Major breakthrough in the treatment of Parkinson's disease: a neuroprosthetic to correct walking disorders

Neuroscientists and neurosurgeons at the EPFL/CHUV/UNIL, Inserm and the University of Bordeaux have designed a neuroprosthetic intended to correct walking disorders associated with Parkinson's disease. In a study published in *Nature Medicine,* the scientists set out in detail the process of developing the neuroprosthetic that has allowed a first patient with Parkinson's to be treated, enabling him to walk comfortably, confidently and without falling.

Disabling walking disorders occur in around 90% of persons who are at an advanced stage of Parkinson's disease. These walking disorders are often resistant to the treatments that are currently available. Marc, 62, has lived with Parkinson's for almost three decades. Dopamine and then the deep brain stimulation he received in 2004 dealt with his tremors and stiffness. More recently, he developed serious walking disorders which did not respond to dopamine or brain stimulation. "I practically could not walk anymore without falling frequently, several times a day. In some situations, such as entering a lift, I'd trample on the spot, as though I was frozen there, you might say."

Electric stimulation of the spinal cord

"The idea of developing a neuroprosthetic that stimulates the spinal cord electrically to harmonise the procedure and correct locomotor disorders in patients with Parkinson's is the result of several years of research on the treatment of paralysis due to spinal-cord injuries," explains Grégoire Courtine, professor of neuroscience at EPFL, the Lausanne University Hospital (CHUV) and UNIL. Unlike conventional treatments for Parkinson's which target the regions of the brain directly affected by the loss of dopamine-producing neurons, this neuroprosthetic targets the spinal area responsible for activating leg muscles while walking, which is not seemingly directly affected by Parkinson's disease.

"It is impressive to see how by electrically stimulating the spinal cord in a targeted manner, in the same way as we have done with paraplegic patients, we can correct walking disorders caused by Parkinson's disease", says Jocelyne Bloch, neurosurgeon and professor at the CHUV, UNIL and EPFL, and co-director of the .NeuroRestore centre with Grégoire Courtine.

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The implantation of this neuroprosthetic in a patient would not have been possible without the collaboration of Dr Erwan Bezard, neuroscientist at Inserm, affiliate at the CNRS and the University of Bordeaux, who has dedicated his career to understanding neurodegenerative diseases. His expertise in preclinical models of Parkinson's disease was essential to correctly produce the technological and conceptual developments required for clinical application in human beings.

"I'm not even afraid of the stairs anymore"

Two years ago, the team of scientists and doctors were ready, and a first patient was operated on, in Lausanne University Hospital (CHUV). After a precision neurosurgical procedure, Marc, from Bordeaux, was fitted with this new neuroprosthetic made up of an electrode field placed against the spinal cord, which controls walking, and an electrical impulse generator implanted under the skin of his abdomen. Using a targeted programming of spinal-cord stimulations which adapts in real time to his movements, Marc has quickly seen his walking disorder subside. After several weeks of rehabilitation with the neuroprosthetic, he is now able to walk almost normally. He currently uses his neuroprosthetic for around 8 hours a day, only turning it off when he is sitting down for a long period of time or when he is sleeping: "I turn on the stimulation in the morning and I turn off in the evening. This allows me to walk better and to stabilise. Right now, I'm not even afraid of the stairs anymore. Every Sunday I go to the lake, and I walk around 6 kilometres. It's incredible."

The challenge of large-scale use

This neuroprosthetic opens up new possibilities to deal with walking disorders that many people suffering from Parkinson's diseases are affected by, but at this stage the treatment concept has demonstrated its effectiveness in one person only, with an implant that still needs to be optimised for large-scale use. In partnership with ONWARD Medical, Grégoire Courtine and Jocelyne Bloch are working on developing a commercial version of the neuroprosthetic, including all the necessary functionalities for optimal everyday use. "Our ambition is to provide general access to this innovative technology to improve the quality of life of Parkinson's patients significantly, all over the world," they explain.

Furthermore, thanks to a generous donation of one million US dollars from the Michael J. Fox Foundation for Parkinson's research, the .NeuroRestore centre is going to carry out clinical tests on six new patients next year. These trials aim not only to validate the technology developed in collaboration with ONWARD, but also to identify the profiles of patients most likely to benefit from this innovative treatment. Founded by the actor Michael J. Fox ("Back to the Future"), who has Parkinson's disease, this foundation is the main private donor in the field of research into Parkinson's disease.

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About .NeuroRestore

.NeuroRestore is an R&D platform based in French-speaking Switzerland that develops neurosurgical approaches for restoring neurological function in people suffering from paraplegia, tetraplegia, Parkinson's disease or the consequences of stroke. The center is led by Grégoire Courtine, a neuroscientist at Ecole polytechnique fédéral de Lausanne (EPFL), and Jocelyne Bloch, a neurosurgeon at Lausanne University Hospital (CHUV) and University of Lausanne (UNIL). .NeuroRestore, founded in 2018, brings together engineers, doctors and scientists from EPFL, CHUV and UNIL, with the support of the Defitech Foundation. It draws on this pooled expertise to develop neurotherapies that can help patients recover motor function. Its innovative and personalized treatments are tested through research protocols and then made available to hospitals and patients. .NeuroRestore is also committed to training the next generation of health-care professionals and engineers on the use of these novel therapeutic approaches.

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