MRI finding of spinal cord injury with wallerian degeneration

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Aims and objectives

Several types of neurological deterioration may be found after spinal cord injury. During the first few hours and days, edema or other secondary changes can be a cause, and during the first few weeks, subacute progressive ascending myelopathy can occur even if its rarity [1]. After then, late delayed complications, such as progressive post-traumatic cystic myelopathy or progressive post-traumatic myelomalacic myelopathy may produce after months, years, or even decades [1]. Besides, wallerian degeneration may be another cause, responsible for delayed neurologic symptom in a patient with spinal cord injury [2].

Wallerian degeneration is secondary degeneration of axons and myelin sheaths from numerous other causes, including infarction, hemorrhage, neoplasm, and demyelinating disease [2]. Until now, only a postmortem study and several case reports described the characteristic MRI findings of wallerian degeneration in spinal cord. They showed increased signal intensity on T2-weighted images in the dorsal columns above and lateral column below the injury site, which is visible on MRI at least 7 weeks after injury [2,3].

The analysis of MRI findings of spinal cord injury with wallerian degeneration can be helpful for understanding the delayed neurological symptoms, correlating with abnormal signal intensity in spinal cord on MRI. Also, it can be a parameter for severity of initial cord injury which can be used for predicting prognosis, and another differential diagnosis of spinal intramedullary lesion in patients with spinal cord injury.

Therefore, we evaluated the clinical and MRI findings of spinal cord injury with wallerian degeneration.
Methods and materials

We retrospectively reviewed eleven MRIs of eight patients who were diagnosed as wallerian degeneration of spinal cord by imaging criteria after spinal cord trauma, between May 2009 and March 2014. The imaging criteria of wallerian degeneration we applied was high signal intensity on T2 weighted images along dorsal columns above the injury site or lateral columns below the injury site, at least 7 weeks after primary injury.

The exam time that wallerian degeneration was appeared, site, and image findings of wallerian degeneration were evaluated with axial and sagittal T1/T2 weighted images with a consensus by two radiologists. We also reviewed primary injury site, including combined intramedullary hemorrhage at initial MRI, injury level, axial and craniocaudal extent, and chronic changes of spinal cord such as myelomalacia, atrophy, syrinx, and cyst at initial and follow up MRI.

Additionally, we reviewed medical record to get an American Spinal Injury Association (ASIA) impairment scale at first examination for each person. ASIA impairment scale, a tool for neurologic assessment clinically, is categorized in 5 groups from A to E. Grade A is complete loss of sensory or motor function in the sacral segments S4-S5, grade B is only sensory function is preserved, but not motor function, below the neurological level including sacral segments S4-S5, grade C is preserved motor function below the neurological level, and more than half of key muscles below the neurological level have a muscle grade 3, grade D is preserved motor function below the neurological level, and at least half of key muscles below the neurological level have a muscle grade 3, and grade E is preserved sensory and motor function normally.
Results

Among eight patients we reviewed, five patients had cervical spinal cord injury and three patients had thoracic spinal cord injury. Wallerian degeneration was found on eleven MRIs of eight patients which had scanned from 10 weeks to 23 years after spinal cord injury. All MRIs showed high signal intensity at dorsal columns above the injury site and only one MRI exhibited combined high signal intensity at lateral columns below the injury site. On follow up MRI (n=3), wallerian degeneration were progressed more cranially from injury site and changed from ill defined to well defined margin.

On the other hand, all eight patients showed hemorrhagic spinal cord contusion initially and seven patients showed severe parenchymal loss of spinal cord at injury site on follow up MRI. Also, all they showed myelomalacia at primary injury site, involving less than three segments craniocaudally. Seven patients showed more than two thirds and one patient showed half of axial extent at the most extensively myelomalatic plane. But, there was no patient with syrinx and only one patient showed a cyst in injury site on follow up MRI.

In clinically, seven patients showed grade A and one patient showed grade D of neurologic status in ASIA impairment scale.
Fig. 1: Fig. 1. MR images of 17-year-old girl with wallerian degeneration of spinal cord after trauma. A and B. T2-weighted image(A) and Gradient image(B) shows contusional injury with petechial cord hemorrhage at C5 level on initial MRI. C and D. Follow up T2-weighted image after 11 months. C shows post traumatic myelomalacia with mild cord atrophy at C4-5 and D shows wallerian degeneration at C3 level, involving posterior column above the injury site. References: Department of Radiology, Inha University hospital - Incheon/KR 2013-2014.

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Fig. 2: Fig. 2. T2-weighted MR images of 51-year-old woman with wallerian degeneration of spinal cord appeared at 2 years after trauma. A. Post traumatic myelomalacia with mild cord atrophy is seen at C4 level. B and C. High signal intensity involving bilateral posterolateral column of spinal cord is appeared at C7-8 level, below the injury site, suggesting wallerian degeneration. References: Department of Radiology, Inha University hospital - Incheon/KR 2012.

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Fig. 3: Fig. 3. T2-weighted MR images of 54-year-old man with wallerian degeneration of spinal cord after trauma. A and B. A shows post traumatic myelomalacia at T9 level and B shows wallerian degeneration of posterior column at T1-2 level at 3 months after trauma. C. Wallerian degeneration at T1-2 level is more discrete on follow up MRI after 2 months later. References: Department of Radiology, Inha University hospital - Incheon/KR 2011.

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Conclusion

Wallerian degeneration of spinal cord is shown more commonly in posterior column at cranial direction than lateral column at caudal direction and closely related with initial hemorrhagic contusion and chronic myelomalacic change at primary injury site.
References


