

**DR  
ROSS  
RADIC**  
ORTHOPAEDIC  
SURGEON



# Long-term performance deficits following ACLR using hamstring tendon versus quadriceps tendon autograft

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# Disclosures

- Consultancy: Arthrex, Smith and Nephew, Zimmer Biomet, DePuy Synthes, AO Sports
- Institutional Support: Arthrex, Smith and Nephew
- Paid Presentations: Corin, Arthrex, Smith and Nephew
- Royalties: Nil
- Hold Shares in: Convergence Medical



# ACLSG St Kitts 2023



1. Kim Collins is faster than Dave Parker and Tim Spalding's sons  
(Even at 2am after copious beers)

# ACLSG St Kitts 2023



2. Brian Devitt doesn't mind a sneaky dart  
(After copious beers)

# ACLSG St Kitts 2023

## A Prospective Randomized Controlled Trial Investigating Quadriceps Versus Hamstring Tendon Autograft in Anterior Cruciate Ligament Reconstruction

Jay R. Ebert,<sup>\*1†§</sup> PhD, Nicholas D. Calvert,<sup>1§¶¶</sup> MBBS, MS, and Ross Radic,<sup>§||¶\*</sup> MD  
Investigation performed at the School of Human Sciences (Exercise and Sport Science),  
University of Western Australia, Perth, Western Australia, Australia

**Background:** Numerous graft options are available when undertaking anterior cruciate ligament (ACL) reconstruction (ACLR), although a lack of high-quality evidence exists comparing quadriceps (QT) and hamstring (HT) autografts.

**Purpose:** To investigate patient outcomes in patients undergoing HT versus QT ACLR.

**Study Design:** Randomized controlled trial; Level of evidence, 1.

**Methods:** After recruitment and randomization, 112 patients (HT = 55; QT = 57) underwent ACLR. Patients were assessed pre- and postoperatively (6 weeks and 3, 6, 12, and 24 months), with a range of patient-reported outcome measures (PROMs), graft laxity (KT-1000 arthrometer; primary outcome variable), active knee flexion and extension range of motion (ROM), peak isokinetic knee extensor and flexor strength, and a 6-hop performance battery. Limb symmetry indices (LSIs) were calculated for strength and hop measures. Secondary procedures, ACL retears, and contralateral ACL tears were reported.

**Results:** All PROMs and knee ROM measures significantly improved ( $P < .0001$ ), and no other group differences ( $P > .05$ ) were observed—apart from the Anterior Cruciate Ligament Return to Sport after Injury (ACL-RSI) score, which was significantly better in the HT group at 3 ( $P = .008$ ), 6 ( $P = .010$ ), and 12 ( $P = .014$ ) months. No significant changes were observed in side-to-side laxity from 6 to 24 months ( $P = .105$ ), and no group differences were observed ( $P = .487$ ) at 6 (HT mean, 1.2; QT mean, 1.3), 12 (HT mean, 1.1; QT mean, 1.3), and 24 (HT mean, 1.1; QT mean, 1.2) months. While the HT group demonstrated significantly greater ( $P < .05$ ) quadriceps strength LSIs at 6 and 12 months, the QT group showed significantly greater ( $P < .05$ ) hamstring strength LSIs at 6, 12, and 24 months. The HT group showed significantly greater ( $P < .05$ ) LSIs for the single horizontal (6 months), lateral (6 and 12 months), and medial (6 months) hop tests for distance. Up until 24 months, 1 patient (QT at 22 months) had a re-tear, with 2 contralateral ACL tears (QT at 19 months; HT at 23 months). Secondary procedures included 5 in the HT group (manipulation under anesthesia, notch debridement, meniscal repair, and knee arthroscopy for scar tissue) and 6 in the QT group (notch debridement, meniscal repair, knee arthroscopy for scar tissue, tibial tubercle transfer, and osteochondral autologous transplantation).

**Conclusion:** Apart from the ACL-RSI, the 2 autograft groups compared well for PROMs, knee ROM, and laxity. However, greater hamstring strength LSIs were observed for the QT cohort, with greater quadriceps strength (and hop test) LSIs in the HT cohort. The longer-term review will continue to evaluate return to sports and later-stage reinjury between the 2 graft constructs.

**Registration:** ACTRN12618001520224p (Australian New Zealand Clinical Trials Registry).

**Keywords:** anterior cruciate ligament reconstruction; clinical outcomes; hamstring autograft; knee function; quadriceps autograft; re-tear; return to sport

Anterior cruciate ligament (ACL) reconstruction (ACLR) remains the standard treatment in patients experiencing ACL injury.<sup>4,5</sup> After surgery, in those who return to sports (RTS), an ipsilateral reinjury rate of 7% has been reported, along with an 8% incidence of contralateral ACL tear.<sup>5,6</sup>

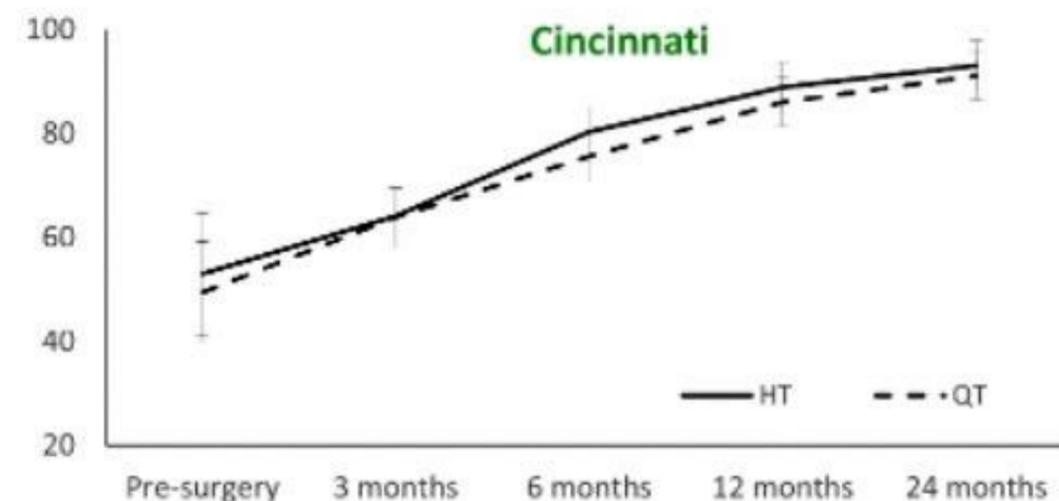
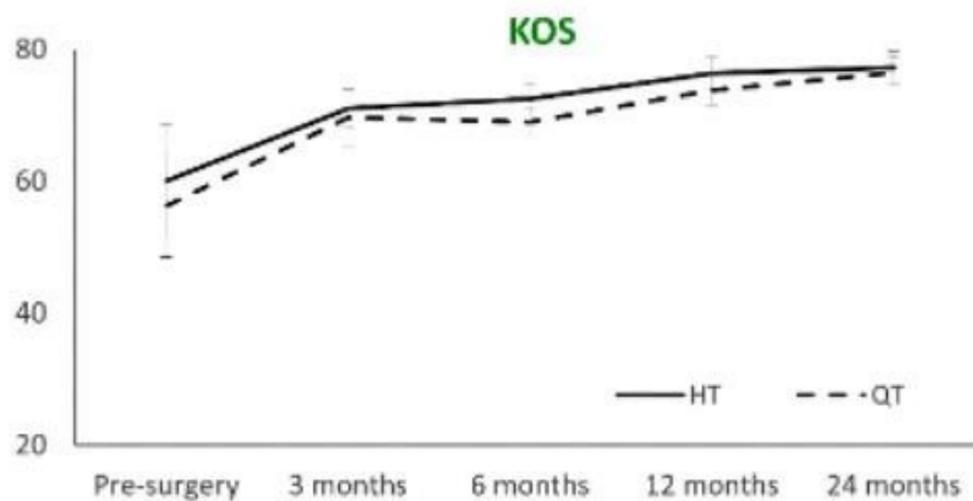
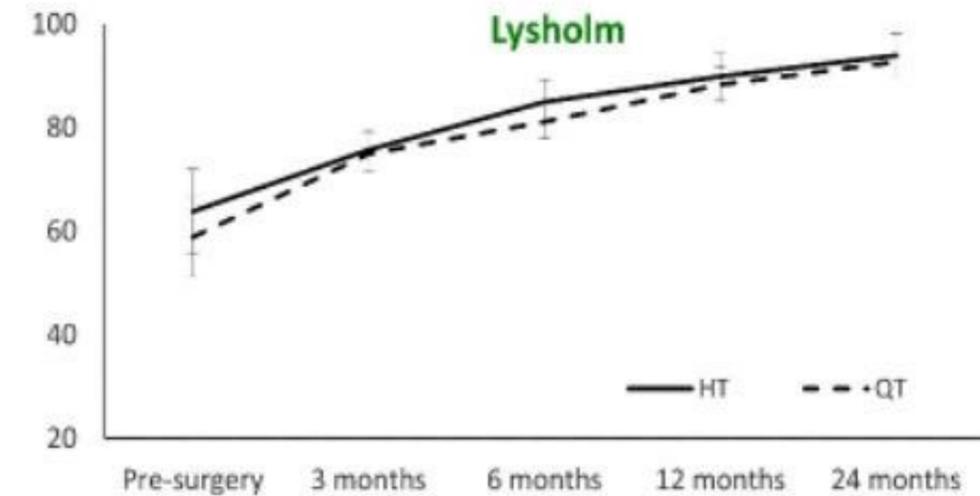
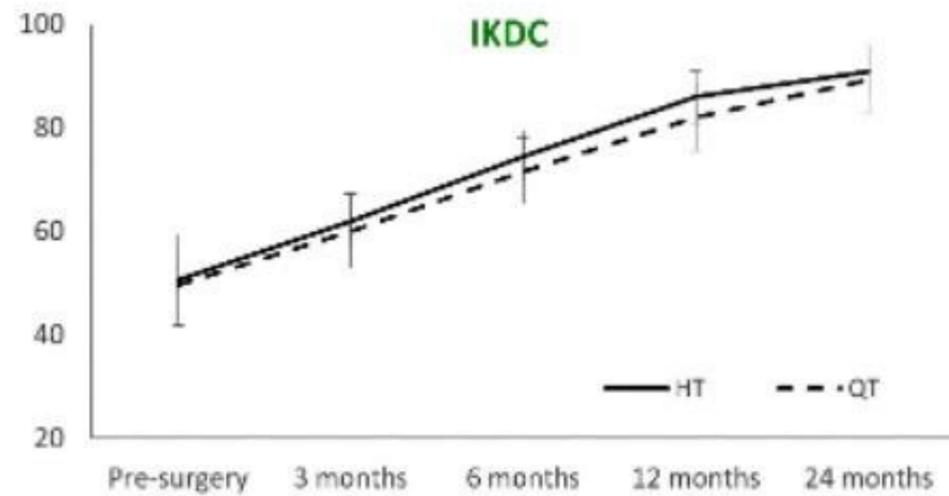
The reasons for reinjury are multifactorial<sup>4,5</sup> and may include graft failure due to inadequate graft selection and/or incorporation, surgical error, inadequate rehabilitation, and/or suboptimal recovery of lower limb strength and functional capacity. ACLR employing a hamstring tendon (HT) or bone–patellar tendon–bone (BPTB) graft has traditionally been a more common option,<sup>3,5</sup> with systematic reviews and meta-analyses generally reporting comparable clinical and functional outcomes,<sup>6,41,46</sup> inclusive of knee stability, graft failure, and patient-reported outcome



3. Quadriceps autograft is roughly similar to Hamstrings autograft in primary, ACL reconstruction

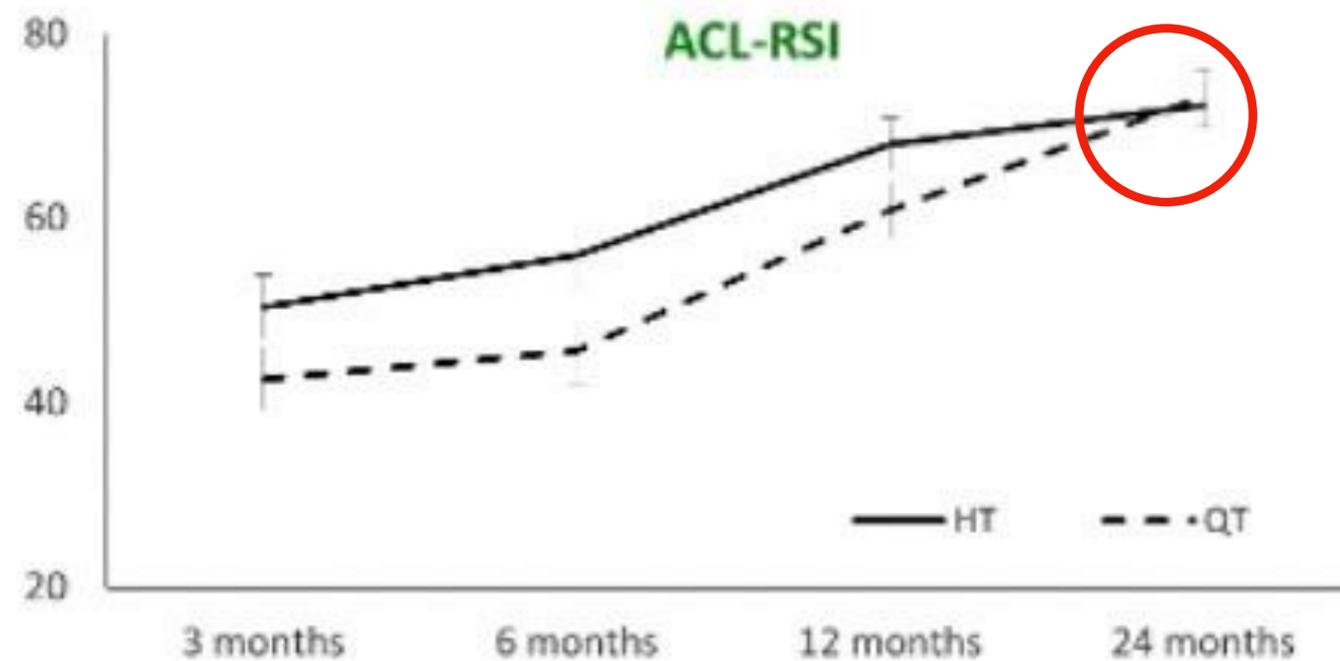
Radic and co  
AJSM 2024

# PROMs through pre- and post operative timelines



All PROMs significantly improved ( $p < 0.05$ ) over the 24-month period and, apart from a significant group effect ( $p = 0.040$ ) in the ACL-Return to Sport after Injury score, there were no further group differences.

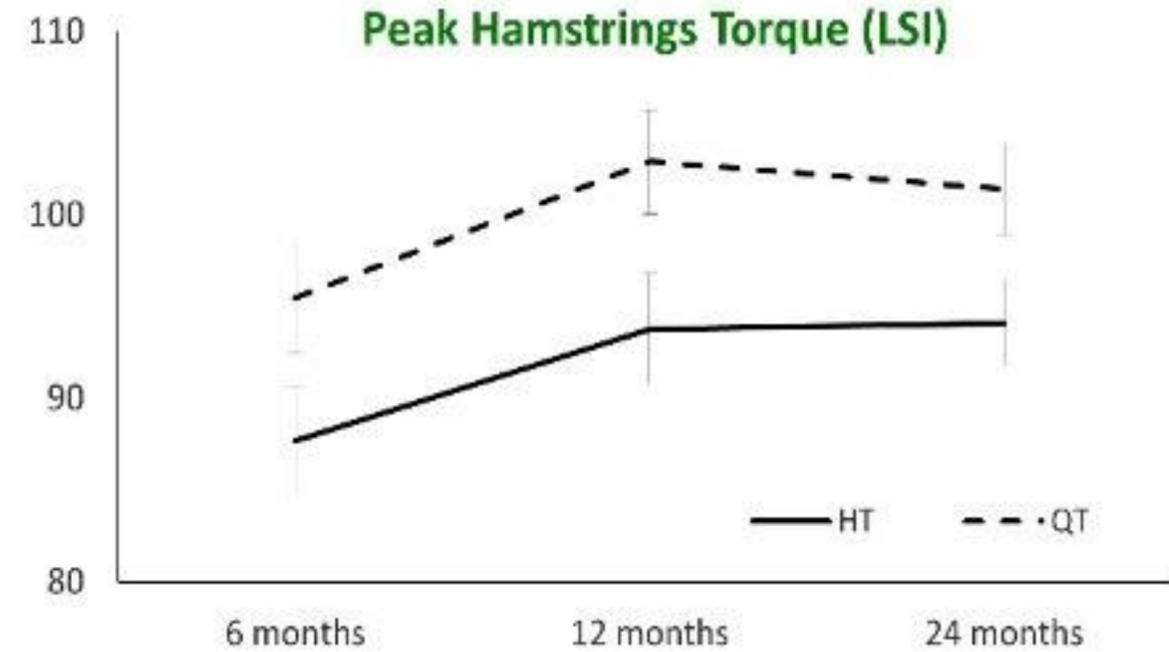
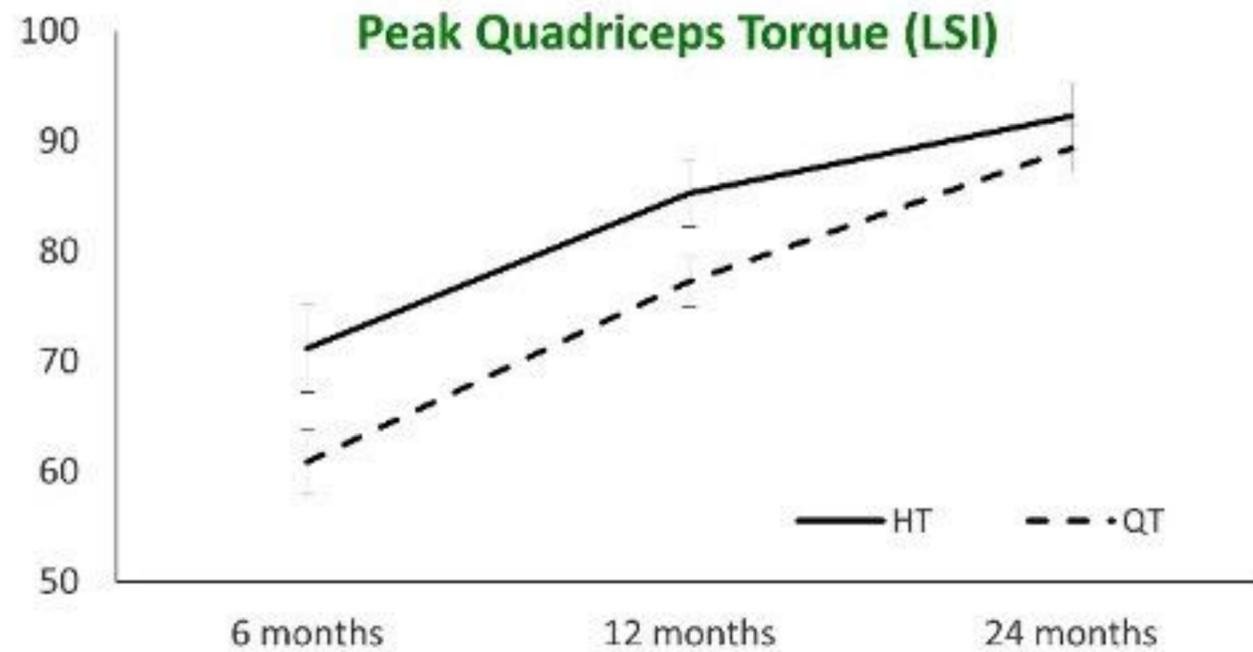
# PROMs through pre- and post operative timelines



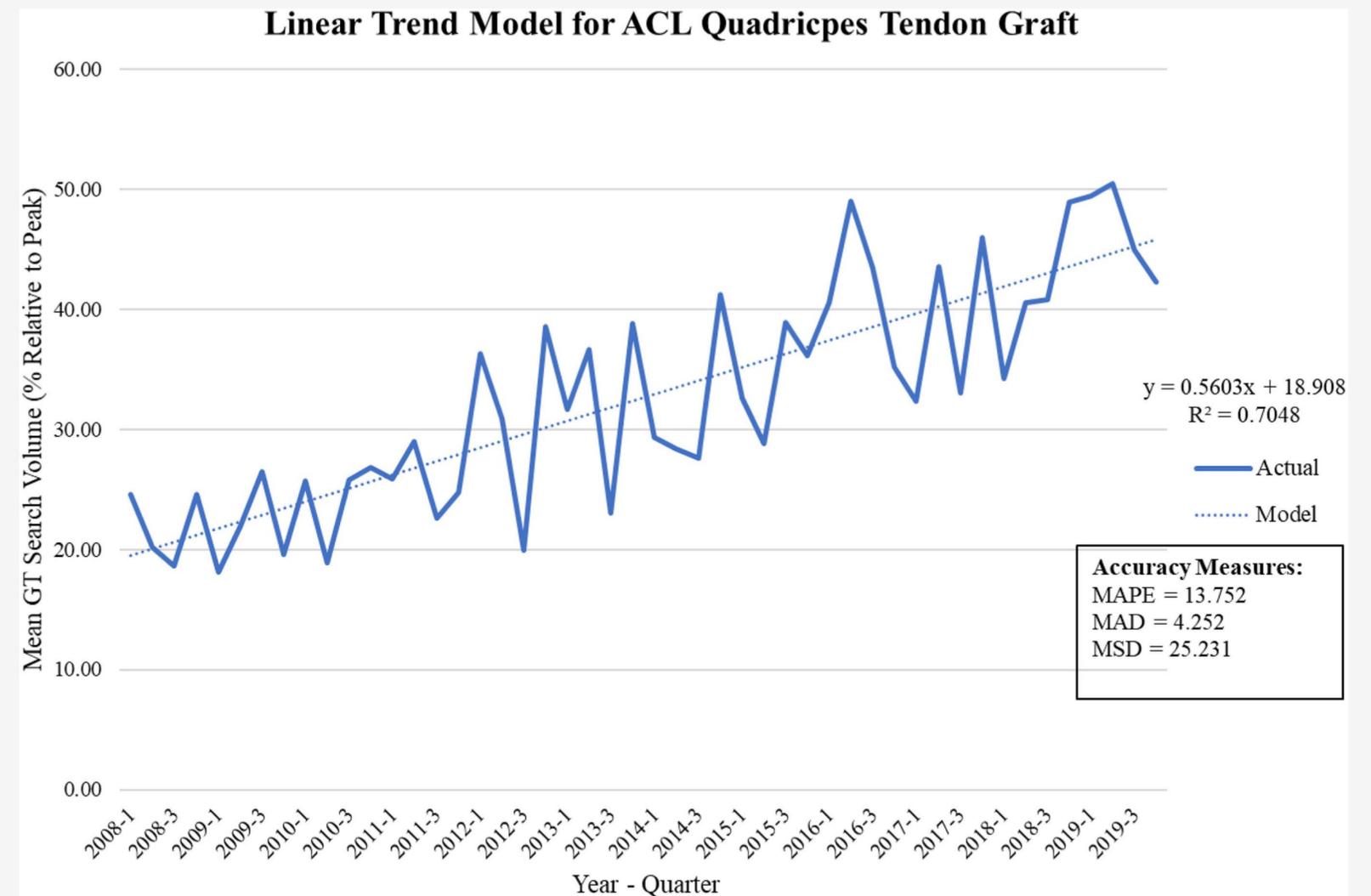
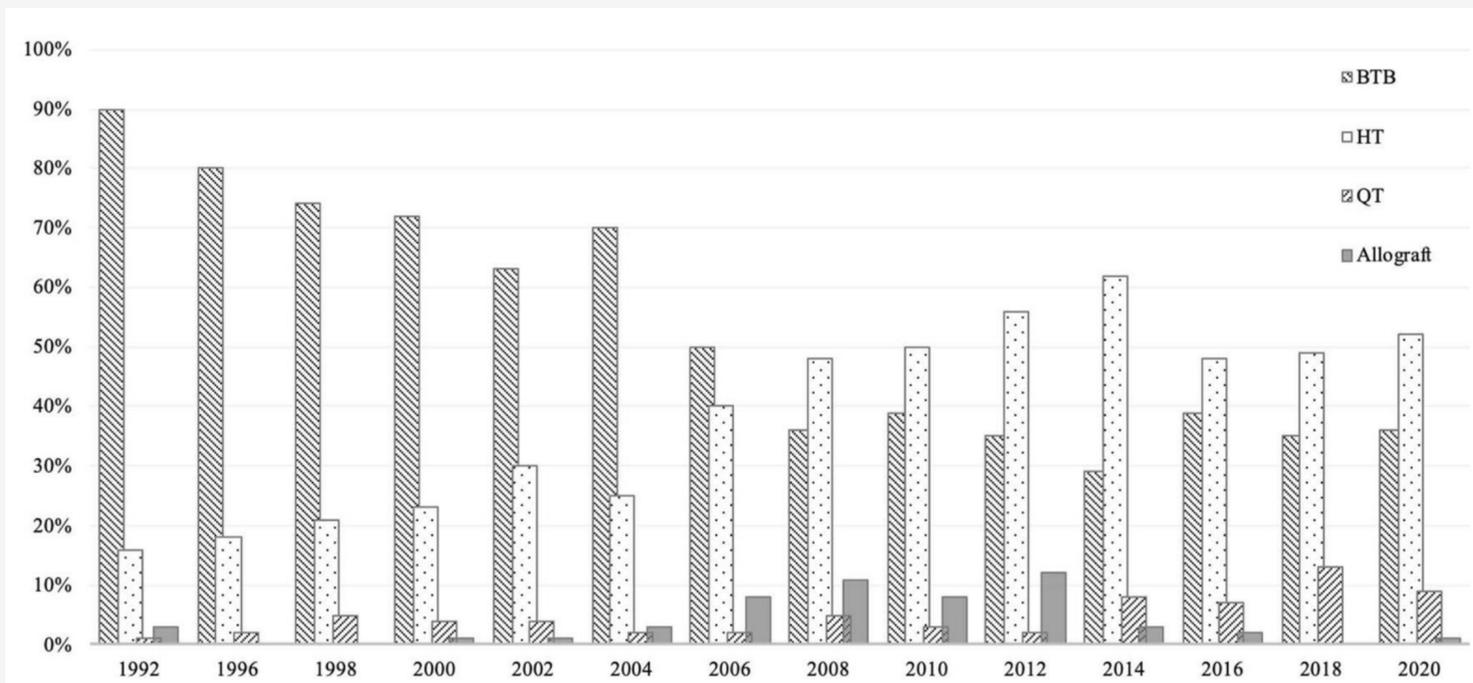
Post-hoc t-tests demonstrated a significantly better ( $p < 0.05$ ) ACL-RSI score in the HT group at 3, 6 and 12 months post-surgery.

At 24 months post-surgery there were no differences in the ACL-RSI score between HT and QT groups.

# Peak isokinetic knee extensor and flexor torque



# GRAFT CHOICE BEHAVIOURS, ACLSG



The initial graft of choice for primary ACLR was BTB autograft, which has declined since 1992; HT autografts have increased in popularity since 1992 and HT autograft is now the most common graft choice; allograft had a burst of popularity from 2006 to 2012; QT autograft has become a more common graft choice since 2014

**Age, gender, quadriceps strength and hop test performance are the most important factors affecting the achievement of a patient-acceptable symptom state after ACL reconstruction**

Stalman et al. KSSTA 2019



“to compare longer term quadriceps strength, and explosive and reactive strength asymmetries between patients having undergone ACLR with either HT or QT autografts.”

# Methods

- Secondary follow-up of a sub cohort (Ebert et al. 2024)
  - Participants between 18 and 45 having undergone primary ACLR with either HT or QT autograft.
- Clinical assessment occurred >2 years post ACLR as part of a long-term follow-up
  - IKDC
  - Peak isometric knee extensor torque (60 deg)
  - Explosive strength measured via single leg vertical jump height on force plates
  - Reactive strength measured via single leg drop Jump (jump height/ground contact time)
- Statistical analysis
  - Independent samples t tests to examine group differences between LSI scores
  - Cohen d effect size to examine magnitude of difference



# ACLR using HT or QT graft

n = 112

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Patient subset n = 30

HT = 15, QT = 15

Time = 45.5 months

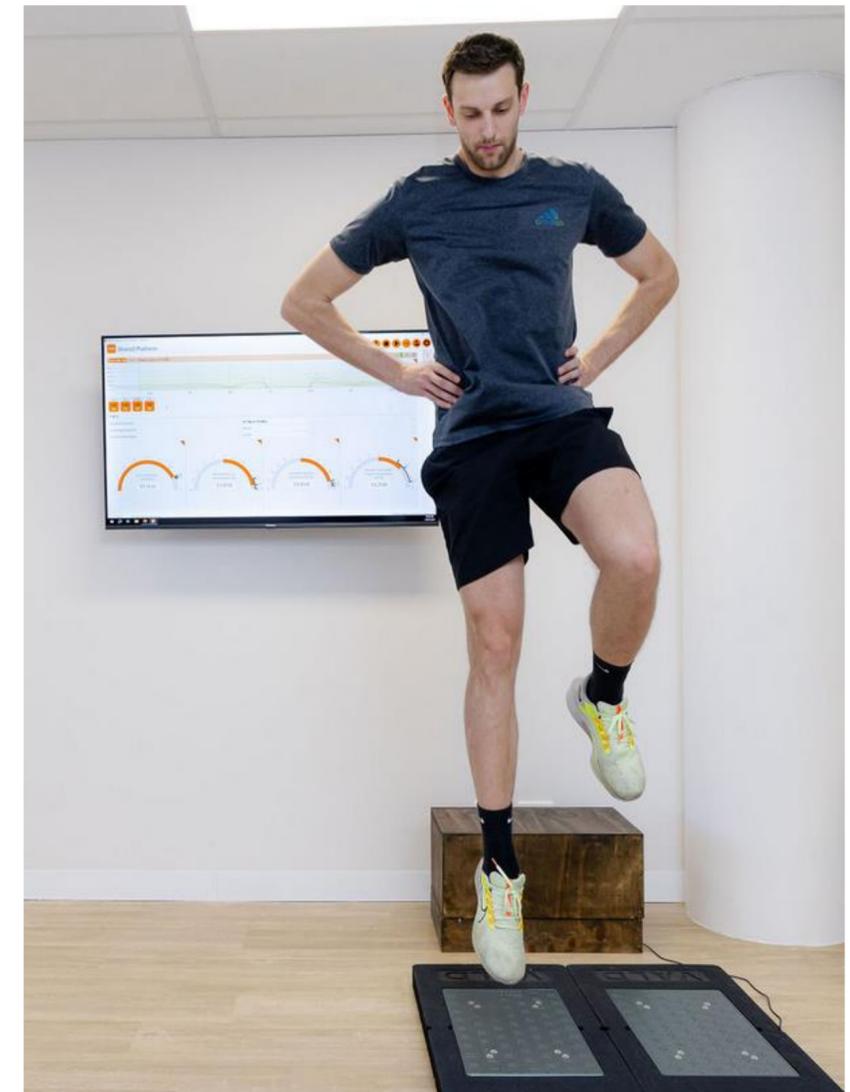
(29-55)

Absolute and LSI  
Isometric extensor  
strength

Reactive Strength  
Single Leg Drop Jump  
(SLDJ)

Explosive Strength  
Single Leg  
Countermovement  
Jump (SLCMJ)

INDEPENDENT SAMPLE T-TESTS WERE USED TO EXAMINE BETWEEN-GROUP DIFFERENCES, WHILST PAIRED SAMPLE T-TESTS EXAMINED INTER-LIMB DIFFERENCES. COHEN D EFFECT SIZES WERE CALCULATED TO INTERPRET THE MAGNITUDE OF BETWEEN-GROUP AND BETWEEN-LIMB DIFFERENCES.



# Strength qualities



Peak knee extensor torque  
Maximal strength



Single leg CMJ  
Height

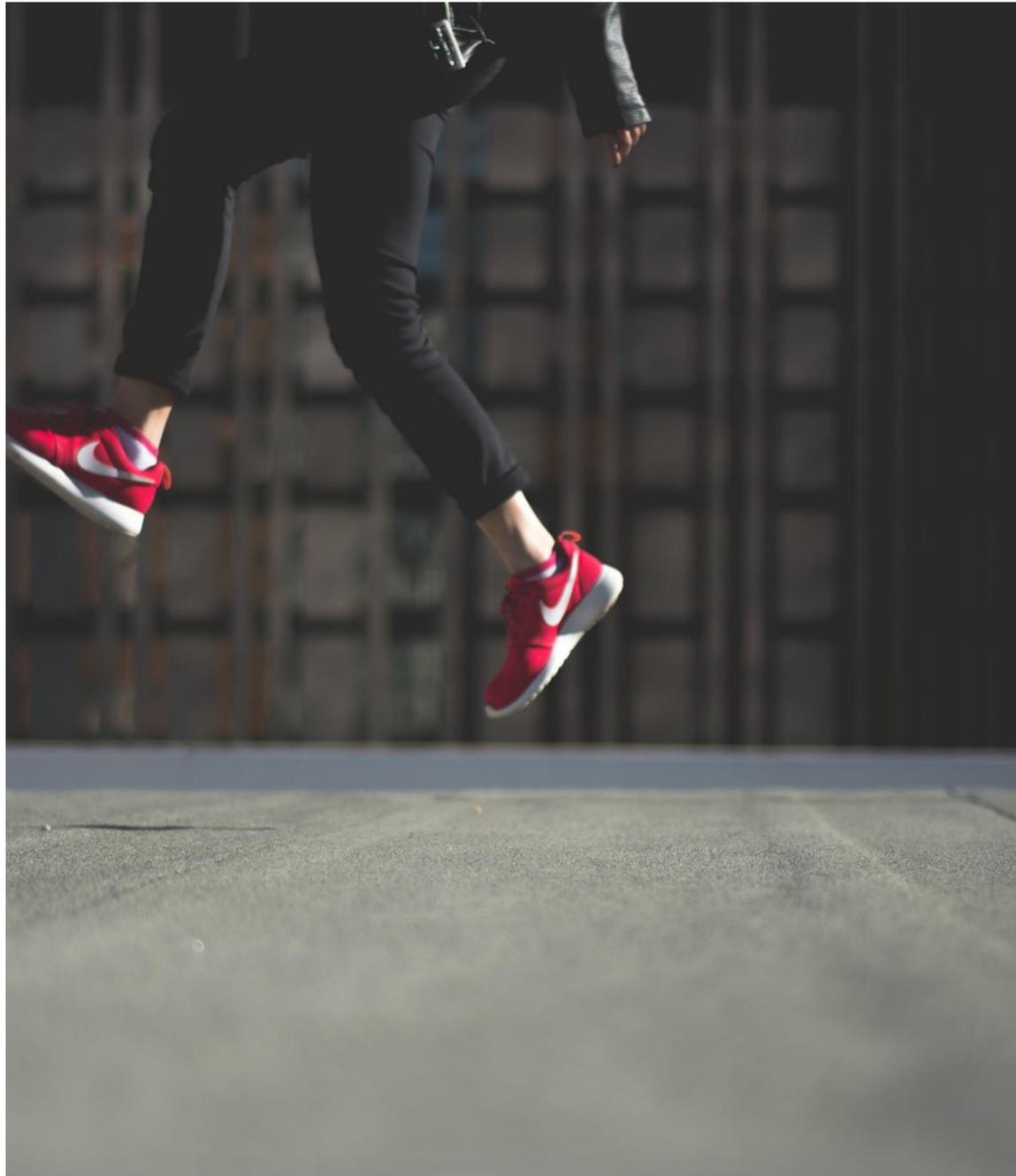


Single leg Drop Jump  
Reactive strength index

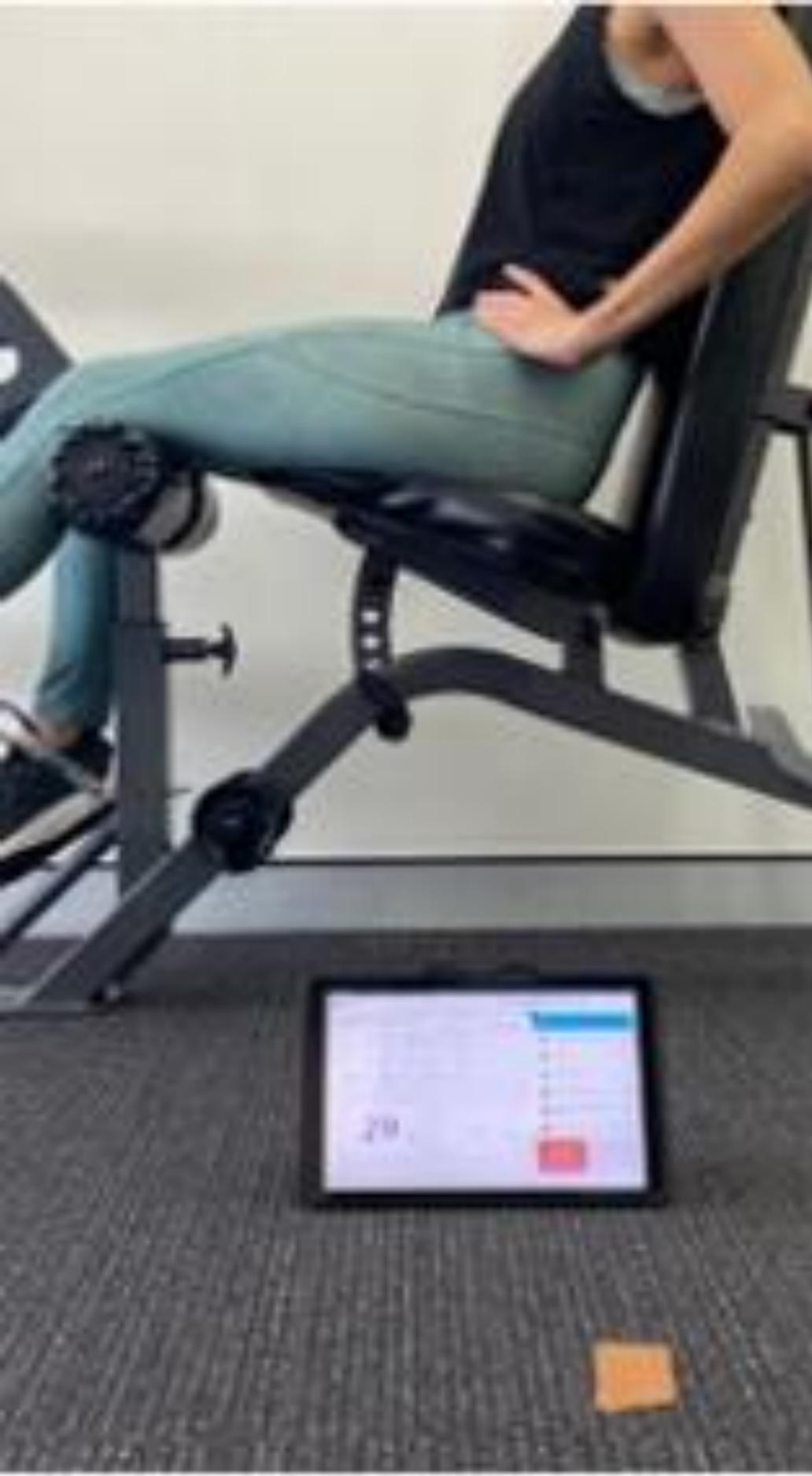
# *RESULTS*



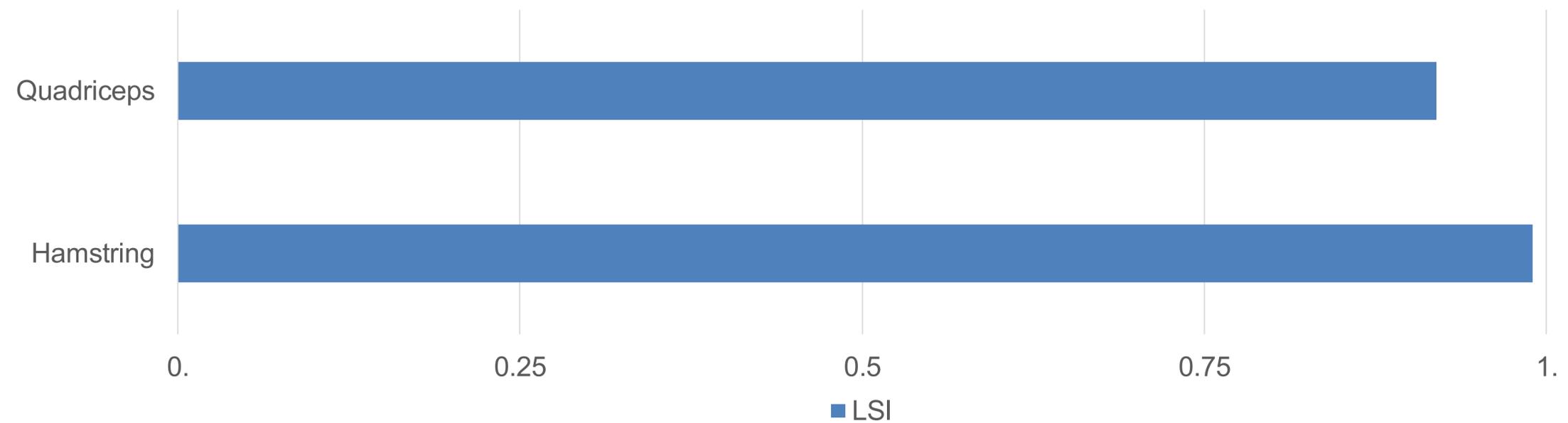
# Demographics



Graft type	HT	QT
Follow-up (months)	45.5	42.2
Sex (female)	8 (53.3%)	10 (66.6%)
Age (y)	29.2	30.7
Body Mass (kg)	80.4	74.9
IKDC	92.0 (7.3)	88.3 (9.1)



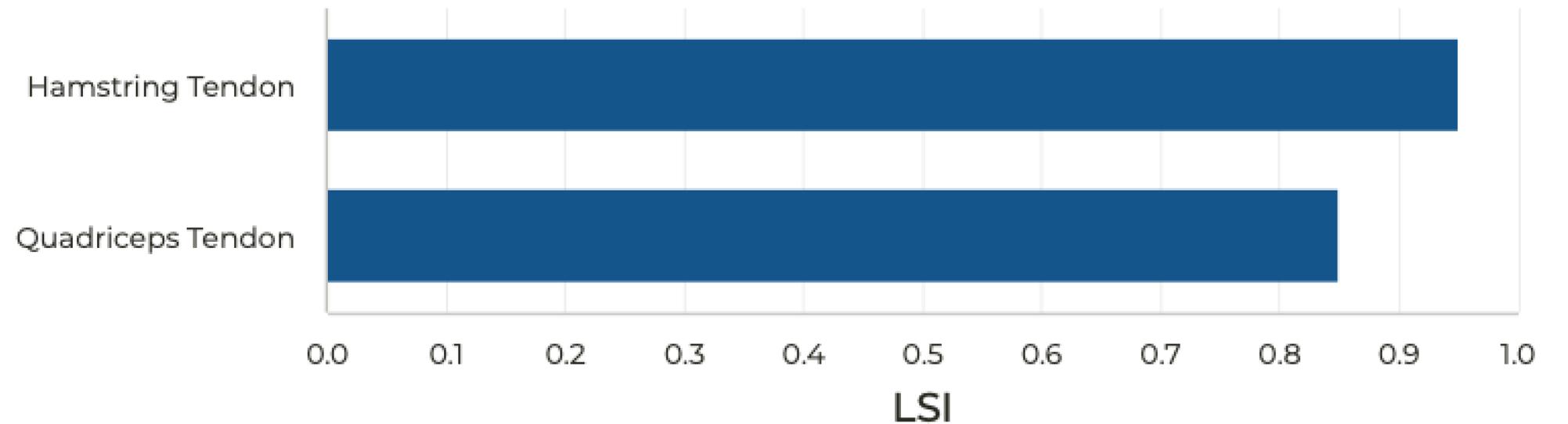
## PEAK KNEE EXTENSOR STRENGTH



- Significantly less knee extensor strength symmetry was observed in the QT group vs the HT group,  $p = 0.045$
- 14/15 in the HT group achieved  $>90\%$  LSI, vs 8/15 in the QT group
- Effect size = 0.65



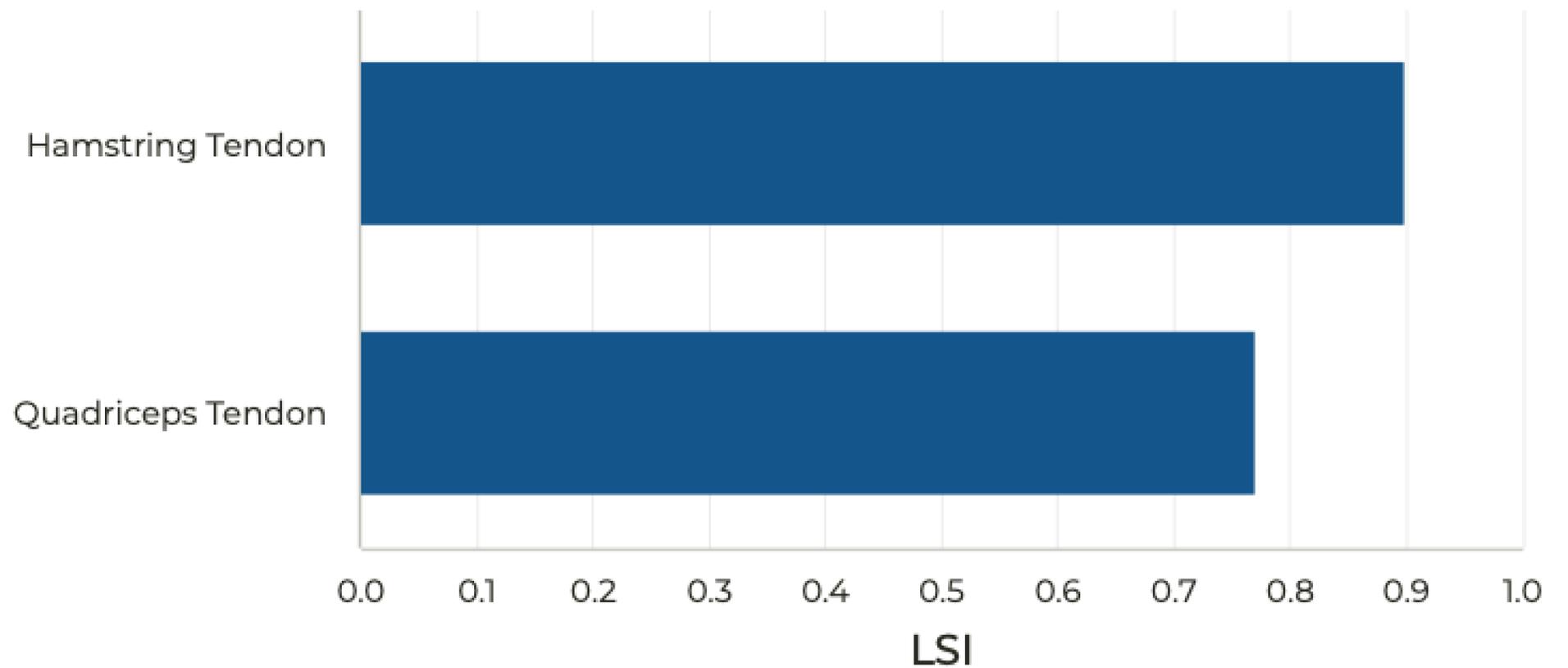
## EXPLOSIVE STRENGTH



- Significantly less single leg vertical hop explosive strength symmetry was observed in the QT group vs the HT group,  $p = 0.018$
- 12/15 in the HT group achieved  $>90\%$  LSI, vs 5/15 in the QT group
- Effect size = 0.80

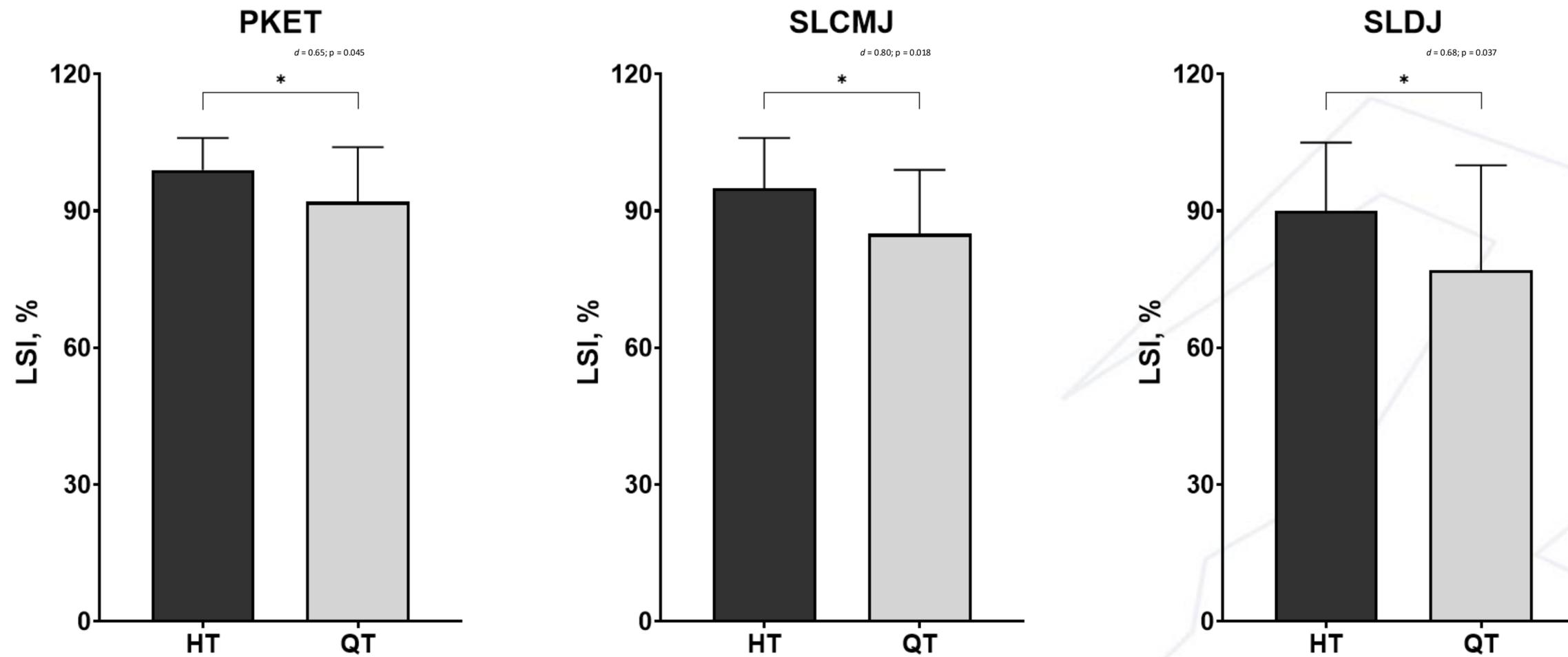


## REACTIVE STRENGTH



- Significantly less single leg drop jump reactive strength symmetry was observed in the QT group vs the HT group,  $p = 0.037$
- 6/15 in the HT group achieved  $>90\%$  LSI, vs 5/15 in the QT group
- Effect size = 0.68

# Results



- Significantly less symmetry was observed in the QT group vs the HT group for all strength and jump tests ( $p \leq 0.05$ )
- Significantly more participants in the HT group achieved  $>90\%$  LSI than the QT group for peak isometric strength and explosive strength ( $p \leq 0.05$ ), though not for reactive strength

Does gender play a role?

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DOI: 10.1002/ksa.12426

**KNEE**

Knee Surgery, Sports Traumatology, Arthroscopy **WILEY**

## Females demonstrate lower levels of activity, psychological readiness and strength symmetry after anterior cruciate ligament reconstruction than males, and also recovery of quadriceps strength and hop symmetry is delayed in females undergoing reconstruction with a quadriceps tendon autograft

Jay R. Ebert<sup>1,2,3</sup>  | Nicholas D. Calvert<sup>1,3,4,5</sup> | Ross Radic<sup>3,4,5,6</sup>

<sup>1</sup>School of Human Sciences (Exercise and Sport Science), University of Western Australia, Crawley, Western Australia, Australia

<sup>2</sup>HFRC Rehabilitation Clinic, Nedlands, Western Australia, Australia

<sup>3</sup>Perth Orthopaedic & Sports Medicine Research Institute, West Perth, Western Australia, Australia

<sup>4</sup>Department of Orthopaedics, Royal Perth Hospital, Perth, Western Australia, Australia

<sup>5</sup>Perth Orthopaedic & Sports Medicine Centre, West Perth, Western Australia, Australia

### Abstract

**Purpose:** To investigate sex-based recovery differences in patients undergoing anterior cruciate ligament reconstruction (ACLR) with a hamstring (HT) or quadriceps (QT) tendon autograft.

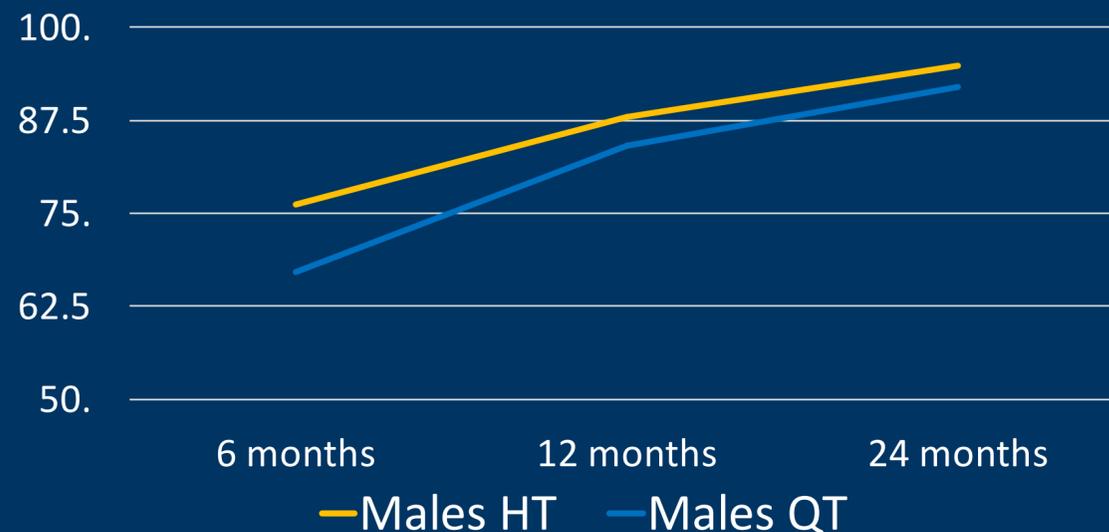
**Methods:** This study included 97 patients, including 50 females (HT = 25, QT = 25) and 47 males (HT = 24, QT = 23), assessed presurgery and at 12- and 24-month postoperatively via surveys, laxity, isokinetic knee extensor and flexor torque and a 6-hop performance battery. Limb symmetry indices (LSIs) were calculated. Outcomes were compared between males and females, as well as within each graft type.

**Results:** Males reported significantly higher Torque scores at 12 ( $p = 0.020$ )

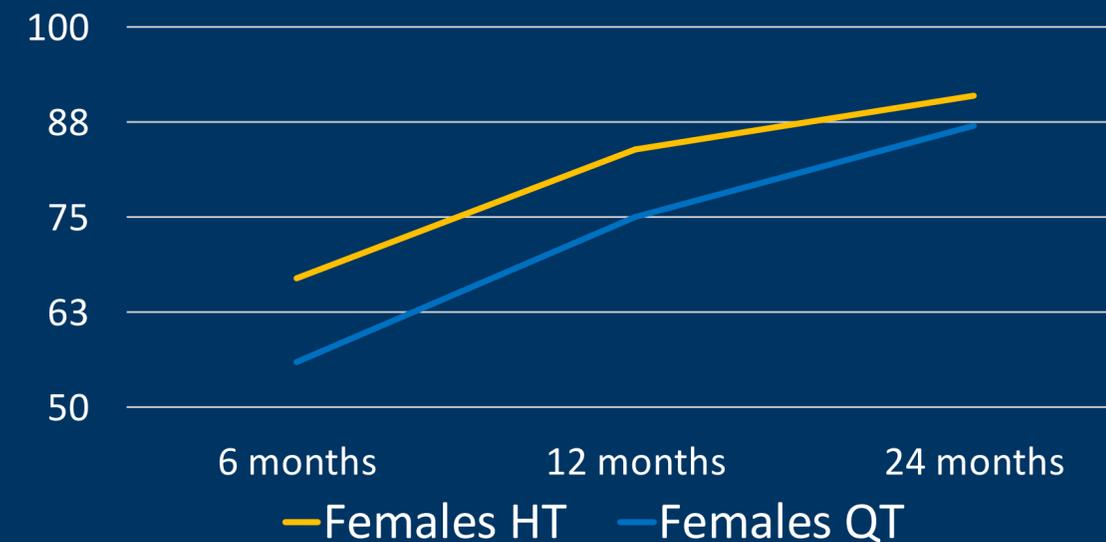
# Does gender play a role?



## Male Knee Extensor Torque LSI



## Female Knee Extensor Torque LSI



**Delayed quadriceps recovery in women with quadriceps graft**

# CONCLUSIONS

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QT autografts exhibit inferior long-term isometric strength, explosive strength and reactive strength compared to HT autografts.

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Athletic patients and males tend to tolerate quads grafts well/better, but wary of their utilisation in younger females and the non-athletic population

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Clinicians and allied health professionals should consider graft type in ACLR and subsequent rehabilitation to enhance outcomes