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NUS researchers use magnetic pulses to reprogram immune cells against breast cancer

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The preclinical approach uses pulsed electromagnetic fields to convert tumour-associated macrophages into an anti-tumour state, with researchers now seeking partners for Phase II testing.

Researchers from the National University of Singapore have demonstrated a non-invasive approach using pulsed electromagnetic fields to reprogram tumour-associated macrophages against breast cancer.

The team showed that pulsed electromagnetic field, or PEMF, exposure could convert tumour-associated macrophages from a tumour-supporting state into an active anti-tumour state.

The study was led by Associate Professor Alfredo Franco-Obregón from the Department of Surgery at the NUS Yong Loo Lin School of Medicine and the NUS Institute for Health Innovation & Technology.

The findings were published in Smart Medicine.

Tumour-associated macrophages are immune cells that are commonly recruited by solid tumours and can be altered by cancer cells to support tumour growth and suppress immune responses.

The NUS team focused on reprogramming these macrophages so that they instead attack cancer cells.

The mechanism involves the TRPC1 protein, which regulates the pro-inflammatory M1 macrophage state and also allows cells to sense and respond to magnetic fields.

In experiments, a 10-minute exposure to PEMFs activated TRPC1 channels on M2-like tumour-associated macrophages.

This triggered signalling that converted the macrophages into the M1 state, enabling them to target cancer cells while sparing healthy tissue.

The same magnetic signature also disrupted signalling between cancer cells and tumour-associated macrophages.

In preclinical models, PEMF treatment without chemotherapy completely eradicated tumours in 75% of tested models after four 30-minute sessions.

“Our study represents a major advancement in breast cancer treatment by demonstrating the potential of PEMFs as a stand-alone, drug-free therapy,” said Associate Professor Franco-Obregón.

The latest findings build on previous NUS research showing that brief PEMF exposure can enhance the uptake of doxorubicin by breast cancer cells.

The researchers are now evaluating whether PEMF-mediated immune reprogramming could work synergistically with chemotherapy.

The team said the immune cells targeted by the technology are also present in many other solid tumours, raising the possibility of applications beyond breast cancer.

The same PEMF device used in the study has completed a Phase I clinical trial demonstrating safety in humans.

The researchers are now seeking partners to conduct Phase II efficacy studies and advance the technology towards clinical use.

The work adds to growing interest in approaches that modify the tumour microenvironment rather than targeting cancer cells alone.