

There has been a renewed interest in primary repair as the treatment for certain patterns of ACL rupture. Primary ACL repair was largely abandoned by the mid-1990s due to inconsistent clinical outcomes. However, careful analysis of the older data reveals that certain subgroups, especially proximal tears with good tissue quality, had better clinical outcomes than the group as a whole.¹

In light of advances in diagnostic imaging, arthroscopic surgical technology, and rehabilitation approaches in recent decades, primary ACL repair is a concept that is ripe for reevaluation. Using modern MRI imaging and in-office diagnostic evaluation with Arthrex's NanoScope™ camera, we have the ability to preoperatively identify tears that might be amenable to repair.

In Vivo Studies: Clinical Outcomes

Anterior cruciate ligament repair with suture augmentation for proximal avulsion injuries.

Presented at AANA19 meeting of the Arthroscopy Association of North America, Orlando, FL, May 2-4, 2019. ASMR. [doi:10.1016/j.asmr.2020.05.003](https://doi.org/10.1016/j.asmr.2020.05.003)

- Retrospective review study of 27 patients that underwent ACL primary repair performed by a single surgeon. Patients were included if they were at least 24 months post-op from repair surgery.
- Authors found that 85.2% of patients had successful ACL repair with no clinical instability and no subjective complaints at final follow-up, and 14.8% required revision to reconstruction surgery.
- Authors found that arthroscopic ACL primary repair with suture augmentation resulted in high functional outcomes and improved patient-reported outcomes at 2-year follow-up.

Return to sports following arthroscopic primary repair of the anterior cruciate ligament in the adult population. *Knee*. 2020;27(3):906-914. [doi:10.1016/j.knee.2020.04.001](https://doi.org/10.1016/j.knee.2020.04.001)

- A retrospective review study of 60 patients treated with ACL primary repair to assess return to sport rates and evaluate the timeline of rehabilitation milestones following arthroscopic primary repair of the ACL.
- Authors identified that time to return to work, time to return to running, and time to return to sport occurred quicker when compared to ACL reconstruction studies.
- Authors found that 85% of patients returned to any sports participation, 70% of adult patients returned to knee-strenuous sports, and 60% to preinjury levels by 180 days after the primary repair.

Douguih WA,
Zade RT,
Bodendorfer BM,
et al

Vermeijden HD,
van der List JP,
O'Brien R,
et al

1. van der List JP, DiFelice GS. Role of tear location on outcomes of open primary repair of the anterior cruciate ligament: a systematic review of historical studies. *Knee*. 2017;24(5):898-908. [doi:10.1016/j.knee.2017.05.009](https://doi.org/10.1016/j.knee.2017.05.009)

van der List JP,
Jonkergouw A,
DiFelice GS

In Vivo Studies: Clinical Outcomes

[Failure and reoperation rates following arthroscopic primary repair versus reconstruction of the anterior cruciate ligament.](#) *Orthop J Sports Med.* 2019;7(7 suppl5):2325967119S00297. doi:10.1177/2325967119S00297

- This study retrospectively reviewed patients with ACL injury operatively treated between April 2008 and May 2016 by one surgeon.
- Of the 154 patients included, 56 underwent primary repair. Patients with proximal tears were treated with primary repair using suture anchors or otherwise underwent standard reconstruction.
- Arthroscopic primary repair is a safe and good treatment for ACL injuries and has similar failure and reoperation rates when compared to the gold standard of ACL reconstruction.
- Failure rates were lower following primary repair (10.7%) than ACL reconstruction (12.2%), but this was not statistically significant ($P = 0.776$).
- **Clinical significance:** This is the first study to compare the failure and reoperation rates following arthroscopic primary repair versus reconstruction in a large cohort of patients.

Vermeijden HD,
van der List JP,
O'Brien R,
et al

[Patients forget about their operated knee more following arthroscopic primary repair of the anterior cruciate ligament than following reconstruction.](#) *Arthroscopy.* 2020;36(3):797-804. doi:10.1016/j.arthro.2019.09.041

- This study assesses extent to which patients forget their operative knee joint on a daily basis following arthroscopic primary repair as compared with reconstruction of the ACL at short- to mid-term follow-up.
- Patients were treated with the algorithm of undergoing arthroscopic primary repair for proximal tears and reconstruction for nonrepairable tears.
- Eighty-three patients completed the questionnaire (57%). Patients who underwent primary repair thought about their operated knee less when compared with those patients who underwent reconstruction.
- Based on the data in this study, patients undergoing arthroscopic primary ACL repair can expect to have less daily awareness of their operated knee at short- to mid-term follow-up as compared with patients undergoing ACL reconstruction.

Jonkergouw A,
van der List JP,
DiFelice GS

[Arthroscopic primary repair of proximal anterior cruciate ligament tears: outcomes of the first 56 consecutive patients and the role of additional internal bracing.](#) *Knee Surg Sports Traumatol Arthrosc.* 2019;27(1):21-28. doi:10.1007/s00167-018-5338-z

- This is a clinical study to assess outcomes of 56 patients who underwent arthroscopic ACL repair at a minimum 2-year follow-up. Twenty-seven of these patients also received additional internal bracing with the repair.
- Improvements were seen on subjective and objective IKDC, modified Cincinnati, SANE, and Tegner scores. There was a 13.8% failure rate without and a 7.4% failure rate with internal bracing.
- Primary repair has resulted in good outcomes at 3-year follow-up in a carefully selected patient population. The role of internal bracing is possibly beneficial.



Heusdens CHW,
Hopper GP,
Dossche L,
et al

In Vivo Studies: Clinical Outcomes

[Anterior cruciate ligament repair with independent suture tape reinforcement: a case series with 2-year follow-up.](#) *Knee Surg Sports Traumatol Arthrosc.* 2019;27(1):60-67. [doi:10.1007/s00167-018-5239-1](#)

- This is the first case series that described the 2-year follow-up results of patients with an acute proximal ACL rupture who were treated with the independent suture tape reinforcement repair technique.
- “A meaningful KOOS sport and recreation change and significant improvements in the KOOS, VAS-pain and VR-12 physical scores as well as a significant decrease of the Marx activity scale in comparison to preoperative scores are demonstrated.”
- “Two of the 42 patients (4.8%) reported an ACL rerupture” and were treated with ACL reconstruction without complications.

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):2162-2171. [doi:10.1016/j.arthro.2015.08.010](#)

- “Ten of eleven patients had good subjective and clinical outcomes after ACL preservation surgery at a minimum of 2 years’ and a mean of 3.5 years’ follow-up.”
- “Preservation of the native ACL using the described arthroscopic primary repair technique can achieve short-term clinical success in a carefully selected subset of patients with proximal avulsion-type tears and excellent tissue quality.”
- The surgical technique is described using a Bunnell-type stitch to secure the ACL and anchor it to the femur wall using SwiveLock® anchors.

Achtnich A,
Herbst E,
Forkel P,
et al

[Acute proximal anterior cruciate ligament tears: outcomes after arthroscopic suture anchor repair versus anatomic single-bundle reconstruction.](#) *Arthroscopy.* 2016;32(12):2562-2569. [doi:10.1016/j.arthro.2016.04.031](#)

- The purpose of this study was “to compare clinical and radiologic results of primary ACL suture anchor repair and microfracturing with anatomic ACL single-bundle reconstruction in patients with acute proximal ACL avulsion tears.”
- “Proximal refixation of the ACL using knotless suture anchors and microfracturing restores knee stability and results in comparable functional outcomes to a control group treated with single-bundle ACL reconstruction. The results suggest that refixation of the ACL is a feasible treatment option in selected patients.”
- “The independent suture tape reinforcement technique reinforces the ligament as a secondary stabilizer, encouraging natural healing of the ligament by protecting it during the healing phase and supporting early mobilization.”

van der List JP,
DiFelice GS

[Successful arthroscopic primary repair of a chronic anterior cruciate ligament tear 11 years following injury.](#) *HSS J.* 2017;13(1):90-95. [doi:10.1007/s11420-016-9530-8](#)

- This case reported on a successful arthroscopic primary repair of a proximal ACL tear 11 years following injury.
- “The conditions, such as proximal tear location, sufficient tissue length, and excellent tissue quality, could potentially be more important for successful outcomes of arthroscopic primary ACL repair than acuity of the surgery.”

MacKay G,
Anthony IC,
Jenkins PJ,
et al

In Vivo Studies: Clinical Outcomes

Anterior cruciate ligament repair revisited. preliminary results of primary repair with internal brace ligament augmentation: a case series. *Orthop Muscul Syst.* 2015;4(2):1-5. [doi:10.4172/2161-0533.1000188](https://doi.org/10.4172/2161-0533.1000188)

- Sixty-eight consecutive patients who underwent ACL repair with internal bracing were followed for a minimum of 1 year following surgery.
- “Improvement was seen over the study period in all KOOS and WOMAC domains with the majority of improvement seen in the first three months.”
- “The results were comparable to the literature on ACL reconstruction.”
- “This audit provides early functional outcome and failure data that demonstrates the technique of ACL repair with IBLA is comparable with early results from ACL reconstruction, with the greatest improvements seen in return to sporting activity.”

DiFelice GS,
van der List JP

Clinical outcomes of arthroscopic primary repair of proximal anterior cruciate ligament tears are maintained at mid-term follow-up. *Arthroscopy.* 2018;34(4):1085-1093. [doi:10.1016/j.arthro.2017.10.028](https://doi.org/10.1016/j.arthro.2017.10.028)

- “The clinical outcomes of arthroscopic primary repair of proximal ACL tears with suture anchors are excellent and are maintained at mid-term follow-up in a carefully selected subset of patients with proximal tears and excellent tissue quality.”

Chahla J,
Nelson T,
Dallo I,
et al

In Vitro Studies: Biomechanical Validation

[Anterior cruciate ligament repair versus reconstruction: a kinematic analysis.](#) *Knee.* 2020;27(2):334-340. [doi:10.1016/j.knee.2019.10.020](https://doi.org/10.1016/j.knee.2019.10.020)

- The purpose of this study was to compare the biomechanical properties of an ACL anatomic repair of a true femoral avulsion to an anatomic ACL reconstruction.
- Ten paired fresh frozen cadaveric specimens (n = 20) were used to investigate knee kinematics when an anterior drawer force, varus, valgus, internal, and external rotation moment were applied at 0°, 14°, 30°, 45°, 60°, and 90° of flexion.
- Conclusion: ACL repair and ACL reconstruction procedures restored knee anterior tibial translation in matched pair specimens. There was no difference in varus, valgus, internal, or external rotation forces.
- Repair and reconstruction procedures both restored anterior tibial translation in matched-pair specimens.

Massey P,
Parker D,
McClary K,
et al

[Biomechanical comparison of anterior cruciate ligament repair with internal brace augmentation versus anterior cruciate ligament repair without augmentation.](#) *Clin Biomech.* 2020;77:105065. [doi:10.1016/j.clinbiomech.2020.105065](https://doi.org/10.1016/j.clinbiomech.2020.105065)

- Proximal femoral avulsion-type anterior cruciate ligament injuries were created in 20 cadaver knees. Anterior cruciate ligament repair only or repair with internal brace ligament augmentation was performed using arthroscopic tools. Load-to-failure and failure modes were collected with calculations of stiffness and energy-to-failure performed.
- The average load-to-failure for the *InternalBrace* ligament augmentation implant group was higher than the repair-only group: 693 N (SD 248) versus 279 N (SD 91)
- There was higher load-to-failure, stiffness, and energy-to-failure for the *InternalBrace* ligament augmentation implant group compared to the repair-only group and a high positive correlation between bone density and load-to-failure for the internal brace implant group.
- **Clinical significance:** Anterior cruciate ligament repair with *Internalbrace* ligament augmentation demonstrates significantly higher load-to-failure. It may be a useful adjunct to protect the anterior cruciate ligament repair from failure during the early stages of healing.

Bachmaier S,
DiFelice GS,
Sonnerly-Cottet B,
et al

[Treatment of acute proximal anterior cruciate ligament tears-part 2: the role of internal bracing on gap formation and stabilization of repair techniques.](#) *Orthop J Sports Med.* 2020;8(1):2325967119897423. [doi:10.1177/2325967119897423](https://doi.org/10.1177/2325967119897423)

- This is a study comparing internally braced ACL repair constructs. Biomechanical testing was performed on single- and double-cinch loop cortical buttons, a knotless suture anchor, and a single-cinch loop cortical button with adjustable loop fixation.
- A significant difference was found between the single-cinch loop cortical button with adjustable fixation compared to all other constructs.
- The study found that internal bracing played a crucial role in improving the stabilization potential of ACL repair at loads occurring during normal daily activity.

van der List JP,
DiFelice GS

[Gap formation following primary repair of the anterior cruciate ligament: a biomechanical evaluation.](#) *Knee.* 2017;24(2):243-249. [doi:10.1016/j.knee.2016.10.009](https://doi.org/10.1016/j.knee.2016.10.009)

- Following proximal ACL repair, gap formation of approximately 1 mm was measured after repetitious knee cycling with mean maximum failure load of 243 N.
- These findings are likely to be sufficient for careful early active range of motion (ROM) when extrapolating from other available studies.

Systematic Reviews and Meta-analysis

Kandhari V,
Vieira TD,
Ouanezar H,
et al

Clinical outcomes of arthroscopic primary anterior cruciate ligament repair: a systematic review from the scientific anterior cruciate ligament network international study group. *Arthroscopy*. 2020;36(2):594-612. [doi:10.1016/j.arthro.2019.09.021](https://doi.org/10.1016/j.arthro.2019.09.021)

- Nineteen eligible studies were identified (including 5 comparative studies).
- Comparative studies identified no significant differences between ACL repair and reconstruction with respect to Lysholm, IKDC, side-to-side laxity difference, pivot shift grade, or graft rupture rates.

van der List JP,
Vermeijden HD,
Sierevelt IN,
et al

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. *Knee Surg Sports Traumatol Arthrosc*. 2020;28(6):1946-1957. [doi:10.1007/s00167-019-05697-8](https://doi.org/10.1007/s00167-019-05697-8)

- Studies reporting outcomes of arthroscopic primary repair of proximal ACL tears using primary repair with static (suture) augmentation and dynamic augmentation between January 2014 and July 2019 in PubMed, Embase, and Cochrane were identified.
- A total of 13 studies and 1,101 patients (mean age 31 years, mean follow-up 2.1 years, 60% male) were included.
- This systematic review found that the different techniques of primary repair (primary repair without augmentation, with static, and with dynamic augmentation) were safe with failure rates between 7% and 11% and good functional outcome scores in 1,101 patients.

van der List JP,
DiFelice GS

Preservation of the anterior cruciate ligament: surgical techniques. *Am J Orthop*. 2016;45(7):E406-E414.

- “Discussed the history of ACL preservation.”
- “Discussed how modern advances altered the risk-benefit ratio for ACL preservation.”
- “Proposed our treatment algorithm for ACL injuries, which is based on tear location and tissue quality.”

van der List JP,
DiFelice GS

Role of tear location on outcomes of open primary repair of the anterior cruciate ligament: a systematic review of historical studies. *Knee*. 2017;24(5):898-908. [doi:10.1016/j.knee.2017.05.009](https://doi.org/10.1016/j.knee.2017.05.009)

- “All studies reporting outcomes of open primary ACL repair published between the inception of PubMed, Embase and Cochrane and 2000 were identified.”
- “Good outcomes were noted in the total cohort, and excellent outcomes were noted following repair of proximal tears. Positive correlation was found between the percentage proximal tears in the studies and percentage satisfied patients ($p=0.010$).”

Moura JL,
Kandhari V,
Rosenstiel N,
et al

Technique Publications

[Figure-of-4 cruciate remnant objective assesment test reducibility of anterior cruciate ligament stump for feasibility of arthroscopic primary anterior cruciate ligament repair.](#) *Arthrosc Tech.* 2019;8(6):e637-e640. [doi:10.1016/j.eats.2019.02.008](https://doi.org/10.1016/j.eats.2019.02.008)

- An arthroscopic technique is described to determine the reducibility of the ACL remnant to help select appropriate patients for arthroscopic primary ACL repair.
- Testing occurs in two different positions to test reducibility of anterior medial and posterior lateral bundles.

Youssefzadeh KA,
Stein SM,
Limpisvasti O

[Anterior cruciate ligament repair using a knotless suture implant.](#) *Arthrosc Tech.* 2020;9(5):e623-e626. [doi:10.1016/j.eats.2020.01.013](https://doi.org/10.1016/j.eats.2020.01.013)

- This is a discussion of the pitfalls of ACL reconstruction, such as graft-site morbidity, invasive drilling, loss of vascularity, and destruction of proprioceptive fibers.
- The article discusses surgical technique using a knotless suture anchor in the lateral femoral condylar ACL footprint.

Vermeijden HD,
van der List JP,
DiFelice GS

[Arthroscopic primary repair of the anterior cruciate ligament with single-bundle graft augmentation.](#) *Arthrosc Tech.* 2020;9(3):e367-e373. [doi:10.1016/j.eats.2019.11.006](https://doi.org/10.1016/j.eats.2019.11.006)

- This is a discussion of ACL repair goals pertaining to tensioning of native tissue and restoration of natural anatomy.
- The technique shows the augmented repair of the anteromedial bundle with reconstruction of the posteromedial bundle using a TightRope® RT implant.

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-E405.

- This study used a proposed modification of the Sherman classification of the different tear types.
- The surgical techniques and variations that can be used to treat these different tear types are discussed.

Heusdens CHW,
Hopper GP,
Dossche L,
et al

[Anterior cruciate ligament repair using independent suture tape reinforcement.](#) *Arthrosc Tech.* 2018;7(7):e747-e753. [doi:10.1016/j.eats.2018.03.007](https://doi.org/10.1016/j.eats.2018.03.007)

- “Repair of the acute proximal ruptured ACL can be achieved with the independent suture tape reinforcement ACL repair technique.”
- “The independent suture tape reinforcement technique reinforces the ligament as a secondary stabilizer, encouraging natural healing of the ligament by protecting it during the healing phase and supporting early mobilization.”