The Knappschafts-krankenhaus Bottrop is among the leading institutions in Germany in treating aortic aneurysms with catheter-based implantation of aortic stents.

Fighting Aortic Aneurysms

with SOMATOM Definition Edge

Abstract

Approximately one in thirty adults will develop an aneurysm in the abdominal aorta throughout his or her life. The German hospital "Knappschaftskrankenhaus" in Bottrop is specialized in catheter-based treatment of these life threatening aortic aneurysms. This method requires several pre- and postoperative CT examinations that add up to fairly high radiation dosages over the years. Together with tumor patients, aortic aneurysm patients probably are the patients with the highest radiation exposure. With the decision to replace their old 64-slice system, the hospital was looking for a high-end CT system that would speed up their examinations and considerably reduce radiation exposure. They decided to go for SOMATOM Definition Edge.

SIEMENS Healthineers

Stent treatments of aortic aneurysms require modern radiology and particularly modern CT examinations. Therefore, the Knappschaftskrankenhaus in Bottrop decided to go for SOMATOM Definition Edge in March 2013.

Introduction

The abdominal aorta is the main supplier of blood to the abdomen and the lower extremities. While every increase in vessel diameter of more than three centimeters is defined as an aneurysm, diameters of more than four centimeters are considered critical from a medical point of view. For decades, open surgery was the method of choice in aortic aneurysm treatment. With the improvement of CT examinations, this method has in recent years been replaced by catheter-based implantation of aortic stents – a quicker and far less invasive method of permanently stabilizing the artery. The Knappschaftskrankenhaus in Bottrop, Germany is specialized in this new method, performing more than 150 of these procedures per year, making it one of Germany's leading institutions in this field. Being among the top from the medical point of view also means utilizing high-end technology for pre- and postoperative imaging, which plays an important role in the whole clinical process. The radiologist is the indispensable partner of the vascular surgeon who is confronted with an aneurysm patient and asks for high quality diagnostic images. With SOMATOM Definition Edge, the hospital is now providing modern minimally invasive surgery in combination with state-of-the-art CT technology.

Challenge

Latest CT technology plays the key role in catheter-based implantation of aortic stents. Throughout the whole procedure, every single patient needs numerous CT examinations of a long scan range before and after the stent implantation. These examinations have to avoid motion artifacts throughout the aorta. “We need an excellent reconstruction of the aorta and the origins of the renal and mesenteric arteries before the intervention to choose the ideal prosthesis,” explains Svenja Hennigs, MD, head of the hospital’s Department of Radiology and Nuclear Medicine. “This is why we use very thin slices to get the necessary raw data and to be able to provide a proper 3D model for our surgeons,” she goes on. After the implantation, the CT becomes the single most important tool for following up the patients.

There are further follow-up examinations after three, six, and twelve months. After that, most patients come at least once a year for a regular check to search for endoleaks. The problem with repeated CT examinations is that they add up to fairly high radiation dosages over the years. “Together with tumor patients, aortic aneurysm patients are probably the patients with the highest radiation exposure,” says Hennigs. Therefore, the important issues when treating these patients are not only scan speed and thin slices, but also dose. These factors set the outline when the hospital decided to replace their old 64-slice system and started to explore the market for a new CT system with modern technology.

"In a regular build patient with an aortic aneurysm, we often see less than half the radiation dose of the previous 64-slice system. We are also able to perform low-dose CT of the lung at 1 to 1.5 mSv and see even patients who are below 1 mSv," says Sylvia Hennigs, MD, who is Head of the hospital's Department of Radiology and Nuclear Medicine.

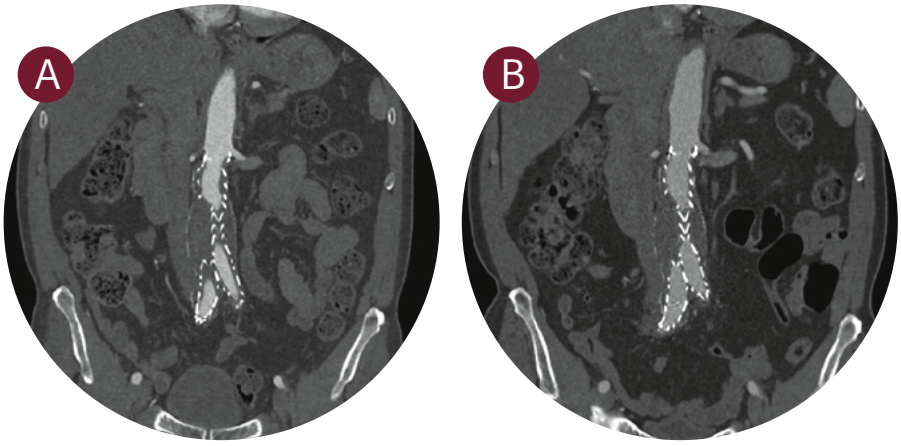
Solution

When looking at modern CT systems, Hennigs and the hospital decided to go for SOMATOM Definition Edge. The compact system in combination with high-end imaging technology including the Stellar detector and SAFIRE*, the fast rotation speed of 0.28 s, and the high pitch of 1.7 with a coverage of up to 23 cm/s made the race. Siemens' Stellar detector is the first fully-integrated detector. It reduces electronic noise, which helps to reduce radiation dose and improve spatial resolution by generating ultra-thin slices down to 0.5 mm. In combination with SAFIRE*, Siemens' first raw-data based iterative reconstruction, dose saving of up to 60% is possible in clinical routine. These are the keys to achieve outstanding image quality and very low radiation doses. The fast pitch is a perfect fit for the challenge to scan the aortic valve without moving artifacts and the posibility to use less contrast media.

"We are now able to perform a long range aortic stent CT scan much faster and the system is extremely quick. The limiting factor is not the examination, but getting the patient in and out again." The fact that SOMATOM Definition Edge also features a 3D guidance for interventional radiology – the Adaptive 3D Interventional Suite – and Single Source Dual Energy (DE) made the decision even easier. With its DE applications, the system offers, for example, metal artifact reduction or gout evaluation to add tissue characterization to morphology. Finally, FAST CARE technology accelerates workflow (i.e. FAST Spine) and additionally reduces dose (i.e. CARE kV and 70 kV protocols for pediatric imaging).

** In clinical practice, the use of SAFIRE may reduce CT patient dose depending on the clinical task, patient size, anatomical location, and clinical practice. A consultation with a radiologist and a physicist should be made to determine the appropriate dose to obtain diagnostic image quality for the particular clinical task. The following test method was used to determine a 54 to 60% dose reduction when using the SAFIRE reconstruc-tion software: noise, CT numbers, homogeneity, low-contrast resolution, and high contrast resolution were assessed in a Gammex 438 phantom. Low dose data reconstructed with SAFIRE showed the same image quality compared to full dose data based on this test. Data on file.*

Image comparison of a follow-up scan of same patient between previous 64-slice system and new SOMATOM Definition Edge with SAFIRE® at less than half the time and one third of dose with comparable diagnostic image quality. Courtesy of Knappschaftskrankenhaus Bottrop, Germany.



SOMATOM Definition Edge

Scan length: 491 mm
Scan time: 5 s
80 kV, 206 mAs
$CTDI_{vol}$: 3.84 mGy
DLP: 201 mGy cm
Eff. dose: 3.01 mSv

Previous 64-slice system

Scan length: 484 mm
Scan time: 12 s
120 kV, 186 mAs
$CTDI_{vol}$: 12.85 mGy
DLP: 664 mGy cm
Eff. dose: 9.96 mSv

Outcomes

The new CT system fulfilled what the hospital expected from their new high-end imaging system: faster acquisition speed with minimized motion artifacts at lower dose. The best way to show this is a follow-up scan of an aortic stent patient. While the previous 64-slice CT system performed the scan at 120 kV, the new 128-slice CT system performed the scan with 80 kV – with comparable diagnostic image quality but with less than one third of the DLP and the CDTI, and in less than half the time as before, reducing possible motion artifacts to a minimum. Hennigs sees this dramatic reduction in dose not only in this case but also in other patients. "In a regular build patient with an aortic aneurysm, we often need less than half the radiation dose of the previous 64-slice system. As expected, adipose patients are somewhat more challenging, but even in these situations, the dose is down by 20 to 30 percent in many patients." The reduction in radiation dose is not only good for aortic aneurysm patients but also for the patients with tumors or neurological conditions who need to be examined again and again. Another impressive example that she cites are patients who need preventive CT examinations for lung tumors. Such exams are being carried out on asbestos workers and they are also increasingly recommended for heavy smokers. "In past days, a conventional lung CT would require a radiation dose of 8 to 10 millisievert (mSv). Modern low-dose CT brings that down to 3 to 4 mSv. With SOMATOM Definition Edge, we are able to do a low dose CT of the lung at 1 to 1.5 mSv, which we consider the right dose for this type of examination. And, believe it or not, we also see patients who need less than one mSv." Hennigs is also impressed by the image quality provided by the new CT system, which has been in place since March 2013: "I would put it this way: the images are more brilliant. When I compare high-resolution images from the same patient recorded with the previous 64-slice CT against the new one, the overall impression is totally different. It is far better now: much clearer and more detailed."

Besides routine imaging, the system is used several times per week for interventional radiology like biopsies with the Adaptive 3D Intervention Suite.

Conclusion

With SOMATOM Definition Edge, the Knappschaftskrankenhaus in Bottrop has found the system that perfectly fits their clinical needs. With the higher diagnostic precision, resulting from thinner slices and minimized motion artifacts due to faster acquisition speed, treatment planning and follow-up scans greatly benefit. A system that delivers excellent image quality at a very low dose – thanks to the combination of newest CT technology with the Stellar detector and SAFIRE.

Tremendous amounts of dose can be saved on patients who have to undergo CT examinations several times, such as oncology patients or patients in the specialist field of catheter-based treatment of aortic aneurysms. All this is in place with a very small footprint. SOMATOM Definition Edge has proven why it is the reference in single CT and why second best is not an option. Not for the Knappschaftskrankenhaus Bottrop, not for Siemens.

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.

SOMATOM Definition Edge

Detector	Stellar detector
Number of acquired slices	128
Number of reconstructed slices	384
Spatial resolution	0.30 mm
Rotation time	0.28 s*
In-plane temporal resolution	142 ms*
Generator power	80 kW, 100 kW*
kV steps	70, 80, 100, 120, 140 kV
Max. scan speed	230 mm/s*
Table load	up to 307 kg/676 lbs*
Gantry opening	78 cm

** Option*

International version.
Not for distribution or use in the U.S.

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