新たなリハビリテーションデバイスは脳卒中後の運動技能を改善する（Abstract: SSE17-06）

思考を上肢を動かす電気インパルスに変換する新たなリハビリテーションデバイスは脳卒中患者に有益である

Stroke patients benefit from novel rehabilitation device that converts their thoughts to electrical impulses to move their upper extremities

個々人の思考を上肢を動かす電気インパルスに変換する新たな脳卒中リハビリテーションデバイスを用いることにより、脳卒中患者の運動機能および日常生活動作の施行能力が改善したと2013年Radiological Society of North America年次集会で発表された。研究者らは、脳卒中により片方の手に障害を負った8人の患者を組み入れ、彼らのリハビリテーションデバイスに関する小規模な臨床試験を行った。また患者らの異常のない方の手をコントロールとした。それぞれの患者が新たなデバイスを用いて2～3時間のリハビリテーションセッションを3～6週間にわたり9～15回受けた。中等度重症度の脳卒中の患者においてリハビリテーションセッション後に運動機能が最も大きく改善した。軽症および重症の脳卒中と診断された患者らはリハビリテーション後には日常生活動作を完全に行えるほどに改善したと報告した。リハビリテーション前後のfMRI結果の比較から運動機能を司る脳領域の再構築が認められた。リハビリテーション過程中の拡張テンソル画像から線維路の整合性が徐々に強化されることが示された。

Full Text

Using a novel stroke rehabilitation device that converts an individual's thoughts to electrical impulses to move upper extremities, stroke patients reported improvements in their motor function and ability to perform activities of daily living. Results of the study were presented at the 2013 annual meeting of the Radiological Society of North America (RSNA).

"Each year, nearly 800,000 people suffer a new or recurrent stroke in the United States, and 50 percent of those have some degree of upper extremity disability," said Vivek Prabhakaran, M.D., Ph.D., director of functional neuroimaging in radiology at the University of Wisconsin-Madison. "Rehabilitation sessions with our device allow patients to achieve an additional level of recovery and a higher quality of life."

Dr. Prabhakaran, along with co-principal investigator Justin Williams, Ph.D., and a multidisciplinary team, built the new rehabilitation device by pairing a functional electrical stimulation (FES) system, which is currently used to help stroke patients recover limb function, and a brain control interface (BCI), which provides a direct communication pathway between the brain and this peripheral stimulation device.

In an FES system, electrical currents are used to activate nerves in paralyzed extremities. Using a computer and an electrode cap placed on the head, the new BCI-FES device (called the Closed-Loop Neural Activity-Triggered Stroke Rehabilitation Device) interprets electrical impulses from the brain and transmits the information to the FES.

"FES is a passive technique in that the electrical impulses move the patients' extremities for them," Dr. Prabhakaran said. "When a patient using our device is asked to imagine or attempt to move his or her hand, the BCI translates that brain activity to a signal that triggers the FES. Our system adds an active component to the rehabilitation by linking brain activity to the peripheral stimulation device, which gives the patients direct control over their movement."

The Wisconsin team conducted a small clinical trial of their rehabilitation device, enlisting eight patients with one hand affected by stroke. The patients were also able to serve as a control group by using their normal, unaffected hand. Patients in the study represented a wide range of stroke severity and amount of time elapsed since the stroke occurred. Despite having received standard rehabilitative care, the patients had varying degrees of residual motor deficits in their upper extremities. Each underwent nine to 15 rehabilitation sessions of two to three hours with the new device over a period of three to six weeks.

The patients also underwent functional magnetic resonance imaging (fMRI) and diffusion tensor imaging (DTI) before, at the mid-point of, at the end of, and one month following the rehabilitation period. fMRI is able to show which areas of the brain are activated while the patient performs a task, and DTI reveals the integrity of fibers within the white matter that connects the brain's functional areas.

Patients who suffered a stroke of moderate severity realized the greatest improvements to motor function following the rehabilitation sessions. Patients diagnosed with mild and severe strokes reported improved ability to complete activities of daily living following rehabilitation.

Dr. Prabhakaran said the results captured throughout the rehabilitation process—specifically the ratio of hemispheric involvement of motor areas—related well to the behavioral changes observed in patients. A comparison of pre-rehabilitation and post-rehabilitation fMRI results revealed reorganization in the regions of the brain responsible for motor function. DTI results over the course of the rehabilitation period revealed a gradual strengthening of the integrity of the fiber tracts.

"Our hope is that this device not only shortens rehabilitation time for stroke patients, but also that it brings a higher level of recovery than is achievable with the current standard of care," Dr. Prabhakaran said. "We believe brain imaging will be helpful in both planning and tracking a stroke patient's therapy, as well as learning more about neuroplastic changes during recovery."

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