Recovery of injured corticoreticulospinal tract following cranioplasty in an ischemic stroke patient: a diffusion tensor tractography study

The corticoreticular pathway (CRP), which mainly mediates proximal and axial muscles, is an important neural tract for gait and postural stability, whereas the corticospinal tract is mainly involved in control of the distal muscles (Jang et al., 2005). Since development of diffusion tensor tractography (DTT), which is derived from diffusion tensor imaging (DTI), a few studies have demonstrated injury of neural tracts following cranioplasty in patients with stroke. In the current study, we report on a stroke patient who underwent decompressive craniectomy showed recovery of the CRT, using DTT.

A 48-year-old right-handed male was diagnosed with infarction in the left middle cerebral artery (Figure 1A). He underwent decompressive craniectomy for management of brain swelling at 2 days after onset. Three weeks later, he was transferred to the rehabilitation department of the same hospital. The patient exhibited right hemiplegia (shoulder abductor: 0, elbow flexor: 0, finger flexor: 0, hip flexor: 0, knee extensor: 0, ankle dorsiflexor: 0) (Paternostro-Sluga et al., 2008). He underwent comprehensive rehabilitation for 5 weeks, however, his right hemiplegia was not recovered (shoulder abductor: 0, elbow flexor: 0, finger flexor: 0, hip flexor: 0, knee extensor: 0, ankle dorsiflexor: 0). The patient underwent cranioplasty using auto-bone 8 weeks after onset. After cranioplasty, his motor weakness of the right leg recovered as follows without motor recovery of the right arm: 10 weeks after onset (2 weeks after cranioplasty); hip flexor: 2, knee extensor: 2, ankle dorsiflexor: 2. He received comprehensive rehabilitative management (movement therapy – physical and occupational therapy, neuromuscular electrical stimulation etc.) in the same university hospital and a local rehabilitation hospital. At 6 months after onset (4 months after cranioplasty), he showed motor recovery of the right leg without recovery of the right arm (hip flexor: 3, knee extensor: 3, ankle dorsiflexor: 2). As a result, he became able to walk with mild assistance. This study was conducted retrospectively, and approval for the study was obtained from the Institutional Review Board of Yeungnam University Hospital (YUMC 2015-07-065-011) on August 28, 2015. The patient signed informed consent.

Diffusion tensor imaging (DTI) was performed twice (2 days before and 10 days after cranioplasty) using a 6-channel head coil on a 1.5T Philips Gyroscan Intra (Philips, Amsterdam, the Netherlands) with single-shot echo-planar imaging. For analysis of the corticoreticulospinal tract (CRT) – the first region of interest (ROI) – was placed on the reticular formation and second ROI was placed on the tegmentum. Termination criteria used for fiber tracking were fractional anisotropy (FA) < 0.15, and angle < 27.

On the pre-cranioplasty diffusion tensor tractography (DTT), discontinuations of the CRTs (the right CRT: the brain stem level, and the left CRT: the subcortical white matter level) were observed compared with a normal subject (49-year-old male). On the post-cranioplasty DTT, the discontinued right CRT was extended to the cerebral cortex level and the transcallosal fibers of the discontinued left CRT were thickened (Figure 1B). In this study, on follow-up DTTs, because the right CRT was extended to the cerebral cortex with thickening of transcallosal fibers of the left CRT concurrently with the motor recovery of the right leg, which is the main function of the CRT, it appeared that the changes of both CRTs mainly contributed to the patient’s motor recovery of the right leg (Miyai et al., 2002; Jang and Seo, 2014). Cranioplasty can restore physiological intracranial dynamics by restoration of the contour of the skull. Thus, it is plausible that the reconstructed skull improves cerebral perfusion of the underlying lobes (Shahid et al., 2018). As a result, we think that cranioplasty contributed at least partly to the recovery of the right CRT in this patient. However, the limitations of DTT should be considered. Because regions of fiber crossing and crossing can prevent full reflection of the underlying fiber architecture, DTT may underestimate or overestimate the fiber tracts (Yamada et al., 2009). In conclusion, the injured CRTs were recovered concurrently with motor recovery of the affected leg after cranioplasty in a stroke patient who underwent decompressive craniectomy. To the best of our knowledge, this is the first study to demonstrate recovery of an injured CRT following cranioplasty in stroke patients.

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