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Radium Hospital continues to innovate with MR and AIR Open Coil Suite for radiotherapy planning

Radium Hospital, part of Oslo University Hospital, is Norway's leading cancer center and a hub for research, clinical treatment and innovation. The hospital receives around 10,000 patient visits and an average of 350 new cancer patients each month. Approximately 10% of existing and new patients have head and neck cancers.

It is also the first hospital to implement GE HealthCare's AIR™ Open Coil Suite on a SIGNA™ Premier 3.0T system for MR simulation, featuring the Universal Couchtop™ MRI Overlay (CIVCO Medical Solutions, Kalona, IA) and 32-channel AIR Open Suite of coils that consists of the AIR Open Head Anterior 16-channel, AIR Open Neck Chest Anterior 7-channel and AIR Open Head Neck Posterior 9-channel coils.

The 32-channel AIR Open Coil Suite is designed for higher SNR and is compatible with all SIGNA™ wide bore scanners. It is easy to set up, requires little training for technologists and offers wide compatibility with patient immobilization devices.

As a leading cancer center, Radium Hospital began using MR for radiation therapy planning in 2006 for brachytherapy and gynecological treatments. The implementation of the AIR Open Coil Suite is part of Radium Hospital's vision to investigate utilizing MR imaging for radiation therapy planning, particularly in cancers that are in/around soft tissue, such as the head and neck.

According to Knut Håkon Hole, MD, PhD, senior MRI radiologist, "To define the exact extent of the tumor, we need higher resolution on the functional, dynamic contrast enhanced and diffusion

sequences, which is typically difficult to achieve. Our goal is to achieve 1.5 mm resolution at 3 mm slice thickness, which was tested and achieved on patients."

The softer, lighter and more flexible AIR™ Coils bring the coil elements closer to the patient, which helps improve image quality. MR image reconstruction with AIR™ Recon DL further sharpens image quality by up to 60% and improves SNR.

The results of Radium Hospital's testing of AIR Coils compared to the fixed, conventional coils in radiation therapy will be presented at RSNA 2024. The team at Radium Hospital are evaluating the image quality, degree of confidence in determining tumor extension and the results of geometric distortion compared to CT.

"It has been of interest to see if we can replace CT imaging for planning and use only MR," says Karsten Rydén-Eilertsen, PhD, physicist, Head of Proton Therapy Physics. "The precision of MR imaging in soft tissue is better and we will look to see if the use of oZTEo, or pseudo-CT based on this MR sequence, is good enough for radiation therapy planning.

The timing is right for Radium Hospital to undertake this study and investigate the use of AIR Open Coil Suite in MR-only imaging. Radium Hospital's new clinic and treatment building opened in the summer of 2024 and now includes proton therapy. There is also greater capacity for MR imaging in the new radiology department, which now has six MR systems compared to three MR systems, previously. Dr. Rydén-Eilertsen believes there will be

more opportunity to explore the use of MR and pseudo-CT for treatment planning.

“After we evaluate this test study on head and neck cancer, we think we can apply it to proton therapy, where we need low geometric distortion and high geometric accuracy,” says Dr. Hole. “We also want to see different areas within the tumor to determine if we can perform dose painting inside the tumor. So, we use higher radiation doses in the cellular dense tumors and lower radiation doses in the other parts of the tumor to minimize radiation damage and optimize the tumor killing.”

Dr. Rydén-Eilertsen explains that precision is very important. Geometric accuracy is more important in proton therapy than photon therapy (conventional radiotherapy) because the range of the protons is very dependent on the accuracy of the anatomy being imaged. Small deviations can have a large impact on the quality of the treatment.

He adds that the pseudo-CT may not be applicable in proton therapy because of the need for high Hounsfield unit value accuracy to perform the dose calculations. However, the use of MR for tumor characterization, both the gross tumor and identifying where the most radiation-resistant areas are located, is important to help in planning the radiation dose to these areas. Proton therapy is excellent for this capability and head and neck cancer patients are an ideal population for this type of treatment.

“Head and neck cancer is the most challenging area to achieve geometric accuracy and that’s why we decided to start here with our study,” says Dr. Hole.

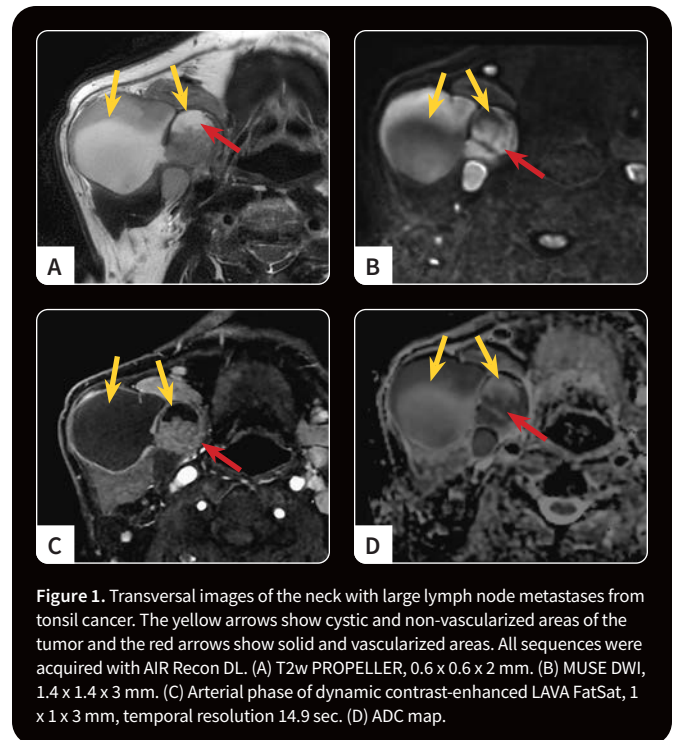
Benefits of AIR Open Coil Suite

A key benefit of the AIR Coil is that the coil elements are closer to the anatomy and region of interest, improving image quality with higher SNR.

“A better SNR does not impact geometric accuracy,” says Dr. Hole. “But if we can use higher SNR to scan faster, then it could translate to better geometric accuracy if the patient doesn’t move. Also, with higher SNR, we can delineate the tumor extension better because of the high image quality. What is most interesting is how accurate it is compared to CT and the accuracy of the new diffusion sequence, because diffusion is vulnerable to geometric distortion.”

The team has also started using a third-party, deep-learning method to segment the tumor and healthy tissue in the MR image.

“If this imaging concept can improve the accuracy of segmentation of both the tumor and healthy tissue, that would be a big benefit for us,” adds Dr. Rydén-Eilertsen. “Head and neck oncologists spend a lot of time delineating different organs. If this technique can help us increase precision and reduce the time and inter-observer variability in the delineation of the different organs and tumors in these patients, that would be a really big step forward for us.”



With the goal of radiotherapy being to deliver a precisely targeted dose to kill only the cancer and not the surrounding healthy tissue, then technology that improves SNR and image quality can translate into multiple benefits: faster sequences/shorter imaging exams that can help decrease the likelihood of patient movement, which can impact quality and distortion, better quality sequences for better tumor extension and delineation, and sequences that are less susceptible to distortion.

“Patient movement is a big issue when imaging for radiotherapy planning,” says Dr. Hole. “They have to breathe, swallow and blink.”

Head and neck cancer patients undergoing radiotherapy must undergo imaging with a headframe and the mask and coil over their face. It’s an extremely uncomfortable position for patients to maintain.

“The patients who have undergone MR imaging with AIR Open Coil Suite have been satisfied and found it doable,” says Edmund Reitan, Lead MRI Radiographer at Radium Hospital.

“The goal is to get the MR imaging exam completed as quickly as possible, in 10 minutes and no longer than 15 minutes.”

Edmund Reitan

With the old solution, MR examinations on these head and neck patients could take up to 50 minutes.

“The AIR Open Coil Suite allows us to perform a faster scan with great image quality.”

Dr. Knut Håkon Hole

“I’m a bit claustrophobic and in testing with the old solution I had to be in the MR scan for almost an hour and it was awful,” adds Dr. Rydén-Eilertsen. “In my opinion, reducing the scan time to 15 minutes would be really great for our patients.”

The patient set-up time is also significantly faster, adds Reitan. “This also minimizes the time the patient needs to be in the fixation mask. Previously, we spent a lot of time setting up the coil fixation holders, so the time before we take the first image is significantly shorter now with the new AIR Open Coil Suite than it was before.”

An inexperienced technologist could take 10 minutes or longer with the old set-up. Now it’s just 1 to 2 minutes maximum.

“You just place the coil on the top of the head, another coil on the shoulder and you’re good to go. I would say it’s maybe 10 minutes faster,” Reitan adds.

Faster patient set-up and scanning times also translate to greater capacity to scan more patients.

“If we can reduce scan time with AIR Open Coil Suite, then the accessibility of MR increases because we can scan more patients.”

Dr. Karsten Rydén-Eilertsen

“That will be of importance. If we don’t have the capacity to offer this imaging modality to a fair number of patients, then it’s often not offered at all because, otherwise, how do we select who gets it and who is not going to get it,” adds Dr. Rydén-Eilertsen.

There is also the potential to use this solution for diagnostic imaging purposes. “We have not only better SNR but have a more homogenous SNR of a large field,” adds Dr. Hole. “That is important for diagnostics.”

An improvement in image quality and patient comfort

For Dr. Hole and Reitan, it was the flexibility of the AIR Coils in AIR Open Coil Suite that piqued their interest in acquiring the technology.

“I’m quite sure the AIR Coils are the right way to develop MR and our previous clinical experience with the earlier generations of flex coils has established that,” Dr. Hole says.

However, it was the capabilities that AIR Recon DL delivers that has impressed him the most. AIR Recon DL can be used with most sequences for therapy planning, allowing for improvements in SNR and resolution while also reducing scan time.

“AIR Recon DL is amazing. I haven’t seen such improvement in MR since we went from single spin echo to fast spin echo and scan times were reduced from 13 minutes to 5 minutes for this sequence. And now, with AIR Recon DL, we can halve the scan time and double the image quality,” he adds.

Plus, Radium Hospital is a national center for soft tissue bone cancers in the fingers, arms and feet. Now with the AIR Coil, they can wrap it around nearly any body part or area.

Adds Reitan, “I love the flexibility with the AIR Coils. It is better to get the coil as close to the fixation mask as possible for the geometric factor. We can use the same amount of parallel imaging that we have in the diagnostic protocols that we were not able to do with the old setup.”



Figure 2. Fast and easy set up with the 32-channel AIR Open Coil Suite.

There is also the excitement and trials with being first to adopt new technology, adds Dr. Rydén-Eilertsen. “We are proud to be first but there are also obstacles in terms of testing new devices. However, having the close collaboration with GE HealthCare, we appreciate the opportunity to provide suggestions and improvements that are then taken into account in the further development of the devices. And I think that is valuable, too, in building the competence internally in the hospital by having that level of involvement.”

There is also the added benefit for the patient and their experience. For head and neck cancer patients, Reitan explains it is the time spent in the fixation mask for the imaging study that is most claustrophobic and difficult for them. Minimizing that time with the faster patient set-up and shorter scan times is the greatest benefit for these patients.

“Telling the patient the MR imaging will take 15 minutes, not 30 minutes or longer, makes it’s easier for them and they have a different mindset,” says Reitan. **S**