論 文 要 旨

Reaching exercise for chronic paretic upper extremity after stroke using a novel rehabilitation robot with arm-weight support and concomitant electrical stimulation and vibration: before-and-after feasibility trial

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Abstract

Background: Our group developed a rehabilitation robot to assist with repetitive, active reaching movement of a paretic upper extremity. The robot is equipped with a servo motor-controlled arm-weight support and works in conjunction with neuromuscular electrical stimulation and vibratory stimulation to facilitate agonist-muscle contraction. In this before-and-after pilot study, we assessed the feasibility of applying the robot to improve motor control and function of the hemiparetic upper extremity in patients who suffered chronic stroke.

Methods: We enrolled 6 patients with chronic stroke and hemiparesis who, while sitting and without assistance, could reach 10 cm both sagitally and vertically (from a starting position located 10 cm forward from the patient's navel level) with the affected upper extremity. The patients were assigned to receive reaching exercise intervention with the robot (YASKAWA Electric Co., Ltd. Fukuoka, Japan) for 2 weeks at 15 minutes/day in addition to regular occupational therapy for 40 minutes/day. Outcomes assessed before and after 2 weeks of intervention included the upper extremity component of the Fugl-Meyer Assessment (UE-FMA), the Action Research Arm Test (ARAT), and, during reaching movement, kinematic analysis.

Results: None of the patients experienced adverse events. The mean score of UE-FMA increased from 44.8 [SD 14.4] to 48.0 [SD 14.4] ($p = 0.026$, $r = 0.91$), and both the shoulder-elbow and wrist-hand scores increased after 2 weeks intervention. An increase was also observed in ARAT score, from mean 29.8 [SD 16.3] to 36.2 [SD 18.1] ($p = 0.042$, $r = 0.83$). Kinematic analysis during the reaching movement revealed a significant increase in active range of motion (AROM) at the elbow, and movement time tended to decrease. Furthermore, trajectory length for the wrist ("hand path") and the acromion ("trunk compensatory movement") showed a decreasing trend.

Conclusions: This robot-assisted modality is feasible and our preliminary findings suggest it improved motor control and motor function of the hemiparetic upper extremity in patients with chronic stroke. Training with this robot might induce greater AROM for the elbow and decrease compensatory trunk movement, thus contributing to movement efficacy and efficiency.

Trial registration: UMIN Clinical Trial Registry, as UMIN000018132, on June 30, 2015. https://upload.umin.ac.jp/cgi-open-bin/ctr/ctr_view.cgi?recptno=R000020398

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