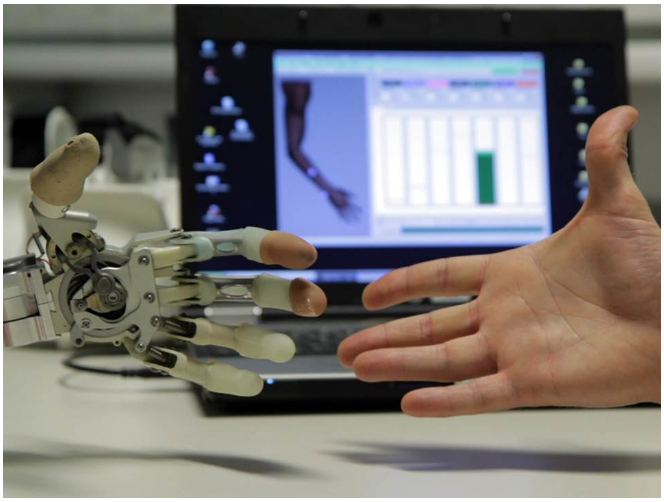
Bionic reconstruction: after amputation of a hand, muscles can be repurposed using nerve transfers

7 January 2019



Bionic reconstruction: after amputation of a hand, muscles can be repurposed using nerve transfers. Credit: Medical University of Vienna

Modern prostheses offer hand amputation patients much greater capability in everyday life than was possible with previous prosthetic reconstructive techniques. Redundant nerves from the amputated extremity can be surgically transferred to provide a much better connection between the patient's body and the prosthesis. This technique has proven to be successful, although the specific reasons were not fully understood. A team of researchers led by Konstantin Bergmeister and Oskar Aszmann from the Division of Plastic and Reconstructive Surgery and the Christian Doppler Laboratory for Recovery of Limb Function at MedUni Vienna, demonstrated in an animal model that the key to success lies in the muscle undergoing a change of identity triggered by the donor nerve.

Bionic prostheses are mentally controlled, registering the activation of residual muscles in the limb stump. Theoretically, it should be possible for the latest generation prostheses to execute the same number of movements as a healthy human hand. However, the link between man and prosthesis is not yet capable of controlling all mechanically possible functions, because the interface is limited in terms of signal transmission. "If we could solve this problem, the latest prostheses could actually become an intuitively operated replacement that functions just like a human hand," the researchers write.

To enable the prosthesis to move at all, nerves have to be surgically transferred during the amputation procedure to increase the total number of muscle control signals. This involves connecting amputated peripheral nerves to residual muscles in the amputation stump. This method is successful because these muscles regenerate after a few months to provide better control of the prosthesis. However, until now, it was not clear what specific changes this nerve transfer technique produces in muscles and nerves.

As part of an experimental study conducted over several years, a research team led by Konstantin Bergmeister and Oskar Aszmann from MedUni Vienna's Division of Plastic and Reconstructive Surgery and the Christian Doppler Laboratory for Recovery of Limb Function have now shown that this nerve transfer technique has previously unidentified neurophysiological effects. These result in more accurate muscle contractility and much more finely controlled muscle signals than previously thought.

The researchers also found that muscles take on the identity of the donor nerves, that is to say, the function of the muscle from which the nerve was originally harvested. This means that muscles can be modified very specifically to achieve the desired control of the lost extremity. This information will now be used in follow-up studies to refine the surgical technique of nerve transfer and adapt it more accurately to fine control systems. The vision of an intuitively controlled prosthesis that can perform all the natural manual functions could become a reality within the next few years.

More information: Konstantin D. Bergmeister et al. Peripheral nerve transfers change target muscle structure and function, *Science Advances* (2019). DOI: 10.1126/sciadv.aau2956

Provided by Medical University of Vienna