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Peripheral cross-neurotization inducing unaffected hemisphere reorganization to enhance the motor control of the spastic hemiplegic hand in central neurologic injury

Wen-Dong Xu
Fudan University, China

Background: Central neurologic injury resulting from different etiological factors (stroke, traumatic brain injury, cerebral palsy) is the main cause of long-term disability. Spontaneous motor recovery would occur at the acute stage predominantly in the initial weeks to the first three months, but continue at a slower pace throughout the years. The activation of ipsilateral motor structures, including primary motor and premotor cortex has been reported to be beneficial to the performance in the chronic stage of central neurologic injury. It could be a novel approach to the medical problem to enhance the unaffected hemisphere control. Our research on brachial plexus roots avulsion demonstrated that ipsilateral motor cortex was capable of controlling both the affected and healthy hand following the peripheral cross-neurotization. Based on the discovery, peripheral cross-neurotization was performed to treat the hemiplegic hands after central neurologic injury for the first time.

Methods: The peripheral cross-neurotization was performed on six spastic hemiplegic patients suffering from different etiological factors such as peri-operative stroke, perinatal asphyxia and central nervous system infection, whose affected arm's function had made little improvement despite their regular outpatient physical and occupational therapies. The six patients were examined for a 24-month period of follow-ups, the spastic evaluation conducted using Modified Ashworth Scale (MAS); the functional use of the affected arm evaluated based on Quality of Upper Extremity Skills Test (QUEST); the peripheral regeneration examined via electromyography; and the cortical reorganization investigated with transcranial magnetic stimulation (TMS), positron emission tomography (PET) and functional magnetic resonance imaging (fMRI).

Results: After a 24-months period of follow-ups, all the patients showed evident improvements in extension of the elbows and wrists; 2 of them showed great improvements in forearm rotation. Scores in both QUEST and MAS tests had been significantly improved at final visit, reflecting the peripheral cross-neurotization could strengthen extension power and improved the motor coordinate of the whole upper extremity in hemiplegia. Longitudinal PET correlation results showed that the intact hemisphere contributed to the motor recovery after surgical treatment. TMS and fMRI studies demonstrated that a new motor control focus of the paralyzed arm occurred in the ipsilateral motor area.

Conclusion: Peripheral cross neurotization to induce intrahemispheric cortical reorganization, as a novel surgical approach, could help control the affected hand in hemiplegia resulting from central neurologic injury. As indicated by the literature, it was the first time to treat the central neurologic injury at a peripheral level.

wendongxu88@yahoo.com.cn