Professor Mathias Prokop, Chairman of the Department of Radiology and Nuclear Medicine, Radboudumc

INTERVIEW

From Molecule to Man to Population

The Radboud university medical centre (Radboudumc) in Nijmegen, the Netherlands, aims to have a significant impact on healthcare with research spanning 'From Molecule to Man to Population'. With a team of more than 150 people , the Imaging Research group within the Department of Radiology and Nuclear Medicine develops imaging applications that bridge the gap between research and practice and help shape the future of healthcare. Professor Mathias Prokop, Chairman of the department, explains how the Aquilion ONE™ and close collaboration with Toshiba Medical's engineers in Japan and Europe over the last five years continue to enable the team to advance techniques in functional imaging.

Radboudumc purchased an Aquilion ONE in 2011 to advance research in functional imaging, recognizing the importance of this field for the future.

SYNERGY

"The market options available at the time meant that we could choose for speed (Dual Source CT scanners) or large coverage per rotation (Aquilion ONE). Functional imaging was in its infancy, so we expected to be able to impact the further development. We were looking for a partner and had a good click with Toshiba Medical," said Professor Prokop. "Before making a final decision, we visited the company's engineers in Japan, because we wanted to know how much they listened to users. I find that very important, because the field only moves forward if you get a good interaction between users and engineers. What we found out was impressive, and convinced us that working with Toshiba Medical was the way forward."

Since then, the collaboration has steadily grown. Radboudumc Imaging Research share their thoughts about the future with the engineers in Japan and co-develop in some areas. Regular meetings in Japan and Nijmegen ensure the continuity of discussions about ongoing projects and fine-tuning of the imaging systems currently in use at the hospital.

RAPID INTRODUCTION

Before installation of their new Aquilion ONE, Radboudumc planned the positioning of the new system strategically to ensure easy access and optimal flexibility for use by the Emergency Rooms and poli-clinics alike. Installation of the scanner went fast.

"We could use the system within a short period of time," said Professor Prokop. "Training went smoothly, although the interface was substantially different to those of the scanners that we had used before. Due to this, we first trained small groups of radiographers and expanded it to the rest, so that everyone felt comfortable."

EXPLORING NEW POSSIBILITIES

With the introduction of the Aquilion ONE, it became possible for the Radboudumc Imaging Research to collect functional together with morphological data. While employed for routine clinical practice, the Aquilion ONE allowed to continually explore new possibilities.

"The development of any new techniques starts with a vision that we initially evaluate. We see what is currently missing, and then approach Toshiba Medical to discuss what is needed to make things a reality. So far, this has gone very well," explained Professor Prokop. "Toshiba Medical also implements our feedback on optimization into new software. I have been amazed by the speed at which the feedback is implemented."

The brain is a classic region for testing a lot of new techniques in radiology. Brain perfusion imaging (CTP) using the Aquilion ONE was introduced early on and is used in addition to a pre-contrast CT and CTA for the evaluation of stroke. "With full brain coverage provided by Aquilion ONE, we can investigate stroke outside the classical field around the basal ganglia," said Professor Prokop. "Perfusion with the Aquilion ONE gives us a higher detection rate of vascular occlusions, even in peripheral branches. Malperfused regions indicate areas that we need to return to in order to look for occlusions. CTP is easy to set up, works quite rapidly and doesn't delay our clinical process."

"Our ultimate goal for CT imaging of stroke, however, is to eliminate the CTA and pre-contrast scan and rely on CTP only. A prerequisite is that the information from CTA and pre-contrast CT can be extracted from a single CTP sequence. In the past years we have developed and optimized such techniques. As a result, we now can reduce overall examination time, the amount of iodinated contrast and the overall radiation dose."

DEVELOPING NEW TECHNIQUES

In their quest for optimum use of CTP, Radboudumc Imaging Research have been developing an interesting technique for a subset of particularly vulnerable patients. The One-Step-Stroke protocol, a single examination sequence, in which the neck CTA is interleaved with CTP. One-Step-Stroke imaging has the potential to replace a separate CTA, which saves radiation dose and contrast agent dose. It can reduce the amount of contrast required by almost half ([1], [2]).

"The nice thing about this technique is that it doesn't affect the qualitative perfusion values," said Professor Prokop."In addition, it acts as bolus triggering for CT perfusion: in a patient with delayed contrast arrival, a 60-second acquisition can stop too early before the contrast is optimally distributed. The One-Step-Stroke protocol interrupts the standard CTP sequence for a wide volume CTA of the neck and then returns to the brain, where a fixed amount of scans (e.g. 20) is performed after the contrast has arrived, which ensures constant CTP quality and avoids truncation artifacts."

"We are currently exploring combining the wide volume CTA of the neck with subtraction; performing an initial pre-contrast scan, followed by the One-Step-Stroke technique, and finally subtracting in the neck region to gain vessel-only CTA. This substantially reduces scatter artifacts in the shoulder region," he added.

OPPORTUNITIES TO ADVANCE EXISTING APPLICATIONS

The Aquilion ONE as well as the Aquilion ONE ViSION Edition and Aquilion ONE GENESIS Edition offer full flexibility in planning scan protocols, which makes them ideal for perfusion studies.

"You can chose continuous volumetric scanning for high temporal resolution, which results in 4D data that overlaps in the time domain," said Professor Prokop. "We do that in patients with arteriovenous (AV) malformations to find the nidus, for example. You can also perform a set of rapid volumetric scans in the early phase of enhancement, followed by longer time delays between scans in later phases, and you can also change the amount of dose that you give for each of these phases."

The flexibility of Toshiba's area detector CTs makes it possible to develop unique protocols that combine the advantages of regular abdominal examinations with those of CT perfusion. "A diagnostic scan interleaved with a perfusion scan gives the best of two worlds - That's possible on this scanner," he added.

Transferring new techniques like these to clinicians so that they understand the full implications of opportunities can be challenging. For the best results, Radboudumc pairs pre-clinical researchers with radiologist, who explore this together with their clinical partners.

Professor Prokop's dream for the future is to use CT perfusion for many of the indications that currently require a multiphasic CT. However, he admits that many prerequisites must be fulfilled before that will be possible.

"We have recently joined forces with Toshiba Medical's engineers to develop a very potent noise reduction algorithm that enables high resolution CT perfusion imaging, at a much higher resolution than we can achieve at the moment. It also allows us to do excellent 4D analysis of the vasculature in the region of interest. It is an essential step forward," he remarked. "We hope to see our noise reduction algorithm introduced in mid-2017. It's a very powerful tool that we think will become a 'game changer'. When transferring this to other areas of the body, such as the lungs or abdomen; motion correction becomes a key factor. The Aquilion ONE scanners already have great motion correction in the abdomen and lung, which is good for subtraction imaging, but we are working to improve it further to create a totally new image quality."

SUBTRACTION

"We are really happy with the subtraction technique for the Aquilion ONE scanners. It's very versatile. We have used it routinely for pulmonary angiographs for more than two years. In the lung, it helps us find perfusion defects, which we then examine further; the enhancement of nodules; and areas of infection or active inflammation," he said."One of the big advantages SURESubtraction is that you get a much better signal at a lower noise - around 40-50% less noise - than with Dual Energy CT scanning techniques. We believe that subtraction will be very important in the future."

"I would, however, like to see even better image registration for the lung that enables not only the lung parenchyma, but also the vessels, to be registered perfectly or almost perfectly," he continued. "We can then use that information for many different things, like being able to reduce the amount of contrast administered by virtually increasing contrast enhancement - similar to virtual monoenergetic images from Dual Energy CT. We can create these images by adding the enhancement from the subtraction image onto the original contrast-enhanced images and combining this with noise reduction. Toshiba Medical has already implemented the first step of this in the abdomen and we hope to see it in other areas of the body in the future."

PIVOTAL IN THE FUTURE

Over the next decades, Professor Prokop anticipates that radiology, and medicine in general, will become far more

Professor Mathias Prokop is one of the world's leading experts on body imaging. With a particular interest in new CT technologies, he has explored the boundaries of this modality for the last 30 years, and led many research efforts worldwide

computer-supported, with a great deal of routine work automated and accelerated, so that the role of radiologists becomes more consultancy-based than focused on pure high throughput. For CT, he believes that spatial resolution could improve further in the coming years, but finally will be limited. And that the biggest focus will be on software development. In addition, he thinks that the introduction of photon counting detectors will make it possible to further optimize functional imaging, but will take a while to emerge.

"Streamlining our workflows will be supremely important and will help us make the right decisions. High-end imagining techniques will be pivotal in this," he concluded.

References:
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