Vertebral Perfusion in Disc Degeneration Patients using Dynamic Contrast-Enhancement MR Imaging

T-C. Lai[1], Y-J. Liu[1], C-J. Juan[2], W. Chan[3], and H-W. Chung[4]

[1]Automatic Control Engineering, Feng Chia University, Taichung, Taiwan, Taiwan, [2]Radiology, Tri-Service General Hospital, Taipei, Taiwan, Taiwan, [3]Radiology, Taipei Medical University-Municipal Wan Fang Hospital, Taipei, Taiwan, Taiwan, [4]Electrical Engineering, National Taiwan University, Taipei, Taiwan, Taiwan

Introduction:

Dynamic contrast-enhanced (DCE) MR imaging technique has been proved highly correlated to the microsphere blood flow measurement in the study of bone marrow perfusion in animals [1] and applied to human to investigate the blood perfusion of the lumbar vertebral column [2-4]. Vertebral blood perfusion has found to be decreased in the normal aging people and post-menopause women [2] and those with arteriosclerosis [3], fat marrow increased and osteoporosis [4]. The relation between the vertebral perfusion and the disc degeneration, however, has not been investigated up to date yet. Since that disc degeneration commonly occurs with the presence of fat marrow increased in the aged patients, it is rational to hypothesize that the blood perfusion of the vertebral column might probably decrease in case of disc degeneration. The aim of this study is to verify the relation between the blood perfusion of the vertebral column and the disc degeneration.

Materials and Methods:

This study enrolled group I containing 7 subjects (14 vertebrae) with disc degeneration (M:F = 2:5, mean age = 62.4 ± 19.3 years) and group II containing 7 subjects (14 vertebrae) with normal appearing vertebrae and discs (M:F= 6:1, mean age = 40.3 ± 10.2 years). The discs were classified to two groups using T2WI. Exclusion criteria of this study include infection, metastasis, primary spine tumor, and compression fracture. DCE-MRI was employed to measure the perfusion of the lumbar vertebral body using axial section at the center of the each vertebra. Three continuous axial images of the vertebrae (L1, L2, and L3) were selected for measurement. Fast RF-spoiled gradient-recalled (FSPGR) sequence (TR/TE = 10/1.4 ms; flip angle = 30o; FOV = 30×15 cm; matrix size = 256×160; slice thickness = 10 mm) was applied in each experiment. The interval time between each measurement will be 3.1 seconds and total acquired time will be 8 minutes and 16 seconds. Bolus Gd-DTPA injection with a total dose of 0.1 mmole/kg via auto-injector at a rate of 2 ml/sec was followed by a 10 ml saline flush at the same rate. The data of DCE-MRI images was analyzed pixel-by-pixel. The fitted signal-time curve of each pixel, which signal enhancement over 10 % of baseline, was calculated using the Brix's model [5] by nonlinear least square error curve fitting. To generate signal peak map, the peak value of fitted signal-time curve was computed pixel-by-pixel. In group I, the peak signal of vertebra between two degenerative discs was calculated and normalized by the peak signal of vertebra between two normal appearing discs. In group II, the normalized peak signal was calculated from two vertebrae with adjacent normal appearing discs, respectively.

Results:

The results were as shown in the figure 1~3. The normalized peak signal of the vertebra is different between two groups; 0.85 ± 0.06 in the disc degeneration group and 0.98 ± 0.05 in the normal group. In patients with degeneration disk, the vertebral perfusion (normalized peak signal) is reduced significantly as compared to the normal group (Student t test, $P < 0.01$).

Figure 1. Illustration of T2 weighted image. (A) Disc degeneration group. (B) Normal group. .

Discussion:

Prior study has shown decrease of vertebral blood perfusion in the normal aging people and post-menopause women [2] and those with arteriosclerosis [3], fat marrow increased and osteoporosis [4]. To avoid the bias coming from age and gender difference, we normalize the peak signals of two different vertebrae subject-by-subject. Using this normalization method, we have a change to evaluate the effect of disc degeneration on the vertebral perfusion. Our study indicates that the vertebral perfusion (normalized peck signal) in the discs degeneration patients is reduced as compared to the normal group. Knowing this relation between the vertebral perfusion and discs degeneration might be helpful in further research in the pathogenesis of HIVD.

References:

1. Cova M, et al. Radiology 1991; 179:535–539.
2. Chen WT, et al. Radiology 2001; 220:213–218
3. Chen WT, et al. J. Magn. Reson. Imaging 2004; 20:811–816.
4. Griffith JF, et al. Radiology. 2005; 236:945-51.
5. Brix G et al., JCAT, 15:621-628, 1991.

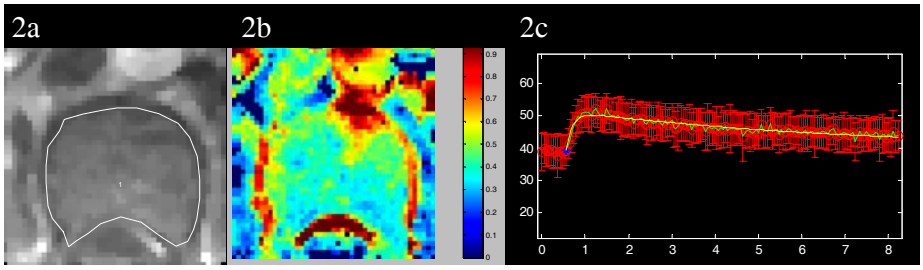

Fig2. DCE-MRI of a normal subject. (a) ROI of whole vertebra on DCE-MR image. (b) Peak signal map. (c) Averaged time-signal curves of ROI.

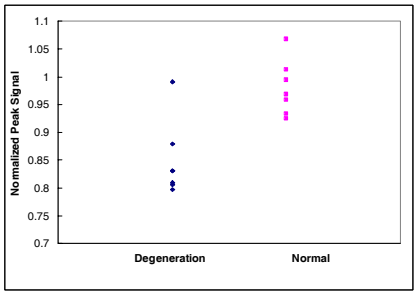

Fig3. The distribution of normalized peak signal ratio of two groups.