Diagnosing skin cancers with light, not scalpels

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In an early step toward nonsurgical screening for malignant skin cancers, Duke University chemists have demonstrated a laser-based system that can capture three-dimensional images of the chemical and structural changes under way beneath the surface of human skin.

"The standard way physicians do a diagnosis now is to cut out a mole and look at a slice of it with a microscope," said Warren Warren, the James B. Duke Professor of chemistry, radiology and biomedical engineering, and director of Duke's new Center for Molecular and Biomedical Imaging. "What we're trying to do is find cancer signals they can get to without having to cut out the mole.

"This is the first approach that can target molecules like hemoglobin and melanin and get microscopic resolution images the equivalent of what a doctor would see if he or she were able to slice down to that particular point," Warren said.

The distributions of hemoglobin, a component of red blood cells, and melanin, a skin pigment, serve as early warning signs for skin cancer growth. But because skin scatters light strongly, simple microscopes cannot be used to locate those molecules except right at the surface. Although laser methods have been developed to probe deeper down for some other molecules that can be made to glow, both melanin and hemoglobin remain dark and inaccessible using those methods.

Warren's group has now developed a technology for coaxing both

hemoglobin and melanin inside questionable skin moles to emit light by exciting them with highly controlled laser pulses.

The innovation uses a delicate interplay between two laser beams, each emitting a different color of light. To keep the skin from overheating in the process, the lasers must also be able to pulse on for only femtoseconds -- a thousand trillionths of a second -- at a time.

The glow of the hemoglobin- and melanin-bearing structures can be magnified by a microscope outside the skin and manipulated by computers to create cellular-scale images. The noninvasive technique could enable doctors to see as much as a millimeter below the skin's surface -- more than enough for diagnosis, Warren said.

"What this is leading to is for a doctor to be able to touch a mole with a fiberoptic cable and characterize what is going on inside it," he said.

"Today, if you visit a dermatologist, he or she will probably see many moles on your body. But the difficulty is trying to figure out which of those, if any, are dangerous."

Warren's group demonstrated at a March conference of the American Physical Society how the technique can visualize melanin from inside an excised human melanoma.

In May, at an international conference on laser advances, the team made a similar presentation on visualizing hemoglobin in blood vessels within mouse skin cells.

Warren said his team is now working with James Grichnik, an assistant professor in the Duke Medical Center's dermatology and cell biology departments, to begin testing the technology in the clinic.

"We have proposals pending for developing a compact laser system that could be sitting in a dermatologist's office here at Duke within three years where we could actually have the first human demonstrations," Warren said.

Source: Duke University