

3D high-resolution in-vivo cartilage deformation of the knee at 3T after different static exercises frequently practised in craftsman professions

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Purpose: Extent and distribution of focal cartilage deformation might provide information about zones which experience proportionally larger loading forces and thus exposure to faster degeneration and increased risk for osteoarthritis (OA) [1]. This is of interest against the background of craftsman professions who perform repetitive static positions during daily work which might induce overuse and clinical symptoms related to OA. This study evaluated cartilage deformation of the knee, after performing of different frequently used positions in craftsman professions.

Materials and Methods: MRI datasets of the right knee of 8 healthy volunteers (21-25a) were acquired before and after exercising (monitoring by a pressure transducer device) of either 90° kneeling, sitting on the heels or squatting for respectively 10 min, as well as after 90 min. of rest post exercise at 3T. Each exercise was performed on a separate appointment. At each exercise phase a sagittal 3D-T1-w FLASH-WE-sequence (TR 14.2ms / TE 7.2ms / FA 15° / resolution 0.32x1.5mm³ / matrix 512²) [2] was acquired. Patellar, femoral and tibial cartilage were semiautomatically segmented, 3D reconstructed and volumetric parameters were calculated (volume, bone-cartilage-interface (BCI), mean thickness, thickness and thickness difference plots). Reproducibility of segmentation was assessed. Statistics were performed by t-test.

Results: Average reproducibility of the segmentation was 1.1% for volume, 0.6% for BCI and 0.7% for mean thickness. Expectedly, no significant change of BCI was found after exercise and after rest. Volume change was 1.44-4.13% and mean thickness change 0.35-3.77% after exercise (details table 1). No significant change was found after resting as compared to the baseline examination except for medial tibial volume and patellar thickness after sitting on the heels. Thickness difference maps (figures 1a-c) revealed similar deformation patterns for kneeling and sitting on the heels at the caudal patella, lateral femur condyle, medial region of medial tibia and centro-dorsal lateral tibia, whereas deformation patterns after squatting reflected increased anterior load in the tibial plates.

Conclusion: High-resolution 3D-MR-volumetry at 3T enables comprehension of significant change in magnitude and focal distribution of cartilage deformation within the different cartilage plates. It provides references for contact zones and focal loading for various activities and allows assessment of the reversibility of stress induced changes. These findings may help to deduce possible future preventive measures for labor protection, cartilage therapy as well as cartilage graft engineering.

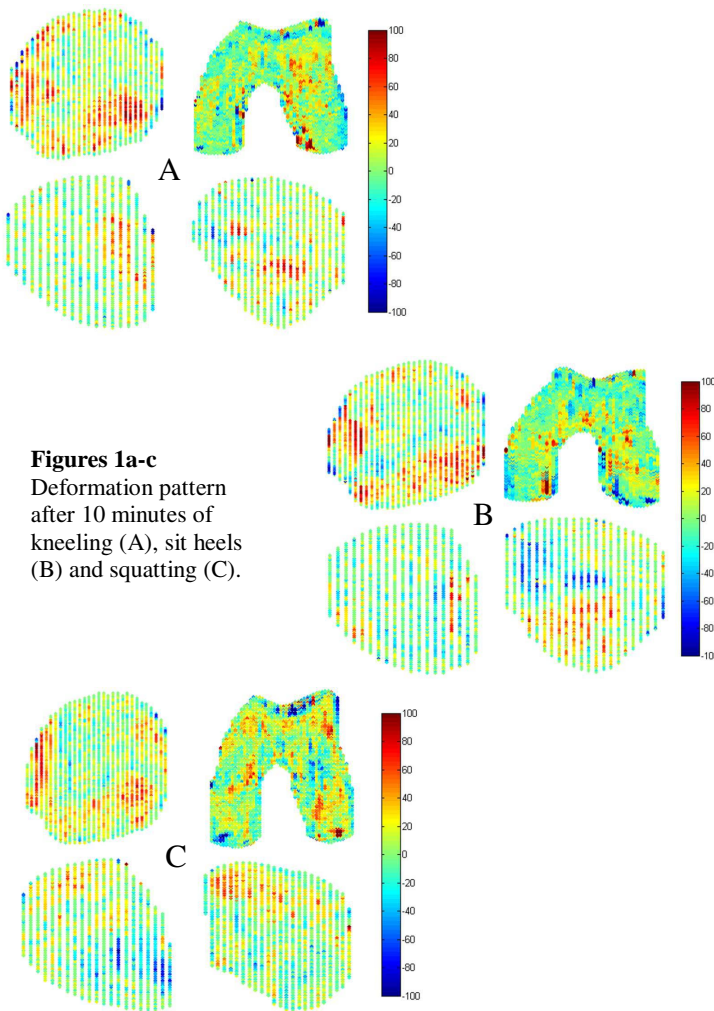
Literature:

1. Eckstein et al, J Anat. 2006
2. Glaser et al, Magn Reson Imaging 2001

		Volume %		BCI %		Mean thickness %	
	Exercise	Def	Rec	Def	Rec	Def	Rec
Patella	Kneeling	4.13*	1.07	0.37	0.15	3.77*	0.93
	Sit heels	2.78*	-0.40	0.45	0.38	2.34*	-0.79*
	Squatting	2.37	0.37	0.29	0.59	2.11	-0.20
Femur	Kneeling	1.36	-0.30	0.54	0.64	0.82	-0.95
	Sit heels	2.08	0.14	0.77	0.34	1.33	-0.20
	Squatting	1.99*	-0.07	0.68	0.24	1.32*	-0.31
Tibmed	Kneeling	2.22*	-1.85	1.88	-0.34	0.35	-1.51
	Sit heels	1.54*	-1.42*	0.61	-0.34	0.93	-1.13
	Squatting	2.25*	0.30	1.21	0.21	1.00	0.08
Tiblat	Kneeling	2.32*	-0.76	0.05	0.24	2.27*	-1.00
	Sit heels	1.61	-0.52	0.71	0.39	0.91	-0.93
	Squatting	2.23*	0.37	0.46	1.25	1.77*	-0.87

Table 1

Differences (%) of cartilage volumetric parameters compared to the baseline examination after exercising (= deformation) and after 90 minutes of rest (= recovery).
Abbreviations: BCI – bone-cartilage-interface, Def – deformation after exercising, Rec – residual deformation after 90 minutes resting compared to the baseline value, Tibmed – medial tibia, Tiblat – lateral tibia, * - significant change p< 0.05



Figures 1a-c
Deformation pattern after 10 minutes of kneeling (A), sit heels (B) and squatting (C).