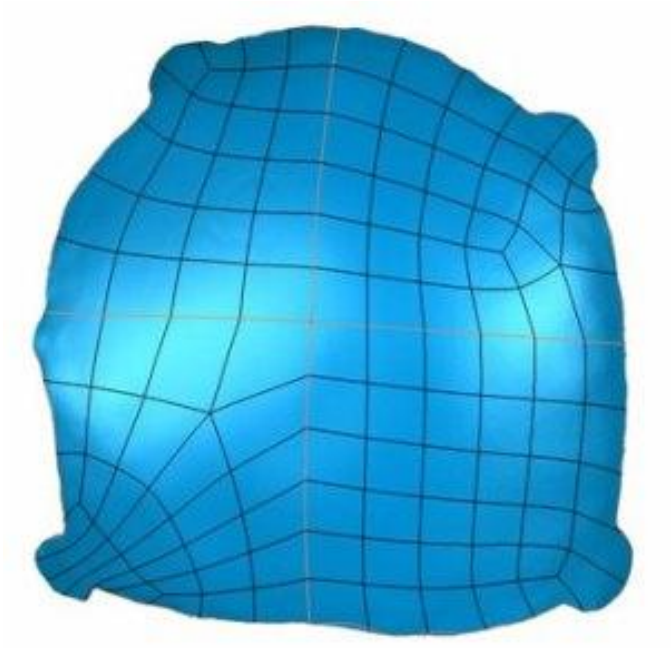
3D Digital Process Aids in Skull Prosthetic Success

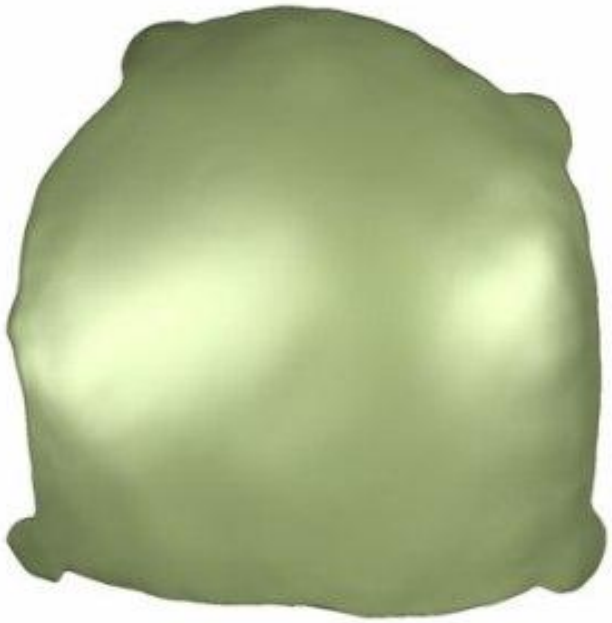
Bob Cramblitt



When Chinese exchange student Jiahone Guo suffered a cranial injury during a club soccer match, he thought "maybe I will go to see God," according to a report on WFAA-TV [1] in Dallas/Fort Worth, Texas. Fortunately, due to timely surgery and a custom-made prosthetic skull plate designed by MedCAD [2], Guo is able to do almost everything he could do before the fateful match.

WFAA-TV reported that about a quarter of Guo's skull was removed after the injury, believed to have been sustained when an opponent accidentally kneed him in the head when he was falling. Guo finished the game, then began feeling pain. Dr. Rob Dickerman, director of neurosurgery at Presbyterian Hospital of Plano, says that Guo was comatose when he initially arrived at the hospital. His brain was swollen and crushing his brain stem. There was no alternative but to remove a portion of Guo's skull and let the swelling subside.

"At the time of the injury, I told the family it was a 50-50 chance of survival," said Dickerman in an interview with WFAA-TV.



AccuShape to the Rescue

Two months after being admitted to the hospital, Guo's swelling was gone and Dickerman implanted the prosthetic skull plate.

"I didn't die," Guo told WFAA-TV. "I can do anything; I can drive, I can walk, I can think."

The prosthetic plate received by Guo was made possible by a new process developed in recent years by MedCAD, a custom biomedical device company specializing in cranial and cranio-facial/oral surgery prosthetics.

MedCAD's trademarked AccuShape process—based on 3D technologies from Geomagic [3]—enables the company to digitally design and manufacture cranial implants from CT scans. Major advantages of the process include:

- Faster digital design and manufacturing that eliminates time-consuming and sometimes error-prone manual sculpting
- Greater accuracy by modeling directly from a patient's CT scan, saving time and reducing risk in the operating room
- Better aesthetic result for the surgeon and the patient
- Ability to create implants in PEEK (poly-ether-ether-ketone), a surgical-quality polymer

A New Standard

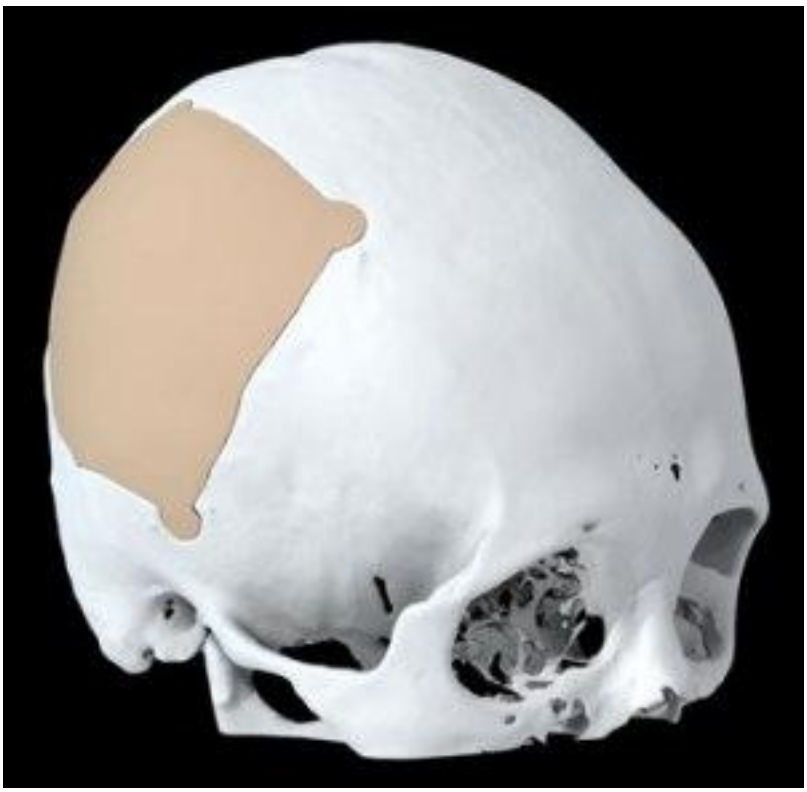
"The standard of care has been to make a mold from a patient's skull defect in plaster and hand-make an implant out of acrylic or some other moldable biomedical material," says Nancy Hairston, MedCAD's president and CEO. "Our digital process is much more accurate and PEEK is the closest biomedical material to natural bone. It is very strong, but very light, and not prone to infection."

Beyond the final product, MedCAD works closely with physicians in surgical planning. The company takes a doctor's surgical plan—including CT data and detailed paperwork—and transforms it into a detailed 3D model.

The virtual surgery approach makes it possible for surgeons to explore the upcoming procedure from every angle, previewing "what-if" scenarios and assessing potential problem areas. Last year, MedCAD made its planning tool, called AccuPlan, available as an iPad app.

Digital Modeling with Geomagic

The Guo project was brought to MedCAD by OsteoMed, a MedCAD distributor and provider of patient-specific implants. OsteoMed couriered Guo's CT scan over to MedCAD, which used its AccuShape digital workflow to create the implant.



First, an STL file (a standardized format for computer-aided design) is brought into Geomagic Freeform—software that enables designers and engineers to work on digital models as if they are molding in clay, except with all the advantages of speed and accuracy inherent in a digital process.

The input device for the modeling process is Geomagic Sensable Phantom—a haptic device that provides tactile feedback, enabling the design engineer to feel surfaces, edges, and topology.

"Geomagic Freeform is the only tool on the market that allows for complex sculptural modeling," says Hairston. "For any anatomical modeling, it shines compared to traditional CAD software due to its direct and intuitive modeling tools."

Another key link in the AccuShape chain is Geomagic Studio software, which gives MedCAD the ability to create complex surfaces from STL data. This is especially important for accurate digital manufacturing of the custom-fitted implant.

"Typical CAD software cannot generate accurate surfaces for these types of intricate, organic shapes," says Hairston.

Tying everything together is proprietary in-house software and procedures developed by MedCAD.

Certain devices created by MedCAD can be manufactured with a 3D printer depending on the material required and how the final piece will be used. But since 3D printing is not approved by the FDA for PEEK material, the Guo implant was manufactured with a CNC machine.

Discovering the Back Story

The implant for Jiahone Guo did not present any unusual technical challenges for MedCAD, but the project did come with a special treat—discovering the story behind the delivered product. Because of strict patient confidentiality, MedCAD engineers rarely know what happens after an implant leaves their hands.

"We make these devices on a daily basis, so this case design-wise was not unique until we learned the back story," says Emily Aberg, MedCAD marketing lead and graphic designer. "But our machining intern, who helped build the implant, saw the story on WFAA, and said ‘That cranial implant looks real familiar.' We were so excited to hear abo

ut Guo's recovery and we wish him the best."

Beyond Bones

Hairston believes that rapid technologies for creating customized medical devices will be the norm for the future, not only for bone implants but someday for organs such as the heart and liver.

"Rapid technologies built upon 3D software such as Geomagic deliver the best possible outcome for patients and surgeons," says Hairston. "More accurate implants are delivered faster, leading to less time in the operating room, less risk for the patient, and a better aesthetic result."

Bob Cramblitt writes about 3D technologies that are radically changing the way we work and live.

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