Does 3.0 T MRI Improve Diagnosis of Internal Derangement of the Knee?

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Purpose: Despite rapid growth in 3.0 T MRI for clinical musculoskeletal evaluations there have been no published studies demonstrating diagnostic benefit or even equivalency of 3.0 T with 1.5 T instrumentation. The purpose of this study is to compare sensitivity and specificity of 1.5 T and 3.0 T knee MRI studies in a tertiary clinical practice.

Methods: A retrospective review of MRI examinations conducted between February 2004 and July 2005 with surgical confirmation were evaluated for presence or absence of full thickness ACL tear, medial or lateral meniscal tear, and cartilage degeneration. Exclusion criteria included prior knee surgery or more than a 1 year interval between MRI and surgery. Cartilage degeneration was considered present if there was visible surface irregularity including fibrillation at surgery. MRI reports describing signal intensity abnormalities without surface irregularity were considered normal. Patella, femur, and tibia articular surfaces were evaluated separately.

Table 1: MRI parameters

3T Sequence	TR	TE	ETL
PD Sag	2800 - 4000	15	5
Fat satT2 Sag	3000-3800	62	13
Fat sat PD Cor	2100-3000	30	5
Fat sat PD Ax	3000 - 3900	30	5
1.5 T Sequence	**TR**	**TE**	**ETL**
PD Sag	1200 - 2000	17	4
Fat sat T2 Sag	2000 - 4000	70	14
Fat sat PD Cor	1600 - 3200	32	7
Fat sat PD Ax	1200 - 2600	32	7

Studies were conducted on either 1.5 T or 3.0 T Philips Intera MRI scanners using phased array extremity coils. As shown in *Table 1*, knee MRI protocols were similar for the two field strengths. On both systems receiver bandwidth was adjusted to maintain a fat/water shift of 2 pixels with a section thickness of 4 mm, a pixel dimension of 0.31 mm^2.

Table 2: Prevalence of conditions at surgery

	Subjects	Normal		ACL Tear		Medial Tear		Lateral Tear		Patellar Cartilage		Femoral Cartilage		Tibial cartilage	
1.5 T	102	2	2%	20	20%	68	67%	21	21%	47	46%	62	61%	40	39%
3.0 T	32	0	0%	8	25%	20	63%	11	34%	14	44%	15	47%	8	25%
Total	134	2	1%	28	21%	88	66%	32	24%	61	46%	77	57%	48	36%

Results: As shown in *Table 2* disease prevalence is similar between 1.5 T and 3.0 T studies with a low incidence of normal exams. As demonstrated in *Table 3* sensitivity and specificity for detection of meniscal and ACL tears were similar for 1.5 T and 3.0 T with lower sensitivity for detection of lateral meniscal tears. Although sensitivity was similar, there was a trend for greater specificity in detection of articular cartilage lesions for 3.0 T (*Table 4*). For Reader 1 3.0 T studies, no tibial lesions were identified at surgery.

Table 3: Sensitivity and Specificity of ACL and Meniscal Tears

			ACL Tear				Medial Meniscus				Lateral Meniscus			
	N		1.5 T		3.0 T		1.5 T		3.0 T		1.5 T		3.0 T	
Reader	*1.5*	*3.0*	*Sens*	*Spec*	*Sens*	*Spec*	*Sens*	*Spec*	*Sens*	*Spec*	*Sens*	*Spec*	*Sens*	*Spec*
Reader 1	42	10	100%	96%	100%	100%	100%	100%	100%	72%	89%	97%	75%	100%
Reader 2	60	22	90%	98%	100%	94%	98%	89%	88%	80%	58%	100%	57%	100%
All Readers	102	32	95%	98%	100%	96%	99%	94%	90%	75%	72%	99%	64%	100%

Table 4: Sensitivity and Specificity of Cartilage Degeneration

			Patella				Femur				Tibia			
	N		1.5 T		3.0 T		1.5 T		3.0 T		1.5 T		3.0 T	
Reader	*1.5*	*3.0*	*Sens*	*Spec*	*Sens*	*Spec*	*Sens*	*Spec*	*Sens*	*Spec*	*Sens*	*Spec*	*Sens*	*Spec*
Reader 1	42	10	69%	94%	100%	100%	60%	77%	50%	83%	53%	63%	-	78%
Reader 2	60	22	68%	77%	50%	100%	54%	91%	64%	91%	68%	91%	43%	94%
All Readers	102	32	68%	82%	72%	100%	57%	85%	60%	88%	63%	79%	43%	88%

Discussion: Results of this study indicate sensitivity and specificity of 3.0 T in diagnosis of meniscal and ACL tears is equivalent to 1.5 T. This result is consistent with similar published studies comparing low field (<0.5 T) with 1.5 T MRI and suggests magnetic field strength is not a significant determinant of diagnostic efficacy for these conditions. The trend for improved specificity in diagnosis of cartilage degeneration may be due to the design of the 3.0 T protocol, which maintained equivalent spatial resolution to that used at 1.5 T, but had greater signal to noise. Future studies are needed to determine if higher spatial resolution acquisitions or modification of image contrast in the 3.0 T protocol is needed to improve sensitivity.