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New computer-based technology may lead to improvements in facial transplantation

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Following several years of research and collaboration, physicians and engineers at Johns Hopkins and Walter Reed National Military Medical Center say they have developed a computer platform that provides rapid, real-time feedback before and during facial transplant surgery, which may someday improve face-jaw-teeth alignment between donor and recipient.

Surgeons performed the first successful transplant of facial features, including the jaw and teeth, in 2008, mainly relying on visual judgment. Since then, approximately 30 facial transplants have been done worldwide, costing an estimated $250,000 to $500,000. These transplants have led to the improvement of patient survival and enhancement of physical appearances. However, current surgical methods often leave patients with some undesired residual deformities and abnormalities in function.

The new computer-assisted development should make it less likely to misalign the new set of bones, jaw and teeth, and prevent other reconstructive abnormalities for patients with severe craniofacial trauma, the researchers report.

Use of the new platform in mock surgeries performed on plastic and cadaveric human donor/recipient pairs is described in the journal *Plastic and Reconstructive Surgery*, published in August.

Called the computer-assisted planning and execution (CAPE) system,

the platform is first used to help plan surgery once a donor has been identified for transplantation. Using information from CT scans, the donor's anatomy is matched to the recipient's anatomy in an effort to optimize form, or appearance, and function, such as chewing and breathing, according senior author Chad Gordon, D.O., an assistant professor of plastic and reconstructive surgery at the Johns Hopkins University School of Medicine and co-director of the Multidisciplinary Adult Cranioplasty Center at Johns Hopkins.

The execution portion of the system's name refers to the technology used during surgery, which includes a novel feature known as real-time cephalometry (RTC), says Gordon. RTC provides the surgeon with objective measurements and angles related to ideal jaw-teeth positions, with instantaneous visual feedback in the operating room unlike ever before.

"Every time the donor's jaw-teeth segment moves during facial transplant inset, the computer recalculates its movements in comparison to the face transplant recipient, meaning the surgical team can have unprecedented visual data in achieving ideal alignment of the face, jaw and teeth," explains Gordon. His collaborators included faculty members and scientists at the Johns Hopkins University Whiting School of Engineering and Applied Physics Laboratory.

The preciseness of the technology will likely reduce the need for patients to undergo revision surgery and will help to improve outcomes in various areas, says Gordon.

Gordon and his colleagues have jointly filed for eight patents related to the system, which has various applications within the field of craniomaxillofacial surgery.

For the study, the team performed donor-to-recipient, Le Fort-based

face-jaw-teeth transplantation on two plastic models and two human cadavers using the CAPE system.

Gordon says the current prototype system can assist face-jaw-teeth transplantation, known as Le Fort-based jaw surgery, and can help surgeons in all forms and types of craniofacial surgery, in both adults and children.

"CAPE and RTC can be adapted for use in other surgical disciplines, such as oral-maxillofacial surgery, head and neck surgery, and neurosurgery," adds co-author Mehran Armand, Ph.D., director of Biomechanical- and Image-Guided Surgical Systems, a collaborative laboratory between the Applied Physics Laboratory and Whiting School of Engineering. "In fact, they share principles with our biomechanical guidance system, which was previously developed for orthopaedic surgery through a grant funded by the National Institute of Biomedical Imaging and Bioengineering."

The team members at Walter Reed National Military Medical Center may find the system especially useful for treating victims of improvised explosive device blasts who have survived but are severely deformed and need reconstruction, according to Gerald Grant, service chief of the 3D Medical Applications Center at Walter Reed. "RTC will provide our team with a much-needed advantage when it comes to reconstructing wounded warriors with devastating maxillofacial or mandibular injuries, both for transplant surgery and for routine reconstruction," he says.

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