Vital Technology

3D printing Enables a Child's Life-Saving Kidney Transplant

Guy's and St. Thomas' NHS Foundation Trust is one of the largest NHS (National Health Service) trusts in the UK. It treats more than 2.4 million patients in acute and specialist hospital and community services every year. Today, surgeons across the hospital are using multi-material 3D printing for planning the most intricate of operations. That includes the world's first use of 3D printing to prepare the successful transplantation of an adult kidney into a small child with anatomical complexities.

The transplant of an adult organ into a young child often presents unique and complex challenges, according to Mr. Pankaj Chandak, Transplant Registrar at Guy's and St. Thomas' NHS Foundation Trust. One such case was that of two-year-old Dexter Clark, who received a kidney from his father, Brendan. It was clear before Dexter was born that he would require a kidney transplant, with his father the likely donor. Due to the complexities of his illness, Dexter was only able to eat through a feeding tube and was severely underweight.

> "This technology enhances and aids our decision-making process, both during pre-surgical planning and in the operating room, and, therefore, can help in minimizing risks in a very complex operation."
>
> Mr. Pankaj Chandak
> **Transplant Registrar at Guy's and St Thomas' NHS Foundation Trust**

stratasys

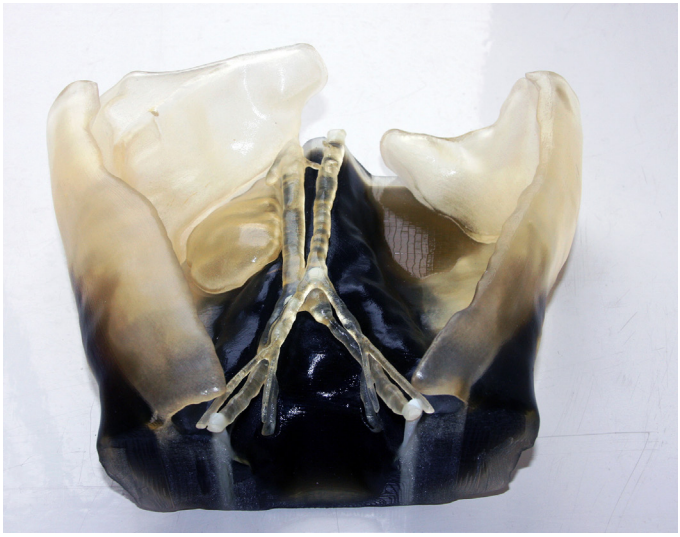
Patient-Specific, Multi-Material 3D Printed Models Help Determine Feasibility

This case presented two distinct challenges for the surgical team. First, Dexter weighed less than 10 kg., significantly increasing surgical risk. Second, his father's kidney was much larger than that of an average adult kidney. This raised questions about the feasibility and safety of implanting the donor kidney. The transplant team was unsure if it would fit inside Dexter's small abdomen.

For this case, Mr. Chandak and his team turned to the trust's in-house multi-material 3D printer. "Using our 3D printer, we worked in collaboration with Nick Byrne and colleagues – clinical scientists from our medical physics department who specialize in medical imaging – and radiology consultants. They converted patient CT scans into anatomically accurate, multi-material 3D models. These helped us appreciate aspects such as depth perception and space within the baby's abdomen, which can often be difficult to ascertain when looking at conventional imaging," explained Mr. Chandak.

"The ability to print a 3D model of the patient's anatomy in varying textures, with the intricacies of the blood vessels clearly visible within it, enabled us to differentiate critical anatomical relations between structures. The flexible materials also allowed us to better mimic the flexibility of organs within the abdomen for simulation of the surgical environment," Mr. Chandak added.

The models allowed the surgical team to plan the complex transplant surgery and assess its feasibility before the operation. 3D printing played an important role in the decision to operate, which meant Dexter would not have to go onto dialysis. The surgeons also used the models to rehearse each step of the procedure and refine their approach before entering the operating room.



3D printed model of Dexter's abdomen, produced using precision, multi-material 3D printing technology.

> "The ability to print a 3D model of the patient's anatomy in varying textures, with the intricacies of the blood vessels clearly visible within it, enabled us to differentiate critical anatomical relations between structures..."
>
> Mr. Pankaj Chandak
> **Transplant Registrar at Guy's and St Thomas' NHS Foundation Trust**

3D Printed Models in the Operating Room

3D printed model of Dexter's abdomen next to a 3D model of his father's kidney, enabling surgeons to determine transplant feasibility.

Usually, the feasibility of complex transplants in children is determined using an invasive surgical exploration under anaesthesia. According to Mr. Chandak, it is hard to predict how long this surgical exploration would take. Ideally, surgeons want to limit operating room time to minimize potential complications.

Mr. Chandak explained that the need for surgical exploration can be reduced using 3D printed models of the patient's anatomy. The surgical team uses them to determine the safest, optimal surgical approach in the pre-planning stages, before the patient is even on the operating table. In Dexter's case, the 3D printed models were sterilized, and then taken into the operating room on the day of the transplant and reviewed by Mr. Nicos Kessaris, a Consultant Transplant Surgeon at Guy's and St Thomas' NHS Foundation Trust.

He was able to use the models to assess the best way the donor kidney would fit into Dexter's abdomen.

Not only did the 3D models help determine the feasibility and surgical plan, they also helped educate the family about the procedure and enhanced its confidence in the surgical team's ability to carry it out.

The surgeons link the success of cases like Dexter's to their ability to 3D print patient-specific anatomical models in-house. Guy's and St. Thomas' Trust uses a Stratasys 3D Printer with multi-material PolyJet™ technology to create the models. Surgical teams across the hospital can utilize the 3D printer, resulting in significant time savings. It also helps train younger surgeons by allowing them to practice complex surgical procedures using anatomically accurate 3D models that simulate real-life cases.

The possibilities of the technology are already being realised across the trust. In another world first, surgeons used patient-specific 3D printed models to enhance the accuracy and precision of robotic cancer surgery.

"This technology enhances and aids our decision-making process, both during pre-surgical planning and in the operating room, and, therefore, can help in minimizing risks in a very complex operation. Having access to such advanced 3D printing technology is already enabling us to consider operating on increasingly complex cases," concluded Mr. Chandak.

Brendan and Dexter Clark, post-transplant.

Stratasys Headquarters

7665 Commerce Way,
Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

stratasys.com
ISO 9001:2008 Certified

1 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)