Custom 3D-Printed Models Improve Precision in Cancer Surgery

Personalized visualization guides complex head and neck cancer removals

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Key highlights

- 3D-printed models tailored to each patient improve tumor removal accuracy in head and neck cancers.
- In surgeries using 3D models, 92% achieved complete tumor removal vs 74% without models.
- Greater precision protects healthy tissue, potentially reducing need for additional treatments.

Using custom 3D-printed models to plan head and neck cancer surgeries increased precision, achieving complete tumor removal in 92% of cases with bone invasion in a recent study published by The Ohio State University Comprehensive Cancer Center – Arthur G. James Cancer Hospital and Richard J. Solove Research Institute (OSUCCC – James).

“The precision of what we take out is critical to ensure we get the whole tumor, but not so much that we're devastating the patient's function in the long term and taking out things that don't need to be removed,” said Kyle VanKoevering, MD, an otolaryngologist (head and neck surgeon) at the OSUCCC – James and medical director of the M4 Lab (Medical Modeling, Materials and Manufacturing Lab) within the Ohio State College of Engineering. “This 3D modeling being completely personalized to each patient is really helping improve the precision in the operating room.”

3D-guided surgery versus regular surgery
For this research, VanKoevering and team compared the surgical outcomes of 68 patients with bone-invading head and neck cancers treated at the OSUCCC – James. Thirty-seven patients received in-house 3D models for intraoperative use while the other 31 did not. The study population was predominantly male, and nearly all were active or previous tobacco users (94.6%).

Surgeries with access to a patient-specific 3D-model to use as a visual planning aid in the operating room had better negative surgical margins – meaning the surrounding tissue showed no evidence of cancer – compared with the group that did not have the assistance of a 3D model.

“This model is especially critical in cancers that have invaded bone, because tumor boundaries are often less visible or palpable. Our 3D models are built based on the patient’s actual tumor imaging, so it gives us a much better visual map at the patient’s bedside for removing the cancer as completely as possible while also sparing important structures and tissue to maintain function after surgery,” VanKoevering explained.

This study looked at the cancer-control impact of using custom, 3D-printed models of a patient’s anatomy to plan complex surgeries impacting the head and neck, where delicate structures that impact speech, chewing and swallowing are often impacted.

Matthew Marquardt, study corresponding author and third-year medical student, noted that this is the first study to evaluate the ability of 3D modeling to help improve cancer control in the operating room.

“This really sets the stage for larger studies looking at how 3D modeling can enhance surgery planning and precision, not just in the field of head and neck cancer surgery but in other areas that involve bone and soft tissue, like orthopedics,” said Marquardt, who worked on this project as part of a focused medical school research year through the Pelotonia Scholars Program. (https://cancer.osu.edu/for-cancer-researchers/pelotonia-funded-research-and-initiatives/pelotonia-scholars-program)

“Long term, our hope is that this work will enable other surgeons to use this technology across the country to help improve people's lives and improve cancer outcomes,” said Marquardt.

The team reports their findings in the September 2025 issue of the journal Oral Oncology. The Pelotonia-funded (https://www.pelotonia.org/) study was co-authored by Taylor Freeman, Amanda Pancake, Joseph Lee, MD, James Rocco, MD, PhD, Matthew Old, MD, Stephen Yang, MD, Lauren Miller, MD, Catherine Haring, MD, Nolan Seim, Enver Ozer, MD, Amit Agarwal, MD, Rachel Herster, Teri Snyder and Megan Malara.

To learn more about cancer care and research at the OSUCCC – James, visit https://cancer.osu.edu/ or call 1-800-293-5066.

About the Pelotonia Scholars Program
Since 2010, the Pelotonia Scholars program has funded more than 500 multidisciplinary cancer research projects led by undergraduate, graduate, medical and postdoctoral students at The

Ohio State University. These projects are conducted in partnership with faculty mentors in OSUCCC – James research labs. To learn more about Pelotonia and ways to get involved in the organization's mission to raise funds for live-saving research at the OSUCCC – James, visit www.pelotonia.org.

NOTE TO EDITORS: High-resolution b-roll and images are available for download at: www.bit.ly/4iByR3b.

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