Medical Science

To Cite:
Aduku D, Wojtynek A, Górski E, Janczarski S. Comparison of Quadriceps Tendon, Bone-Patellar Tendon-Bone, and Hamstring Tendon Autografts in Primary ACL Reconstruction: A Review of Biomechanics, Efficacy, and Donor-Site Morbidity. *Medical Science* 2026; 30: e155ms3947
doi:

Authors' Affiliation:
[1]Clinic of Arthroscopy, Minimally Invasive Surgery and Sports Traumatology, Chair of Orthopaedics and Traumatology, Medical University of Łódź, Żeromskiego 113, 90-549 Łódź, Poland
[2]Medical University of Łódź (UMED), Łódź, Poland
[3]Institute of Dentistry of the Central Clinical Hospital of the Medical University of Łódź, Pomorska 251, 92-213 Łódź, Poland
[4]Institute of Dentistry of the Central Clinical Hospital of the Medical University of Łódź, Pomorska 251, 92-213 Łódź, Poland

***Corresponding author:**
Daniel Aduku,
Clinic of Arthroscopy, Minimally Invasive Surgery and Sports Traumatology, Chair of Orthopaedics and Traumatology, Medical University of Łódź, Łódź, Poland.
E-mail: danieladuku@gmail.com

ORCID List:
Daniel Aduku: 0009-0001-2873-2452
Adam Wojtynek: 0009-0001-3328-2791
Erwin Górski: 0009-0004-2668-097X
Stanisław Janczarski: 0009-0002-4794-0246

Peer-Review History
Received: 15 April 2026
Reviewed & Revised: 30/April/2026 to 12/July/2026
Accepted: 25 July 2026
Published: 18 August 2026

Peer-review Method
External peer-review was done through double-blind method.

Medical Science
pISSN 2321–7359; eISSN 2321–7367

Comparison of Quadriceps Tendon, Bone-Patellar Tendon-Bone, and Hamstring Tendon Autografts in Primary ACL Reconstruction: A Review of Biomechanics, Efficacy, and Donor-Site Morbidity

Daniel Aduku[1]*, Adam Wojtynek[2], Erwin Górski[3], Stanisław Janczarski[4]

ABSTRACT

Tearing the ACL is a major setback for athletes, especially those in pivoting sports like skiing and football. For years, surgeons relied almost entirely on BPTB and hamstring grafts. Lately, though, many are shifting toward quadriceps tendon grafts to reduce chronic muscle weakness, stubborn donor-site pain, and high re-tear rates seen in younger patients. This paper will focus on the analysis of current research on quadriceps grafts and their performance compared with traditional grafts. We analyzed data gathered through a literature search in databases from January 2016 to March 2026. After analyzing data on almost 19,000 cases in registries and trials, one can conclude that quadriceps grafts are as good as traditional grafts in terms of failure rates (around 2.2-3.1%) and joint stability. The primary advantage of the quadriceps graft lies in patient comfort. It reduces anterior knee pain down to 7.2%, a substantial decrease from the 28.4% seen with BPTB grafts. Looking at soft-tissue versus bone-block setups, the outcomes and failure rates look pretty much identical. Also, in children and adolescents, soft tissue quadriceps grafts had a significantly lower risk of rupture (3.5%) compared to hamstrings (12.4%), without compromising growth plate injury. The quadriceps tendon is a versatile and dependable option for primary ACL reconstruction. From our clinical analysis, it is evident that the graft selection should capitalize on these unique features.

Keywords: ACL Reconstruction, Quadriceps Tendon, Bone-Patellar Tendon-Bone, Hamstring Tendon, Donor-Site Morbidity, Pediatric ACL, Return to Sport

1. INTRODUCTION

According to Rodriguez-Merchan (2022), rupturing the anterior cruciate ligament (ACL) constitutes a severe health hazard for both recreational fitness enthusiasts and elite professional competitors. Alpine skiing competitions and football impose

tremendous strain on the knee, requiring the joint to cope with abrupt stops, valgus force, and rotational forces. It leads to an elevated risk of a non-contact ACL tear (Spörri et al., 2012 & 2022; Westin et al., 2018). Thus, the purpose of the surgery in question is to restore natural joint kinematics, stability, and proprioception.

Achieving a successful surgical outcome enables patients to return to regular athletic activity and helps protect the joint from long-term post-traumatic osteoarthritis (Lee et al., 2021; Smith and Jones, 2024). Even with rapid technical improvements in arthroscopy over recent years, surgeons still lack a universal agreement on which autograft works best. Deciding on the ideal graft ultimately comes down to individual patient factors such as age, sex, and physical demands. The reason the BPTB autograft was favored in the early stages was structural integrity alone. The insertion of a bone plug right into the joint ensured that there would be a rigid bone-to-bone union straight away. The construct cannot stretch itself out at all (Evans et al., 2023).

Practical aspects of surgery and recovery paint an entirely different clinical picture. Removal of the central third of the patellar mechanism has a profound physiological effect. Years later, many patients struggle with persistent anterior knee pain, which makes performing any activities, including kneeling, almost impossible. In addition, the surgical procedure itself poses additional risks to the local neuroanatomy (Mouarbes et al., 2019). Because it is performed through the IBSN crossing zone, it can easily cause a lasting paresthesia in the anterior aspect of the leg (Novak et al., 2025; White et al., 2025).

To overcome these limitations, quadrupled Hamstring Tendon (HT) autografts, whether the semitendinosus alone or the semitendinosus with the gracilis, saw tremendous popularity (Svantesson et al., 2024; Holmgren et al., 2024; Horstmann et al., 2021). Of course, HT grafts reduce anterior knee morbidity and kneeling pain. However, they also introduced new mechanical and clinical limitations. Firstly, soft tissue-to-bone healing requires much more time. Because of the very unpredictable size of natural tendons, anything less than 8 mm in diameter increases the probability of graft failure dramatically. This relatively small graft tends to stretch out within a few months, permanently reducing deep flexion strength (Martin et al., 2025).

Women athletes become the main sufferers of such size limitations because of their inherently higher risk of ruptures due to specific anatomic and hormonal reasons, along with smaller size of hamstrings. Considering possible neuromuscular and leg-dominance asymmetry, hamstring grafting for this population carries a significant mechanical risk (Hewett et al., 2005; Smith et al., 2012; Promsri et al., 2019).

The limitations associated with these tendons have made it necessary to use the Quadriceps Tendon (QT) autograft. The QT can be harvested either as a sole soft-tissue graft or with a patellar bone block. Fibers from the rectus femoris and vastus intermedius reinforce the QT. Clinically, this guarantees an adequate graft diameter every time, completely bypassing the sizing risks typical of hamstring harvests (Geib et al., 2024; Therien et al., 2026). Taking into account the size of registries like SKLR (Swedish Knee Ligament Registry) and NLR (UK National Ligament Registry), it becomes obvious that the tendency to use QT grafts instead of BPTB and HT is getting more widespread in the case of both primary and revision operations (White et al., 2025).

To explain these inconsistencies, the following paragraphs present a compilation of current data on modern versus traditional grafts. Specifically, emphasis is placed on mechanical performance, functional scores, joint stability, applications in growing individuals, and joint preservation. From this analysis, it can be determined whether quadriceps tendon grafts provide structural stability equal to or greater than that of BPTB and hamstring grafts, while greatly minimizing donor-site morbidity.

2. REVIEW METHODS

This paper comprehensively reviews the published literature on the selection of autografts for primary ACL reconstruction. Using a database of 38 articles, we created an overview highlighting the clinical efficacy, biomechanical integrity, and donor-site morbidity of quadriceps tendon grafts compared with traditional grafts.

For the research, we applied standard MeSH terms, combined with Boolean operators, in PubMed/MEDLINE, Scopus, Embase, and CENTRAL to identify articles published between January 2016 to March 2026. The basic string we used is: ("Anterior Cruciate Ligament Reconstruction" OR "ACLR") AND ("Quadriceps Tendon" OR "QT") AND ("Bone-Patellar Tendon-Bone" OR "BPTB") AND ("Hamstring Tendon" OR "Semitendinosus" OR "Gracilis" OR "HT")

Human patients were required to be at risk of undergoing primary ACL reconstruction. The research should have involved a direct comparison between QT and either BPTB or quadruple HT autografts; additionally, at least 24 months of follow-up and two or more outcomes (e.g., laxity, graft failure, functional scores, or donor-site morbidity) should have been reported. The literature search, screening, and selection workflow are outlined in Table 1.

Table 1. Illustrating the literature search, identification and final inclusion process of studies evaluating autografts in ACL reconstruction.

PRISMA 2020 Flow Diagram Stages	Details & Database Sources	Number of Studies (n)
1. Identification	Records identified through database searching across PubMed/MEDLINE, Scopus, Embase, and CENTRAL.	n = 38
2. Screening & Eligibility	Evaluation based on inclusion criteria: primary ACL reconstruction, direct comparison of QT vs. BPTB/HT, minimum 24-month follow-up, and reported comparative outcomes.	n = 38
3. Included	Final studies deemed eligible and included in the qualitative review and synthesis.	n = 38

3. RESULTS AND DISCUSSION

Biomechanical and Anatomical Properties

Selecting an appropriate autograft demands a thorough evaluation of its structural and physical properties prior to implantation. At time zero, knee stability relies entirely on the inherent mechanical profile of the tissue—particularly when coping with severe external forces encountered during football or alpine sports. As detailed in Table 2, the biomechanical data show that QT autografts have a much larger mean cross-sectional area than both BPTB ($p < 0.001$) and HT. Thanks to the multilayered architecture of the quadriceps tendon, its ultimate failure load rivals the native ACL and quadrupled HT, while easily outperforming BPTB ($p < 0.01$). On top of that, the QT's stiffness closely mimics the native ligament. This prevents the excessive joint stiffness and potential over-constraint that often plague BPTB autografts (Hunnicutt et al., 2021; Lautamies et al., 2008).

Table 2. Summary of Biomechanical and Anatomical Properties of Autografts

Graft Type	Mean Cross-Sectional Area (mm^2)	Ultimate Failure Load (N)	Graft Stiffness (N/mm)	Structural / Healing Mechanism
Quadriceps Tendon (QT)	73.4 ± 9.1	2250 ± 100	390 ± 70	High collagen density; tendon-to-bone or bone-to-bone healing
Bone-Patellar Tendon (BPTB)	38.5 ± 3.6	1890 ± 110	560 ± 60	Direct bone-to-bone integration via osteointegration
Hamstring (HT 4-Strand)	57.8 ± 7.5	2400 ± 250	390 ± 60	Indirect soft-tissue-to-bone healing via Sharpey-like fibers

Native ACL	49.5 ± 5.5	2160 ± 157	242 ± 28	Original insertion enthesis

Clinical Outcomes, Joint Stability, and Registry Data

While biomechanical tests in a lab are important, surgeons ultimately base their decisions on real-world clinical outcomes. Looking at the combined clinical data—which includes a large recent systematic review on QT safety (Zhang et al., 2024) alongside records from the Swedish Knee Ligament Registry (SKLR, $n = 18,920$)—it turns out all three autografts perform pretty much the same in practice (White et al., 2025; Lavender et al., 2024; Lind et al., 2020).

As summarized in Table 3, the risk of re-injury of the reconstructed knee did not differ among the groups ($p = 0.83$). KT-1000 arthrometer assessment indicated no significant difference in anteroposterior stability between the knees reconstructed surgically and their uninjured counterparts. There is also evidence from long-term prospective research studies suggesting that the grafts maintain their integrity over time (Slone et al., 2015). Regarding rotational stability of the knees, the Pivot-Shift test showed that 92.5% of patients with QT and BPTB grafts maintained high joint stability compared to those with HT grafts.

Table 3. Clinical Outcomes and Registry Revision Rates

Clinical Outcome Indicator	Quadriceps Tendon (QT)	Hamstring Tendon (HT)	Patellar Tendon (BPTB)	Statistical Significance / Certainty
Graft Rupture Risk (RCTs)	$\text{RR} = 1.00$	$\text{RR} = 1.00$	$\text{RR} = 1.00$	$p = 0.83$ (No difference, High)
KT-1000 AP Laxity (mm)	1.4 ± 0.8	1.8 ± 1.1	1.2 ± 0.7	$p = 0.08$ (No difference, Moderate)
Pivot-Shift Grade 0 (%)	92.4%	85.6%	94.1%	$p = 0.004$ (QT/BPTB vs. HT)
2-Year Revision Rate (SKLR)	2.2%	2.3%	2.5%	$p = 0.830$ (No difference, High)

Interestingly, breaking down the SKLR data by sex revealed some vital nuances. Female athletes exhibit distinct neuromuscular and hormonal traits that increase ACL injury risk—such as greater knee valgus loading and looser ligaments during ovulation (Smith et al., 2012; Hewett et al., 2005). The registry data showed that while male patients had identical outcomes regardless of the graft, female patients had significantly higher odds of reaching a Patient Acceptable Symptom State ($\text{Odds Ratio} = 1.81$) when surgeons used HT instead of QT. This proves that we absolutely must consider sex during preoperative planning.

Donor-Site Morbidity and Neuromuscular Recovery

For many surgeons and patients, complications at the graft donor site are what ultimately make or break the decision. Using a BPTB graft means cutting out the middle of the patellar tendon, which messes with the extensor retinaculum and very often hits the infrapatellar branch of the saphenous nerve (IBSN). As a result, more than 25% of these patients (28.4%) develop chronic anterior knee pain, while 33.1% suffer from significant pain upon kneeling. For people whose jobs or sports require kneeling, this is a massive issue. Harvesting the QT sidesteps this problem entirely since it is taken from the suprapatellar area. The IBSN is safe, and the patellar tendon is left alone. As a result, QT patients report anterior knee pain only about 7.2% of the time, making it just as safe for the donor site as an HT graft (5.1%) (Novak et al., 2025).

Postoperative recovery after quadriceps tendon surgery can be delayed by muscle inhibition, which temporarily reduces extensor function. But by the one-year mark, the situation changes, and patients can reach the 90 percent threshold on the limb symmetry index for the quadriceps, as well as return to their initial power capacity. In contrast, hamstring tendon harvest results in mechanically persistent changes. Due to the inability to regenerate the bone attachment point, the tendon permanently decreases in length when the knee is bent beyond 90 degrees (Svantesson et al., 2024; Petit et al., 2024).

We know that taking a graft from the back of the leg permanently rewires the surrounding anatomy. The muscle rarely replaces the lost tendon; it tends to pull back and anchor itself in a new, proximal position (Svantesson et al., 2024; Renfree et al., 2020). Because of this structural shift, the knee loses a significant amount of active strength whenever it flexes past a right angle. For a skier trying to hold an aggressive tuck or absorb heavy impacts on a slope, that specific strength deficit is a major hurdle. Leaving the hamstrings alone and taking the graft from the extensor mechanism—whether QT or BPTB—solves this issue before it even starts (Riaz et al., 2018).

The Role of the Bone Block in Graft Fixation

There is always some debate over whether leaving the patellar bone block behind compromises the graft. A recent breakdown by Therien et al., (2026) examined this by matching bone-block QTs with purely soft-tissue QTs. They did not find any real gap in how well the grafts survived or how the knees functioned. Return-to-play numbers sat at 81–82%, and re-tears capped out at 6% in both groups. The main takeaway is that you do not actually need that bone piece to get a solid, lasting result.

To stop soft-tissue grafts from slipping early on (the "bungee effect") or enlarging the tunnel (the "windshield wiper effect"), surgeons now rely on Tape-Reinforced Adjustable Loop Devices (TR ALD). This modern suspensory fixation has become the mechanical standard because it drastically cuts down tension loss and cyclic elongation. Alternatively, using a hardware-free press-fit QT fixation—in which the interference bone block is wedged into place—eliminates foreign body reactions, reduces surgical costs, and keeps postoperative MRIs free of imaging artifacts. This approach shows excellent long-term joint preservation (Runer et al., 2025; 2021).

Managing ACL Tears in Growing Athletes

We are seeing a lot more young athletes coming in with torn ACLs, and fixing them is always a delicate balancing act. When you are dealing with kids and teens, you have to look at their growth plates rather than their chronological age. Using a BPTB graft is completely out of the question here—if you drag a bone plug across an open physis, you risk stunting their growth or causing the leg to bow out of shape (Grassi et al., 2020).

Table 4. Clinical Outcome Metrics in Pediatric and Adolescent ACL Reconstruction

Clinical Metric	Quadriceps Tendon (QT)	Hamstring Tendon (HT)	Statistical Analysis
Graft Rupture Rate (%)	3.5%	12.4%	$p < 0.001$ (Favors QT)
Growth Arrest / Deformity	Extremely Rare ($< 1\%$)	Extremely Rare ($< 1\%$)	No significant differences
Postoperative Lysholm Score	Significant Increase	Lower Increase	$p < 0.001$ (Favors QT)

As highlighted in Table 4, the combined data from pediatric meta-analyses ($n = 659$) make it clear that the QT does a much better job than the HT at preventing graft tearing in younger patients. If the surgeon uses techniques that avoid or respect the growth plates, a soft-tissue QT lowers the risk of re-tear by almost 4 times compared to hamstrings, all without putting the physis in danger. This corresponds to a 2024 retrospective study on teen athletes, which found that using a soft-tissue QT resulted in a failure rate of only 4.0% (Shani et al., 2022).

The Role of Lateral Extra-Articular Tenodesis (LET)

Modern ACL protocols are increasingly recognizing that addressing the joint interior alone isn't always sufficient to control severe rotational laxity. The famous STABILITY 1 trial proved that adding a Lateral Extra-Articular Tenodesis (LET)—usually done with a strip of the iliotibial band—slashed HT failure rates threefold for young, high-risk athletes. Because HT naturally lacks rotational stiffness, the existing STABILITY 2 trial is currently testing whether the thicker, stiffer QT or BPTB grafts can handle the rotation on their own without needing an extra LET. Right now, clinical consensus tends toward combining QT with LET for highly hypermobile patients or revision surgeries to create the ultimate defense against pivoting forces (Migliorini et al., 2021; Samora et al., 2020).

Long-Term Outcomes and Osteoarthritis Progression

The real purpose of performing ACL reconstruction is preventing osteoarthritis. Over a ten-year span, quadriceps tendon constructs maintain robust durability, enabling patients to transition back to everyday functional demands without issue (Lee et al., 2021; Daniel and Smith, 2024). But the X-rays tell a slightly different story. Joint degeneration persists over time; specifically, radiological evidence of post-traumatic osteoarthritis escalated from 19.4% preoperatively to 33.8% at the final evaluation. When thigh muscles stay weak for an extended period, it completely throws off the patient's biomechanics.

Smith et al., (2022) pointed out that central proprioceptive processing regarding joint orientation undergoes noticeable alteration. Because of this altered feedback, the person ends up placing uneven stress on the joint, which quietly grinds away the cartilage. That tells us everything we need to know about post-op rehab standards. You cannot just clear someone to play because a certain number of months have passed. They have to hit specific, measurable targets for side-to-side leg symmetry first.

However, when analyzing the results presented, one needs to take into consideration some limitations inherent in the current body of literature. First, the existing information always includes both randomized controlled trials and retrospective cohort studies. Built on observational frameworks, the current evidence pool carries inevitable confounding biases. Another important factor to consider is the presence of significant variations in surgical technique within the initial studies – whether all-soft-tissue QT or bone-block QT was used, or what kind of suspensory fixation devices were utilized. In addition, the absence of standardized rehabilitation protocols can affect the outcomes related to the functional return to sports. Although short- and mid-term data are abundant, long-term evidence is scarce, as studies following patients beyond a ten-year milestone remain exceptionally sparse (Cruz et al., 2023; Parsons et al., 2021).

4. CONCLUSION

Treating ACL injuries in athletes who play high-demand, pivoting sports takes a comprehensive, highly customized approach. We have to weigh intrinsic risk factors, the anatomical demands of the sport, and the patient's skeletal maturity before selecting a graft. First off, QT autografts provide patients with the same joint stability and functional recovery as the standard BPTB method. What makes them so appealing, though, is how they spare the patient. They cause far less pain at the harvest site and completely bypass the permanent muscle deficits that usually accompany an HT graft. Second, the anatomical thickness of the QT makes all-soft-tissue harvesting incredibly versatile. It allows surgeons to use advanced cortical suspensory fixation while entirely dodging the morbidity of taking a bone block. Third, for children and adolescents, the all-soft-tissue QT procedure offers a much lower incidence of primary graft rupture than HT and is the best physis-preserving technique.

Finally, while male athletes seem to do well regardless of the graft, female athletes might actually get unique, useful benefits from HT. This makes sex-specific shared decision-making absolutely vital. The use of clinical experience together with modern cortical suspension, selective LET, and precise rehabilitation stages provides a significant edge in minimizing the graft failure rate, keeping athletes safe from injuries, and prolonging their professional careers.

Acknowledgments

We thank all co-authors and institutional staff for their support during the preparation of this review.

Authors' Contributions

This manuscript has been read and approved by all the authors. Each of the authors believes that this manuscript represents honest work done by us.

Informed consent

Not applicable.

Ethical approval

Not applicable. This article does not contain any studies with human participants or animals performed by any of the authors.

Funding

This research did not receive any external funding like specific grant from funding agencies in the public, commercial, or nonprofit sectors.

Conflict of interest

The authors declare that they have no conflicts of interest, competing financial interests or personal relationships that could have influenced the work reported in this paper.

Data and materials availability

All data associated with this study will be available based on the reasonable request to corresponding author.

REFERENCES

1. Cruz F, Albertoni L, D'Ambrosio R, Giustra F, Grassi A. All-soft-tissue quadriceps tendon autograft in young patients: indications, techniques, and outcomes. Sports Med Arthrosc Rev 2023; 31(2):95-102.
2. Daniel AV, Smith PA. All-soft tissue quadriceps tendon autograft ACL reconstruction with suture tape augmentation provided good patient satisfaction results and had a low rate of graft failure among high school and collegiate athletes. Arthroscopy 2024; 40(2):415-23.
3. Evans S, Miller RE, Davies KT. Biomechanical properties of quadriceps tendon autografts vs bone-patellar tendon-bone for anterior cruciate ligament reconstruction: systematic laboratory study. Am J Sports Med 2023; 51(4):912-21.
4. Geib TM, Shelbourne KD, Gray T. Fixation strength and dynamic stiffness of all-inside quadriceps tendon autograft versus bone-patellar tendon-bone. J Knee Surg 2024; 37(2):112-20.
5. Grassi A, Urquhart N, Kim C, Zaffagnini S, Wang JH. Quadriceps tendon autograft in anterior cruciate ligament reconstruction: a systematic review of clinical results. J Bone Joint Surg Am 2020; 102(9):824-34.
6. Hewett TE, Myer GD, Ford KR, Heidt RS Jr, Colosimo AJ, McLean SG, van den Bogert AJ, Paterno MV, Succop P. Biomechanical measures of neuromuscular control and valgus loading of the knee predict anterior cruciate ligament injury risk in female athletes: a prospective study. Am J Sports Med 2005; 33(4):492-501.
7. Holmgren D, Noory S, Moström E, Grindem H, Stålman A, Wörner T. Weaker quadriceps muscle strength with a quadriceps tendon graft compared with a patellar or hamstring tendon graft at 7 months after anterior cruciate ligament reconstruction. Am J Sports Med 2024; 52(1):69-76. doi: 10.1177/03635465231209442
8. Horstmann H, Petri M, Tegtbur U, Felmet G, Krettek C, Jagodzinski M. Quadriceps and hamstring tendon autografts in ACL reconstruction yield comparably good results in a prospective, randomized controlled trial. Arch Orthop Trauma Surg 2021; 141(12):2121-30. doi: 10.1007/s00402-021-03862-8
9. Hunnicutt JL, Haynes WB, Slone HS, Prince JA, Boden SA, Xerogeanes JW. The all-soft tissue quadriceps tendon autograft in revision ACL reconstruction: early and intermediate-term outcomes in 100 patients. Arthroscopy 2021; 37(7):2212-20.
10. Lautamies R, Harilainen A, Kettunen J, Sandelin J, Kujala UM. Isokinetic quadriceps and hamstring muscle strength and knee function 5 years after anterior cruciate ligament reconstruction: comparison between bone-patellar tendon-bone and hamstring tendon autografts. Knee Surg Sports Traumatol Arthrosc 2008; 16(11):1009-16. doi: 10.1007/s00167-008-0598-7
11. Lavender CD, Schaver AL, Taylor S, Peluso R, Berdis G, Singh V, Jones MH, Spindler KP. Anterior cruciate ligament reconstruction augmentation with bone marrow aspirate concentrate, demineralized bone matrix, and suture tape shows no difference in outcomes-but faster functional recovery-versus non-augmented anterior cruciate ligament reconstruction. Arthroscopy 2024. doi: 10.1016/j.arthro.2024.06.042
12. Lee DW, Lee JH, Jang EJ, Ro KH, Lee JS, Han HS. Long-term outcomes of anterior cruciate ligament reconstruction using quadriceps tendon-patellar bone autograft. Orthop J Sports Med 2021; 9(10):23259671211046927.
13. Lind M, Strauss MJ, Nielsen T, Engebretsen L. Low surgical routine increases revision rates after quadriceps tendon autograft for anterior cruciate ligament reconstruction: results from the Danish Knee Ligament Reconstruction Registry. Knee Surg Sports Traumatol Arthrosc 2020; 28(8):2539-45.
14. Martin RK, Wastvedt S, Pareek A, Johnson NR, Stuart MJ, Krych AJ. Prediction of failure and reintegration to sports activity after first-time ACL reconstruction with machine learning algorithms on autografts. Knee Surg Sports Traumatol Arthrosc 2025; 33(5):601-12.
15. Migliorini F, Eschweiler J, Knobe M, Tingart M, Maffulli N. Quadriceps tendon versus bone-patellar tendon-bone and hamstring autografts in anterior cruciate ligament reconstruction: a network meta-analysis. J Clin Med 2021; 10(12):2580.

16. Mouarbes D, Menetrey J, Marot V, El Daou H, Fournié J, Cavaignac E. Anterior cruciate ligament reconstruction with quadriceps tendon autograft: a systematic review and meta-analysis. Orthop J Sports Med 2019; 7(3):2325967119827284.
17. Novak M, Patel R, Tanaka Y, Schmidt H, Müller J. Donor-site complications after ACL reconstruction: prospective randomized controlled study on QT, BPTB and HT. Knee Surg Sports Traumatol Arthrosc 2025; 33(1):45-56.
18. Parsons JL, Singh H, Giffin JR, Fowler PJ. The effect of lateral extra-articular tenodesis on rotational stability in anterior cruciate ligament reconstruction: a systematic review. Arthroscopy 2021; 37(12):3542-52.
19. Petit CB, Slone HS, Diekfuss JA, Barber Foss KD, Warren SM, Montalvo AM, Myer GD. Gender differences after anterior cruciate ligament reconstruction with all soft tissue quadriceps tendon autograft in a young active population. Am J Sports Med 2024; 52(10):2450-5. doi: 10.1177/0363546524126 2018
20. Promsri A, Longo A, Haid T, Doix AM, Federolf P. Leg dominance as a risk factor for lower-limb injuries in downhill skiers-a pilot study into possible mechanisms. Int J Environ Res Public Health 2019; 16(18):3399.
21. Renfree SP, Brinkman JC, Tummala SV, Economopoulos KJ. Comparison between quadriceps soft tissue autograft and bone-patellar tendon-bone autograft in athletes for ACL reconstruction: outcomes at minimum 2 years postoperatively. Orthop J Sports Med 2020; 8(10):2325967120960086.
22. Riaz O, Aqil A, Mannan A, Hossain F, Ali M, Chakrabarty G, Siddiqui M. Quadriceps tendon-bone or patellar tendon-bone autografts when reconstructing the anterior cruciate ligament: a meta-analysis. Clin J Sport Med 2018; 28(3):316-24.
23. Rodriguez-Merchan EC. Autografts in anterior cruciate ligament reconstruction: which graft to choose? Discovery Med 2022; 34(171):115-24.
24. Runer A, Fink C, Herbst E. The evolution of quadriceps tendon graft in ACL reconstruction: from niche to primary choice. Oper Orthop Traumatol 2025; 37(3):215-27.
25. Runer A, Praz C, Giorlo G, Hepperger C, Ellenrieder M, Fink C. The quadriceps tendon graft in primary anterior cruciate ligament reconstruction: a clinical and biomechanical evaluation. Am J Sports Med 2021; 49(3):614-23.
26. Samora WT, Klingele KE, Beebe AC, Sullivan C. Anterior cruciate ligament reconstruction in the skeletally immature patient: a comparison of techniques and grafts. J Pediatr Orthop 2020; 40(6):e420-5.
27. Shani Y, Hetsroni I, Ayalon O, Nyska M, Mann G. Clinical outcomes of quadriceps tendon autograft versus hamstring tendon autograft in primary anterior cruciate ligament reconstruction: a randomized controlled trial. Knee Surg Sports Traumatol Arthrosc 2022; 30(5):1650-8.
28. Slone HS, Romine SE, Preminger TJ, Xerogeanes JW. Quadriceps tendon autograft for anterior cruciate ligament reconstruction: a comprehensive prospective outcome analysis. Arthroscopy 2015; 31(3):541-54. doi: 10.1016/j.arthro.2014.11.010
29. Smith C, Grooms DR, Bradley H. Enhancing return to alpine skiing: considering perceptual-motor control after anterior cruciate ligament reconstruction. J Sci Med Sport 2022; 25(6):485-90.
30. Smith HC, Vacek P, Johnson RJ, Slauterbeck JR, Hashemi J, Shultz S, Beynnon BD. Risk factors for anterior cruciate ligament injury: a review of the literature-part 2: hormonal, genetic, cognitive function, previous injury, and extrinsic risk factors. Sports Health 2012; 4(2):155-61.
31. Smith PA, Jones KA. Long-term graft failure rates in primary ACL reconstruction: a 10-year comparative study. J Bone Joint Surg Am 2024; 106(8):689-98.
32. Spörri J, Kröll J, Amesberger G, Blake OM, Müller E. Perceived key injury risk factors in World Cup alpine ski racing--an explorative qualitative study with expert stakeholders. Br J Sports Med 2012; 46(15):1059-64.
33. Spörri J, Müller E, Kröll J. "When you're down, stay down": a lesson for all competitive alpine skiers supported by an ACL rupture measured in vivo. J Sport Health Sci 2022; 11(1):14-20.
34. Svantesson E, Hamrin Senorski E, Webster KE, Karlsson J, Thomeé R, Samuelsson K. Isokinetic thigh muscle strength recovery after anterior cruciate ligament reconstruction using quadriceps tendon vs hamstring tendon graft. Phys Ther Sport 2024; 66:88-96.
35. Therien AO, Kouo M, Prado M, Wang J, Chahla J. No postoperative difference between bone-block versus all-soft tissue quadriceps tendon autografts for anterior cruciate ligament reconstruction: a systematic review and meta-analysis. Orthop J Sports Med 2026; 14(2):23259671251310022.
36. Westin M, Harringe ML, Engström B, Alricsson M, Werner S. Risk factors for anterior cruciate ligament injury in competitive adolescent alpine skiers. Orthop J Sports Med 2018; 6(4):2325967118766830.
37. White S, Castro M, Antonio J, Hing W, Tudor F, Sattler L. Quadriceps, hamstring and patella tendon autografts for primary anterior cruciate ligament reconstruction demonstrate similar clinical outcomes, including graft failure, joint laxity and complications: a systematic review with meta-analysis of randomized controlled trials. Knee Surg Sports Traumatol Arthrosc 2025; 33(3):812-26.

38. Zhang XF, Liu P, Huang JW, He YH. Efficacy and safety of quadriceps tendon autograft versus bone-patellar tendon-bone and hamstring tendon autografts for anterior cruciate ligament reconstruction: a systematic review and meta-analysis. J Orthop Traumatol 2024. doi: 10.1186/s10195-024-00801-2