GE HealthCare

AIR™ Coils

Leveraging AIR™ Coils to support MRI-only Radiation therapy workflow to deliver improvements in Prostate Cancer Treatment

(SUHCCC) in southern Sweden stands as a beacon of advanced medical care and specialized research. Collaboratively established by Skåne University Hospital, Lund University Faculty of Medicine, Regional Cancer Center South, Medical Service, and Palliative Care & Primary Care, SUHCCC delivers excepional, patient-centered cancer care while embracing scientific evidence and innovation.

At the forefront of this comprehensive center lies the Radiation Therapy Centre, a vital service line caring for paients from across the region. Faced with an increasing demand for cutting-edge treatments, the center established a modern facility in 2012 with twelve linear accelerators and two brachytherapy units along with a GE HealthCare SIGNA™ Architect 3.0T MRI scanner used for precise radiation therapy planning.

Challenges developing an MRI-only radiation therapy workflow

For prostate cancer, radiation therapy (RT) stands as the established standard for treatment. Traditionally, therapy planning relies upon a combination of CT and MR imaging using image registration to account for both tissue density and target delineation when creating the patient's radiotherapy treatment plan. The use of CT and MR imaging in radiation therapy strives to harmonize the advantages of both modalities, leveraging CT's prowess in capturing tissue density and MR's superior contrast in delineating treatment soft tissue targets and organs at risk. However, this combination is not without challenges, in addition to the intricacies of image registration, the associated costs and additional time related to using multiple imaging modalities have motivated some radiation therapy departments to evaluate alternative systems/solutions.

The emergence of MRI-only RT planning workflow provided a promising development that eliminates the reliance on CT imaging and using instead synthetic CT images created from MRI data. This transition offers potential benefits, from reducing patient radiation exposure, streamlining the treatment planning process, and most importantly enabling precise treatment by eliminating image registraion errors.

Skåne University Hospital

Yet, this leap forward introduces a new quandary, particularly in the context of prostate cancer treatment. The traditional coils used in MR imaging, a necessary component for creating MR images, present a unique challenge for RT planning due to their rigid design. Precision is key in RT planning but the pressure of the rigid coils on the patient's body can deform the tissue significantly from the desired ideal, leading to distortions and diminished image quality. Such uncertainties can propagate along the treatment workflow. The traditional solution to avoiding patient deformation is to use coil bridges, which raise and keep the coil above the patient contour to eliminate the pressure on the patient's body.

Positioning with Coil Bridge

Positioning without Coil Bridge

Figure 1: AIR™ Coil Patient positioning with and without a coil bridge. Photo provided by Skåne University Hospital staff member demonstrating the patient positioning.

However, this solution can itself cause problems as the inflexible, rigid coil increases the distance between the coil and the patient resulting in loss of signal and compromised image quality. At the Radiation Therapy Centre at SUHCCC, coil-to-patient distances ranged from 3 cm to 10 cm when using coil bridges, which was higher than the optimal alignment as the coil should be intimately adjacent to the patient's anatomy. Bridging this space between the coil and patient often necessitates intricate coil setup maneuvers by the radiation therapy team, reducing image signal-to-noise and consequently affecting the precision of treatment planning and increasing the scanning time needed to reach an equivalent signal to noise ratio.

The impact of lightweight AIR™ Coils on MRI-only radiotherapy planning

The development of GE HealthCare AIR™ Coils technology has redefined the approach to acquiring accurate images for treatment planning when using MR coils. With overlapping and ultra-light elements that are flexible, AIR™ Coils can be positioned closer to the patient without distorting the tissue compared to rigid coils. By investing in GE HealthCare's AIR™ Coils and AIR™ Recon DL technology, the Radiation Therapy Centre at SUHCCC was able to leverage the most recent technology alongside the state-of-the-art software platform for a much needed solution.

The Radiation Therapy Centre at SUHCCC conducted a study to evaluate the impact of using the AIR™ Coils with and without a coil bridge for MRI-only radiotherapy. The expectation was that as the AIR™ Coils are lighter, they apply less pressure on the patient compared to traditional coils and this would enable the possibility of placing the coils directly onto the patient and thus avoiding the coil bridges and decreased image signal-to-noise (SNR)[1].

The evaluation compared differences in both the geometric impact and the patient dose when removing the coil bridges from an MRI-only radiotherapy workflow and positioning the coil directly on the patient. Imaging was performed on the department's GE HealthCare SIGNA™ Architect 3.0T MR scanner using the large lightweight AIR™Anterior Array (AA) Coil for 21 patients. The 2.7 kg weight of the coil is up to 54% lighter per element than traditional coils which enables placement directly on the patient[2].

The test compared both patient and phantom imaging with and without a coil bridge. The 21 patients included in the study were first scanned using the traditional method of placing a coil bridge between the patient and the coil. Once images were acquired, the bridge was removed, and the GE HealthCare AIR™ AA Coil was placed directly on the patient and three additional sequences were obtained. These images were compared between using a coil bridge and placing the GE Healthcare AIR™ Coil directly on the patient along with comparing image features such as signal-to-noise against a standard phantom.

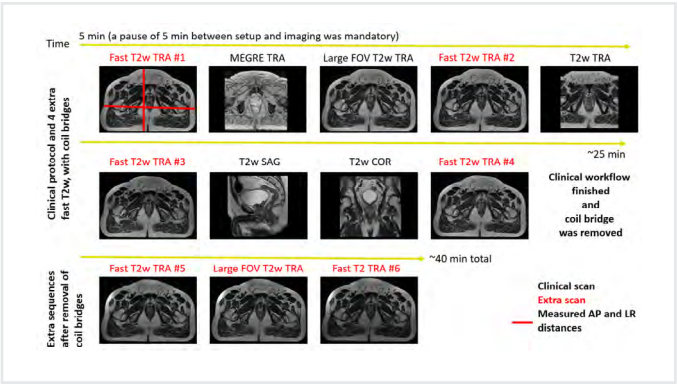

Figure 2. Workflow for the study with clinical protocol and added acquisitions. AP – Anterior Posterior, COR – Coronal, LR – Left right, SAG – Sagittal. T2w – T2 weighted. TRA – Transversal. Adapted from "Geometric impact and dose estimation of on-patient placement of a lightweight receiver coil in a clinical magnetic resonance imaging-only radiotherapy workflow for prostate cancer."[1]

When comparing the signal-to-noise between coil bridge, direct AIR™ Coil placement, and phantom imaging, the SNR decreased as the coil distance increased. Phantom measurements showed that at coil distances of 5, 10, 15 and 20 cm the SNR decreased 18%, 30%, 40% and 43% respectively. The median increase in SNR measurements in patients was 21% with the AIR™ Coil after removing the coil bridges. In the geometric analysis, no statistically significant differences were found between using the coil bridge and AIR™ Coil. When assessing the estimated dose, some minor differences were noticed, however, these were clinically negligible, and no dose differences were identified for organs at risk.

"It's a game-changer as it eliminates the disadvantages that was introduced using coil bridges."

Dr. Christian Jamtheim Gustafsson, Medical Physicist; Associate

These results show that an MRI-only workflow using AIR™ Coils without coil bridges can be implemented in the radiation therapy department.

*"Scan time for T2 weighted sequences was reduced from 7 to 3.5 minutes with the combined use of AIR™ Coils and AIR™ Recon DL "**

Dr. Christian Jamtheim Gustafsson, Medical Physicist; Associate Professor, Lund University

Avoiding the use of the coil bridges enables easier patient setup for the radiation therapy team and an increased image SNR without compromising the integrity of RT planning. Both phantom and in-vivo measurements showed an SNR increase when positioning the GE Healthcare AIR™ Coil closer to the phantom/patient. This confirmed the potential to accelerate image protocols, improve image quality and increase contour accuracy when able to position the coil as close to the patient as possible.

The clinic is observing a reduction in motion artifacts due to less patient movement as the scans can be made shorter in duration using the lightweight AIR™ Coils. A decreased scan time is more comfortable for the patients which may increase overall patient satisfaction.

"Our clinic has evolved thanks to GE HealthCare's AIR™ technology."

Dr. Christian Jamtheim Gustafsson, Medical Physicist; Associate Professor, Lund University

*no guarantee of results

References

1. Scherman, J., af WeSerstedt, S., Persson, E., Olsson, L. E., & Gustafsson, C. J. (2023). Geometric impact and dose estimation of on-patient placement of a lightweight receiver coil in a clinical magnetic resonance imaging-only radiotherapy workflow for prostate cancer. Physics and imaging in radiation oncology, 26, 100433
2. Comparison between the product specifications of AIR™ AA 30ch and TID AA.
3. Structured interview with Dr. Christian Jamtheim Gustafsson conducted on 5th of September 2023.

The example findings cited are limited to the referenced studies only and may not be applicable to your clinical practice. Cited scan times may vary because scan time depends on the clinical task, injected dose, anatomical location, and site's clinical experience. A radiologist should determine the appropriate scan time for the patient and clinical task.

Dr. Christian Jamtheim Gustafsson is a paid consultant for GE HealthCare. The statements by Dr. Jamtheim Gustafsson described here are based on his own opinions and on results that were achieved in his unique seeng. Since there is no "typical" hospital/clinical seeng and many variables exist, i.e. hospital size, case mix, staff expertise, etc. there can be no guarantee that others will achieve the same results.

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