Reliability of Preoperative MRI in the Prediction of ACL Tear Location

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INTRODUCTION: Anterior cruciate ligament (ACL) injuries are common among active patients and can be managed with primary repair or reconstruction. The most important predictor of good outcomes following primary repair is the tear location from proximal to distal and length of remnant stump tissue. Magnetic resonance imaging (MRI) is used by surgeons to guide pre-operative decision making. While MRI has robust sensitivity for diagnosing complete ACL ruptures, its accuracy in identifying precise tear location is understudied. The purpose of this investigation is to evaluate the accuracy of pre-operative MRI in identifying ACL tear location.

METHODS: Patients who underwent ACL reconstruction or repair by two surgeons at a single, urban academic medical center from 2019 to 2024 were identified. Exclusion criteria included prior ACL surgery and inadequate preoperative or intraoperative imaging. The location of the ACL tear on preoperative MRI was retrospectively graded using the modified Sherman classification system [type I (proximal avulsion, > 90% of tibial length remaining), type II (proximal tear, 90-75% length remaining) type III (mid substance, 75-25% length remaining), type IV (distal tear, 25-10% length remaining), and type V (distal avulsion, < 10% length remaining] in a blinded manner by the two senior authors. Reference diagnosis was the tear location as noted in the surgeon's operative note and confirmed with intraoperative arthroscopic images. The primary endpoint was the accuracy of MRI as compared to the observed intra-operative tear type.

RESULTS: 203 patients were included in this study (Figure 1). There were no significant differences across age, sex, BMI, time from injury to MRI, or time from MRI to surgery for the cases in which MRI correctly identified the tear location compared to when it did not (Table 1). Overall, MRI accurately predicted the ACL tear type found on diagnostic arthroscopy 35.47% (72/203) of the time. When the MRI classification did not match the intraoperatively noted classification, it was within 1 classification grade 74.81% (98/131) of the time. In 70.99% (93/131) of the incorrect cases, the tear was over classified on MRI (the tear location on MRI was perceived to be more distal than was noted intraoperatively). These results are summarized in Table 2. MRI was more sensitive in detecting type III (51.6%) and II (43.7%) tears than it was type I tears (2.5%) (Table 3).

DISCUSSION AND CONCLUSION: Our study demonstrates that MRI is unreliable for determining the precise location of an ACL tear. It tends to overestimate how distal a tear is, which may influence surgical decision making. Repair-inclined surgeons should discuss both treatment options with patients preoperatively and thoroughly assess remnant stump tissue during diagnostic arthroscopy prior to making a final determination on ACL repair versus reconstruction.

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Table 1. Characteristics of patient cohorts with accurate vs. inaccurate preoperative MRI predictions of ACL tear type observed intraoperatively. Abbreviations: anterior cruciate ligament (ACL), magnetic resonance imaging (MRI), body mass index (BMI), interquartile rance (IOR).				Table 2. Analysis of accuracy of preoperative MRI predictions of ACL tear type observed intraoperatively. Abbreviations: magnetic resonance imaging (MRI), anterior cruciate ligament (ACL), positive predictive value (PPV), negative predictive value (NPV).				Table 3. Distribution of ACL tear type classifications from preoperative MRI images and intraoperative arthroscopic images. Abbreviations: anterior cruciate ligament (ACL), magnetic resonance imaging (MRI), positive predictive value (PPV), negative predictive value (NPV).						
	Accurate MRI Prediction (n=72)	Inaccurate MRI Prediction (n=131)	P-value				%			Intraoperative				
				Accurate MRI Pres	MRI Prediction of Intraoperative ACL Tear Type e MRI Prediction of Intraoperative ACL Tear Type	Tear Type	35.47% (n=72) 64.53% (n=131)	ACL Tear Type	Preoperative	Arthroscopic	Sensitivity	Specificity		NPV
				Inaccurate MRI I		. Tear Type			n (%)	n (%)			PPV	
Age in years, median (IQR)	29 (14)	29 (13.5)	0.66	Inaccurate MRI Pr	ediction Within 1 ACL Tear Ty	ype	74.81% (n=98)	Type I	6 (2.96)	40 (19.70)	2.50%	96.93%	16.67%	80.20%
BMI, median (IQR)	25.49 (6.19)	25.00 (5.95)	0.79	Inaccurate MRI Pr	ediction by Greater than 1 AC	L Tear Type	25.19% (n=33)	Type II	86 (42.36)	87 (42.86)	43.68%	58.62%	44.19%	58.12%
Injury to MRI interval in days, median (IOR)	11 (41)	12.5 (35)	0.95	Inaccurate MRI Pr	ediction over-classified ACL T	Tear Type	70.99% (n=93)	Type III	94 (46.31)	62 (30.54)	51.61%	56.03%	34.04%	72.48%
MBI to Anthencomy interval	42 (74)	42 (20)	0.02	Inaccurate MRI Pr	ediction under-classified ACL	Tear Type	29.01 % (n=38)	Type IV	17 (8.37)	12 (5.91)	8.33%	91.62%	5.88%	94.09%
in days, median (IQR)	43 (74)	42 (70)	0.93				,	Type V	0 (0.00)	2 (0.99)	0.00%	100.00%	-	99.01%
Procedure Type, n (%)			0.69											
Reconstruction	52 (72.22%)	98 (74.81%)												
Repair	20 (27.78%)	33 (25.19%)												
Sex, n (%)			0.28											
Female	37 (51.39%)	57 (43.51%)												
Male	35 (48,61%)	74 (56.49%)												