

# Photoacoustic imaging may help doctors detect ovarian tumors earlier

November 14 2018, by Beth Miller

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Ovarian cancer claims the lives of more than 14,000 in the U.S. each year, ranking fifth among cancer deaths in women. A multidisciplinary team at Washington University in St. Louis has found an innovative way

to use sound and light, or photoacoustic, imaging to diagnose ovarian tumors, which may lead to a promising new diagnostic imaging technique to improve current standard of care for patients with ovarian cancer.

Quing Zhu, professor of biomedical engineering in the School of Engineering & Applied Science and of radiology, and a team of physicians and researchers at Washington University School of Medicine in St. Louis recently conducted a [pilot study](#) using co-registered photoacoustic tomography with ultrasound to evaluate ovarian tumors on 16 patients at the School of Medicine and Barnes-Jewish Hospital. Results of the study were recently published online in Radiology.

"When ovarian [cancer](#) is detected at an early, localized stage—stage 1 or 2—the five-year survival rate after surgery and chemotherapy is 70 to 90 percent, compared with 20 percent or less when it is diagnosed at later stages, 3 or 4," said Zhu, a pioneer of combining ultrasound and near-infrared imaging modalities for cancer diagnosis and treatment assessment. "Clearly, early detection is critical, yet due the lack of effective screening tools only 20-25 percent of ovarian cancers are diagnosed early. If detected in later stages, the survival rate is very low."

In their approach, researchers use transvaginal ultrasound to obtain information about [ovarian tumors](#), but ultrasound lacks accuracy in diagnosis of ovarian masses, Zhu said. Photoacoustic tomography, however, gives researchers a very detailed look at the [tumor's](#) vasculature, or tumor angiogenesis, and blood oxygen saturation ( $sO_2$ ) by lighting up the tumor's vasculature bed and allowing for more accurate diagnoses of ovarian masses seen by ultrasound.

Both tumor angiogenesis and tumor  $sO_2$  are related to tumor growth, metabolism and therapeutic response. The Washington University team is the only team using co-registered photoacoustic imaging and

ultrasound to diagnose [ovarian cancer](#).

In the pilot study, Zhu and her team created a sheath with optical fibers that wrap around a standard transvaginal ultrasound probe. The optical fibers are connected to a laser. Once the probe is inside the patient, Zhu turns the laser on, which shines through the vaginal muscle wall. With [photoacoustic tomography](#), the light from the laser propagates, gets absorbed by the tumor and generates sound waves, revealing information about the tumor angiogenesis and  $sO_2$  inside the ultrasound-visible ovaries. A normal ovary contains a lot of collagen, Zhu said, but an ovary with invasive cancers has extensive blood vessels and lower  $sO_2$ .

The team used two biomarkers to characterize the ovaries: relative total hemoglobin concentration (rHbT), which is directly related to [tumor angiogenesis](#), and mean oxygen saturation ( $sO_2$ ). In this pilot study, the team found that the rHbT was 1.9 times higher for invasive epithelial cancerous ovaries, which make up 90 percent of ovarian cancers, than for normal ovaries. The mean [oxygen saturation](#) of invasive epithelial cancers was 9.1 percent lower than normal and benign ovaries. All five invasive epithelial cancerous ovaries, including two stage 1 and 2 cancers, showed extensive rHbT distribution and lower  $sO_2$ .

"Physicians are very excited about this because it might bring significant change into current clinical practice," Zhu said. "It is very valuable to detect and diagnose ovarian cancers at early stages. It is also important to provide information and assurance to patients that there is no worry about their ovaries, instead of removing a patient's ovaries. This technology can also be valuable to monitor high-risk patients who have increased risk of ovarian and breast cancers due to their genetic mutations. The current standard of care for these women is performing risk reduction surgeries to remove their ovaries at some point, which affects their quality of life and causes other health problems."

"We are very fortunate to participate in this research endeavor headed by Dr. Zhu," said Cary Siegel, MD, professor of radiology and chief of gastrointestinal/genitourinary radiology at the School of Medicine. "This photoacoustic imaging study has great potential to better identify [ovarian cancers](#) and may play a valuable role in screening high-risk patients and triaging patients for follow-up imaging or surgical excision."

Zhu credits her physician collaborators, including Siegel; Matthew Powell, MD, associate professor and chief of the Division of Gynecologic Oncology; Ian Hagemann, MD, Ph.D., assistant professor of pathology & immunology; David Mutch, MD, the Ira C. and Judith Gall Professor of Obstetrics and Gynecology; the radiology team and the entire gynecology group, as well as her doctoral students Sreyankar Nandy, Atahar Mostafa and Eghbal Amidi, who worked on instrumentation, control software and data processing.

"I really appreciated this as a group effort to bring the study to this point," Zhu said. "This technology may provide a means to improve [early ovarian cancer](#) detection, help avoid surgery in most patients with a normal or benign ovary, substantially reduce medical costs, and improve women's quality of life. We look forward to bringing this study to the next level."

These initial results will need to be validated with more patients, Zhu said, and the team is applying for funding to conduct a large clinical trial.

**More information:** Sreyankar Nandy et al. Evaluation of Ovarian Cancer: Initial Application of Coregistered Photoacoustic Tomography and US, *Radiology* (2018). [DOI: 10.1148/radiol.2018180666](https://doi.org/10.1148/radiol.2018180666)

Provided by Washington University in St. Louis

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