Clinical Added Value from New Technology

German Armed Forces and Patients Benefit from New Options for Low-Dose Volume CT

Dr. S. Waldeck 1)

The Radiologists at the Bundeswehr Central Hospital in Koblenz (BWZK), Germany, used the high-end volume CT - Toshiba’s Aquilion ONE™ / VISION Edition - for several months, along with the Vitrea Advanced web-based image-processing software. The new, low-dose volume CT expanded clinical diagnostics and provided added value for trauma- and routine CTs, as well as special examinations.

1) Army Head Doctor, Head Doctor and Department Manager of the Vili Radiology Department, Armed Forces Central Hospital, Koblenz, Germany.
The Diagnostic and Interventional Radiology department comprises of a team of 19 doctors and 24 technicians who work under the direction of Head Doctor, Dr. Stephan Waldeck. The new Volume CT scanner is predominantly employed in the following areas: low dose scans of all body regions and organs (e.g. for diagnosis of accident victims and patients with multiple injuries); for complete diagnosis of heart and brain disease; and in angiography. It is also used for examinations of the face, paranasal sinuses, upper and lower jaw, temporal bones and dental CT. It is used in planning CT guided interventions, e.g. stenting of thoracic, abdominal and carotid arteries and neurological interventions; minimally invasive treatment of tumors as well as targeted pain therapies in the spine.

With 16cm coverage and 640 slices per rotation, the CT system has set a new technological standard, and has created opportunities for a variety of new examinations.

Dr. Waldeck and his Team are excited both by the new technology and the clinically advanced applications options. Examinations can now be performed with the Aquilion ONE / VISION Edition, in which the balance between low dose and excellent image quality is standardized for all patients. The following examples show the added value that volume CT offers routine applications.

Case 1: 64-year-old patient with slightly progressive exertional dyspnea

The patient presented with slightly progressive exertional dyspnea, but otherwise unremarkable symptoms. With no history of smoking, but a family history of coronary disease, the patient was at a low risk for coronary artery disease.

A cardiac CT scan was performed that demonstrated 2 plaques in the proximal LAD. Distal to the first diagonal branch a calcified plaque was seen that was not causing significant stenosis. More distally a second non-calcified plaque was seen at the location of the second diagonal branch. This plaque was determined to be causing a significant stenosis (Fig. 1).

Due to the clear CT findings, a timely cardiac catheterization examination was performed, which confirmed the high grade LAD stenosis (Fig. 2). A stent was then placed and the patient was symptom free after the revascularization.

In particular, the large detector width of the new CT, which is 16 cm, enables high-resolution cardiac imaging, while reducing the radiation exposure of the patient by about 80% (actual dose in cardiac CT: 0.6 to 2 mSv, 1 mSv on average). Artefact-free, diagnostic imaging of the heart and the coronary arteries can be performed, even in the case of cardiac arrhythmias.

After just a few months of using the new CT in the Hospital, the system is widely accepted by clinicians and cardiologists, who have expressed only positive feedback. As part of the evaluation of chest pain, major causes can be ruled out with CT using the ‘Triple Rule Out’ protocol.

In particular, in a hospital, like the BWZK, where the emphasis is placed on great expertise in cardiology and cardiac surgery, the long-awaited new CT has already met the high expectations of the clinical colleagues.
Case 2: Subarachnoid hemorrhage with hemorrhagic bifurcation aneurysm and acoc aneurysm
A comatose patient was brought to the emergency room by emergency services. In a third-party anamnesis, the husband reported sudden extremely intense headaches and increasing disorientation.

The initial Brain CT in the emergency room detected a massive subarachnoid hemorrhage with ventricular rupture. The subsequently performed CTA revealed a large cerebral artery aneurysm in the area of the bifurcation, which was confirmed by invasive angiography and treated (Fig. 2).

The platinum coils used in the treatment of such aneurysms are very susceptible to artefacts in conventional CTs due to the quantity of constituent metal. In particular, an assessment of the vessels and the immediate area, is thus, considerably more difficult or impossible (see Fig. 2: CCT without SEMAR vs. CCT with SEMAR in Fig. 2).

The CTA scan was reconstructed with single energy metal artefact reduction (SEMAR) to reduce the artefact from the coils, enabling the contrast to be seen in the aneurysm (Fig. 2).

The 16-cm detector width makes it possible, especially in cases involving such complex issues, to acquire highly-detailed vessel imaging and perfusion measurements in the shortest possible time. The new SEMAR technology also makes it possible to image vessels and cerebral parenchyma elements immediately adjacent to the coiled aneurysm in good diagnostic quality.

In particular, valid vessel imaging in cases involving interventionally- or surgically treated aneurysms was not previously possible with conventional devices due to the pronounced metallic artefacts and could only be performed by means of invasive catheter angiography. The combination of whole-brain perfusion with whole-brain angiography and optional artefact suppression (SEMAR), thus, represents an enormous diagnostic advantage.

Case 3: Stroke
The Emergency Room admitted a 53-year-old female patient with acute right-side hemiparesis, which occurred approximately two hours earlier. The patient was immediately taken a CT evaluation for acute stroke which was suspected.
A non contrast brain CT performed on the Aquilion ONE excluded hemorrhage (Fig. 1).

A whole-brain perfusion examination was then carried out with 50 ml of contrast. The 4D DSA revealed a occlusion of the left MCA, and analysis of the perfusion examination detected a significant ‘mismatch’ between the infarct core and penumbra in the right centrum semiovale (Fig. 2).

Based on the CT findings and the patient’s symptoms, subsequent to interdisciplinary clinical conferencing and consultations on site, the patient was immediately taken for catheter angiography, where the vessel occlusion was confirmed, and could then be successfully treated by stent retriever (Fig. 3).

The Toshiba Aquilion ONE, which is capable of performing whole brain perfusion examinations saves valuable time, especially in such cases involving agitated stroke patients. In no other disease is time of such critical importance, as in the case of a stroke, in which the maxim ‘Time is Brain’ applies. Whole-brain perfusion patients can be selectively filtered to determine those, in whom intervention will be able to reperfuse brain tissues, since the still-to-be-rescued but vulnerable brain (tissue-at-risk) can be imaged in an extremely short time.

With regard to the envisaged stroke unit at BWZK, the Aquilion ONE provides radiologists and clinicians with an additional highly effective tool for diagnosing and making treatment decisions in patients with acute stroke symptoms. It has been welcomed into clinical routine by the neurology and intensive care teams.

Figure 1: Non contrast brain CT
Figure 2: Selected axial sections of a colour-coded, whole-brain perfusion CT, with axial perfusion maps showing A, cerebral Blood Flow (CBF), B, Blood volume (CBV), C, Mean Transit Time (MTT), D, Time to Peak (TTP).
Figure 3: Catheter angiogram
Figure 4: Whole-brain perfusion and whole brain angiography in one examination
Case 4: Hip Replacement with SEMAR

A 71-year-old woman with a dual right hip prosthesis presented suffering increasing pain post-operatively. Material rupture and significant loosening of the prosthesis was ruled out by means of a conventional X-ray examination.

To detect any soft tissue abscess, a CT scan of the pelvis was performed with IV contrast. The metal prosthesis caused significant artefact preventing evaluation of the surrounding tissues.

A reconstruction with SEMAR was then performed. This reconstruction demonstrated a hypodense structure in the right iliopsoas muscle, immediately anterior to the hip joint with surrounding contrast enhancement. This structure was determined to be an abscess (Fig. 1).

In this clinical situation, the SEMAR technology demonstrated the diagnostic relevance of suppressing metal artefacts due to implants, particularly in the surrounding tissue.

Case 5: ArterioVenous Malformation in the Right lower leg

This patient presented with a mass in the right lower leg. A 4D CTA was performed to determine the cause of the mass.

The arterial phase of contrast-enhanced examination revealed a normal perfusion of the leg vessels.

The primary finding was an approximately 2.5 x 1.3 x 5 cm large arteriovenous malformation posterior to the distal tibia and almost 4 cm above the ankle joint. Considering the inundation time, this corresponded to a low flow malformation mainly supplied from two branches of the fibular artery, as well as by a cranially extending branch of the anterior tibial artery. There were, however, multiple small feeders, particularly from the fibular artery.

Figure 1a: Plain X-ray of the hip demonstrating no loosening of the prosthesis
Figure 1b: CT scan demonstrating significant artefact from the metal prosthesis
Figure 1c: SEMAR reconstruction demonstrating the abscess anterior to the hip prosthesis

Figure 4: The 4D CTA demonstrated the feeding arteries and draining veins of this AVM of the leg.