Correlation between Cartilaginous endplate defects and Intervertebral disc degeneration: An In Vivo MRI Study at 3.0 Tesla

Dong Xing[1], Jiao Wang[1], Yunfei Zha[1], Lei Hu[1], Hui Lin[2], and Yuan Lin[1]

[1]*Department of Radiology, Renmin Hospital of Wuhan University, Wuhan, Hubei, China,* [2]*GE Healthcare China, Shanghai, China*

Target Audience: Clinicians and researchers who interested in Intervertebral disc degeneration.

Purpose & Introduction: Low back pain, which mainly caused by Intervertebral disc degeneration (IVDD), is one of the major health problems in industrialized societies. Although IVDD is a multifactorial disease, it is well accepted that limited nutrition is the final common pathway for IVDD and the changes in the structure or composition of the cartilaginous endplate (CEP) have been considered a crucial role in IVDD. CEP, which covers the cranial and caudal ends of the disc, cannot be represented by conventional MRI due to its very short T2 relaxation time. The ultrashort echo time (UTE) sequence, which permits the echo times (TEs) as low as 0.008 ms, was able to visualize short T2 CEP[1], and Law *et al.*[2] have been proved a statistically significant association between the presence of CEP defects and the classification of IVDD which is based on the loss of signal intensity in T2WI. However, since this visual IVDD evaluation strategy is subjective and may be not as goood as T2- or T2*- mapping in detecting early dics degeneration[3], a further study utilized the quantitative parameter of T2*-relaxation time (T2*-RT) would be benefit to understand the causes of disc degeneration of early stage. The purpose of this study was to use 3D-UTE and T2*- mapping sequence to ascertain the relation between CEP Integrity and IVDD.

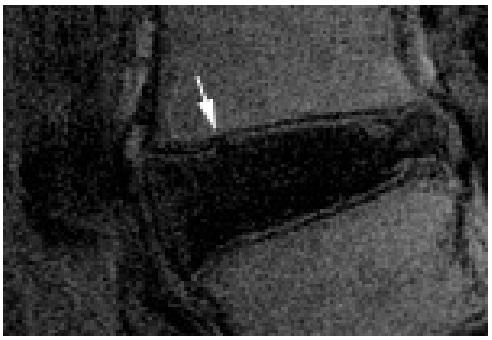

Fig1: UTE of CEP: CEP defects were considered as discontinuity of the high signal of CEP

Methods: One hundred and eighty CEPs and 90 lumbar discs from 18 individuals (8 male, 10 female) with age of 45.110±12.528 years (Mean±SD) were evaluated by 3D-dUTE (Dual-echo UTE with echo subtraction, TR/TE1,TE2=300/0.008,6.6ms) and T2*- mapping (echo time 9.6-77.2 ms), respectively. Raw UTE data were post-processed by the image subtraction tool provided in Advantage Workstation (version 4.6, GE), and the discontinuity of the high signal, recognized as CEP defect, between the disc and the osseous vertebral body were observed (**Fig. 1**). Ninety lumbar discs were classified according to the CEP defects into 4 groups: Group A: having no CEP defects in the both of cranial and caudal ends of the disc; Group B: only having cranial CEP defects; Group C: only having caudal CEP defects; and Group D: having CEP defects in the both ends. T2*-RT of nucleus pulposus (NP) were measured as the method illustrated by Welsch *et al.*[4] (**Fig. 2**). Univariate ANOVA with post-hoc tests (LSD) was employed to judge the difference of the T2*-RT of NP among these groups, and $p<0.05$ was considered statistically significant.

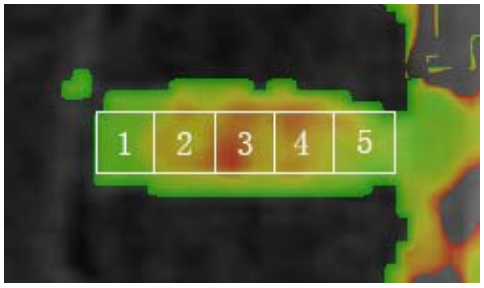

*Fig2: T2*mapping of IVD: ROIs 2 to 4 as the nucleus pulposus*

Results: In this study, Group A have 64 discs, Group B and C have 6 discs, and Group D have 14 discs. The T2*-RT of NP of each group was 49.068±13.560, 46.313±6.086, 48.168±28.636, 28.815±10.353 (ms), respectively. Statistically significant difference in T2*-RT values of NP among the Group D with the other three groups was observed, while no difference among the Group A, B and C observed, as shown in **Fig 3**.

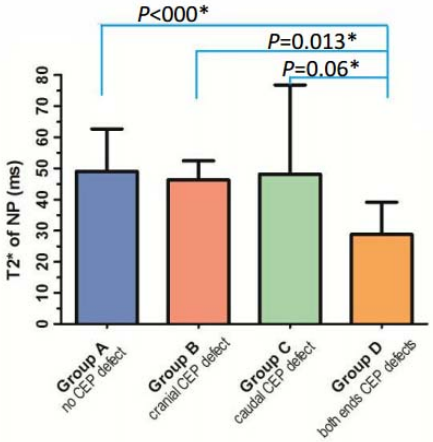

Fig3: Statistically signifiant difference in T2 values of NP among the Group D and other three groups*

Discussion: The results of this study demonstrated the occurrence of intervertebral disc degeneration might only at a situation of both the cranial and caudal ends CEP of the IVD appeared defects. This phenomenon could be interpreted that one intervertebral disc had two CEPs cover the superior and inferior ends, which meant one disc owned two pathways for nutrient transport from adjacent blood vessels. When the integrity damage of CEP just occurred in one end of the disc, the disc could get the diffusion of nutrients to the cells of the NP from the other side to maintain the metabolism of it. Thus, there would not be a severely change of water content in the NP, as well as a manifested variation on the T2*-RT of NP. Otherwise, severe decline of the values of NP would occur.

Conclusions: UTE is an exquisite sequence in detecting the integrity of CEP, and our study provides the defects of both ends of the Intervertebral disc is highly associated IVDD.

References: 1.Bae *et al.*Radiology 266 (2013)564-574. 2.Law *et al.* Journal of Medical Imaging and Radiation Oncology 57 (2013) 427-434. 3.Blumenkrantz *et al.* Magnetic Resonance in Medicine 63 (2010)1193–1200. 4.Welsch *et al.*Skeletal Radiols 5(2011)543-551.