Poster 73

MRI Prediction of Five-Strand Hamstring Autograft Size for ACL Reconstruction

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Disclosures

- Bryan Vopat reports a relationship with The University of Kansas Medical Center that includes: Altior: Stock or stock Options; American Orthopaedic Foot and Ankle Society: Board or committee member; Artelon: Paid consultant; Carbon 22: Stock or stock Options; Spinal Simplicity: Stock or stock Options

- Jeffery Randall reports a relationship with The University of Kansas Medical Center that includes: Johnson & Johnson: Stock or stock Options; Stryker: Stock or stock Options

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Background

ACL Autografts

- Options generally utilize bone-patellar tendon-bone, quadriceps tendons, or hamstring tendons grafts
- Studies have shown an association between graft diameter and rate of graft failure [1]
- Use of a five-strand hamstring autograft with two strands of gracilis tendon and three strands of semitendinosus tendon is one approach to increase graft diameter
- Pre-operative MRI has shown to be predictive of graft diameter for other hamstring and bone-patellar tendon-bone autograft options [5,6]

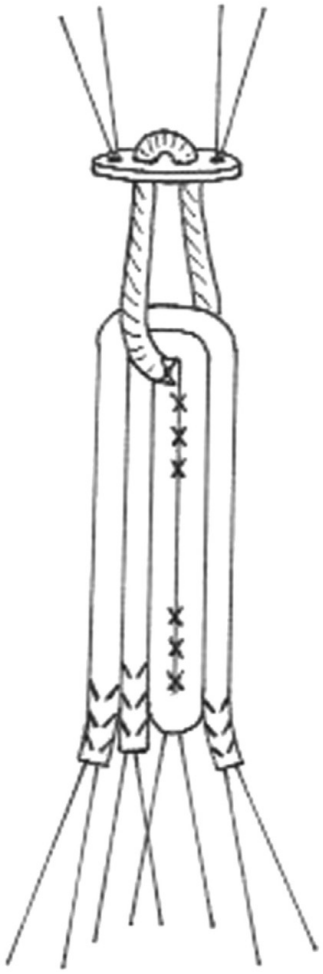

Figure 1. Lavey et al.[2] illustration of final 5-strand graft

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Objective

Determine if pre-operative MRI measurements of the cross-sectional area (CSA) of the semitendinosus and gracilis tendons accurately predicts the intra-operative graft diameter of a five-strand hamstring autograft for ACL reconstruction.

Methods

Study Design

- A retrospective chart review was performed
- **Included patients:** Patients who had undergone ACL reconstruction with a five-strand hamstring autograft by a single surgeon between September 2018 and September 2021
- **Excluded patients:** allograft or an autograft with a technique/graft selection other than a five-strand hamstring autograft technique
- **Variables:** diagnosis, procedure, graft diameter as determined by the sterile graft sizer used intraoperatively, height, weight, BMI, age, and gender
- All pre-operative knee MRI's were reviewed

Methods

Pre-operative MRI Measurements

- Pre-operative knee MRI's were reviewed by two or three reviewers
- CSAst and CSAgr were measured on the axial image at the level for which the femoral condyle was the widest, per the technique described by Wernecke et al.[3] and Grawe et al. (Included image) [4]

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Key Findings

	Graft Diameter									
	8.0mm		8.5mm		9.0mm		9.5mm		≥10.0mm	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
n	1	4	1	6	3	4	5	5	13	3
age	18.00	42.75	37.00	28.33	16.33	38.75	35.20	25.40	21.23	44.00
Height (in)	69.00	67.50	76.00	66.67	70.17	64.88	70.20	66.95	71.85	68.67
Weight (lb)	140.00	176.75	280.00	152.33	172.67	133.50	208.40	188.00	198.15	177.67
BMI	20.67	27.20	34.08	66.67	24.50	22.32	29.67	29.40	26.82	26.59
CSA Semi-T (mm^2)	11.33	12.45	14.73	12.45	15.30	13.69	16.69	16.40	13.38	11.72
CSA Gracilis (mm^2)	8.31	7.15	8.07	8.45	8.77	8.64	8.92	10.07	8.01	8.93

Demographics

- Graft diameter from 8.0 mm to 11.0 mm
- Patients ranged in age from 15 to 59 years and BMI ranged from 20.01 to 41.05
- MRI measurements of cross-sectional area (mm^2) of the semitendinosus and gracilis tendons ranged from 9.71-21.50 and 5.80-12.94, respectively.

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Key Findings

Reliability analysis

- Within-Rater reliabilities for both CSAst and CSAgr were excellent for raters 2 and 3.
- Between-Rater reliability was excellent for CSAst and good for CSAgr.

Table 1: Summary of rater reliability ICC analyses. Between-Rater reliability was assessed from within-rater averages.

		ICC	95% CI	p value
Rater 1*	CSAst	NA	NA	NA
	CSAgr	NA	NA	NA
Rater 2	CSAst	0.93	0.88-0.96	<0.001**
	CSAgr	0.87	0.79-0.92	<0.001**
Rater 3	CSAst	0.90	0.84-0.94	<0.001**
	CSAgr	0.83	0.74-0.89	<0.001**
Between-Rater	CSAst	0.86	0.77-0.93	<0.001**
	CSAgr	0.60	0.44-0.73	<0.001**

ICC: Inter Class Correlation, CI: Confidence Interval, CSAst: Semitendinosus Cross Sectional Area, CSAgr: Gracilis Cross Sectional Area. * Rater 1 only completed a single set of CSAst and CSAgr measures. ** Indicates significance at p<0.001.

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Key Findings

- An initial multiple linear regression model was created using CSAst, CSAgr, gender, age at the time of surgery, height, weight, and BMI (Adjusted R2 = 0.62, p<0.001).
- CSAst was the only significant predictor of graft diameter.
- VIF analysis showed moderate collinearity for both CSAst and CSAgr, and high collinearity for height, weight, and BMI.

Table 3: Summary of multiple linear regression models for predicting final graft diameter.

		Coefficient	p value	VIF
Model 1	Intercept	2.018		
	CSAst	0.128	0.040*	4.858
	CSAgr	0.154	0.088	4.240
	Gender, Male	0.021	0.930	2.508
	Age	-0.007	0.270	1.416
	Height	0.060	0.630	25.475
	Weight	-0.004	0.845	160.817
	BMI	0.014	0.925	110.513
Model 2	Intercept	5.324		
	CSAst	0.124	0.028*	3.902
	CSAgr	0.183	0.038*	3.902

CSAst: Semitendinosus Cross Sectional Area, CSAgr: Gracilis Cross Sectional Area, BMI: Body Mass Index, VIF: Variance Inflation Factor. * Indicates significance at p<0.05.

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Key Findings

The second multiple linear regression model was created using CSAst and CSAgr (Adjusted R2 = 0.61, $p<0.001$). Both CSAst and CSAgr were significant predictors of graft diameter. The resulting equation for determining the graft diameter based on CSAst and CSAgr is as follows:

$$[Graft\ Diameter\ (mm)] = 5.324 + 0.124*[CSAst\ (mm^2)] + 0.183*[CSAgr\ (mm^2)]$$

Conclusions

The CSA of the semitendinosus (CSAst) and gracilis (CSAgr) tendons on preoperative MRI may be used to accurately predict the graft diameter of a five-strand hamstring autograft for ACL reconstruction.

Significance

Prior studies have discussed the use of the five strand technique as a “bailout” option for an unexpected small tendon, but with adequate methods of predicting tendon size preoperatively this could be avoided. Among the patients included in this study, the five-strand technique was a planned procedure and achieved the literature recommended minimum of an 8.0 mm diameter graft.

Adequate graft diameter is a critical factor in the success of ACL reconstruction surgery with strong associations to graft failure rates and overall patient outcomes. Better preparative planning can help to avoid negative outcomes.

References

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