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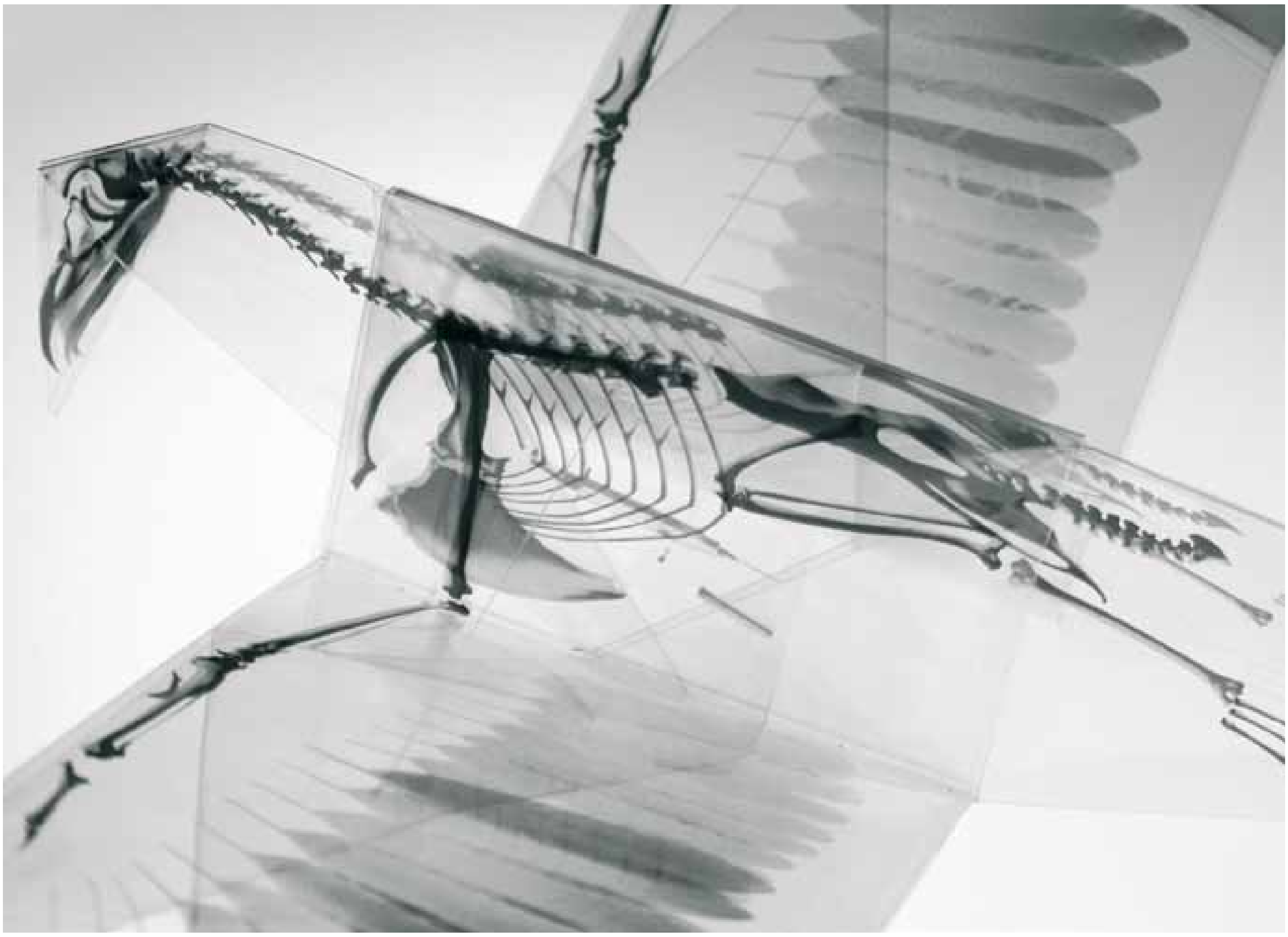

CT
Dose reduction through dual energy, AIDR and new high-end technology

Ultrasound
Echocardio-graphy in takotsubo cardiomyopathy

X-Ray
Infinix-i with Volume Navigation for greater confidence

MR
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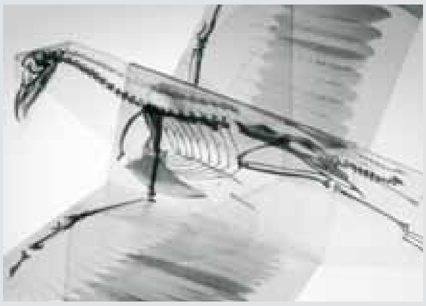
VISIONS

19 · 2012

Japanese art between tradition and modernity: X-ray like skeleton of a bird printed on translucent foil folded into a three-dimensional sculpture



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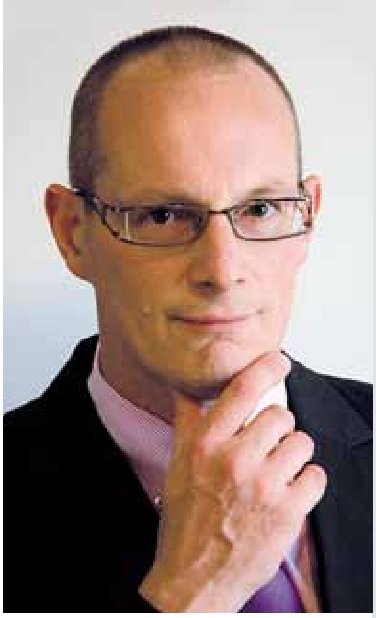

recently, I visited Barcelona on a private trip. The incredible buildings, structures, sculptures, furniture and interior designs of Antoni Gaudí, the famous Spanish architect and figurehead of Catalan Modernism, are a must see there.

Much of Gaudí's work was inspired by his four passions in life: architecture, nature, religion and love of Catalonia. The most eye-catching of his creations is without doubt the Sagrada Família – his magnum opus. Although incomplete, the church is a UNESCO World Heritage Site. After Gaudí's death in 1926, work to realize his extra-ordinary design continued. Completion is scheduled for 2026. Gaudí's initial vision inspired passion, craftsmanship and accuracy for generations after him and his work will continue to fascinate generations ahead.

Craftsmanship and accuracy are also at the heart of the beautiful sculptures created by Japanese artist Takayuki Hori presented in this edition of VISIONS. The remarkable origami objects highlight a complex symbiosis of material, object and message.

Passion, craftsmanship and accuracy. That is also what drives us at Toshiba when we develop innovative systems and new technologies to provide you with the best diagnostic images.

From the first CT scanner developed in 1978 to today's state-of-the-art Aquilion ONE, we have been working on dose reduction technologies resulting in AIDR 3D, the most robust dose reduction technology currently available commercially. Fully integrated into our customers' scan protocols, it delivers routine, ultra low-dose imaging with no work-flow penalties and no image quality trade-offs.

Or take our unique non-contrast enhanced MR ventri-culography and cysternography that uses CSF itself as an endogenous contrast thanks to Time-SLIP technology. It is safe, fast, non-invasive and can be used repeatedly in preoperative and postoperative imaging. It can in some cases even obviate invasive ventriculography.

Passion, craftsmanship and innovation.
That's what makes us at Toshiba stand out as professionals in diagnostic imaging!

Jack Hoogendoorn
Sr. Manager Marketing Communications
Toshiba Medical Systems Europe BV

EDITORIAL

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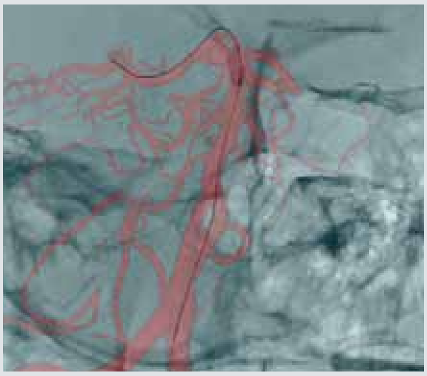

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Time-SLIP for Non-Invasive and Non-Enhanced Imaging of CSF Flow Dynamics

S. Yamada

Dr. Shinya Yamada

Introduction

Cardiac-gated phase-contrast magnetic resonance (MR) imaging is the only technique currently available to observe cerebrospinal fluid (CSF) flow non-invasively. The phase contrast technique provides "to and fro" CSF flow velocity and direction during a single cardiac cycle[1–10]. However, this technique is limited because of poor visualization of turbulent flow[3–4] and the inability to measure bulk flow[5]. Currently, to measure bulk CSF movement or to observe if communication exists between two specific CSF spaces, it is necessary to use invasive techniques, such as introduction of a contrast agent[11,12] or a radiopharmaceutical[13,14] into the CSF. This procedure is typically followed by imaging of one or more hours.

Toshiba's Time-SLIP (Spatial Labeling Inversion Pulse) technique is a well-known non-contrast enhanced MR angiography technique[15-16]. Rooted in arterial spin-labeling methods, it offers the user a free hand tag that can be positioned in any orientation to fit the anatomy of the vasculature segment or tree of interest[17]. We modified the Time-SLIP technique to be able to acquire a series of single-shot images with incremental inversion recovery times to help visualize CSF bulk and turbulent flow without the administration of contrast material.

The main goal of this technique was to compare bulk and turbulent CSF flow in normal conditions with that in altered physiologic conditions. This technique is also a very useful tool in clinical setting to observe whether two or more CSF spaces (ex. the case of arachnoid cyst or intra-ventricular cyst) were in communication or to determine the obstruction site of CSF pathway non-invasively. Understanding the CSF dynamics in a patient may provide useful information for the treatment strategy.

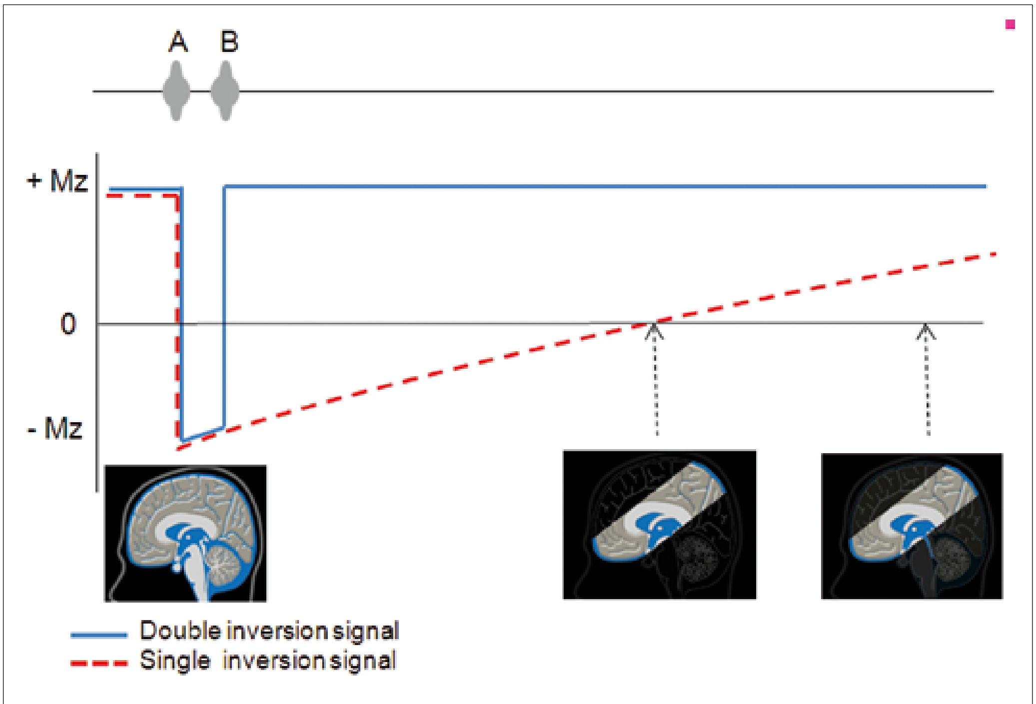


Fig. 1: Sequence diagram of Time-SLIP with two-dimensional half-Fourier fast spin-echo (FSE) imaging (bottom) and magnetization states (+ Mz, -Mz) of signals (top) covered by non-selective pulse (A) and selective tagged pulse (B). An initial non-selective pulse (A) inverts all magnetizations within the radio-frequency coil and is followed by a selective pulse (B) that restores magnetization to +Mz in a plane that can be placed freely in any orientation. Untagged signals return to +Mz after T1 recovery relaxation. When untagged signals reach a null point, tagged and untagged signals have an optimal contrast.

Tokai University
Oiso Hospital, Japan

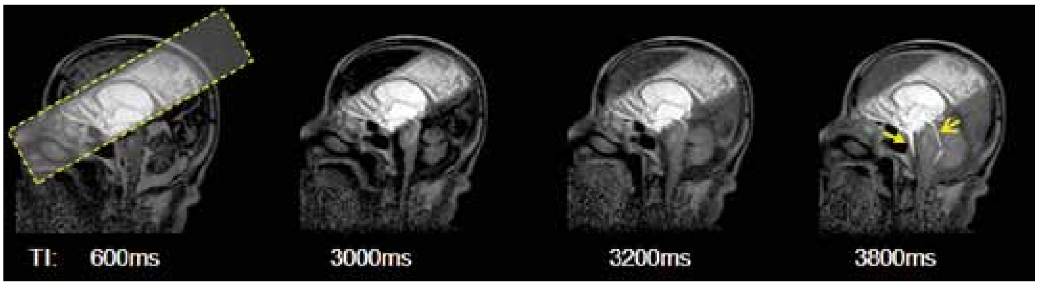


Fig. 2: Sagittal brain MR images in a healthy male volunteer at TIs from 1500 to 5000 ms. The labeling pulse (dotted line) was placed in an oblique coronal plane. Best contrast exists between the labeled and unlabeled CSF at TI 3000 ms (null point of the CSF signal), but a good visualization can be obtained at TIs between 1500 and 4500 ms. Note the pulsed CSF flow from the 3rd ventricle to the 4th ventricle through the aqueduct (open head arrow). Note also the pulsed CSF flow in the prepontine subarachnoid space towards the spinal subarachnoid space (arrow).

Time Spatial Labelling Inversion Pulse

Time-SLIP can be used either with a Fast Advanced Spin-Echo (FASE) or a Steady State Free Procession (SSFP) sequence[17]. For CSF flow visualization the Time-SLIP sequence was slightly modified. The Time-SLIP tag is preceded by a non-selective inversion recovery pulse that inverts all proton spins in the field of view from their initial longitudinal magnetization (+Mz) to a negative magnetization (-Mz). Immediately after this initial inversion, the Time-SLIP pulse, which is spatially selective, is applied to invert (tag) only the magnetization of tissue and fluid in the region of interest. By this second inversion, the longitudinal magnetization in the tagged region is restored to +Mz, whereas the magnetization elsewhere remains at -Mz and follows the exponential T1 relaxation (see Figure 1). After this preparation and a variable delay period (or TI), an MR image that shows tagged and untagged regions is read out by using single-shot two-dimensional half-Fourier fast spin-echo imaging. The Time-SLIP pulse can be applied in any orientation with a width up to 30 cm.

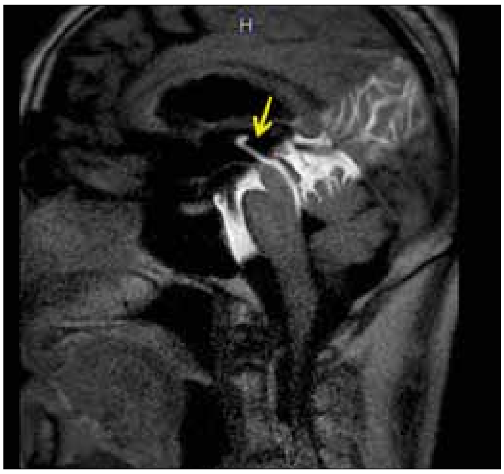
To determine suitable TIs that provide enough contrast between tagged and untagged areas, various TIs (between 30 and 10 000 ms) were applied on mid-sagittal images in volunteers. As shown in (18), a short TI (< 1500 ms) and a long TI (>6000 ms) result in a similar contrast between tagged and untagged CSF.

A good contrast between tagged and untagged CSF occurs from 1500 to 4500 ms. At a TI of 3000 ms, untagged CSF shows null signal. These findings were similar in seven healthy individuals we imaged.

For Time-SLIP, one can use a Fast Advanced Spin-Echo technique (FASE) or a Steady State Free Procession (SSFP) sequence. The typical Time-SLIP imaging parameters used for CSF flow visualization using the FASE sequence, with ECG gating, on a 1.5T MR system, are as follows:

TR:	12,000ms (10–15 R-R intervals)/80
TE:	80 ms
Flip angle:	80°
Refocusing flip angle:	180°
Matrix size:	256 x 256
Field of view:	26 x 26 cm
Bandwidth:	83.3 kHz
Echo train length:	144
Section thickness:	5-mm
ECG (or PPG) gating	
Electrocardiographic time delay from an R wave to the beginning of the non-selective inversion recovery pulse:	0 msec
Time-SLIP pulse width:	1-5 cm

Figure 3: Sagittal brain Time-SLIP MR images. The size and position of the labeling pulse can clearly be seen by the difference of contrast between tagged and untagged tissues. At TI 3600 ms a CSF flow from the aqueduct into the third ventricle was noted by high signal intensity (arrow).



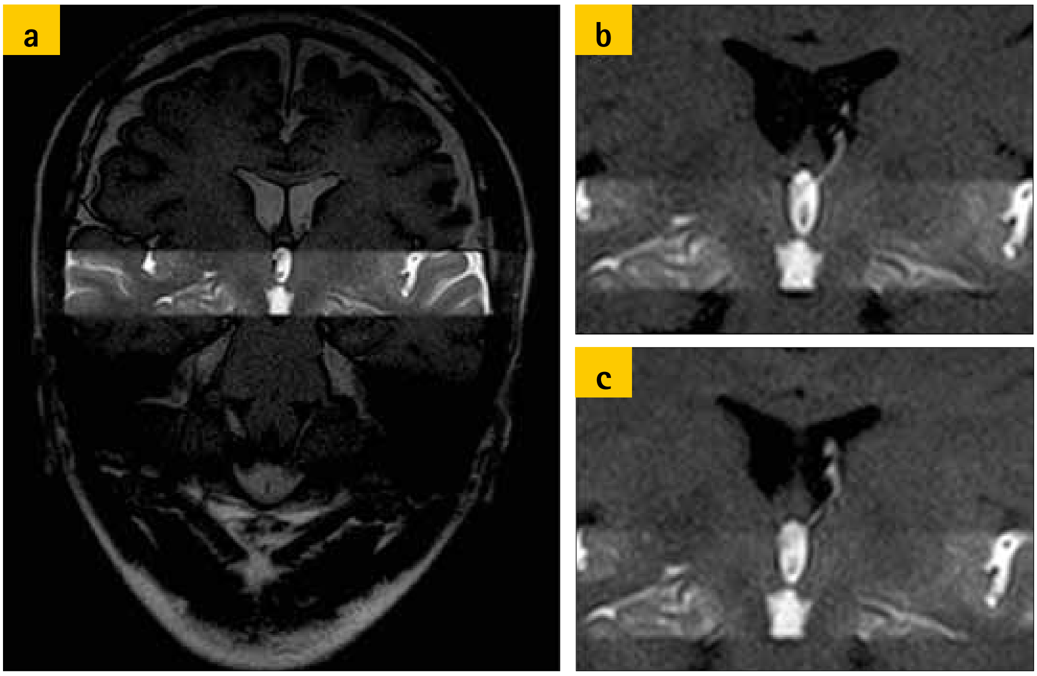


Fig. 4: Coronal brain Time-SLIP in a healthy male volunteer at 3 different TIs. TI: 500 ms. The position and size of the labeling pulse can clearly be seen due to the contrast between tagged and not tagged tissues. The high signal intensity (arrows) on the top row images indicates CSF reflux from the third ventricle into the lateral ventricles through the foramen of Monro, at TI=2900 ms (b) and TI=3500 ms. Bidirectional flow was observed from the third into the lateral ventricles and from the lateral ventricles into the third ventricle

A repetition time of about 12,000 msec is applied to gain full recovery of longitudinal magnetization. A series of two-dimensional single-shot images with various TIs is obtained by repeating a TI increment of 200 ms 23 times, starting from 1000 ms, up to 6000 ms. All images are acquired within one acquisition[16]. Total acquisition time is about 4 minutes.

Normal CSF flow dynamics

Intracranial pulsed CSF flow

In (18), we showed that the pulsed or tagged CSF travels from the third ventricle into the fourth through the aqueduct, indicating bulk movement of CSF (Figure 2). Net, or bulk, CSF flow was also observed to travel from the prepontine cistern to the cervical subarachnoid space through the cisterna magna. In addition, this technique allows for the determination of distance and velocity measurements of CSF movement[15]. In the third ventricle, we showed that tagged CSF moves approximately 2 cm during a TI of 5000 ms and, with an effective echo time of 80 ms, the mean velocity calculates to about 4 mm/s. These findings were similar in all seven healthy individuals imaged.

Intracranial turbulent and reflux CSF flow

The Time-SLIP technique was applied separately to the CSF in the third and lateral ventricles above the aqueduct (Figure 3) and in the aqueduct and fourth ventricle (Figure 4). Reflux of CSF with turbulent flow from the aqueduct into the third ventricle was noted. In Figure 4, coronal images were obtained after tagging CSF in the third ventricle. As TI increased, CSF from the third ventricle flowed into the lateral ventricles. In (18) we also showed that CSF from the lateral ventricles simultaneously moved into the third ventricle. This active bidirectional exchange

Fig. 5: Mid-sagittal cervical spine Time-SLIP of a healthy male volunteer in supine position: Up-and-down movements of pulsed CSF (arrows) were predominately observed in the ventral side of the subarachnoid space.

between the third and lateral ventricles was seen in all seven healthy individuals imaged.

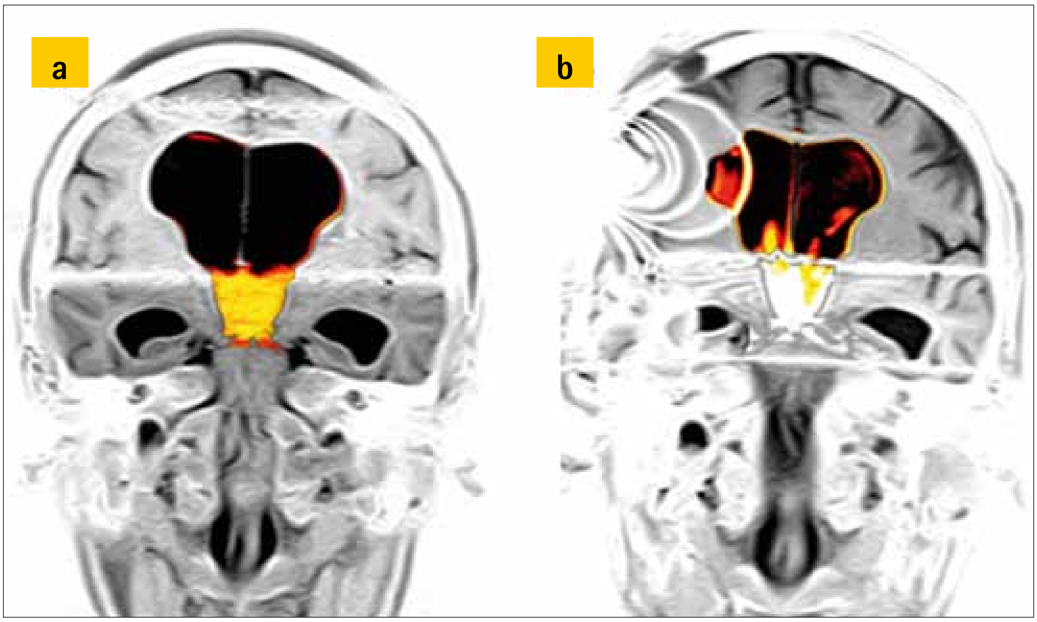
Intraspinal CSF flow

We investigated intraspinal CSF flow by placing the labeling pulse in the region of C4 through C5 on mid-sagittal cervical spine images (Figure 5). Up and down CSF motions were observed in the subarachnoid space anterior to the spinal cord (as noted by the arrows in Figure 5). In 18, we also showed that in prone position, with a similar pulse tag, CSF flow was decreased in the ventral subarachnoid space and correspondingly increased on the dorsal side. This may be explained by the positional-related shift of the spinal cord. These findings were similar in all seven healthy individuals imaged.

Clinical cases

Hydrocephalus. Figure 6 shows coronal images with Time-SLIP in a patient with idiopathic hydrocephalus. The CSF in the third ventricle was tagged. Reflux of the tagged CSF from the third ventricle to the lateral ventricles had disappeared (Figure 6a). After a ventricle-peritoneal shunt, the CSF reflux from the third to the lateral ventricles was re-established (Figure 6b).

Fig. 6: Coronal Time-SLIP images using a balanced SSFP sequence in a patient with idiopathic hydrocephalus. Color coding is used for esthetic visualization purpose. (a) Labeled CSF in the third ventricle did not reflux into lateral ventricles prior to surgery. (b) After a ventricle-peritoneal shunt, labeled CSF reflux is seen in the lateral ventricles.



Arachnoid cyst. Figure 7 shows axial Time-SLIP images in a patient with a left middle fossa arachnoid cyst. The tagged CSF in the basal cisterns prior to fenestration of the cyst showed no evidence of communication with the arachnoid cyst[18] (not shown in the Figure 7). After surgical internal fenestration, the labeled CSF in the basal cisterns was noted to be present in the arachnoid cyst which indicates communication between the two CSF-containing spaces.

Discussion

The ideal tracer to study the movement of CSF is CSF itself. With the Time-SLIP technique, the tagged CSF is used as an endogenous tracer to non-invasively observe CSF flow.

The Time-SLIP technique enables the labeling of a variable volume of CSF in any orientation and in any location in the central nervous system. The acquisition time to obtain a series of two-dimensional data is relatively short (in average about 3-4 minutes per examination). Repeated studies are readily doable and can be used to assess CSF movements in normal physiologic conditions as well as in altered states to determine the effectiveness of therapy.

Non-invasive unenhanced direct visualization of CSF flow is useful in understanding CSF dynamics, diagnosis and treatment choice for patients with a CSF-related disease. Turbulent CSF flow from the aqueduct into the third ventricle was evident in every study in the seven healthy individuals, as was turbulent bidirectional flow between the third ventricle and the lateral ventricles. Reflux of CSF from the third ventricle into the lateral ventricles disappeared in the patient with hydrocephalus. However, reflux flow was reestablished after ventricle-peritoneal shunt (V-P shunt) in a typical hydrocephalus

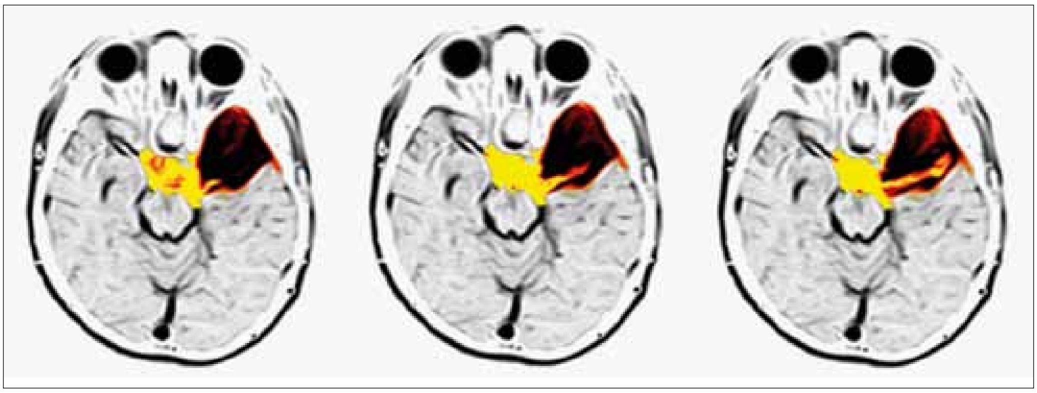


Fig. 7: Post-surgical internal fenestration axial Time-SLIP images using a balanced SSFP sequence in a 9-year-old male patient with a left middle fossa arachnoid cyst (TIs between 2500 ms and 3900 ms). Color coding is used for esthetic visualization. Labeled CSF in the basal cisterns is clearly flowing into the cyst.

case. Re-established CSF flow from the third ventricle to the lateral ventricles may reflect compliance change of hydrocephalic brain.

Relkin et al[19] reported that none of the present MR imaging techniques, especially those to examine CSF flow in the region of the aqueduct, have with any high degree of accuracy been able to help predict individuals suspected of having idiopathic normal-pressure hydrocephalus who would benefit from CSF diversion. It will be interesting to investigate in future studies whether Time-SLIP pulse labeling of CSF will be more predictive.

Another potential use of CSF pulse labeling is to determine if two CSF containing spaces are in communication. As mentioned previously, tagged cisternal CSF was in communication with a left middle fossa arachnoid cyst after surgical internal fenestration. The patency of CSF flow through the hole between the third ventricle to basal cistern after endoscopic third ventriculostomy is readily doable using Time-SLIP with very short acquisition time.

In the spine, movement of CSF in SAS was observed during normal conditions. The change from the supine to the prone position increased the movement of CSF in the dorsal SAS and decreased the movement in the ventral SAS; these findings may be attributed to a change in the CSF flow resistance in the SAS after the positional shifts of the spinal cord. One can consider using Time-SLIP labeling to assess CSF movement in the subarachnoid space at the craniocervical junction or the CSF within a syrinx to better assess the need for and efficacy of treatment. It would be interesting to assess in future studies the clinical value of Time-SLIP in patients with syringomyelia associated with Chiari malformation Type I.

The current limitation of this technique, however, is the limited observation time. Cerebrospinal fluid flow with good contrast definition is only possible at TIs of 1500-4500 ms. Beyond this range, untagged and tagged CSF become similar in contrast.

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Toshiba goes full steam ahead

Toshiba Corporation as one of the world's leading suppliers of thermal power generation equipment has won a major contract to supply a 971 MW supercritical steam turbine and generator for the Holcomb Thermal Power Plant in Kansas, USA. Partners are Tri-State Generation and Transmission Association, Inc., a major utility based in Colorado, and Sunflower Electric Power Corporation, a major utility in Kansas. The supply of equipment is scheduled for July 2014, and plant operation is expected to start in 2017. The US will see continuing demand for thermal power plants as a cost-efficient, stable source of energy, with increasing interest in highly efficient fossil power plants as a means to mitigate global warming and meet Environment Protection Agency standards for power plant operation.

Toshiba considers North America an important strategic market for its thermal power plant business and has built up a comprehensive service, maintenance and support network centred on REGENCO LLC, which it acquired in 2007.

Smart Grids for Smart Communities in France and the UK

Toshiba will support two innovative Smart Community projects in Lyon, France, and on the British Isle of Wight.

Lyon Confluence is a major project to redevelop a former industrial and transportation hub on the lower end of the peninsular formed by the confluence of the Rhone and Saone rivers in central Lyon. The project, which will run through March 2016 and which has a value of approximately 5 billion yen, will showcase advanced technologies.

Toshiba Corporation and Toshiba Solutions Corporation were selected by Japan's New Energy and Industrial Technology Development Organization (NEDO) as lead contractors and will deliver key technologies in four areas: positive energy Buildings (PEB); remote monitoring and management of photovoltaic power generation for an electric vehicle charging system; home energy management; and a network to integrate and support Smart Community management.

In the UK, Toshiba Corporation has partnered with EcoIsland to make the Isle of Wight a model sustainable community. EcoIsland will explore solutions that harness renewable energy and advanced technology to secure self sufficiency in energy. As a Global Partner, Toshiba will provide diverse Smart Community technologies.

Located off the south coast of England, the Isle of Wight (IOW) has a population of 142,000 in an area of 384 square kilometres. Through EcoIsland, the people of the island will seek to meet needs from their own resources and achieve a sustainable community that lives in closer harmony with nature while leaving a lighter footprint on the land. By 2020, using a mix of wind, solar photovoltaic, tidal, geothermal and biomass renewable energy sources integrated with Smart Grid technology, the IOW expects to be the first region in the UK to be both energy self-sufficient and capable of exporting surplus energy to the mainland.

Toshiba is strongly positioned to support development of the EcoIsland concept. The company is an industry leader in power generation, transmission and distribution, with expertise in renewable energy sources that includes photovoltaic and wind power. Toshiba integrate this know-how with extensive, state-of-the art capabilities in other areas, including metering, communications, high density storage batteries, home and building management and road transportation, to deliver comprehensive, low-carbon solutions in Smart Grid and has participated in 13 projects around the world, including a "Smart Grid Research and Demonstration Project in New Mexico" in the United States, the "Delhi-Mumbai Industrial Corridor Project" in India and the "Tianjin Urban Development and Environment Project" in China.

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President's message

As a company involved in the global healthcare business, Toshiba Medical Systems Corporation (TMSC), which operates under the management slogan "Made for Life", has moved forward in partnership with its many customers around the world by responding to their changing needs.

We conduct our business based on three management concepts: "Improving the quality of life", "Lifelong commitment to innovation", and "Establishing lifetime partnerships".

In order to contribute to society through healthcare, we strive to be a company of the highest integrity by achieving our corporate social responsibility (CSR) goals and giving top priority to life, safety, and compliance with laws and regulations.

The basis of our development is to create new clinical value in cooperation with our customers. Today, there is strong demand for even better and more efficient healthcare, and establishing a global patient/disease-centered framework is a basic requirement.

I feel that TMSC should respond to this challenge by moving forward on two broad fronts with a focus on diagnostic imaging.

First, further enhancing our clinical applications to provide advanced visualization and analysis capabilities based on the images acquired using our systems.

Second, providing the foundation for an infrastructure which facilitates the use of such clinical images for both diagnosis and treatment anytime and anywhere.

The imaging solutions business of Vital Images Inc., which joined TMSC last year, will be an important part of our continuing efforts to contribute to the advancement of healthcare worldwide.

Satoshi Tsunakawa
President and Chief Executive Officer
Toshiba Medical Systems Corporation

Initial Clinical Experience of Dual Energy Blended Images and Iodine Mapping Visualization

T. Maeda[1], C. Verlooij[2], R. Kwok, MD[3]

Tatsuo Maeda

Introduction

The concept of dual energy scanning was developed back in the 1970s[1,2], however it has only recently become clinically viable due to technical improvements in CT scanner technology. Dual energy has shown the potential to improve characterization of the composition of materials as well as to increase specificity in diagnostic imaging. Multi-spectral data acquisition allows for the decomposition of materials through the use of attenuation differences produced by two distinct energy spectra.

The theory behind dual energy is that the attenuation measured by the detector is based on the energy of the incident beam as well as on the properties of the object such as atomic composition, density or thickness. The use of more than one energy beam allows for material decomposition due to these attenuation differences at different energies. One of the challenges that arise from dual energy acquisitions is the interpretation of the increased amount of data available. Improved visualization methods may be beneficial in reviewing and interpreting dual energy data.

Dual energy CT allows for decomposition of materials and thus the differentiation of materials with high atomic numbers such as iodine. An iodine map image data set using dual energy methodology can display the distribution of iodine and thus differentiate regions of vascularity within the organ post scanned. The iodine enhancement map is usually a color overlay over an anatomical image to emphasize the differences in vascularity and to allow anatomical localization.

Beyond decomposition analysis there are methods that provide additional valuable information on the characteristics of the materials being imaged, for example blended images. Essentially, a blended image is a fusion of the 135 kVp scan and the 80 kVp scan to produce one combined image. This type of visualization improves SNR (signal to noise ratio) by using the noise characteristics of the 135 kVp scan as well as CNR (contrast to noise ratio) by using information from the 80 kVp scan.

The two different techniques can be applied in parallel for more effective patient evaluation. In this paper we present our initial clinical experience assessing the effectiveness of blended images and iodine maps in dual energy analysis.

Basic principles

To produce the best possible image, it is necessary to decrease the noise in the image and to increase contrast in order to be able to detect abnormalities.

In CT imaging, higher energy (135 kVp) scanning gives a better signal to noise ratio whereas lower energy (80-100 kVp) imaging generally produces enhanced contrast between materials. The best image would therefore be a combination of these two methods, thus decreasing the noise while maintaining the best possible contrast detail.

Dual energy can create a blended image for routine clinical diagnosis. A blended image is typically produced through a linear combination of the high energy image and the low energy image. This, however, generates a less than optimal image due to the noise of the low energy image and lower contrast detail in the 135 kVp image. Therefore, a pixel by pixel blending function was developed which uses the greater contrast detail of iodine in the 80 kVp image. At the same time, low-intensity values such as water benefit from the 135 kVp image due to its low noise properties. The combination of these images can be described as a ratio between these two images which is based on the noise characteristics needed for diagnosis as well as on the amount of contrast available in the images.

Blended image = (1-ratio) low kVp image
+ ratio high kVp image

The automatic optimization of this ratio is important to the overall quality of the blended image. The workflow for the blended image is shown in Figure 1. Each image is evaluated on a per voxel basis. The comparison of the mass attenuation coefficients between the water and the contrast medium allows calculation of the ratio necessary for combining the energy images. The blending curve is actually based on a sigmoidal curve. A combination of the 135 kVp and the 80 kVp image is used to produce a kVp equivalent image of 120 kVp (see Fig. 2).

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2 *Toshiba Medical Systems Europe BV, The Netherlands*
3 *Mount Elizabeth Hospital, Singapore*

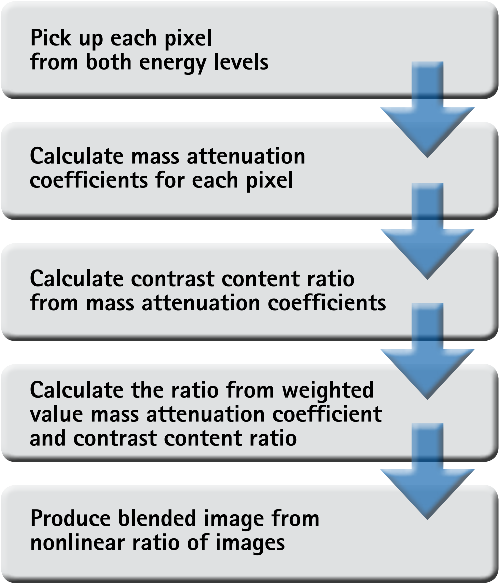
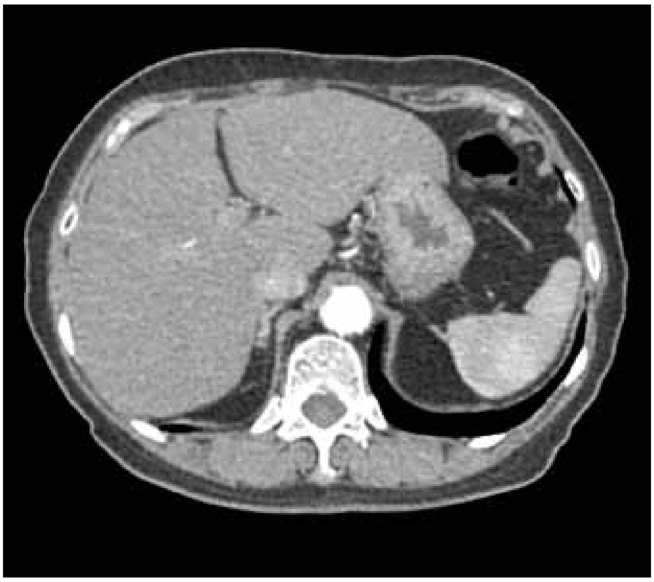


Fig. 1: Calculation workflow of blended image

Fig. 2: 80 kVp original image

Scan Condition	
Tube voltage	80/135 kVp
Tube current	570/100 mA
Rotation speed	0.5 s/r
Slice × Rows	0.5 mm × 80 rows
Scan FOV	40 cm
HP	11.4
Backside exposure	OFF
Contrast Condition	
Concentration	370 mg I/cc
Injection duration	50 and 80 ml
Injection speed	2.5 ml/s
Reconstruction Condition	
Reconstruction kernel	FC13
AIDR 3D	strong

Table 1: General protocol conditions



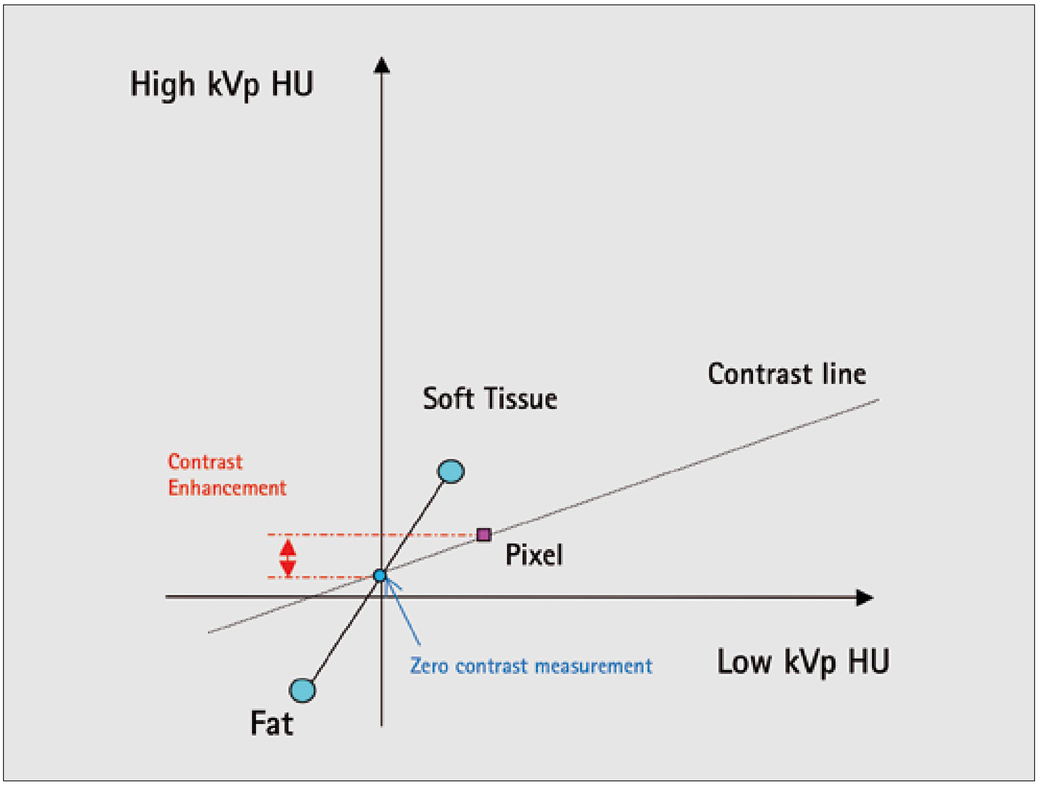
Blended image

The decomposition of the dual energy data produces an iodine map which allows the physician to evaluate the distribution of iodine within the organ post scanned.

In Figure 3 the pixel values from the high energy data sets and the low energy data sets can be plotted on the y-axis and x-axis respectively. The HU for pixels with contrast (high density) form a so-called contrast line. Similarly, the lower density pixels of tissue and fat form a tissue fat line. A zero contrast measurement is determined from the intersection of the contrast and tissue lines along the y-axis. The difference between the pixel value HU on the high energy image and the zero contrast measurement determines the amount of enhancement which is shown as a color map overlay.

135 kVp original image

Fig. 3: Decomposition



Initial Clinical Experience

Case I – Hypervascular liver tumor

Dual energy scans were performed in the late arterial phase to assess hepatoma recurrence. Dual energy technique allowed for a reduction in the amount of contrast with better conspicuity of small lesions from the combination of blended images and iodine maps (Figure 4).

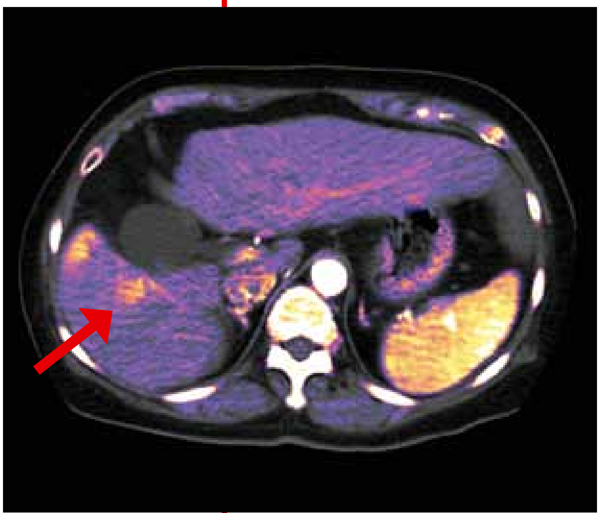


Fig. 4: Hypervascular liver tumor in late arterial phase, 50% fusion image of iodine map and blended image

Blended image of selected 120 kVp

Case 2 – Necrotic tumor

A dual energy scan was performed in the late arterial phase to visualize this lesion. The blended image provides the low noise level of 135 kV and the improved contrast enhancement of 80 kV. Still the differentiation between necrotic areas and enhanced areas is difficult in this image. The fusion image of the iodine map and the blended image allows us to differentiate the necrotic areas from the areas of enhancement in the late arterial phase.

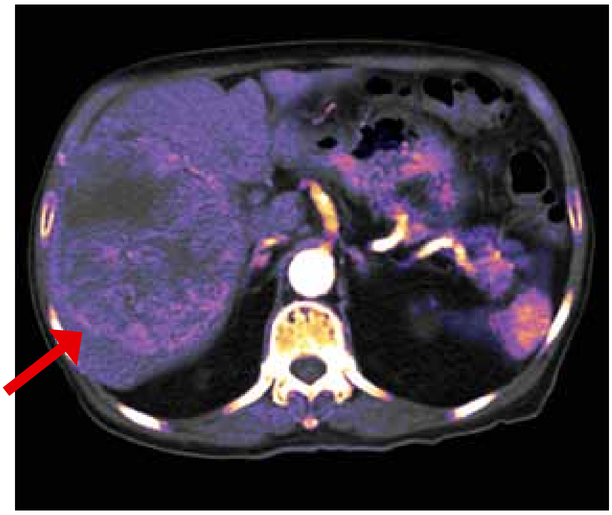
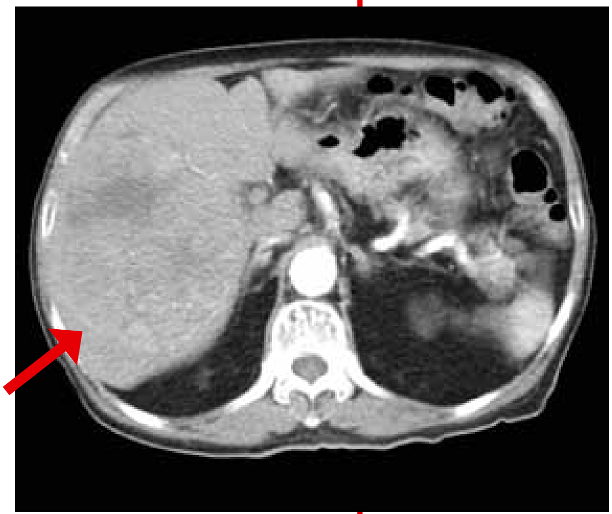


Fig. 5: Necrotic tumor in late arterial phase
50% Fusion image between iodine map and blending images



Blended image
of selected 120 kVp

Material and methods

Dual energy data sets were acquired on an Aquilion PRIME using the single source dual energy helical scan mode. This scan mode applies the high kV at the first part of the rotation and lower kV on the conjugate views and maintains a low pitch. This allows for near simultaneous acquisition of data to minimize movement between energy levels. Another approach to perform a single source dual energy helical scan is to acquire two consecutive helical scans, each acquiring a different energy level and pitch. Performing this "go and go" dual energy helical scan with two big time difference and two different helical runs, however, will result in mismatch of patient position and therefore reduces diagnostic accuracy.

Furthermore, the tube currents were adjusted in such a way that the noise levels of both images matched, a point that fast kV switch fails to do. This matched noise level is very important to achieve high accuracy dual energy diagnostic results.
Finally, the FOV was set to 50 cm for both energy scans assuring correct comparison between two images, as opposed to the dual source dual energy which utilizes two different FOVs.

Conclusion

Our initial experience shows that the blended image and iodine mapping strongly promise to improve the conspicuity of lesions in the abdomen and the overall specificity of the images and area of enhancement. We have demonstrated the diagnostic utility of full FOV dual energy helical scans with one helical run and matched noise levels. These fundamental principles on Toshiba's dual energy mode ensure high diagnostic accuracy.

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Kreisklinikum Siegen benefits from new high end, low dose CT technologies

Worlds first Aquilion RXL installed in Siegen, Germany

The new Toshiba CT Aquilion RXL - for **R**adiology e**X**aminations with **L**owest dose – combines high-end and low-dose technologies. Accelerated workflows and the new adaptive iterative dose reduction application AIDR 3D are core features of the new system. The management of Kreisklinikum Siegen is delighted to be able to offer their patients a new level of care.

"For almost 150 years, our hospital has been a mainstay of regional healthcare, assuming responsible for all people in the region and beyond. Today, Kreis- klinikum Siegen – county hospital Siegen – has two sites with a total of 600 beds", says Managing Director Bertram Müller and adds: "We are also the focal point for emergency care and patients are brought to us by ambulance car and helicopter. We consider it our responsibility towards our patients to set the highest standards for ourselves and to always try to deliver state-of-the-art care. The new Toshiba CT is another big step forward."

Highest standards – to the benefit of our patients

"However", Administrative Director Eckhard Haub points out, "we not only provide optimum care for our patients, we also keep an eye on our budget. We meticulously weigh the pros and cons of any investment before we make a decision. That was no different when we considered purchasing a new CT scanner. Price/performance ratio is the key term. On the one hand we want to profit from newest CT technology, on the other hand we have to stay within our budget. Thus we very consciously opted for the Aquilion RXL since it offers state-of-the-art technology and a convincing price/performance ratio."

"We scan 40 to 50 patients per day, on some days even more, covering the entire radiological

From left to right: Bertram Müller, Managing Director Eckhard Haub, Administrative Director; Senior Consultants, Department of Radiology and Neuroradiology Dr Burkhard Irnich, Dr Gregor Richter, Kreisklinikum Siegen Hospital

Bertram Müller, Managing Director

"The new Toshiba CT is another big step forward to deliver state-of-the-art care."

Eckhard Haub, Managing Director

"The Aquilion RXL offers most innovative technology and a convincing price/performance ratio."

Senior Consultant Dr Burkhard Irnich

"We need a perfect environment and the best tools to manage 10,000 CT scans per year."

Senior Consultant Dr Gregor Richter

"Iterative reconstruction can reduce radiation dose by up to 75 percent."

Yasuo Nobuta, Vice President of Toshiba Medical Systems Corporation, Japan

"The letters RX stand for Radiology eXaminations and L for lowest dose."

and neuroradiological range", says Dr Burkhard Irnich, one of the two Senior Consultants at the Department of Radiology and Neuroradiology. "Our teams require a perfect environment and very good tools to be able to perform their wide variety of tasks. We try to provide this environment and these tools with medical technology which is on par with university hospitals. After all, as a teaching hospital of Philipps University in Marburg we do train physicians. We offer 24/7 service with one CT and two MRI scanners. And our patient numbers show that we need this equipment: of the 70,000 services our radiology department provides each year, 10,000 are CT exams.

The pace of development in computed tomography, particularly with regard to computing power, is mind-boggling. We knew that we did not want to lag behind but wanted our patients to benefit from the technological innovations.

Faster image acquisition – faster diagnosis

Today, images are available much quicker and waiting times are dramatically reduced. The radiologist can assess images within seconds and the patient and the physician in charge obtain a diagnosis much faster. Clinical workflows are further optimized and it is above all trauma patients where every second counts that benefit from shorter total examination times, meaning the time from patient positioning to diagnosis. The new CT's broad array of applications allows us to offer even more examinations and to further increase utilization of the scanner."

Dr Irnich: "With the new CT Aquilion RXL we introduced among other applications ^{Sure}Subtraction for CT angiography of the head. This procedure is indicated for example when a vascular clip was implanted. While before the clip compromised image quality ^{Sure}Subtraction visualizes the vessels despite the clip. Thus we were able to detect an aneurysm right next to a clip. This would have been difficult, if not impossible, with other imaging methods."

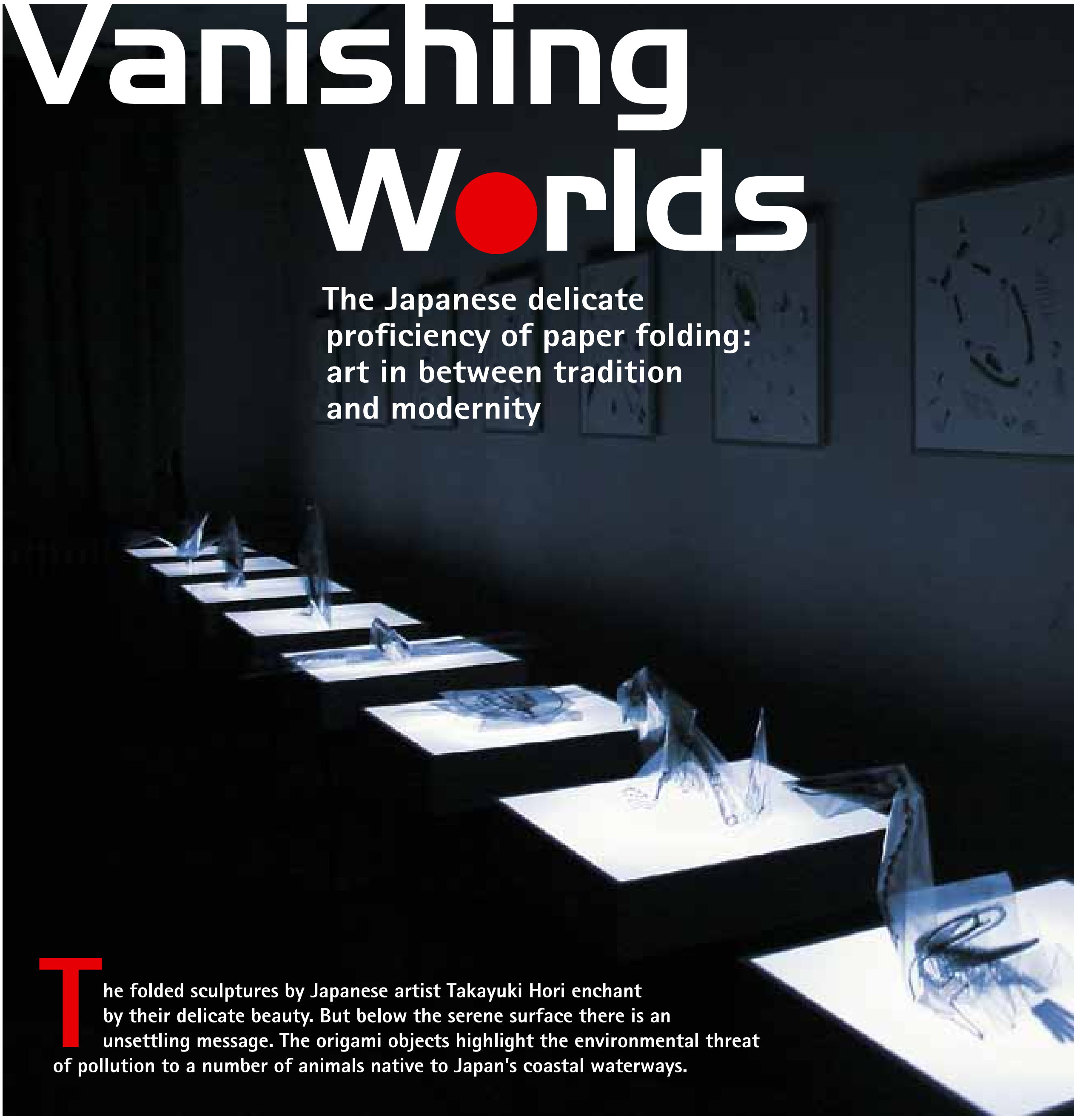
Up to 75 percent less radiation dose – in clinical routine

"Another important issue is the further reduction of radiation. New algorithms, so-called iterative reconstruction, can reduce radiation dose by up to 75 percent. The draw-back? These algorithms require immense computing power which means in the past it took very long for an image to be created. Therefore iterative procedures were not suited for clinical routine. Not to mention the fact that such systems were very expensive and only very few university hospitals in Germany could afford them. With the new Aquilion RXL state-of-the-art technology comes to Siegen and radiation dose can be reduced by up to 75 percent thanks to AIDR 3D, as Toshiba calls this technology. An invaluable advantage for our patients, in particular young patients and women," says Dr Gregor Richter, Senior Consultant at the Department of Radiology and Neuroradiology.

"Especially for customers with a high patient throughput we have developed the new CT Aquilion RXL", said Yasuo Nobuta, Vice President of Toshiba Medical Systems Corporation, Japan.

Workflow and speed are demands of our customers in the development of new CT systems. These demands combined with the iterative dose reduction AIDR 3D, the latest technology for enhanced dose reduction, have now been implemented in the Aquilion RXL." "The letters RX stand for Radiology eXaminations and L for lowest dose. Here we take responsibility – to offer our customers the best technology to master their daily challenges. Hospital Siegen was the best hospital for Toshiba to install the world's first Aquilion RXL in terms of its multitude and wide range of CT examinations."

Vanishing Worlds



The Japanese delicate proficiency of paper folding: art in between tradition and modernity

The folded sculptures by Japanese artist Takayuki Hori enchant by their delicate beauty. But below the serene surface there is an unsettling message. The origami objects highlight the environmental threat of pollution to a number of animals native to Japan's coastal waterways.

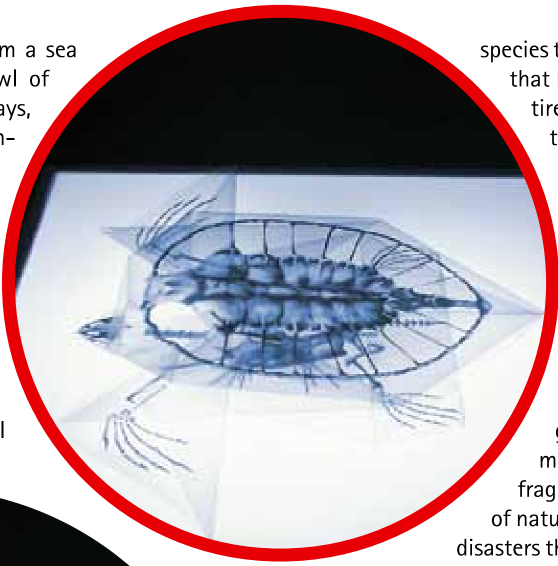
Takayuki Hori-san was still a design student when he submitted his senior thesis work "Oritsunagumono" for Mitsubishi Chemical's Junior Designer Award in 2010. The jury, all of them renowned industry professionals, awarded the first prize to Hori-san's creations. The series encompasses eight objects that show x-ray like skeletons of eight reptiles and birds. The images are printed on translucent foil folded into three-dimensional sculptures. Hori-san simply called them "Oritsunagumono", which means things folded and connected.

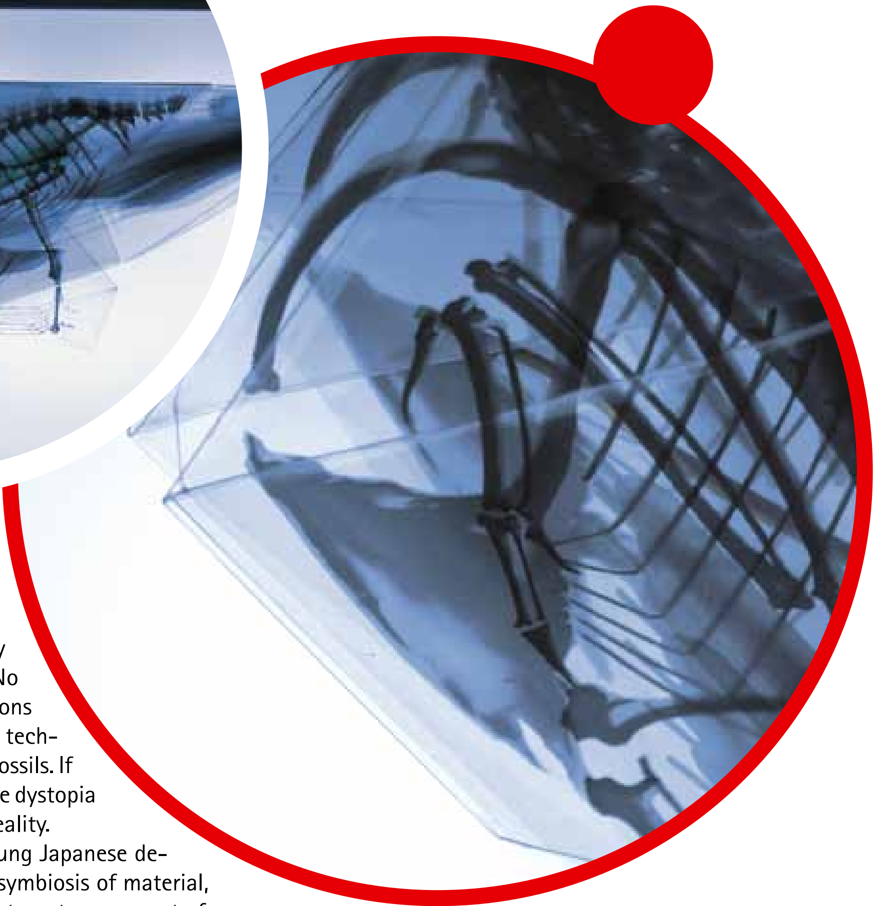
The title indicates the close link to the traditional Japanese art form of origami that has been cultivated and perfected for many centuries. Earliest references date from the Heian period (794 to 1185 AD). "Ori" means fold and "kami" means paper and indeed the only material needed for this fascinating form of art is a sheet of paper. Other aids such as scissors or glue are consciously avoided. The sheet of paper is turned into an object of art by sheer dexterity. The artist folds the paper and as such, brings it to life. In Hori-

sans's work, the different folding patterns are as important as the objects themselves.

Origami – similar to calligraphy – embodies in a unique way the aesthetic ideal of Japanese culture: puristic, reduced to the essential and displaying the artist's virtuosity. Maybe that exactly is one of the reasons why in Japan the traditional art of origami has become an endangered species. Origami can easily seem anachronistic in a modern world that is characterized by acceleration and automated production processes.

Takayuki Hori-san not only tries to preserve origami as an important element of Japan's cultural heritage, his criticism of the modern world reaches much deeper. For Hori-san the history of culture and civilization is also the history of nature. Indeed, the animals that are shown in his origami sculptures were not incidentally chosen. They are eight species, among them a sea turtle and different waterfowl of the Japanese coastal waterways, whose habitats are acutely endangered. Have a closer look and you will see that Hori-san offers an explanation why this is the case. Locked in the bodies of the animals on the colourless x-ray images coloured industrial waste can be seen that the animals have swallowed. This is a radical break with the ideal of filigree beauty that traditionally informs origami. The increasing pollution caused by humans is about to destroy the delicate eco systems. No surprise then that the skeletons made visible by modern x-ray technology seem to be prehistoric fossils. If the pollution is not stopped, the dystopia will soon become a very sad reality.





The works of art by the young Japanese designer thus create a complex symbiosis of material, object and message. He presents so to say an art of vanishing: it is the craft that is vanishing, a craft that has shaped the culture of an entire nation. It is the species that vanish, species that have shaped an entire habitat. Ironically, the process of vanishing is made visible by imaging technology: x-rays. The images are translucent, seemingly without substance, ephemeral. They turn "Oritsunagumono" into a metaphor of the fragility of life. In view of natural and man-made disasters this message is even more urgent: there is a fine line between life and catastrophe.

Sources:
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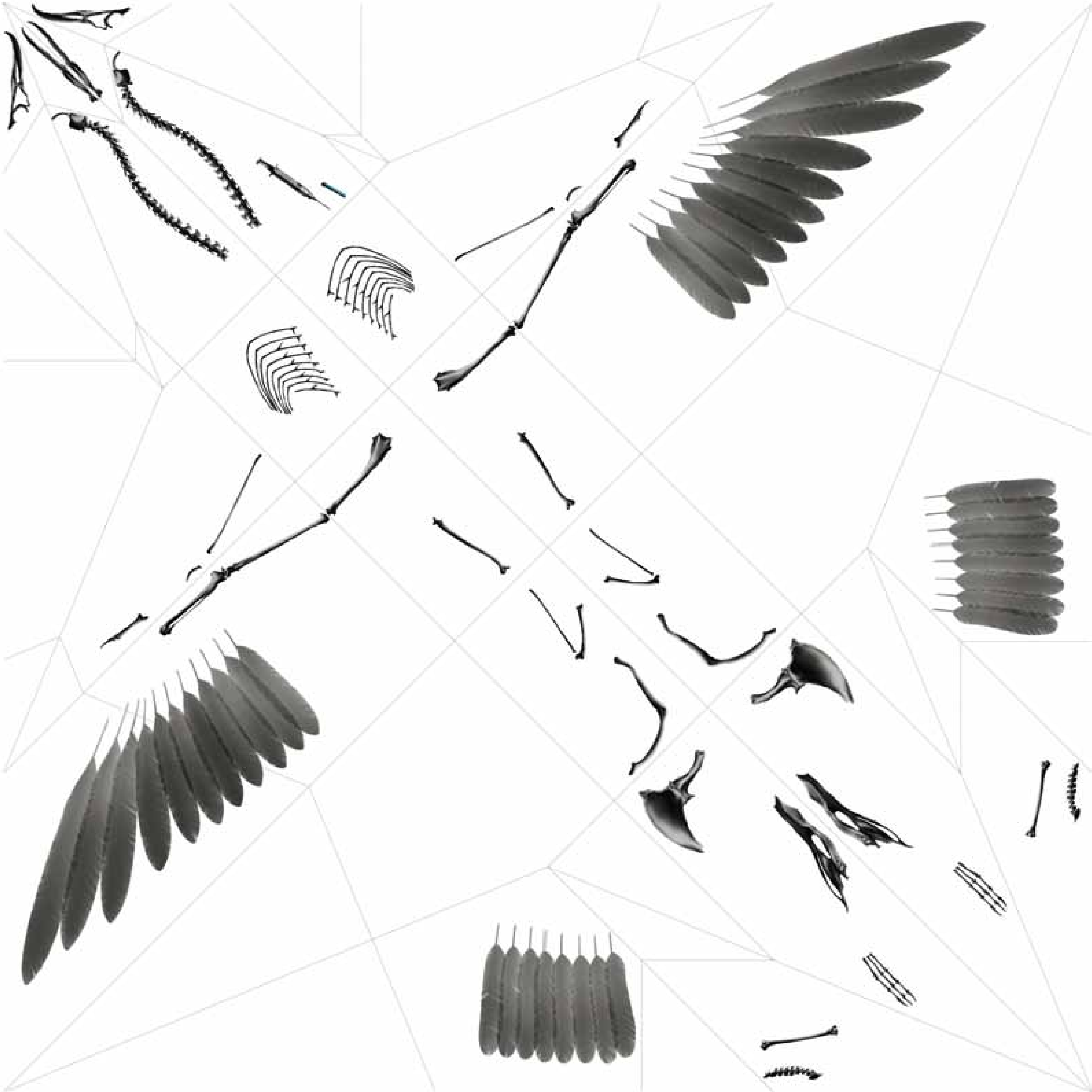
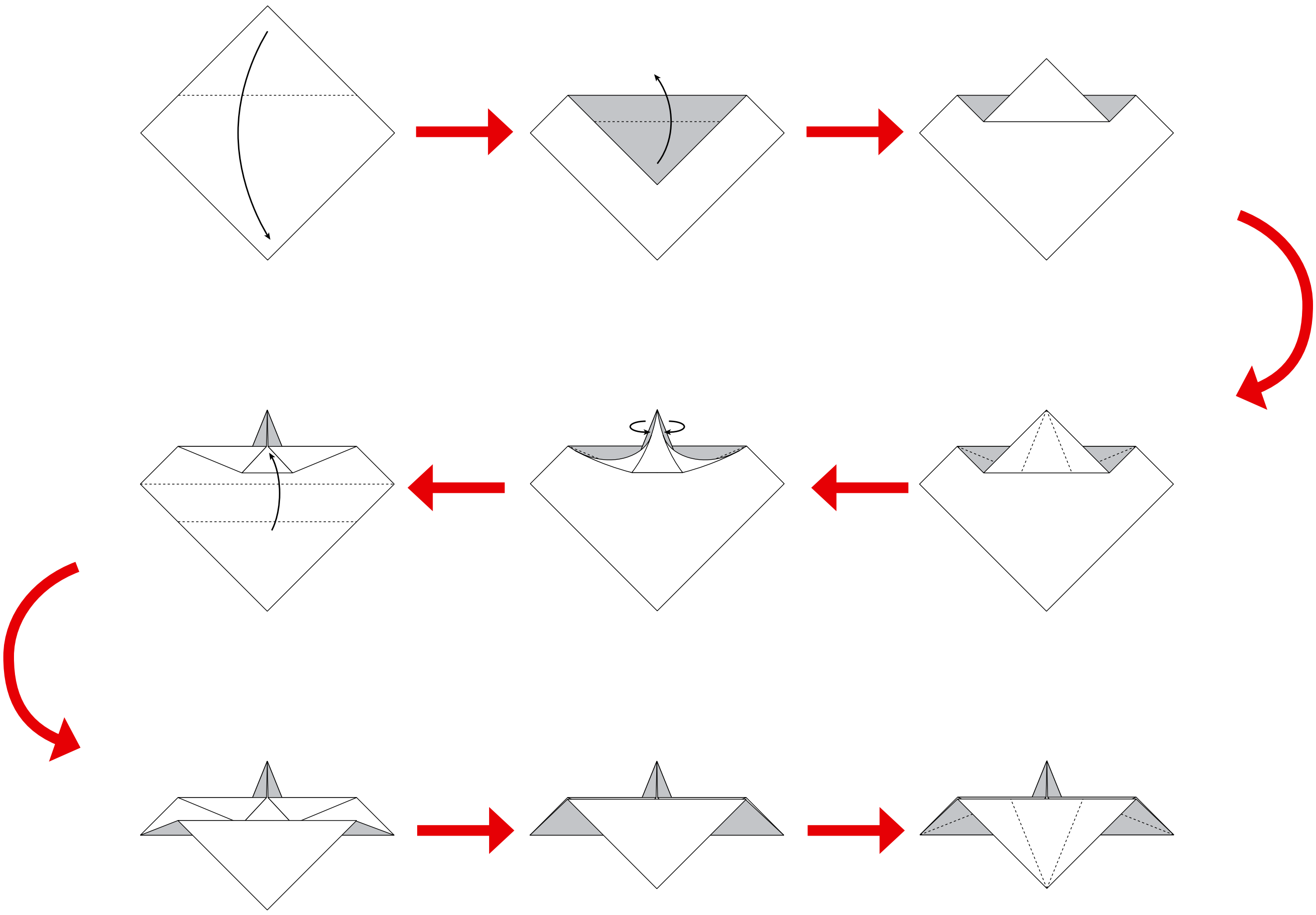
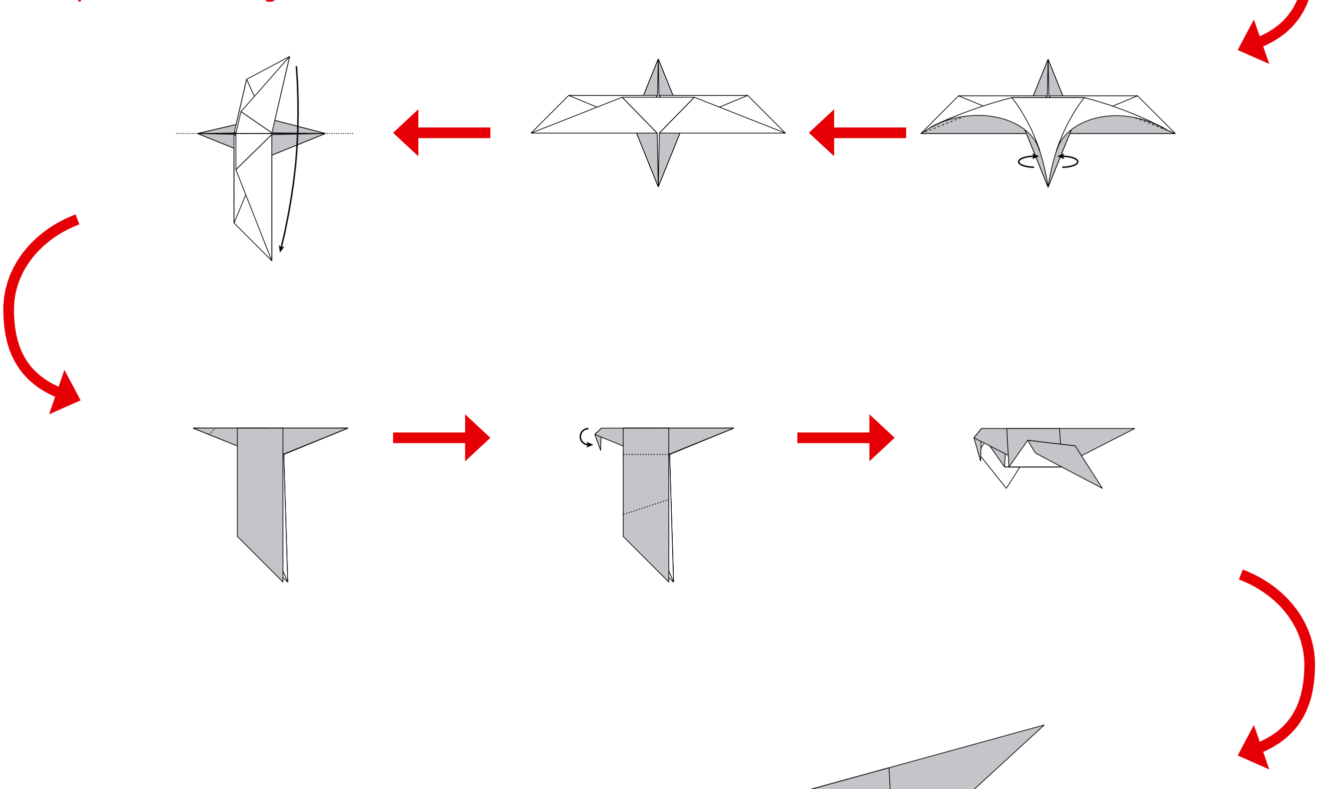
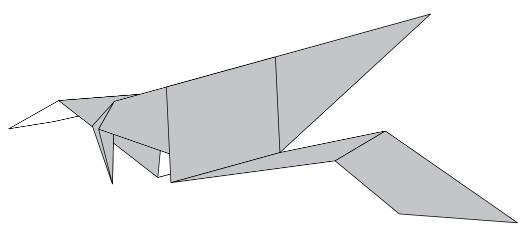




The printed plan on the semi-transparant sheet
will enable you – together with this Origami plan instructions –
to fold your own Oritsunagumono bird.





Volume Navigation – 3D Roadmap at Centre Hospitalier Régional de la Citadelle

Advances in digital imaging technologies and information technology have greatly expanded the application of interventional angiography systems from diagnosis to interventional catheterization procedures. Toshiba's innovative interventional angiography systems Infinix-i have been designed with the latest technologies reflecting the voice of the customer. They play an important role in medical imaging and intervention whilst providing the lowest dose for each procedure.

Visions spoke with Dr. Laurent Collignon, neuro-interventional radiologist at Centre Hospitalier Régional (CHR) de la Citadelle, about his experience with the hospital's new Toshiba interventional angiography system Infinix-i.

Liège, a major city of Belgium, is the capital of the province bearing the same name. It is situated in the valley of the river Meuse, near Belgium's eastern borders with the Netherlands and Germany, where the Meuse meets the river Ourthe. The city is the principal economic and cultural centre of Wallonia, the French-speaking region of Belgium. The metropolitan area of Liège, including the outer commuter zone, covers an area of 1,879 km^2 and has a total population of 750,000 and ranks as the third most populous in Belgium, after Brussels and Antwerp.

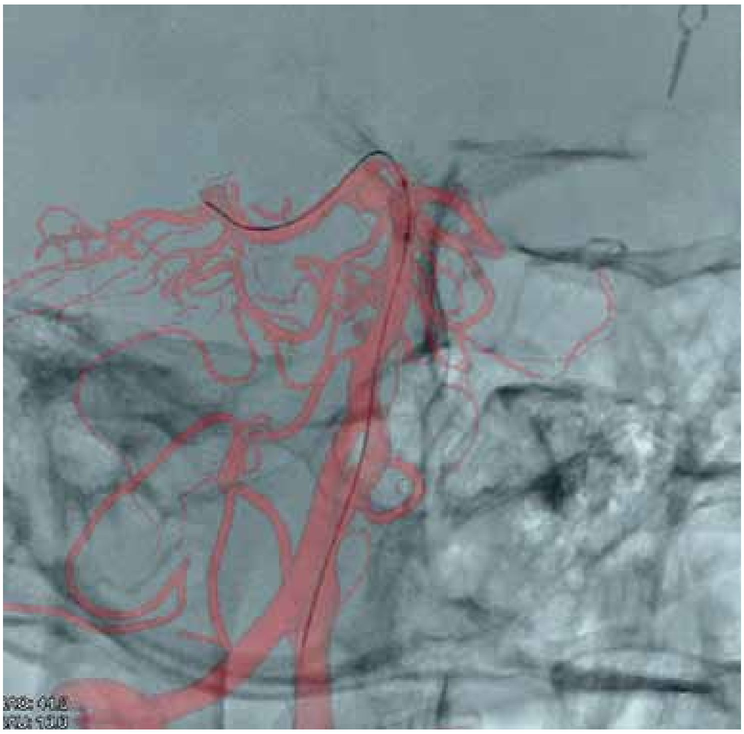
"The Infinix-i provides me with more choice, not another choice."

Dr. Laurent Collignon

CHR de la Citadelle, Liège, Belgium

The Infinix-i in the angiography suite of CHR de la Citadelle

3D Roadmap delivers a higher level of fluoroscopic and radiographic image quality



With 1,036 public hospital beds CHR de la Citadelle is one of the largest French-speaking hospitals in Belgium. All medical specialties are available within the facility. CHR de la Citadelle is also a major employer in the Liège region with some 3,450 employees and more than 400 physicians. The hospital has a regional focus due to its high specialization.

Radiologist Dr. Laurent Collignon, who heads the interventional angiography service, specializes in diagnostic and interventional neuro-radiology. He and his colleagues Dr. Denis Henroteaux, Dr. Paul Jamblin, Dr. Jean-Luc Lismonde and Dr. Pierre-Julien Bruyère use the Infinix-i 5-axis interventional C-arm system for vascular neuro-interventional procedures. Interventional angiography procedures are carried out five days a week. Three days a week the system is used for peripheral examinations, whilst the unit is used for two half days a week for neuro-interventional examinations.

During a long mutually beneficial relationship with the hospital, Toshiba Medical Systems in Belgium has installed several diagnostic imaging products in the radiology department. The hospital's current interventional floor-mounted 5-axis angiography system Infinix-i is the successor of the previously installed Infinix system. The angiography suite of CHR de la Citadelle is also equipped with a Toshiba Nemio XG ultrasound system. Dr. Laurent Collignon: "Toshiba's service department has a very

Laurent Collignon and team

display, including FOV switching, SID movement and table height adjustments as well as C-arm angulations. Easy manual realignment of the map image is possible for fine-tuning image position. This reduces the risks associated with repeat 3D acquisitions during the procedure, ensuring safer interventions and more confident decision-making in difficult situations.

Dr. Laurent Collignon: "The possibilities of the Infinix-i interventional angiography system are virtually endless, but 90% of time I only use 10% of the functionality. Only in exceptional cases the additional functionality of the interventional angiography system is called up. But it is good to know that the advanced functionality can be applied when necessary. The ease of using acquired images as mask for the 3D roadmap is highly appreciated. Acquisitions of the carotid bifurcation before the intra-cranial phase are used as mask for the volume navigation. This eliminates the need for additional contrast agent and radiation dose to the patient."

good reputation here in CHR de la Citadelle. Regular scheduled maintenance is performed by the local service team, which leads to a guaranteed system uptime exceeding 98%. The support of Toshiba is outstanding."

There is a strong clinical requirement to identify lesions as early as possible and to rapidly initiate treatment. A system is needed which offers excellent fluoroscopic and radiographic image quality, thus ensuring highest patient safety. Infinix-i meets these needs: it reduces stress on the interventional radiologist and provides a safe, comfortable environment for catheterization examinations and treatment.

Dr. Laurent Collignon: "The recent upgrade with Volume Navigation – the 3D Roadmap – delivers a higher level of fluoroscopic and radiographic image quality. Changing the field of view of the images does not lead to a detoriation of image quality. I can even observe small details at the largest field of view. The visibility of stents remains unchanged. The exact positioning of the Volume Navigation image is extremely useful for neuro-interventional procedures."

Toshiba has created an advanced easy-to-use 3D roadmap tracking system for the interventional angiography system Infinix-i that moves with the radiologist during the interventional procedure. With table-panning capability as standard the 3D overlay is automatically aligned with the fluoroscopic image even when the table is moved longitudinally or laterally. All system movements are linked with the fusion 3D and fluoroscopic

Toshiba's Volume Navigation takes 3D roadmapping and image fusion to the next level by providing a range of display options that can be applied at any stage of the procedure. This allows optimal solid vessel or transparent vessel display of the 3D anatomy and separate 2D live image display for manipulation of the wire.

"The simultaneous display of 2D and 3D images next to each other is the perfect tool to place stents and coils with great ease. After placement of three to four coils in an inter-cranial aneurysm, repositioning of the C-arm is required to obtain the optimum view for my desired image angulations. The fact that the 3D roadmap image is linked to the C-arm angulations speeds up the interventional procedure substantially. There is no need to create an additional roadmap mask image and the procedure can be carried out without additional radiation or time delay."

Dr. Laurent Collignon: "The system and its imaging features are very important to us and an improvement in our daily work. The team at CHR de la Citadelle is very happy with it. It's a pleasure to work with the Infinix-i as it is to work with Toshiba."

Takotsubo Cardiomyopathy with Severe Left Ventricular Outflow Obstruction

S. Gilarevsky, E. Antonic, I. Kuzmina, O. Baturina, S. Nikolskiy

S. Gilarevsky

E. Antonic

A 60-year-old woman presented to intensive care unit with acute, left-sided, substernal chest pain at rest and shortness of breath.

The patient had been in her usual state of health with mild hypertension until three hours before of admission, when following an episode of emotional stress she had felt chest pain at rest and shortness of breath.

On admission, the patient was conscious, her blood pressure was 90/60 mmHg, the heart rate was 95 bpm. A harsh systolic murmur was noted over the parasternal border. Tachypnea 24 per minute. Bilateral rales from the base to the mid-lung fields.

The ECG at hospitalization showed 2 mm segment ST elevation in leads V_{2-6}; on ECG during follow up T wave inversion in leads I, II, aVL,V_{2-6}.

Transthoracic echocardiography showed akinesia of the mid-to-distal portion of the left ventricular (LV) chamber (Fig. 1); LV dilation: end diastolic volume 187 ml, end systolic volume 120 ml. Ejection fraction 36% (Simpson). Interventricular wall thickness and posterior wall thickness were 25 mm and 14 mm, respectively. The maximal and mean pressure gradient through the left ventricular outflow obstruction (LVOT), measured using continuous wave Doppler, was 119.3 and 64.4 mmHg, respectively. Functionally mitral regurgitation grade 2 was also present.

Laboratory findings were within normal limits, except troponin T (one day after admission: 1.09 ng/mL; three days later: 1.3 ng/mL (reference 0-0.04) After written informed consent was obtained, emergency cardiac catheterization was performed through the right femoral artery. Coronary angiography showed no significant coronary artery disease (stenosis 30% of left anterior descending artery stenosis at site of ostium of 1-st diagonal branch, ostium stenosis 50% of 1-st diagonal branch).

Standard therapy with furosemide and dopamine (3-5 mcg/kg/min) infusion was not effective. SpO_2 decreased to 78-80%. Patient was intubated and managed with mechanical ventilation.

Hemodynamic was unstable, blood pressure decreased to 85/62 mmHg despite increasing the rate of dopamine infusion to 9 mcg/kg/min. Heart rate was 100 bpm. Following the β-blocker infusion (esmolol), we observed a reduction in LV intraventricular maximal pressure gradient from 96.8 to 71.4 mmHg and mean pressure gradient from 42.3 to 35.3 mmHg. During infusion β-blocker heart rate decreased to 83 bpm and systolic blood pressure increased to 90 mmHg.

Oral administration of carvedilol (6.25 mg B.I.D.) and perindopril (2.5 mg O.D.) was started. After 14 days of follow-up in hospital chest pain had not recurred and shortness of breath had decreased.

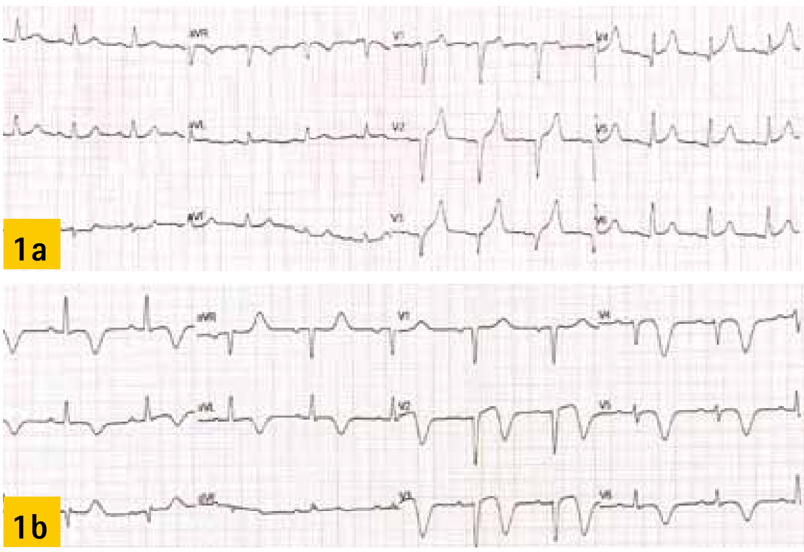


Fig. 1: ECG at baseline and follow-up
1a: ECG at hospitalization (acute phase), ST elevation 2 mm at leads V_{2-4}
1b: ECG 3 days after hospitalization, deep inverted in leads I, II, aVL and in leads V_{2-6}

S. Gilarevsky, E. Antonic, I. Kuzmina, O. Baturina, S. Nikolskiy Sklifosovsky Institute of Emergency Care

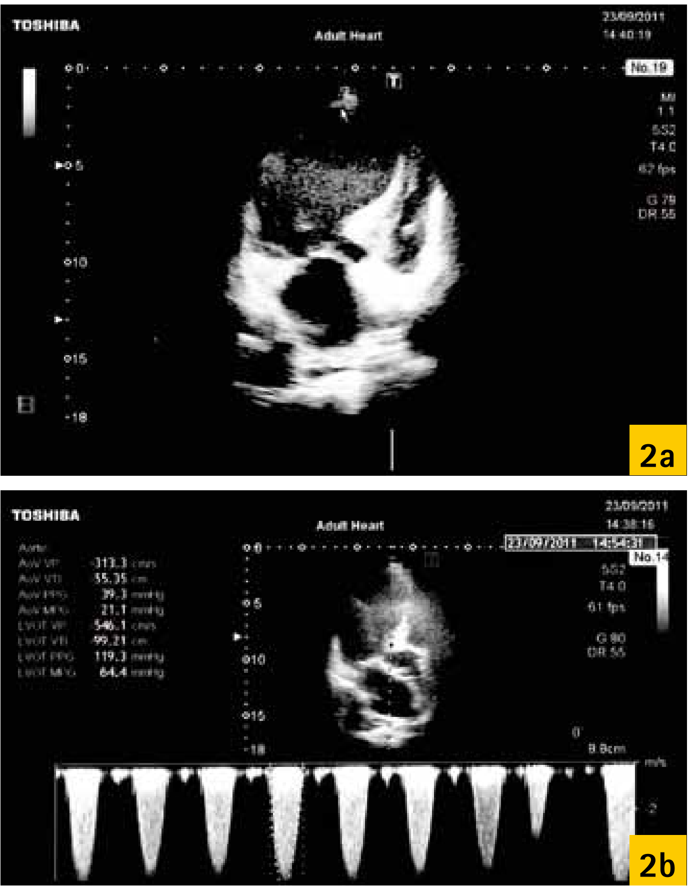


Fig. 2: Echocardiography at hospitalization
2a: 4-chamber view
2b: Doppler echocardio-graphy at the level of left ventricular outflow tract

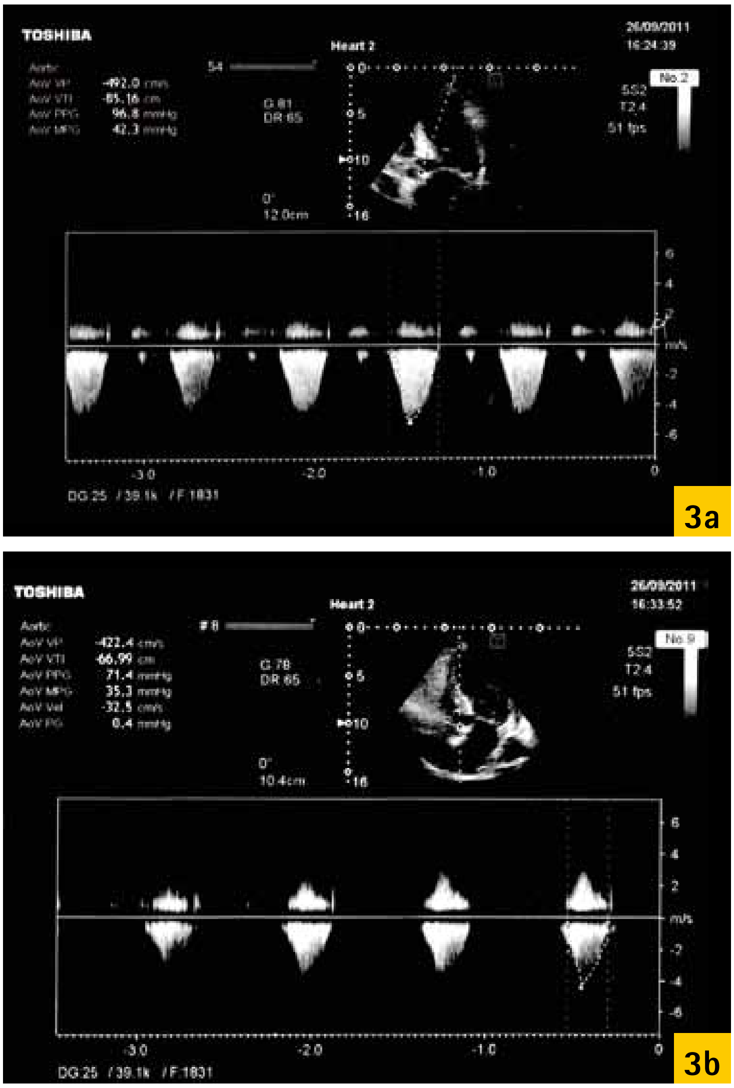
Transthoracic echocardiography before discharge showed hypokinesia of anterior and septal segments at the level of lower third of interventricular wall. End-diastolic volume decreased from 187 ml (at baseline) to 140 ml. The maximal and mean pressure gradient through the LVOT, measured using continuous wave Doppler, decreased to 13.0 and 6.2, respectively. Ejection fraction increased from 36 to 57%. Mitral regurgitation decreased to 1 grade. Interventricular wall thickness decreased to 19 mm.

Two weeks after discharge the patient was examined in clinic: she had no complaints, no limitations in physical activity. Blood pressure was 130/80 mmHg. Therapy, including carvedilol and perindopril, was continued.

Transthoracic echocardiography normal contractility of all segments of LV. End-diastolic volume decreased from 187 ml (at baseline) to 140 ml. No signs of LVOT obstruction (the maximal and mean pressure gradient through the LVOT 14.7 and 8.2 mmHg, respectively). LV ejection fraction 65%.

In our practice it was the first time a patient with Takotsubo cardiomyopathy presented with very high gradient through the LVOT, low blood pressure and pulmonary edema, which was resolved after prescription of β-blockers.

Fig. 3: Doppler echocardiography at the level of left ventricular outflow tract during infusion of β-blocker (esmolol)
3a: before infusion of β-blocker, 3b: after infusioncharge: 2-chamber view



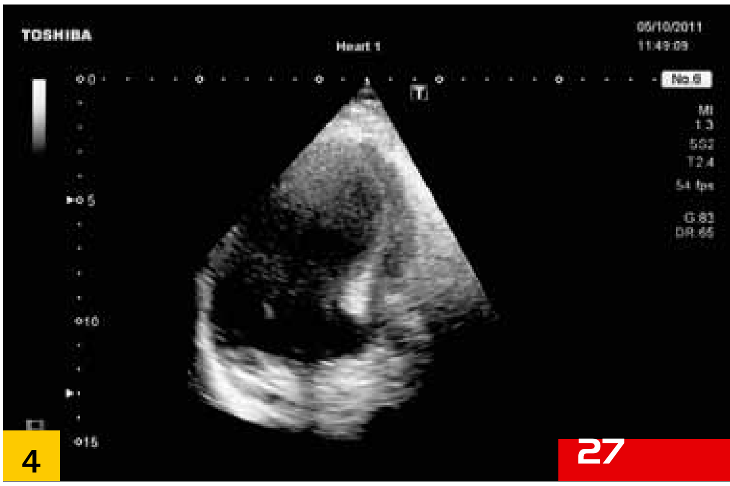


Fig. 4: Echocardiography 2 weeks after discharge: 2-chamber view

Lighting up the Louvre

Toshiba's new LED lighting is illuminating the Louvre, the world's most famous art museum. In a lighting ceremony on 6 December 2001 some 350 light fittings out of a total of 3,200 that will eventually completely replace 4,500 high energy xenon lamps were switched on. The Pyramid, the three pyramidions and the Colbert pavilion of the Louvre are now suffused with the soft glow of the lighting every evening and night.

The palace of the Louvre must be lit in a way that brings out its intrinsic beauty, drawing attention to the building but not intruding on its atmosphere. This is especially true of the physical light fittings. Working in collaboration with the Louvre, Toshiba's lighting engineers developed and installed six series and ten models of lighting fixtures, including high beam-lamps to illuminate the Pyramid and the palace walls.

The remaining facades of the Napoleon Court will be completed in April 2012, and the courtyard will follow in 2013. When fully installed, the environmentally-friendly LEDs will cut the annual power consumption for exterior lighting by 73%, from 392,000 to 105,000 watt-hour.

www.toshiba.co.jp/lighting/about/louvre.htm

Toshiba's new LED lighting is illuminating the Louvre

A "third eye" for vehicle drivers

Toshiba Corporation improves traffic safety with its Visconti2 (TMPV7500) image recognition processors for automotive applications that recognize lanes, vehicles, pedestrians and traffic signs using camera-based vision systems.

One component of the processors is able to detect pedestrians in the daytime in addition to conventional detection of pedestrians at night. Supporting colour cameras, the new processor recognizes not only the tone of the target object but also the colour, enabling recognition of traffic lights and signs. As it can connect up to four sets of cameras simultaneously, the processors can provide a bird's-eye view parking assistance system that uses images synthesized from image data captured by four cameras. Another innovative component in the Visconti2 series is a forward monitoring system which simultaneously detects multiple targets, including vehicles, lanes and traffic signs.

Ultra powerful, ultra portable: stylish 13.3" laptops by Toshiba

In a superb blend of style, ultra-portability and performance the Portégé Z830 and the Satellite Z830, Toshiba's first Intel® Core™ processor based Ultrabook™ devices, weigh a mere 1.12 kg and are 15.9 mm slim. Thus the Z830 series is about 20 percent lighter and 40 percent thinner than the award-winning ultraportable Portégé R830 series.

Supporting the latest 2nd generation Intel® Core™ processors and ultra-fast DDR3 memory, the Z830 series provides the performance needed for work and entertainment plus improved power management for great battery life. The 128 GB solid state drive delivers an extremely responsive experience, increased durability and increased energy efficiency.

The Ultrabook's light, yet durable magnesium alloy casing is reinforced with an enhanced "honeycomb rib" design and new internal structures that provide shock absorption, increased rigidity and resistance to flexing. This makes the laptops highly resistant to drops and shocks. Plus, the full-size LED backlit and spill-resistant keyboard withstands accidental fluid spills to give users enough time to shut down the laptop and protect data stored on the device.

The impressive Z830 series features a versatile set of interfaces including Bluetooth™, WLAN and Mobile Broadband plus a selection of full-size ports including VGA, HDMI® and several USB ports, one of which is a USB 3.0 port. The machines offers a superb multimedia experience for both professional and leisure needs. The bright 13.3" non-reflective high-definition display and powerful stereo speakers enhanced with Dolby® Advanced Audio™ make the Z830 ideal for multimedia consumption on the go and at home.

eu.computers.toshiba-europe.com

Toshiba on Georgia's mind

Georgia's first Toshiba Aquilion ONE was installed at the Scientific Research Institute of Clinical Medicine in Tbilisi, a university hospital and one of the country's biggest diagnostic and treatment centres. The Director of the Institute, Professor Fridon Todua, who is a Member of the Georgian Academy of Sciences, and George Tsivtsivadze MD, Head of the Department of Computed Tomography, and his team are looking forward to working with the state-of-the-art system. The scanner was supplied by Toshiba Medical Systems' Representative Office in Georgia and the on-site training was conducted by Niels Smit of Toshiba Medical Systems Europe's Business Group Computed Tomography.

Dr George Tsivtsivadze MD (left) and his team of the Department of Computed Tomography

Ultra thin, ultra light: Toshiba's innovative tablet technology

Toshiba's ultra-thin 10.1" AT200 tablet measures only 7.7 mm from front to back, but its 558 g are chock-full of functions, ports and interfaces. It offers an amazing wide-view display for comfortable content consumption plus full web browsing capabilities to meet the preferred usage for tablets. Every bit as powerful as it is stylish and robust, this tablet is built to exceed expectations.

To connect with other devices, all essentials are on-board amongst them micro-USB, micro-SD, Wi-Fi™ and Bluetooth®. The micro-HDMI®-port allows streaming HD content to the large screen of a TV. Front and back HD cameras are ideal for video conferencing and augmented reality applications. The Toshiba AT200 allows users to enjoy eight hours of video at home or while out and about. It features a brilliant 10.1" high-definition screen that displays pictures with crisp colours and in full detail. To complement the first-class video capabilities the new Toshiba tablet with stereo speakers allows for a high quality sound playback. The Adaptive Sound Device Enhancer's sophisticated algorithm maximises sound quality to achieve a quality that normally only can be found with large speakers. Plus, a technology called Sound Masking Equalizer identifies and enhances sound that is being masked or distorted by surrounding noise. The result is a well-balanced, powerful playback of music and video sounds even under high ambient noise levels.

Toshiba's new tablet also offers a rich web browsing experience including support of Adobe® Flash® Player, access to more than 250,000 apps on Android Market™ and Toshiba Places for endless possibilities.

eu.computers.toshiba-europe.com

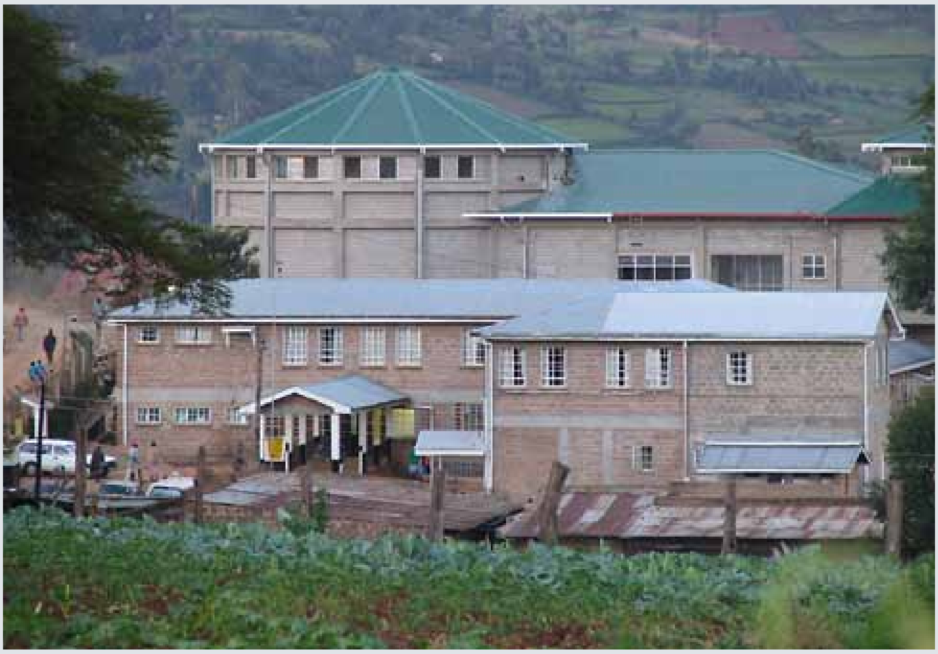
MediaGuide for Smart TV's

Toshiba's new 2012 range of internet-connected smart TVs will feature the innovative MediaGuide powered by Rovi as standard (internet connection required). In comparison to a traditional electronic programme guide the application offers multiple search options and a broad variety of extra content. MediaGuide includes deep, descriptive information on actors, TV shows and movies as well as enhanced imagery and links to more than 2.5 million TV programme descriptions, 120,000 celebrity profiles, and searchable data on TV shows since 1960.

eu.consumer.toshiba.eu/en/products/tv

Secondlife Equipment in Rift Valley, Kenya

In an effort to provide patients in remote areas easy access to medical imaging technology, Toshiba America Medical Systems, Inc. has donated and installed a refurbished Aquilion™ 4 CT system at Tenwek Hospital in Bomet, Kenya. The healthcare facility serves about 2.5 million people in the Rift Valley province in Western Kenya. Before the Aquilion 4 was installed, a patient who required a CT scan had to travel four hours to a hospital in Nakuru. The system will also support a neurosurgery training program for medical students who will stay in the communities where they were trained to provide skilled healthcare services.



The Tenwek Hospital in Bomet, Kenya

"This community-based program will provide Africans with access to medical professionals that Americans take for granted," said Bob Pagett, President of Assist International, an organization that works with corporate partners to address the medical needs of emerging countries.

"Our 'Made for Life' philosophy is a deep-running theme in everything we do at Toshiba," said Tim Mahanna, Director of Service Technical Operations at Toshiba. "Everyone from the Toshiba management team was immediately onboard when we were approached with the opportunity to help this hospital. We look forward to partnering with Assist International again in the future on other life-changing medical projects."

In addition to the CT system Toshiba has donated a spare X-ray tube for the facility to have on hand. This is vital, as it will ensure that the facility will be able to maintain and use the equipment for an extended period of time.

Toshiba launches FlashAir

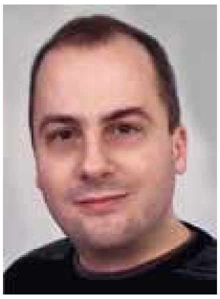
As digital cameras have achieved immense popularity, users want a quick and easy way to share photographs with friends and to transfer them to and from online storage services and social networks. Toshiba provides the solution with FlashAir™, the world's first SDHC memory card with embedded wireless LAN functionality that is fully compliant with the SD Memory Card Standard. The new card has an 8 GB capacity and its embedded wireless communication function allows users to upload and download photographs to and from a server and to exchange photographs and other data with other devices, including digital cameras that are FlashAir compliant and smartphones and PCs that support wireless LAN. All transfers are done wirelessly, without any need for a cable connection. Key features of the new card include the ability to receive as well as transmit and lower power consumption than other cards with similar functions.

Even in digital cameras not compliant with FlashAir, the new card can share digital images with smartphones and PCs that support wireless LAN.

Volume CT-Perfusion Imaging

Evaluating early response after transarterial chemoembolization (TACE) of hepatocellular carcinoma (HCC)

T. Wimmer, H. Schoellnast



T. Wimmer

H. Schoellnast

Hepatocellular carcinoma (HCC) is one of the most frequent malignant tumors worldwide and with 80-90% the most common primary malignancy of the liver. While surgical therapy provides the only possible curative approach, only 10 to15% of the patients are eligible. Transarterial chemoembolization (TACE) is widely recognized as an interventional therapeutic option in patients who are not able to undergo surgical resection. The therapeutic rationale of TACE is based on the findings that normal liver tissue receives 75-83% of its blood supply from the portal vein while HCC tumor tissue receives 90-100% of its blood supply from the hepatic artery since the tumor is highly vascular and forms neovasculature through angiogenesis. TACE enables specific targeting of tumor lesions with chemotherapeutic agents and reduces arterial tumor blood supply while sparing normal liver tissue. The goal is to induce tumor necrosis and to inhibit tumor growth while preserving functional liver tissue.

Multiphase contrast-enhanced computed tomography plays a crucial role in determining therapeutic response after TACE since it shows deposits of embolic material such as lipiodol, tumor necrosis and residual or recurrent vital tumor tissue. The assessment of therapeutic response with contrast-enhanced CT facilitates further therapeutic decisions, including retreatment with TACE. However, this technique is limited since it may fail to show vital tumor tissue due to visually not detectable contrast media enhancement or the presence of embolic deposits which compromise the detection of tissue contrast media enhancement. Therapy response may better be assessed by a method which is able to

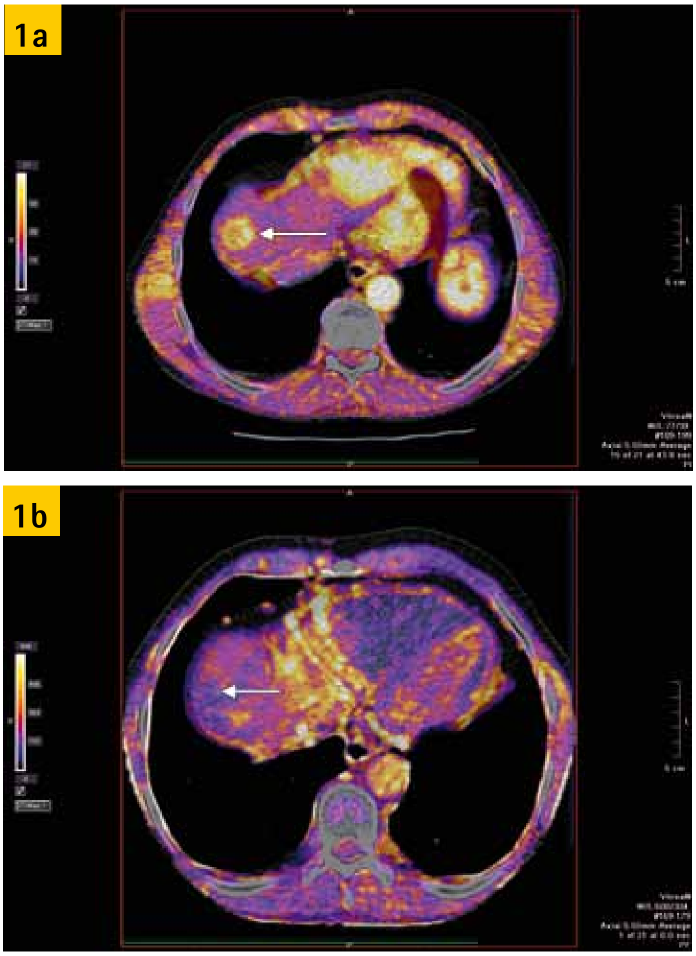


Fig.1 a, b: PI color mapping of a small HCC in the right liver lobe before (a) and after TACE (b). PI color mapping before TACE in a shows a high PI of the lesion (arrow) demonstrating that the overall perfusion of the lesion is mainly due to arterial perfusion. PI color mapping after TACE in b shows a significant decrease of the PI of the lesion without evidence of residual tumor (arrow).

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dynamically display tumor vascularization rather than tissue enhancement at a given delay after contrast media application.

CT perfusion imaging (CTPI) represents a functional method which is able to depict tumor vascularization taking into account the dual blood supply of the liver via the portal vein and hepatic artery thus allowing discrimination between tumor and normal liver tissue. Due to its functional approach CTPI might be a more sensitive tool to assess therapeutic response after TACE compared to multiphase contrast-enhanced CT. The continuous increase in the number of detector rows since the introduction of multi-detector row CT led to an increase of detector width which is up to 16 cm with the 320 detector row CT scanner Aquilion ONE by Toshiba Medical Systems. Coverage of up to 16 cm allows volume CT perfusion imaging (VCTPI) of nearly the entire liver and thus functional imaging of singular or multiple HCCs after TACE.

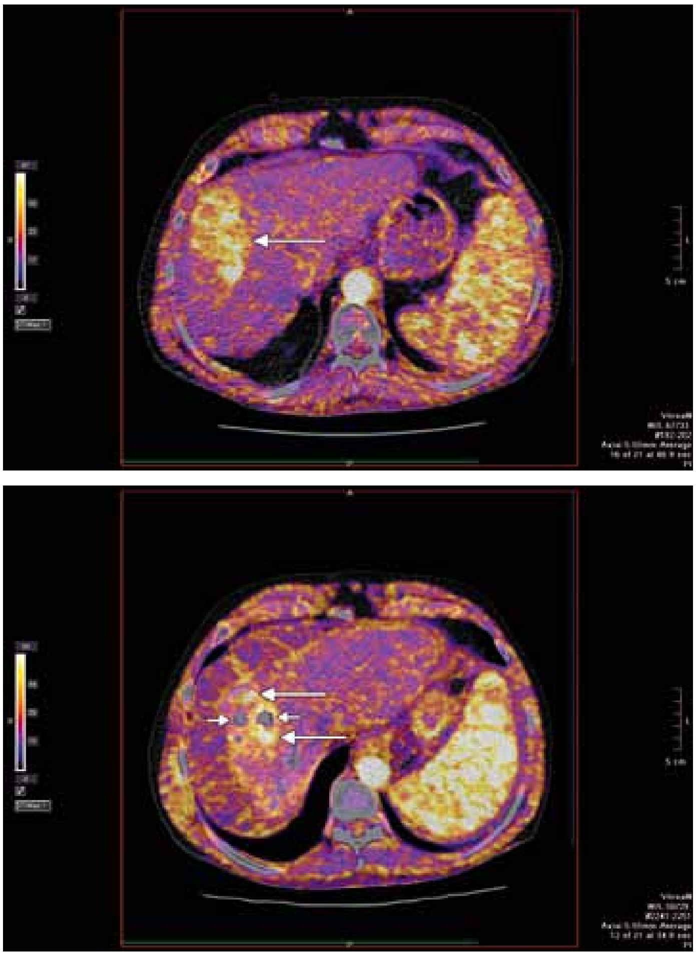


Fig. 2 a, b: PI color mapping of a large HCC in the right liver lobe before (a) and after TACE (b). PI color mapping before TACE in a shows a high PI of the lesion (arrow) demonstrating that the overall perfusion of the lesion is mainly due to arterial perfusion. PI color mapping after TACE in b shows a significant decrease of the PI of the lesion; however, areas of high PI are still clearly detectable consistent with residual tumor (arrows). Note lack of color mapping due to embolization material in b (arrowheads).

Technique

VCTPI was performed in patients who underwent TACE of a known HCC one day before and 5 to 7 days after the procedure. Dynamic volume CT acquisitions were performed after administration of 30-60 mL of iodinated contrast media (Iomeron 400 mg/mL, Bracco) at a flow rate pg 5-8 mL/s followed by saline chaser. Arterial blood flow (AF; mL/min/100mL), portal venous blood (PF; mL/min/100mL) as well as perfusion index (PI; AF/(AF+PF); %) were calculated using the dual input maximum slope method of the body perfusion software.

Acquisition data	
Tube voltage	100 kV
Tube current	100 mA
Gantry rotation time	0.5 s
Detector width	10 cm

The acquisition was performed without table movement or shuttle mode ensuring uniform temporal resolution.

Initial results

Figure 1 shows perfusion index (PI) color mapping of a small HCC in the right liver lobe before (a) and after TACE (b). PI color mapping before TACE shows a high PI demonstrating that the overall perfusion of the lesion is mainly due to arterial perfusion. PI color mapping after TACE shows a significant decrease of the PI of the lesion without evidence of residual tumor.

Figure 2 shows PI color mapping of a large HCC in the right liver lobe before (a) and after TACE (b). Although there is an obvious decrease in PI after TACE, areas of high PI are still clearly detectable consistent with residual tumor.

The overall DLP of 21 volumes (10 cm detector width) was 504 mGy*cm which is equivalent to an effective dose of 7.5 mSv.

Conclusion

VCTPI allows functional imaging of nearly the entire liver and thus evaluation of early success of TACE of HCC. Perfusion images with uniform temporal resolution were acquired with an effective dose of 7.5 mSv. Uniform temporal resolution can only be achieved by using non-shuttle acquisition, i.e. without table movement.

A. Blum

R. Irwan

S. Nakanishi

AIDR 3D Reduces Dose and Simultaneously Improves Image Quality

R. Irwan[1], S. Nakanishi[2], A. Blum[3]

Introduction

Remarkable attention is being paid to dose-saving technologies in CT both for commercially available systems and for those under development. At Toshiba, reducing patient dose has always been one of the major objectives. Some of the most significant developments over the past decade are outlined in Fig. 1.

Toshiba's dose-saving technologies include Active Collimator, SUREExposure 3D, Boost 3D, QDS and AIDR 3D and have been extensively utilized in many clinical applications such as cardiac CT Angiography (CTA), dual energy and perfusion.

Integrated AIDR 3D

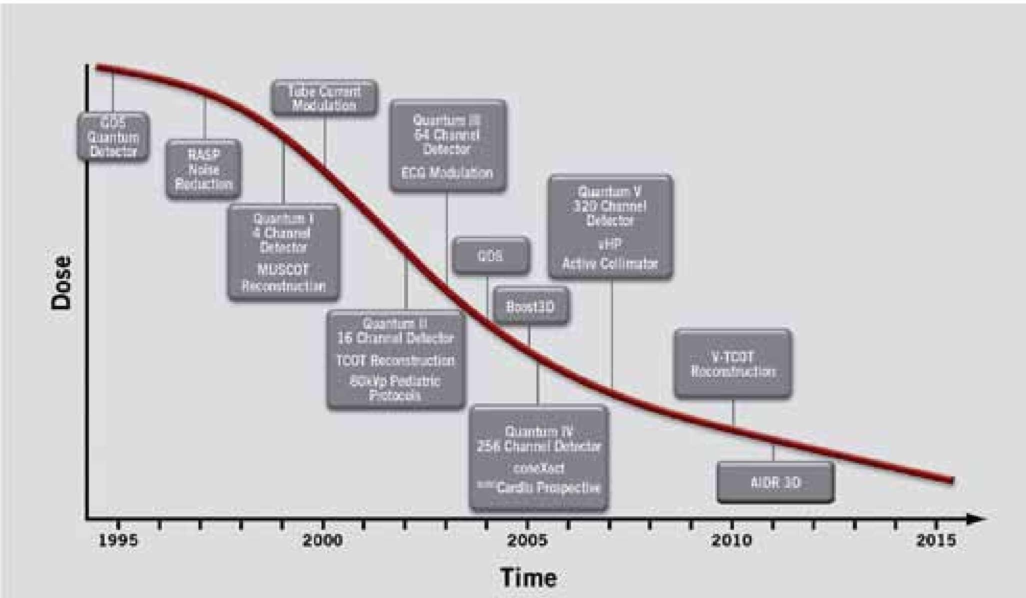
Since patients come in all shapes and sizes, automatic exposure control systems have proven to be very useful in maintaining diagnostic image quality at a radiation dose suitable for each patient. It is therefore imperative that exposure control systems automatically react to existing dose reduction technology.

SUREExposure 3D is fully integrated into the imaging chain and can therefore calculate the minimum radiation exposure required for each examination in every patient. With the inclusion of AIDR 3D in the scan protocol, the calculated exposure is automatically reduced by up to 75% compared to a scan performed with traditional filtered back projection (FBP) reconstruction. Below we will demonstrate that dose reduction in a clinical setting can be even more than 75%.

The AIDR 3D algorithm is designed to work in both the raw data and reconstruction domains (Fig. 2). In a low dose scan, the number of X-ray photons becomes relatively small and electronic noise in the Data Acquisition Systems (DAS) becomes dominant and degrades image quality. AIDR 3D processing uses a scanner model and a statistical noise model considering both photon and electronic noise to eliminate noise due to photon starvation in the projection data[1].

The statistical and scanner models are used together with projection noise estimation for electronic noise reduction processing which takes place

Fig. 1: Toshiba's on-going committment to dose reduction



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[2] Toshiba Medical Systems Corporation (TMSC), CT Systems Division, Nasushiobara, Japan
[3] University Hospital (CHU) Nancy, Radiology Department, Nancy, France

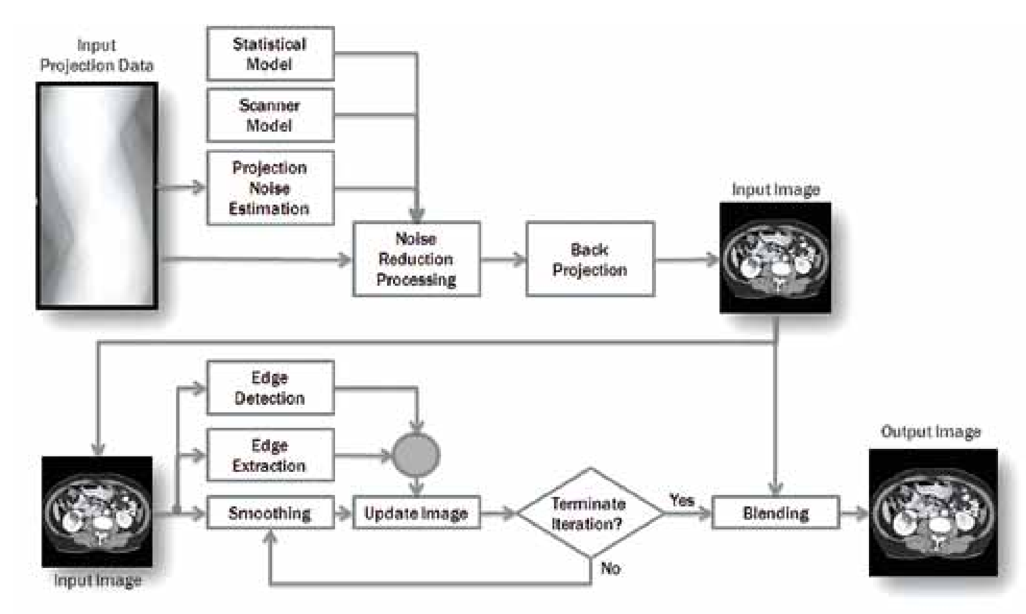


Fig. 2: AIDR 3D is an advanced iterative reconstruction algorithm that reduces noise both in the raw data domain and in the 3D reconstruction process.

in the raw data domain. The first model analyzes the physical properties of the CT system at the time of the acquisition while the second model characterizes both electronic and quantum noise patterns in the raw data domain. The projection noise estimation takes care of noise and artifact reduction.

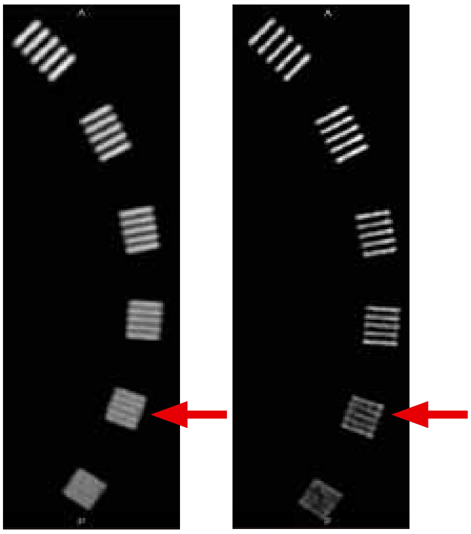
The initial image (FBP) is used as an input image in every iteration to be compared with the output image.

A sophisticated iterative technique is then performed to optimize reconstructions for the particular body region being scanned by detecting and preserving sharp details and smoothing the image at the same time. Finally, a weighted blending is applied to the original reconstruction and the output of this iterative process to maintain the noise granularity. The complete AIDR 3D reconstruction therefore increases the signal-to-noise ration (SNR) while improving the spatial resolution and it produces images which look natural[2].

In short, Toshiba's unique AIDR 3D reduces image noise while preserving and even improving spatial resolution and structural edges. This iterative algorithm permits scanning to be performed at lower doses. The dose reduction is approximately 75% and may even be higher depending on the anatomical regions and body weight and height (body mass index, BMI). Patients with a low BMI may benefit from reducing the tube voltage from 120 kV to 100 kV or even 80 kV.

Spatial resolution was investigated by high resolution acquisitions using the same Catphan phantom and on the same scanner (Aquilion PRIME) with the following scan parameters: collimation 80 × 0.5 mm, tube voltage 120 kVp, tube current 300 mA, rotation time 0.5 sec., helical pitch 65 corresponding to beam pitch 0.8125, FOV 240 mm.

We used a convolution filter FC 50 for the standard FBP reconstruction and AIDR 3D reconstructions for the following reasons: AIDR 3D images show reconstructions obtained using a "sharp" protocol which combines noise reduction with sharp FC filter.



FBP
FC 50
0.5 mm slice

AIDR 3D
FC 52
0.5 mm slice

Fig. 3: Line pair images demonstrating spatial resolution improvement achieved with AIDR 3D (right) compared to the reference FBP image (left). Red arrows show the line pair's visibility improvement from left to right.

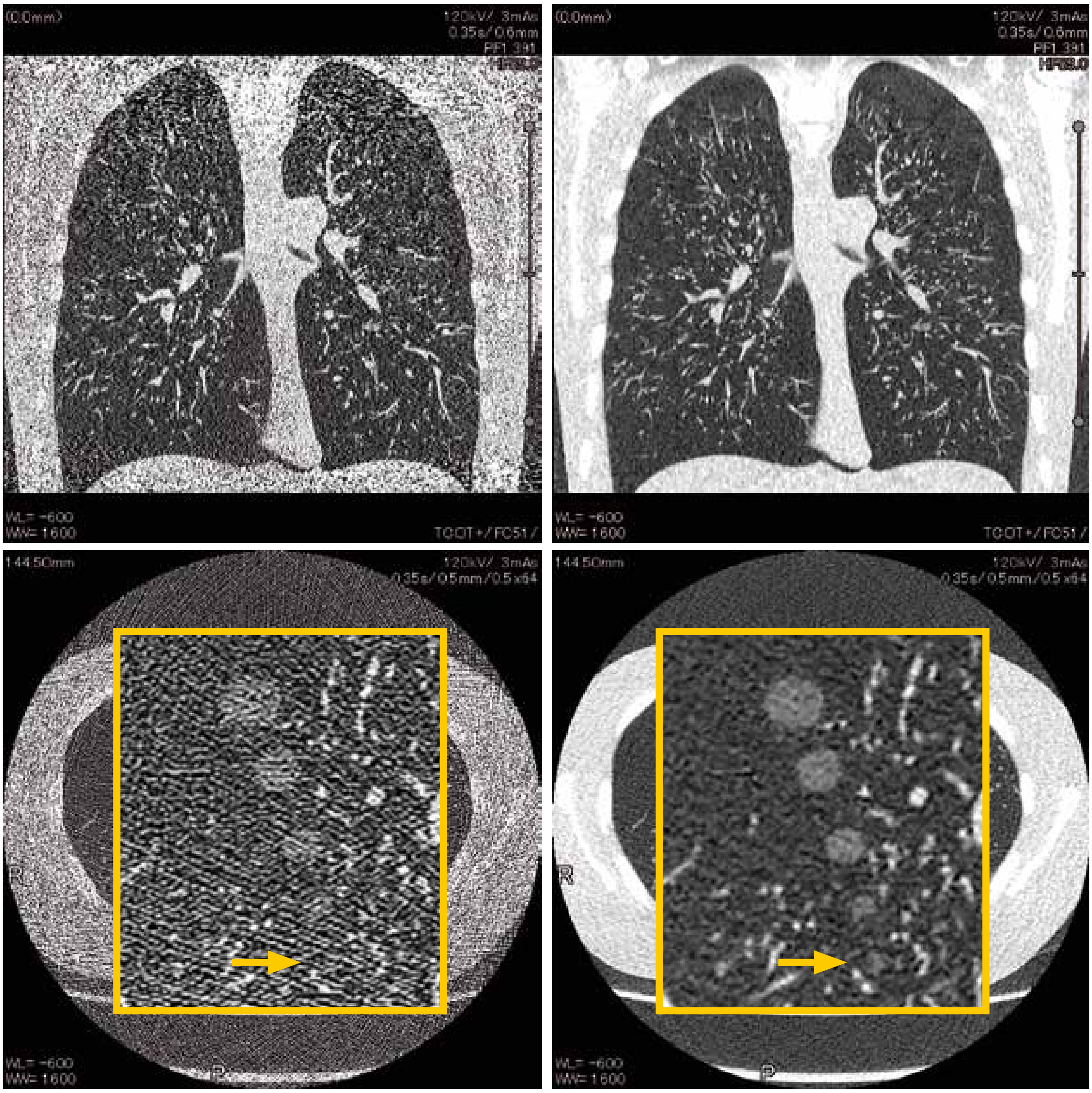
This way, a slight spatial resolution improvement has been achieved as shown by red arrows in Fig. 3. Such a combination of low noise and high resolution may prove valuable in the diagnosis.

It is therefore expected that the proposed "sharp" protocol will have significant impact on clinical practice by making iterative dose reduction more valuable.

Antrophomorphic phantom

In Fig. 4, the FBP (left) and AIDR 3D (right) reconstructions of an ultra low dose thorax scan of a Rando phantom are presented. The improvement in the image quality is clearly noticeable. Especially the small details in the pulmonary branches can be clearly seen. The dose length product (DLP) is 6.43 mGy*cm which is equivalent to 0.09 mSv.

The scan and reconstruction protocol of the images in Fig. 4 are summarized in Table 1.



Images courtesy of Keio University, Japan

Fig. 4: Images obtained with FBP reconstruction (left) and AIDR 3D reconstruction (right) of a thorax scan of a Rando phantom. The effective dose is 0.09 mSv (k-factor = 0.014).

Tube voltage [kV]	**120**
Tube current [mA]	**10**
Rotation time [s]	**0.35**
Reconstruction	**FBP/AIDR 3D**
FOV [mm]	**320**
Matrix	**512x512**
Pitch	**1.391**
Reconstruction filter	**FC 51**

Table 1: Scan and reconstruction parameters for the images displayed in Fig. 4

Clinical applications

Cardiac

A 75-year-old female with BMI of 20 was scanned using the prospectively gated volume mode with Aquilion ONE. SUREExposure 3D and AIDR 3D were used resulting in a DLP of 29 mGy*cm which is equivalent to an effective dose of 0.4 mSv (k-factor = 0.014).

Furthermore, in only one 0.35 second scan, coronary CTA using 80 kVp tube voltage produced the images presented in Fig. 5.

Pediatric

Dose in pediatric imaging is a big concern because the tissues of children are particularly sensitive to radiation. The younger the patient, the higher is

Images courtesy of Monash Medical Center, Melbourne, Australia

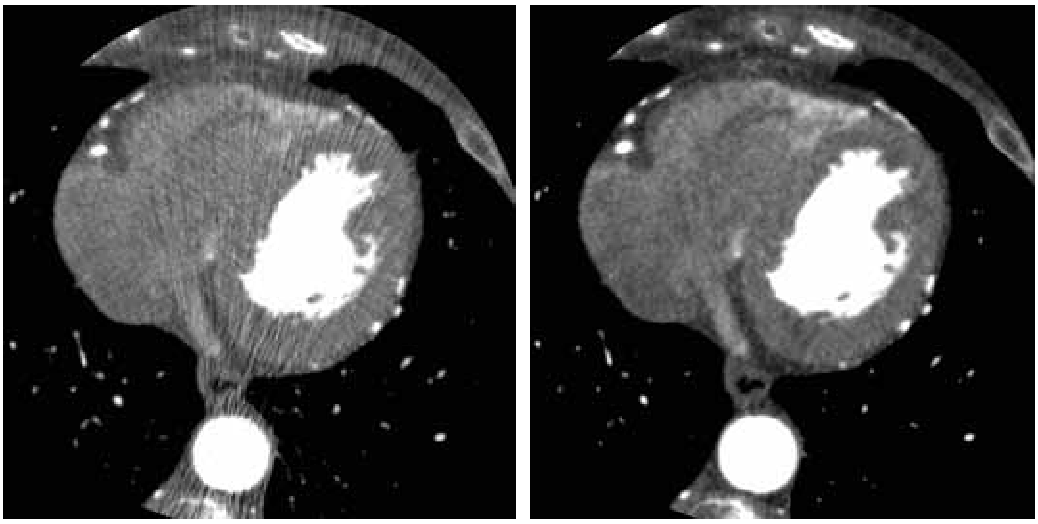


*Fig. 5: Cardiac CTA: FBP reconstruction (left) and AIDR 3D reconstruction (right) with a DLP of 29 mGy*cm and an effective dose of 0.4 mSv.*

the potential risk of radiation. With Aquilion ONE, dose saving of 18-40% has already been reported by Kroft et al.[3]. Furthermore, with 16 cm z-coverage in a single non-helical rotation use of sedation can be dramatically minimized and even eliminated.

In this example we show that AIDR 3D can reduce the dose even further for a one-day-old baby with a congenital heart defect. The scan protocol was: 80 kVp, 100 mA, 0.35 seconds and 80 mm scan range, resulting in a DLP of 6.8 mGy*cm (equivalent to 0.27 mSv). Figure 6 shows the clinical images demonstrating narrowing of pulmonary trunk while there is no compression of the airways.

Dual Energy

Dual Energy is one of the clinical applications for which AIDR 3D is well suited. For example, standard abdominal pelvic CT scanning protocols can be converted to Dual Energy protocols by maintaining the same DLP. Tube currents for each energy are chosen so that the image noise of both images is matched.

Figure 7 shows coronal and axial images of a patient with renal colic with a total effective dose of just 2.2 mSv. The top row presents images without AIDR 3D while the bottom row with AIDR 3D.

Images reconstructed using AIDR 3D (Fig. 7A bottom row) demonstrate clear noise reduction compared to FBP images (Fig. 7A top row). Due to the improved image quality with AIDR 3D, the radiologist decided to increase the SD level in the SUREExposure 3D to further reduce dosage.

The percentage of noise reduction using AIDR 3D is generally about 50%. In CT, image noise is inversely proportional to the square root of dose, hence a factor of two reduction in noise accomplished by AIDR 3D corresponds to a dose reduction of a factor of 4 (i.e. 75%) to achieve the same image noise (SD) as the conventional FBP image. Because the SD has now been increased from 9 to 10 in this example, the corresponding dose reduction was more than 75%.

Body perfusion

Renal cell carcinoma (RCC) is the most common renal neoplasm accounting for cancer. While ultrasound and MR have been used to detect this disease, body perfusion with CT is becoming a more and more important tool as it produces fast and accurate diagnostic results and allows better evaluation of malignant or benign renal masses.

In Fig. 8 we demonstrate a clinical application of AIDR 3D for low dose kidney perfusion performed at Keio University, Japan. With a z-coverage of 16 cm, Toshiba's body perfusion technology guarantees the temporal uniformity across the images. A powerful image registration algorithm was applied to make

Images courtesy of Monash Medical Center, Melbourne, Australia

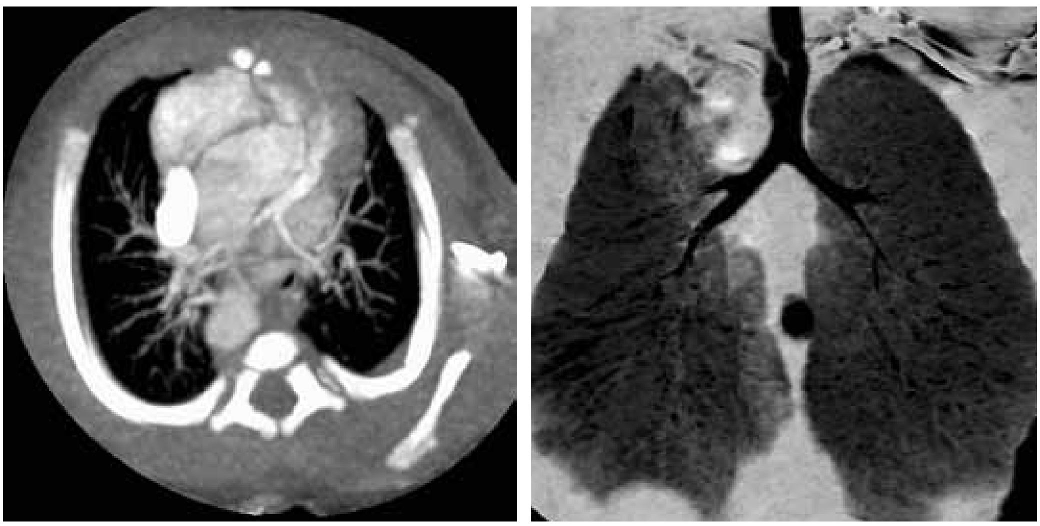
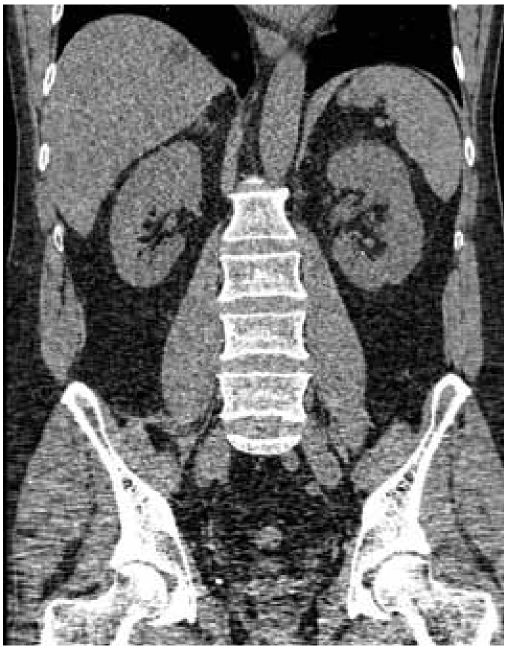
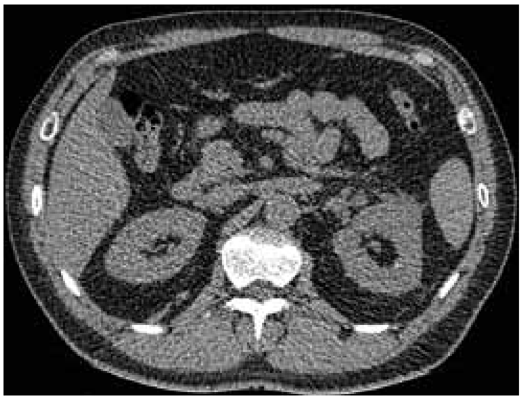
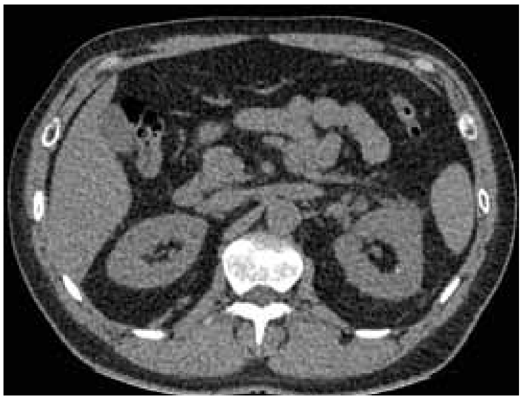


*Fig. 6: One-day-old baby with tetralogy of Fallot. In 0.35 seconds the infant was scanned with Aquilion ONE and reconstructed with AIDR 3D producing a DLP of 6.8 mGy*cm (equivalent of 0.27 mSv).*

Fig. 7A: Dual Energy composition coronal and axial images of patient with renal colic: without AIDR 3D (top row), with AIDR 3D (bottom row). The total effective dose is 2.2 mSv.







Images courtesy of Nancy University Hospital (CHU), France

sure that the mismatch due to the motion during respiration is eliminated.

Using a low dose protocol of 100 kV, 25 mAs for each volume and a full z-coverage of 16 cm, renal masses can be detected with a total effective dose of below 10 mSv.

Trauma

Fast reconstruction is very important particularly in the emergency department. We measured the reconstruction speed with and without AIDR 3D which is below 10% depending on anatomical regions being scanned. Figure 9 illustrates an example of whole body (thorax, abdomen, pelvis) of a trauma patient. A fast helical mode of 80 × 0.5 mm was used with a helical pitch of 111 and a rotation time of 0.35 seconds.

Conclusion

An overview of Toshiba's dose saving technology and of AIDR 3D are described in this paper. AIDR 3D is Toshiba's newest iterative technology which has been designed to be fully integrated into Automatic Exposure Control (SUREExposure 3D). The reported results demonstrate that a dose reduction of 75% or more can be achieved while improving spatial resolution. Results confirm that the images look natural and clinical details are preserved despite an effective dose of 0.09 mSv for a thorax scan. In terms of reconstruction speed, there is no significant difference between FBP and AIDR 3D processing. This is particularly important for trauma and emergency departments.

In conclusion, it has been demonstrated that the ability to substantially reduce noise in CT images using AIDR 3D produces "natural looking" image quality with almost no penalty in reconstruction speed.

Acknowledgements
We thank Jeff Hall, Chloe Steveson, Henk de Vries, Joanne Schuijf, Niels Smit, René Ceuleers and the TMSC engineering team for their contribution.

Images courtesy of Nancy University Hospital (CHU), France

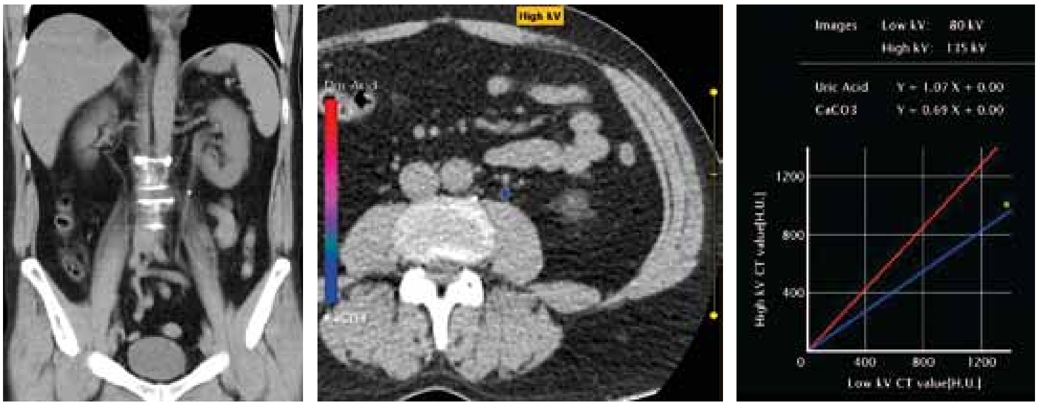


Fig. 7B: Example of calcium classification using Toshiba's Dual Energy protocol (referring to Fig. 7A).

Images courtesy of Keio University, Japan

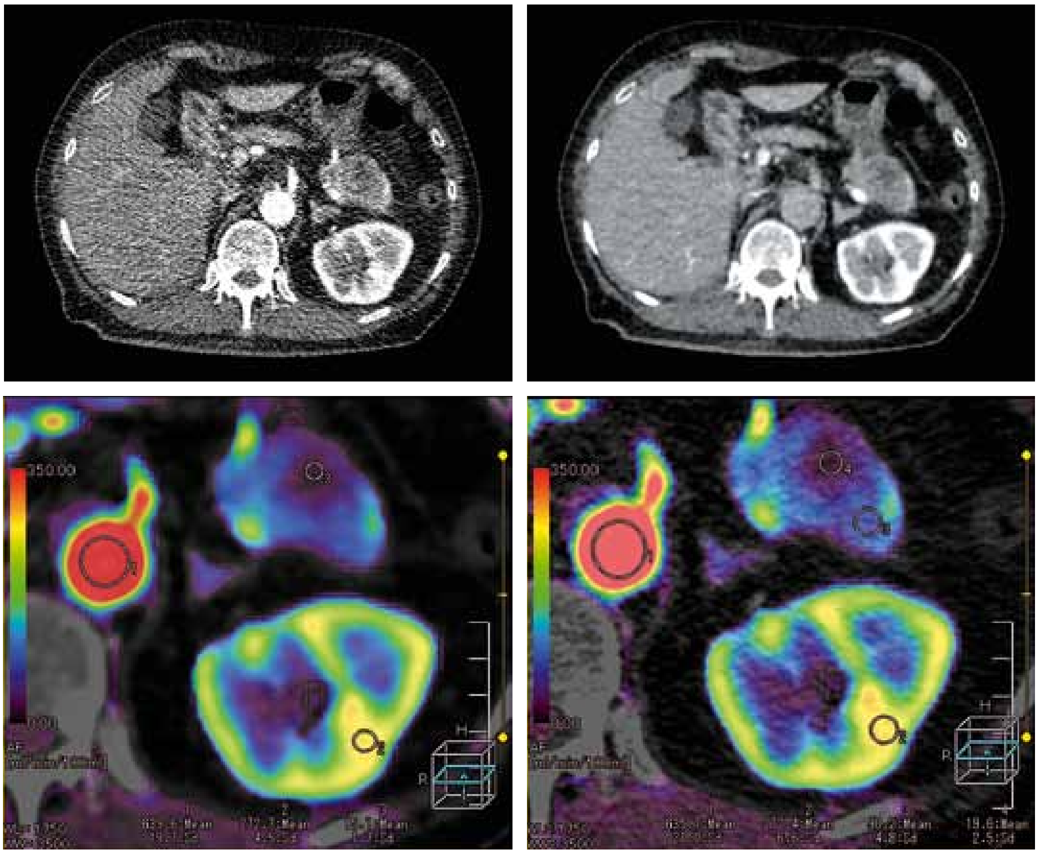


Fig. 8: AIDR 3D (right) was applied to a low dose kidney perfusion protocol: 100 kV, 25 mAs, 16 cm z-coverage, producing an effective dose of 9 mSv (k-factor = 0.015).

Fig. 9: FBP reconstruction (left) and AIDR 3D reconstruction of a trauma patient. The total scan range was 649 mm. Images courtesy of Fujita Health University, Japan. The reconstruction speed difference between FBP and AIDR 3D was below 10%.

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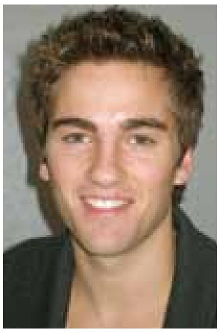
3 Kroft L.J.M. et al., "Scan time and patient dose for thoracic imaging in neonates and small children using axial volumetric 320-detector row CT compared to helical 64-, 32-, and 16- detector row CT acquisitions", Pediatric Radiology 40 (2010).



R. Verlaan

M. Wolswijk

4D DSA of the Lower Limb

R. Verlaan, M. Wolswijk

Introduction

With the introduction of the 320-row detector Aquilion ONE imaging a volume of up to 16 centimeters within one non-helical rotation of 0.35 seconds became possible. This volumetric scan range allows assessment of most of the vital organs such as brain, liver and heart with temporal uniformity. Moreover, images can be acquired that deliver vital information on the blood vessels of the brain. The entire brain and the cerebral blood flow can be evaluated with a so-called time resolved 4D Dynamic Subtraction Angiography (DSA) scan.

The aim of our study was to develop a 4D DSA scanning protocol for the blood vessels in the lower limbs to help improve preoperative planning for patients with a sarcoma in the lower limb. The volumetric scan might facilitate the decision whether a part of the lower limb has to be amputated or whether limb-sparing, wide excision of the tumor without or with minor resection of blood vessels can be performed. The study was conducted at Leiden University Medical Centre (LUMC), the Netherlands.

4D DSA scanning of cerebro-vascular blood flow

4D DSA allows visualization of the entire cerebrovascular phase, including arterial and venous blood flow. The 4D DSA scan consists of multiple sets of scans (Fig. 1). In a first step a single contrast bolus (10 ml Ultravist 370 mg I/ml) is administered to determine the scan delay which in turn is required to determine the optimal scan with minimal dose. Scan and Views (S&Vs) obtained after the test injection provide information on the scan delay, that is the time at which the contrast fluid arrives at the proximal part of the volumetric scanning range of 16 centimeter, the "time of arrival".

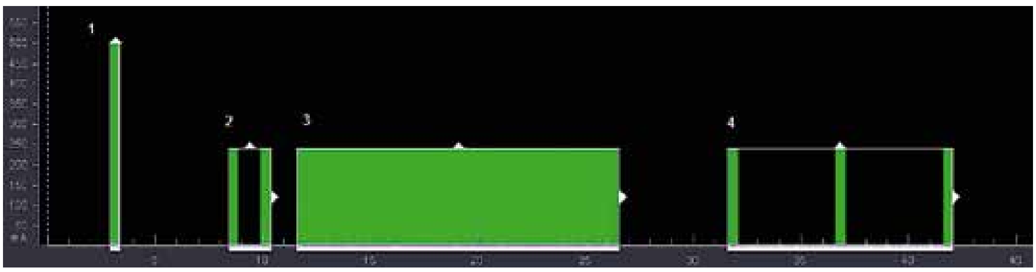
After having determined the delay, the actual dynamic volumetric scan consisting of 4 steps is performed:(1) a non-contrast mask which is essential for SURESubtraction (1), a set of 2 intermittent volumetric scans (2), a continuous scan of 15 seconds based on the delay determined by the test bolus, an intermittent scan (4) with a 5 second interscan delay to image the venous vessels of the brain.

Timing in the 4D DSA protocol of the lower limb

Timing is crucial in a 4D DSA scan of the brain. A single contrast injection is needed to image a whole cerebro-vascular phase. Professor emeritus A. Taminiau of LUMC underlined the importance of imaging the arterial and venous blood vessels in patients with tumors in the lower limb. By imaging both, the orthopedic surgeon can obtain vital information on the exact location of the vessels in relation to the tumor. In veins located close to the tumor, there is a risk of micro-metastasis in the vessel wall caused by tumor cells penetrating the wall. In such a case wide excision of the tumor without resection of the vessels is not possible. The aim of this study was to image an optimal arterial and venous phase resulting in a DSA scan of the lower limb. A method was developed to determine an optimal arterial phase in which all arteries in the lower limb are imaged. That method was based on the "time of arrival" combined with the newly introduced "time of departure".

The "time of departure" enables the physician to obtain a dynamic image of the lower limb when fully filled with contrast fluid which in turn allows examination of all the arteries in the lower limb. By

Fig. 1: 4D DSA scanning protocol



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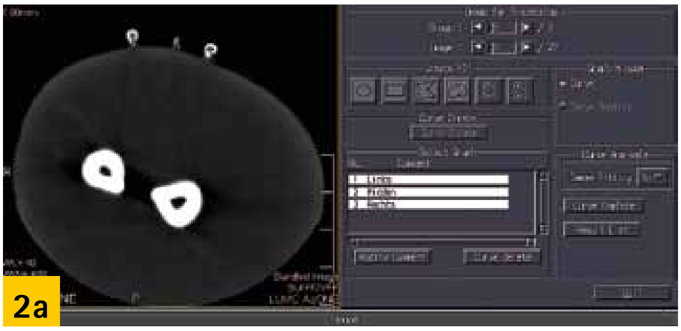

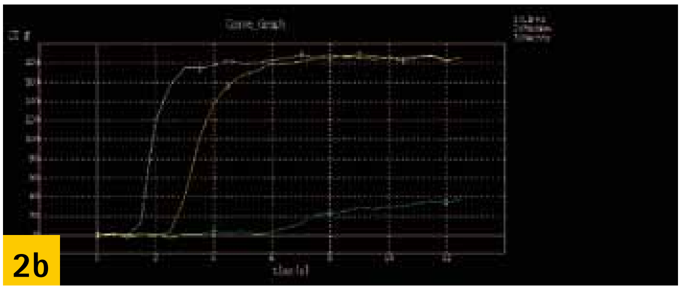

Fig. 2a (top) :The manikin with the tubes attached

Fig 2b (below): Time Intensity Curves show a difference in peak enhancement and timing.

acquiring a second set of S&Vs at the distal part of the 16 centimeter volumetric scan and injecting a second contrast bolus (10 ml), a time phase for the arterial blood flow is obtained. After performing both the first and second test bolus, the time phase can be determined.

In a manikin study it was investigated whether the "time of departure" contributes to the developed protocol. In the course of the study multiple scans with different injection rates were performed. Three flexible tubes (Fig. 2) were modified to simulate blood vessels: One was modified with a clamp, simulating partial stenosis of a blood vessel, one was not modified and the third one had a significantly smaller diameter than the first two tubes (1.0 mm instead of 2.5 mm). The objective was to create and simulate three different blood vessels with different flows. The tubes were glued to the manikin. By applying different injection rates we could see whether the blood vessels show different mean peak enhancements in Hounsfield Units (HU) at different times after the injection.

The following injection rates were used: 1.5 ml/s, 2.5 ml/s, 3.5 ml/s and 4.5 ml/s. For every injection rate, three scans (80 kVp, 100 mA, slice thickness 2.0 mm) were performed at the distal part of the volumetric scan simulating the location of the "time of departure". In post-processing time intensity curves (TIC) displaying HU (y-axis) vs. time (x-axis) showed a clear difference in both HU and time. Based on an analysis of all graphs for all flow rates we concluded that adding the "time of departure" to the protocol could help optimize timing.

4D DSA scanning protocol of the lower limb

The developed protocol consists of multiple sets of scans: a set of S&Vs to ensure the right "time of arrival" of the bolus of contrast fluid at the proximal part of the 16 centimeter coverage, a set of S&Vs (80 kVp, 100 mA, slice thickness 2.0 mm, fixed delay of 10 s, interscan delay 2.0 s) to ensure the right "time of departure" at the distal part of the 16 centimeter, one non-contrast volumetric scan for acquisition of a bone subtraction mask and 15+2 intermittent volumetric scans. These steps obtain images of the arterial vessels in the lower limb. Following the 15+2 volumetric scans, 7 volumetric scans are performed to obtain images of the venous vessels around the tumor.

Arterial phase

The entire arterial blood circulation in the lower limb can be visualized with multiple sets of volumetric scans. At first the aim was to conduct 15

Fig.3: Overview of the arterial scan. The first scan is the non-contrast mask for SURESubtraction followed by 15+2 volumetric scans which are scanned intermittently.

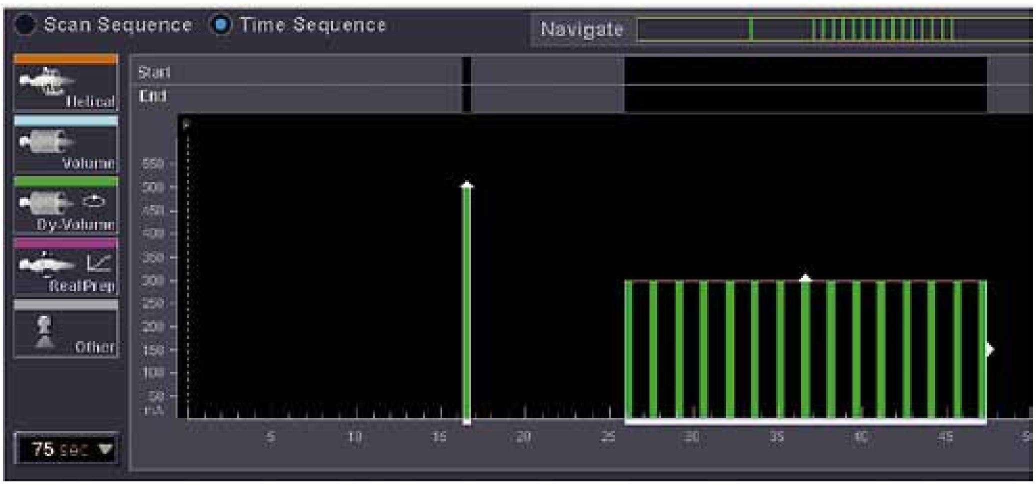

Fig. 4: 4D DSA scan of the lower limb, seen from medial, in a patient with a giant cell granuloma and showing arterial vessels around the granuloma that could not be located accurately with MRI.

volumetric scans (80 kVp, 300 mA, 0.5 ms) to image the optimal arterial phase. After the manikin study however the number of volumetric scans to determine the optimal arterial phase was adjusted to 15+2. As discussed above, the manikin study showed a notable difference in mean peak enhancement of the contrast fluid versus time with regard to several vessels. Adjusting the amount of volumetric scans minimized the risk of not imaging every artery.

In the developed protocol it was not necessary to image the vascularization of the tumor, but the importance of venous vessels was pointed out. To obtain better contrast enhancement, the amount of contrast fluid was adjusted to 80 ml in the volumetric scans[1].

The primary aims was to obtain information on the position and location of the vessels in relationship to the tumor, therefore an interscan delay was used (Fig. 3) in contrast to a 4D DSA scan of the brain which is scanned continuously. The Aquilion ONE needed 0.5 seconds to image one dynamic volume. With a fixed interscan delay of 1 second total scan time was 1.5 seconds. Since a continuous scan was not required, an intermittent scan was selected which allowed dose reduction. Obtaining 15+2 volumetric intermittent scans required a total scan time of 17*1.5 = 25.5 seconds for the arterial phase.

If the interval between the "time of arrival" and the "time of departure" is greater than the minimal scan time of 25.5 seconds, preferrably the time between the two parameters is divided by 15+2 to choose a new interscan delay. While leaving the dose unchanged this would provide a patient-adapted scanning method.

The first of the non-contrast intermittent scans is acquired with a higher tube current to reduce the noise level which delivers an excellent mask for SURESubtraction. With the new AIDR 3D dose reduction software this scan could be performed at less mA while maintaining excellent image quality. Dose reduction of up to 75 percent can be obtained with AIDR 3D. This study however was performed without AIDR 3D since at that time it had not yet been introduced at LUMC.

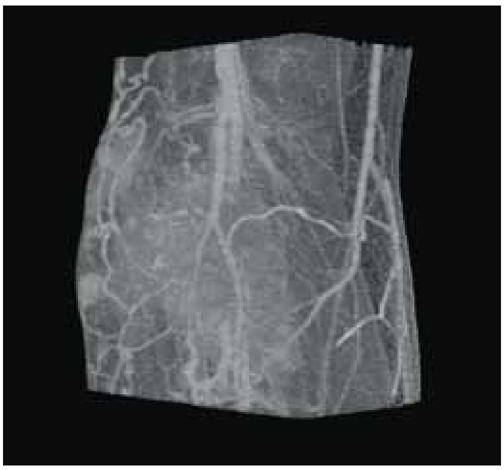

Fig. 5: Venous vessels were imaged as well as arterial vessels.

Results

The volumetric scans provided an optimal arterial phase in which the arterial blood vessels were imaged. This patient was diagnosed with a giant cell granuloma in the right proximal fibula.

Fig. 4 shows that 4D DSA can provide accurate information on the precise location of arterial vessels in relation to the granuloma. The popliteal artery in the proximal part of the volumetric scan, the bifurcation into the posterior tibial artery and the anterior tibial artery and numerous collateral veins surrounding the granuloma are imaged.

According to Hohenberger et al.[2] the "decision whether or not to resect vessels in close proximity to soft tissue sarcoma depends on how exactly a true invasion by tumor can be assessed pre- or intraoperatively (...) until such reliable data are available, vessel resection is recommended if there remains doubt whether a safe margin of clearance can be obtained by dissecting perivascular or perineural tissue". Contrast-enhanced imaging of the lower limb

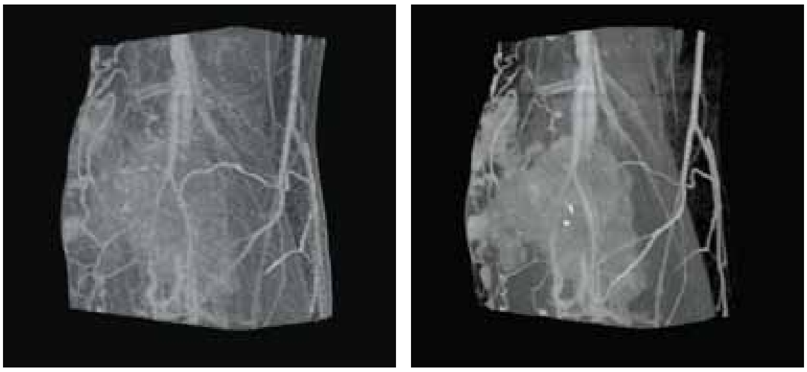

Fig. 6: Venous phase without BrainTimestack (left) and with BrainTimestack (right)

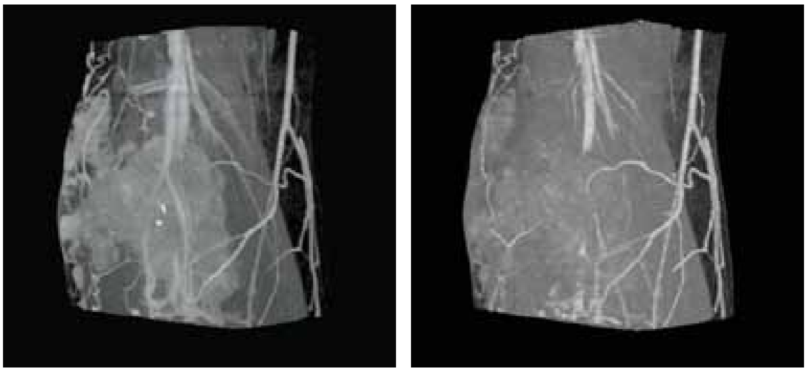

Fig. 7: Venous phase with arterial blood vessels (left) and after subtraction (right)

using 4D DSA allows examination of the vessels and tumor mass and margins during pre-operative planning. CTA is considered a more accurate imaging technique than MRI for the evaluation of vascular invasion of musculoskeletal tumors[3]. The 16 centimeter non-helical coverage of the Aquilion ONE offers an entirely new imaging approach that allows the evaluation of the arterial vessels in the lower limb due to the patient-adapted scanning.

Venous phase

After having imaged the arterial vessels with 15+2 volumetric scans the venous vessels were imaged using the same single injection of contrast fluid. Time-density curves (TDC) were evaluated to obtain optimized timing for CT venography of the lower limbs. Mean peak enhancement values were examined regarding the popliteal vein.

For the popliteal vein a mean peak enhancement of 98 +/- 30 HU was obtained after 147 +/- 57 seconds[4]. To cover the 57 seconds of deviation, it was decided to perform 7 volumetric scans with a fixed interscan delay of 7 seconds. With this fixed interscan delay a total of 49 seconds would be covered, starting the first scan 126 seconds PI and performing the last scan 168 seconds PI. As discussed above, the amount of contrast medium was adjusted to obtain better contrast enhancement in venous vessels. This resulted in a scan that imaged venous veins as well as arterial veins (Fig. 5).

Since the purpose was to image only venous vessels SURESubtraction was applied during post-processing to subtract the venous phase from the arterial phase.

Post-processing

In post-processing of the venous phase noise was reduced and the diagnostic value was improved. Noise reduction was realized with BrainTimestack, a tool which was developed for noise reduction in 80 kV scans of the brain. By stacking multiple low tube voltage scans, the noise level can be reduced while maintaining perfect image quality (Fig. 6). Venous vessels can be assessed more accurately with BrainTimestack.

After using BrainTimestack a subtraction of the venous scan was performed. Subtracting a venous scan from an arterial phase led to a mere venous phase as shown in Figure 7.

Dose

In 15+2 volumetric scans to image the arterial phase, 7 volumetric scans to image the venous phase and the S&Vs a total combined dose of 2.5 mSv was used for the 4D DSA protocol of the lower limb.

Conclusion

4D DSA on the 320-row Aquilion ONE allows imaging of the arterial and venous blood vessels in the lower limb with patient-adapted scan protocols. "Time of arrival" and "time of departure" provide an optimal time phase and pre-operative planning can be enhanced due to additional information regarding the exact location of the blood vessels in relation to the tumor.

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