Journal of Clinical Neuroscience xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

Journal of Clinical Neuroscience

journal homepage: www.elsevier.com/locate/jocn

Case report

Symptom-associated change of motor-related neuromagnetic fields in a patient with multiple sclerosis: A case report

Ji Hee Kim [a,1], Bong Soo Kim [b,1], Su Jeong Hwang [c], Won Seok Chang [c], Ki Woong Kim [d], Hyuk Chan Kwon [d], Yong Ho Lee [d], Jin Woo Chang [c,*]

[a] Department of Neurosurgery, Hallym University Sacred Heart Hospital, Anyang, Gyeonggi-do, Republic of Korea
[b] EIT/LOFUS R&D Center, International St. Mary's Hospital, Catholic Kwandong University, Incheon, Republic of Korea
[c] Department of Neurosurgery, Brain Research Institute, Yonsei University College of Medicine, Seoul, Republic of Korea
[d] Korean Research Institute of Standard and Science (KRISS), Daejeon, Republic of Korea

ARTICLE INFO

Article history:
Received 14 November 2017
Accepted 8 January 2018
Available online xxxx

Keywords:
Demyelinating disease
Magnetoencephalography
Multiple sclerosis
Neuromagnetic field
Demyelination

ABSTRACT

The objective of this study was to investigate functional abnormalities of the brain in a patient with multiple sclerosis (MS) by using magnetoencephalography (MEG) and a finger-tapping task. A 46-year-old woman that presented with motor weakness of left hand and was diagnosed with MS. Conventional magnetic resonance imaging demonstrated a white matter lesion with hyperintensity on T2-weighted images in the right motor area. MEG recordings were performed during the period of motor weakness and after clinical improvement. Neuromagnetic brain activation was elicited by a simple, visually cued finger movement. The Equivalent current dipole (ECD) strength of the movement-evoked field (MEF) in the affected hemisphere was significantly decreased relative to the unaffected hemisphere. After improvement in motor weakness, we found that the lower amplitude of the readiness field and decreased ECD strength of the MEF observed in affected hemisphere during motor weakness had recovered. Analysis of motor-related neuromagnetic fields revealed that MEG may be used to detect diffuse changes in the brain that are not observable by conventional imaging of white matter regions in MS. We further found that brain activities can change after improvement in motor weakness.

1. Introduction

Multiple sclerosis (MS), is a chronic and disabling disease of the central nervous system (CNS) characterized by loss of motor and sensory function, that results from immune-mediated inflammation leading to demyelination and subsequent axonal damage [1]. The prevalence of the disease varies in different regions of the globe, ranging from 15/100,000 to 250/100,000 [1]. There are approximately 400,000 cases of MS in the USA, or 0.1% of the general population. The age of onset is in young adulthood (ages 20–40 years), and women are affected more commonly than men [2]. Clinically, most MS patients experience recurrent episodes (relapses) of neurological impairment, but in most cases (60–80%) the course of the disease becomes chronic and progressive with time, leading to cumulative motor disability, and cognitive deficits [1].

Imaging techniques, in particular conventional magnetic resonance imaging (MRI), play an important role in the diagnosis and management of MS and related demyelinating diseases. Although MRI is a highly useful tool in providing in vivo measures of disease-related activity, there are some important limitations of MRI findings in MS, including the non-specific nature of detectable white matter changes and the poor correlation with clinical disability [2]. In addition, conventional MRI is unable to provide accurate estimates of damage outside focal lesions, and cannot be used to identify the mechanisms through which the CNS recovers following tissue injury. In contrast, structural, metabolic, and functional neuroimaging techniques are able to provide new markers that are more closely linked to the pathologic features of the disease, and may therefore in part overcome the limitations of conventional MRI [3]. Nevertheless, there have been relatively few metabolic or functional neuroimaging studies of MS patients.

In this study, we investigated the motor-related neuromagnetic field, during a finger-tapping task in a patient with MS, who showed motor impairment of left upper extremity associated with a focal lesion of the primary motor area. We characterized difference in neuromagnetic fields between the affected and unaffected

* Corresponding author at: Yonsei University College of Medicine, 50 Yonsei-ro, Seodaemungu, Seoul 03722, Republic of Korea.
E-mail address: JCHANG@yuhs.ac (J.W. Chang).
[1] Ji Hee Kim and Bong Soo Kim contributed equally to this study.

https://doi.org/10.1016/j.jocn.2018.01.060
0967-5868/

hemispheres by comparing imaging data. In addition, we assessed the changes in neuromagnetic fields observed after improvement in motor impairment.

2. Case report

A 46-year-old woman presented to our center with a five-day history of left hand weakness and facial palsy. MRI revealed a T2-weighted hyperintense white matter lesion with incomplete rim enhancement in the primary motor area (Fig. 1). This finding was compatible with demyelination. Cerebrospinal fluid (CSF) analysis showed normal protein and cell counts, as well as a serum antinuclear antibody test. The presence of oligoclonal bands was not observed by electrophoresis of the CSF, while the anticardiolipin antibody result was low positive (23.1). Results of the patient's neurologic examination were normal, except for motor function. A history of a vaccination six months prior to the development of neurological symptoms supported the diagnosis of MS. The patient was treated with high doses of intravenous corticosteroids (methylprednisolone 1 gm per day for 5 days). Subsequently she was treated with a one-month course of oral prednisone. One month later, the patient's condition gradually improved. A follow-up MRI one month later revealed no new lesions and the hyperintense lesion had visibly reduced in size on T2-weighted images with little enhancement (Fig. 2).

Neuromagnetic signals were recorded using a whole-head magnetoencephalography (MEG) system (KRISS, Daejeon, Korea) located in a magnetically shielded room. This system consists of 152 axial first-order gradiometers in a helmet shaped array. All measurements were carried out with the patient in a sitting position. MEG data were acquired with a sampling rate of 1000 Hz and filtered from 0.1 to 100 Hz. Head position was determined from four head position indicator (HPI) coils secured to an elasticized cap placed on the patient's head. To determine the exact location of the head with respect to the MEG sensors, an electric current was fed to the HPI coil, and the resulting magnetic fields were measured with the MEG sensors. These procedures allowed for alignment of the individual head coordinate system with the MEG coordinate system. The location of the HPI coils with respect to the three anatomical landmarks (nasion and bilateral preauricular points) was also measured using a three- dimensional digitizer to align the MEG coordinate systems with MR images, obtained with a 1.5 T MR imaging system. During the MEG recordings, the patient was seated at a viewing distance of 1 m from the projection screen for visual stimulus presentation. The patient was instructed to press a button with her index finger when the visual stimulus appeared on the screen. The visual stimuli were presented for 100 ms and inter-stimulus intervals varied randomly between 1.9 and 2.1 s. The task lasted 10 min to collect approximately 300 trials, and then repeated with the opposite hand.

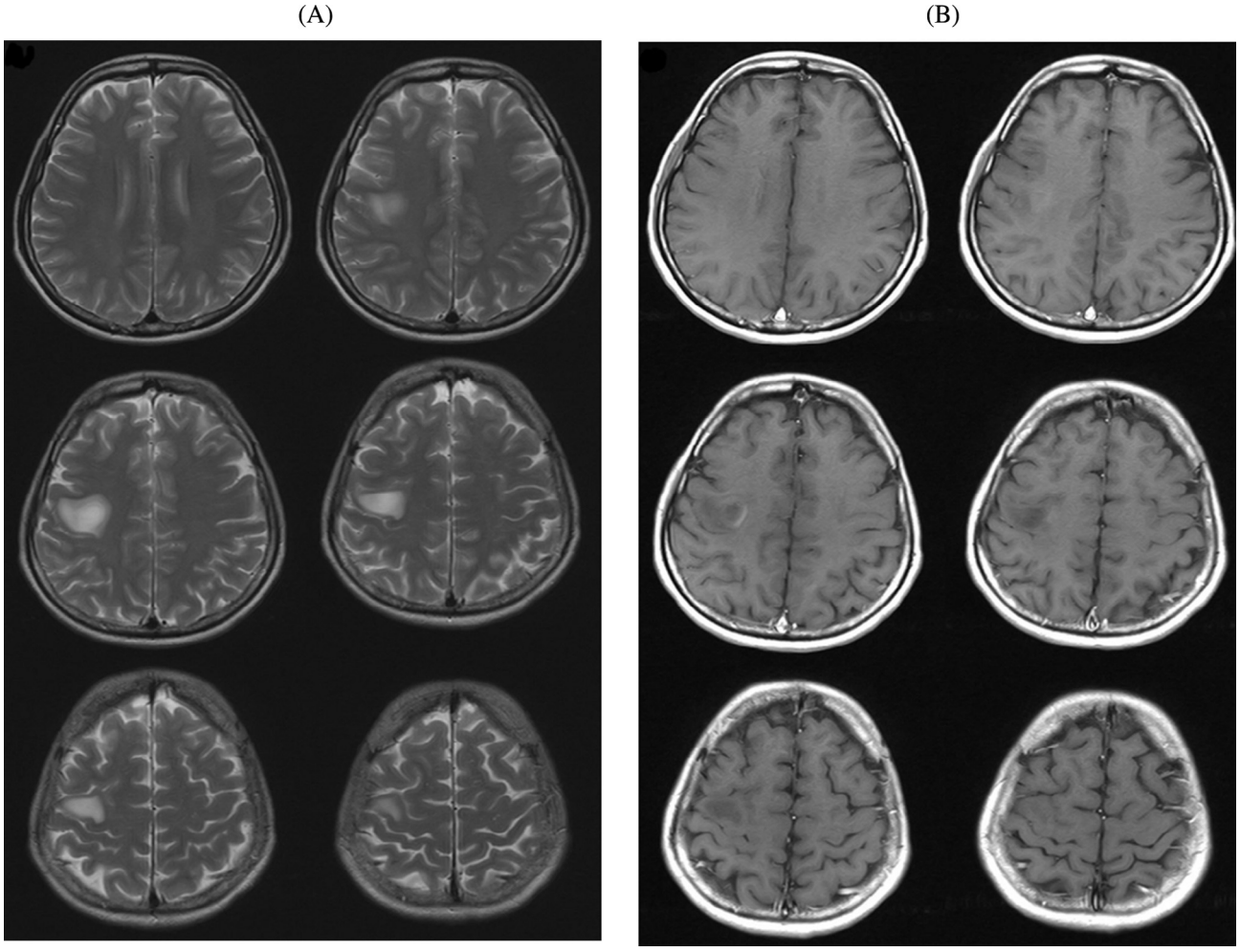

Fig. 1. Magnetic resonance images taken at the time symptom onset. (A) A T2-weighted MRI showed hyperintense lesion in the white matter of the right frontal lobe. (B) A contrast injection revealed that this lesion showed an incomplete rim enhancement.

Please cite this article in press as: Kim JH et al. Symptom-associated change of motor-related neuromagnetic fields in a patient with multiple sclerosis: A case report. J Clin Neurosci (2018), https://doi.org/10.1016/j.jocn.2018.01.060