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Cortical nerve function in former amputees remains poor decades after reconstructive surgery

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Researchers have found that the nerve cells (neurons) controlling sensation and movement of the hands show injury-induced changes for years after hand amputation, reattachment or transplant. The small study, the first of its kind to non-invasively explore the health and function of the cortical neurons (neuronal integrity) in these populations at the neurochemical level, is published ahead of print in the *Journal of Neurophysiology*. The manuscript was chosen as an APSselect article for April.

The sensory and motor components of a hand's nerves are severed during hand amputation, resulting in a dramatic reduction in stimulation in the brain's cerebral cortex, which controls these functions. Cortical areas formerly devoted to the missing hand undergo substantial functional reorganization as a result of this nerve loss. Little, however, is known about neurochemical changes at this level and the potential to reverse these changes with reconstructive surgery.

To explore the range of neuronal integrity in amputees, the research team compared a group of healthy controls with:

- Current hand amputees ("amputees") and
- Former amputees who'd undergone either hand reattachment ("reattachment") or hand transplant ("transplant").

Volunteers flexed the fingers of both hands—or in the existing hand in the amputee group—to activate sensorimotor areas in both sides of the brain. The research team then analyzed levels of N-acetylaspartate (NAA), a chemical associated with neuronal integrity, in these areas.

When compared to the healthy controls, the amputees had significantly lower NAA in the areas of the brain formerly involved in processing sensory and motor signals related to the missing hand. This result, indicating poor neuronal integrity, was expected and supports evidence that due to lack of stimulation, the neurons in these areas may degenerate.

NAA values for the reattachment and transplant patients remained lower than the control group, suggesting that these neuronal effects may not be fully reversible through restored sensory and motor activity. This was unexpected and raises the possibility that the effects of nerve injuries on the mature brain may be persistent, even as these patients recover sensory and motor functions to varying degrees. However, due to the small number of reattachment and transplant patients studied, the researchers urge caution in interpreting these results until more work is completed. This work may have implications for understanding the potential to reverse the effects of injuries to the limbs or spinal cord on the mature brain.

More information: Carmen M. Cirstea et al. Magnetic resonance spectroscopy of current hand amputees reveals evidence for neuronal-level changes in former sensorimotor cortex, *Journal of Neurophysiology* (2017). DOI: 10.1152/jn.00329.2016

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