Magnesium-based 3D-printed implants: A solution for paediatric patients

Ava Azadi Chegeni, University College Dublin, An Coláiste Ollscoile Baile Átha Cliath

Impact in a nutshell

My research focuses on helping children suffering from skull fractures, by using 3D-printed magnesium-based implants. Currently, non-resorbable implants used in treatment require a second surgery for removal after the bone heals. This project aims to develop magnesium-based implants that dissolve naturally in the body as the bone heals, eliminating the need for a second operation.

Research details

My PhD research focuses on developing a new type of implant for children suffering from skull fractures. The goal is to create an implant that can dissolve naturally in the body, removing the need for a second surgery to take it out. This is important for children because it avoids extra medical procedures, reducing both physical and emotional stress.

The implant material I am working on is based on magnesium, combined with calcium and zinc, which are naturally found in the human body. Using special software, I can predict how different amounts of these elements will behave together. This helps me choose the best mix to ensure the implant is both safe and compatible with the body.

Once the ideal composition is selected, I move to the lab to actually create the implant. First, I melt magnesium, calcium, and zinc together, then shape the mixture into a solid form using a casting process. This solid piece is turned into a fine powder, which I can then use for 3D printing.

In the 3D printing stage, the powder is combined with a polymer to create a material that can be printed into the shape of an implant. After printing, I remove the polymer through a chemical process, leaving behind a metallic implant. To make sure the implant is strong enough to function like human bone, I expose it to high temperatures for several hours. This final step gives the implant the necessary strength.

What is or will be the impact of your research?

My research centres on developing innovative, biodegradable magnesium-based implants aimed at helping children with skull fractures. Current implants, made from materials like titanium, require a second surgery for removal once the skull heals. My work eliminates this problem by designing implants that dissolve naturally in the body after fulfilling their purpose.

The impact of this research could be transformative for both patients and healthcare systems.

Children with cranial defects would no longer face the trauma of multiple surgeries, reducing recovery time and improving overall well-being. Since 3D printing allows for customization, the implants can be designed to perfectly match the patient's anatomy, leading to better surgical outcomes. Furthermore, because these implants use biodegradable materials, they lower the risk of long-term complications compared to traditional implants.

Hospitals worldwide could adopt this technology to enhance the care of young patients with skull defects. This research contributes to a future where surgeries are less invasive and medical care becomes more personalized, particularly for vulnerable pediatric populations.