Researchers use nanoparticles stimulated by microwaves to combat cancer

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A physicist at The University of Texas at Arlington has proposed a new concept for treating cancer cells, further advancing the University's status as a leader in health and the human condition.

In a recently published paper in the journal *Nanomedicine: Nanotechnology, Biology and Medicine*, UTA physics Professor Wei Chen and a team of international collaborators advanced the idea of using titanium dioxide (TiO2) nanoparticles stimulated by microwaves to trigger the death of cancer cells without damaging the normal cells around them.

The method is called microwave-induced radical therapy, which the team refers to as microdynamic therapy, or MDT.

The use of TiO2 nanoparticles activated by light and ultrasound in cancer treatments has been studied extensively, but this marks the first time researchers have shown that the nanoparticles can be effectively activated by microwaves for cancer cell destruction—potentially opening new doors to treatment for patients fighting the disease.

Chen said the new therapy centers on reactive oxygen species, or ROS, which are a natural byproduct of the body's metabolism of oxygen. ROS help kill toxins in the body, but can also be damaging to cells if they reach a critical level.

TiO2 enters cells and produces ROS, which are able to damage plasma

membranes, mitochondria and DNA, causing cell death.

"Cancer cells are characterized by a higher steady-state saturation of ROS than normal, healthy cells," Chen said. "This new therapy allows us to exploit that by raising the saturation of ROS in cancer cells to a critical level that triggers cell death without pushing the normal cells to that same threshold."

The pilot study for this new treatment concept builds upon Chen's expertise in the use of nanoparticles to combat cancer.

Chen's collaborators hail from the Guangdong Academy of Medical Sciences and Beihang University. The team conducted experiments that demonstrate the nanoparticles can significantly suppress the growth of osteosarcomas under microwave irradiation.

While TiO2 and low-power microwave irradiation alone did not effectively kill cancer cells, the combination of the two proved successful in creating a toxic effect for the tumor cells. Microwave ablation therapy has already proven to be an effective treatment against bone cancer, obtaining better results than MDT. However, MDT has applications for combatting other types of cancer, not just the osteosarcomas used for this pilot case.

Using light to activate ROS—as is seen in photodynamic therapy—can be challenging for the treatment of tumors deeply located within the body; in contrast, microwaves lend the ability to create deeper penetration that propagates through all types of tissues and non-metallic materials.

"This new discovery is exciting because it potentially creates new avenues for treating cancer patients without causing debilitating side effects," Chen said. "This targeted, localized method allows us to keep

healthy cells intact so patients are better equipped to battle the disease."

The results of the pilot study indicate MDT is a promising approach for cancer treatment even though the method is still being developed and its limitations explored. The research team has filed a patent for MDT. Next, they plan to turn their attention to understanding the physics and internal mechanisms behind the powerful combination of microwaves and TiO2.

"Dr. Chen continues to build a research portfolio that holds transformative implications for cancer treatment," said Alex Weiss, chair of UTA's Department of Physics. "This new work is exemplary of the spirit of discovery we strive to embody at UTA. I look forward to what Dr. Chen and his collaborators can accomplish in the coming phases of this research as they pioneer a potential new avenue for combatting cancer."

More information: Xiao Chu et al, Exploration of TiO2 nanoparticle mediated microdynamic therapy on cancer treatment, *Nanomedicine: Nanotechnology, Biology and Medicine* (2019). DOI: 10.1016/j.nano.2019.02.016

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