

UTE MR MORPHOLOGY OF CARTILAGINOUS ENDPLATES ADJACENT TO VERTEBRAL ENDPLATE LESIONS IN HUMAN LUMBAR SPINE

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INTRODUCTION: The cartilaginous endplate (CEP) is located between the vertebral endplate (VEP) and intervertebral disc,¹ and serves as a mechanical support and a pathway for nutrient supply² to the intervertebral disc. Due to its very short T2, the CEP does not routinely show detectable signal with clinical MR sequences such as the T1- and T2-weighted spin echo (SE), despite its clinical importance. In a recent study,³ it was demonstrated that ultrashort time-to-echo (UTE) sequences can provide direct imaging of the CEP, unlike conventional SE sequences. Disease of bony vertebral endplate such as Schmorl's node⁴ is common, and is often symptomatic. Literature has suggested focal weakening of the CEP as a potential cause,⁵ but this has not been investigated. The purpose of this study was to determine if UTE abnormalities of the CEP are associated with lesions of the bony VEP, including fracture, irregularity, and classic Schmorl's nodes.

METHODS: Samples. Cadaveric lumbar spines (6 donors, mean age 52.3 yrs, 5 male, 1 female) were obtained from a tissue bank. **MR Imaging.** MR imaging was performed at 3T (GE Signa HDx) using conventional SE T2 weighted (TR=2000 ms, TE~70 ms) and UTE sequences (TR=500 ms, TE=0.008 and 10 ms, FOV=16 to 20 cm, matrix=512x512). With UTE images, digital subtraction of the second from the first echo image was used. **Evaluation.** First, two musculoskeletal radiologists (15 and 4 years experience) identified in consensus, the location of VEP lesions (**Fig.1B, right pink box**), including fractures, Schmorl's nodes, and irregularity. The readers then individually evaluated morphology of the CEP overlying the VEP lesions, and the adjacent normal VEP (**Fig.1B, left green box**). A total of 36 VEP lesions and 36 normal VEP regions were evaluated. Normal CEP morphology consisted of continuous and linear high signal intensity, while abnormal CEP morphology included marked thinning or absence of the signal intensity, diffuse thickening, or irregularity. Additional degenerative changes of the vertebral body level, including osteophytes, morphological changes of the anterior and posterior longitudinal ligament, and abnormal intervertebral disc signal and morphology were also assessed. **Statistics.** Agreement between observers was determined using Cohen's kappa analysis, and association between CEP and VEP lesions was determined using the chi-square test.

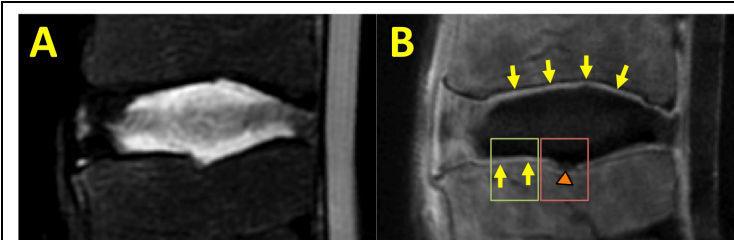


Fig.1: (A) SE T2 weighted and (B) UTE subtraction MR image of a bone-disc-bone segment. The UTE image (B) exhibits cartilaginous endplate (CEP) as a linear high signal intensity (B, arrows). Vertebral endplate (VEP) lesions were identified (B, pink box), and along with adjacent normal region, evaluated for morphology of overlying CEP. A loss of CEP signal (B, triangle) is seen over a VEP lesion.

Table 1: Normal VEP		Observer #1	
		Normal CEP	Abnormal CEP
Obsv	Normal CEP	29	1
#2	Abnormal CEP	6	0

Table 2: VEP Lesion		Observer #1	
		Normal CEP	Abnormal CEP
Obsv	Normal CEP	0	0
#2	Abnormal CEP	1	35

Table 3: Combined		Observer #1	
		Normal CEP	Abnormal CEP
Obsv	Normal CEP	29	1
#2	Abnormal CEP	7	35

RESULTS: Unlike conventional SE images (**Fig.1A**), UTE subtraction images (**Fig.1B**) exhibited the layer of CEP (**Fig.1B, arrows**) with great contrast. CEP morphology was significantly ($p<0.001$) associated with VEP lesions: 29 normal CEPs were found overlying 36 normal VEP regions (**Table 1**), while 35 abnormal CEPs were seen overlying 36 VEP lesions (**Table 2**). Combined (**Table 3**), there was a substantial agreement on the CEP morphology (64 out of 72), with a kappa of 0.78. The presence of VEP lesions was also associated with the presence of osteophytes (20 out of 36 levels), altered morphology and signal of the anterior longitudinal ligament (21 of 36), and abnormal intervertebral discs (19 of 36) at the same lumbar level.

DISCUSSION: UTE MRI enables evaluation of the CEP. Abnormal changes in the CEP may precede formation of lesions of the vertebral endplate. Additional studies to determine sequelae of changes in the CEP and VEP in a wider range of ages, as well as comparison of biomechanical properties of normal and abnormal CEP, may provide greater insight into the pathophysiology of VEP lesions.

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REFERENCES: 1. Inoue *Spine* 6:139, 1981; 2. Crock+ *Spine (Phila Pa 1976)* 9:702, 1984; 3. Bae+ *Radiology* 266:564, 2013; 4. Hamanishi+ *Spine (Phila Pa 1976)* 19:450, 1994; 5. Hansson+ *J Orthop Res* 5:479, 1987.