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Primary ACL repair has limited adoption among experts: Perspectives from the 2024 Freddie Fu Panther Sports Medicine Symposium

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Abstract

Purpose: To provide a commentary on the indications and current state of anterior cruciate ligament (ACL) repair versus ACL reconstruction (ACLR), utilising a case-based discussion among a group of international Orthopaedic surgeons at the 2024 Freddie Fu Panther Sports Medicine Symposium.

Methods: An electronically distributed survey was provided to participants of the 2024 Freddie Fu Panther Sports Medicine Symposium during the meeting with questions regarding their indications for a primary ACL repair and their views on rehabilitation, return to sport, and complications after ACL repair. Three cases were discussed, the results of the surveys were recorded, and a post-case discussion followed to reach a consensus during the case resolutions.

Results: Fifty-nine participants replied to the surveys during the symposium's 'Repair versus Reconstruction' session. For acute, complete, proximal ACL tears (modified Sherman classification I) in active patients older than 50 years, 34% of the participants would treat nonoperatively, 61% of the participants would treat with ACLR, and 5% of the participants would treat with primary ACL repair. For the same case in a 17-year-old patient, 3% of the participants would treat non-operatively, 90% of the participants would treat with ACLR, and 7% of the participants would treat with primary ACL repair. Bone-patellar tendon-bone autograft was most commonly selected for young patients (51%), while allografts were used in older patients (13.5%), and synthetic grafts were rarely considered.

Conclusion: Consensus was achieved on ACLR as the standard of care for young patients (90%). Treatment choices in patients over 50 years were more variable (61% ACLR, 34% non-operative and 5% ACL repair). Based on the survey results, ACL repair remains a procedure with limited indications. Future clinical research is necessary to understand long-term clinical outcomes of ACL repair and to compare the clinical efficacy of ACL repair with ACLR or non-operative treatment.

Abbreviations: ACL, anterior cruciate ligament; ACLR, anterior cruciate ligament reconstruction; BEAR, bridge-enhanced anterior cruciate ligament repair; BPTB, bone-patellar tendon-bone; DIS, dynamic intraligamentary stabilisation; HT, hamstring tendon; IKDC, International Knee Documentation Committee; MRI, magnetic resonance imaging; QT, quadriceps tendon; RCT, randomised controlled trial.

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Level of Evidence: Level V.

KEYWORDS
anterior cruciate ligament, clinical outcomes, expert opinion, repair, reconstruction

INTRODUCTION

Anterior cruciate ligament (ACL) tears are commonly treated with single-bundle ACL reconstruction (ACLR) using autograft or allograft, with graft choice influenced by patient-specific factors such as age, gender, and activity level [26, 30, 38]. Recent studies emphasise anatomic graft placement at native femoral and tibial attachment sites, demonstrating superior knee stability and function compared to non-anatomic positioning [5, 7, 33].

While ACLR is the gold standard in treatment of ACL tears, there has been a growing interest in ACL repair as an alternative treatment method. Historically, outcomes after ACL repair were variable [10, 11, 22, 27, 31, 37]. The low rate of ACL healing is thought to be multifactorial, with negative predictors including an unfavourable intra-articular biological environment and compromised ligament blood supply after injury, although tears located proximally demonstrate a better healing capacity [34, 36].

Recently, renewed interest in surgical techniques and biologics research has led to numerous studies evaluating short-term clinical outcomes of ACL repair [1, 6, 8, 9, 17, 35, 39, 41, 43]. Various techniques, including suture anchor fixation, suture tape augmentation, and dynamic intraligamentary stabilisation (DIS), and bridge-enhanced anterior cruciate ligament repair (BEAR), have been investigated as potential alternatives to ACLR, particularly in select cases of proximal ACL tears [1, 6, 8, 9, 35, 39]. Suture anchor repair, often combined with biologic augmentation, aims to restore native ligament continuity, while suture tape augmentation techniques use additional fibre tape constructs to reinforce the primary ACL repair. DIS, which relies on continuous dynamic stabilisation of the ACL during healing, has also shown promising biomechanical and early clinical results [35, 39]. BEAR utilises a bioengineered collagen scaffold combined with autologous blood to support ACL healing by promoting tissue regeneration within the native ACL structure. This approach seeks to preserve native ligament fibres while enhancing biological healing [3, 29]. A randomised controlled trial (RCT) on BEAR demonstrated that the BEAR technique is non-inferior to autograft ACLR at two years post-procedure [29]. Indications for ACL repair are generally limited to carefully selected cases, particularly acute proximal ACL tears with good tissue quality, minimal retraction, and sufficient blood supply to support healing [1, 6, 8, 35, 39]. Patients with significant concomitant knee injuries, such as full-thickness chondral damage or severe collateral ligament tears, are generally excluded from these approaches.

There is short term clinical evidence on ACL repair in patients over 30 years, with studies reporting a minimum follow-up of 2 years [13, 32]. However, indications remain controversial due to the scarcity of long-term results and unpredictable outcomes, particularly in high-demand populations, and therefore uncertainty persists regarding (1) long term clinical outcome or (2) ACL repair in young athletes. Therefore, the purpose of this study was to present the trends and criteria for primary ACL repair discussed by a global consortium of experts during the 2024 Freddie Fu Panther Sports Medicine Symposium. Additionally, the goal was to develop consensus for the role of ACL repair compared to ACLR.

MATERIALS AND METHODS

Study group and survey administration

This was a cross-sectional study design of a multidisciplinary global consortium of clinical and research experts on ACL biology, injury, and treatment/rehabilitation. The experts participated in the 2024 Freddie Fu Panther Sports Medicine Symposium from 6–8 June 2024 at the University of Pittsburgh Medical Center in Pittsburgh, Pennsylvania. During the symposium, a case-based session was held to discuss the role of ACL repair in the setting of ACL injury. Following three case presentations with relevant clinical history, physical examination findings, and imaging, participants completed an anonymous, internet-based survey discussing diagnostic, treatment, and rehabilitation options. This process was repeated for all three cases. At the conclusion of the case presentations, the results of the surveys were recorded and a post-case discussion followed to reach consensus during the case resolutions. Satisfactory consensus was defined as 80% agreement, previously defined as the minimum acceptable interrater agreement [28].

Survey design

The survey was developed to include questions (Supporting Information: S1) evaluating the role of ACL repair as a treatment strategy for ACL injury. Three cases were presented to the symposium members (Figures 1–3). Cases varied based on patient age, mechanism of injury,

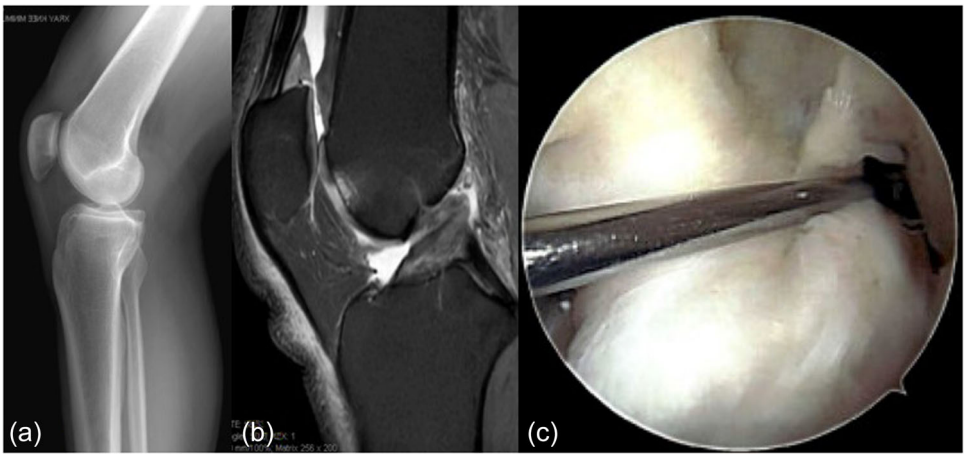

FIGURE 1 Case 1, Sagittal view of (a) knee radiograph, (b) knee MRI, (c) arthroscopic view of a proximal ACL tear, illustrating the torn ligament fibres near their femoral attachment. Case 1: 53 year-old male patient, 1 week status post twisting right knee injury while practicing Jiu-Jitsu, moderate effusion of the knee, no lateral or medial joint line tenderness, range of motion 0°–140°, Lachman IIB, modified Sherman classification type 1. ACL, anterior cruciate ligament; MRI, magnetic resonance imaging.

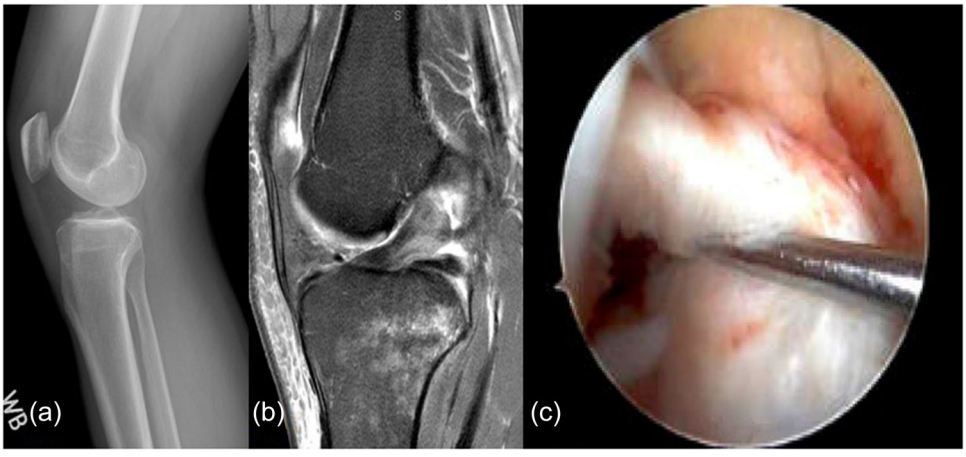

FIGURE 2 Case 2, Sagittal view of (a) knee radiograph, (b) knee MRI, (c) arthroscopic view of a proximal ACL tear, illustrating the torn ligament fibres near their femoral attachment. Case 2: 58 year-old male patient, 2 weeks status post right knee injury while skiing, mild effusion of the knee, no lateral or medial joint line tenderness, range of motion 0°–120°, Lachman IIB, modified Sherman classification type 1. ACL, anterior cruciate ligament; MRI, magnetic resonance imaging.

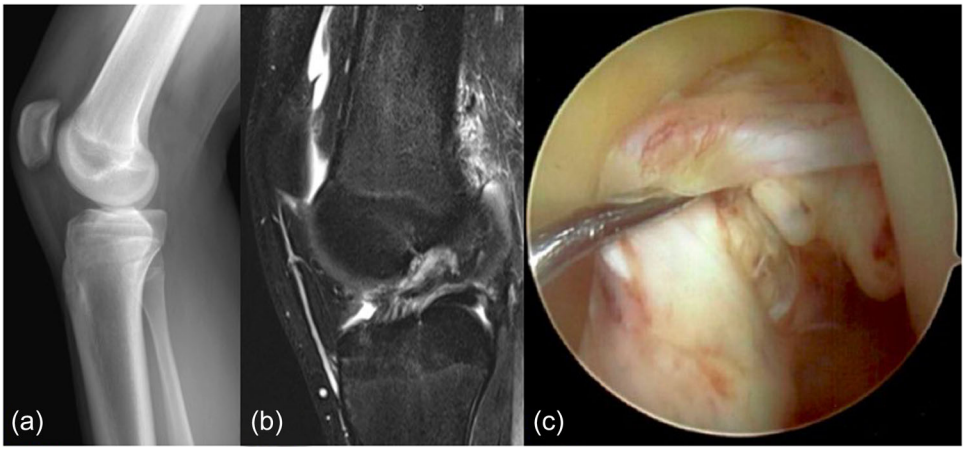

FIGURE 3 Case 3, Sagittal view of (a) knee radiograph, (b) knee MRI, (c) arthroscopic view of a proximal ACL tear, illustrating the torn ligament fibres near their femoral attachment. Case 3: 17 year-old male patient, 2 days status post twisting left knee injury while playing soccer, moderate effusion of the knee, no lateral or medial joint line tenderness, range of motion 0°–110°, Lachman IIB, modified Sherman classification type 1. ACL, anterior cruciate ligament; MRI, magnetic resonance imaging.

TABLE 1 Summary of clinical characteristics of presented cases.

	Case 1	Case 2	Case 3
Age (years)	53	**58**	**17**
Activity level	Active	Active	Competitive
Sport	Jiu-Jitsu	Skiing	Soccer
Mechanism of injury	Twisting injury	Fall	Twisting injury
Time since injury	1 week	2 weeks	2 days
Knee effusion	Moderate	Mild	Moderate
Range of motion (°)	0–140	0–120	0–110
Lachman test	IIB	IIB	IIB
Sherman classification	Type 1	Type 1	Type 1

and the specific morphology of the ACL tear, categorised using the modified Sherman classification [40]. This classification system categorises ACL tears into five types based on the length of the distal remnant relative to the total ligament length: Type 1 represents proximal avulsion tears (distal remnant length >90% of the ligament), Type 2 includes proximal tears (75%–90%), Type 3 refers to mid-substance tears (25%–75%), Type 4 represents distal tears (10%–25%) and Type 5 includes distal avulsion tears (<10%) [37, 40].

A summary of the clinical details of the presented cases is provided in Table 1.

At the conclusion of each case, a QR code was provided for participants to complete the anonymous, internet-based survey. Answers were saved automatically and participants could not change their answers. The moderators had the ability to determine if there was a repeat survey response, allowing for deletion of any duplicate responses.

Statistical analysis

Continuous variable data were presented as means and standard deviations. Categorical data were collected and displayed as proportions and percentages. A power analysis was not performed given the use of survey data, although including responses from 59 clinical and research experts provides a considerable dataset size for conclusions about trends and criteria for primary ACL repair versus ACLR.

RESULTS

There were 59 responses from the global consortium of experts. For Cases 1 and 2, which involved highly active patients over 50 years of age, 28 (47.5%) of the participants preferred autograft ACLR. Twenty-one (35.5%) selected hamstring tendon (HT) autograft, 6 (10%) quadriceps tendon (QT) autograft, and 1 (2%) bone-patellar tendon-bone (BPTB) autograft. Non-operative management was chosen by 20 (34%) participants, while 8 (13.5%) selected allograft ACLR and 3 (5%) opted for ACL repair.

With respect to ACL tear anatomy, 13 (22%) of the participants agreed with considering ACL repair for a proximal tear, 12 (20%) neither agreed nor disagreed, and 34 (58%) disagreed. The use of synthetics and biologics for ACL rupture was rejected by 52 (88%) of participants, while 7 (12%) selected suture augmentation, biologic scaffold, or synthetic mesh reinforcement.

Regarding the impact of patient age on return-to-sport and rehabilitation in Cases 1 and 2, 44 (74%) agreed, 8 (14%) disagreed, and 7 (12%) neither agreed nor disagreed.

For Case 3, 57 (97%) of the participants preferred operative treatment. ACLR was chosen by 53 (91%), while 4 (7%) selected ACL repair. Among graft options, BPTB autograft was the most common (30 participants, 51%), followed by QT (12 participants, 20%) and HT autograft (11 participants, 19%). Non-operative management was selected by 2 (3%) participants. Regarding the influence of patient age in Case 3 on return-to-sport and rehabilitation, 39 (67%) agreed, 10 (17%) disagreed, and 10 (17%) neither agreed nor disagreed (Table 2).

Twenty-eight (47.5%) of the participants disagreed or strongly disagreed that ACL repair allows for faster rehabilitation and earlier return to sport compared to ACLR, while 13 (22%) agreed or strongly agreed. Additionally, 19 (32%) of the participants believed ACL repair would result in less stiffness and cyclops formation, while 13 (22%) disagreed and 27 (46%) neither agreed nor disagreed.

DISCUSSION

The main findings of this study were that, among a group of experienced international Orthopaedic surgeons, ACLR remains the preferred treatment approach for both young and older active patients with complete proximal ACL tears, although there was variability in treatment preferences based on patient age. Specifically, there was a strong consensus for ACLR as the preferred treatment for a 17-year-old patient, reinforcing its role as the standard of care for young, active individuals. In contrast, treatment choices for patients over 50 years of age varied, with ACLR being the most common approach, followed by non-operative management, while ACL repair remained a less frequent option. Moreover, the majority of participants did not support the use of synthetic or biologic augmentations for ACL repair, and there was limited agreement

TABLE 2 ACL repair versus ACLR.

Survey question	Respondents *n* (%) (Cases 1 & 2)	Respondents *n* (%) (Case 3)
What is your preferred management strategy for these patients?		
ACLR with HS autograft	21 (35.5%)	11 (19%)
ACLR with QT autograft	6 (10%)	12 (20%)
ACLR with BPTB autograft	1 (2%)	30 (51%)
ACLR with allograft	8 (13.5%)	0 (0%)
Non-operative	20 (34%)	2 (3%)
ACL repair	3 (5%)	4 (7%)
I would consider an ACL repair in these patients with a femoral sided ACL tear		
Strongly agree	5 (8.5%)	2 (3%)
Agree	8 (13.5%)	5 (8.5%)
Neither agree nor disagree	12 (20%)	0 (0%)
Disagree	21 (36%)	15 (25.5%)
Strongly disagree	13 (22%)	37 (63%)
Do you consider any synthetics for these ACLs?		
Yes	7 (12%)	5 (8.5%)
No	52 (88%)	54 (91.5%)

Abbreviations: ACL, anterior cruciate ligament; ACLR, anterior cruciate ligament reconstruction; BPTB, bone-patellar tendon-bone; HS, hamstring tendon; QT, quadriceps tendon.

on the ability of ACL repair to offer faster rehabilitation or reduced complications compared to ACLR. These findings highlight the sustained preference for ACLR, especially in young athletes, while also indicating a need for further research to clarify the long-term outcomes and optimal indications for ACL repair.

Earlier studies from the 1970s reported that at two years follow up, ACL repair was successful in many patients and failure occurred in less than 20% of patients. However, only three years later almost all patients experienced instability and reinjury [11, 12]. Similarly, subsequent studies revealed high failure rates, persistent anteroposterior knee laxity, and unpredictable outcomes during the long-term follow-up [10, 11, 22, 27, 31, 37]. The high failure rates and inconsistent long-term outcomes of early ACL repair techniques led to the widespread adoption of ACLR, which has since demonstrated more reliable and predictable results, with failure rates under 10% [4, 14, 25]. Recently, new surgical techniques for proximal ACL tears have led to encouraging early results in ACL repair [2, 18, 21].

This study showed that in young athletes with a proximal ACL tear, only 11.5% of the participants would consider primary ACL repair. Future research is needed for high level studies with long term clinical outcome. A 2020 systematic review and meta-analysis of over 13 studies involving more than 1100 patients found that arthroscopic primary ACL repair for proximal ACL tears had a failure rate between 7% and 11%, leading the authors to conclude that primary ACL repair is a viable option for these injuries [42]. However, the main limitation, as cited in a separate 2020 systematic review of 31 articles including over 2400 patients, was that the clinical and patient-reported outcomes are difficult to interpret given the low quality of evidence, small sample size, short-term follow up, with most studies reporting a minimum of 24 months and others at least 12 months, and retrospective nature of the majority of the included studies [19].

Additionally, recent studies [15, 44] in the literature have failed to evaluate the role of ACL repair in younger individuals, an entirely separate cohort that must be considered. A recent retrospective, age-stratified study found that while patients older than 21 years had acceptable outcomes after ACL repair (with failure rates of 4.2% and 3.2% in the middle and older age groups, respectively), those aged 21 years or younger experienced a failure rate approaching 40%, necessitating further consideration before attempting ACL repair [44]. In a separate study evaluating the role of ACL repair with suture augmentation in adolescent patients, short-term outcomes revealed a failure rate of nearly 50% [15]. More recent data have demonstrated a higher failure rate and revision after ACL repair compared to ACLR in patients younger than 21 years

of age [13, 32]. A systematic review and meta-analysis comparing ACL repair (primary repair, dynamic intraligamentary stabilisation [DIS], and BEAR) to ACLR with a focus on age as a risk factor found that ACL repair in skeletally mature patients younger than 21 years old was associated with a six-fold increased risk of revision ACLR compared to ACLR [32].

The literature on ACL repair remains largely unfavourable, as evidenced by a recent 2024 meta-analysis [24], which included prospective randomised studies with 24- to 60-month follow-up [16, 20, 23, 29], demonstrating that while ACL repair yielded similar IKDC subjective scores to ACLR, it was associated with higher rates of failure, reoperation, and hardware removal. While the 2024 Freddie Fu Panther Sports Medicine Symposium did not reach consensus on the appropriateness of ACL repair in younger cohorts, the variability in responses, the lack of high-level studies, and the preliminary data showing high failure rates suggest further research is needed before its implementation within the Orthopaedic community.

Regardless of a patient's age, the patients with lower activity levels or those participating in sports not requiring significant rotational stability could potentially benefit from ACL repair. This was reflected in the survey responses, where non-operative management and ACL repair were preferred amongst 40% of the consortium for the Jiu Jitsu athlete and skier (Case 1 and 2, respectively), compared to just 10% for the female soccer player (Case 3).

More research is needed in the field of orthobiologics. The BEAR technique for ACL repair was found to be noninferior to ACLR (HS or BPTB autograft) at 2-year follow-up [29]. There was no statistically different but clinically different failure rate in retear rate requiring a second ipsilateral ACL surgery between the two groups (14% failure with BEAR, 6% failure with ACLR). There is currently an ongoing multicenter RCT comparing BEAR with ACLR with BPTB autograft [3].

This study has a few limitations. The use of survey data allowed an expert panel of Orthopaedic surgeons to offer independent assessments of case scenarios based on their clinical experience. However, the reliance on survey data limits the ability to perform statistical comparisons and may introduce self-reporting biases, including the potential for over- or underestimation of treatment practices. Additionally, the responses were collected anonymously through a QR code survey, meaning the demographics of the respondents, beyond the expert panel group, are not available. This lack of detailed demographic data prevents a deeper understanding of how factors such as geographical location or the specific patient populations and sports commonly treated might have influenced the responses. It is possible that the results could differ in a more homogenous group, such as one consisting solely of surgeons from a single region or specialty focus. The cases presented in this study reflect the exact details provided during the expert panel discussion. These discussions were based on predefined case information to facilitate a structured consensus process. While additional clinical factors may influence treatment decisions in practice, the recommendations in this study were formed based on the information available during the symposium. Another key limitation is the lack of high-quality studies evaluating ACL repair and ACLR outcomes in patients over 50 years of age. Future research should focus on long-term functional outcomes, failure rates, and return-to-function in this population to better inform treatment decisions. Despite these limitations, the study provides valuable insights into trends and criteria for clinical decision-making among a diverse panel of experts.

CONCLUSION

This study investigated current treatment choices for acute proximal ACL tears. While consensus was reached on ACLR as the standard of care for young patients (90%), treatment choices in older patients were more variable (61% ACLR, 34% non-operative and 5% ACL repair). Although primary ACL repair has shown promising results in select patients over 30 years of age, further research is needed to establish its long-term effectiveness and define its role relative to ACLR and non-operative treatment. The 2024 Freddie Fu Panther Sports Medicine Symposium panel emphasised the importance of future studies to clarify optimal indications for ACL repair and compare its outcomes with non-operative management in select patients.

AUTHOR CONTRIBUTIONS

All listed authors have contributed substantially to this work. Literature search, study design, and primary manuscript preparation were performed by Efstathios Konstantinou, Ehab M. Nazzal, and Jonathan D. Hughes. Data collection, analysis, and interpretation of results were performed by Efstathios Konstantinou and Ehab M. Nazzal. Statistical analysis was performed by Efstathios Konstantinou and Ehab M. Nazzal. Final manuscript drafting and editing were performed by Jonathan D. Hughes, Bryson P. Lesniak, Stephen J. Rabuck, Kurt P. Spindler, Andy Williams, James J. Irrgang, Volker Musahl, Michael J. Alaia, Nicholas A. Apseloff, Olufemi R. Ayeni, Jeremy M. Burnham, João Espregueira-Mendes, Alan M. J. Getgood, Christopher C. Kaeding, Jón Karlsson, Ryosuke Kuroda, David A. Parker, Andrew D. Pearle, Andrew J. Sheean, Seth L. Sherman, and Armando F. Vidal.

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CONFLICT OF INTEREST STATEMENT

J.D.H is on the editorial board of Knee Surgery, Sports Traumatology, Arthroscopy (KSSTA) and Annals of Joint. A.D. is a shareholder in Innovate Orthopaedics, a Board member of AMJSpMed, and has received payments for lectures and research from Smith & Nephew. J.J.I. is President of the Board of Directors for the Journal of Orthopaedic and Sports Physical Therapy (JOSPT). V.M. received consulting fees from Smith & Nephew and Newclip, stock or stock options from Ostesys, and is a board member of the International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine (ISAKOS), and is a Deputy Editor of Knee Surgery, Sports Traumatology, Arthroscopy (KSSTA). V.M. is the 1 st Vice President for the ACL Study Group. V.M. has grant funding from the NIH and DOD, but not pertinent to this current study. V.M. has a patent, U.S. Patent No. 9,949,684, issued on April 24, 2018. O.R.A. reports receiving speaking and lecture fees from Stryker Canada. ORA is a Tier 2 Canada Research Chair in Joint Preservation and serves as President/Owner of Notch Academy. ORA is also the Editor-in-Chief of the Journal of ISAKOS (JISAKOS). D.A.P. serves on the editorial boards of AJSM, JISAKOS, AP-SMART Journal, and OJSM. D.A.P. holds shares in Personalised Surgery, Ganymed Robotics, and DBD. D.A.P. has received royalties from Smith & Nephew and has conducted consulting work for Smith & Nephew. Additionally, D.A.P. has delivered paid presentations for Arthrex and Smith & Nephew. Institutional support has been provided to D.A.P. from Smith & Nephew, Zimmer, Corin, and Arthrex. A.J.S. reports serving as a paid consultant for Stryker and a member of the Surgeon Advisory Board for Springbok Analytics. A.J.S. is a Board/Committee Member of the American Orthopaedic Society for Sports Medicine (AOSSM) and receives personal fees from the Arthroscopy Journal. A.J.S. has also received hospitality payments and educational support from Stryker and MedInc. S.L.S. has received a $25,000 grant from the American Orthopaedic Society for Sports Medicine (AOSSM) for an orthopaedic motion analysis study. S.L.S. receives royalties from Conmed, DJO (now called Enovis), and Ostesys. He has served as a consultant for AO (Sports Medicine Principles Course Taskforce), Arcuro, Arthrex, Conmed (Knee design team member), Depuy J&J, DJO (Knee brace design team), Kinamed, LifeNet, LinkX (Consultant/Stock options), Moximed (Consultant/Stock options), Ostesys, Vericel, Reparel, Sarcio, Sparta Biomedical, and Vivorte. S.L.S. serves on advisory boards for Reparel, Sarcio, Sparta Biomedical, Vericel, and Vivorte. He also holds stock or stock options in Sarcio, Vivorte, Ostesys, Reparel, and LinkX. Additionally, S.L.S. has received research support from J.R.F., Smith & Nephew, Octane Biotherapeutics, Miach Orthopaedics Inc., the University of Pittsburgh, and Organogenesis Inc. S.L.S. holds unpaid leadership positions and committee memberships with several organisations, including AANA, AAOS, the ACL Study Group, AOSSM, the Biologic Alliance, ICRS, ISAKOS, ISMF, and the PF Foundation. He is also an editorial board member for the Arthroscopy Journal, Current Reviews in Musculoskeletal Medicine (Cur Rev MSK Med), and VJSM. A.F.V. serves as a consultant for Stryker Sports Medicine and receives royalties from the same company. A.F.V. has received research support from Arthrex and is a member of the Board of Directors for the American Academy of Orthopaedic Surgeons (AAOS). The other authors declare no conflict of financial interests or personal relationships that could have appeared to influence the work reported in this paper.

DATA AVAILABILITY STATEMENT

Anonymised data from the study are available upon reasonable request.

ETHICS STATEMENT

This is a consensus study. The Ethics Committee of University of Pittsburgh, in Pittsburgh, USA has confirmed that no ethical approval is required.

DECLARATIONS

A.D. is a shareholder in Innovate Orthopaedics and has received payments for lectures and research from Smith & Nephew. V.M. received consulting fees from Smith & Nephew and Newclip, stock or stock options from Ostesys. V.M. has grant funding from the NIH and DOD, but not pertinent to this current study. ORA reports receiving speaking and lecture fees from Stryker Canada. D.A.P. holds shares in Personalised Surgery, Ganymed Robotics, and DBD. D.A.P. has received royalties from Smith & Nephew and has conducted consulting work for Smith & Nephew. Additionally, D.A.P. has delivered paid presentations for Arthrex and Smith & Nephew. Institutional support has been provided to D.A.P. from Smith & Nephew, Zimmer, Corin, and Arthrex. A.J.S. reports serving as a paid consultant for Stryker and receives personal fees from the Arthroscopy Journal. A.J.S. has also received hospitality payments and educational support from Stryker and MedInc. S.L.S. has received a $25,000 grant from the American Orthopaedic Society for Sports Medicine (AOSSM) for an orthopaedic motion analysis study. S.L.S. receives royalties from Conmed, DJO (now called Enovis), and Ostesys. He has served as a consultant for AO (Sports Medicine Principles Course Taskforce), Arcuro, Arthrex, Conmed (Knee design team member), Depuy J&J, DJO (Knee brace design team), Kinamed, LifeNet, LinkX (Consultant/Stock options), Moximed (Consultant/Stock options), Ostesys, Vericel, Reparel, Sarcio, Sparta Biomedical,

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REFERENCES

1. Achtnich A, Herbst E, Forkel P, Metzlaff S., Sprenker F., Imhoff A.B., et al. Acute proximal anterior cruciate ligament tears: outcomes after arthroscopic suture anchor repair versus anatomic single-bundle reconstruction. Arthroscopy. 2016; 32(12):2562–9.
2. Ahmad SS, Difelice GS, van der List JP, Ateschrang A, Hirschmann MT. Primary repair of the anterior cruciate ligament: real innovation or reinvention of the wheel? Knee Surg Sports Traumatol Arthrosc. 2019;27(1):1–2.
3. BEAR-MOON Design Group G, Spindler KP, Imrey PB, Yalcin S, Beck GJ, Calbrese G, et al. Design features and rationale of the BEAR-MOON (Bridge-Enhanced ACL Restoration Multicenter Orthopaedic Outcomes Network) randomized clinical trial. Orthop J Sports Med. 2022;10(1):23259671211065447.
4. Brophy RH, Schmitz L, Wright RW, Dunn W.R., Parker R.D., Andrish J.T., et al. Return to play and future ACL injury risk after ACL reconstruction in soccer athletes from the Multicenter Orthopaedic Outcomes Network (MOON) group. Am J Sports Med. 2012;40(11):2517–22.
5. Byrne KJ, Hughes JD, Gibbs C, Vaswani R., Meredith S.J., Popchak A., et al. Non-anatomic tunnel position increases the risk of revision anterior cruciate ligament reconstruction. Knee Surg Sports Traumatol Arthrosc. 2022;30(4):1388–95.
6. De Smet E, Heusdens CHW, Parizel PM, Van Dyck P. MRI following primary repair of the anterior cruciate ligament. Clin Radiol. 2019;74(8):649.e1–649.e10.
7. DeFrate LE. Effects of ACL graft placement on in vivo knee function and cartilage thickness distributions. J Orthop Res. 2017;35(6):1160–70.
8. DiFelice GS, Villegas C, Taylor S. Anterior cruciate ligament preservation: early results of a novel arthroscopic technique for suture anchor primary anterior cruciate ligament repair. Arthroscopy. 2015;31(11):2162–71.
9. Douoguih WA, Zade RT, Bodendorfer BM, Siddiqui Y, Lincoln AE. Anterior cruciate ligament repair with suture augmentation for proximal avulsion injuries. Arthrosc Sports Med Rehabil. 2020;2(5):e475–80.
10. Engebretsen L, Benum P, Fasting O, Mølster A, Strand T. A prospective, randomized study of three surgical techniques for treatment of acute ruptures of the anterior cruciate ligament. Am J Sports Med. 1990; 18(6):585–90.
11. Feagin JA, Curl WW. Isolated tear of the anterior cruciate ligament: 5-year follow-up study. Am J Sports Med. 1976;4(3): 95–100.
12. Feagin JA, Abbott HG, Rokous JR. The isolated tear of the anterior cruciate ligament. J Bone Joint Surg Am. 1972;54: 1340–1.
13. Ferreira A, Saithna A, Carrozzo A, Guy S., Vieira T.D., Barth J., et al. The minimal clinically important difference, patient acceptable symptom state, and clinical outcomes of anterior cruciate ligament repair versus reconstruction: a matched-pair analysis from the SANTI Study Group. Am J Sports Med. 2022;50(13):3522–32.
14. Fox MA, Engler ID, Zsidai BT, Hughes JD, Musahl V. Anatomic anterior cruciate ligament reconstruction: Freddie Fu's paradigm. J ISAKOS. 2023;8(1):15–22.
15. Gagliardi AG, Carry PM, Parikh HB, Traver JL, Howell DR, Albright JC. ACL repair with suture ligament augmentation is associated with a high failure rate among adolescent patients. Am J Sports Med. 2019;47(3):560–6.
16. Glasbrenner J, Raschke MJ, Kittl C, Herbst E, Peez C, Briese T, et al. Comparable instrumented knee joint laxity and patient-reported outcomes after ACL repair with dynamic intraligamentary stabilization or ACL reconstruction: 5-year results of a randomized controlled trial. Am J Sports Med. 2022;50(12):3256–64.
17. Gobbi A, Whyte GP. Long-term outcomes of primary repair of the anterior cruciate ligament combined with biologic healing augmentation to treat incomplete tears. Am J Sports Med. 2018; 46(14):3368–77.
18. Heusdens CHW. ACL repair: a game changer or will history repeat itself? A critical appraisal. J Clin Med. 2021;10(5):912.
19. Hoogeslag RAG, Brouwer RW, de Vries AJ, Boer BC, Huis In 't Veld R. Efficacy of nonaugmented, static augmented, and dynamic augmented suture repair of the ruptured anterior cruciate ligament: a systematic review of the literature. Am J Sports Med. 2020;48(14):3626–37.
20. Hoogeslag RAG, Huis In 't Veld R, Brouwer RW, de Graaff F, Verdonschot N. Acute anterior cruciate ligament rupture: repair or reconstruction? Five-year results of a randomized controlled clinical trial. Am J Sports Med. 2022;50(7):1779–87.
21. Hughes JD, Lawton CD, Nawabi DH, Pearle AD, Musahl V. Anterior cruciate ligament repair: the current status. J Bone Jt Surg. 2020;102(21):1900–15.
22. Kaplan N, Wickiewicz TL, Warren RF. Primary surgical treatment of anterior cruciate ligament ruptures. A long-term follow-up study. Am J Sports Med. 1990;18(4):354–8.
23. Kösters C, Glasbrenner J, Spickermann L, Kittl C., Domnick C., Herbort M., et al. Repair with dynamic intraligamentary stabilization versus primary reconstruction of acute anterior cruciate ligament tears: 2-year results from a prospective randomized study. Am J Sports Med. 2020;48(5):1108–16.
24. Kunze KN, Pareek A, Nwachukwu BU, Ranawat AS, Pearle AD, Kelly BT, et al. Clinical results of primary repair versus reconstruction of the anterior cruciate ligament: a systematic review and meta-analysis of contemporary trials. Orthop J Sports Med. 2024;12(6):23259671241253591.
25. Maletis GB, Inacio M.C.S., Funahashi TT. Analysis of 16,192 anterior cruciate ligament reconstructions from a community-based registry. Am J Sports Med. 2013;41(9):2090–8.
26. R.W. Wright, L.J. Huston, A.K. Haas, K.P. Spindler, S.K. Nwosu, C.R. Allen, et al. Effect of graft choice on the outcome of revision anterior cruciate ligament reconstruction in the Multicenter ACL Revision Study (MARS) Cohort. Am J Sports Med. 2014; 42(10):2301–10.
27. Marshall JL, Warren RF, Wickiewicz TL. Primary surgical treatment of anterior cruciate ligament lesions. Am J Sports Med. 1982;10(2):103–7.
28. McHugh ML. Interrater reliability: the kappa statistic. Biochem Med. 2012;22(3):276–82.
29. Murray MM, Fleming BC, Badger GJ, Freiberger C., Henderson R., Barnett S., et al. Bridge-enhanced anterior cruciate ligament repair is not inferior to autograft anterior cruciate ligament reconstruction at 2 years: results of a prospective randomized clinical trial. Am J Sports Med. 2020;48(6): 1305–15.

30. Musahl V, Engler ID, Nazzal EM, Dalton J.F., Lucidi G.A., Hughes J.D., et al. Current trends in the anterior cruciate ligament part II: evaluation, surgical technique, prevention, and rehabilitation. Knee Surg Sports Traumatol Arthrosc. 2022;30(1):34–51.
31. Odensten M, Hamberg P, Nordin M, Lysholm J, Gillquist J. Surgical or conservative treatment of the acutely torn anterior cruciate ligament. A randomized study with short-term follow-up observations. Clin Orthop Relat Res. 1985;1(198):87–93.
32. Rilk S, Goodhart GC, van der List JP, Von Rehlingen-Prinz F, Vermeijden HD, O'Brien R, et al. Anterior cruciate ligament primary repair revision rates are increased in skeletally mature patients under the age of 21 compared to reconstruction, while adults (>21 years) show no significant difference: A systematic review and meta-analysis. Knee Surg Sports Traumatol Arthrosc. 2025;33(1):29–58.
33. Rothrauff BB, Jorge A, de Sa D, Kay J, Fu FH, Musahl V. Anatomic ACL reconstruction reduces risk of post-traumatic osteoarthritis: a systematic review with minimum 10-year follow-up. Knee Surg Sports Traumatol Arthrosc. 2020;28(4):1072–84.
34. Schliemann B, Lenschow S, Domnick C, Herbort M., Häberli J., Schulze M., et al. Knee joint kinematics after dynamic intraligamentary stabilization: cadaveric study on a novel anterior cruciate ligament repair technique. Knee Surg Sports Traumatol Arthrosc. 2017;25(4):1184–90.
35. Schneider KN, Ahlbäumer G, Gosheger G, Theil C, Weller J, Goth A. Promising functional outcomes following anterior cruciate ligament repair with suture augmentation. Knee Surg Sports Traumatol Arthrosc. 2023;31(7):2836–43.
36. Senftl M, Petek D, Jacobi M, Schallberger A., Spycher J., Stock A., et al. Occurrence of inadequate ACL healing after dynamic intraligamentary stabilization and functional outcome-a multicentre case series. Eur J Orthop Surg Traumatol. 2022;32(7):1265–74.
37. Sherman MF, Lieber L, Bonamo JR, Podesta L, Reiter I. The long-term followup of primary anterior cruciate ligament repair. Defining a rationale for augmentation. Am J Sports Med. 1991;19(3):243–55.
38. Sim K, Rahardja R, Zhu M, Young SW. Optimal graft choice in athletic patients with anterior cruciate ligament injuries: review and clinical insights. Open Access J Sports Med. 2022;13:55–67.
39. Strassman AK, Stokes DJ, Sanchez RA, Shinsako K.K., Smith P.A., DiFelice G.S., et al. Anterior cruciate ligament repair using a re-tensionable all-suture construct. Arthrosc Tech. 2024;13(3):102890.
40. van der List JP, DiFelice GS. Preservation of the anterior cruciate ligament: a treatment algorithm based on tear location and tissue quality. Am J Orthop. 2016;45(7):E393–405.
41. van der List JP, Mintz DN, DiFelice GS. Postoperative magnetic resonance imaging following arthroscopic primary anterior cruciate ligament repair. Adv Orthop. 2019;2019:5940195.
42. van der List JP, Vermeijden HD, Sierevelt IN, DiFelice GS, van Noort A, Kerkhoffs GMMJ. Arthroscopic primary repair of proximal anterior cruciate ligament tears seems safe but higher level of evidence is needed: a systematic review and meta-analysis of recent literature [published correction appears in Knee Surg Sports Traumatol Arthrosc. 2020 Jun;28(6):1958-1959.] [published correction appears in Knee Surg Sports Traumatol Arthrosc. 2022 Mar;30(3):1123-1125. doi:10.1007/s00167-020-06248-2]. Knee Surg Sports Traumatol Arthrosc. 2020;28(6):1946–57.
43. Vermeijden HD, van der List JP, DiFelice GS. Acute and delayed anterior cruciate ligament repair results in similar short to mid-term outcomes. Knee. 2021;29:142–9.
44. Vermeijden HD, Yang XA, van der List JP, DiFelice GS. Role of age on success of arthroscopic primary repair of proximal anterior cruciate ligament tears. Arthroscopy. 2021;37(4):1194–201.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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