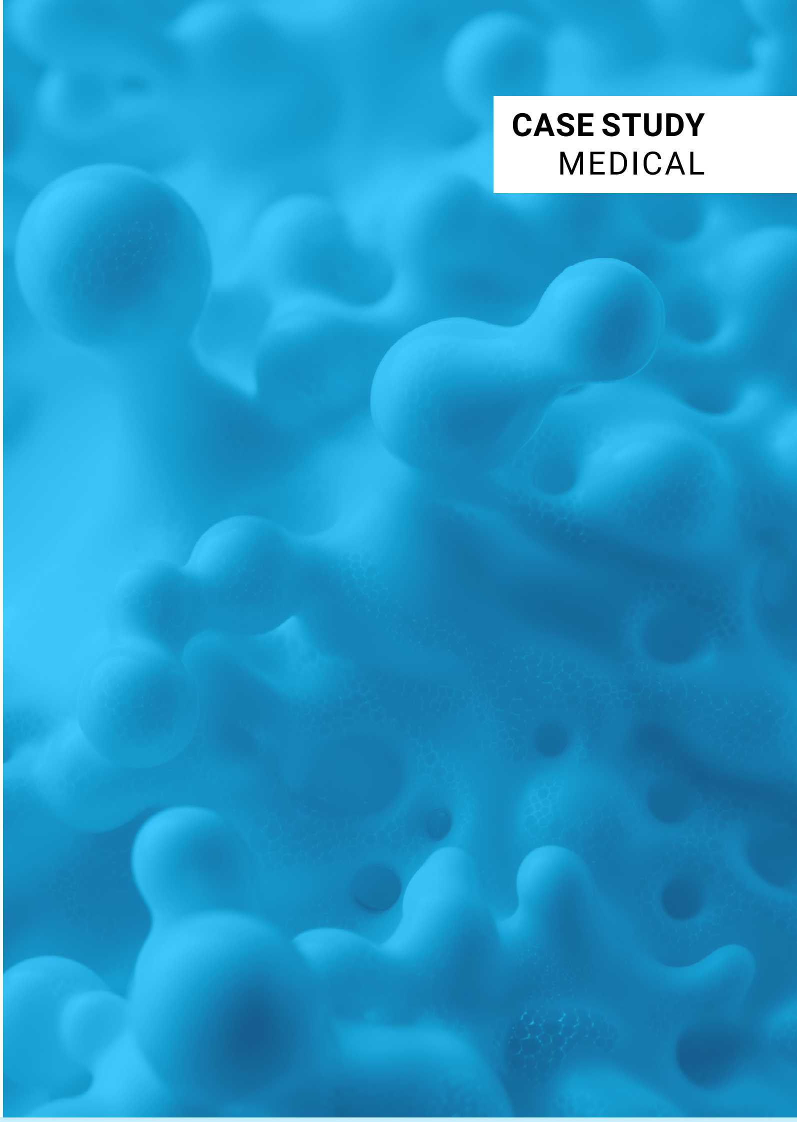
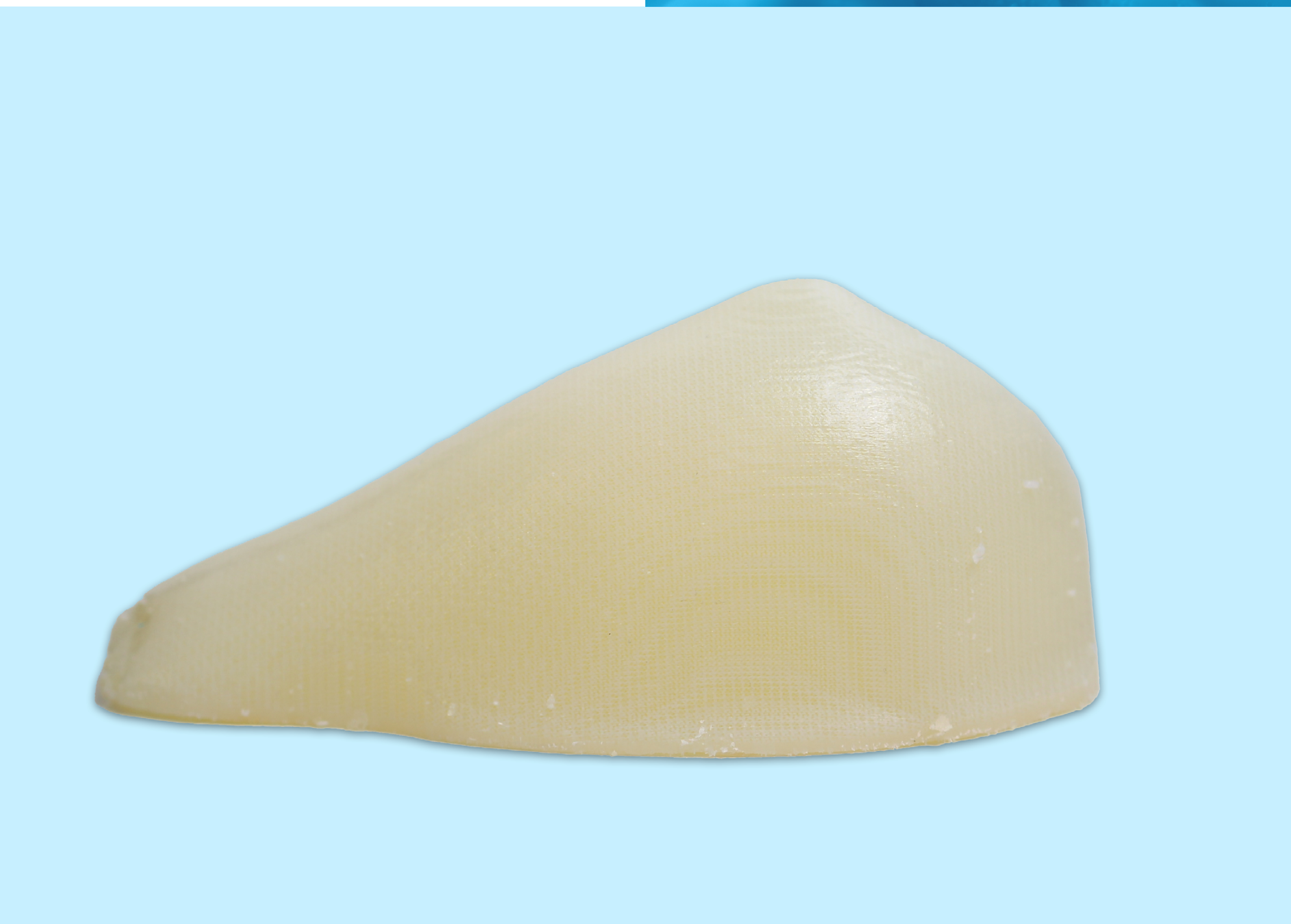
CASE STUDY
MEDICAL

Developing Patient-Specific, Ultrasound-Guided Breast Biopsy Models Using the Digital Anatomy™ Printer





Details	
The technology used by the research team for modeling	**Digital Anatomy Printer**
The anatomical preset in GrabCAD used for printing breast tissue	**Subcutaneous fat**
The anatomical preset in GrabCAD used for printing the lesion for ultra-sound-guided biopsy	**Solid internal organ 6**

The Creighton University School of Medicine's radiology department develops patient-specific biopsy models for medical trainees

Medical schools around the country regularly use prefabricated silicone models to demonstrate and practice ultrasound-guided radiological procedures like breast lesion biopsies. Experienced radiologists report that these standard practice models produce an unnatural recoil during needle biopsy when compared to human tissue—and for a procedure like a breast lesion biopsy, the feel is important.

The Creighton University School of Medicine in Omaha, Nebraska aimed to build a model that actually feels and behaves like human tissue so that their medical trainees are able to accurately distinguish between breast and lesion tissue.

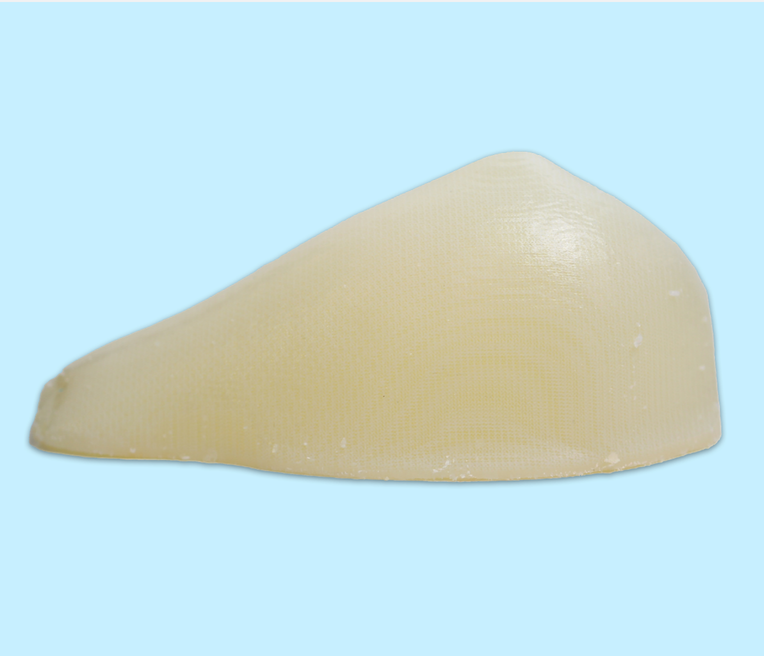
"What I've wanted to do is produce patient-specific models so that residents and medical students can train on something that will match what their experience is going to be with the specific patient," says Dr. Christian Cox, Chair of the Department of Radiology at the Creighton University School of Medicine, Omaha Campus. "I wanted the printing resolution that would make the School of Medicine leadership see the model and say, 'Wow. It's incredible that you can do that."

Creighton University

RESEARCH CENTER
Clinical Biomedical Imaging Core, Creighton University School of Medicine

LOCATION
Omaha, Nebraska

DEPARTMENT
Radiology

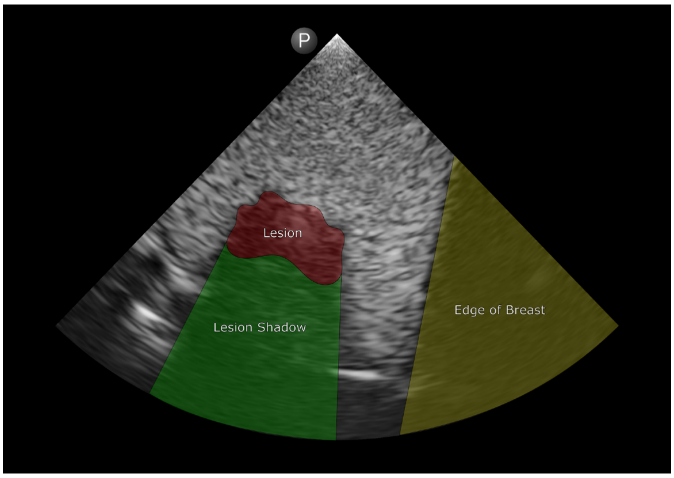


The Process: Finding the recipe for an high-fidelity breast phantom to enhance research and training

When Dr. Cox joined the faculty of the Creighton University School of Medicine, he and his team wanted to push the boundaries of patient-specific, tactile education using 3D printing—and the most basic place to start was with biopsy simulation.

"We wanted to create a breast biopsy model that looks and feels like an actual lesion, but we didn't know how 3D print materials would behave with ultrasound," says Dr. Cox. "The 3D print technology we had tried to date didn't produce the results I wanted. And it wasn't until I had access to the Digital Anatomy Printer that we could produce high-fidelity simulation models."

The Digital Anatomy Printer uses PolyJet 3D printing technology to create visual and functional models with a range of features, including intricate details, complex geometries, full-color combinations, different transparencies, and flexible parts. In addition, GrabCAD Print software includes 100+ clinically validated anatomy presets that deposit materials to realistically mimic the various textures and densities of human tissue and bone.



Ultrasound signal of the printed breast biopsy phantom

How it was done: Building a realistic ultrasound-guided breast biopsy model

Using Digital Anatomy materials and a deidentified patient MRI scan, the research team wanted to create an ultra-realistic breast tissue model. From the GrabCAD software's anatomical preset library, they chose Encapsulated Subcutaneous Fat to replicate the tissue of the breast itself and Solid Internal Organ 6 for the tumor.

With point of care ultrasound (POCUS), the team was able to visualize the lesion right away, but when they transitioned to the ultrasound suite with a more powerful transducer, they discovered that they needed to lower the frequency to match the POCUS settings. This adjustment ensured that the printed model would produce signals similar to those from actual human breast tissue.

To enhance the realism of the models, they finished the models with the Soft DM 400 preset for the skin surface, which provided a lifelike feel while allowing for effective ultrasound penetration.

Finally, the team provided their model to a mammographer to gather feedback on its performance and tactile qualities compared to prefabricated silicone.

After testing many variations to create the functional model, Dr. Cox and his research associate and prototyping engineer, Richard "Beni" Csordas, noted some important lessons learned.

1. The interface between print materials matters.

"What seems to matter most is the difference between the object that you're putting inside the material and the bulk material," says Csordas. "Subcutaneous Fat and Solid Internal Organ 6 work well in contrast." "The two materials have a really nice echogenic interface," adds Dr. Cox.

2. Be mindful about fluids for model longevity

"Soaking the subcutaneous fat tissue in water degrades the model over time, as does leaving ultrasound gel on the model," says Csordas. This happens when Elastico coating absorbs some of the fluids used during cleaning or the training application. "Generally speaking, unless the material is fully encapsulated inside of the model, we don't soak uncoated models in water," adds Csordas.

3. Calibrate your ultrasound equipment.

While the 3D printed model had good ultrasound penetration using POCUS, the ultrasound suite equipment required some calibration.

"We had to do a series of adjustments, but when we dropped the frequency to the same range as POCUS, the clinical unit began to show the lesion," says Cox. "A low frequency setting is what allowed us to see the materials inside the model."

The result: A breast biopsy model that performs better than standard silicone

"In the initial comparisons between our purchased, molded breast biopsy model versus the one we created, the experience of our mammographer was that the feel of the biopsy is much more similar to a true patient than the silicone," says Dr. Cox.

Dr. Cox explains that with the silicone prefabricated model, the biopsy needle recoils unnaturally during the initial capture. Along with that, the trough of the biopsy itself is lower in volume than what the mammographer is able to get on the 3D printed model or on an actual patient.

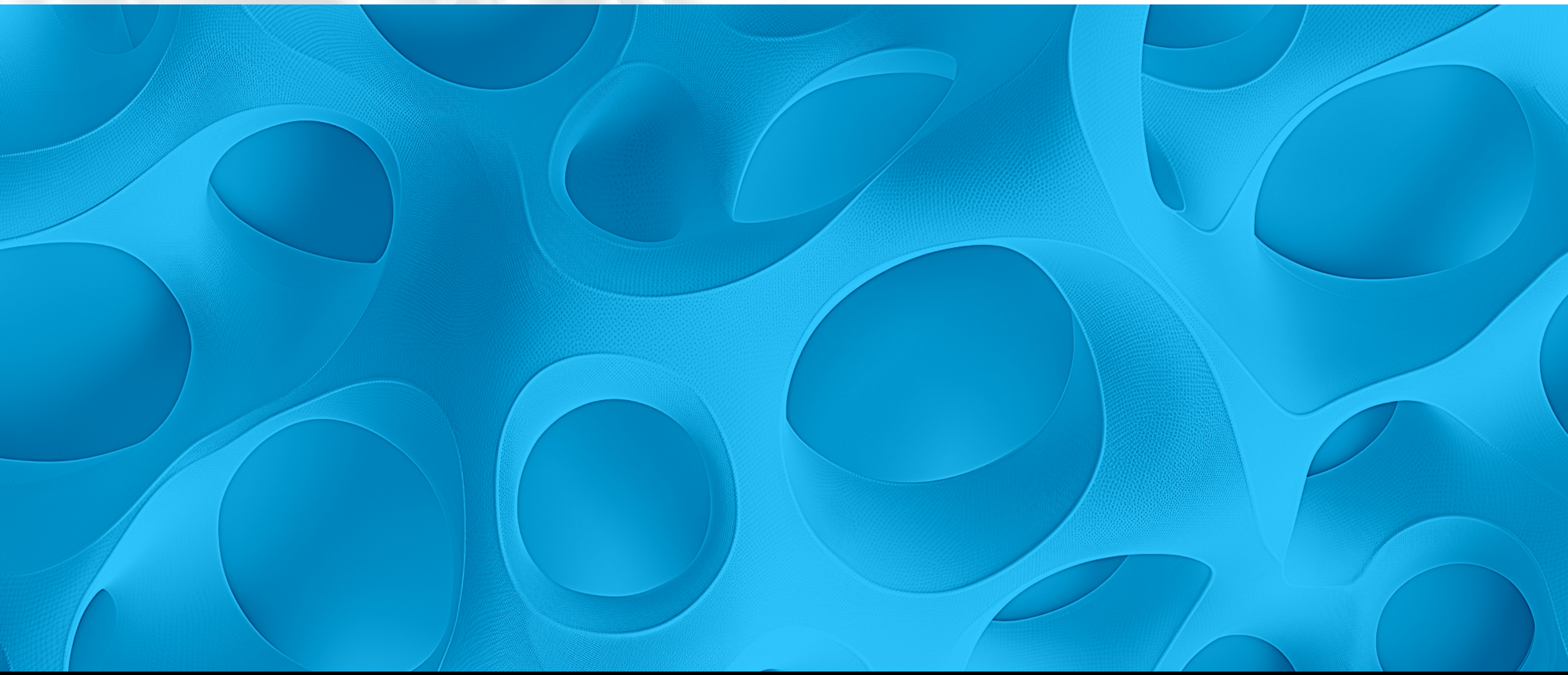
"Across the board—from ultrasound fidelity to feel to the volume of trough capture—our printed model is much, much better than what we can buy online," says Cox.

When better training and preparation means better patient outcomes, the quality of the tools for medical education matters. The Digital Anatomy Printer can create biomechanically accurate, highly realistic practice models that significantly improve surgical preparation and clinical acumen.

Patient-specific 3D printed models for case preparation have been shown to reduce OR and recovery time, and with highly repeatable, realistic surgical preparation, hospitals can standardize delivery of care.

"Being able to print specific patient anatomy so that we can train a resident on a model, and they can turn around and do the same biopsy on the actual patient—that's the dream."

Make it with Stratasys. [Learn more about Digital Anatomy Printer technology.]



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