Biotech Innovations

Lightweight Exosuit Could Help Patients Walk After Stroke

Researchers at Harvard University and Boston University have developed a lightweight, soft robotic exosuit that improves gait in patients who have experienced a stroke.

In a small study of 9 patients who ranged from 9 months to more than 14 years poststroke, the exosuit worn on the partially paralyzed lower limb improved forward propulsion and ground clearance during treadmill and overground walking and reduced the energy required to walk. The research appeared in *Science Translational Medicine*.

The device attaches to the wearer with textile bands at the waist and calf, which are connected by a leg strap. Motors pull on cables that attach to a calf anchor and an insole in the wearer's shoe to help support movement. The heavier components—motors, pulleys, and batteries—are worn around the waist, making them easier to carry.

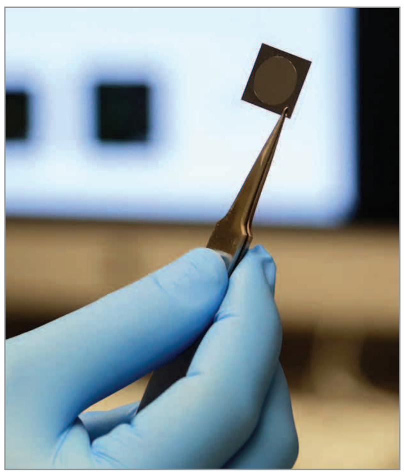
The exosuit also includes wearable sensors on the foot that identify key aspects of the gait cycle. This information is read by a small microprocessor that determines when to send power to the motors.

Because the system uses textiles on the limbs, it's less noticeable when powered off than existing rigid exoskeletons, according to Terry D. Ellis, PT, PhD, a lead author of the study and director of Boston University's Center for Neurorehabilitation. "In contrast, existing exoskeletons are heavy and difficult to move when they are not powered on," Ellis said in an email. "This makes our exosuit particularly well-suited for use by elderly and neurologically-impaired patients in community settings."

The research team envisions physical therapists could employ the exosuit in the early phases of stroke rehabilitation to help patients restore more normal walking patterns, which could improve their health outcomes. Patients could also continue to wear it after rehabilitation to get more practice walking. "Limitations in gait contribute to sedentary lifestyles which can reduce quality of life and increase risk of subsequent strokes," Ellis said.

Nanochip Turns Skin Into a Bioreactor

A nanochip that delivers genetic "cargo" to reprogram skin cells into different types of cells in vivo could one day be used to repair injured tissue or restore tissue function at the bedside, according to researchers at Ohio State University (OSU). The researchers dubbed the technology tissue nanotransfection (TNT) in a recent article in *Nature Nanotechnology*. Unlike other in vivo cell reprogramming technologies being researched, TNT does not employ viral vectors, which can cause inflammatory responses leading to cell death.



Clark Powell/The Ohio State University Wexner Medical Center

"The nanochip may be viewed as a series of tiny needles delivering the genetic code [target gene cDNAs/mRNAs] to cells in the tissue," said colead author Chandan K. Sen, PhD, director of the OSU Center for Regenerative Medicine and Cell-Based Therapies. "It takes less than a second to deliver using an electric pulse."

Working in mice, the researchers used a cocktail of genes to convert skin tissue into blood vessels to rescue an injured leg. They also switched mouse skin cells into nerve cells, which they injected into the rodents' brains to improve stroke-induced damage.

Next, they plan to test the feasibility of using TNT in an ischemic human limb that has been scheduled for amputation, which could lead to limb rescue studies. Although limb injuries and peripheral nerve injuries could be a good place to start in the clinic, "the scope of application is vast and does not exclude any organ," Sen said.

Expanded Tissue Samples Poised to Assist Pathologists

A novel method to physically expand small biopsy tissue samples could help pathologists predict and diagnose disease more accurately using light microscopy. Researchers at the Massachusetts Institute of Technology, Harvard Medical School, and the Broad Institute developed the method, called expansion pathology (ExPath).

In ExPath, clinical samples are attached to a polymer that swells when wet. An enzyme called proteinase K digests parts of the samples that are not of interest before water is added, swelling the remaining tissues. Expanded to 100 times their original volume, the larger specimens enable 70-nm-resolution imaging on conventional diffraction-limited microscopes. This level of resolution is currently limited to costly electron microscopes, which are rarely used in the clinic.

In a study reported in *Nature Biotechnology*, when human ExPath samples were used instead of unexpanded samples, pathologists and nonpathologists were able to more accurately classify diseased kidney tissues, and a machine learning algorithm was able to more accurately classify early breast neoplasms into diagnostic categories with differing risk of progression to invasive carcinoma.

According to the researchers, large-scale blinded studies using ExPath are still needed to determine if the method improves diagnoses. The technique must also be optimized for the fast-paced clinical setting, and computational approaches for efficiently analyzing the images further developed and validated, said researcher Andrew H. Beck, MD, PhD, a former associate professor of pathology at Harvard Medical School and now chief executive officer of PathAI, a company that develops artificial intelligence technology for pathology.

Beck said the digestion step is necessary to ensure even tissue expansion, but the technique may be further developed to preserve more biological information in the tissue samples. **– Jennifer Abbasi**

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