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Development of Magnet-Based Rehabilitation Device for Recovery of Hand Function after Stroke

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Purpose
We proposed a novel one-dimensional rehabilitation device using electromagnetic control system for the recovery of hand function after stroke.

Methods
When an electric current is applied to a coil in an electromagnetic control system, a magnetic field is generated in coil. Between this magnetic field and the magnet, the attractive force or repulsive force act by the electromagnetic phenomena. A Method of flexing or extending fingers by using the magnetic force between the magnetic field and the permanent magnet was devised. To attach the magnets to the fingers, a magnet structure was fabricated using a 3D printer and elastic band. When flexing the fingers, magnets were attached to the palm so that the magnets could be attracted to each other and the fingers could flex more effectively. Four patients with hand motor grade 0 after stroke within 1-month had hand rehabilitation therapies for 2 weeks. The finger training consisted of various motions such as finger flexion, extension, opposition, and lateral deviation, and conducted for 30 minutes per day.

Results
For finger extension, the magnets are placed below the fingers to extend as much as possible. To verify the above Method, we investigated the magnetic field distribution in the coil through simulation and observed how the fingers were flexed and extended through the experiment. First, to investigate the force during the rehabilitation, the magnitude of the magnetic force acting between the magnet on finger and the magnetic field generated by coil was measured along the movement trajectory of the finger. Second, the magnitude of the magnetic force acting between the finger magnet and the auxiliary magnets on the palm and below the finger without applying current to the coil was measured along the movement trajectory as well. Finally, the magnitude of the magnetic force was measured according to the movement trajectory when the current was applied to the coil and magnets were added on the palm and below the fingers. 10-session hand training by this device improved gross finger motion without any complications for all participating patients.

Conclusion
We have developed a novel hand rehabilitation device, and it can be safely applied to hemiplegic patients to improve hand function after stroke.