Cartilage thickness loss correlates to UTE-T2* early after ACL reconstruction

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Introduction

Anterior cruciate ligament (ACL) injury increases risk for development of post-traumatic osteoarthritis (PTOA).[1;2] While cartilage thickness loss is a marker of disease progression, thickness changes can be highly variable within the first 2 years after ACL rupture.[3] Cartilage compositional damage can be detected by MRI ultrashort echo time T2* (UTE-T2*) mapping[4;5] which is sensitive to collagen matrix integrity and organization.[6] Whether or not cartilage thickness change is related to or affects cartilage collagen matrix organization as assessed with UTE-T2* within the first year of reconstruction surgery has not been examined

Objective

To compare location-independent cartilage thickness loss over 6 months and 1 year after ACL reconstruction surgery to MRI UTE-T2* at 1 year after surgery.

Methods

19 ACL tear patients underwent MRI 6 months and 1 year after ACL reconstruction (ACLR)

3T UTE-T2* Mapping

- Radial out 3-D Cones sequence[7]; resolution = 0.31 x 0.31 x 3mm
- 8 TEs (32µs-16ms), non-uniform spacing; TR = 22ms
- mono-exponential fit of a single slice from the medial condyle
- 4 regions of interest (ROIs): full-thickness and deep cartilage to the medial and lateral femoral condyles and tibial plateaus (MFC, LFC; MTP, LTP)[5]

Cartilage Thickness Change

- DESS images (TE/TR=34/12ms, FA=35º ; 0.31x 0.31 x 1.4mm resolution)
- Regional[8] and ordered values (OV) of thickness change[9] were determined for 16 tibiofemoral subregions[10]; Location independent thinning, thickening and total change scores were calculated[11]

Results

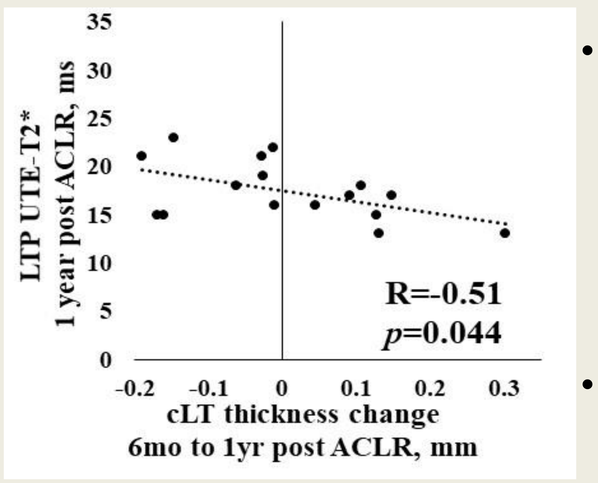
Location-Independent cartilage thinning correlates to UTE-T2*

OV1 Location-Independent Cartilage Thinning correlation to UTE-T2*

	MFC		MTP		LFC		LTP	
	full	deep	full	deep	full	deep	full	deep
R	-0.66	-0.60	-0.55	-0.30	-0.58	-0.56	-0.59	-0.22
p	**0.005**	**0.015**	**0.027**	0.253	**0.019**	**0.025**	**0.017**	0.418

Location-independent measures of cartilage thinning were associated with increasing UTE-T2* (indicating decreased matrix organization) in all cartilage plates assessed.

Regionally-matched cartilage thinning correlates to UTE-T2*



- Cartilage thinning between 6 months and 1 year following ACLR correlates to increasing UTE-T2* at 1 year post-surgery in the lateral tibial plateau.
- No other regionally-matched correlations were detected.

Cartilage thickness is most volatile within the first year after ACL reconstruction

	Type of Cohort	n	Age mean±STD	thinning	thickening	total change	OV1	OV16
Current Study	ACL reconstructed 6 months to 1 year post-SX	19	29±8	-570 (-660, -480)‡	690 (470, 900)‡	1260 (1010, 1510)‡	-160 (-190, -120)‡	200 (80, 320)‡
KANON	ACL reconstructed baseline to 2 years post-SX	117[3]	26±5[3]	NR	NR	902 (836, 967)[3]	-115 (130, 100)[3]	116 (104, 128)[3]
KANON	ACL reconstructed 2 years to 5 years post-SX	112[3]	NR	NR	NR	483 (452, 515)[3]	-54 (62, 47)[3]	69 (63, 75)[3]
OAI	Healthy Reference Cohort 1 year	93[14]‡,101[13]	55±8[13]	-540 (NR)[14]‡	450(NR)‡*	990(NR)‡*	−111 (−122; −100)[13]	NR

NR indicates not reported. ‡Calculated from sagittal DESS images. All others calculated from FLASH/SPGR. *Indicates new result not previously reported.

Conclusions

- Observed rates of location-independent cartilage thickness changes were substantially larger than previously reported for healthy controls[12-14] and also from ACL-injured subjects[3]
- Location-independent measures of cartilage thinning were associated with increasing UTE-T2* (indicating decreased matrix organization) in all cartilage plates assessed
- Regionally-matched cartilage thinning correlated to increased UTE-T2* in the lateral tibial plateau

SIGNIFICANCE: This study provides evidence that knee cartilage thickness is more volatile early after ACL reconstruction than was previously recognized.[3] However, despite variable cartilage thickness changes across different regions of the knee, results from this study suggest that decreasing tibiofemoral cartilage thickness as early as 6 months to 1 year after ACL reconstruction is associated with increasing disruption to collagen matrix organization throughout the joint as measured with UTE-T2* mapping.

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