Walking on uneven ground possible but impossible to backpack or hike	2 (1.8)	0 (0)
Level 3: Work involving light labor (nursing and so on) and/or competitive and recreational sports	3 (2.6)	2 (4.9)
Level 4: Work involving moderately heavy labor (truck driving and so on) and/or recreational sports	6 (5.3)	2 (4.9)
Level 5: Work involving heavy labor (construction and so on) and/or competitive sports	10 (8.8)	8 (19.5)
Level 6: Recreational sports, such as tennis and badminton, handball, or jogging, at least 5 times per week	23 (20.2)	6 (14.6)
Level 7: Competitive sports, such as tennis, running, or handball, and/or recreational sports	27 (23.7)	7 (17.1)
Level 8: Competitive sports, such as racquetball, squash or badminton, and track-and-field athletics (jumping and so on)	6 (5.3)	3 (7.3)
Level 9: Competitive sports, such as soccer, football, or rugby (lower divisions)	22 (19.3)	9 (22.0)
Level 10: Competitive sports, such as soccer, football, or rugby (national elite)	21 (18.4)	3 (7.3)

ACLR, anterior cruciate ligament reconstruction.

**Fig 2.** Twelve questions comprising total ACL Return to Sport After Injury (ACL-RSI) score, analyzed on individual basis between unilateral and bilateral anterior cruciate ligament reconstruction (ACLR) cohorts. Two components were statistically significantly different between the 2 cohorts (asterisks). Unilateral ACLR patients were more confident that their knee would not give way and were less concerned with thoughts of having to go through a second surgical procedure and rehabilitation. However, the scores for the remaining 10 components, as well as the total overall ACL-RSI score, were not statistically significantly different between unilateral and bilateral ACLR patients.



of statistical significance. Furthermore, there was no difference in ACL-RSI scores for patients participating in high- versus low-impact sports (52.7 vs 44.3,  $P = .33$ ) or pivoting versus non-pivoting sports (52.8 vs 47.1,  $P = .49$ ).

### Unilateral ACLR Cohort Subanalysis

There were no significant differences in ACL-RSI scores within the unilateral ACLR group with respect to sex (48.5 for male patients vs 47.8 for female patients,  $P = .89$ ) and age (44.0 for age < 30 years vs 50.7 for age  $\geq$  30 years,  $P = .22$ ) (Fig 4). There was no significant difference in RTS rate for patients aged 30 years or older versus those younger than 30 years ( $P = .51$ ). There was no significant difference in the rate of RTS between patients who participated in high-impact activities (77.8%) and those who participated in low-impact activities (78.6%,  $P = .88$ ). There was also no significant difference in the rate of RTS for patients participating in pivoting sports (77.0%) versus non-pivoting sports (80.0%,  $P = .86$ ). Furthermore, there was no difference in ACL-RSI scores for patients participating in high- versus low-impact sports (47.4 vs 49.7,  $P = .69$ ) or pivoting versus non-pivoting sports (50.4 vs 47.0,  $P = .54$ ).

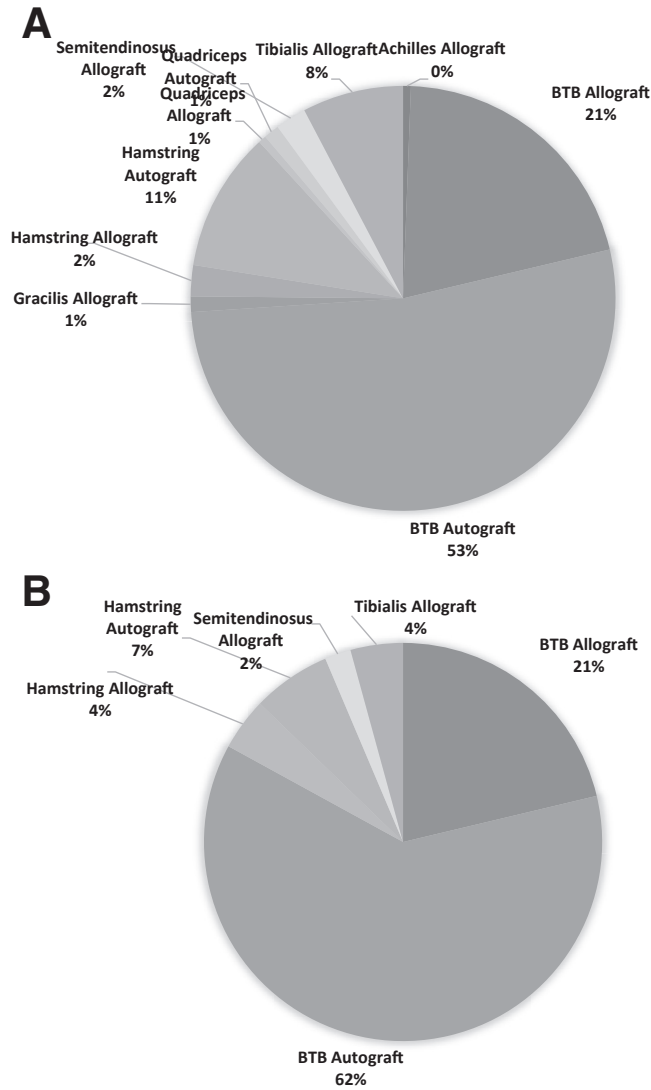
### Discussion

The most important finding in this study is that patients who underwent bilateral ACLR are

psychologically just as ready to RTS postoperatively as patients who underwent unilateral ACLR. Subsequently and in keeping with the aforementioned finding, patients who underwent bilateral ACLR returned to sport at the same rate, level, and time postoperatively as patients who underwent unilateral ACLR.

Our findings support previous literature showing no difference in RTS and level of return between patients who undergo unilateral ACLR and those who undergo bilateral ACLR. A matched-cohort study by Koca et al.<sup>14</sup> evaluated activity level, patient-reported knee function, and health-related quality of life in patients undergoing unilateral or bilateral ACLR and found there was no difference in activity level between the unilateral and bilateral groups after a minimum 5-year follow-up.<sup>10</sup> However, although no difference in RTS rates was found between the cohorts, the absolute difference in RTS rates was quite large (78.0% in unilateral cohort vs 65.9% in bilateral cohort,  $P = .16$ ). Additionally, the difference in the time to RTS between the 2 cohorts was large ( $41.2 \pm 29.3$  weeks in unilateral cohort vs  $35.2 \pm 23.7$  weeks in bilateral cohort,  $P = .31$ ) but not statistically significant. Although no statistically significant differences were found in these comparisons, this may be because of lack of statistical power. Larger studies are needed to determine the potential clinical significance of the findings.

Understanding that patients who sustain bilateral ACL injuries are not hindered psychologically as



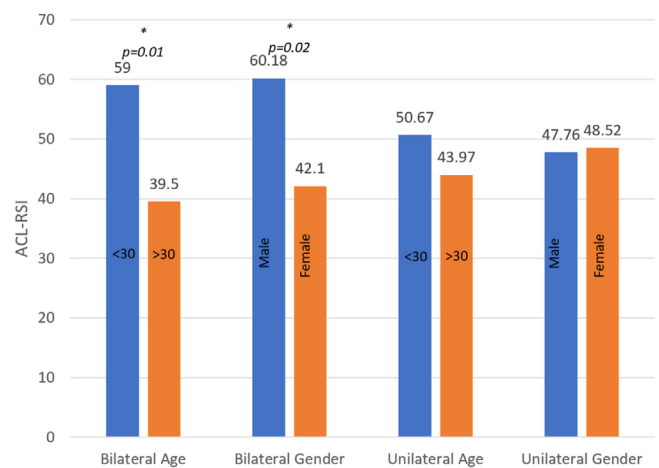
**Fig 3.** Breakdown of graft type in unilateral (A) and bilateral (B) anterior cruciate ligament reconstruction (ACLR) cohorts. In both cohorts, bone-tendon-bone (BTB) autograft was the most commonly used graft type.

compared with patients with unilateral injuries can be beneficial in returning athletes to their sports, as Faleide et al.<sup>19</sup> found that psychological readiness to RTS after ACLR was most strongly associated with returning to preinjury activity. Additionally, Paterno et al.<sup>20</sup> found that young athletes who underwent ACLR and reported high knee-related confidence at the time of RTS were more likely to perform better physically. Furthermore, Ardern et al.<sup>21</sup> reported that psychological interventions during the postoperative rehabilitation period were capable of improving patients' rates of RTS.

In recent years, there has been a focus on identifying factors that influence ACL-RSI scores to optimize patients' psychological readiness to RTS. Several studies have explored the effects of age on ACL-RSI scores and RTS after unilateral ACLR, with some studies reporting

that younger age favors RTS, but the data are inconclusive.<sup>16,19,22-26</sup> Our study shows that patients aged 30 years or older had significantly lower ACL-RSI scores, and subsequently, there was a decline in RTS rates above age 32 years. Although few studies have focused on the effect of age on psychological readiness after bilateral ACLR, these findings can be contextualized by differences in both the mentalities and responsibilities of younger and older patients. First, as patients age, they often become more aware of physical vulnerability, whereas younger athletes may show a level of naive fearlessness.<sup>27,28</sup> Similarly, older patients in general tend to have longer recovery periods and less time to devote to vigorous rehabilitation programs, as they may have more demanding financial and social responsibilities with employment and family, respectively.<sup>29</sup> Thus, it is plausible that a second, taxing surgical procedure, such as an ACLR, may be more negatively impactful for older patients.

Prior literature has also shown that there are sex differences in psychological readiness to RTS after unilateral ACLR, with male patients scoring higher on the ACL-RSI scale.<sup>23,30</sup> We found similar results for patients who underwent bilateral ACLR (60.2 for male patients vs 42.1 for female patients,  $P = .02$ ) but not those who underwent unilateral ACLR (48.5 for male patients vs 47.8 for female patients,  $P = .89$ ). Sex differences are pervasive in the ACL literature, with female patients at a significantly greater risk of initial rupture and reinjury than their male counterparts.<sup>31</sup> It is therefore surprising that a difference in ACL-RSI scores was not found between the male and female patients in the unilateral cohort. Lindanger et al.<sup>32</sup> reported that the incidence of contralateral ACL injuries



**Fig 4.** Subgroup analysis of unilateral and bilateral anterior cruciate ligament reconstruction cohorts based on age and sex. Significantly greater ACL Return to Sport After Injury (ACL-RSI) scores were observed in male patients and patients younger than 30 years in the bilateral cohort (asterisks); no significant difference was observed in the unilateral cohort.

was 32% for female patients compared with 23% for male patients, and similarly, the risk of revision surgery was 12% for female patients versus 7% for male patients. If female ACLR patients became aware of these sex difference in susceptibility to contralateral ACL injury and risk of revision surgery, possibly through consultation with the surgeon, this could more specifically explain the lower psychological readiness in female patients versus male patients after undergoing bilateral ACLR versus unilateral ACLR found in this study.<sup>31,33</sup>

There was no difference in psychological readiness to RTS or RTS rate in bilateral ACLR patients participating in pivoting and high-impact sports. However, there was a decrease in RTS for this cohort of bilateral ACLR patients that did not reach the level of statistical significance, which could be due in part to a type II error given the lower sample size. Lindanger et al.<sup>32</sup> reported that only 53% of patients participating in pivoting sports in their unilateral ACLR cohort returned to their preinjury level. The risk of reinjury in pivoting and high-impact sports has been shown to be significantly greater after ACLR.<sup>34,35</sup> Therefore, after a second surgical procedure, the risk of reinjury would seemingly be even more tangible.

### Limitations

One limitation of this study is that perioperative experiences and outcome satisfaction could each influence patients' willingness to participate in the study, thus introducing selection bias. Given the retrospective design of this study, the time to RTS and level of RTS provided by patients could be subject to recall bias. The ACL-RSI, although a validated psychometric scale, is a short questionnaire and does not necessarily address all psychosocial aspects of RTS. When analyzed as separate entities, 2 individual questions on the ACL-RSI scale were statistically significantly different between the 2 cohorts (Fig 2). The weight of these differences was not substantial enough to make the overall psychological readiness scores significantly different between the cohorts. However, the differences do highlight some limitations in the ACL-RSI scale and show that psychological readiness is likely more nuanced than reflected by the survey results. Additionally, patients may have been exposed to different levels of expectation management preoperatively, as well as differences in goal setting postoperatively, as a result of multiple-surgeon involvement within our institution and varying physical therapists. Another limitation of this study is that the ACL-RSI survey was administered retrospectively at the patient's final follow-up rather than at the time of the patient's RTS. The patient's ACL-RSI score would likely be more reflective of his or her ability to RTS if the survey was given before his or her RTS. Finally, given the smaller size of the bilateral

ACLR cohort, it is possible that we failed to find a difference because of a type II error. In particular, there were many comparisons in the subanalyses investigated in this study that were likely underpowered because this study was only powered to identify a statistically significant difference in the ACL-RSI score. As a consequence, many of the results in the subanalyses investigated in this study showed large differences but a lack of statistical significance.

### Conclusions

Compared with patients who undergo unilateral ACLR, patients who undergo bilateral ACLR are equally as psychologically ready to RTS, showing equal rates of RTS, time to return, and level of return.

### Disclosure

The authors report no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as [supplementary material](#).

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