ACL reconstruction with hamstring autograft utilizing independent femoral tunnel drilling yields low failure rates: analysis of 2,711 cases from over 10 years

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INTRODUCTION:

Graft choice in anterior cruciate ligament reconstruction (ACLR) is frequently based upon patient age, activity level, lifestyle factors, perceived risk of reinjury, and surgeon preference. Patellar tendon and more recently quadriceps tendon autografts are common options in the United States but hamstring autografts are more commonly utilized worldwide. Prior studies based in the U.S. have indicated that hamstring autograft reconstructions demonstrate higher risk for retears compared to other autograft reconstructions while studies from international registries report low failure rates with hamstring autograft. Further, modern techniques for anatomic ACL reconstruction using independent femoral tunnel drilling may yield greater stability than previous transtibial drilling techniques. Thus, further clarity is needed regarding the revision rates of ACLR, particularly with hamstring autograft utilizing independent femoral tunnel drilling in a large cohort from the United States. The purpose of this study was to review primary isolated ACL reconstructions performed at a single institution over a ten-year period using independent femoral tunnel drilling and assess the reoperation rate in patients who received hamstring autograft (HS), bone-patellar tendon-bone autograft (BTB), quad tendon autograft, and allograft.

METHODS:

Patients with first-time ACL ruptures were collected in an institutional registry beginning in 2012. All patients underwent primary, unilateral, isolated ACLR without the addition of a lateral extra-articular tenodesis (LET) or anterolateral ligament (ALL) reconstruction. Independent drilling of the femoral tunnel was performed through the anteromedial portal or in a retrograde fashion. Additional meniscus procedures were performed as indicated. Hamstring autografts and soft tissue allografts were fixed with an adjustable loop suspensory button system on the femur, and a sheathed biocomposite or PEEK interference screw on the tibia. BTB autografts were fixed with metal screws in the femur and tibia. Quad tendon autografts were secured with suspensory fixation on both the femur and tibia. The primary outcome was the incidence of revision ACLR over the recorded follow-up period. Other data collected included demographic information (age, sex, body mass index), graft size, concomitant meniscal repairs and/or debridements, and duration of clinical follow-up. Data were stratified by graft type. Analyses were performed using one-way analysis of variance (ANOVA) for continuous variables and chi-squared testing for categorical variables in R statistical programming. Additionally, a multivariate logistic regression was performed to determine the influence of graft type and size on rates of revision ACLR while controlling for patient age, gender, and BMI. A p-value less than 0.05 was considered statistically significant.

RESULTS:

A total of 2,668 patients who underwent 2,711 ACLRs between 2012 and 2023 were included (Table 1). 1,788 hamstring autografts (mean age 29.0, BMI 24.8, 51.2% male) were performed with a mean follow-up of 2.1 years. 574 allografts (mean age 41.2, BMI 25.4, 44.1% male) were performed with a mean follow-up of 2.4 years. 182 patellar tendon autografts (mean age 22.2, BMI 24.6, 64.8% male) were performed with a mean follow-up of 1.6 years. 167 quadriceps tendon autografts (mean age 18.7, BMI 25.1, 47.3% male) were performed with a mean follow-up of 1 year. The overall revision surgery rate over the recorded follow-up period was 2.2%. There was no difference in failure rates between the four cohorts as revision ACL reconstruction rates were 2.6% for allograft, 2.4% for quadriceps autograft, 2.1% for HS autograft, and 1.1% for BTB autograft (P=0.5). In the multivariable logistic regression model evaluating factors associated with ACL reconstruction failure, older age at the time of surgery was associated with decreased odds of failure (OR 0.94; 95% CI 0.91–0.98; $p < 0.001$). Female patients had lower odds of failure compared to male patients (OR 0.52; 95% CI 0.30–0.92; $p = 0.03$).

Compared to patients with a normal BMI, those who were overweight had significantly lower odds of failure (OR 0.39; 95% CI 0.19–0.83; $p = 0.01$). Obese (OR 0.46; 95% CI 0.16–1.30; $p = 0.14$) and underweight patients (OR 2.04; 95% CI 0.58–7.19; $p = 0.27$) did not show statistically significant differences (Table 2).

Graft type was significantly associated with failure risk. Compared to hamstring autografts, allografts were associated with higher odds of failure (OR 3.14; 95% CI 1.52–6.50; $p = 0.002$). No significant difference was observed for patellar tendon autografts (OR 1.71; 95% CI 0.38–7.67; $p = 0.49$) or quadriceps tendon autografts (OR 0.96; 95% CI 0.31–2.95; $p = 0.94$). Graft size was not significantly associated with failure (OR 0.89; 95% CI 0.61–1.30; $p = 0.55$) (Table 2).

DISCUSSION AND CONCLUSION:

Hamstring autografts demonstrate low failure rates comparable to BTB and QT autografts when using independent femoral tunnel drilling. Younger patient age, male sex and allograft use exhibited higher risk for revision ACLR within 2 years of ACLR.

Table 1. ACL Reconstruction Demographic Information

.	Total Cases	Total Patients	Age (STD)	Gender, Male (%)	BMI (STD)	Revision Cases (%)	Follow-up Years (STD)	Graft Size (STD) (mm)
Total Primary ACL Reconstructions	2,711	2,668	30.5 (11.4)	1,365 (50.3%)	24.9 (4.4)	59 (2.2%)	2.4 (2.8)	8.63 (0.75)
Hamstring Autograft	1,788	1757	29.0 (9.8)	915 (51.2%)	24.8 (4.3)	38 (2.1%)	2.5 (2.9)	8.49 (0.76)
Allograft	574	569	41.2 (10.3)	253 (44.1%)	25.4 (4.5)	15 (2.6%)	2.9 (3.0)	8.91 (0.57)
Patellar Tendon Autograft	182	175	22.2 (6.9)	118 (64.9%)	24.6 (3.7)	2 (1.1%)	1.8 (2.3)	8.93 (0.80)
Quadriceps Tendon Autograft	167	166	18.7 (6.0)	79 (47.3%)	25.1 (5.4)	4 (2.4%)	1.3 (0.9)	9.21 (0.67)
P-Value			**<0.001**	**<0.001**	0.036	0.497	**<0.001**	**<0.001**

*P<0.05 bolded for significance, Age in years, BMI in kg/m^2

Table 2. Multivariable Logistic Regression

Variable	OR [95% CI]	p-value
Age at Surgery (per year)	0.94 [0.91–0.98]	**0.001**
Sex		
Male	Reference	
Female	0.52 [0.30–0.92]	**0.030**
BMI Category		
Normal Weight (18.5<BMI<25)	Reference	
Overweight (25<BMI<30)	0.39 [0.19–0.83]	**0.010**
Obese (BMI >30)	0.46 [0.16–1.30]	0.140
Underweight (BMI <18.5)	2.04 [0.58–7.19]	0.270
Graft Type		
Hamstring Autograft	Reference	
Allograft	3.14 [1.52–6.50]	**0.002**
BTB Autograft	1.71 [0.38–7.67]	0.490
QT Autograft	0.96 [0.31–2.95]	0.940
Graft Size (per mm)	0.89 [0.61–1.30]	0.550

*P<0.05 bolded for significance
BMI in kg/m^2