Computer-controlled table could direct radiotherapy to tumours while sparing vital organs

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Swivelling patients around on a computer-controlled, rotating table could deliver high doses of radiotherapy to tumours more quickly than current methods, while sparing vulnerable organs such as the heart, brain, eyes and bowel.

Sophisticated computer modelling could be used to slowly move the table - known as a couch - and a radiation source in three dimensions to direct radiation precisely to the patient's tumour, researchers have suggested.

At the moment, a radiotherapy table can be angled during treatment, but there is no way to synchronise its rotation with a moving radiation beam. But with some modifications, an upgraded system could move both the patient and the beam while reducing the radiation dose of healthy tissue.

A team at The Institute of Cancer Research, London, and The Royal Marsden NHS Foundation Trust modelled the effectiveness of the technique using data from four patients with different cancers close to major organs – and found it could substantially cut the amount of radiation delivered to healthy tissue.

The study, published in *Physics in Medicine and Biology*, was funded by the NIHR Biomedical Research Centre at The Royal Marsden and The Institute of Cancer Research (ICR), with additional support from Cancer

Research UK.

In breast cancer, the average radiation dose to the heart could be reduced by 53% compared with radiotherapy without the new technique. In a patient with a brain tumour, maximum calculated doses to the left and right eye lenses dropped by 61% and 77% respectively, and by 37% and 40% to the left and right eyes respectively.

The technique could lower the average dose a prostate cancer patient's bowel is exposed to by 15%. Patients with advanced prostate cancer, where the pelvic nodes are also treated, could see the volume of their bowel exposed to radiation lowered by as much as 45%.

This next-generation radiotherapy technique, known as dynamic couch rotation volumetric modulated arc therapy (DCR-VMAT), would use a beam of radiation which would move around the patient, while also moving the patient table simultaneously. Doctors could control the angle of the beam, the dose rate and the shape of the beam, and limit the radiation dose to the patient's healthy organs.

The technique is very new, so very little research has been conducted about how to coordinate the patient's movement with the radiation source to minimise organ exposure while treating tumours in different parts of the body. This is the first study using sophisticated computer modelling to directly optimise the technique.

Researchers at the ICR and The Royal Marsden used computer modelling of the path of the radiation beam to produce maps showing the amount of radiation from the moving source which intersected with healthy organs near the patient's tumours. They cross-referenced this with every possible orientation of the table in relation to the beam to calculate how to move the patient during DCR-VMAT to minimise the radiation dose to healthy organs.

Study leader Dr James Bedford, Principal Clinical Research Physicist in the Joint Department of Physics at The Institute of Cancer Research, London, and The Royal Marsden NHS Foundation Trust, said: "Radiotherapy continues to improve as new ways of directing radiation to the tumour while sparing the critical structures are found. The outcome of radiotherapy depends very much on the type of cancer and where it is located in the body. This technique allows us to maximise the dose to the tumour while steering the radiation beam around the sensitive normal tissues. It will be of particular value for patients whose tumours are located near to radiation-sensitive organs.

"Although other high-tech radiotherapy systems exist, they are only available at a few sites around the UK, and the time taken to treat the patient is considerable. The advantage of our proposed system is that it improves on radiotherapy machines already widely available – it's the natural progression for these devices. The new technique could provide precision radiotherapy that would be easier to implement in every radiotherapy facility in the country. Furthermore, treatment would only take a few minutes, which is more comfortable for the patient and improves accuracy."

Professor Alan Ashworth, Chief Executive of The Institute of Cancer Research, London, said: "Research into physics has played an important but largely unheralded role in advancing cancer treatment, with around 40 per cent of cancer survivors having received radiotherapy.

"Our physicists are developing cutting-edge techniques to deliver doses of radiation to tumours more precisely. This work could substantially reduce the amount of harmful radiation patients' healthy organs are exposed to, allowing us to hit the cancer with higher and more effective doses of treatment."

Dr Imogen Locke, Lead for Clinical Oncology at The Royal Marsden said: "This research has the exciting potential to translate into significant clinical benefit for patients by reducing some of the long term effects of radiotherapy on healthy tissue. Delivering radiotherapy using advanced rotational techniques also allows treatment to be targeted more accurately and delivered more rapidly."

Provided by Institute of Cancer Research