



Seattle Children's Uses 3D Printing to Plan Complex Surgeries & Personalize Care

For over 100 years, Seattle Children's Hospital has been specializing in the unique needs of infants and children. With physicians focused on compassionate care and breakthrough research within 60 pediatric subspecialties, Children's is not only the top-ranked pediatric hospital in the Pacific Northwest, but it is also consistently ranked among the best pediatric hospitals in the nation.

An example of how Children's is improving outcomes through innovation, is their use of 3D printing to map out complex surgeries and practice intricate surgical techniques before ever entering the operating room. And this custom care approach helps to provide safe and improved treatments for patients with rare conditions.

One such case was an infant brought to Seattle Children's, who at only a few days old, was showing signs of labored breathing. A CT scan found that she had right bronchial stenosis, a rare etiology of respiratory distress in a neonate. The narrowing of her right bronchial tube was so severe she couldn't breathe effectively, and her bronchus was only the size of a hair. She was put under the care of Kaalan Johnson, MD, the director of Seattle Children's Aerodigestive Program, who specializes in treating children who have complex upper airway breathing and swallowing problems.

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The more opportunities that we're able to utilize, to expand our horizons through the applications of technology, including 3D printing, the closer we're moving to the finish line. And we're making these things easier that have traditionally been very challenging and riskier to accomplish. We are making these situations become more favorable and the outcomes better for kids.”

Kaalan Johnson, MD



Confidence In a Successful Surgery

Like many of Seattle Children's patients, this infant's healthcare needs were complex and required a team of specialists across disciplines, including otolaryngology, cardiology, pulmonology and anesthesiology. Once it was confirmed what type of stenosis they were dealing with, Johnson and his team were able to discuss which surgery was necessary.

After careful consideration, a slide tracheoplasty was determined to be the best option. And while Otolaryngologists perform multiple slide tracheoplasties every year, it is far less common than other procedures. "Each specific case is unique," Johnson said. "The exact location of the stenosis, the degree of narrowing, the position, these factors all impact our approach to surgical planning and decision making."



Kaalan Johnson, MD working with a 3D printed airway

Confidence In a Successful Surgery

Because precision is imperative and the surgery is incredibly complex, Johnson and his team embarked on a protocol in which they 3D printed each of the slide tracheoplasties ahead of time, so they had life-sized models of the infant's airway to practice on and evaluate. The Stratasys Digital Anatomy™ 3D Printer was used to create the exact airway of the infant — right down to the biomechanical properties — allowing them to practice on an exact replica of her airway.

The ability to digitally design a complex patient-specific airway, and then print it, not only allowed for a detailed virtual surgical planning session, but also the ability to rehearse as a team — which gave everyone confidence that the surgery would be successful. “That very first step of dividing the windpipe is something you can’t walk back from,” Johnson said. “You need to know exactly where to cut and at exactly what angle.”



3D Printed Airway



Kaalan Johnson, MD with 3D printed airway and patient's mother

The Value in Providing Personalized Medicine

Explaining a complex diagnosis like bronchial stenosis to an overwhelmed family is tough. And evidence suggests that information can be lost between what a family hears and what a physician tells them — that's where 3D printing can help. By printing 3D models, families, physicians and students can physically hold what's being referenced and parents can actually see the effects of a disease.

“There is something that is specifically valuable in our experience in having something you can touch and feel and move around in your hands. When you're dealing with the airway of a tiny baby, it's a constantly moving, soft, flexible structure. Being able to hold a model in your hands and perform the actual procedure alongside your peers, allows critical discussions and learnings to take place.”

Kaalan Johnson, MD

The Value in Providing Personalized Medicine

“It’s been fascinating to see the benefits from the planning process, the rehearsal that the team goes through preparing for the procedure and the ability of the family to understand the procedure and actually explain it to other people,” says Johnson. “I think we’ve really found value in the process and providing more personalized medicine for our airway patients,”

Before the surgery, Johnson and his team sat down with the family and reviewed every detail. They also printed a 3D model of the infant’s airway to show the surgical plan to repair their daughter’s abnormality. At the time, she was the smallest patient to undergo a slide tracheoplasty at Seattle Children’s.

Johnson also gave the patient’s mother a life-size 3D printed model when her daughter was a month old. This allowed her to show family members and friends. She said it was invaluable to be able to visually explain it to other people and that the small piece of plastic meant the world to her.

The night before the operation, the surgeons gathered in a conference room to review the surgery and its procedural complexities. They practiced making the incision on the tiny 3D models and everyone felt prepared for the big day — which went better than even anticipated. “One day, [she] is going to have the most amazing item for show-and-tell,” the patient’s mother said with a smile. “She’ll be able to hold up the [3D] model and show people exactly how far she’s come.”

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To be a good surgeon also requires excellent communication with families. That shared medical decision-making is vital. You’re trying to understand the value system of the family and what you can offer to improve their quality and quantity of life. To fully understand that and commit to that, you have to be able to communicate complex concepts. That’s where 3D printing also has added value.”

Kaalan Johnson, MD

3D Printing Can Make a Big Impact

The Digital Anatomy printer has an unprecedented ability to create anatomical models that mimic the feel and properties of actual tissue, allowing physicians to print complex, patient-specific models that are increasingly life-like, which has helped to advance surgical care, research and training.

Many patients have benefited from Digital Anatomy 3D printing at Seattle Children's. Their custom care approach has helped surgeons and care teams plan complex surgeries across a variety of specialties, improve clinical outcomes, and provide better care for patients and their families.

Seattle Children's has found through the use of 3D printing, that they can make a big impact by providing an experience that families don't necessarily expect — such as handing them a physical replica of an individual and personal disease. According to Johnson, the applications and opportunities of 3D printing are immeasurable, but the objective is always the same: to provide the best possible care.



Seth D. Friedman, PhD, with a 3D printed unicorn, a gift for the patient's two-year-old birthday

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