

A photograph of a man in a white lab coat and a blue surgical mask, wearing glasses, looking down at something on a table. In the background, another person in a lab coat is working at a computer. The setting is a laboratory with various equipment and supplies visible.

\$7,891,773

in NIH funding was won by our faculty in 2020, often leveraging our seed grants.

## Waves over knives

Engineer develops energy-based alternative to tumor surgery

By Marcia Locke

Ideally, cancerous tumors can be removed with surgery. But in many cases, they can't. The tumor is too big or inaccessible, or the patient is unable to tolerate surgery. Minimally invasive alternatives are needed.

Punit Prakash, associate professor of electrical and computer engineering at Kansas State University, is developing technologies for minimally invasive treatment of localized cancers, or tumors. Specifically, his team is developing energy delivery devices and strategies for thermal therapy of cancer. They work primarily with microwave and radio-frequency energy.



\$55,814

supported laboratory equipment purchases in 2020.  
But hundreds of thousands of dollars are needed.

Thermal therapy involves precisely depositing energy into the target tissue where it is absorbed and converted into heat. It can be done in a couple of ways. One is to intensely and briefly heat tumors to destroy them, called thermal ablation. The other is to moderately heat tumors for longer durations to increase their blood flow, which can have various effects that synergize with other therapies.

"With our thermal ablation therapy, the idea is to go in and destroy that solid mass or tissue without as big of an incision, and hopefully even without general anesthesia," Prakash said.

Prakash and collaborators are working to improve tumor ablation technologies currently used with cancers in the liver, prostate, lung, kidney, other organs and bone. The team's image-guided device better addresses the challenges of energy delivery, direction and dosing.

The moderate heating approach stimulates tumors, which typically have irregular blood flow. The increased blood flow could help get more chemotherapy or immunotherapy drugs into the tumor. Similarly, it could amplify radiation therapy within the tumor as well.

To carry out these therapies, Prakash's team has developed a needle-based device about two millimeters in diameter that can be inserted through the skin and into a tumor with guidance from MRI technology.

"The goal is to maximize therapeutic heating of the tumor while preventing thermal damage to critical structures," Prakash said. "Our device radiates the microwaves in a pattern so they localize within and slightly beyond the tumor with minimal disruption or damage to surrounding tissue."

Prakash's team has also made the device capable of shaping the pattern of the energy that is radiated.

"Instead of going off in all directions, it heats only to one side, so clinicians treating close to a critical structure can aim the energy away from it," Prakash said. "This technology is now being translated by a Manhattan-based startup company founded by a recent K-State graduate."

Since MRI also monitors temperature in real time, energy dosing — or measuring and controlling how much the tumor is heated — is intrinsic to Prakash's technology.

"Working in the MRI environment is tricky because of the associated risks, but we are focused on producing a closed-loop treatment that can deliver energy while simultaneously monitoring and correcting it," Prakash said.

Prakash, who leads K-State's Pancreatic Cancer Research Collaboration of Excellence, thinks that his technology offers some hope for pancreatic cancer patients, who are often diagnosed after

their tumors are too advanced for surgery. According to Prakash, thermal ablation could shrink the tumors so that they're eligible for surgery and moderate heating could augment nonsurgical therapies.

Prakash appreciates the support he has received from the Johnson Cancer Research Center and has leveraged his awards to garner millions of dollars in extramural funding.

"The JCRC funds are really helpful," Prakash said. "Initially, you might think it's a small amount, but it's critical because it helps you generate the next level of evidence that helps you apply for the bigger funding."

Indeed, Prakash and partners received a \$1,321,648 National Cancer Institute grant to develop a bronchoscopic microwave ablation system for lung tumors. According to Prakash, microwave needles are effective, but since lungs can collapse, a safer approach to lung tumors may be from inside the airways, which are difficult to navigate. He and collaborators have developed a system that is showing success in animals and may advance to human testing by next year. This work has resulted in multiple pending patent applications.

"This has been really exciting for us," Prakash said. "It's not every day you're involved in developing a new technology from concept to clinical translation."