Diffusion tensor imaging and fiber tractography in cervical spondylotic myelopathy at 3.0T: correlation with clinical symptoms in 104 cases

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Purpose

Cervical spondylotic myelopathy (CSM) is a common disease which can lead to severe functional impairment. But in the early stage, without high signal changes in T2WI, conventional MRI can't evaluate the degree of spinal cord injury; even if with high signal in T2WI, it is still unable to quantitatively analyze the severity of spinal cord injury. Therefore, it is necessary to take a developed MR technique to detect the early changes of compressive spinal cord at the molecular level. In our study, the purpose is to evaluate the correlation of diffusion tensor imaging (DTI) parameters and fiber tractography with clinical symptoms in patients with cervical spondylotic myelopathy (CSM) at 3.0T.

Methods and Materials

Conventional MRI and DTI were performed in 104 patients with CSM. According to the Japanese Orthopaedic Association (JOA) score, the patients were devided into four groups: mild, moderate, severe and extreme group. The patients were divided into 3 groups based on the spinal cord signal intensity at the lesion level: (A) normal signal intensity in T1WI and T2WI; (B) normal signal intensity in T1WI and hyperintensity in T2WI; (C) hypointensity in T1WI and hyperintensity in T2WI. Apparent diffusion coefficient (ADC), fractional anisotropy(FA), #1, #2, #3 were measured at the most stenotic level. Fiber tractography was performed using functool software.

Results

FA values were positively correlated with JOA score (P<0.05), but ADC, #1, #2 and #3 had no correlation with JOA score (P>0.05). FA showed statistically significant differences among the JOA score groups (P<0.05) and A, B, C groups (P<0.05). The differences in ADC, #2 and #3 between mild and moderate groups were not significant, while significant differences were found among moderate, severe and extreme groups (P<0.05) and A, B, C groups (P<0.05). No significant differences were found in #1 among groups. The damage of fiber bundle was more obvious with FA reduction.
**Fig. 1:** The DTI parameter maps of the normal cervical spinal cord. The T2 map shows no cervical disc protrusion or bulge, and no abnormal intramedullary signal. The FA map at the C4/C5 level clearly reveals the dark red intramedullary signal and blue cerebral blood fluid (CSF) signal. The ADC map demonstrates the blue-green signal of the spinal cord and nerve roots, and also the yellow signal of the CSF. The #2, #3 maps shows the light yellow signal of the spinal cord, reddish yellow signal of the nerve roots, and the dark red signal of the CSF. The #1 map shows the light yellow signal in the center of the spinal cord, much lighter with smaller diameter compared to those in the #2 and #3 maps. The pericentral spinal cord is shown as dark red in the #1 map and covering larger area compared to those in the #2 and #3 maps. The DTT map and its local magnified map demonstrate the intact morphology of the spinal fiber bundles.
Fig. 2: The DTI parameter maps of patients in the mild JOA group. The T2 map shows multiple cervical disc protrusions, compressed spinal cord, but no increased intramedullary signal. The FA map at the C4/C5 level shows the dark red medullary signal with irregular shape. The ADC map reveals the distorted blue in the center of the spinal cord. The #1, #2, and #3 maps demonstrate the light yellow central medullary signal becomes irregular in shape and smaller in area. The DTT map and its local magnified map reveal the sparse local fiber bundle (as indicated by the arrow).

Fig. 3: The DTI parameter maps of patients in the severe JOA group. The T2 map shows posteriorly convex cervical vertebrate curvature and the degenerative high intramedullary
T2 signal. The FA map at the C5/C6 level demonstrates irregular dark red signal in the center of the spinal cord with narrow vertebral canal. The ADC map reveals the normal blue-green signal of the spinal cord and nerve roots is replaced with irregular green signal. The #1, #2, and #3 maps show the yellow medullary signal covering much smaller area than that in the normal maps. The DTT map and its local magnified map show irregular morphology of the spinal fiber bundle with multiple broken segments (as indicated by the arrow).
Conclusion

FA values and fiber bundle abnormalities are positively correlated with clinical symptoms. FA and fiber tractography are more sensitive than conventional T2-weighted imaging for cervical cord injury and clearly reflect the severity and range of the injured spinal cord.

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