BS Structured Summary

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Artigo original: Risk of Revision and Reoperation After ACL Reconstruction: Comparison of Quadriceps Tendon, Patellar Tendon, and Hamstring Autografts Stratified by Patient Sex and Age: A Cohort Study of 27,715 Patients From 2012 to 2023

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Study Objective

The primary objective of this study was to evaluate the risk of subsequent surgical outcomes, specifically revision and ipsilateral reoperation, after primary anterior cruciate ligament reconstruction (ACLR) based on autograft selection (quadriceps tendon [QT], patellar tendon [PT], or hamstring tendon [HT]). A key aspect of the study was to stratify these risks by patient sex and age, addressing a recognized gap in the existing literature regarding graft selection outcomes in specific demographic subgroups. The authors hypothesized that differences in outcomes based on graft type would vary according to patient sex and age.

Main Methodology

This was a large-scale retrospective cohort study utilizing data from the Kaiser Permanente ACLR Registry (ACLRR) between 2012 and 2023.

Patient Cohort: A total of 27,715 patients who underwent primary isolated single-bundle autograft ACLR were included. Patients with same-day bilateral ACLR or documented prior procedures in the same knee were

excluded.

Exposure of Interest: The primary exposure was the type of autograft used: QT, PT, or HT. Graft selection was determined by mutual agreement between the patient and surgeon.

Outcomes of Interest:

- **Primary Outcome:** Aseptic graft revision, defined as surgery to remove and replace the original graft for non-infectious reasons.
- **Secondary Outcome:** Ipsilateral aseptic reoperation, defined as any surgery for non-infectious reasons after primary ACLR where the graft was left intact. Specific reoperation reasons analyzed included stiffness (arthrofibrosis or cyclops lesion), extensor disruption (patellar fracture, QT/PT rupture), meniscal reasons, and cartilage reasons.

Data Collection and Follow-up: Data were prospectively collected into the ACLRR from intraoperative forms, electronic health records (EHR), administrative claims, and other registries. Subsequent surgical interventions were monitored longitudinally using EHR screening algorithms and manually validated. The median follow-up for the overall cohort was 4.7 years, with a maximum of 12 years. Follow-up for comparisons involving QT ACLR was restricted to within 5 years due to lower numbers of QT procedures at longer follow-up times.

Statistical Analysis:

- Descriptive statistics (means, standard deviations, frequencies, proportions) were used for patient and procedure covariates.
- Multivariable Cox proportional hazards regression models were employed to evaluate the risk for revision and reoperation, adjusting for potential confounders including patient factors (age, BMI, race/ethnicity, smoking status, ASA classification, activity at injury, prior contralateral ACLR) and procedure factors (cartilage injury, meniscal injuries, tunnel drilling technique, operative time).
- Analyses were stratified by patient sex and age to assess effect modification. Age stratification was generally based on <22 years and ≥22 years, or <25 years and ≥25 years, depending on the specific comparison and outcome.

Key Results:

The study revealed significant differences in revision and reoperation risks across graft types, particularly when stratified by patient sex and age

- **QT vs. PT ACLR:**
  - No significant differences were found in revision or reoperation risks between QT and PT ACLR across all sex and age groups.

- **QT vs. HT ACLR:**

- **Females < 22 years:** QT was associated with a significantly *lower* revision risk compared to HT (Hazard Ratio [HR], 0.45; 95% CI, 0.22-0.92). This implies HT had a 2.2 times higher revision risk than QT in this subgroup.

- **Males < 22 years:** QT was associated with a *higher* risk of reoperation for stiffness (HR, 3.12; 95% CI, 1.00-9.72) and cartilage issues (HR, 3.65; 95% CI, 1.28-10.44) compared to HT.

- **Males ≥ 22 years:** QT was associated with a *higher overall reoperation risk* compared to HT (HR, 1.59; 95% CI, 1.06-2.40).

- **PT vs. HT ACLR:**
  - **Females < 22 years:** PT had a significantly *lower* risk of revision compared to HT (HR, 0.57; 95% CI, 0.43-0.75). This indicates HT had a 1.75 times higher revision risk than PT in this subgroup. However, PT was associated with a *higher stiffness reoperation risk* (HR, 1.58; 95% CI, 1.11-2.25).
  - **Males ≥ 22 years:** PT was associated with *higher overall reoperation* (HR, 1.39; 95% CI, 1.12-1.73) and *stiffness reoperation* (HR, 1.56; 95% CI, 1.10-2.21) risks compared to HT.

Conclusions and Clinical Implications:

The study concludes that the choice of autograft for primary ACLR significantly impacts the risk of revision and reoperation, with these risks varying considerably based on patient sex and age.

- **Young Females (<22 years):** Hamstring tendon (HT) autograft was associated with a substantially higher risk of revision compared to both quadriceps tendon (QT) (2.2 times higher) and patellar tendon (PT) (1.75 times higher) autografts. This is a critical finding, suggesting that QT and PT may offer superior graft survival in this high-risk demographic.

- **No Difference Between QT and PT for Revision:** Across all groups, no significant differences in revision risk were observed between QT and PT autografts.
- **Reoperation Risks Vary:** The risk for ipsilateral reoperation, particularly for stiffness, showed complex variations. QT and PT autografts were associated with higher stiffness reoperation risks in certain male age groups compared to HT. For instance, young males (<22 years) receiving QT had higher stiffness and cartilage reoperation risks, and older males (≥22 years) receiving QT or PT had higher overall reoperation risks compared to HT.

Clinical Implications:
This large-registry study provides valuable, granular data that should inform shared decision-making between surgeons and patients.

1. **Graft Selection in Young Females:** For young female patients, the data strongly suggest that HT autografts carry a higher revision risk compared to QT or PT autografts. Surgeons should carefully consider this when discussing graft options with this specific patient population, potentially favoring QT or PT to minimize revision rates.
2. **Balancing Revision and Reoperation Risks:** While QT and PT may offer better revision rates in young females, they might be associated with higher risks of specific reoperations (e.g., stiffness) in other demographic groups, particularly males. This highlights the need for a nuanced discussion about the full spectrum of potential complications with each graft type.
3. **Personalized Approach:** The findings underscore the importance of a personalized approach to ACLR graft selection, moving beyond a "one-size-fits-all" strategy. Patient-specific factors like age, sex, activity level, and individual preferences, alongside these new risk profiles, should guide graft choice.
4. **Further Research:** The observed higher reoperation risks for stiffness and cartilage issues with QT and PT in certain male subgroups warrant further investigation into the underlying biomechanical or biological reasons for these differences.

In summary, this study provides compelling evidence that patient sex and age are crucial modifiers of outcomes following ACLR with different autograft types, particularly highlighting the increased revision risk associated with HT autografts in young female patients.
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