Professor Jürgen Debus, Medical Director of the Department of Radiation Oncology and Radiotherapy, Heidelberg University Hospital, Germany.

Precisely Targeted Radiotherapy, Even for Moving Tumors

In radiotherapy, limiting the target volume within the treatment area has always been hugely important so as to give maximum protection to the healthy tissue surrounding a tumor. Moving tumors present a particular challenge in this regard. Professor Jürgen Debus, Medical Director of the Department of Radiation Oncology and Radiotherapy at Heidelberg University Hospital, tells us about how his department is using new technology to tackle this issue and to make some significant improvements.

Text: Philipp Braune | Photos: Christine Blei

Professor Debus, what improvements have been made in radiotherapy as a result of advances in computed tomography in recent years?
PROFESSOR JÜRGEN DEBUS: The key thing for us is to get an exact 3D picture of the patient's anatomy and the area around the tumor, so that we can target it precisely with radiation. Thanks to the huge advances that have taken place in computed tomography in recent years, we have been able to make significant progress in this area in terms of geometric precision, contrast resolution, and temporal resolution. With modern CT systems, we can now generate not just a 3D model of the patient, but a 4D one, taking into account movements within the patient. This means that we can match the treatment area even more closely to our target volume and provide even better protection for the tissue surrounding the tumor. In short, our aim is more accurate and we are able to hit the target better than with previous CT scanners.

Where do you use 4D CT imaging?
DEBUS: We find moving tumors in the lung, for example, but the pancreas also moves several centimeters back and forth. If 4D imaging can be used to offset this motion, treatment can be delivered in an extremely gentle way that protects the gut, for instance, which sits just above and below the pancreas. There are two procedures we use to do that. The first is gating, where we use the information from the 4D scan to ensure that the beam is on only when the tumor is in exactly the right position. The second approach involves precisely synchronizing the delivery of radiation with the patient's breathing.

How were moving tumors treated previously?
DEBUS: They could be irradiated, but we had to leave a safety margin around them. We would determine the maximum phases for inspiration and expiration, for instance. But this gave us only an approximate idea of the area in which the tumor was moving around. In fact, tumors don't just move back and forth – they can also tip over and twist backwards and forwards. With 4D CT, we can capture this

complex movement precisely on all three axes of rotation.

What are the advantages of modern CT technology for particle therapy?
DEBUS: To treat tumors with protons and carbon ions, we need to be able to predict the penetration characteristics of the tissue in question with a high degree of accuracy, so that we can determine how deeply the beam is able to penetrate. The new detectors on modern CT systems allow us to determine tissue characteristics much more accurately. That means that we can work out in advance exactly how the radiation will act when it is applied. This is helpful, by the way, not just in proton and carbon ion therapy but also in conventional radiotherapy.

Are there other features that are important for a CT system used for the radiotheray workflow, as compared with normal diagnosis?
DEBUS: There is one issue we haven't even mentioned yet. In radiotherapy, we have specific requirements as regards variability of patient positioning. We have to place patients in the same position for imaging as for their subsequent treatment – namely, in a prone position or with their arm or leg extended. For that reason, we need a particularly big gantry. In addition, the table must have a particularly high load-bearing capacity. Older CT systems were often designed with a weight limit of 135 kg. With the additional load of our specialist equipment, that meant that sometimes it wasn't possible to scan heavier patients.

To overcome those challenges, you installed one of the first SOMATOM Confidence® RT Pro systems in summer 2016. Does this scanner do everything that you require of a CT system?
DEBUS: Yes, it meets our needs perfectly. It is not just that it has an 80 cm gantry and a table that can take up to 250 kg. The main thing is that using this system we are able, in the specific conditions in which we operate, to achieve excellent image quality with low noise and high reproducibility. It also allows us to take extremely precise measurements for particle therapy modelling. Furthermore, it was important for us to be able to do image processing, especially 4D processing, as soon as possible after imaging – instead of having to postpone it until the treatment planning stage. The *syngo*.via RT Image Suite allows us to do just that.

The SOMATOM Confidence® RT Pro.

You are now also using the new iMAR package for metal artifact suppression. How important is that for radiotherapy?
DEBUS: Many of our patients now have metal implants, which produce artifacts in the area that is being examined. These can be artificial joints, pacemakers, chemotherapy ports or simply dental implants. We therefore use iMAR with about 10% of patients. We have just used CT imaging on a patient with two artificial hip joints. Previously that would have been a guessing game, but with iMAR we can suppress the artifacts which may be beneficial in our RT workflow.

Was radiation dose also a factor for you when choosing your new CT system?
DEBUS: Radiation dose is actually a very important issue for us. We treat lots of children here and have chosen specifically to use proton beams in those cases on radiation safety grounds. It is therefore only logical that we should also use a scanner that minimizes radiation exposure. Our SOMATOM Confidence RT Pro CT system offers us a variety of ways to keep doses as low as possible – by using the CARE dose package, for example.

What feedback have you had from your staff on operating the new system?
DEBUS: Our staff love the machine. It is very easy to operate, which is particularly important, as our staff have to get to grips with the technical possibilities of the system, and to be able to harness them, to

"The new SOMATOM Confidence® RT Pro CT system is ideal for the needs of radiotherapy."

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achieve the result that best meets our complex needs. For example, if I want to capture density values for proton therapy with high precision, I can't work using the default setting.

How has your workflow changed?
DEBUS: In fact, scan time is no longer the limiting factor for us with a CT system. The thing that really holds us up is image processing. We have to segment normal tissues – for example, the entire lung or the spinal cord – for radiotherapy, and that is very time consuming. The *syngo*.via RT Image Suite, with its intelligent, automatic algorithms, is enormously helpful in that regard. Also, when using the 4D applications, we no longer have to segment the time series completely by hand. Segmentation in one breathing phase is enough – the program does the rest. That makes processing not just a good deal faster, but also more reliable, as it is less dependent on the person doing the examination.

Where do you see new approaches being developed in the future to optimize the synergy between CT imaging and radiotherapy?
DEBUS: There are sure to be some improvements around image processing – for instance, in the use of data from treatment carried out previously as a parameter set when delivering similar treatment to other patients. The same is true of follow-up examinations, so that if I am comparing images taken two years apart, for instance, the image processing system shows up the differences automatically. We are looking closely at those issues right now, and we think that the *syngo*.via RT Image Suite will enable us to bring that in.

Professor Debus, thank you for taking the time to talk with us.

The statements by Siemens' customers described herein are based on results that were achieved in the customer's unique setting. Since there is no "typical" hospital and many variables exist (e.g., hospital size, case mix, level of IT adoption), there can be no guarantee that other customers will achieve the same results.