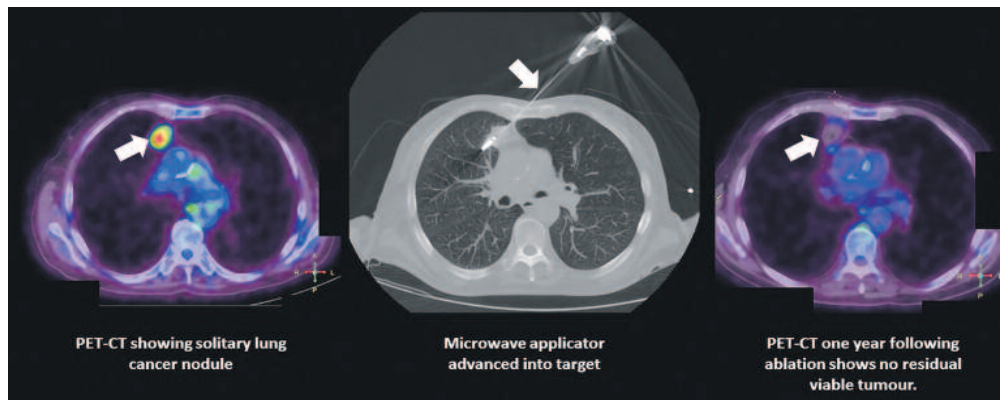
Destroying cancer cells with heat

KELVIN CORTIS, FEDERICO CILIA, and JULIAN BONELLO



A diagram showing how the cancerous tissue disappears after an interventional operation. PHOTO: KELVIN CORTIS

Microwave ablation is a technique for treating certain types of cancer, whereby a microwave antenna is positioned inside the target tumour by an interventional radiologist. Microwaves are a band of frequencies between 300 MHz and 300 GHz in the electromagnetic spectrum. Microwave ablation procedures utilize the frequencies 915 MHz and 2.45 GHz due to regulatory reasons. However, other frequency ranges are possible, depending on the target lesion.

These microwave antennas have a 'feedpoint', a specific area located close to the tip of the antenna through which all the microwave energy is channeled and released in the surrounding tumour. Precise positioning of the antenna is usually achieved by the interventional radiologist using real-time ultrasound or Computed Tomography (CT) imaging, avoiding surgical incisions.

Tumour cells need to be heated to at least 60 °C to be destroyed, and microwave ablation reaches temperatures of 160 °C or more. Given this, patients are usually under heavy sedation or general anaesthesia in order to avoid unnecessary pain.

Microwave ablation has been extensively studied in kidney, liver and lung cancer. Not all tumours are suitable for microwave ablation - target tumours have to be at a safe distance from other vital structures such as major blood vessels or neighbouring organs. Microwave ablation achieves results equivalent to surgical removal in tumours that are smaller than 3-4 cm and patients can be discharged within a few hours following the procedure.

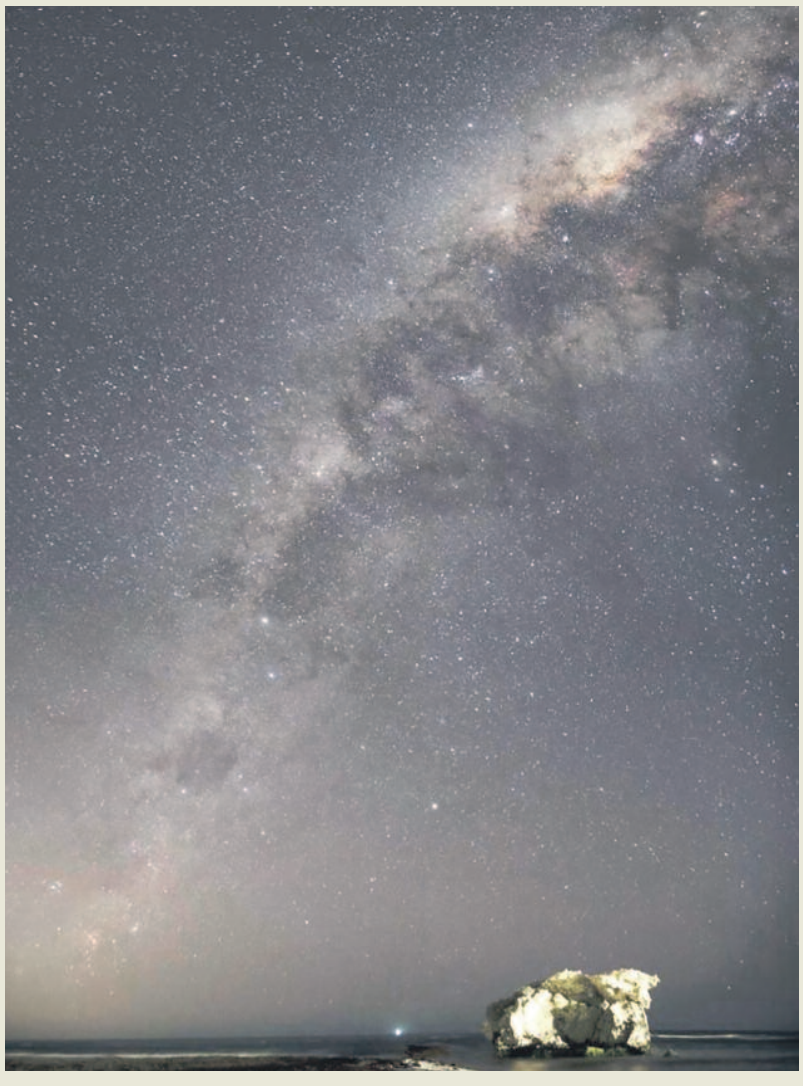
The surgical procedure is performed using a needle-like applicator which is around 1.6 mm in diameter and is inserted through the skin to reach the tumour. The applicator is made up of a microwave antenna and a water jacket. The water jacket is used to keep the needle structure cool and avoid damaging the surrounding healthy tissue. At the tip of the applicator, a nearly spherical microwave frequency electric field is generated.

Similar to how food is heated in a microwave oven, as most foods contain a significant amount of water content, this surgical procedure heats up the biological tissue. The water molecules within the biological tissue are polar, and when microwaves interact with the molecular dipoles it causes their re-orientations to align with the external electric field. This rapid dipole re-alignment causes the generation of heat in the tissue surrounding the applicator, this causes the tissue to reach the ablative temperatures thus destroying the cancer cells.

Microwave ablation is performed locally by a multidisciplinary team, composed of an interventional radiologist, an anaesthetist, radiographers, and nurses. This therapeutic modality has been available since 2015, and nearly 300 patients at Mater Dei Hospital have benefited from this technological innovation to date.

Dr Kelvin Cortis is a radiologist with a special interest in hepatobiliary imaging and interventional oncology. Federico Cilia is an Electrical Engineering M.Sc student. Together with Julian Bonello, who is studying for his doctoral studies, form part of the Electromagnetics Research Group (EMRG), Department of Physics, University of Malta.

PHOTO OF THE WEEK



The Milky Way arching over the Indian Ocean, captured from Two Rocks, Perth, Australia. The Milky Way's galactic center lies 26,000 light years from Earth, and the galaxy itself contains a total of 400 billion stars. From Australia, parts of the Milky Way not visible from Malta can be seen, due to its southern latitude. This image was captured last September by Maltese astronomer Josef Borg, using a Nikon D610 and a 24mm lens. The image was captured as a single long exposure of 20 seconds at an ISO setting of 1600. This exposure was enough to capture the faint Milky Way against the dark Australian night skies. PHOTO: JOSEF BORG

SOUND BITES

- Two research teams from the University of Malta led by Prof. Charles V. Sammut and University College London are looking into using gold nanoparticles for the focusing of microwaves. The team is made up of engineers, radiologists and physicists. The gold nanoparticles are very small particles (nanometer in diameter) and are not dangerous to humans. These are injected into humans and are designed in such a way that they are attracted to cancerous tissues. In the preliminary stage of the study the investigation looks at the dielectric properties of the targeted gold nanoparticles to increase the absorption of microwaves. The measured dielectric properties show promise in focusing the waves. To date numerous different nanoparticles have been designed and have had their dielectric properties measured.
- A team of scientists from Trento, Italy are looking into making Magnetic Resonance Imagers (MRI) safer to people with implanted electronic systems. At present people who have implanted electronic systems, such as a pacemaker, cannot undergo an MRI examination. The scientists from Trento have identified the rate at which the magnetic field changes, as the biggest danger to electronic systems. The team propose altering the current MRI procedure, by reducing the rate at which the field changes and therefore making it safer for people with such implants. The results obtained to date show promise and will serve as a base for future studies. https://onlinelibrary.wiley.com/doi/pdf/10.1002/bem.22201

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DID YOU KNOW?

- The most powerful magnets in the universe are actually stars called magnetars.
- The magnetic field from these magnetars is so strong that it could destroy small planets if they get close enough.
- Scientists have created what is believed to be the strongest continuous magnetic field ever produced in a laboratory. The magnet reaches the strength of 45.5 Tesla equivalent to around 45 loudspeaker magnets.
- "Blind" rats with a neuroprosthetic device that stimulates the brain when the rats turn their heads to the North or South can navigate mazes as well as sighted rats.
- The most powerful thunderstorm ever measured produced 1.3 billion volts.

For more trivia see: www.um.edu.mt/think

MYTH DEBUNKED

Mice prefer to eat cheese!

DANIELLE MARTINE FARRUGIA

In cartoons, cheese is always seen as mice's favourite food. However, is this actually true?

While we may want to keep our houses mice free, they still seem to make their way into our homes. We try to keep them away as they tend to chew on things, mostly wires, books, papers and insulation around our home. The reason why they chew on these objects is not for sustenance but to build their nests wherever it is warm, close to food and well-hidden.

Nowadays we can prevent the damage caused by mice using traps that capture them rather than harm them, so that we are able to release them safely, somewhere away from our homes.

This of course needs to be a couple of hundred metres away from our homes, so they are not able to return. To lure them to the trap, we usually put some sort of food, usually cheese. However, trap manufacturers recommend sweet foods as bait such as peanut butter or chocolate as mice seem to enjoy sweet foods.

While mice will still eat the cheese as they are omnivorous, that is they eat both meat and plants, they would rather raid your cupboards for cereal, dried fruit and foods with a high sugar content.

PHOTO: COLBY GUTIERREZ-KRAYBILL

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