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Tel Aviv University's Dr Tali Ilovitsh shares her innovative cancer research

By Linda Chase
Contributing Editor

Dr. Tali Ilovitsh is an Assistant Professor and Senior Lecturer in the Department of Biomedical Engineering at Tel Aviv University. Dr. Ilovitsh presented her research at the FALL 4 TAU conference held recently in Miami. Following the conference, Dr. Ilovitsh shared details regarding her innovative research.

Linda: Share details regarding your research work as an assistant professor in the Department of Biomedical Engineering at TAU?

Dr. Ilovitsh: I am a Senior Lecturer in the Department of Biomedical Engineering and the Sagol School of Neuroscience at TAU. My research focuses on developing ultrasound technologies for diagnostic and therapeutic purposes. In our search for a cure for cancer and other diseases, particularly through non-invasive means, we are developing technologies that combine gas bubbles and ultrasound. With these technologies, we can deliver drugs to precise areas in the brain, treat targeted cancerous growths without the need for surgery, diagnose and treat brain diseases such as Alzheimer's and Parkinson's. We even teach the immune system to fight cancerous tumors without unnecessary chemotherapy and radiation treatments. In parallel, we develop diagnostic ultrasound technologies to guide the treatment and enable super resolution imaging.

Linda: Share details regarding your postdoctoral research in ultrasound therapy and imaging?

Dr. Ilovitsh: During my postdoctoral research with Professor Katherine Ferrara, initially at UC Davis and later at Stanford University School of Medicine, I focused on ultrasound imaging and therapy. Leveraging my expertise in optical imaging, super-resolution and beam shaping, I aimed to revolutionize ultrasound imaging techniques. I developed an optically-inspired holographic algorithm to manipulate the emitted acoustical field, enhancing ultrasound imaging capabilities beyond previous limitations. Initially, I utilized this method to achieve ultrasound super-resolution. Subsequently, I applied this beam shaping technology to image areas traditionally difficult to penetrate with ultrasound, such as air and bones. For instance, I successfully imaged tissue behind a rat's spine, previously invisible with standard ultrasound. Concurrently, I discovered the therapeutic ultrasound field and was fascinated by it. So I decided to delve into this field and explore its potential. I employed low-frequency ultrasound to open the blood-brain barrier in mice and enhance cancer therapy by improving drug delivery to tumors in murine models.

Linda: How does that research relate to your present work at TAU?

Dr. Ilovitsh: At the end of 2019, I established my laboratory at the Department of Biomedical Engineering at Tel Aviv University. My research is focused on the development of medical ultrasound technologies that provide non-invasive, cost effective, real-time and safe monitoring, diagnostics and therapy for clinically relevant problems. These technologies are built upon the knowledge and expertise I gained during my postdoctoral training.

Linda: You originally were interested in a career in optics, why did you transition to ultrasound research?

Dr. Ilovitsh: I completed my doctorate in Electrical Engineering in the field of microscopy. Towards the end of my doctorate, I came across a paper that implemented the optical method I had been working on in ultrasound. I realized there was immense potential here because ultrasound is the most common imaging modality used in clinics today and any improvement to it could aid in early diagnosis and saving lives. This led me to pursue a post-doctorate in the field and later establish my own lab at the Faculty of Engineering at Tel Aviv University.

Linda: Did your enrollment in a gifted program as a child inspire your career path?

Dr. Ilovitsh: The gifted program I participated in as a child greatly influenced my career path by fostering my fascination with science. Exposed to a diverse array of topics, the program sparked my curiosity and instilled a passion for exploration. I distinctly recall a pivotal moment in sixth grade when I constructed a rocket, igniting my enthusiasm for hands-on projects and engineering. During junior high, I delved into an advanced math program, eventually completing the SAT math exam in 10th grade. This program sped up my learning and increased my love for math and independent study. Collectively, these formative experiences solidified my passion for science, engineering and mathematics, shaping my trajectory toward a career in these fields.

Linda: Who was your greatest influence in life and why?

Dr. Tali Ilovitsh. **COURTESY OF TEL AVIV UNIVERSITY**

Dr. Ilovitsh: My mother, who studied mathematics and computer science at a time when computers were still unfamiliar and raised me in a household with a career-driven approach. She greatly enjoys her work as a computer programmer in the Israeli aerospace industry. This inspired me to follow a path in STEM subjects of engineering and physics, which I've been drawn to since a young age.

Linda: Share medical breakthroughs/developments you have made?

Dr. Ilovitsh: Our new technology makes it possible to inject nanobubbles into the bloodstream, offering a promising approach to cancer treatment, particularly for brain cancer patients. Unlike conventional methods that require invasive procedures such as drilling into the skull for brain access, our approach utilizes low-frequency ultrasound which can penetrate through the intact skull, enabling non-invasive treatment. Once injected, the nanobubbles travel through the bloodstream and naturally dissolve over time. However, when ultrasound is focused on a specific area, the nanobubbles respond

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by expanding and contracting, facilitating enhanced delivery of substances to surrounding tissues. This mechanism is especially crucial for overcoming barriers like the blood-brain barrier, which typically impedes drug delivery to the brain. Our technology provides a targeted, temporary opening of the blood-brain barrier, offering a non-invasive solution for treating brain disorders, from cancerous tumors to Alzheimer's and Parkinson's.

Linda: Explain your approach to cancer treatment with bubbles?

Dr. Ilovitsh: We leverage the characteristic of cancerous tumors, which mechanically have leakier blood vessels, allowing them to engulf larger substances than those in the bloodstream. We exploit this feature akin to a Trojan horse. Upon injecting the nanobubbles into the bloodstream, tumors uptake them, but they cannot exit healthy blood vessels. This traps the nanobubbles within the tumor. In the final stage, we employ low-frequency ultrasound to burst the bubbles, causing mechanical destruction of the cancerous growth. All treatment is conducted at low pressures, minimizing the risk of damage to healthy tissue. This approach serves as an alternative to surgical procedures. Currently, we have only conducted the treatment in mice, but in the future, we hope to extend it to humans.

Linda: What is your ultimate goal as a researcher?

Dr. Ilovitsh: As a researcher in the field of biomedical engineering, my goal is to develop methods to improve quality of life and save lives. One of the major challenges today is treating metastases, as a significant portion of cancer-related deaths result from metastases rather than the primary tumor. In our initial research stage, we focused on ultrasound treatment of the primary tumor. However, we often do not know the exact location of all metastases and treating each one is not always feasible. One thing we observed is that the treatment we developed with the nanobubbles triggers an immune response in the treated area. This is significant because one reason cancer succeeds in growing is its ability to evade the immune system. If we can influence the immune system, it may be possible to treat metastases as well. Currently, we are combining ultrasound treatment with nanobubbles alongside complementary treatments like immunotherapy in an effort to target both the primary tumor and metastases. This is one of the significant challenges I aim to address as a researcher.

Linda: Express your thoughts on the medical advances you and your team have made?

Dr. Ilovitsh: I am very proud of our research and believe in it wholeheartedly. Of course, none of this would have been possible without the hard work of all the members of the lab who dedicate their time and every ounce of their effort to the research. Today, we know that cancer is not a single disease. Each type of cancer can be classified into different subtypes based on specific characteristics. Developing a biological or chemical therapy for each type of cancer would require tailored approaches for each subtype, making it an incredibly challenging task bordering on the impossible. In contrast, the technologies we are developing, such as targeted destruction of bubbles leading to non-invasive tumor removal, are physical technologies. While we primarily test them in models of breast and brain cancer, the mechanism should be applicable to all solid cancer types. Therefore, I believe that this platform represents a scientific breakthrough that could significantly advance the field of cancer therapy.

Linda: Congratulations on being honored by Forbes Israel Magazine "30 under 30" list.

Dr. Ilovitsh: Being honored by Forbes Israel Magazine's "30 under 30" list is an incredible recognition of the hard work and dedication that I put into our research. From a young age, I was motivated to excel, and this drive has propelled me to achieve these accomplishments at a relatively young age. It's a testament to the impact our work is making in the field of biomedical engineering and cancer therapy and it's truly humbling to be recognized among such a talented group of individuals. This acknowledgment not only validates our efforts but also serves as motivation to continue pushing boundaries and striving for excellence in our work. I'm immensely grateful for this honor and excited to see where our research journey takes me next.