

Quadriceps Tendon (QT) ACL Reconstruction

Scientific Update



QT ACL reconstruction continues to be one of the fastest growing ACL reconstruction techniques performed worldwide. The clinical benefits of the QT technique – including robust and predictable graft sizing, superior biomechanics, equal or better clinical outcomes, low morbidity, and improved cosmesis – are now supported in a number of clinical and biomechanical studies as well as systematic reviews. The following document summarizes the scientific support for successful outcomes with the QT technique.

In Vivo Studies: Clinical Outcomes

A comparative study on functional outcome of ACL reconstruction: quadriceps versus hamstring tendon autograft. *J Arthrosc and Jt Surg*, 2018. doi.org/10.1016/j.jajs.2018.09.005.

- A comparative clinical study of 96 patients to evaluate functional outcomes of ACLR between quadriceps tendon (QT) and hamstring tendon (HS) autografts. Four of the original 48 QT patients were lost to follow-up and 6 of the original 48 HS patients were lost to follow-up at 12 weeks.
- The IKDC scores at 2-year follow-up for the QT tendon group was 114 in 40 patients and 100 in 4 patients (mean IKDC score of 113). In the HS group, IKDC scores were 119 in 38 patients and 113 in 4 patients (mean IKDC score of 118).
- This study showed no statistically significant difference between quadriceps vs. hamstring tendon autograft ACLR.

Pain level after ACL reconstruction: a comparative study between free quadriceps tendon and hamstring tendons autografts. *Acta Orthop Traumatol Turc*. 2017;51(2):100-103. doi:10.1016/j.aott.2017.02.011.

- This clinical study of 48 patients compared pain levels and analgesic consumption after single bundle ACLR with QT vs HS tendon autograft.
- In the HS group, supplementary analgesic drug administration proved significantly higher, with a median (interquartile range) of 1 (1.3) dose, compared to the group of subjects treated with a quadriceps graft, median = 0.5 (0.125) (p = 0.009).
- A significantly higher number of subjects with a quadriceps graft did not require any supplementary analgesic drug (50%) as compared with subjects with hamstring graft (13%).
- Patients in the quadriceps tendon group had less pain and less analgesic consumption in the immediate postoperative period compared with patients in the hamstring tendon group.

Clinical outcomes of all soft-tissue quadriceps tendon autograft in ACL reconstruction. *Orthop J Sports Med*. 2017;5(7 suppl6). doi:10.1177/2325967117S00310.

- Prospectively followed 353 patients undergoing ACL reconstruction with QT autograft
- No evidence of early graft failure or lengthening, reaffirming technique and graft choice in young, athletic patient population
- Low complication and failure rates when compared to existing literature on other graft options
- Supports all soft-tissue QT ACL reconstruction

Central quadriceps tendon for anterior cruciate ligament reconstruction: long-term results. *Arthroscopy*. 2008. 24(6)(suppl):e18. doi:10.1016/j.arthro.2008.04.033.

- One hundred twenty-four patients were enrolled in study; describes outcomes of ACLR using central quadriceps free tendon (CQFT) at 2+ years follow-up.
- Concluded that CQFT is a reliable, low-morbidity autograft for ACL reconstruction with stable outcomes at 5+ years.

Tirupathi SY,
Goyal D,
JVS V

Buescu CT,
Onutu AH,
Lucaciu DO,
Todor A

Xerogeanes JW,
Godfrey W,
Gebrelul A,
et al

DeAngelis JP,
Cote M,
Fulkerson JP,
Caminiti S

Cavaignac E,
Coulin B,
Tscholl P,
Fatmy NNM,
Duthon V,
Menetrey J

[Is quadriceps tendon autograft a better choice than hamstring autograft for anterior cruciate ligament reconstruction? *Am J Sports Med.* 2017;45\(6\):1326-1332.](#)

doi:10.1177/0363546516688665.

- A comparative study with mean follow-up of 3.6 years
- Ninety-five patients enrolled in the study: 50 patients had QT reconstruction and 45 had hamstring.
- Assessment methods included various parameters: surgical revision, functional outcomes, joint stability, anterior knee pain, and isokinetic strength
- Authors concluded that the use of the QT graft leads to equal or better functional outcomes than HT without affecting morbidity

Lund B,
Nielsen T,
Faunø P,
Christiansen SE,
Lind M

[Is quadriceps tendon a better graft choice than patellar tendon? A prospective randomized study. *Arthroscopy.* 2014;30\(5\):593-598. doi:10.1016/j.arthro.2014.01.012.](#)

- Prospective, randomized controlled study to compare quadriceps tendon-bone (QTB) and bone-patellar tendon-bone (BPTB) reconstructions
- Fifty-one patients in the study: 26 with QTB and 25 with BPTB
- Concluded that use of QTB results in less kneeling pain, graft site pain, and sensitivity loss than BPTB. Similar anterior knee stability and subjective outcome scores were reported.

Runer A,
Wierer G,
Herbst E,
et al

[There is no difference between quadriceps- and hamstring-tendon autografts in primary anterior cruciate ligament reconstruction: a 2-year, patient-reported outcome study. *Knee Surg Sports Traumatol Arthrosc.* 2014;30\(5\):593-598. doi:10.1016/j.arthro.2014.01.012.](#)

- Two-year, patient-reported outcome study
- Eighty patients were included: 40 patients with QT and 40 with hamstring tendon (HT)
- There was no significant difference between PRO scores in either QT or HT autografts. Both QT and HT show acceptable and comparable PRO scores thereby reaffirming QT as a suitable graft choice for primary ACL reconstruction.

Iriuchishima T,
Ryu K,
Okano T,
et al

[The evaluation of muscle recovery after anatomical single-bundle ACL reconstruction using a quadriceps autograft. *Knee Surg Sports Traumatol Arthrosc.* 2017;25\(5\):1449-1453.](#)

doi:10.1007/s00167-016-4124-z.

- Twenty patients were included in the study and were evaluated for muscle recovery at pre-op, and at 3, 6, 9, and 12 months post-op
- Authors found that ACL reconstruction using QT resulted in equivalent level of muscle recovery and knee stability when compared with previously reported ACL reconstruction using hamstring tendon
- No reported donor site complications

Martin-Alguacil JL,
Arroyo-Morales M,
Martin-Gomez JL,
et al

[Strength recovery after anterior cruciate ligament reconstruction with quadriceps tendon versus hamstring tendon autografts in soccer players: a randomized controlled trial. *Knee.* 2018;25\(4\):704-714. doi:10.1016/j.knee.2018.03.011.](#)

- Fifty-six patients were enrolled in randomized controlled trial and placed into either the HT or QT group
- ACLR with QT graft demonstrated similar functional results with a better isokinetic hamstring/quadriceps ratio compared with ACLR with HT graft

Karkosch RF,
Ettinger M,
Bachmaier S,
Wijdicks CA,
Smith T

Shani RH,
Umpierrez E,
Nassert M,
Hiza EA,
Xerogeanes J

Sasaki N,
Farraro KF,
Kim KE,
Woo SL

Stäubli HU,
Schatzmann L,
Brunner P,
Rincón L,
Nolte LP

Ashford WB,
Kelly TH,
Chapin RW,
Xerogeanes JW,
Slone HS

In Vitro Studies: Biomechanical Validation

Adjustable-length loop cortical button versus interference screw fixation in quadriceps tendon anterior cruciate ligament reconstruction: a biomechanical in vitro study. *Clin Biomech.* 2018;60:60-65. doi:10.1016/j.clinbiomech.2018.10.001.

- Biomechanical cadaveric in vitro study evaluated and compared the “dynamic elongation behavior and ultimate failure strength of tibial adjustable-length loop cortical button versus interference screw fixation in quadriceps tendon-based anterior cruciate ligament reconstruction”.
- Tibial interference screw fixation showed no statistically significant differences in the initial, dynamic, and total elongation compared to adjustable-loop device fixation.
- Quad tendon ACLR using a tibial adjustable-loop cortical button “provides for comparable dynamic stabilization of the knee with increased ultimate failure-load at decreased stiffness compared to screw fixation”.

Biomechanical comparison of quadriceps and patellar tendon grafts in anterior cruciate ligament reconstruction. *Arthroscopy.* 2016;32(1):71-75. doi:10.1016/j.arthro.2015.06.051.

- Quantified the structural and material properties of 10 mm sections of QT and BPTB grafts
- Cross-sectional area of QT graft was nearly twice that of BPTB graft
- Biomechanical properties were significantly higher for QT vs BPTB as measured by ultimate load and stiffness. Variability in cross-sectional area was similar in both graft choices.
- Reaffirms that QT is suitable option for ACL reconstruction

Biomechanical evaluation of the quadriceps tendon autograft for anterior cruciate ligament reconstruction. *Am J Sports Med.* 2014;42(3):723-730. doi:10.1177/0363546513516603.

- Measured 6 degrees of freedom knee kinematics and in situ graft forces after ACL reconstruction with QT graft compared with quadrupled semitendinous and gracilis (QSTG) graft
- Ten cadaveric knees were tested in 3 conditions: ACL intact, ACL deficient, and ACL reconstructed
- There were no significant differences between the grafts under any experimental condition
- Supports the use of QT autograft for ACL as it could restore knee function immediately

Mechanical tensile properties of the quadriceps tendon and patellar ligament in young adults. *Am J Sports Med.* 1999;27(1):27-34. doi:10.1177/03635465990270011301.

- Analyzed biomechanical properties of 16 full thickness QT and patellar ligament (PL) grafts from paired knees
- Preconditioned PL grafts exhibited significantly higher elastic modulus than QT grafts
- The QT construct may represent a versatile alternative graft in primary and revision ACL and PCL reconstruction

Anatomy and Graft Characteristics

Predicted quadriceps vs quadrupled hamstring tendon graft size using 3-dimensional MRI. *Knee.* 2018; pii:S0968-0160(18)30354-5. doi:10.1016/j.knee.2018.08.001.

- A retrospective review of 54 knee 3D MRIs was conducted to compare the cross-sectional area and diameter between the quadriceps (QT) and quadrupled hamstring (HS) tendon autografts and to assess the predicted size of the QT tendon graft in patients with insufficient HS autografts.
- It was determined that the mean cross-sectional area of the QT and quadrupled HS tendon grafts were 84.4 mm² and 47.2 mm² respectively. A statistically significant positive correlation exists between quadrupled hamstring graft and quadriceps tendon graft cross-sectional area.

Todd DC,
Ghasem AD,
Xerogeanes JW

- All 54 patients had predicted QT grafts diameters > 8 mm. However, 17% of these same patients were predicted to have insufficient quadrupled HS grafts for successful ACLR. Therefore, quadriceps tendon grafts are a viable alternative in patients at risk for insufficient quadrupled hamstring grafts.

Height, weight, and age predict quadriceps tendon length and thickness in skeletally immature patients. *Am J Sports Med.* 2015;43(4):945-952. doi:10.1177/0363546515570620.

- Cross-sectional study to determine whether QT length and thickness follow a predictable pattern
- Height, weight, age, and sex of 151 children between 4 and 16 years of age were recorded. Ultrasound was used to measure the length and thickness of bilateral QT.
- QT is of sufficient length and thickness to be used for pediatric patients. The size of the graft is predictable using age, height, and weight of patient. Ultrasound can be used to confirm graft length and thickness.

Xerogeanes JW,
Mitchell PM,
Karasev PA,
Kolesov IA,
Romine SE

Anatomic and morphological evaluation of the quadriceps tendon using 3-dimensional magnetic resonance imaging reconstruction: applications for anterior cruciate ligament autograft choice and procurement. *Am J Sports Med.* 2013;41(10):2392-2399. doi:10.1177/0363546513496626.

- MRI study of 60 patients to determine if QT had the anatomical characteristics to produce a graft that had length and volume that is adequate, reproducible, and predictable vs other grafts
- Authors found that QT has the anatomic characteristics to produce a graft whose length and volume are reproducible and predictable with greater intra-articular volume than patellar tendon grafts

Hadjicostas PT,
Soucacos PN,
Berger I,
Koleganova N,
Paessler HH

Comparative analysis of the morphologic structure of quadriceps and patellar tendon: a descriptive laboratory study. *Arthroscopy.* 2007;23(7):744-750. doi:10.1016/j.arthro.2007.01.032.

- Comparative laboratory study to analyze the morphologic structure of quadriceps and patellar tendon
- Quadriceps and patellar tendons from 20 cadavers were harvested and evaluated by light and electron microscopy, immunohistochemistry, and morphometry
- Found that QT graft may provide up to 20% more collagen than patellar tendon graft with same thickness, which may provide greater ultimate strength

Todor A,
Nistor D,
Roman M,
et al

Autograft options for ACL reconstruction. Which is best? *Journal of Interdisciplinary Medicine.* 2017;2(S3):32-34. doi:org/10.1515/jim-2017-0042.

- Short review of ACL autograft options highlighting the main characteristics and clinical data for each autograft
- Concluded that autografts provide similar functional outcomes. Quadriceps tendons are versatile grafts with similar results to BTB but with less donor site morbidity.

Systematic Reviews and Meta-analysis

Kanakamedala AC,
de Sa D,
Obioha OA,
et al

No difference between full thickness and partial thickness quadriceps tendon autografts in anterior cruciate ligament reconstruction: a systematic review. *Knee Surg Sports Traumatol Arthrosc.* 2018. doi:10.1007/s00167-018-5042-z.

- A systematic review compared outcomes and complication profiles of ACLR between full thickness and partial thickness quadriceps tendon autografts.
- Twenty studies met the inclusion/exclusion criteria. "Due to heterogeneous reporting, data were not combined in a meta-analysis and were summarized descriptively."

Hurley ET,
Calvo-Gurry M,
Dan Withers,
Farrington SK,
Moran R,
Moran CJ

Belk JW,
Kraeutler MJ,
Marshall HA,
Goodrich JA,
McCarty EC

Slone HS,
Romine SE,
Premkumar A,
Xerogeanes JW

Mulford JS,
Hutchinson SE,
Hang JR

- “There appeared to be no difference in outcomes or complications between either FT-Q or PT-Q in primary ACL-R. Moreover, primary ACL-R using QT autografts appears to have successful outcomes with a low rate of graft failure, irrespective of tendon thickness. While further comparative studies are needed to better delineate the optimal thickness of quadriceps tendon for primary ACL-R, these data suggest that, in primary ACL-R, either FT-Q or PT-Q is efficacious and, in the clinical setting, surgeons may be justified in using either graft thickness.”

Quadriceps tendon autograft in anterior cruciate ligament reconstruction: a systematic review. *Arthroscopy*. 2018;34(5):1690-1698. doi:10.1016/j.arthro.2018.01.046.

- Systematically reviewed current evidence to ascertain whether QT is a viable option for ACLR
- Identified 15 clinical trials with 1910 patients
- In all studies, QT resulted in lower anterior knee pain than BPTB. No difference in graft rupture between QT and BPTB or HT in any of the reported studies.
- Concluded that current literature suggests QT is a viable option in ACLR

Quadriceps tendon autograft for primary anterior cruciate ligament reconstruction: a systematic review of comparative studies with minimum 2-year follow-up. *Arthroscopy*. 2018;34(5):1699-1707. doi:10.1016/j.arthro.2018.01.047.

- Systematic review of the literature compared outcomes of patients undergoing primary ACLR with a quadriceps tendon autograft vs BPTB or HT tendon autograft.
- Authors found that patients undergoing primary ACLR with QT, HT, or BPTB can all be expected to experience improved clinical outcomes.
- QT patients experienced less knee laxity postoperatively compared with HT patients, although no significant differences in graft failure rate were found.

Quadriceps tendon autograft for anterior cruciate ligament reconstruction: a comprehensive review of current literature and systematic review of clinical results. *Arthroscopy*. 2015; 31(3):541-554. doi:10.1016/j.arthro.2014.11.010.

- Literature review and systematic review of clinical results of quadriceps tendon autograft for ACL reconstruction
- Performed comprehensive review of literature regarding anatomy, histology, and biomechanical studies of QT for ACLR
- Concluded that use of QT for ACLR is supported by the current orthopedic literature. It is a safe, reproducible, and versatile graft for ACLR.

Outcomes for primary anterior cruciate reconstruction with the quadriceps autograft: a systematic review. *Knee Surg Sports Traumatol Arthrosc*. 2013;21(8):1882-1888. doi:10.1007/s00167-012-2212-2.

- A systematic review to determine the suitability of quadriceps tendon autografts for primary ACLR
- Seventeen articles met the inclusion criteria with 1580 reconstructions studied
- Concluded that QT autograft is a promising alternative for primary ACLR with good outcomes and minimal donor site morbidity

