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Corticoreticular tract lesion in children with developmental delay presenting with gait dysfunction and trunk instability

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Abstract
The corticoreticular tract (CRT) is known to be involved in walking and postural control. Using diffusion tensor tractography (DTT), we investigated the relationship between the CRT and gait dysfunction, including trunk instability, in pediatric patients. Thirty patients with delayed development and 15 age-matched, typically-developed (TD) children were recruited. Fifteen patients with gait dysfunction (bilateral trunk instability) were included in the group A, and the other 15 patients with gait dysfunction (unilateral trunk instability) were included in the group B. The Growth Motor Function Classification System, Functional Ambulation Category scale, and Functional Ambulation Category scale were used for measurement of functional state. Fractional anisotropy, apparent diffusion coefficient, fiber number, and tract integrity of the CRT and corticospinal tract were measured. Diffusion parameters or integrity of corticospinal tract were not significantly different in the three study groups. However, CRT results revealed that both CRTs were disrupted in the group A, whereas CRT disruption in the hemispheres contralateral to clinical manifestations was observed in the group B. Fractional anisotropy values and fiber numbers in both CRTs were decreased in the group A than in the group TD. The extents of decreases of fractional anisotropy values and fiber numbers on the ipsilateral side relative to those on the contralateral side were greater in the group B than in the group TD. Functional evaluation data and clinical manifestations were found to show strong correlations with CRT status, rather than with corticospinal tract status. These findings suggest that CRT status appears to be clinically important for gait function and trunk stability in pediatric patients and DTT can help assess CRT status in pediatric patients with gait dysfunction.

Key Words: *nerve regeneration; corticoreticular tract; corticospinal tract; gait; trunk; diffusion tensor; Trunk Control Measurement Scale; Functional Ambulation Category; Growth Motor Function Classification System; cerebral palsy; motor; neural regeneration*

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Introduction
Gait dysfunction is the most frequent motor problem in the pediatric rehabilitation field. The main motor pathways are classified as the corticospinal tract (CST, pyramidal tract) and the non CST (extrapyramidal tract) (Lessek, 1948; de Oliveira-Souza, 2012). The main function of the CST is to control voluntary movements of the distal extremities (Lessek, 1948; Son et al., 2009), and in particular, the CST is known to be critically related to the fine motor activities of the hands (Son et al., 2007; Yeo et al., 2014). Interestingly, there is evidence that stroke patients are able to walk even after complete injury to the lateral CST (Cho et al., 2012), and gait function, which is mainly related to trunk and leg motor function, is less dependent on the CST than hand function (Yeo et al., 2014). Non-CSTs are more involved in gait (Matsuyama et al., 2004; Jang, 2010; de Oliveira-Souza, 2012; Yeo et al., 2014). The cortico-reticulospinal tract, one of the non-CSTs, is known to be important for locomotion control. This tract consists of the cortico-reticular and reticulo-spinal tracts, and sends signals to the spinal cord through the reticulo/vestibule/rubrospinal tracts (Shik and Orlovsky, 1976; Jang, 2010). Furthermore, the cortico-reticulospinal tract is involved in walking and postural control because it regulates proximal and axial muscles (Matsuyama et al., 2004; Yeo et al., 2014).

The corticoreticular tract (CRT) originates from the premotor cortex (PMC), descends through the corona radiata and the posterior limb of the internal capsule anterior to the CST, and passes through the tegmentum in the midbrain to terminate at the pontomedullary reticular formation in the pons (Yeo et al., 2012). Several studies have reported a strong association between PMC injury and gait dysfunc-

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