SUBREGIONAL BUT NOT TOTAL PLATE CARTILAGE CHANGE DIFFER BETWEEN EARLY AND LATE FOLLOW-UP AFTER ANTERIOR CRUCIATE LIGAMENT RUPTURE

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Purpose: Anterior cruciate ligament (ACL) rupture is associated with acute joint trauma and chronically altered joint mechanics, and with increased risk of incident radiographic knee OA. Using quantitative MRI, we have shown that the mean femorotibial cartilage thickness increases significantly in young adults after ACL rupture, and that this increase had a similar rate during the first 2 years (BL→Y2) and the subsequent 3 years (Y2→Y5). The purpose of the present study was to compare cartilage thickness change in femorotibial subregions during early (BL→Y2) and later (Y2→Y5) follow-up, using location-independent analysis and novel disease activity (i.e. subregional cartilage thickness change summary) scores.

Methods: 121 young active adults with an acute ACL rupture were studied as part of the KANON RCT. Sagittal MRIs were acquired within 5 weeks of the rupture (BL), and at Y2 and at Y5. 117 participants had BL, 112 Y2 and 112 Y5 images; 107 had Y2 and Y5 images (81men, 26 women; median age 25.6y; age range 18-36). Cartilage thickness in the medial (MFTC) and lateral (LFTC) compartment was measured after segmentation of the medial and lateral tibial (MT/LT) and weight-bearing femoral (cMF, cLF) cartilage. Thickness was analyzed in 16 femorotibial subregions (8 medial, 8 lateral, 10 tibial, 6 femoral), and thickness changes in these subregions were summarized using an ordered value (OV) system: the magnitude of change in the subregion with the strongest thinning was assigned to OV1, the one with the second strongest thinning to OV2, and so forth, and the one with the strongest thickening to OV16. A total femorotibial subregional cartilage thickness change score (ThCChS) was computed by summarizing magnitudes of all subregions, independent of their direction (i.e. thickening or thinning). Further, a total femorotibial subregional cartilage thickening (ThCTkS) and thinning (ThCTnS) score was computed by summarizing the changes across all subregions with thickening or thinning, respectively. Comparisons between early and later follow-up was performed using paired t-tests.

Results: The annualized increase in MFTC cartilage thickness from Y2→Y5 (+24µm; 95% confidence interval [CI] 17,31 µm) was very similar to that between BL→Y2 (+25 [10,40] µm; Table 1). Two of 16 subregions (the posterior medial and lateral tibia; pMT and pLT) showed significant cartilage thinning during early follow-up that was not seen later (Table 1). OV1 (the subregion with the strongest thinning) exhibited a change of -115µm [-130,-100] during early, and a much smaller change during later follow-up (-54µm [-62,-47]). Similar significant differences were observed for OV 2-5 and for OV 11-16, with OV16 exhibiting much stronger thickening early (+116µm [104,128]) than later (+69µm [63,75]). Differences in the TCChS between early (902µm [836;967]) and later (483µm [452;515]) follow-up were striking, and so were those in ThCTkS and ThCTnS (Table 1).When dividing the cohort into tertiles of ThCChS change, no obvious difference was noted in terms of sex, age, height, weight, or body mass index (BMI) between upper and lower tertiles (data not shown).

Table 1: 5 Year cartilage thickness change (µm/a) after ACL rupture

	Early Follow-up (BL→Y2)		Later Follow-up (Y2→Y5)		Later vs. Early
	Mean	SRM	Mean	SRM	P value
MFTC	+24*	+0.29	+23*	+0.54	0.90
LFTC	+5	+0.05	+8	+0.18	0.71
MT	+5	+0.11	+11*	+0.49	0.28
cMF	+19*	+0.34	+12*	+0.42	0.31
LT	-6	-0.13	+6*	+0.22	0.04
cLF	+11*	+0.21	+3	+0.09	0.17
pMT	-10*	-0.20	+9*	+0.28	0.002
pLT	-41*	-0.49	-3	-0.07	<0.001
OV1	-118	-1.52	-54	-1.36	<0.001
OV16	+116	+1.77	+69	-1.28	<0.001
ThCTkS	+500	+1.23	+308	+1.58	<0.001

ThCTnS	-408	-1.39	-175	-1.17	<0.001
ThCChS	+908	+2.57	+483	+2.96	<0.001

Conclusions: Substantial subregional cartilage thickness increase and decrease appear to take place simultaneously within two years after ACL rupture. These changes are not captured when cartilage thickness change is measured at total plate, compartment or joint level. The strongest subregional cartilage thinning during early follow-up co-located with acute posttraumatic bone marrrow lesions and osteochondral fractures, but varied in location between patients. OVs were therefore statistically superior in unraveling differences in cartilage thickness change between early and later follow-up. The novel structural disease activity scores of cartilage thinning (CTnS), thickening (CTkS) and total change (CChS) are highly efficient in describing the different aspects of subregional cartilage change. They may thus be important when relating structural imaging observations of cartilage change to wet biomarker analyses of cartilage turnover.

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