Medical Xpress

Bioceramic implant induces cranial regrowth

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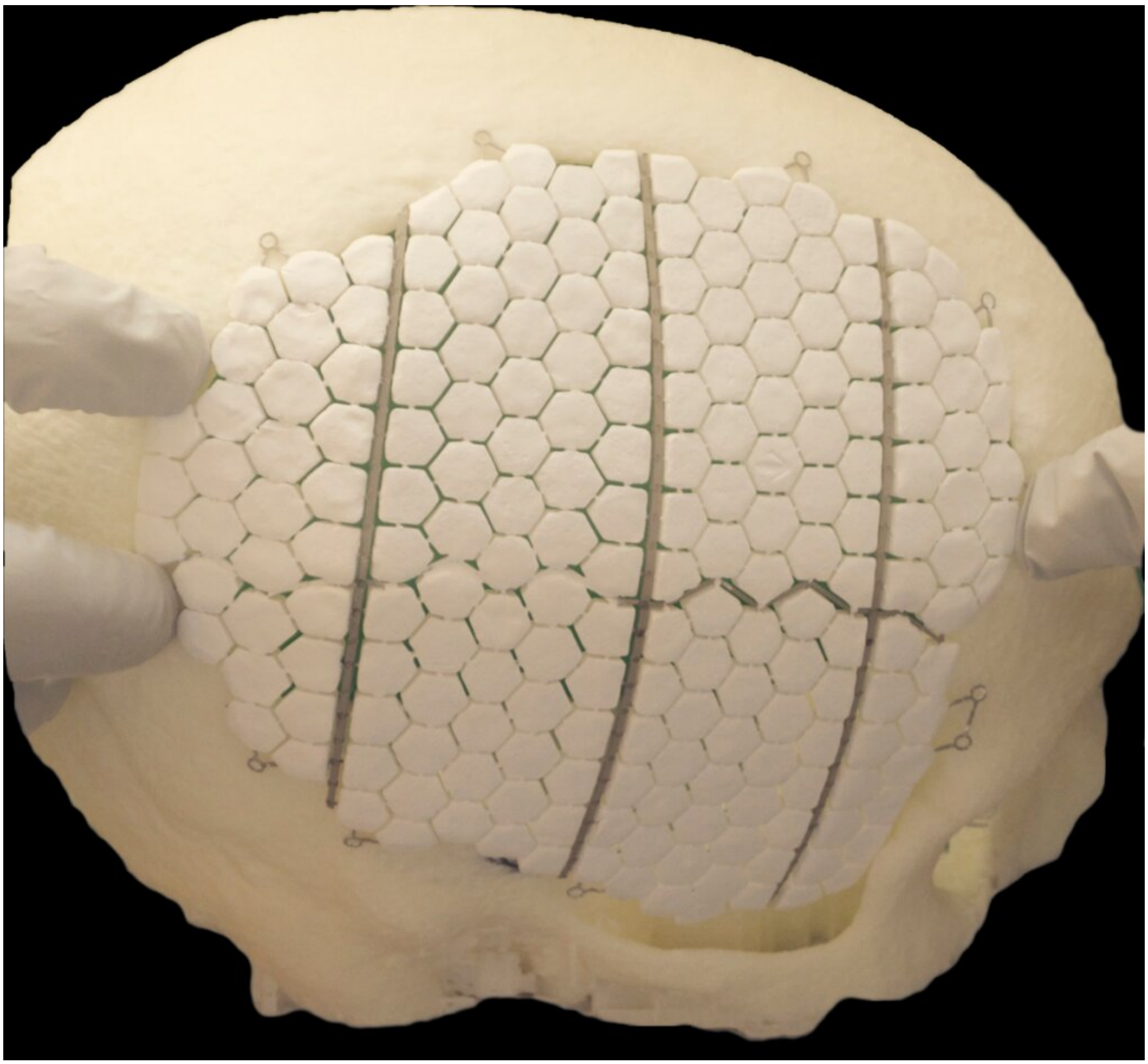

Human skull model with BioCer implant. Credit: PNAS

A bioceramic implant has proved to stimulate regeneration of natural skull bone, so that even large cranial defects can be repaired in a way that has not been possible before. The research, led from the University of Gothenburg, is now presented in the scientific journal *PNAS*.

Reconstructing major bone and soft-tissue injuries in the skull after an accident or treatment of a brain tumor, blood clot, or hemorrhage is a difficult challenge. Worldwide, the routine clinical practice is to transplant bone, or use plastic or metal implants.

Transplanting bone from elsewhere in the body involves risks in both sites—where the tissue is removed and where it is placed. Integration of plastic or metal implants, for example, is inferior to that of bone, and using them therefore increases the infection risk.

"Growth factors and stem cells are thought to contribute to healing but haven't yet been demonstrated to have any obvious advantages after administration in large, human skull defects," says Peter Thomsen, Professor of Biomaterials at the University of Gothenburg, who is responsible for the current study.

Seeing skull bone grow

Instead, under Thomsen's guidance, researchers have used a new, 3-D-printed bioceramic material attached to a titanium frame shaped like the missing part of the skull bone. For the first time, they have shown that large cranial defects can heal by means of new bone formation, without growth factors or stem cells being added.

In the experiments, the bioceramic implant was shown to transform into bone, with a composition indistinguishable from natural bone. Experiments with titanium-only implants also resulted in bone formation, but only adjacent to the host bone.

"We can see the skull bone growing out, not just on remaining parts of the cranium but also centrally in the defect itself," Thomsen says.

"All the cells that we know are involved in bone formation and remodeling are recruited to, or are in place, in the central part of the defect and in soft tissue where the bioceramic was inserted. What happens is that the main constituent of the bioceramic, monetite, transforms into another material in the body: apatite," he adds.

Gradual breakdown

The experiments were performed on sheep, and the results could then be confirmed in humans, one individual, where the bioceramic, 21 months after the intervention, had become a tissue with structure and composition similar to natural bone. This process is called osteoinduction.

Behind the study are researchers at Sahlgrenska Academy, University of Gothenburg, and at Karolinska Institutet and Uppsala University. The first authors are Omar Omar, Associate Professor in Gothenburg, and Associate Professor Thomas Engstrand, Uppsala.

Håkan Engqvist, Professor of Applied Materials Science, Uppsala University, points out that the innovative bioceramic breaks down relatively slowly.

"The combination of the ceramic's composition and its slow breakdown has turned out to be extremely good for bone formation in large cranial defects."

Peter Thomsen stresses the need for further research, both to investigate the molecular processes and in the form of controlled clinical studies.

"We believe this principle will compete with existing treatment principles of bone transplantation, and plastic and metal implants," he concludes.

More information: Omar Omar et al. In situ bone regeneration of large cranial defects using synthetic ceramic implants with a tailored composition and design, *Proceedings of the National Academy of Sciences* (2020). DOI: 10.1073/pnas.2007635117

Provided by University of Gothenburg