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New organ-on-a-chip finds crucial interaction between blood, ovarian cancer tumors

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Abhishek Jain and his team at Texas A&M are collaborating with researchers at MD Anderson Cancer Center and Rice University to develop and test their new microdevice, the ovarian tumor microenvironment-chip. Credit: Texas A&M Engineering

Researchers at Texas A&M University are pushing organ-on-a-chip devices to new levels that could change the way clinicians approach cancer treatment, particularly ovarian cancer. A team has recently

submitted a patent disclosure with the Texas A&M Engineering Experiment Station.

The research team, led by Abhishek Jain, an assistant professor in the Department of Biomedical Engineering with a joint appointment in the College of Medicine, has created a device that focuses on platelets, tiny blood cells that help the body form clots to stop bleeding. The ovarian tumor microenivornment-chip (OTME-Chip) is about the size of a USB and models the properties of a tumor in the lab. Researchers can use the microdevice to recreate events within platelets circulating in the blood as they approach the tumor and make it more potent and metastatic.

"We claim several novelties in technological design as well as biological capabilities that didn't exist in prior organs-on-chips," Jain said.

In the evolving field of cancer biology and treatment, innovations in organ-on-a-chip microdevices allow researchers to discover more about the disease outside the human body. These organs-on-chips serve as a model of the state a cancer patient is in, thus allowing an opportunity to finding the correct treatment before administering it to the patient.

"We are creating a platform technology using the organ-on-a-chip approach where tumor biology can be advanced, and new drugs can be identified by recreating the platelet-tumor and platelet-tumor-drug interactions under the influence of flow, supporting blood vessels and the extracellular matrix," Jain said.

Ovarian cancer is a particularly challenging one to monitor. Tumors generally form deep inside a patient's tissue, and it can be difficult to obtain real-time information of the tumor's properties and how it is interacting with blood cells. Also, ovarian tumors can quickly spread inside the body, making time another vital factor in mapping the disease's progression.

The OTME-Chip builds on the current clinically observed understanding of how blood platelets move inside tumor tissue and what triggers them to spread outside the tumor. However, the actual mechanism behind this process remains mostly unknown, until now.

"For the first time, we identified a crucial interaction between platelets and the tumor via their surface proteins," Jain said. "By applying high-resolution imaging, advanced cell and molecular readouts and RNA sequencing methods leveraging the OTME-Chip, we discovered the actual genetic signaling pathways behind the blood cell triggered metastasis of ovarian cancer and a new drug strategy to stop this process."

Jain's team in College Station for this research includes postdoctoral researcher Biswajit Saha and doctoral students Jim Tronolone and Tanmay Mathur. Their research was recently published in the journal *Science Advances*.

Jain said the OTME-Chip has several applications, both in observing how cancer cells interact differently with vascular and blood cells and testing novel ways to treat the disease that may complement chemotherapy and radiotherapy of tumors.

"This multimodal OTME-Chip is going to provide an ideal platform to the health care researchers to evaluate their anti-cancer, vascular and hematological drugs individually or in combination in an artificially created human-level tumor microenvironment," Jain said.

Jain collaborates with Dr. Anil Sood, professor and vice chair for translational research in the Departments of Gynecologic Oncology and Cancer Biology at MD Anderson Cancer Center. The team also works with Gang Bao, a gene editing expert from Rice University.

"Sood is a leader in the ovarian cancer field," Jain said. "He has been a fantastic collaborator and has provided us access to patient tissue and blood samples needed to validate the findings from our chip, which brings us very close to initiating new clinical trials."

More information: Biswajit Saha et al, Human tumor microenvironment chip evaluates the consequences of platelet extravasation and combinatorial antitumor-antiplatelet therapy in ovarian cancer, *Science Advances* (2021). DOI: 10.1126/sciadv.abg5283

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