CARTILAGE THICKNESS IS CORRELATED WITH IN VIVO KNEE JOINT LOADING INDICES IN OSTEOARTHRITIC TIBIA

Sophie Rapagna (1), Bryant C Roberts (1,2), Lucian B Solomon (3,4), Karen J Reynolds (1), Dominic Thewlis (3), Egon Perilli (1)

1. Medical Device Res. Institute, College of Science & Engineering, Flinders University, Adelaide, Australia
2. Dep. of Oncology & Metabolism, Insigneo Inst. for in silico Medicine, University of Sheffield, United Kingdom
3. Centre for Orthopaedic & Trauma Research, The University of Adelaide, Adelaide, Australia
4. Department of Orthopaedics and Trauma, Royal Adelaide Hospital, Adelaide, Australia

Introduction

Variations in joint loading have been linked to disruptions of cartilage homeostasis that may contribute to knee osteoarthritis (OA) [1]. *In vivo* indices of joint loading, such as the knee adduction moment (KAM), have been associated with altered distributions of cartilage thickness (Cg.Th) in the tibial plateau using *in vivo* MRI [2]. However, MRI may overestimate Cg.Th, particularly in OA joints with thinner cartilage [3].

Aim: To investigate in end-stage knee-OA subjects undergoing total knee replacement, relationships between knee joint loading indices, joint alignment (pre-operative gait analysis and radiographs) and cartilage thickness of their excised tibial plateaus quantified with 3D micro-CT.

Methods

Participants: Tibial plateaus were retrieved from 25 knee-OA subjects (68±7 years; 90±18 kg). Prior to knee arthroplasty, subjects underwent gait analysis with 3D kinematics and ground reaction force data captured using 12 Vicon MX-F20 cameras and 4 force platforms (Vicon Metrics, Oxford, UK). Kinematic variables investigated were the first peak KAM (KAM1), second peak KAM (KAM2), peak KAM and external rotation moment (ERM). Mechanical axis deviation (MAD) was obtained from pre-operative radiographs.

Micro-CT: The entire plateaus were micro-CT scanned (17 µm/voxel, model 1076, Skyscan-Bruker, Belgium). From the micro-CT images, cartilage thickness (Cg.Th) was analysed in four cylindrical subregions of interest (ROIs, 10mm diameter, 3-5mm length), in anteromedial (AM), anterolateral (AL), posteromedial (PM) and posterolateral (PL) condyles (Fig 1a). The medial-to-lateral (M:L) Cg.Th ratio was also explored.

Statistics: Relationships between Cg.Th, joint loading indices and MAD were examined using Pearson's correlations ($p<0.05$).

Results & Discussion

Significant correlations were found between Cg.Th and joint loading parameters, with positive correlations in AM region between Cg.Th and KAM1 ($r= 0.54$, $p<0.01$), KAM2 ($r= 0.44$, $p=0.03$), peak KAM ($r= 0.47$, $p=0.02$) and ERM ($r= 0.51$, $p<0.01$), and negative with MAD ($r= -0.76$, $p<0.01$; Fig 1b, Tab 1); whereas in the lateral regions, these correlations had opposite signs. The M:L Cg.Th ratio correlated with ERM ($r= 0.65$, $p<0.01$, Fig 1c) and MAD ($r= -0.74$, $p<0.01$; Tab 1).

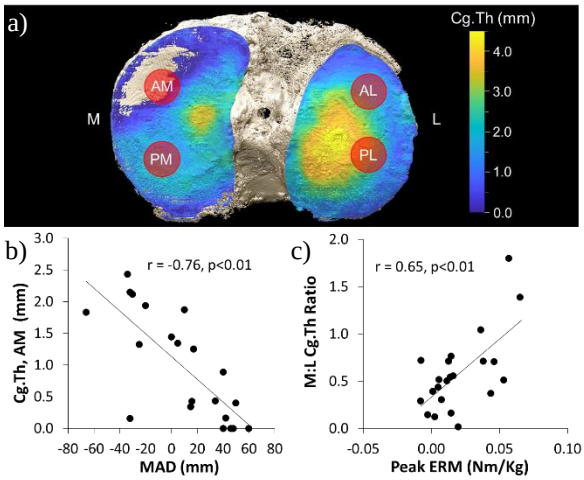

Fig 1. a) Micro-CT 3D rendering, entire excised tibial plateau showing cartilage thickness map (17µm/pixel). Scatter plot with line of best fit: b) "AM Cg.Th vs. MAD" and c) "M:L Cg.Th Ratio vs. Peak ERM".

	KAM1	KAM2	KAM	ERM	MAD	r-value
AM	**0.54**	**0.44**	**0.47**	**0.51**	**-0.76**	**1**
AL	-0.45	-0.39	**-0.43**	**-0.48**	0.55	0.5
PM	0.22	0.22	0.20	0.37	-0.39	0
PL	**-0.62**	**-0.52**	**-0.56**	**-0.62**	**0.65**	-0.5
M:L	0.39	0.29	0.31	**0.65**	**-0.74**	-1

Table 1. Heatmap, Pearson's correlation coefficients (r-values) for a selected subset of "subregional Cg.Th vs. knee joint loading parameters". Bold numbers: $p<0.05$

Conclusion

In knees of end-stage knee-OA subjects, joint loading indices (KAM, ERM and MAD) significantly correlated with regional Cg.Th variations and the M:L Cg.Th ratio. Interestingly, these relationships have the inverse sign compared to those for the underlying subchondral bone microarchitecture found in our previous study on the same specimens [4]; taken together, this suggests a whole joint response to loading. These findings may contribute to improve understanding of OA and development of targeted treatment options.

References

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