The influences of vertebral level and age on perfusion parameters of thoracic-lumbar vertebral marrow in adults using T1-Weighted dynamic contrast enhancement MRI

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Introduction: DCE-MRI which based on the first effection of a contrast agent can be used to evaluate semi-quantitatively or quantitatively the permeability of the microcirculation of an organization[1]. Some previous researchs[2,3] have found some characteristics of the semi-quantitative parameters of the vertebral marrow infusion, however, the semi-quantitative parameters cannot directly reflect the microcirculation of a tissue. Our objective was to investigate the differences in quantitative perfusion parameters of thoracolumbar vertebral bone marrow(VBM) in adults in relation to vertebral level and age using dynamic contrast enhancement MRI(DCE-MRI).

Material and Method: 50 subjects(9 females,41males,median age 52.61±17.31 years) were examined with DCE-MRI at 3.0T MR unit. DCE-MRI was performed with LAVA-XV (3D-GRE-T1WI) sequence with a region of interest (ROI) placed on sites of VBM(Th10-L5)of all subjects. The fitted time signal intensity curves (TICs) were generated by Cine tool software at AW4.4 workstation (GE Healthcare). Consequently, perfusion quantitative parameters (K^{trans},K_{ep} and V_e) were calculated respectively and their corresponding color mappings were provided(Fig1). 400 vertebral bodise were divided into three groups according to anatomical level: the fiest group of LT(Th10,Th11 and Th12),the second group of UL(L1,L2 and L3),the third group of LL (L4 and L5).All groups then were subdivided into younger or older than 50 years.

Fig.1 K^{trans} (a), K_{ep} (b) and Ve (c) of L4

Results: Quantified perfusion parameters are summarized in Table 1-4. Statistically significant differences were observed between the different groups (LT, UL and LL) for K^{trans} and K_{ep}(F=43.392,31.357,respectively),P＜0.001), but except for V_e(F=3.543, P=0.33). Furthermore, K^{trans} and K_{ep} values decreased gradually from lower thoracic vertebrae to upper lumbar vertebrae and lower vertebrae. When age was considered, K^{trans} and K_{ep} values showed significant negative correlation with age（r=-0.688,-0.684, respectively, P＜0.001）,and V_e opposite（r=0.717,P＜0.001). K^{trans} and K_{ep} were significantly higher in younger subgroup compared with those in older subgroup (P＜0.05), while V_e was significantly lower in younger than that in older subgroup(P＜0.05).

Table 1 Different vertebral levels quantitative parameter comparison (MEAN ± SD)

Group	Sample	K^{trans} (ml/100ml/min)	K_{ep} (ml/100ml/min)	V_e （%）
LT	46	0.2587±0.05595	1.0841±0.32964	0.2242±0.03576
UL	46	0.2151±0.02967	0.8092±0.06254	0.2483±0.08285
LL	46	0.1709±0.01605	0.7036±0.25404	0.2108±0.04058

Table 2 Different age groups LT parameters (MEAN ± SD) comparison

Group	Sample	Ktrans (ml/100ml/min)	Kep (ml/100ml/min)	Ve （%）
＜50 years	26	0.2836±0.05412	1.1860±0.36820	0.2086±0.03291
≥50 years	20	0.1985±0.02474	0.8234±0.11366	0.3047±0.09315

Table 3 Different age groups UL parameters (MEAN ± SD) comparison

Group	Sample	Ktrans (ml/100ml/min)	Kep (ml/100ml/min)	Ve （%）
＜50 years	26	0.2312±0.01857	0.8375±0.00727	0.2106±0.01574
≥50 years	20	0.1815±0.01429	0.8147±0.00564	0.2581±0.01602

Table 4 Different age groups LL parameters (MEAN ± SD) comparison

Group	Sample	Ktrans (ml/100ml/min)	Kep (ml/100ml/min)	Ve （%）
＜50 years	26	0.1717±0.01723	0.6549±0.00809	0.1838±0.00800
≥50 years	20	0.1106±0.01031	0.6382±0.00418	0.2077±0.00707

Discussion: Quantitative perfusion parameters (K^{trans}, K_{ep}, V_e) of vertebral marrow could display dual characteristics of Perfusion and Permeability .From the thoracic vertebrae to the lower lumbar spine, the distribution of K^{trans} and K_{ep} was showed decreasing from the cephalic side to the caudal side. The thoracic spine performing higher perfusion and permeability may be associated with both greater range of flexion and more exuberant metabolism. V_e reflects the ratio of Extra-vascular Extra-cellular Space (EES) of vertebral marrow. The reason why V_e value did not show significant difference between different vertebral segments is not clear yet, may indicates that bone marrow infusion is a complex functional integration, and not very closely related to EES geometric proportion. We observed that the elder spine which is rich in yellow marrow was showed lower perfusion. The phenomenon may be relate to arteriosclerosis, which could lead to ischemia, stimulate yellow marrow conversion simultaneously.

Conclusion: The analysis of DCE-MRI dates which based on permeability of vessel allows detecting both the permeability and the perfusion of VBM. The quantitative parameters (K^{trans},K_{ep} and V_e)were significantly associated with vertebral level and significantly influenced by age, which could lay a foundation for the further research of vertebral marrow perfusion.

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