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TOSHIBA MEDICAL SYSTEMS JOURNAL

CT
AIDR 3D sets a trend in cardiac computed tomography

X-Ray
Mobile and flexible Infinix-i system helps in pediatric cardiac care

Ultrasound
Myocardial deformation can be quantified with 2D speckle-tracking

MR
Titan Helios MR offers unique non-contrast MRA acquisition techniques

VISIONS

20·2012

20 editions of VISIONS Magazine have been published continuously to inform our readers about major achievements in healthcare in general and medical imaging technologies in particular.

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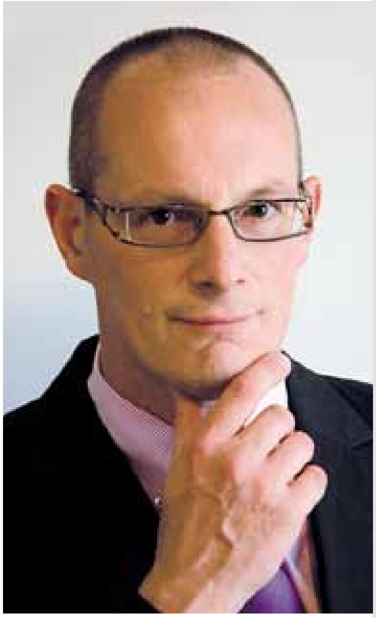
Dear reader,



Last year there was a big fuss when CERN, the European Organization for Nuclear Research, announced that its OPERA experiment reported an 'anomaly in the flight time of neutrinos'[1]. This not only implicated the possibility of movement faster than light but also raised the prospect of time travel. However, while writing this editorial, CERN confirms that neutrinos 'respect the cosmic speed limit'[2]. Conclusion: Time travel is not (yet) possible and will probably remain the domain of science fiction writers for many years to come.

Despite this, I'm quite sure we are able to travel back in time. Let's give it a try and revisit 1999 – just one year before the Millennium which was celebrated globally with high expectations. Through an initiative of our German subsidiary, VISIONS magazine was born in that year, with the first international edition published in 2001. That issue featured articles about multi-slice cardiac CT and 'acquiring continuous volume data sets of the entire heart in just 30 seconds only', 'the comparison of several protocols of low dose CT', the portable JustVision ultrasound system and Tissue Doppler Imaging (TDI) – a then emerging tool for cardiac wall motion assessment, our first X-ray flat panel detector that permitted fluoroscopy to be performed at a rate of up to 30 images per second and the MR EXCELART 0.5T system with Pianissimo.

Now, 20 editions later, the progress made in healthcare and medical imaging technologies, in particular, is evident. Major achievements include 640 slices per rotation using double-slice mode reconstruction technology and AIDR 3D in CT, ultrasound's picture perfect image quality, streamlined workflow and a whole range of real-time applications for advanced visualization and quantification on the new Aplio series, Volume Navigation (3D road map) in X-ray and non-contrast enhanced MR angiography on the Vantage Titan 3T.

I'm very curious what the next decade will bring us, but that, I'm afraid, has to wait for another ten years, unless we truly discover how to travel in time.

Kind regards,

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

1 CERN Press Release (23 Sep 2011): "OPERA experiment reports anomaly in flight time of neutrinos from CERN to Gran Sasso."
2 CERN Press Update (8 June 2012): "Neutrinos sent from CERN to Gran Sasso respect the cosmic speed limit"

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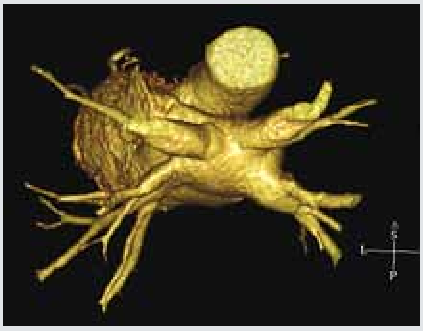

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Highest Diagnostic Image Quality at Lowest Dose with AIDR 3D

R. Bull

Dr Russell Bull

Introduction

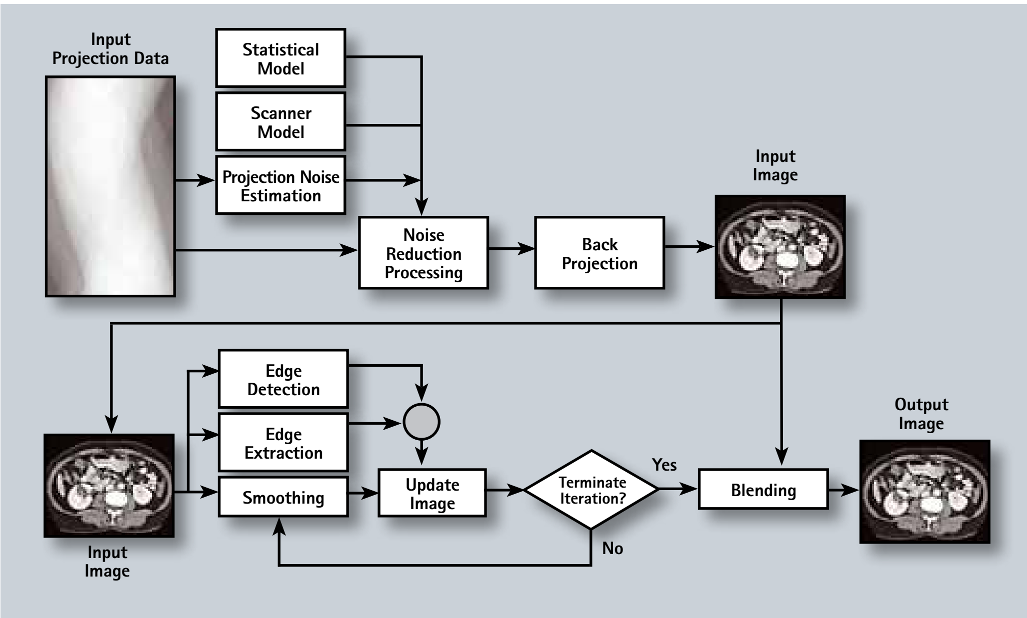
Traditionally CT images have been reconstructed from the raw data using techniques based on filtered back projection (FBP). Although this has served the CT community well for over 30 years, FBP has its limitations at very low radiation doses when it tends to produce noisy images which may impair diagnosis. Iterative reconstruction on the other hand is a technique whereby the final image is reconstructed from the raw projectional data in multiple steps rather than in a single step with FBP.

All iterative reconstruction solutions start with an assumed image, compute projections from the image, compare the original projection data and update the image based upon the difference between the calculated and the actual projections. Iterative reconstruction techniques are superior to FBP when the projectional data is sparse as occurs in CT when using very low radiation doses. Iterative reconstruction was the original technique used on the first CT scanner developed by Godfrey Hounsfield in 1971. This technique was subsequently abandoned on all commercial scanners due to the increased computational requirements of iterative reconstruction which led to unacceptably long image reconstruction times even with the most powerful mainframe computers of the time.

Toshiba has recently implemented its second generation iterative reconstruction system as a commercial product – AIDR 3D (Fig. 1).

AIDR 3D works in both raw data and reconstruction domains in three dimensions. It uses a scanner model and a statistical model considering both photon and electronic noise to eliminate noise and artifacts due to photon starvation in the projection data. A filtered back projection of this processed data is then blended with the final result from the iterative process. This produces images which are visually similar to FBP images but have much higher spatial resolution and suffer from much less image noise and artifacts. Critically, image reconstruction times are almost identical to those of FBP thus enabling AIDR 3D to be used in routine clinical practice. In addition AIDR 3D is totally integrated into the scanning process so that the automatic dose modulation software (SUREExposure 3D) will take account of it when setting the radiation dose required to achieve the desired image quality. This means that all patients are scanned at lower radiation doses

Fig. 1: AIDR 3D is an advanced iterative reconstruction algorithm that reduces noise both in the raw data domain and also in the reconstruction process in three dimensions.



Royal Bournemouth Hospital, UK

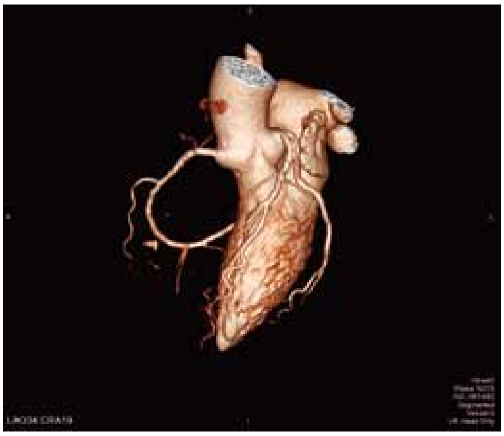


Fig. 2: Normal coronaries. 80 kVp BMI 16, prospective single beat 70-80%, total radiation dose 0.2 mSv (k=0.014)

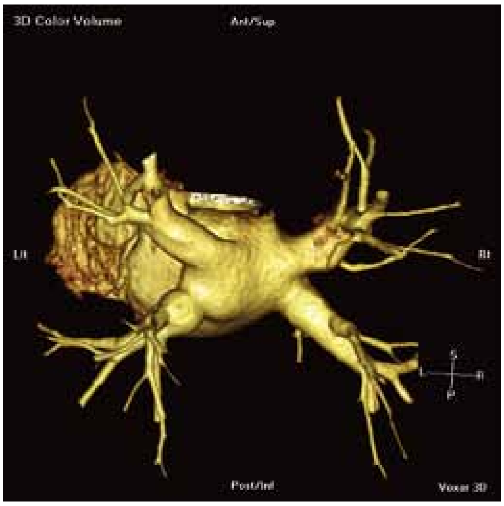


Fig. 3: Left atrial/pulmonary vein assessment prior to pulmonary vein isolation. 80 kVp, BMI 24, prospective single beat 75%, total radiation dose 0.3 mSv (k=0.014)

automatically with no manual input from the radiology staff.

AIDR 3D was installed on the Aquilion ONE at the Royal Bournemouth Hospital in January 2012. Since then all patients have been scanned using AIDR 3D with dramatic reductions in radiation doses coupled with marked improvements in image quality. The use of routine 100 kVp scanning, even in large patients, has led to reductions in contrast volumes for all types of angiography whilst preserving or even increasing contrast-to-noise (CNR) ratios. This article focuses on CT coronary a ngiography where doses in the microsievert range (<1 mSv) are now a clinical reality for many patients.

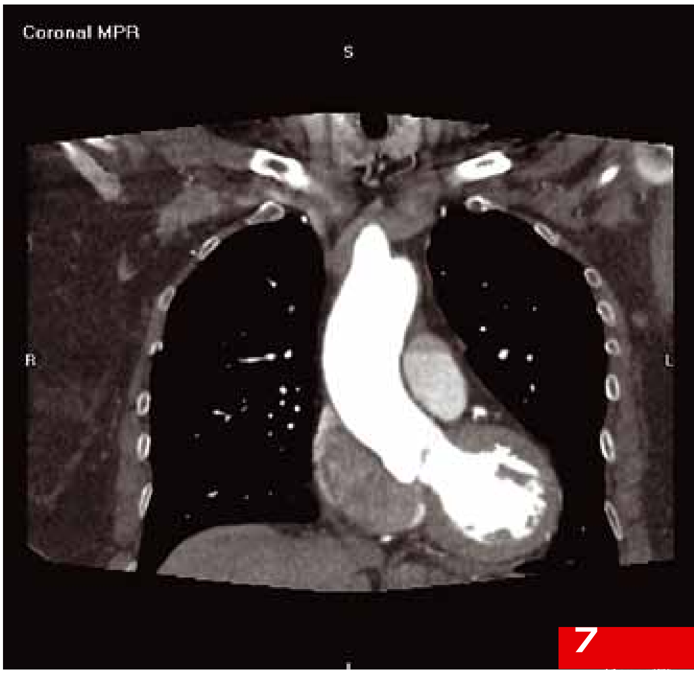
Ultra-low radiation dose

As the Aquilion ONE is able to scan the entire heart in one tube rotation, all patients at our institution are scanned using prospective gating in a single heart beat. Using conventional filtered back projection in conjunction with quantum denoising (QDS) this 'prospective only' approach has led to low radiation doses of < 5 mSV in almost all patients regardless of body mass index, heart rate or rhythm. AIDR 3D is so efficient at removing noise and artifacts at extremely low radiation doses that we have seen further very dramatic reductions in radiation doses. It is now usual for us to scan patients with low to normal body mass indexes (BMI) at doses of < 1 mSv and even in much larger patients up to a BMI of approx. 35, doses of < 2 mSv are now typical (k=0.014); Figs. 2,3 and 4a,4b and Table 1.

Lower kVp with reduced contrast volumes

There is a marked increase in the X-ray absorption of iodine at relatively low photon energies of 33.2 keV. This means that a CT X-ray beam containing numerous photons at or around this energy will be attenuated more strongly by iodinated contrast media compared with higher-energy beams. Consequently for the same total radiation and contrast

Fig. 4a and 4b: Normal chest and coronaries. 100 kVp BMI 25, 2-step whole chest coverage, prospective single beat 70-80%, total dose 1.7 mSv (k=0.014)



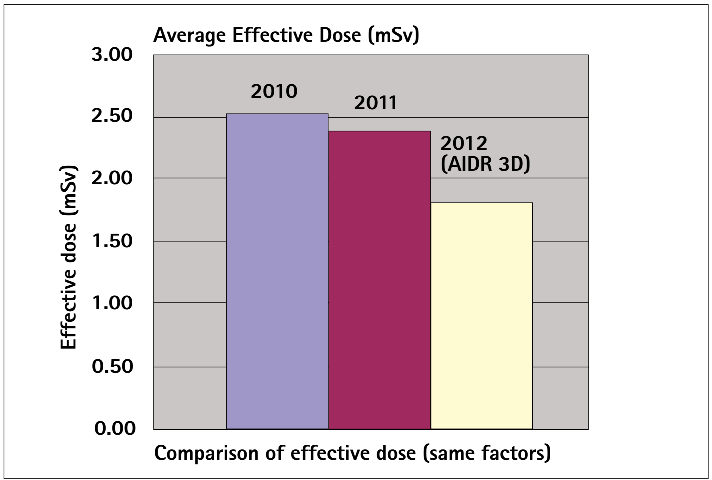


Table 1: Mean total radiation dose for cardiac CTCA 2010-2012 (prospective single beat 70-80%), BMI range 18-65 (k=0.014)

dose, reducing the peak kilovoltage (kVp) of the X-ray tube will lead to much denser contrast within the heart and coronary vessels with a substantial increase in the contrast-to-noise ratio (CNR) of the image. This increased CNR allows excellent images to be produced at lower radiation doses and also allows use of lower flow rates and total volumes of contrast media. This leads to potential benefits in terms of cost savings and reduced risk of contrast-induced nephropathy (CIN). The introduction of AIDR 3D with its dramatic ability to reduce noise whilst increasing spatial resolution now allows us to scan slim to average patients (BMI <23) at 80 KVp and much larger patients (up to a BMI of approx. 35) at 100 kVp whilst maintaining tube current (mA) at low levels (Figs. 5,6). This ability to scan almost all patients at a kVp of 100 or lower has enabled us to use 60 ml Niopam 370 IV at 4.5 ml/s as our standard protocol for medium to large patients (BMI <35), with slim patients (BMI <23) now routinely scanned using 50 ml or less of contrast at flow rates of 4 ml/sec or less. This represents a reduction in IV contrast volumes of up to 33% compared with our former protocols.

Scanning obese patients at very low radiation doses with AIDR 3D

Scanning of obese patients at acceptable radiation doses has always been a challenge using conventional systems. Increased X-ray attenuation and scatter is seen in obese patients which results in noisy images with substantial artifact when using conventional filtered back projection (FBP). In addition, higher tube voltages (up to 135 kVp) often have to be used in these patients to obtain sufficient X-ray penetration which leads to reduced contrast-to-noise ratios. This is further exacerbated by the fact that intravenous access is often poor in these patients meaning that it is not possible to deliver high contrast flow rates through sufficiently large bore cannulae. Due to the above factors relatively high radiation doses are required, while the quality of CT angiographic images in obese patients is still poor when using traditional FBP techniques.

AIDR 3D now allows us to scan obese patient up to a BMI of approx. 35 using 100 kVp (compared with a maximum BMI of approximately 28 prior to AIDR 3D) with much better contrast opacification (and therefore increased CNR), less

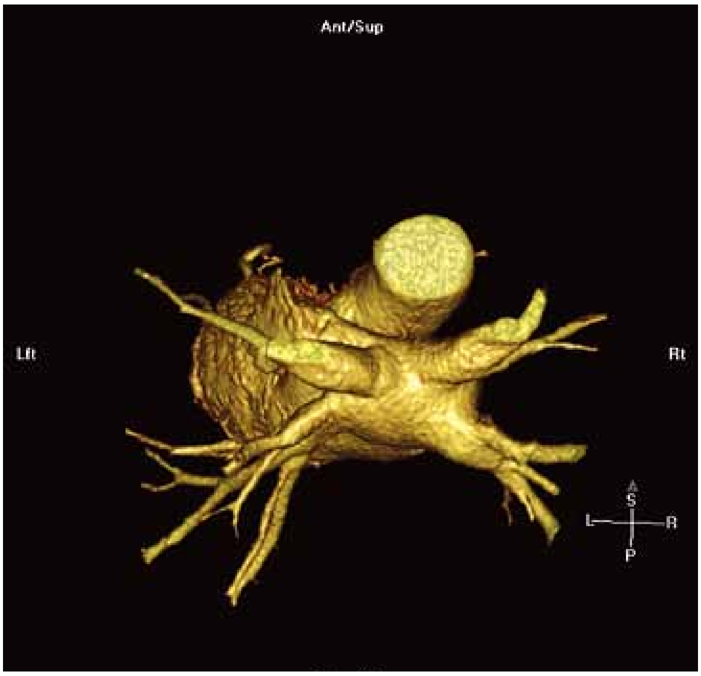


Fig. 5: Left atrial planning, 80 KVp, 40 ml Niopam 370 IV@3.5ml/s

Fig. 6: RCA graft, HR 79 AF, eGFR 29, 80 kVp, 45 ml Niopam 370 IV @ 3.5 ml/s

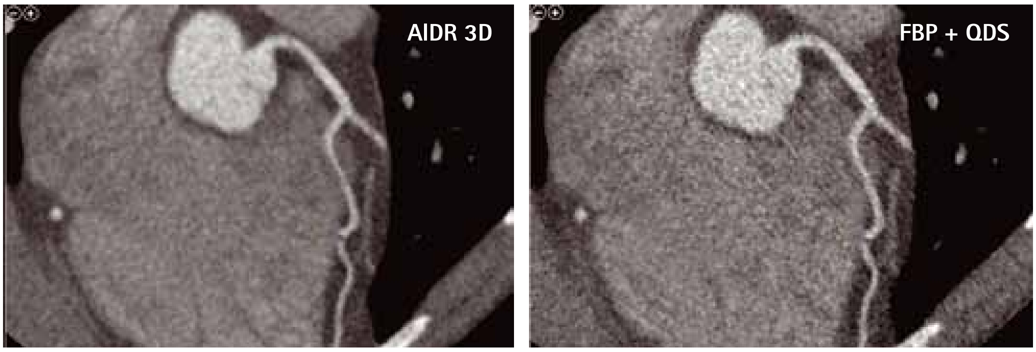


Fig. 7: Normal LAD with segment of intramyocardial bridging, AIDR 3D vs. FBP with QDS (BMI 33, dose 2 mSV)

artifacts, better spatial resolution and dramatically reduced radiation doses (Figs. 7,8,9). Image quality (using 120 kVp) is also dramatically improved in very obese patients (BMI >35) leading to reliably diagnostic images at very acceptable radiation doses (typically <3 mSv) even in this very challenging patient group.

Increased spatial resolution

The use of 'sharper' higher spatial frequency reconstruction algorithms increases spatial resolution and allows better visualization of the lumens of structures such as coronary stents and heavily calcified vessels due to reduced blooming. The use of these algorithms is however limited using traditional FBP

Fig. 8: Normal RCA, BMI 34, 100 kVp, 2 mSv total radiation dose (k=0.014)

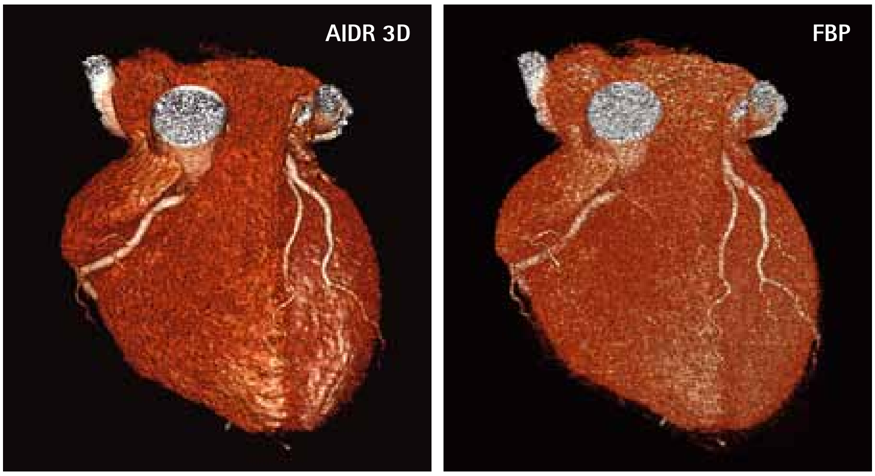


Fig. 9: 3D heart, BMI 34, dramatic reduction in image noise using AIDR 3D compared with conventional FBP

techniques as at low radiation doses, image noise often becomes unacceptably high. AIDR 3D now allows us to generate images with minimal noise using the highest spatial reconstruction frequency coronary algorithm (FC05) whilst reducing radiation dose. In addition, AIDR 3D approximately doubles spatial resolution (lp/mm), compared with FBP for any given dataset. Thus we are now able to take full advantage of the unmatched inherent spatial resolution provided by the 0.5 mm wide Aquilion ONE detectors. Owing to the above changes all our patients are effectively scanned in high definition mode but without the penalty of increased radiation dose inherent in some other systems designed to improve spatial resolution.

Conclusion

In our clinical setting of a busy general CT department providing a high volume cardiac CT service, AIDR 3D had transformed our service. In addition to the robustness already provided by the Aquilion ONE, we are now able to scan all patients with even better image quality using even lower doses of both radiation and IV contrast. The combination of excellent image quality and extremely low radiation doses is likely to increase the trend for cardiac CT to replace conventional catheter angiography in many patient groups.

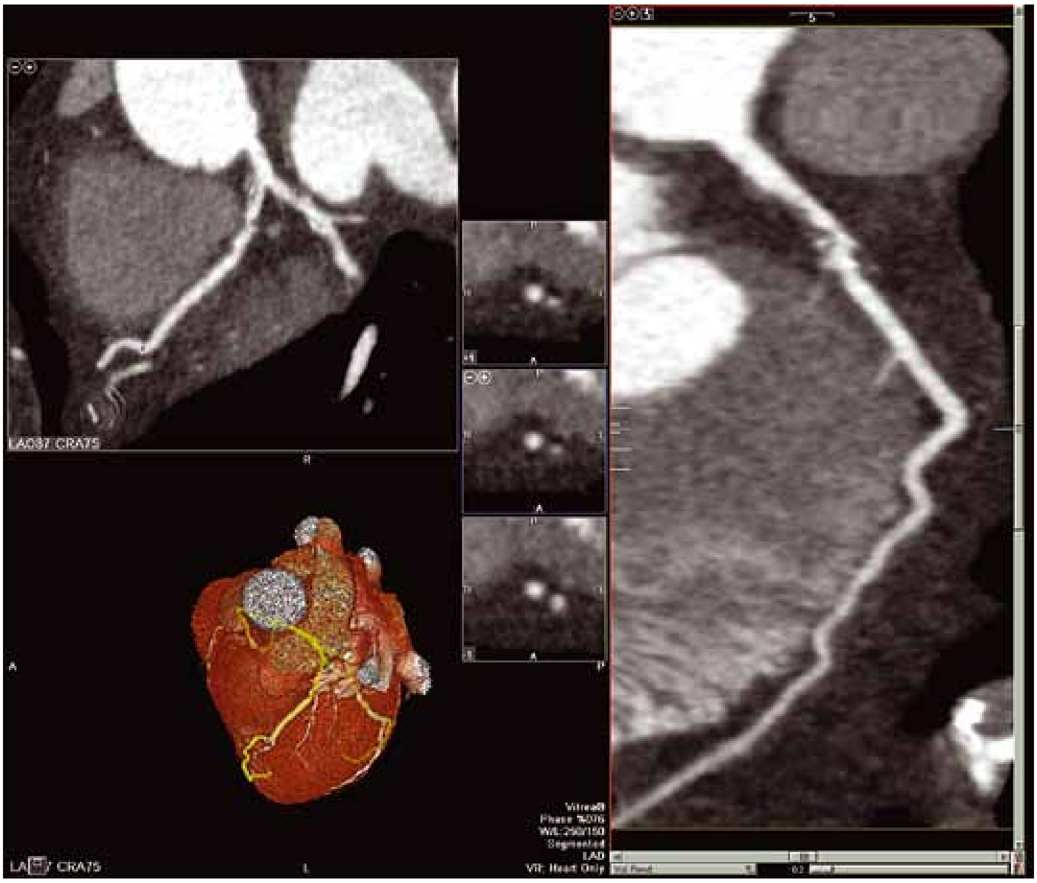


Fig. 10: 100 kVp, BMI 25, FC05, excellent visualization of critical proximal LAD stenosis (prospective single-beat 70-80% protocol), total radiation dose 0.7 mSv (k=0.014)

President's Message

"We are particularly focusing on dose reduction and patient safety."

I am honored to have the opportunity to present my message in this issue of VISIONS. The healthcare industry is changing rapidly, and this presents Toshiba with greater challenges than ever before. Among these, we are particularly focusing on dose reduction and patient safety, which reinforce our management slogan "Made For Life".

Our low-dose technologies have been developed from the idea of "care" for patients, and also for radiographers, cardiologists, and other operators. I believe that "care" and "safety" should be understood by all of us as vitally important goals that embody our mission to contribute to society.

For example, in CT we have introduced our AIDR 3D technology, which significantly reduces the exposure dose during scanning. So far, AIDR 3D has been positively received in the global market.

In X-ray, we have developed Spot Fluoroscopy as a low-dose solution. This technology allows X-ray exposure to be limited to the necessary area. A previously acquired image is displayed around the area selected for the live fluoroscopic image. With this feature, users can visualize the locations of devices during interventional procedures while dramatically reducing not only the dose for patients, but also the scatter radiation to which doctors and radiographers are exposed.

In ultrasound, as there is no radiation exposure, dose reduction is not an issue. Instead, Toshiba is working to develop more advanced Smart Fusion technology, in which CT or MR images can be combined onscreen with ultrasound images. Smart Fusion provides realtime synchronization of the CT or MR image display with that of the ultrasound image so that both are shown for the same plane. This allows safer, more accurate biopsies and other interventions.

Finally, in MRI, we have been developing contrast-free MRA technology. This was in response to increasing awareness of the potential risk associated with use of gadolinium-based contrast agents. As most of you will know, we have won awards for our contrast-free MRA. Another feature we have been working on is Pianissimo™, which greatly reduces acoustic noise in MRI examinations, providing a less stressful environment both for the patient and for medical staff.

It is my hope that we can achieve our mission by continuing to implement "care" and "safety" in each modality and incorporating them in all products.

Satoshi Tsunakawa
President and Chief Executive Officer
Toshiba Medical Systems Corporation

Cardiac Arrhythmia: overcoming the unexpected

G. Lo, C. Steveson

Dr Gladys Lo

Introduction

In routine clinical practice about 10% of patients undergoing cardiac CT angiography experience arrhythmia during the scan. The Aquilion ONE virtually eliminates the challenge of imaging patients with cardiac arrhythmias. A sophisticated arrhythmia detection algorithm is incorporated into the acquisition software, taking full advantage of the system's volumetric scanning capabilities. The system monitors the cardiac rhythm in real time and aborts exposure if an arrhythmia is detected. Furthermore, the software is designed to recognize different arrhythmias and can adjust the exposure window to ensure a diagnostic scan.

Arrhythmia detection software

If a patient receives a contrast medium injection for a cardiac CTA examination, the aim is to acquire a meaningful diagnostic image, no matter what the heart rhythm. This includes patients that are in cardiac arrhythmia or patients that have an anomalous heartbeat at the time of the scan. Therefore, a sophisticated arrhythmia detection algorithm that automatically adapts the exposure in real time in response to the patient's heartbeat is integrated into SURECardio software.

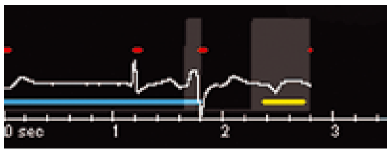
The arrhythmia detection software attempts to recognize an abnormal heartbeat and minimize exposure while achieving the specific scanning objective: to provide high quality diagnostic images. In the example below (Case 1), a single unexpected short heartbeat occurred during the scan. The system detected it and immediately terminated the exposure to acquire the scan in the next normal heartbeat. This particular patient was examined during the first week following installation of the Aquilion ONE. After completion of the scan, I knew immediately that this is a truly unique scanner because I know of no other CT system that could be used to perform coronary CTA in this patient with such ease and exquisite images.

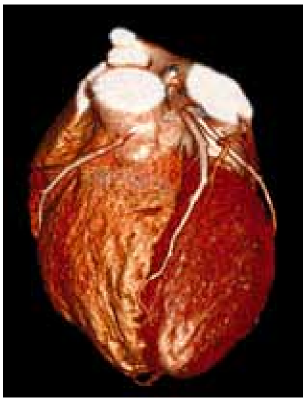
Cardiac arrhythmias have a wide variety of presentations that make diagnostic scans in helical mode impossible. However, the arrhythmia detection software on the Aquilion ONE is designed to recognize arrhythmic beats and adjust the exposure timing in response to abnormal cardiac rhythm.

Case 1

Ventricular Ectopy

A 61-year-old woman with recurrent ventricular ectopy presented with chest tightness. The patient experienced a premature ventricular contraction (PVC) at the time of the scan. PVC is characterized by a very short heartbeat that is followed by a compensatory long heartbeat. The software recognized this pattern and aborted exposure in the abnormal beat. To ensure a motion-free image a diagnostic scan was obtained in the next beat and the exposure window was extended to include the next R wave, ensuring the diastolic phase was captured. As a result, the examination is diagnostic and a failed examination with wasted X-ray exposure has been avoided.





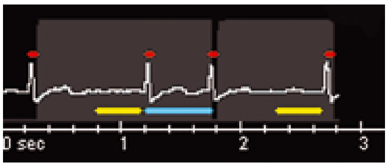
The RCA arises from the ascending aorta just above the right coronary sinus.

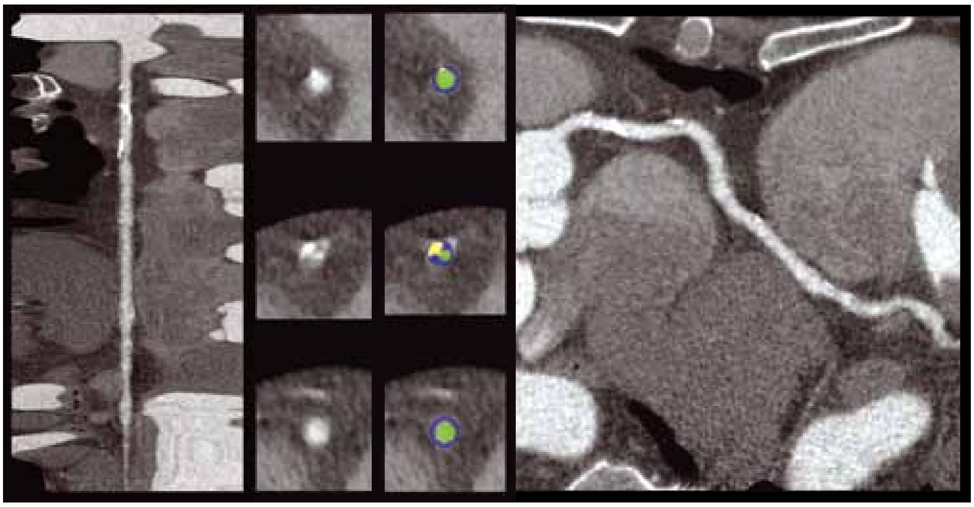
Hong Kong Sanatorium & Hospital

Case 2

Atrial Fibrillation

This 71-year-old man presented with various risk factors for coronary artery disease, including diabetes, hypertension and symptoms of angina. The patient experienced atrial fibrillation while in the scanner, as seen in the irregular ECG trace recorded during this multi-segment 2-beat scan. The heart rate during the scan was 63-113 bpm.





A mixed lesion is seen in the mid-RCA. The stenosis was considered to be greater than 50% but not more than 70%.

A stenosis is seen in the proximal LAD. It contains calcified and non-calcified regions. The lesion is causing less than 50% stenosis. A second plaque is seen in the mid-LAD, distal to the 1st diagonal branch. This lesion is causing greater than 50% stenosis (arrow).

The arrhythmia detection software reacts to each clinical presentation as it occurs. In this second clinical example (Case 2) the patient experienced atrial fibrillation during the scan. Each beat is normal however the length of the second beat is shorter. Aquilion ONE recognized this and as a 2-beat scan was required the next, longer, beat was also acquired.

Summary

Over 5500 cardiac patients have been examined since the scanner was installed, with close to a 100% success rate. The robust arrhythmia detection software installed on the Aquilion ONE allows us to perform cardiac CTA on all patients with confidence that the scan will result in diagnostic images every time without the necessity of repeat scanning.

Contrast-to-Noise Ratio Improvements with AIDR 3D

N. W. Weir, M. C. Williams

Michelle Claire Williams, MD

Introduction

Contrast-to-noise ratio (CNR) is commonly cited as one of the single most useful indicators of image quality for optimisation studies in computed tomography[1]. CNR takes into account not only the difference in mean attenuation between tissues, but also the confounding effect of pixel noise, both of which influence the diagnostic confidence of an observer. In general, contrast in CT is affected by factors influencing the relative linear attenuation coefficients of tissues, including X-ray tube kilovoltage and, if used, concentration of iodinated contrast agent. Factors affecting image noise include those determining the number of contributing X-ray photons: tube current, kilovoltage, slice thickness and patient size, as well as the convolution filter used in reconstruction and electronic noise inherent in the detector system. Reducing patient exposure in CT decreases the flux of X-ray photons to the detector and is generally associated with increased image noise. The recent introduction of iterative reconstruction methods in CT has offered the possibility of significantly reduced noise, hence improved CNR, for a given exposure.

AIDR 3D

The recently introduced AIDR 3D software[2], released with Aquilion software version 4.74, is an advanced iterative reconstruction algorithm in which noise is reduced via two processes. First, quantum noise and electronic detector noise (which dominates at very low levels of photon flux to the detector) are modelled and suppressed in the raw data contributing to the initial input filtered back projection (FBP) image. Secondly, a process of smoothing, combined with edge detection to preserve sharp detail, is employed in the iterative process. Three 'strengths' of AIDR 3D are available, Mild, Standard and Strong, providing a varying blend of FBP and iterative solutions, Mild having the least iterative weighting and Strong the greatest. In order to characterise the performance of the AIDR 3D algorithm for introduction into clinical use at our centre, we performed phantom studies measuring CNR for clinical 320 multi-detector row CT (320 MDCT) protocols, comparing results with previous algorithms.

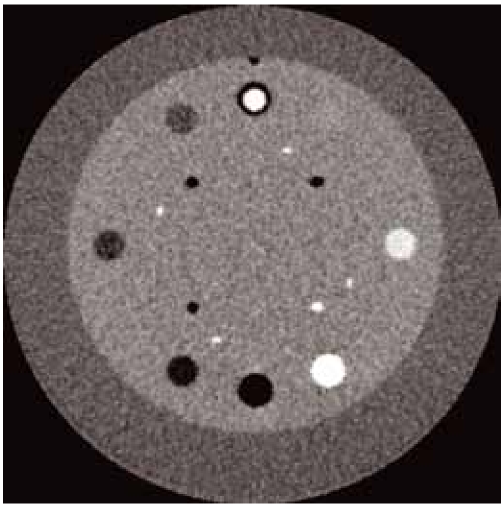


Fig.1: Cross section through Catphan 600 showing iodinated contrast vial (arrow)

Phantom measurements

One of the main clinical applications of 320 MDCT at our institution is CT coronary angiography (CTCA). Phantom images were acquired with our clinically used prospectively ECG triggered CTCA protocol, utilising a set-up previously adopted in studies of the AIDR 3D algorithm (Aquilion v4.6)[3]. In order to simulate a contrast filled vessel, the water target of the Catphan 600 phantom[4], replaced with a vial containing 4% iodinated contrast (Iomeron 400, Bracco UK Ltd.) in isotonic saline, representative of the contrast concentration found in the coronary arteries during CTCA acquisition (Figure 1). The 30 cm diameter Catphan expansion annulus was used to simulate body scanning conditions. Acquisition parameters included simulated ECG at 60 bpm, 0.35 s rotation, display field of view 200 mm (M), FC03 convolution filter, VolumeXact interpolation and 0.5 mm slices spaced at 0.25 mm. A range of tube current and kilovoltage combinations were acquired.

All scans were reconstructed with AIDR 3D Mild, Standard and Strong. CNR was calculated as the difference in mean Hounsfield Units (HU) for regions of interest (ROIs) placed within the contrast vial and the Catphan background material, divided by the pixel standard deviation in the background material. Figure 2 shows representative CNR results for acquisitions at 100 and 120 kV. These illustrate a general improvement in CNR with AIDR 3D relative to FBP and AIDR algorithm. The CNR gain is seen to increase with increasing iterative blend, from Mild to Strong. The CNR increase is also greater at 100 kV compared to 120 kV. This may be attributed to two factors: i) improved noise modelling and noise reduction at low photon flux, and ii) an increase in

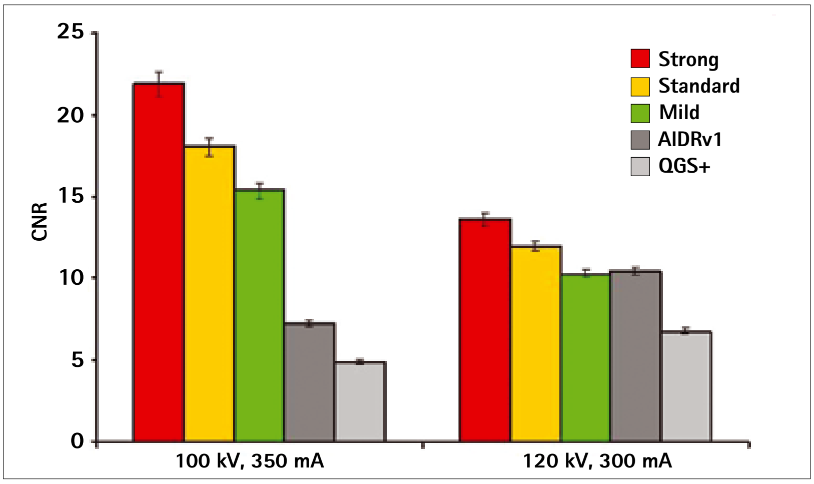


Fig. 2: Contrast-to-noise ratio results for iodinated contrast solution at 100 kV and 120 kV, comparing AIDR 3D, AIDR and QDS+ (filtered back projection) reconstructions

HU for high density structures with the new reconstruction software which is greater at 100 kV than 120 kV.

Cardiac applications

Figure 3 shows an MPR through the left anterior descending coronary artery for a CTCA patient scanned at 100 kV, reconstructed with AIDR 3D Mild, Standard and Strong (Aquilion v4.74), AIDR (Aquilion v4.6) and the filtered back projection based QDS+ algorithm (Aquilion v4.6). Mean HU and standard deviation results for ROIs placed over the aorta illustrate the increase in HU for iodinated contrast with the new software as well as progressive reduction in noise standard deviation with increasing AIDR3D iterative blend.

Dose reduction

The significant gains in CNR found with AIDR 3D for a given exposure imply potential to reduce patient dose while maintaining an adequate level of image quality. Our results illustrate scope for substantial patient dose reduction in CTCA using AIDR3D. The amount of dose reduction achievable will be dependent on the AIDR3D strength (Mild, Standard, and Strong) selected as well as specific scan conditions such as tube kilovoltage and body habitus. However, dose reductions of up to 75% may be achievable[2]. The observed increase in contrast may provide an opportunity to reduce another risk factor associated with CTCA. The increased sensitivity of the new reconstruction software to high density iodinated contrast material may allow the contrast agent dose to be reduced while maintaining adequate opacification of the coronary arteries and, consequently, help to reduce the risk of contrast induced nephropathy[5].

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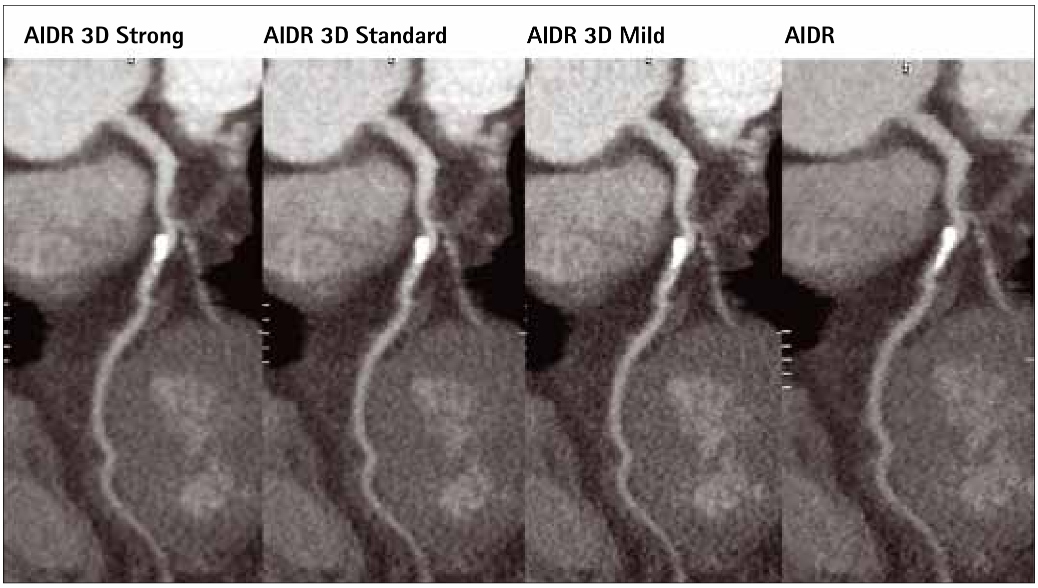
Fig. 3: MPR through LAD from a CTCA patient scanned at 100 kV reconstructed with AIDR 3D Mild, Standard and Strong, AIDR, and QDS+



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Ultrasound for the Detection of High Altitude Pulmonary Edema: the APEX 3 study

H. Dunton, S. Hanlon

APEX team with the Huayna Potosí mountain range in the background. At 19,974 ft Toshiba clinical applications specialist Shane Hanlon and expedition leader Andrew Beck (left and right of the Viamo portable) test the new system.

Introduction

High altitude pulmonary edema (HAPE) is a life-threatening condition defined as noncardiogenic pulmonary edema occurring at altitudes exceeding 3000 m in non-acclimatised individuals.[1] Anyone ascending high enough and without adequate acclimatisation is vulnerable to HAPE[2], although some individuals seem more susceptible than others. At an altitude of 5500 m, 2 – 15% of people can be expected to suffer from HAPE, although it has been postulated that a slow ascent of approximately 300 – 350 m/day is enough to prevent onset.[3] A widely accepted pathological explanation for HAPE has not yet been established[4], but a theory suggests the pathogenesis relates to an increased vascular permeability in hypoxic subjects at altitude. The leakage of intravascular fluorescin dye into the extravascular tissues and the lung fluid has been demonstrated in two studies in rats stressed in a hypoxic environment.[5,6] Based on this observation, Purushothaman et al. hypothesised that altitude illness may occur from the extravasation of fluid into the lungs.[5]

The presence of pulmonary edema and interstitial fluid is usually detected at sea level using chest radiography and (more sensitive) computed tomography; however, neither technique is easily applied at altitude. Thus, an alternative method, ultrasonography, which may be applied as a bedside test or away from a hospital setting, is of interest. The degree of pulmonary vascular leakage and consequent edema can be measured ultrasonographically by the detection of so called "lung comets". Comets are artefacts from the microreflections of the ultrasound beam in the presence of lymphatic fluid from interstitial or alveolar fluid.[7] Ultrasound scanning has been shown accurately to assess for pneumonia, pleural effusion, pulmonary embolism and atelectasis, and as such fills a key diagnostic role in the care of critically ill patients. Based on this experience, ultrasonography for the presence of comets appears to be an accurate method of detecting fluid in the absence of clinical signs of HAPE and, although it may not influence clinical decisions at altitude, has great research potential as a less expensive, more versatile alternative to CT scanning.[8]

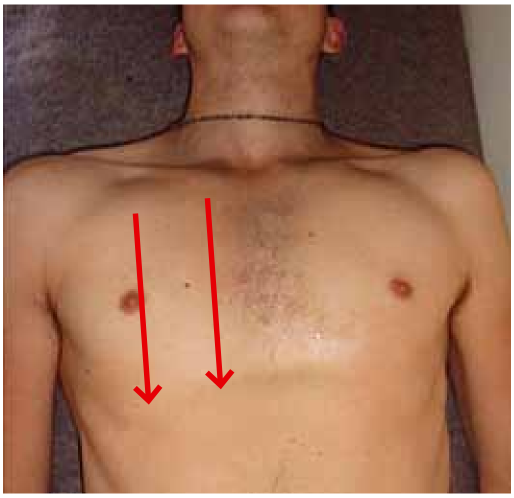
APEX is a Scottish charity with a strong history of high altitude experimentation in previous expeditions. This expedition (APEX-3) to the Bolivian Andes in the summer of 2011, aimed to build upon this foundation, and upon the previous research in the field to discover more about the physiology and detection of HAPE. Unique in the fact that it is entirely student run, this project investigated the changes in global vascular permeability as a potential leading cause of the life-threatening physiological responses to altitude. Multiple measurements were performed, but this report is focused on the potential detection of subclinical lung fluid using ultrasonography in subjects at high altitude. The hypotheses tested were that detectable comet numbers would increased as subjects ascended to higher altitudes and that these numbers would stabilise once subjects were acclimatised at high altitude.

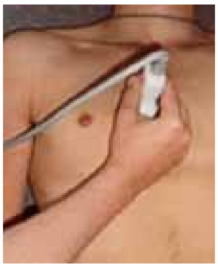
Methods

28 healthy research volunteers aged 18 – 25 were recruited. Exclusion criteria exempted volunteers who:

a) Had previously been admitted to hospital with acute asthma
b) Had significant cardiorespiratory disease
c) Took regular cardiovascular medications
d) Were, or believed they may be, pregnant
e) Smoked

The expedition took one group of 28 people to high altitude at the Laboratorio Fisica Cosmica, Chacaltaya, La Paz, Bolivia (5270 m). The group arrived in La Paz, Bolivia (3600 m) four days prior to travelling to the laboratory. Subjects had baseline measurements taken at sea-level before the expedition in May 2011 and one reading in La Paz.





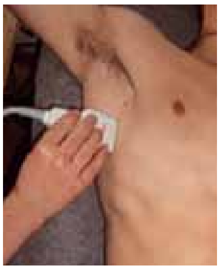


Fig. 1: Scanning planes – Parasternal, mid-clavicular, anterior and mid-axillary lines

After 4 days at 3600 m in La Paz subjects travelled by 4x4 to the Chacaltaya laboratory. Further samples were taken on the day after arrival at 5270 m and on the 5th and 7th day. There were five sample days in total. The intensity of the research was similar to the pervious Apex expeditions and ascent profile had been used safely on two previous expeditions.

Imaging techniques

Tests were conducted by an experienced ultrasonographer utilizing the Toshiba Viamo portable ultrasound system with a 7 MHz linear transducer. The examinations were performed in the supine position Ultrasound scanning of the anterior and lateral chest were obtained on the right and left hemithorax, from the second to the fourth intercostal spaces (on the right side to the fifth), parasagitally from parasternal to the midaxillary line (Fig. 1). The comet-tail sign was defined as an echogenic, coherent, wedge-shaped signal with a narrow origin in the near field of the image with through transmission beyond both the parietal and visceral pleura (Fig. 2). In each intercostal space, the presence of comet-tail signs was recorded at the parasternal, midclavear, anterior axillary and midaxillary sites: zero being defined as a complete absence of comet-tail artefact on the investigated area. Two independent observers assessed the images for quality and any intra- or inter-observer variability in the lung comet scores. Images were scanned using a PLT-704ST linear transducer: preset at 6.2 MHz Pulse Subtraction Tissue Harmonic Imaging defaulted to a depth 4 cm, focus 2 cm.

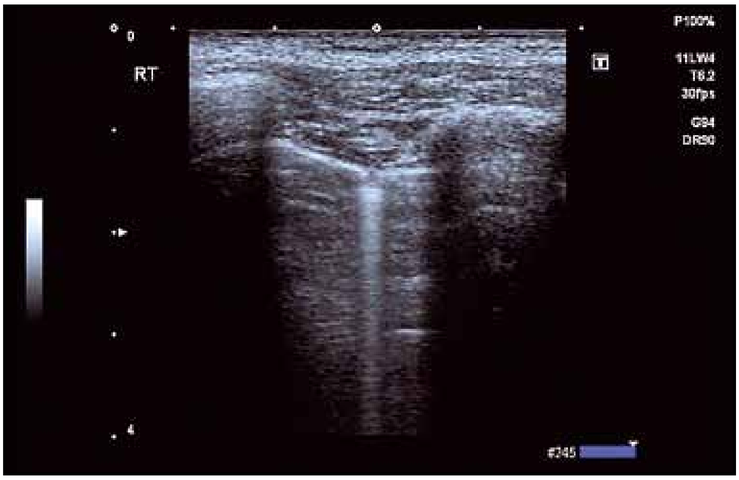


Fig. 2: An example of a lung comet

The data were split into two sets to answer the two hypotheses: the first hypothesis was addressed by comparing the data from sea level, La Paz and Day 2 at the lab; the second hypothesis by comparing the data from days 2, 5 and 7 from the subject's stay at 5270 m. For the purposes of statistical analysis, the data were categorised as 0 = no comets,

Ascending altitude and its relationship to lung comet presence

	Exact sig (1sided)	Bonferroni corrected p value	n
Sea Level & La Paz	0.188	0.564	26
La Paz & 5.270m (Day 2)	0.145	0.435	23
Sea Level & 5.270m (Day 2)	0.035	0.105	23

Table 1: Tabulated results of McNemar test with Bonferroni corrected p values comparing presence and absence of lung comets in subjects at sea level, La Paz and at the second day spent at 5270 m

Time spent at 5270 m and its relation to lung comet development

	Exact sig (2sided)	Bonferroni corrected p value	n
Day 2 & Day 5	0.07	0.21	19
Day 5 & Day 7	0.625	1.875	19
Day 2 & Day 7	0.008	0.0.24	19

Table 2: Tabulated results of McNemar test with Bonferroni corrected p values comparing presence and absence of lung comets in subjects at day 2, 5 and 7 of their stay at 5270 m

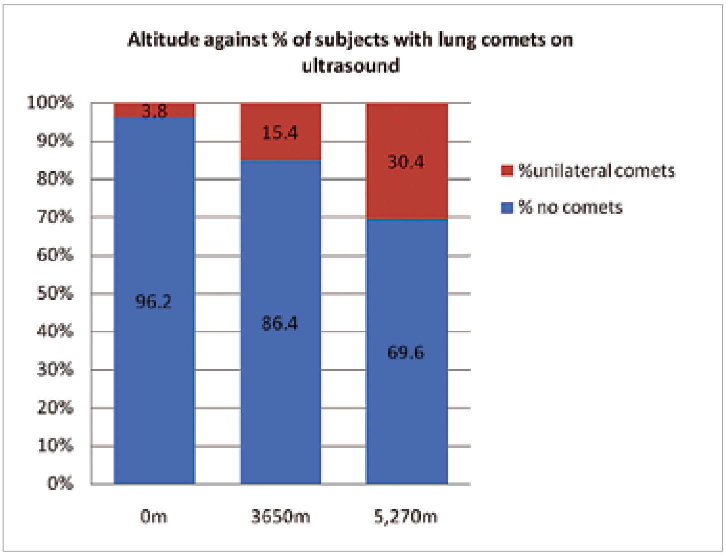


Fig. 3: Stacked bar chart showing the % of subjects with no comets, and with unilateral comets at each measured altitude

and 1 = comets detected on ultrasound. The results were statistically analysed with Cochran's Q test to establish initial significance of associations, then if general significance was present, the McNemar test was used to conduct paired analysis on the data. The data were further analysed in graphical format to compare the presence of no comets, unilateral comets and bilateral comets.

Results

Of the 28 volunteers recruited, two were excluded from the study before the La Paz testing stage for personal reasons, three experienced symptoms of acute mountain sickness (AMS) and withdrew before the second test day at 5270 m, and four withdrew before day 5's tests were complete due to AMS. Subjects experiencing symptoms of AMS were either started on Diamox, or were immediately taken down to a lower altitude in La Paz. These subjects eventuality resulted in exclusion from the study, and all clinical decisions were taken by the expedition doctor. For the purposes of the analysis, the two excluded subjects have been removed from the study and their sea level readings ignored.

Cochran's Q test: p value (exact sig) 1 sided = 0.0385, demonstrating a significant association between an increase in altitude and the presence of lung comets in subjects ($p<0.05$). On further exploration of these relationships, it was discovered that there was no association between lung comets and ascent from sea level to La Paz (exact sig 1 sided = 0.188) or from La Paz to 5270 m (exact sig 1 sided 0.145), although the overall ascent profile was significantly associated with the development of

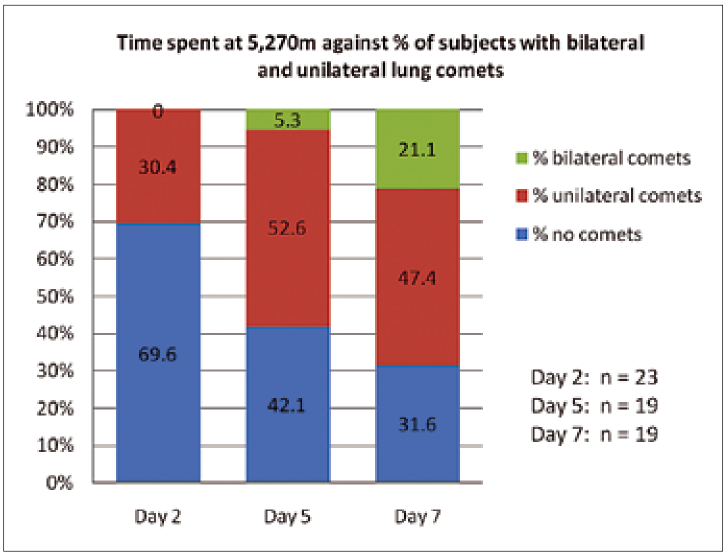


Fig. 4: Stacked bar chart showing the % of subjects experiencing no comets, unilateral and bilateral comets and each test day at 5270 m

comets (exact sig 1 sided = 0.035). When Bonferroni's correction was applied to the p values they increased beyond our level of significance (Table 1).

Based on the odds ratio for this data set, the odds of subjects developing lung comets were 10.94 times higher at 5270 m than at sea level (1/26 subjects had comets at sea level, compared with 7/23 at day 2 at 5270 m).

There was a significant association between the amount of time spent at altitude, and the presence of lung comets on ultrasound ($p<0.05$): Cochran's Q test exact sig = 0.004. On completion of paired analysis, this association was strongly observed between days 2 and 7 (exact sig 2 sided = 0.008), and remained significant when Bonferroni's correction was applied ($p<0.05$). However, there was no significant increase in subjects developing lung comets between days 2 and 5, and between days 5 and 7 (Table 2). Based on the odds ratio for this data set, the odds of subjects developing lung comets were 4.95 times higher on day 7 of testing at 5270 m than on day 2 (7/23 subjects had comets on day 2 at 5270 m, compared with 13/19).

The proportion of subjects with unilateral comets increased as altitude increased (Fig. 3) from 3.8% at sea level to 15.4% at La Paz (3650 m) and 30.4% at 5270 m. There were no subjects experiencing bilateral comets during the ascent stages.

The proportion of subjects with no detectable comets fell from day 2 to day 7 (Fig. 4) from 69.6% at day 2, to 42.1% on day 5 and 31.6% on day 7. Subjects began to demonstrate bilateral comets on day 5 and the number of these cases increased from 5.3% on day 5 to 21.1% on day 7. No bilateral comets were found on day 2.

Discussion

The main findings are that the number of lung comets and likelihood of developing subclinical effusions increases with altitude, and increases with time spent at altitude (up to 7 days).

These results dovetail with a 2007 study performed in the Himalayas, suggesting that patients with clinically evident pulmonary edema have higher comet tail scores than asymptomatic controls at the same altitude. Fagenholz et al. elucidated that the comet tail score is predictive of decreasing oxygen saturation (using regression analysis: 1 point increase in CTS corresponded to a 0.67% in O_2 sats. n= 11, controls= 7) thus reinforcing the power of ultrasound for clinical diagnosis. A similar study in Nepal in 2010 showed the presence of clinically silent comets in 100% of subjects at 4790 m (n=18) and an accompanying rise in systolic artery pressure. The comets were absent at baseline, and numbers increased during ascent.[10]

This study followed a similar structure to its predecessors, but has reinforced these findings by ascending to a higher final altitude, and using the high quality portable Toshiba Viamo ultrasound system for increased accuracy in comet detection. The ever-increasing portability and durability of portable ultrasound machines is transforming imaging into a crucial diagnostic tool at altitude[11], and so increasing our understanding of edematous imaging changes is becoming increasingly vital to wilderness medicine.

A significant limitation of this study was the time spent at 5270 m. The subjects only had 7 days at peak altitude, so although we can conclude that the number of lung comets increases with time spent at altitude, we cannot extrapolate this conclusion to individuals with longer acclimatisation periods. It would be interesting to see if the number of lung comets falls with prolonged altitude exposure.

It is also important to recognise the limitations of the ultrasound scan as a means of assessing for comets. Ultrasound cannot view the pleural surface under bony structures, and as such 30% of the pleural surface is hidden from view[12], for example the subscapular, paravertebral or retrosternal pleura.

In the process of elucidating a cause of HAPE and related effects of altitude, the global picture has to be taken into account. By contrasting this picture of lung comet presentation with other examples of vascular leakage, we can begin to build a more complete picture of the human body at altitude.

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Shane Hanlon, Toshiba Medical Systems

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The Diagnostic Value of Quantification of Myocardial Deformation in the Assessment of Patients with Coronary Artery Disease

S. Imre Sarvari, T. Edvardsen

Introduction

Two-dimensional speckle-tracking echocardiography (2D-STE) is a semi-automated quantitative technique for assessment of cardiac function based on grayscale images. Strain echocardiography has proven to be an accurate tool for assessment of regional[1] and global[2] myocardial function and has demonstrated to be more sensitive and accurate than conventional echocardiographic measurements of systolic function, such as ejection fraction (EF), especially in early myocardial disease. Strain is a measure of deformation, an intrinsic mechanical property, and measures myocardial systolic function more directly than conventional cavity-based echocardiographic measures. Accurate analysis of myocardial viability is important to optimize therapy and to define prognosis in patients with ischemic myocardial disease. Non-ST elevation myocardial infarctions (NSTEMI) affect primarily the subendocardial layers while the subepicardial layers are spared. However, transmural infarction can also be present in patients with NSTEMI[3,4].

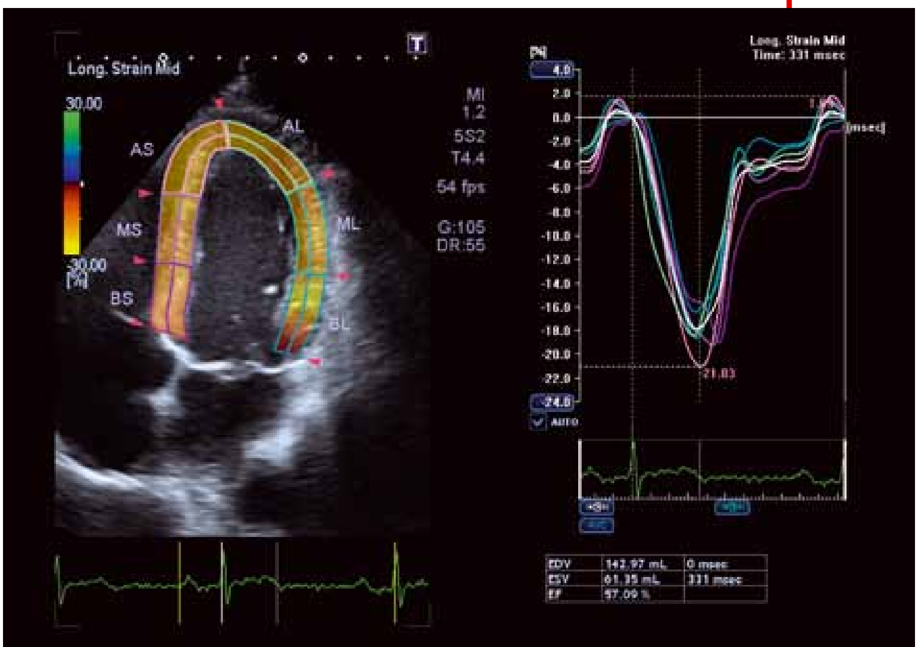
Presented here are two cases demonstrating 2D STE analysis in risk-stratification of patients with NSTEMI.

Clinical Cases

CASE I

A patient was admitted with chest pain but without ECG changes or elevation of myocardial infarct markers. Conventional echocardiography showed no abnormalities, 2D-STE demonstrated normal strain values (Fig. 1) and coronary angiography confirmed the absence of any significant stenosis (defined as >50 % stenosis in any coronary artery).

Fig. 1: The automatic strain analysis in Case 1 – a patient with no signficiant coronary artery stenosis. The image on the left is a colour coded longitudinal strain image acquired from an apical four-chamber view. Strain curves for the six myocardial segments are displayed on the right.



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CASE 2

This patient presented with several risk factors for coronary artery disease including hypertension, diabetes mellitus and smoking. The patient was admitted to a local hospital with crescendo angina, increased myocardial infarct markers and ST-depression on ECG. Subsequently the patient was transferred to our hospital for coronary angiography where conventional echocardiography showed normal left ventricular (LV) function assessed by EF (56%) ad modum Simpson.

The endocardial borders of the 2D images were traced in the end-systolic frame from the three apical views for the assessment of longitudinal strain. Peak systolic longitudinal mid-myocardial strain was assessed by 2D-STE in sixteen LV segments and averaged to LV global longitudinal strain (GLS). Fig. 2 shows a four-chamber view of the LV from this case, demonstrating reduced longitudinal mid-myocardial strain in the baso-, mid- and apico-lateral segments, segments mainly supplied by the circumflex (Cx) coronary artery. LV GLS was reduced to 14%. Coronary angiography showed a proximally occluded Cx artery.

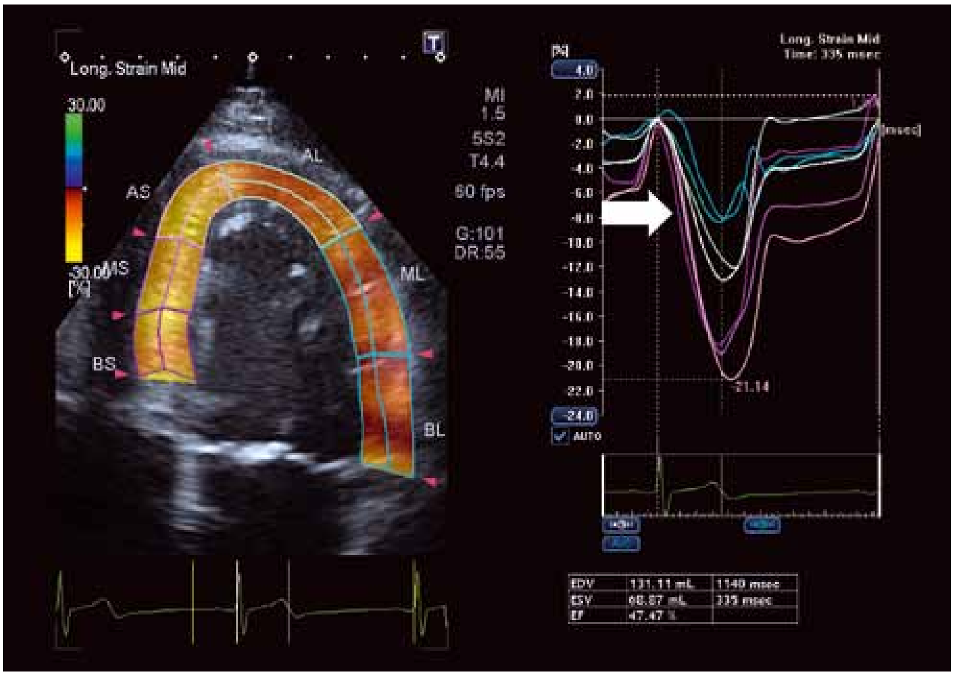

Fig. 2: The automatic strain analysis from an apical four-chamber view in a NSTEMI patient with occluded circumflex (Cx) artery shows reduced colour-coded strain values in the segments supplied by the Cx artery (left). Colour-coding from yellow to green indicates strain from +30 % to -30 %. Yellow/orange indicates preserved strain. Brown indicates areas with reduced strain. Strain curves for the six LV segments are displayed on the right. The curves representing the segments supplied by the Cx artery show reduced strain values of -8 % (white arrow).

Summary and conclusion

Two-dimensional speckle-tracking echocardiography is an accurate tool for assessment of regional and global myocardial function. It is a simple and fast bedside procedure performed as part of the echocardiographic study. LV global longitudinal strain might provide better insight into myocardial contractility than LV ejection fraction in patients with coronary artery disease. The case presented here shows that strain echocardiography could identify a NSTEMI patient with coronary artery occlusion.

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Ultrasound Ergonomics

A Practical Guide to Reducing the Risk of Musculoskeletal Disorders

R. Graveling

Preface

This paper was prepared with the help and support of a number of people, particularly staff in the Simpson's Centre for Reproductive Health at the Royal Infirmary of Edinburgh whose contributions are gratefully acknowledged. Whilst I have provided the ergonomics knowledge; advice and guidance on the clinical work of a sonographer was provided by Lynn Mackenzie, Superintendent Radiographer, RIE and Tracey Bellas, Clinical Application Specialist, Toshiba Medical Systems. I owe a huge debt to their insight and practical expertise relating to carrying out ultrasound scans.

Introduction

Musculoskeletal disorders (MSDs) are a significant problem in most occupational groups. According to the European Agency for Safety and Health at Work, 62% of workers in the 27 Member States of the EU are exposed for at least a quarter of their working day to repetitive hand and arm movements and 46% have work requiring them to maintain painful or tiring postures. As an occupational group, those carrying out ultrasound scans on a regular basis are no exception to this problem.

This paper takes an objective look at the ergonomics of ultrasound procedures. It looks at where the procedures are carried out; what equipment is used; and how they are performed; providing advice and guidance to help those undertaking these procedures on a regular basis reduce the risk of musculoskeletal pain and discomfort associated with their work.

The paper starts by looking at the transducer itself. How you hold and move the transducer when you are scanning can have a significant effect on your risk of suffering hand and wrist pain. Shoulder symptoms are another major problem amongst those who carry out ultrasound procedures and your arm posture when scanning provides the next focus as this will have a big impact on such problems. The focus then moves to your neck and back. Once again, pain and discomfort in these areas can be a real problem for those carrying out ultrasound procedures and how you sit (and whether you sit) are important issues. Finally, the paper looks at the bigger picture, briefly considering how you plan and organise your work.

Every effort has been made to make sure that the following guidance is practicable. However, it is recognised that you might not always be able to follow the guidance given all of the time, especially for some procedures. It is important to realise however that most MSDs are cumulative, with repeated and sustained exposure increasing fatigue, inflammation, etc.

Fig. 1: The narrow neck of this transducer allows it to be gripped without overstretching the hand.

Fig. 2: Change your grip to minimise wrist postures like this.

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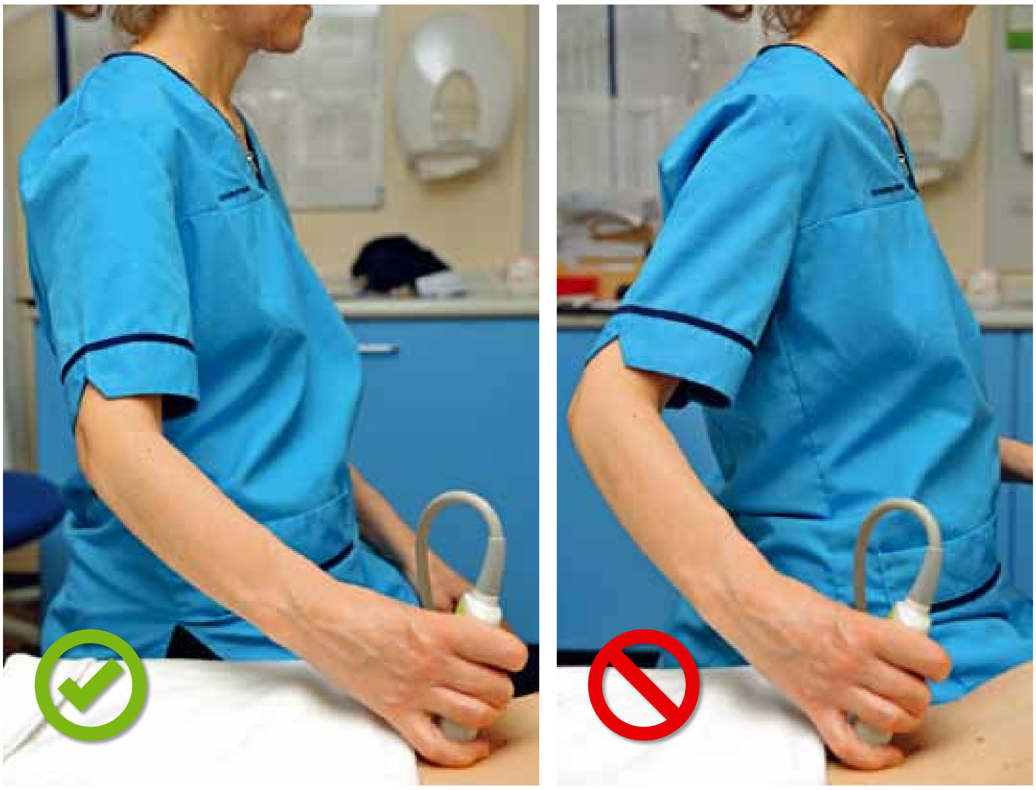

Fig. 3 a/b: Move yourself back, not just your arm, to avoid shoulder angles like this.

Even a short break, doing a different procedure or carrying out the same procedure slightly differently, will allow tissues to start the recovery process and help reduce the risk of problems.

It is also important to remember that the human body is designed for movement (many muscular symptoms arise from a prolonged lack of movement). There is no reason why joints can't be moved through their entire range from time to time (and several reasons why they should be). Although the advice given in this paper refers to avoiding this posture or minimising that joint angle it is not a question of doing so at all costs. As with so many things it is a question of 'anything in moderation'. Thus, occasionally raising your arm above a certain angle to reach across a patient will not cause you any harm; whilst carrying out almost the whole procedure with your arm raised too high, time after time, is a different matter.

Creating an ergonomic work environment

The transducer

Historically, a number of studies have identified transducer cable weight and rigidity as contributing to musculoskeletal problems amongst those carrying out ultrasound procedures. The use of lighter, more flexible cables in modern transducers helps to reduce these factors.

Ideally, tool size should be adapted to the size of your hand, with larger tools for those with larger hands and vice versa. This is because the further your hand moves away from its 'neutral' (relaxed) shape the greater the potential tension and strain in the finger tendons. Large tools make you stretch the hand (and tendons).

Unfortunately, although this works as an abstract concept, transducer size is largely dictated by the technical requirements of the specific scan they are designed for and choosing different sizes for a given procedure is rarely an option. However, you should be aware of this in carrying out scans and, where possible, adapt your scanning style accordingly, for example by making a particular effort to avoid or reduce wrist flexion movements if you have small hands and are using a large sensor. This is particularly important when making transverse scans, when you are gripping across the transducer rather than it lying in your hand (Fig. 1).

The tighter you grip, the greater the tension in the tendons of the hand and wrist. Relax your hand when you can, especially if you are using a specialist transducer such as an intracavity probe. Some transducers, such as those in the Toshiba range are made of a non-slip plastic material to help maintain a good grip. These transducers also incorporate a 'shoulder' in their design. If using one of these try, where possible, to hold the transducer so that it 'fits' into the palm of your hand, with the shoulder against your hand or fingers so it can't slip so easily when you need to apply pressure, especially with those more amply proportioned patients or when performing DVT procedures. These design features will help you to use as little grip force as possible to maintain control. If you can't do this, or the probe is still slipping in your hand, wipe it or wear a thin glove to improve grip, rather than gripping it more tightly. A 'pencil' grip is best avoided as it is harder to prevent the probe from sliding through your fingers without gripping it tightly.

Scanning movements

Where possible, try to scan by moving your forearm, not your wrist. 'Bending' the tendons linking the fingers to the flexor/extensor muscles in the forearm when they are under tension gripping a transducer

Fig. 4: Swivelling the console to the side can help avoid unnecessary stretching.

Fig. 5: Re-programme console controls to minimise repeated stretching or reaching

will increase any strain (Fig. 2). Extreme wrist flexion or extension postures will also increase the pressure in the carpal tunnel. If possible, try to adjust how you hold the transducer to avoid or reduce this.

Some procedures such as DVT procedures, or when scanning patients with a high BMI, need you to press harder than usual to get the correct image. This might also cause you to increase the grip force used to help prevent the transducer from slipping. Both factors will increase the tension in the tendons passing through the wrist. As mentioned earlier, where the transducer has a shoulder, using it to help prevent the transducer from slipping through your hand will help here. Wrist flexion/extension movements with these high levels of tension should be avoided altogether or at least kept to a minimum.

Arm posture

Try to keep your arm as close to your side as possible. Sit close to the patient and, where possible, get the patient to lie close to your side of the table or bed. Many patients attending for routine or investigative procedures (such as in obstetrics) are perfectly mobile and capable of adjusting their position as required. Make sure that you sit high enough to reach onto or, where necessary, over the patient. Standing might help you to adopt a better posture.

Where appropriate, move down the table or bed, rather than reaching behind you (Fig. 3). If necessary move the machine or its console. The new Aplio is smaller and lighter than its predecessor, so this is easier to do. Units fitted with a central pedal will make this even easier.

The shoulder joint has a very wide potential range of movement but, as with other joints, it is better when kept close to the neutral point of that range. Raising the arm, to the side or forwards, by more than about 45°, can restrict shoulder tendon blood flow and press the tendon against the underside of the acromioclavicular arch (linking the collar bone and shoulder blade). The arm is best kept in front of the line of the shoulders (sagittal plane), especially when elevated.

Some people have advocated the use of arm rests, supporting the arm in a raised position above the patient. While these might be beneficial in the short term, especially for those with existing shoulder problems, they are no substitute for working on getting the arm angle down.

Elevating the shoulder joint itself (this will occur at arm angles above about 60°) can lead to a risk of tension or compression in the nerves of the brachial plexus, especially if combined with adverse neck postures.

Fig. 6: Setting the screen to one side can make it easier to view.

Fig. 7: Move the screen if you need to during a procedure.

As well as the patient, the other area you will need to reach to on a regular basis will be the controls of the ultrasound machine. At times this will need a compromise between the need to reach the patient and the need to reach the controls. The Toshiba Aplio can help you with this. The position of the control console can be adjusted, to move the controls to a better location (Fig. 4) and, to give you even greater flexibility, many of the controls are re-programmable so you can decide, for example, where on the console you want important controls to be located (Fig. 5). As well as altering the controls on the console, moving the whole console can be helpful, especially in carrying out procedures where you would otherwise be stretching both ways at once.

Watch when you're looking

What do you most need to look at when you are doing a scan? It will usually be the ultrasound monitor screen (with the occasional glance at the patient). Are you sitting facing this screen, or is it to one side of you so that you have a twisted neck? Is it at the right height for your line of sight, or are you looking down at it, adding flexion to the neck rotation?

As with the console, the wide range of adjustability of the Aplio monitor helps you to get this right. Make sure that you have it at the right height, especially if you are standing to scan. Moving the screen sideways, towards the patient, can be a great help when carrying out procedures that require you to lean across (Fig. 6).

The neck vertebrae are the most mobile in the spine, but this mobility comes at a potential cost. Working for long periods with your neck twisted creates a low level tension within the neck muscles, which allows the gradual build-up of fatigue. Add shoulder elevation to one side and you have a recipe for neuromuscular tension problems. With age-related spinal degeneration in the mix, the scope for some gradual misalignment of bony structures in the neck is increased. You should take priority over the patient in viewing the screen. Showing any images to them is a courtesy not a primary requirement. Ideally, where this is customary (such as in pregnancy scans), a second screen will be provided. If it is not, freezing an image and then turning the screen to the patient is preferable to 'sharing' the screen while scanning. The monitor handle allows you to move the screen with one hand while you are scanning (and avoid finger smears on the screen (Fig.7).

Are you sitting comfortably?

Sitting is fundamentally bad for the human spine and trunk muscles. It distorts the shape of the spine, increases the pressure on the intervertebral discs, and increases the tension on the muscles, ligaments and other soft tissues which help to maintain the integrity of the spine – and that is when you are sitting upright. Add on the leaning and twisting which can also be associated with ultrasound procedures and the problems are compounded.

Fig. 8 a/b: Standing to scan can reduce the strain on the back and pelvis.

The first point to consider therefore is whether or not you would be better off standing – at least for some types of scan. Any procedure which requires a lot of twisting, leaning or stretching might well be better performed standing (but don't forget to get the patient to move for you when possible (Fig. 8). Sitting, particularly on a conventional chair 'holds' your pelvis in place, reducing your mobility compared to standing.

Even for simpler, more static procedures, much of the discomfort from sitting stems from spending prolonged periods with little or no movement of the muscles involved. If nothing else, standing up and moving about between patients (perhaps to fetch the next patient) is valuable exercise. If you are going to stand to work however, do make sure that you raise the bed or couch accordingly. Sometimes, having the patient sitting offers the best solution (Fig. 9).

Another potential benefit of standing to scan is that, depending on the design of the bed, it can solve the problem of where to put your knees. Much ultrasound work requires a compromise between your legs and arms. The arm 'works' best in front of the body and so, ideally, you would sit facing the patient. However, on a conventional chair your knees stick forwards and you won't be able to reach – so you sit sideways and reach out to the side. This solves the knee problem but, as a result, you will be twisting your neck or back (or both) to look towards the patient (as well as not being so good for your shoulder).

One compromise is the sit-stand chair. As the name suggests, it results in a posture somewhere between sitting (legs at 90°) and standing (legs straight). As a result, there is less knee in the way and it is easier to sit facing the patient. If you are not familiar with these chairs, try sitting on the edge of a desk. This will give you a good idea of the posture which results from using such a chair. Of course you are sitting higher, and so the patient bed will need to be raised accordingly.

In some sit-stand chairs, the seat is relatively shallow (front to back). Other styles however are shaped, rather like a large bicycle saddle. This leads to another style of chair which can be useful, the saddle chair. Saddle chairs can be lower (more like a conventional chair) but you bestride it (as you would a saddle on a horse) with your thighs sloping downwards (again, as on a horse). This has the benefit of providing for a more 'open' trunk-thigh angle (good for the spine) and again meaning that your knees do not 'stick out' so far. However, the main advantage of this type of chair is the enhanced lateral mobility compared to a conventional chair. With a normal chair, the pelvis 'sits' firmly on the flat seat and any sideways leaning is predominantly achieved through lateral flexion of the spine (many are also slightly dished which increases this effect). In contrast, on a saddle chair the seat shape allows the user to tilt their pelvis as they lean, placing their foot more to the side at the same time to provide further stability (Fig. 10).

A similar sitting posture can be obtained from another style of chair, the kneeling chair. However, this style is NOT recommended for ultrasound work. The stabilisation provided by the knees make any leaning, turning or twisting required more of a problem and, unless you can guarantee working straight ahead of you, such chairs should not be used.

Some chairs used for ultrasound work are fitted with a backrest. In normal sitting, using the backrest (correctly adjusted for angle and support height) is an essential part of minimising the strain on the spine and back. Ultrasound work is no different and a good, well-designed backrest, properly adjusted can be a great help. Again, the design of the backrest should help you, not hinder you. With most conventional seating, the backrest is concave, curving round you to help hold you in an upright position. In ultrasound work this would be a hindrance as it would work against you when you need to lean to the side. In contrast a flat, or even slightly convex, backrest allows you to lean to the side while still leaning back against the backrest, still therefore providing you with some upper body support and taking some of the strain off your trunk muscles (Fig. 11).

The type of chair you choose will, to a certain extent, be a matter of personal preference. You should therefore take into account the design of bed or couch; the type of procedure you are mostly going to carry out; and the availability of different types of chair; in making your selection.

However you sit, you should ideally sit high enough for your elbow height to be higher than the patient so you are not holding your arm up all the time.

Many hands make light work

One idea which some people have advocated is that of sitting facing the other way, allowing you to change hands, to scan with your left rather than your right (or vice versa). Intuitively this would, you would think, halve the strain on either side. It could be helpful but, the reality is unlikely to be so straightforward and I certainly wouldn't advocate it for everybody. Firstly, if you try this, bear in mind that it will initially place extra strain on the unaccustomed side. Think how much more strain you felt when you first started out carrying out scans. There is always more muscle tension with unaccustomed movements and actions and this will be the case here until you have learned them all over again with the other hand. It will certainly slow you down, and might reduce the accuracy and precision with which you can work.

Secondly, not everybody finds such change easy. Apart from anything else, the habit of facing the patient's face or their feet (depending on how you have been trained) is hard to break. A third factor is the question of how 'handed' you are. Some people are very strongly one-handed (usually the right) and would find swapping over much more of a challenge.

Looking at the big picture

In summary, the muscles, ligaments, joints etc. of the human body are designed for movement. No matter how good a posture you adopt, it will become uncomfortable over time with little or no movement. How long a particular muscle will tolerate immobility will depend, to some extent, on the muscle in question, but also on the amount of effort demanded of it in maintaining that position.

Each body segment or joint has a 'neutral' posture: the position it adopts when relaxed. As a rough rule of thumb, the further you deviate from that posture the more load is imposed on the muscles maintaining that position. Think about how you sit and work. A twisted spine has more load on it than a straight spine; an arm hanging by your side creates less shoulder load than one at 45°; and so on.

Fig. 9: Getting the patient to sit can help you to achieve a good working posture.

Fig. 10: Using a saddle seat can reduce the strain on the low back and pelvis, especially when reaching across a patient.

Fig. 11: As the name suggests, the back rest on your chair is important. Make sure that it is correctly adjusted and use it when scanning.

With this in mind, think about how you lay out and use your workplace. Move things (including patients) to a better position if possible, rather than compensating with awkward postures.

Where equipment can be adjusted, make full use of that facility. Where it can't be adjusted, can it be replaced by adjustable versions? This applies to your patient couch; your chair; and your ultrasound machine. As mentioned earlier, your Toshiba Aplio has a variety of adjustable features. However, these are only as good as you make them. Make sure you know how they work and how best to use them and the rest of your workplace to make your ultrasound scanning as comfortable and efficient as possible.

How big a problem are MSDs?

As stated earlier, musculoskeletal disorders (MSDs) are a significant problem in most occupational groups and those carrying out ultrasound scans on a regular basis are no exception. Morton and Delf (2008) summarised the findings from more than ten surveys of ultrasound operators which reported prevalences of musculoskeletal pain and discomfort ranging from 63 – 89.7%. Although some of these surveys have methodological deficiencies, the overall message is clear, that musculoskeletal disorders are a serious problem amongst ultrasound practitioners (sonographers)[2].

The symptoms associated with MSDs can vary in nature and intensity. They can range from an occasional aching after an extended period of ultrasonography to severe, disabling pain. Neural symptoms can similarly vary from a vague numbness or tingling in the hand to severe loss of sensation (or again disabling neural pain radiating up or down the whole arm).

These symptoms are not restricted to one part of the body. For example, Wihlidal and Kumar (1997), in a study of sonographers in Alberta, Canada, reported the highest levels of symptoms affecting the shoulder girdle, neck, low back and forearms/hands. The exact order might vary between studies. Nevertheless a clear pattern emerges of these four areas of the body being those most affected.

What causes MSDs?

MSD symptoms occur widely in the adult population. For example, a UK-based survey of adults randomly selected from GP practices (Palmer et al, 2008) found that 46% reported arm pain in the previous 12 months. Of those with arm pain, nearly a quarter considered it to have been caused by their work, although interestingly only just over half of these had work which was considered to involve 'arm straining activities'. Clearly, it is not always easy to differentiate between provoking symptoms and causing any underlying problem.

Put simply, if you have a sore muscle for whatever reason, using that muscle will make it hurt, even though that use has not caused the soreness in the first place.

In practise however, the distinction is less important if trying to carry out your job leads to disabling pain. For example, in a study of sonographers which showed shoulder pain to be their most common problem, it was no surprise that work involving sustained shoulder abduction was most likely to aggravate symptoms (Muir et al, 2004).

Other researchers have carried out a more objective evaluation. For example, using a mixture of joint angle measurement and muscle electrical activity (emg), Village and Trask (2007) showed that, on average, sonographers spent almost 50% of their scanning time with their shoulders raised by more than 45° and had their neck bent forward, laterally or twisted more than 20° for an average of almost 40 % of the scanning time. Data such as these can be compared objectively to factors believed to cause MSDs and can add to our understanding of causation (rather than aggravation). For example, objective emg data from the same study provided

How your work is organised is also important. Although any ultrasound procedure can lead to problems, the different procedures do place more strain on different body parts and, where practicable, carrying out a variety of procedures during the day will allow parts of the body to recover at different times. Try to organise your work so you get frequent short breaks away from your ultrasound station, even if it is just to write up report notes or greet the next patient. The muscle movement associated with this will provide valuable active recovery. While you are about it, if you have a separate desk for writing-up, make sure that this is correctly set up as well.

Finally, this paper provides a basic guide to the ergonomics of ultrasound work. It is however inevitably general and you might benefit from more detailed advice, tailored to the working conditions you have to contend with. Your Toshiba clinical specialist can give some further help or, if you need to go for the hard stuff, a professional ergonomist (preferably one recognised by the Institute of Ergonomics and Human Factors in the UK, or the equivalent professional body in your country) should be able to help you.

Possible sources of expert help:
Institute of Ergonomics and Human Factors:
http://www.ergonomics.org.uk
International Ergonomics Association: Federated Societies:
http://www.iea.cc/03_member/Federated%20Societies.html

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Footnotes

1 Some types of glove have been shown to cause allergies, especially with sustained use. Alternatives are available and you should liaise with relevant health and safety experts to select the most suitable type.

2 Although most papers on this topic relate the problem to sonographers, other occupational groups or sub-groups can also be affected. Those reported in the literature include echocardiologists, vascular technologists, and sonologists.

objective support for the perceived role of high grip force in hand/wrist problems amongst ultrasound practitioners.

A number of studies have shown the prevalence of MSDs to increase with years of experience in ultrasound. For example, Evans et al (2009) reported pain while scanning to be most common amongst those over 50 with more than 20 years of experience. In many sonographers, age and years of experience go hand in hand, and it is easy to assume that all of this increased incidence with age can be blamed on their work. However, many MSDs have an age-related degenerative component. For example, by the age of 50, most people will have signs of degeneration of their cervical vertebrae, and a proportion will have symptoms as a result (such as pain or neural symptoms across the shoulder and down the arm) regardless of what they do for a living.

It should be also noted that Evans et al found nearly 15 % to have less than 6 years experience. Studies amongst other populations have shown individual differences in anatomy, to have a significant impact on the risk of subsequent injury. For example, specific aspects of the anatomy of the wrist have been related to carpal tunnel syndrome. In extreme cases, individuals have been known to develop symptoms (for example of tenosynovitis) within a week of starting work (although not, I hasten to add, in sonography).

Does it matter what type of ultrasound procedure I carry out?

Anecdotally, the type of scan undertaken is believed to be an influential factor in developing MSDs. However, although the differences in postures required suggests this to be a valid assumption, objective data presents a mixed picture. For example, Wihlidahl and Kumar (1997) demonstrated relationships between the type of postural 'shortcoming' (e.g. twisted neck, elevated shoulder) and the sites of symptoms. In turn, this might be expected to lead to specific procedures being more likely to result in more symptoms. Similarly, Smith et al, (1997) reported an increased incidence of symptoms amongst those performing longer scans; or more scans per month. Again, it could be assumed that those procedures which routinely take longer would therefore be more likely to lead to problems. However, Russo et al (2002) found few differences between those reporting pain and discomfort and those not, for different procedures, in terms of the frequency of scans performed per week or their typical duration.

The explanation is probably that the picture is, in reality, quite complex. Burnett and Campbell-Kyreghyan (2010) presented the results of a systematic assessment of various risk factors associated with different scan procedures. The authors found certain aspects to predominate in certain procedures. For example, average transducer force was much higher in DVT procedures than others whilst, in contrast, the average angle of wrist deviation was much higher in thyroid scans. The authors concluded that all of the investigated scan procedures involved injury risks, although the specific risk factors and their relative importance varied between scan types.

In all instances, the individual variation in values was usually extremely high. This high level of variation between individuals, even for the same procedure, suggests, in the words of the popular song, that the answer is probably: "It ain't what you do, it's the way that you do it".

The Diagnostic Value of Contrast-enhanced Ultrasound in the Management of HCC

H. Kinkel

Introduction

Hepatocellular carcinoma (HCC) is one of the most common gastrointestinal tumors and the third leading cause of cancer mortality[1]. Chronic hepatitis B and C, alcoholic steatohepatitis (ASH) and nonalcoholic steatohepatitis (NASH) play a major role in the development of HCC. To reduce the mortality associated with HCC, early detection and initiation of curative therapy are essential.

While alpha-fetoprotein (AFP) levels and high resolution liver imaging are mainstays of monitoring programs for patients with chronic cirrhosis, contrast-enhanced ultrasound (CEUS) imaging visualizes HCC vascularity facilitating differential diagnoses. Being a dynamic real-time procedure, CEUS reflects both arterial wash-in and perfusion phases (portal venous and late phases) with high frame rates and outstanding spatial resolution. Since perfused (viable) and non-perfused (non-viable) areas are well distinguished, CEUS characterizes and differentiates liver tumors with high sensitivity and specificity[2]. CEUS can be used to select and monitor the most appropriate curative HCC therapy from the range available to best meet the needs of individual patients.

Diagnostic confirmation of focal liver lesions with CEUS

Ultrasound is a simple, inexpensive modality allowing differentiation of focal lesions from surrounding healthy tissue. Echogenic characteristics are varied and include lesions which appear echogenic, hypoechoic and/or inhomogeneous (Fig. 1). Fibrotic and cirrhotic liver parenchyma have different architecture to normal tissue because of the growth of connective tissue, subsequently the B-mode image is significantly more heterogeneous and hyperechoic than in normal liver, making the detection of focal lesions in this scenario more difficult. Moreover, regenerative processes in the cirrhotic liver appear heterogeneous, partly echogenic and partly hypoechoic in the B-mode image, making clear differentiation from tumor tissue with conventional ultrasound difficult.

The role of ultrasound is well established in the follow-up of patients with cirrhosis[3,4]. It is well accepted by patients, is a low-cost procedure and reportedly offers reasonable diagnostic certainty with a sensitivity of up to 89 % and a specificity of 90 %[5,6]. However the detection of small lesions (less than 2 cm diameter) depends to a great extent on operator experience and the quality of the ultrasound system[7]. The performance of low mechanical index (MI) contrast-enhanced ultrasound (CEUS) with SonoVue® (Bracco, Milan, Italy) allows greater characterization and diagnostic differentiation of focal lesions[2].

Fig. 1: B-mode representation of an HCC showing mixed echogenicity with both echogenic and hypoechoic areas.

Dr Horst Kinkel, Department of Gastroenterology, Akademisches Lehrkrankenhaus Düren, Germany

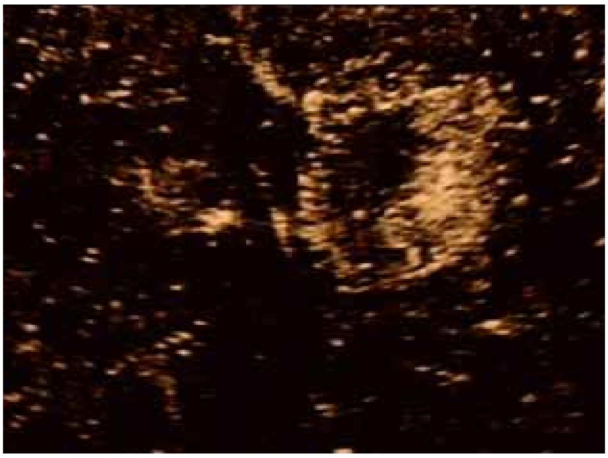

Fig. 2: CEUS image of an HCC showing the hyperechoic contrast agent during the wash-in phase

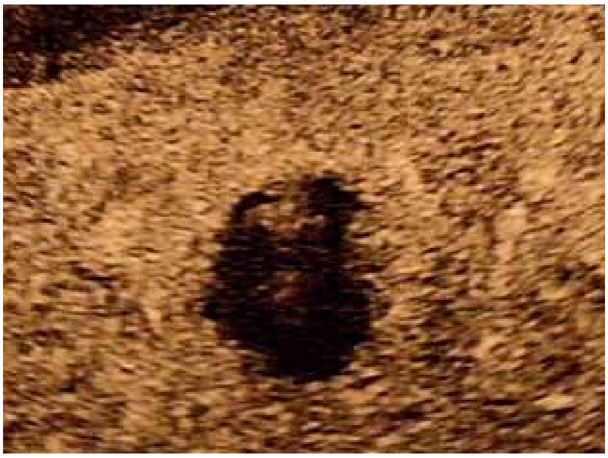

Fig. 3: CEUS image of an HCC depicted as anechoic region during the wash-out phase (portal venous and late phase)

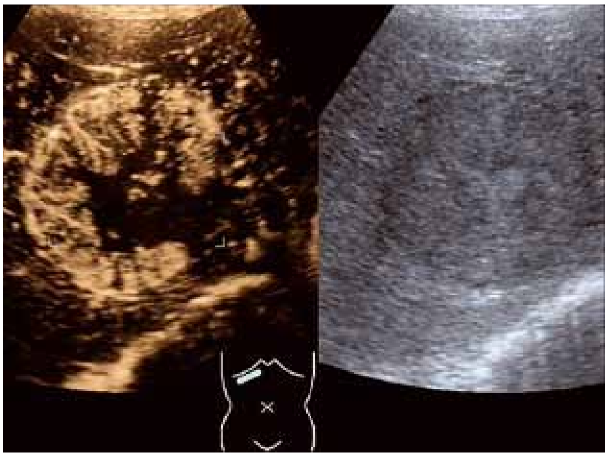

Fig. 4: Micro-architecture of the tumor blood supply can be visualized by CEUS

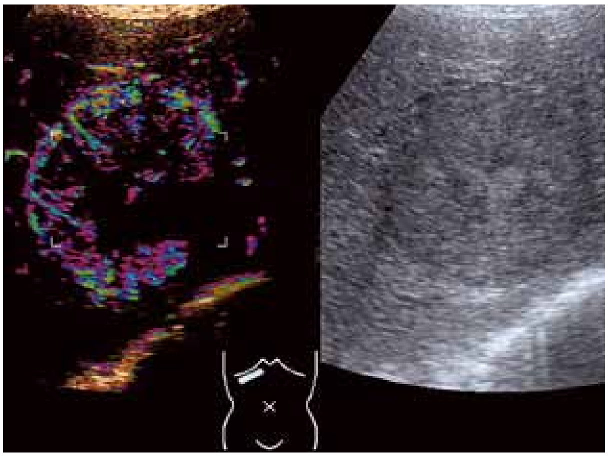

Fig. 5: Parametric imaging – color-coded representation of the "wash-in" phase in the tumor

A typical HCC has a unique vascularization due to arterial neoangiogenesis. This vascularity can be visualized in CT, MRI and CEUS as contrast enhancement[8,9,10,11]. Three distinct phases can be seen in HCC during CEUS evaluation. In the arterial phase the HCC is hyper-perfused compared to the surrounding tissue and presents as a region of hyper-echogenicity (Fig. 2). During the portal venous phase the contrast agent is washed out as portal venous blood supply in the HCC is less than that in the surrounding liver parenchyma (Fig. 3). In the late phase the wash-out increases and the HCC can be differentiated clearly from the surrounding parenchyma as a hypoechoic lesion. CEUS visualizes this vascularity with a sensitivity of up to 91%, and a specificity of up to 92% depending on operator experience[12,13].

The intensity and speed of the wash-out correlate to the differentiation of the HCC, in well differentiated HCC (G1) wash-out is late and low, in less well differentiated HCC (G2 and G3) wash-out is early and strong[14].

CEUS real-time visualization of vessel architecture and vascularization allows recognition of different pathologic patterns greatly facilitating diagnosis (Fig. 4). Additional ultrasound data processing can lead to color-coded vessel patterns to represent arrival time of contrast (Fig. 5) or display 3D reconstructions (Fig. 6), aiding interpretation especially by inexperienced or non-imaging medical personnel. Raw data acquisition of CEUS enables to carry out a time curve analysis with graphical and numerical values for parameters such as time to peak, wash-in, wash-out and area under the curve.

Ultrasound and CEUS-assisted biopsy

In a non-surgical setting histological confirmation of HCC prior to any curative therapy is recommended. Ultrasound-guided biopsy is a safe and easy way to collect tissue samples. CEUS-assisted biopsy highlights the viable region of tumor tissue improving the sampling results[15].

Ultrasound and CEUS-assisted therapy

Sonography plays a vital role in the perioperative follow-up of HCC surgery. CEUS can incidentally also improve the diagnostic certainty in the diagnosis of hemorrhage, hematoma or abscess.

Local ablation procedures such as RFA (radiofrequency ablation) and PEI (percutaneous ethanol injection) are standard therapeutic options for inoperable patients[3,16]. Such therapies require safe positioning of the probe. Ultrasound and specifically CEUS guidance supports the exact tran-

Fig. 6a: An HCC in the left hepatic lobe in the B-mode

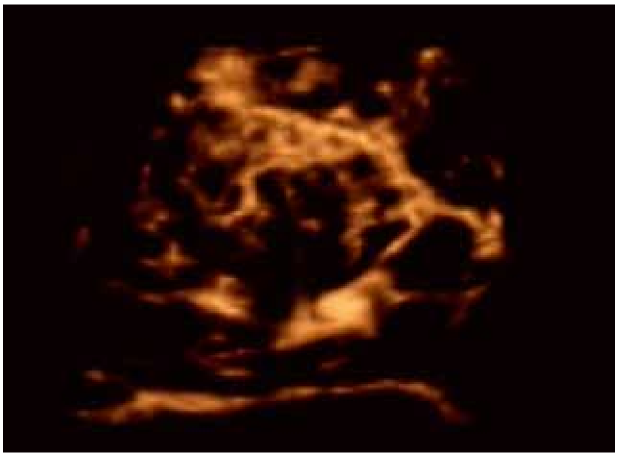

Fig. 6b: 3D visualization of CEUS in an HCC in the arterial phase

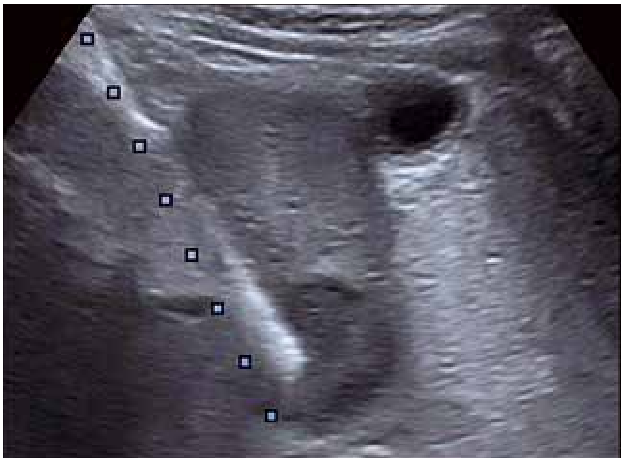

Fig. 7a: A small HCC in the left hepatic lobe (close to the gall bladder) which was inoperable due to a comorbidity. The biopsy guide (dotted line) and needle position can been seen in the image.

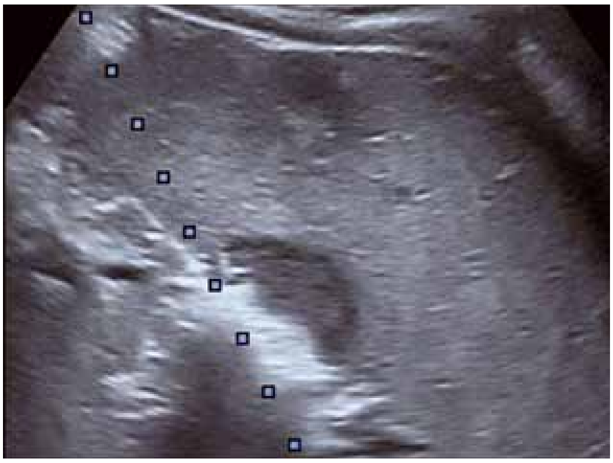

Fig. 7b: Ethanol injection during local ablation is visible as echogenic filling of the HCC

scutaneous and intraoperative probe placement while allowing continuous monitoring of the ablation procedure[4] (Fig. 7).

The outcome of the ablation procedure is defined by the resultant extent of the coagulative necrosis – and thus tumor destruction. Tumor necrosis post ablation is visible in CEUS as a complete contrast defect at the ablated site in the arterial, portal venous and late phase (Fig. 8). Visible perfusion indicates viable tumor tissue requiring a repeat ablation (Fig. 9). Depending on tumor size and degree of the cirrhosis local ablation therapy can achieve a five-year survival rate of more than 70%[17]. Hence optimization of the ablation outcome using CEUS has potential benefits for patient outcome.

Summary

CEUS is well suited for the detection and differentiation of HCC in the cirrhotic liver and increases diagnostic certainty compared to conventional B-mode imaging.

CEUS can support different therap ies by visualizing tumor vascularity. This allows the assessment of the tumor response and improves the clinical outcome for the patient.

In local ablation procedures ultrasound is well suited for monitoring purposes both during intervention and follow-up.

Used by an experienced sonographer ultrasound and CEUS may be the modalities of choice for the diagnosis of HCC.

Fig. 8a: HCC post-RFA in the B-mode

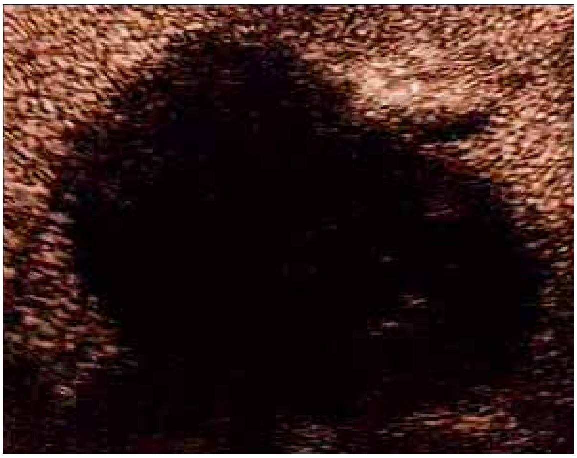

Fig. 8b: Complete contrast defect confirms successful complete ablation

Fig. 9a: HCC post-SIRT (selective internal radiation therapy) in the B-mode image

Fig. 9b: Incomplete necrosis after SIRT, suggesting viable tumor tissue is present

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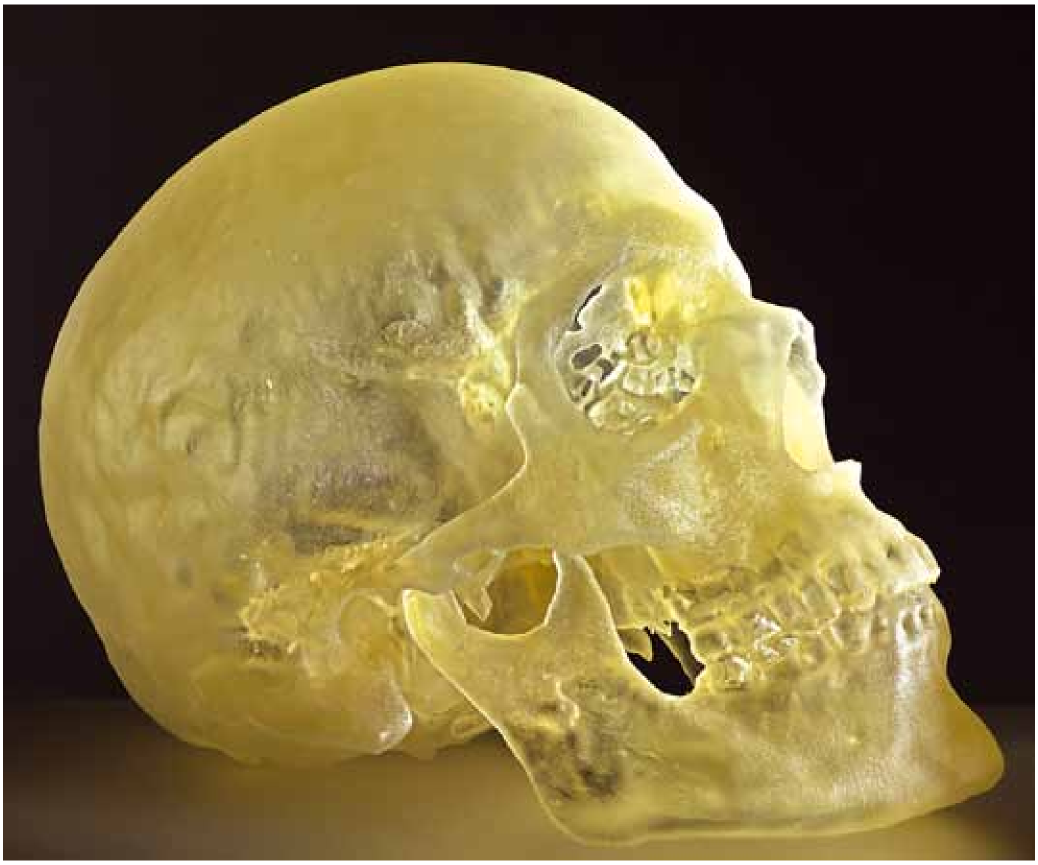
From CT scan to solid gold

Bone as Art

By Marije Wilmink

For his new project Skeleton, Dutch sculptor Caspar Berger has used the very latest medical techniques to reveal the invisible. He has had his body scanned using the advanced Toshiba AquilionPrime CT scanner, which can 'capture' a body in slices just half a millimetre thick. After much experimentation, a copy of Berger's own skeleton finally rolled off the 3D printer. This will now form the basis for a series of art works in bronze, silver and gold. So far the highlights are an upper arm bone cast in gold and a skull in photo-polymer. Berger's project not only adds an entirely new dimension to the concept of the self-portrait, it has also brought about a unique form of medical, technical and artistic collaboration.



3D print of Caspar Berger's skull

Caspar Berger's work has been exploring the phenomenon of the self-portrait in art history for the past ten years. His most recent portraits have mainly been casts of his own body, his own skin as the essential boundary between the external (outward appearance) and the internal (the inner self). The work raises questions about how much 'self' is actually needed to create a portrait of someone.

For his latest work Berger decided to delve a layer deeper and concentrate on what supports the body from within: the skeleton. "In my view the skeleton isn't only the basis of the physical body, it's also the bearer of our 'eternal identity'," he says. "After all, our bones are what will continue to reveal who we were long after we're gone." Berger became fascinated by the increasingly advanced medical techniques to make the invisible visible. Wouldn't a CT scan be the ideal way to achieve the ultimate state of having 'nothing left to hide'?

Radiation

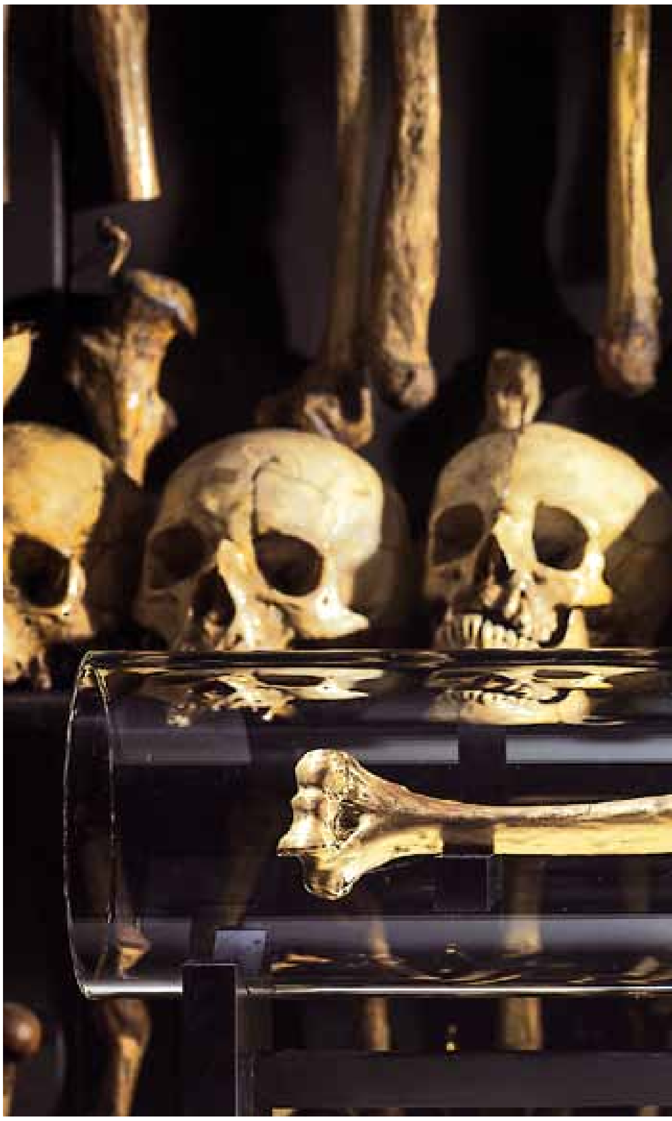
Through a metal casting specialist he'd worked with before, Ron Klauss, Berger contacted radiologist Jan Willem Kuiper of the Lange Land Hospital in Zoetermeer, close to The Hague in the Netherlands. Kuiper was immediately fascinated by the idea – although he had his doubts at first. "Of course we quite often reconstruct parts of a person's body using a CT scan, for example to prepare for complicated operations or bone implants," he says. "But to scan a healthy body for artistic reasons... With a CT scan you're exposed to quite a considerable dose of radiation." He also drew Berger's attention to another risk: that the scan could potentially reveal a tumour or some other latent physical threat. But again, this wasn't enough to deter the artist. So in the end Kuiper agreed to work on the project. And one evening, when there were no patients at the radiology department, he put Berger through the ultra-advanced Toshiba scanner.

"Toshiba Wizard"

Because the data from the CT scanner had to be exported via the 3D workstation to the 3D printer using Toshiba systems, Kuiper also got Jos Ruis, Director of Toshiba Medical Systems Europe, involved in the project. "The plan intrigued me," Ruis says, "and I wanted to contribute our expertise. There was also a lot we could learn from it, because up to then we'd only worked with 3D simulations on a flat plane. This was the first time the image processing station was being used to generate a tangible 3D print."

There proved to be a lot more problems than had been anticipated in converting the data from the scan. So another Toshiba man came on board: Roy Verlaan, CT system application specialist. Berger calls him the 'Toshiba Wizard', because he wouldn't stop experimenting until the digital data was good enough to make a 3D copy that left all the fine bone structure visible.

"Eventually, after a lot of testing, it turned out to be down to a combination of different parameters," Verlaan says. "The size of the reconstruction intervals, the level of filtering and the number of triangles the images were made up of." The imaging techniques used in the process aren't new, says Kuiper. "But they've been packaged together by a group of people from different disciplines who've



Golden humerus (picture taken in Museum Vrolik – Amsterdam)

gone off the beaten track and applied their expertise to make a new result possible. That's how innovation happens."

Three kilos of gold

Two parts of Berger's skeleton – a humerus, or upper arm bone, and the skull – were 'printed out' in June by RP2, the company run by 3D printing specialist Mike de Winter. In the meantime, Berger had received an inheritance from his recently deceased father. "I could have put the money in the bank, but I thought I might just as well invest it in gold and cast an art work with it. After all, banks are only banks these days... And at the same time I thought the symbolism was wonderful, using what my father had left me to make a gold upper arm bone and knowing that he'd always be in my bones."

Casting the bone was quite a challenge for metal caster Ron Klauss. "I'd never cast in gold before in such a large quantity, so I was sweating over it beforehand trying to work out the right way to do it. Especially because it was a tricky shape: long and thin in the middle, wide at the ends. And gold shrinks quite differently from silver and bronze. For-

Detail of golden humerus

Artist Caspar Berger in discussion with radiologist Dr Jan Willem Kuiper

tunately it has turned out beautifully. And the fact that everyone was working right at the edge of their ability is exactly what has made it such a fascinating project for everyone involved."

Berger has incorporated the gold bone in the piece Self-portrait 20. A modern relic, as he describes it. "Normally with relics people venerate dead bits of saints. I'm playing with the idea of venerating people after their death. This is a relic while I'm still alive."

Secrets of our being

Self-portrait 20 is the first work in a series to be entitled Skeleton. After the arm and skull, Berger will go on to cast the other bones and incorporate them in different forms of presentation. "I'm planning to present my bones as a set of sculptural objects, based on the idea of a collection, and I also want to further develop the concept of the veneration of relics, reconstruction and identity".

In Skeleton Berger deals with themes such as life and death, the veneration of the body and the desire for (and fear of) all-encompassing knowledge. "Driven by the will to understand and fathom the workings of the human body, science is able to go deeper and deeper into the secrets of our being. And look: while I'm alive I can now hold a piece of my own skeleton in my hands and show it to the world. Something that in the past would only have appeared after my death. In fact, with this bone I'm holding a symbol of my own death. But am I holding the true essence of my being? Is this piece of bone really all that will remain of the person Caspar Berger, for ever and ever?"

Translation: Michael Blass
Photography: Erik en Petra Hesmerg
Website: www.casparberger.nl

Royal Service

Toshiba's Managed Equipment Solution at the Queen Elizabeth Hospital

Queen Elizabeth Hospital is a modern NHS General Hospital near Greenwich, close to central London. It is part of an NHS Trust which provides acute hospital care for a population of over 1.3 million people across South London.

The Queen Elizabeth is one of two acute hospitals in the Trust, while a third hospital provides elective care. The QE hospital was built in 2001 and was one of the first UK hospitals to eliminate film in favour of complete digital imaging and archiving. The hospital has led in adopting new technology and equipment in radiology, cardiology, operating theatres, the large maternity unit (with over 5,000 deliveries a year), modern pathology, full intensive care facilities and it also has a very busy emergency service.

In 2001, the Queen Elizabeth Hospital decided to implement an innovative managed equipment service (MES) solution for its entire medical equipment. Ten years have passed and we felt it was a good time to look at the service. We talked to Dr Robert Baxter, a vastly experienced anaesthetist, who has been at the forefront of selecting new technology for the hospital and is interested in every patient service and clinical area.

Why did the hospital decide to adopt a managed solution for its medical equipment?

Dr Baxter: We wanted a better way. The old system allocated a fixed sum of money at the start of each financial year, based on what Management thought it could afford, rather than the actual clinical need. All clinical departments then had to bid against this at a large equipment meeting, so everyone ended up equally unhappy and there were cumulative deficiencies and obsolescences that were never addressed. We also found that whenever a new quality standard was published or when there was a major breakdown threatening service, Management had to find extra funding from somewhere, and this was very uncertain.

Our move to a new hospital site in 2001 allowed us to have a complete rethink of service provision, and the idea of paying a regular charge to an outside provider to manage the entire equipment service, provide guaranteed replacements on a pre-defined

The Toshiba MES team at the QEH

schedule and ensure servicing and training was all done on time, was seen as the most attractive option. In addition, the UK Government Treasury levied a capital charge of 6% per annum on all hospital-owned equipment with a certain value and coupled with the high rate of VAT, the cost to re-equip was very high. We have found that having the medical equipment owned by an outside provider minimised and even eliminated these charges, and helped to pay for better service management.

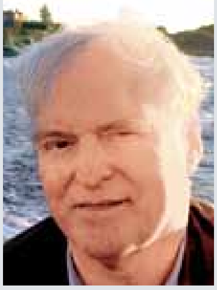
Now that the first 10 years have passed, how do you look back on this new way of working?
Dr Baxter: The managed solution has worked very well. Equipment has been replaced on schedule, with some flexibility of timing on both sides to meet changing clinical needs. Servicing has been properly resourced with better continuity of workforce than the NHS had previously managed, so that we know our locally based Toshiba equipment team and that consistency helps with faster response.

The project has developed over 10 years so that Toshiba not only provide our choice of equipment but they also source a number of consumable products and re-agents with considerable cost saving to the hospital. A review of the first 10 years showed that, for the remaining 5 years of the contract, the hospital could expect to save approximately £1.5M per year - the equivalent of the nursing salaries required to staff 2 busy wards or 4.5 operating theatres.
Important lessons we learnt from the project:
– The initial equipment inventory needs to be accurate in both the quantity of equipment and the replacement schedule.
– It may better to include all equipment rather than to leave some as “hospital owned, but provider serviced”, which can cause problems with optimising replacement schedules.
– The hospital needs to be flexible in its decision making such that the relevant clinicians can join in the selection process fully. This ensures clinical choice benefits to the hospital and continual clinical engagement in the re-equipping process itself.

How important was “Clinical Freedom of Choice” for you?
Dr Baxter: “Clinical Freedom of Choice” was a key component for gaining the support of the hospital consultant body, at the start of the project. Without this, it is unlikely that the Management at the time could have gained enthusiastic clinical support. So we were looking for both financial benefits and clinical choice.

Did Toshiba’s performance meet your expectations?
Dr Baxter: Relations with Toshiba have been very good and a mutual trust and supportiveness have overcome early difficulties experienced by both sides - Toshiba’s original financial partner withdrew and a major hospital merger meant that the hospital was unable to authorise a number of things for some months. Without good relations, these could have been problem times, but they were overcome in a collaborative way. Performance has been excellent in equipment availability and communications, and the mutual co-operation and benefits were confirmed in a recent 10-year contract review.

Dr Baxter thank you for your insights, into what was an innovative managed solution to the medical equipping of a large new acute care hospital. It is refreshing that the 10-year review period has passed successfully and the managed equipment service has proven to be excellent.



Dr Robert Baxter

Dr Robert Baxter is an eminent anaesthetist who has led the advancement of techniques and technology across numerous London hospitals. He has served on many influential Medical and Management committees both nationally in the UK and across London. He has chaired the Medical Equipment and Devices Group at the QE Hospital for some years and is active with the Royal Colleges and the British Medical Association.

He has always taken a very active interest in the widest possible application of the beneficial aspects of bringing new equipment and technology to hospitals in the acute sector. This is across all specialities, and has led to championing the adoption of these developments and new diagnostic technologies and techniques, for the direct benefit of patients.

Toshiba's Managed Equipment Services at the Queen Elizabeth Hospital

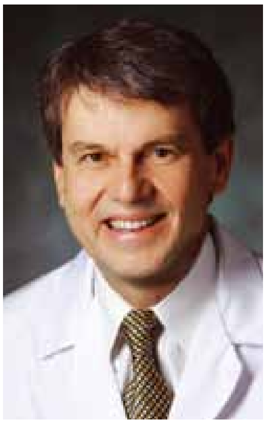
- Procurement, management, maintenance and financing of all medical equipment including service level agreements on overall and individual equipment performance
- Planning and scheduling new equipment in all areas of the hospital with decisions being taken ‘under a clinical choice regime’
- User training initiation and coordination
- Implementation of three ISO quality systems
- Project management (including turnkey) of complex commissioning in radiology, theatres, and pathology
- Transfer of hospital medical technical EME department to Toshiba (all these staff are still with Toshiba today)
- IT communications and the provision of the hospital wide PACS and RIS systems
  Coverage: All medical equipment installed in the hospital and affiliated outpatient/community clinics, in total approx. 7,500 individual systems and products.
  Start of services: 2001; Duration: 15 years

Toshiba Medical Systems
Satellite Symposium @ ESC 2012
"Latest update on 320-row
Computed Tomography Cardiac
Imaging and its clinical results"
25 August, 13.00-14.30,
Room Copenhagen, Village 5

Cardiac Imaging at Its Best: a sneak preview of ESC

From 25 to 29 August 2012 the European Society of Cardiology will meet for its annual congress in Munich, Germany. The ESC Congress is the world's premier conference on the science, management and prevention of cardiovascular disease. More than ever the largest gathering of cardiovascular professionals worldwide is a highly sought-after forum for researchers to present their work. On 25 August from 13:00-14:30 Toshiba Medical Systems will present its Satellite Symposium entitled "Latest update on 320-row computed tomography cardiac imaging and its clinical results". This symposium focuses on current myocardial perfusion research and its clinical relevance. Furthermore, AIDR 3D, an iterative dose reduction technique to acquire ultra low dose chest images, will be presented. Lastly, the use of 320-row CT to guide percutaneous valve replacement will be highlighted.

Myocardial perfusion



Dr Joao Lima
Johns Hopkins Hospital,
Baltimore, USA

CORE320 study design

CORE320 is a prospective, multicenter, multinational study which is unique in that it is designed to assess the diagnostic performance of combined 320-row CTA and myocardial CT perfusion imaging (CTP) in comparison with the combination of invasive coronary angiography and single photon emission computed tomography myocardial perfusion imaging (SPECT-MPI). The trial is being performed at 16 medical centers located in eight countries worldwide. CT has the potential to assess both anatomy and physiology in a single imaging session. The co-primary aim of the CORE320 study is to define the per-patient diagnostic accuracy of the combination of coronary CTA and myocardial CTP to detect physiologically significant coronary artery disease compared with (1) the combination of conventional coronary angiography and SPECT-MPI and (2) conventional coronary angiography alone. If successful, the technology could revolutionize the management of patients with symptomatic CAD. The CTP analysis methods developed for CORE320 will also be described including adjudication for matching vessels to territories. A review of recently published studies will be included.

Myocardial perfusion

Studies of human coronary physiology using 320-row myocardial perfusion imaging

Dr Klaus Fuglsang Kofoed
Rigshospitalet,
Copenhagen, Denmark

Combined 320-row CTA and myocardial CT perfusion imaging provides a unique opportunity to study the relationship between coronary anatomy and myocardial perfusion in humans non-invasively. At Rigshospitalet, University of Copenhagen, Denmark, this new method has been explored in a variety of clinical and research settings. The anatomical and physiological parameters of the heart that may be obtained with 320-row CTA/CTP are reviewed. In addition to high resolution structural information on coronary vessel size, coronary plaque morphology and cardiac chamber size, furthermore very detailed global and regional measures of myocardial perfusion and perfusion reserve may be obtained. Describing the basic relationship between coronary anatomy and myocardial perfusion and perfusion reserve in humans is a prerequisite for understanding and identifying pathophysiology of microvascular disease and coronary atherosclerosis. The experience and results from Rigshospitalet within this field will be presented.

Chest pain triage

with Aquilion ONE and dose reduction strategies – AIDR 3D

Dr Sujith Seneviratne
Monash Heart, Monash Medical Centre, Clayton, Australia

Chest pain represents an important global challenge, accounting for more than 6 million ED presentations at a cost of over 6 billion dollars in the United States alone.
Recent studies utilizing cardiac CT to triage acute chest pain have drawn considerable interest due to its high sensitivity and negative predictive value in excluding obstructive coronary disease and thus acute coronary syndrome. Data supporting the use of Aquilion ONE in this setting will be demonstrated highlighting the safety of discharging after a single troponin in patients with no demonstrable coronary artery disease.
Exposure to multiple radiological procedures may increase life time risk of malignancy. Last few years have seen significant improvements in radiation dose for cardiac CT due to various technological advances. The second half of the presentation will be devoted to the success of AIDR 3D utilized by Toshiba to significantly reduce radiation dose without compromising high image quality.

320-row CT

to guide percutaneous valve replacement strategies – AIDR 3D

Dr Victoria Delgado
Leiden University Medical Center, The Netherlands

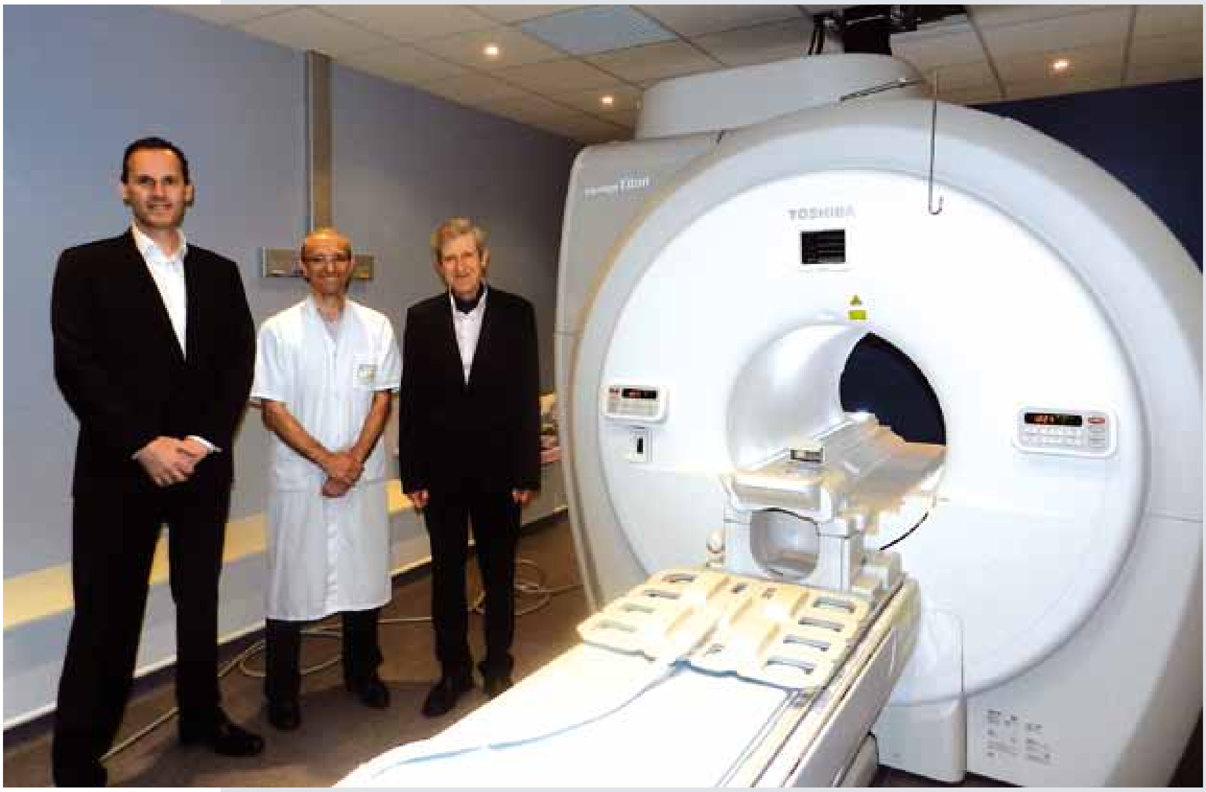
Transcatheter valve implantation has been an important therapeutic breakthrough in the last decade. To date more than 40,000 patients with severe symptomatic aortic stenosis have been treated with this innovative method. In addition, several transcatheter mitral valve repair techniques have been developed to provide a feasible and safe therapeutic alternative for patients with severe mitral regurgitation. Accurate patient selection and procedural guidance are crucial to optimize the outcomes of these therapies. 320-row computed tomography permits visualization of the aortic or mitral valves from unparalleled planes, accurate assessment of the dimensions and geometry of the aortic root and mitral valve complex and precise evaluation of the anatomical relationship with surrounding structures. In transcatheter aortic valve implantation, accurate assessment of the aortic valve annular dimensions is crucial to select the prosthesis size whereas the assessment of the peripheral arteries and aorta will indicate the procedural approach. In transcatheter mitral valve repair, indirect mitral annuloplasty with implantation of a cinching device in the coronary sinus requires exact assessment of the anatomical relationships of the coronary sinus with the mitral annulus and the circumflex artery to optimize the results and minimize complications. These and other aspects can be comprehensively evaluated with 320-row computed tomography.

Worldwide first new Titan Helios MR scanner installed in France

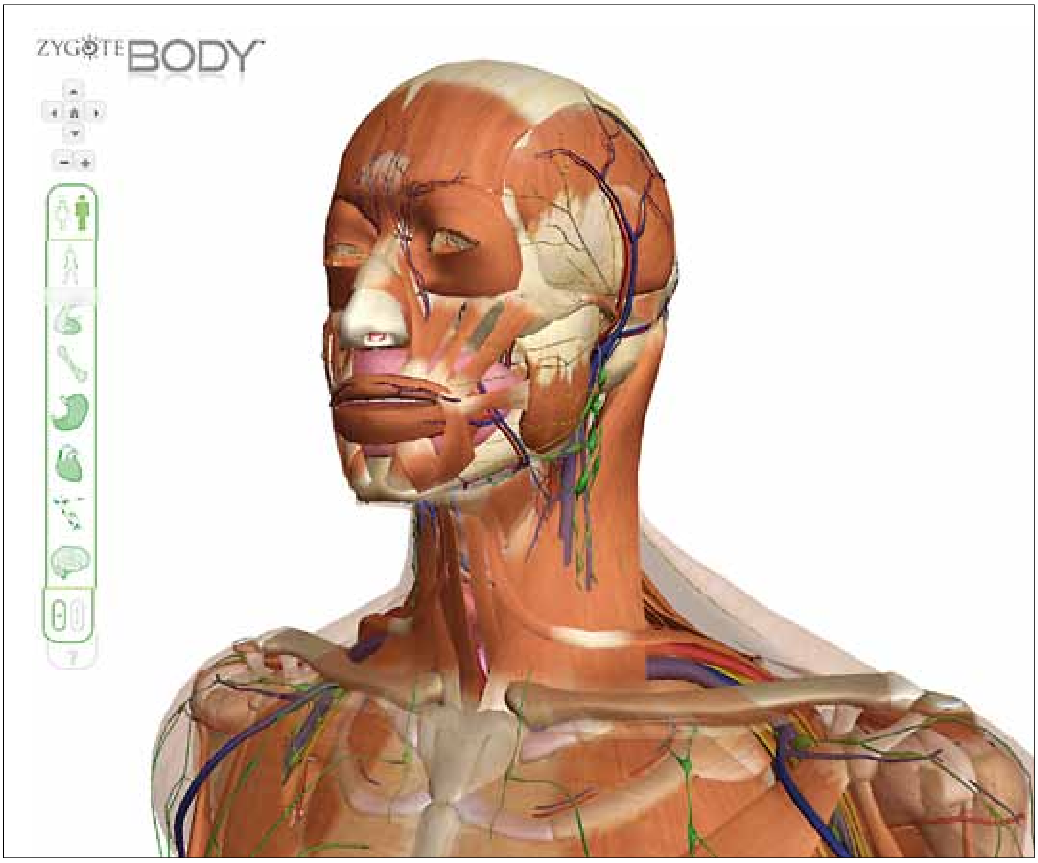
On Monday, 16 April 2012, patient scanning started with the worldwide first Titan Helios MR system in Hôpital Robert Boulin in Libourne, France, close to the famous Bordeaux vineyards of Pomerol and Saint-Émilion.

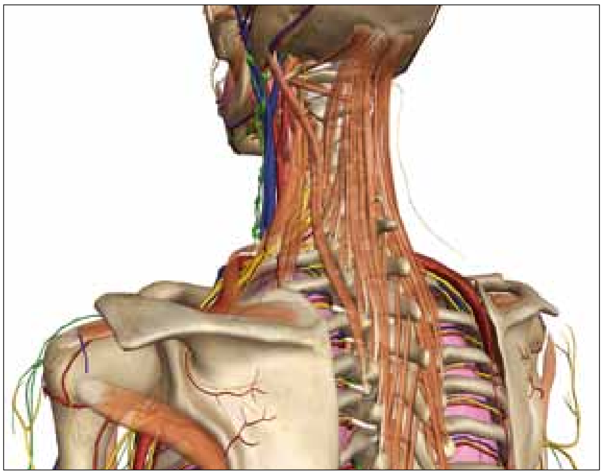
The hospital's medical team is enthusiastic about the new functionalities of Titan Helios – ultra fast Helios gradient, 32 acquisition channels, the M-Power V2 workstation user interface – which are integrated into an MR scanner that offers superior image quality even for diffusion techniques. The greatest clinical benefit of this innovative system are the unique non-contrast MRA acquisition techniques, a robust and efficient application that satisfies a very wide range of diagnosis requirements.

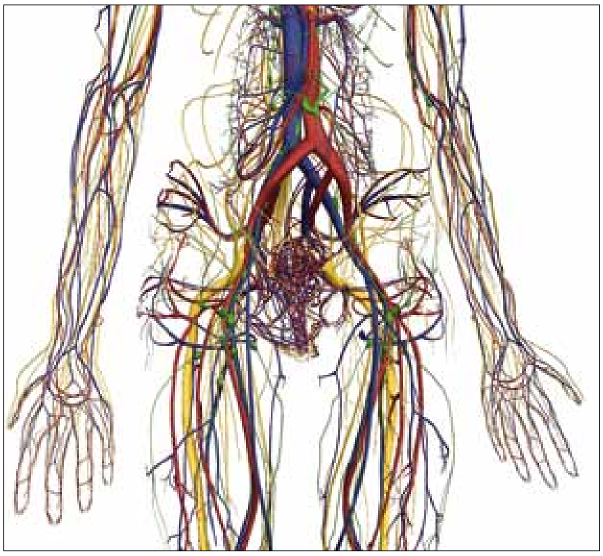
And of course, the Titan's exclusive features, such as large opening, short bore and Pianissimo noise reduction technique make examinations very comfortable. Our patients and physicians alike will benefit from the state-of-the-art high-end technology. The installation process went smoothly down to the agreed delivery date and Dr Merignargues was happy to report: "From the early beginning of this project, Toshiba has kept its commitments".



From left to right: Patrice Coudray (MR market & BU manager, Toshiba Medical France), Dr Frédéric Merignargues (Head of the Medical Imaging Center, Libourne Hospital), Pierre Riou (Financial General Director, Libourne Hospital)







Google Body Browser is now Zygote Body

The Google 3D body reconstruction project has been taken over by Zygote and expanded to include a male as well as a female version.

Body Browser is one of the many products that were discontinued when Google closed Google Labs. The good news is that the service is now back online hosted by Zygote, the company that provided the imagery for Google Body Browser. Zygote Body looks almost like the old Google version and still requires a browser that supports WebGL (Chrome or Firefox). But beware: the site is very slow.

Body Browser started as a project built by Google engineers in their "20 percent time" and it was a great way to promote Chrome's support for WebGL, an API that allows Web apps to generate interactive 3D graphics without using additional plug-ins. The app also worked in Firefox and it was ported to Android Honeycomb. There is no Android app for Zygote Body right now, but the company promises to release one in the future.

Zygote Body uses an open source 3D viewer developed by Google. "This viewer provides a standard way to create and view 3D models in a Web browser, with multiple layers and instant search," explains Google.

http://www.zygotebody.com/

Toshiba to light up the Mona Lisa

©2007 Musee du Louvre/Angele Dequier

The fusion of French artistry with Japanese technology will set a new highlight when Toshiba Corporation replaces part of the interior lighting of the Louvre with its own LED lighting. In phase 2 of a renovation project that Toshiba Corporation and the Louvre Museum have pursued in partnership since 2010, Leonardo da Vinci's Mona Lisa, the Red Rooms, which display famous masterpieces such as Jacques-Louis David's Consecration of the Emperor Napoleon I and Coronation of the Empress Josephine or Delacroix's Liberty Leading the People, as well as the Napoleon Hall, the Louvre's main entrance, will be fitted with Toshiba's LEDs.

Toshiba has already lit up parts of the Louvre's exterior, including I.M. Pei's Pyramid, the Pyramidion, the Colbert Pavilion and the Cour Napoleon. The implementation of the second phase of the project is testament to the successful collaboration between Toshiba and the Louvre Museum in balancing environmental and aesthetic considerations. Renovation of LED lighting in the Cour Carré is also scheduled to be completed in 2013.

With the renovation of exterior lighting, Toshiba and the Louvre Museum are reducing power consumption by 73% without compromising the visual beauty of the museum. The partnership has pursued artistic integrity in the LED lighting from every conceivable perspective – the shape of the fixtures, illumination brightness, colour tone and installation angle – to achieve a lighting finish that respects the scenery of Paris.

Cour Napoleon where lighting has been converted to LED

Since April 2010 Toshiba Corporation has undertaken new lighting projects on a global scale as part of its approach to creating a new lighting culture in harmony with people and the environment. Toshiba perceives this project as an important exemplar of how to extend the longevity and sustain the aesthetic integrity of world heritage sites. As one of the world's foremost eco-conscious companies, Toshiba will further enhance its technical capabilities through experience gained at the Louvre, while contributing to global culture and the mitigation of environmental burdens.
For further information on Toshiba's collaboration with the Louvre, please visit
http://www.toshiba.co.jp/lighting/about/louvre.htm

Powerful business in Russia

Toshiba Corporation has established a joint venture, PM&T Holding B.V. (PM&T), with Power Machines, Russia's leading supplier of power generation equipment. PM&T will be the holding company for Toshiba and Power Machines' power transformer manufacturing company in Russia.

After receiving necessary regulatory approvals, Toshiba acquired 49.99% ownership of PM&T, with Power Machines correspondingly holding 50.01% of the shares. PM&T will function as the holding company for Izhora Transformers (IZT) LLC, which will design, manufacture and sell power transformers. The joint venture is capitalized approximately at US$50 million and the total amount of investment for the construction of new factory is planned to be more than US$160 million.

Established in December 2011 in St. Petersburg, Russia, IZT is currently building a power transformer manufacturing factory that is scheduled to start operation in December 2013. IZT will be active in Russia and other countries of the former Soviet Union, a major market characterized by growing power consumption and a need to replace aging transmission equipment including power transformers. IZT aims to secure market share with products designed and manufactured under technology license agreement with Toshiba.

Smart community for a smart future

Toshiba Corporation is establishing a Smart Community Center in Kawasaki, Japan, that will support, enhance and advance the continued global development and expansion of Toshiba Group's highly promising smart community business. The 15-storey building is scheduled to open in October 2013, and will provide a business base for approximately 7,000 people.

The new center will bring together Toshiba's organizations engaged in smart community businesses in Japan, including Toshiba Group companies and business divisions developing cloud solutions. The consolidation of related staff in a single location will facilitate closer cooperation with Toshiba's nearby R&D centers and social infrastructure engineering and manufacturing facilities.

The center will itself be a showcase for smart community solutions, as it will integrate an intelligent Business Energy Management System (BEMS). Operation of the BEMS will be featured in the center's smart community show room, along with Toshiba Group's latest smart community and smart factory technologies. The new center will comprise inter alia a quake-absorbing structure, uninterruptible power supply and flood barriers.

Cool air for tropical data

Toshiba Corporation has been selected by the Singapore government to carry out a pilot project to promote innovations in energy efficiency that cut the high costs of cooling data centers in tropical climates.

As a major ICT hub, Singapore is host to a huge data center cluster that the BroadGroup has predicted to grow by 50% in scale over the period 2010 to 2015. In Singapore, the ten largest data centers are known to consume as much energy as 130,000 typical households. Such an expansion will trigger a major surge in electricity demand. With the objective to raise overall data center energy efficiency and boost competitiveness of the data center industry, the Infocomm Development Authority of Singapore (IDA), initiated the Green Data Center Innovation Challenge. This challenge encourages companies to innovate solutions that will significantly improve energy efficiency in the data center sector.

Artist's impression of module type data center and facilities

Toshiba has developed and demonstrated a space- and energy-efficient data center that is cooled by air drawn from outside the data center whenever possible—the outside air cooling method—and has reworked this design to deal with the cooling demands imposed by the heat and humidity of the tropics. In a consortium with Singapore-based subsidiary, Toshiba Asia Pacific Pte., Ltd., NTU, Toshiba will provide the module and evaluate operation. NTU, a leader in energy-related research, will provide the site and also undertake evaluation. Simulations indicate that the system has the potential to cut the annual power consumption of a data center by 33% and decrease approximately 2,800 tons of CO_2 emissions.

Toshiba's original outside air data center cooling system was developed in Japan for more temperate climates and has three modes: outer air cooling mode for spring and autumn; mixed air cooling mode for winter, which adds heat from the hot area of the data center to outer air; and circulating cooling mode for summer, which uses a refrigeration unit to cool the air in the data center.

The page on the right is the first in a series of recurrent photo pages that shows that Toshiba and its customers have an eye for the beauty of our planet, the environment and the direct surroundings where Toshiba's systems are installed. Not the actual imaging products but photos of sceneries, cities, countries or other cultural aspects are highlighted on this photo page.

Every reader of VISIONS can participate and get their picture published. The submitted content should include: high resolution (300dpi) image, photo of the hospital and a brief text, name of photographer and Toshiba system(s) installed. The complete result is shown on the opposite page.
Send your pictures and texts to:
jhoogendoorn@tmse.nl, Subject: Photo Page

Landssjúkrahúsið is the Main Hospital in the Faroe Islands where Toshiba's Aquilion ONE is installed.

Faroe is characterised by the lack of trees, resembling Connemara and Dingle in Ireland and the Scottish islands. The Faroe Islands are an island group situated between the Norwegian Sea and the North Atlantic Ocean, approximately halfway between Norway and Iceland.

Photography: Kees Verlooij,
Toshiba Medical Systems Europe
Text source: Wikipedia
This page is based upon an idea
of Prof. Edwin van Beek.

Social Media meets Healthcare

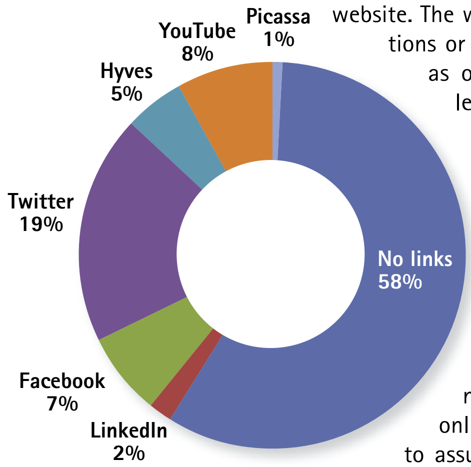
R. Kessels, A. van der Heyden

Today social media are an important part of the overall marketing and communication strategy of a company and a solution for many logistic problems. In Europe 98% of the inhabitants are aware of social media. No less than 73% of the Europeans are member of at least one social network. For the USA these figures are 95% and 76%, for Brazil 97% and 86% and for India 98% and 88%. It is safe to say that today many people get their information from social networks. In addition people tend to connect with their favourite brands or complain about not so favourite ones (Insights Consulting 2011).

Social media and hospitals

But what about connecting with a 'not so sexy' institute such as a hospital? To find out we investigated the use of social media by hospitals in the Netherlands. 12 million of the 16 million Dutch are unique users of social platforms; most of them are on Twitter, Facebook, LinkedIn and/or the Dutch network Hyves. Since we are active on all these platforms ourselves, we wondered: to which extent do Dutch hospitals interact with their clients?

We investigated the usage of social media by Dutch hospitals on a quantitative as well as a qualitative level. The first result revealed that a mere 34 of the 92 hospital organisations in the Netherlands referred to their social media accounts on their website. The way hospitals reacted to posts, questions or check-ins was highly disappointing, as only 30% are (re)active on Twitter, less than 10% on Facebook and even less than 5% on LinkedIn. These results deviate significantly from the Dutch averages on social media use by commercial entities.



Dutch hospitals with links to Social Media on their websites

Another result: only 16.7% of the employees in Dutch hospitals are active on the social media channel LinkedIn. This might be due to the fact that healthcare workers cannot or, more likely, are forbidden to be online during working hours. We have to assume however that these employees are on these platforms when they are not at the job. Otherwise we cannot explain the 12 million unique users.

From interviews with hospital communication departments we know that there is a lack of knowledge or willingness to build and maintain a lively and engaged social media platform. Reasons mentioned were: the communication crew is too small; there is also a lack of capacity to maintain the accounts, and last but not least: the internal interest in social media, also on the Board, is rather low. This is in stark contrast to the outside world which is ready to interact and engage with the hospitals.

It is safe to conclude that the unfamiliarity with social media is a handicap for both hospitals and their clients (patients, their families, etc) who expect much more from their 'innovative healthcare provider'. Obviously, most hospitals lack a clear vision and strategy for interacting and engaging with their clients via social media. In view of the fact that the more 'social media savvy' hospitals on social media also score high on patient friendliness it seems that many hospitals do not realise the possibilities of social media with regard to marketing, logistics, client friendliness, information management, professional stature, and so on.

In early July we started a follow-up survey on the use of social media by Dutch hospitals and have already noted significant improvements compared to our first study. Almost every hospital now has a reference to social media on their website. We hope that it was our first study that stimulated hospitals to make these changes.

Recommendations for hospital managements

- Be active in social media. Your patients already are! They post on Facebook or other social media that they are staying in your hospital and share this with their own network.
- Commit to maintaining an active presence on social media. Creating an account is one thing, but maintaining it requires an investment in terms of time and budget.
- Identify yourself as moderator. It is not always clear who manages the accounts, thus many opportunities for information exchange or dialogue remain untapped.
- Actively seek interaction. Today many accounts only broadcast information and do not listen or react. While (pro-)active interaction with patients may not be common yet, your organization will surely benefit from it.
- Engage with your patients. In general we are convinced that it is a missed opportunity not to engage with your patients or clients as healthcare in the Netherlands and elsewhere is becoming more and more a for profit activity.

About Ruud Kessels

Ruud is the owner of Kessels [communicatie | media]. After having spent seven years as a project manager for clients in national television, Ruud decided to start his own business in 2002. As a communications consultant he focuses on online communications as a part of a larger integrated communication strategy because target groups should be reached in both the physical as well as the virtual world. Today Ruud works for different organizations in IT, healthcare, industry, education and local governments.

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About Anne van der Heyden

After studying medicine and specialising in internal medicine Anne changed his career to address managerial issues. Whilst being a member of the Board of a small healthcare insurance company and a hospital he became familiar with the managerial / financial components of healthcare. As a strategic consultant he advised hospitals and insurance companies. Today he is partner at BMC, the biggest Dutch consultancy and management firm working in the public sector. He delivers hospital boardroom consultancy or acts as a hospital board member ad interim in specific situations.

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Social media and companies in the healthcare sector

Social media are here to stay and using them can enrich a company's perception and performance. Social media activities should hence be part of the strategic marketing and communication mix of any company in the healthcare sector as a complementary media service. While their return on investment may be low or difficult to measure at this moment, social media do offer new communication possibilities. They can increase the overall brand perception by creating a more authentic reputation.

With regard to social media vendors of medical equipment are not different than any other company: their clients also want to discuss experiences with the products and the brand. But who exactly are the clients of a medical equipment company? The Board of a hospital, the professionals in the hospital, the insurance companies or the patients who are the "end user" of the medical devices?

Once you know who your clients are, social media are excellent tools to get to know and understand them better. What are they looking for? What are their complaints? The opportunity for more interaction enables reshaping of processes and attitudes that are taken for granted today. Thus, an organisation which it is active in social media will enjoy a more contemporary and stronger reputation.

In a world where information is spread so widely, discussions are conducted globally and patients want to know everything about their diagnosis and possible therapies and ask other social media users and "Dr. Google" or similar services for help. Thus it is wise for companies active in the healthcare sector to see patients as a very important client group. Because once a brand or device fails in its performance, that news will likely be posted, with possible negative side effects as a result. For this reason we recommend every vendor to at least monitor what is said about their brand in social media.

Mutual respect and trust between the brand and its (social media) clients and fans can enhance the professional culture of a modern company. And should things unexpectedly go wrong such companies will immediately react both on the internet and with regard to the behaviour of their organization or employees.

Dutch study on usage of social media by hospitals. Read our full research results on the Frankwatching weblog http://www.frankwatching.com/archive/2011/12/08/top-5-nederlandse-ziekenhuizen-op-social-media/

Social Media Membership and Awareness in Europe

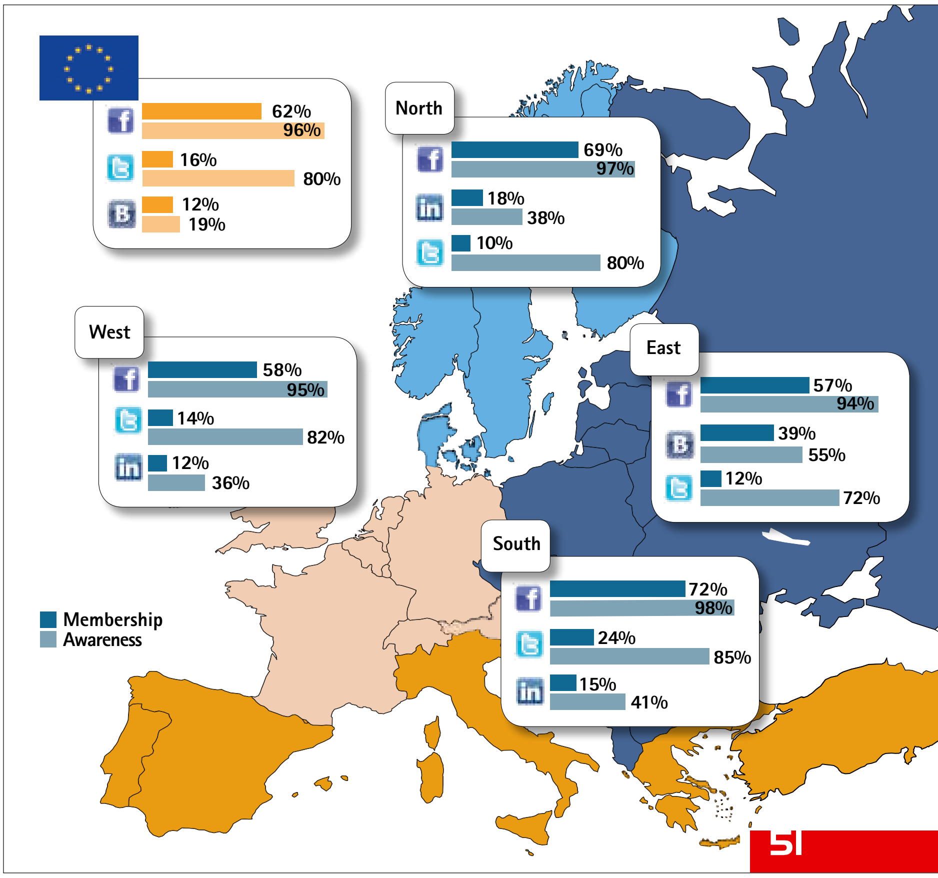


Illustration: InSites Consulting, Social Media around the world 2011

Radrex-i at Direct Röntgen

Direct Röntgen is a private radiology clinic in Gothenburg. It will become the first in Sweden to offer patients DR examinations with Toshiba's Radrex-i digital radiography system. Exceptional image quality combined with a highly streamlined workflow creates a better working environment for staff and higher accuracy in reporting clinical X-ray images.

"The demand for medical imaging is generally increasing, and our business is expanding. We therefore need more imaging resources. Recently we invested in new equipment, by purchasing a Toshiba Excelart Vantage Titan MRI system and two Radrex-i digital radiography systems," said Teddy Bitvai, President of Direct Röntgen. "With our new DR systems Direct Röntgen releases the pressure on hospitals. We can perform the same DR examinations as hospitals at a lower cost, because our overhead expenses are lower. We don't have shifts, we don't perform complicated cases that need aftercare nursing. The overhead cost in hospitals is tremendous with a large management team. For us DR works with a small team of radiographers and teleradiology."

"The patients are our customers, and it goes without saying that we want everything to be as good as possible for them.

Radrex-i at Direct Röntgen

Direct Röntgen at Backavägen 3 in Gothenburg

Through our organization, we can react quickly to changes in demand, and adapt faster and more flexibly than the public sector. We want to be an obvious resource within Swedish healthcare. If we can relieve hospitals, this will create efficiency on both sides."

When Direct Röntgen decided to upgrade their equipment, it thus seemed only natural to invest in state-of-the-art medical imaging systems. This must, of course, be safe for the patient and easy to use for the staff. But the most important factor when Teddy Bitvai and colleagues choose a manufacturer is that the technology always has to work.

"We decided to work with Toshiba because of the high quality and good service we receive. We have limited resources compared

Teddy Bitvai,
President, Direct Röntgen

"With our new DR systems Direct Röntgen takes pressure off hospitals."

Frank Zingaropoli,
CEO, Toshiba Sweden

"For us every customer is unique and we are eager to meet the customers' individual needs."

with publicly-funded units and must utilize our resources in the best possible way. A reliable supplier is extremely important to us. Nothing is more costly than an expensive piece of equipment standing still. We have very high demands on reliability and quality. That is what makes an investment affordable in the long run."

The exceptional image quality and the fantastic ergonomic design of the Radrex-i makes it the perfect DR imaging system for Direct Röntgen. The new radiography systems present Direct Röntgen high functionality due to the dual detector configuration with a fixed detector in the wall stand and the portable flat panel detector for use in the table and for tabletop exposures.

"We now have medical imaging systems from a recognized high profile partner company. Toshiba doesn't consider us to be customers, but also sees us as a partner for a mutually beneficial long term relationship. Our user feedback is truly appreciated by Toshiba. This results in an evolution and further development of Toshiba's medical imaging product portfolio."

"Although our Toshiba systems have proven to be very reliable problem handling is important. The attitude of a company regarding small issues, shows how this company will behave with larger or more important problem. Toshiba hasn't disappointed us. Our experience with Toshiba is very positive. Direct Röntgen likes to work with people, not with companies and Toshiba fulfils this need."

Frank Zingaropoli is CEO of Toshiba Medical Systems, Sweden. He is both pleased and proud to be partnering with Direct Röntgen. "We see this development as a sign of great confidence, given the high demands a private operator must always put on availability and service. We always view every customer as unique and, regardless of size, are eager to meet their individual needs."

Facts

Direct Röntgen is a private radiology clinic with headquarters in Gothenburg and units in nearby Torslanda, Stenungssund and Kungsbacka. They received their first patients in spring 2009 and have since expanded significantly. In 2012, their aim is a total throughput of 200 examinations per day.

Direct Röntgen has agreements with both the Västra Götaland region and private operators as a provider of imaging services, including all types of outpatient examinations with conventional radiography, CT, MRI and ultrasound. The exception is mammography and fluoroscopy examinations (colon, stomach).

The company has 30 employees. For peak workloads, it enjoys access to a network of reviewing radiologists.

Teddy Bitvai with his collegues at Direct Röntgen, Samantha Selerkvist and Heimir Snorrason

Birmingham Children's Hospital Invests in a Toshiba Cath Lab

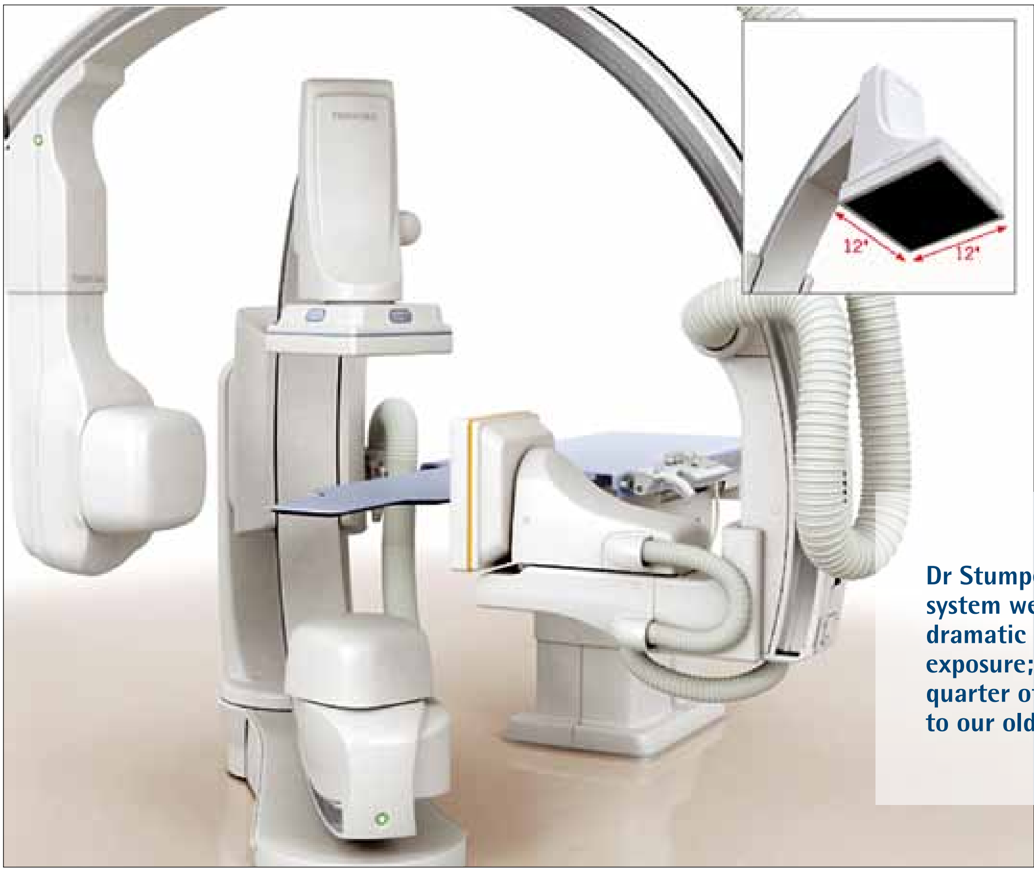
The Birmingham Children's Hospital – NHS Foundation Trust moved to its current site in 1998. The Paediatric Cardiac Services have established a national and international reputation for excellence and innovation. In 2009, the Trust, led by Dr Oliver Stumper, Consultant Paediatric Cardiologist, embarked on a project to replace the ageing and outgrown cardiac and interventional diagnostic X-ray imaging facilities.

The vision and need was to provide for two theatres: one with multi-disciplinary biplane angiographic equipment and the other with cardiac surgical operating facilities incorporating single plane angiographic equipment, to allow for novel and emerging hybrid surgical cardiology/radiology procedures. Ideally, the two theatres and X-ray imaging systems were to have the same user interface to facilitate training and ease of use.

Paediatric interventional peripheral and cardiac X-ray systems have to cope with a very diverse range of young patients weighing between some 1.5 and 100 kg. Exceptional image quality using the minimum possible X-ray dose across the full weight range is a must! Working practices in paediatric cardiac/neuro/peripheral intervention is highly variable and, thus,

Dr Stumper: "The five-axis set-up and the unparalleled head access it gives us was one of the main reasons we selected the Toshiba system. Eleven per cent of all our cath lab procedures require neck access and we can now work entirely from the top end of the table using the second row of monitors. We also like the ability to raise and lower the height of the lateral tube, effectively providing the option to change the isocentre/table height."

The Infinix-i Hybrid System at Birminham Childrens Hospital



Dr Stumper: "With the new system we are achieving a dramatic reduction in dose exposure; about a third to a quarter of the dose compared to our old system."

the ideal system design poses huge challenges to the design team. Ideally, the system should be truly flexible. Full 180 degree head access would allow for improved approach and study of children, whereas free and open access to the head of the patient would be extremely beneficial, if not mandatory.

Toshiba's biplane system complied with the majority of these requirements and in addition appeared to offer a number of additional unique facilities. The design concept was developed in association with Dr Cheatham and his team at The Children's Hospital, Columbus, Ohio, one of the foremost paediatric hospitals in the United States. The five-axis frontal C-arm in its own right presents an unmatched 270 degree of open patient access. When integrated with the lateral Omega C-arm in the biplane mode, the system can be considered to have even greater appeal by virtue of its 180 degree of open access to the head of the patient. Being able to independently raise and lower the lateral Omega C-arm and the flexibility of left or right sided orientation of the X-ray tube brings added value. This compendium of features together with the realization that one is able to achieve all desired projection angles with expedient ease without the need to move the patient table captured the attention of Dr Stumper.

Seeing is believing! Dr Stumper took the initiative to make arrangements for members of his team to visit and review the facility in Columbus. He also established a personal opportunity to work for one week with Dr Cheatham. This experience left a very positive impression. The design of the equipment ticked all the right boxes. Of equal merit was a strong impression that Toshiba demonstrated the attitude and approach of a company that is ready to listen and work in a proactive manner with its clinical partners. Impressions however count for little in the procurement process of two angiographic systems and a detailed evaluation had to be undertaken.

Key questions included the very important issue of X-ray dose. How does the technology of Toshiba in this regard stand up to that of its competitors? What about future and ongoing development, including the prospect of upgrades to stay abreast of new and emerging techniques?

Dr Stumper: "We worked very closely with Toshiba throughout the planning, design, build and implementation of the project and have been impressed with the level of support provided by Toshiba."

With such an investment and the ongoing speed of product development, Birmingham Children's Hospital wanted to avoid any possibility of premature obsolescence.

There is very little to choose between the major companies when reviewing the quality of acquired images. While there are discrete differences in the presentation of images, to all intents and purposes the quality from all suppliers being considered can be universally classified as very good. However, the priority in the cardiovascular world is fluoroscopic im-

Dr Stumper: "The 30x30 cm field size allows for single run angiograms of the entire chest in patients weighing more than 40 kg. At the same time it covers the entire spectrum of peripheral and neuro interventions. The impact on 3D volume acquisitions during rotational angiographic runs is impressive."

aging. It represents more than 95% of the time spent during routine interventional procedures. It can be said that Toshiba has established a new benchmark for the industry in terms of multiple features that have been developed to reduce fluoroscopic dose to an absolute minimum, without any compromise of image quality.

Real-time processing of the digital fluoroscopic signal, aided and abetted by an extensive range of sophisticated software programs effectively enhances contrast and resolution, while suppressing noise and halation. Single image capture, real-time digital image zoom, real-time table-side control of the fluoroscopic frame rate, and instantaneous fluoroscopic image storage with single touch button control; are all very positive and important features. Add the ability to pre-program all elements of specific procedures, the ergonomics of the system which contribute significantly to expediency and a dramatic reduction in dose. The ability to store fluoro sequences and do detailed analysis without interrupting workflow greatly enhances efficiency.

One must not ignore the contribution of the flat panel detector (FPD). Toshiba presents the choice of either a 20 x 20 cm or a 30 x 30 cm detector. It is important to validate the actual dimension of the active surface of a detector and also the external dimensions of its housing. They are critical to anatomical coverage and during angled projections they also impact on dose. Toshiba's active surface area is very close to the declared size. The housings are very compact by comparison to those from alternate suppliers. The 30 x 30 cm FPD, unique to Toshiba, is a very important option for those who wish to manage a more diverse range of procedures as commonly seen in a children's hospital.

Interactive programs such as on-line QCA, Guide View and the option of 3D angiography emphasize the flexibility of the system, facilitating the measurement of anatomy and disease in addition to the precise implant of devices within the heart.

Multi-tasking capacity in today's computer driven environment is an important consideration, contributing to workflow. The system from Toshiba is without compromise. It permits a wide range of processing functions in parallel to a procedure in progress, without hindering the procedure in any way.

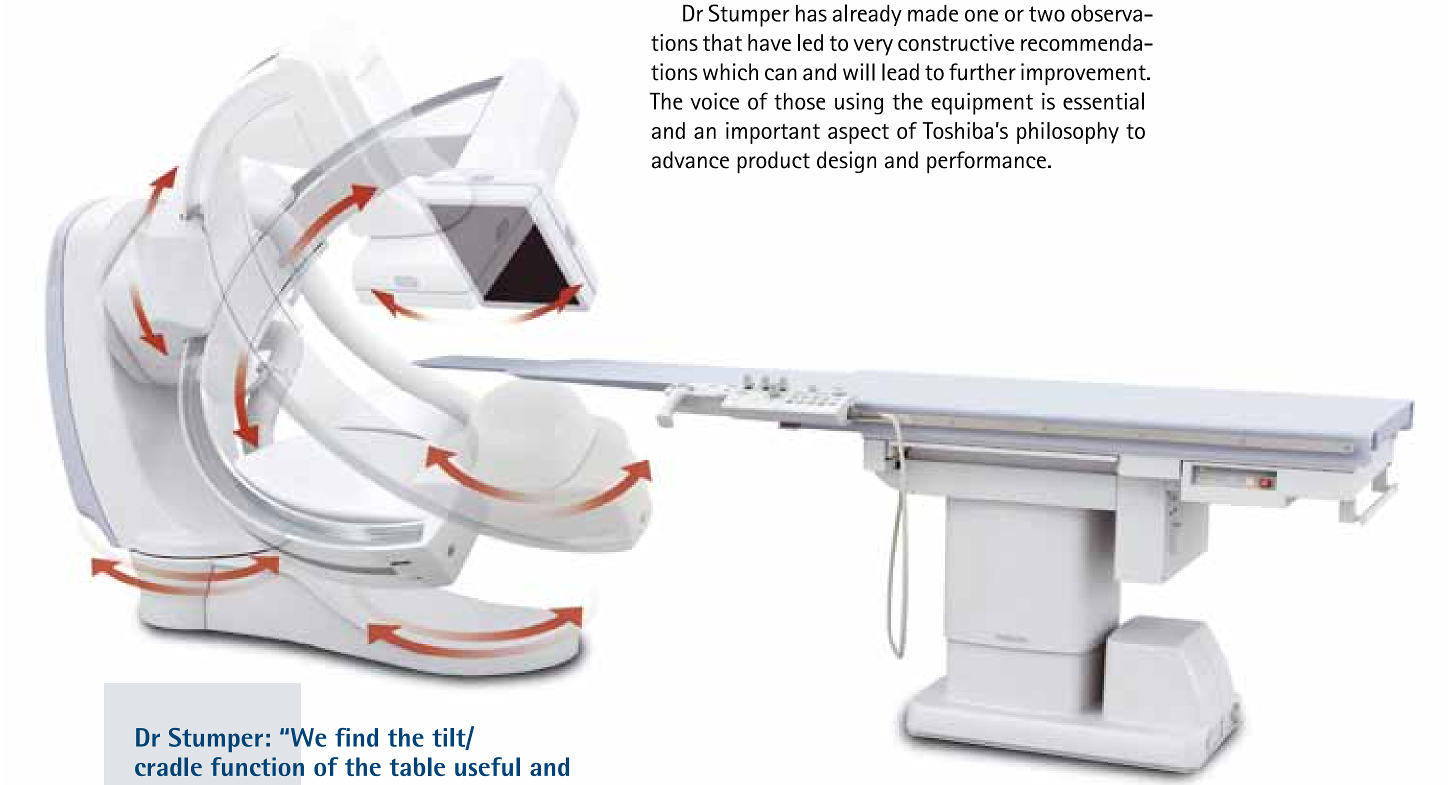
Last but by no means least is the patient table. Toshiba introduced a completely new tilting-rolling angiographic table to its product portfolio during the assessment process. Its innovative streamlined design was immediately acknowledged to bring added value to what was already considered to be an exceptional strong system.

Is there such a thing as a perfect product? The answer to this is obviously no, but some do come much closer to perfection than others. All of the major companies present viable solutions and they will all

Dr Stumper: "With the new system we have a much improved workflow and a reduction in procedure time. New software packages, including rotational angiography and vessel quantification, with the ability to do quantitative assessment whilst screening, plus the 'instant store fluoro' button, without having to wait – all contribute to the improved efficiency."

express a strong case for their own. It is important to look carefully into the clinical impact of the different features that each has to offer; features that can and will make the difference during the more difficult procedures. Careful consideration of all factors based upon demonstrated technical and clinical merit, complimented by the definition of a strong long term proactive partnership, led Birmingham Children's Hospital to endorse a partnership with Toshiba. To date it is fair to state that the expectations on both sides have been fully met.

Dr Stumper has already made one or two observations that have led to very constructive recommendations which can and will lead to further improvement. The voice of those using the equipment is essential and an important aspect of Toshiba's philosophy to advance product design and performance.



Dr Stumper: "We find the tilt/cradle function of the table useful and also the table extension which largely facilitates work with exchange wires, etc."

Improved Brain Vessel Imaging Creates Great Opportunities

To benefit cutting-edge research. Treatment as a matter of life and death. The tasks assigned to the new neuro-angiography lab in Uppsala are far from insignificant. Both clinicians and researchers have great expectations of the equipment and so far, they have not been disappointed.

In December 2011, the new X-ray lab for neuro-angiography, Infinix VF-i/BP, was inaugurated at the Medical Imaging Center of Uppsala University Hospital. With the new system in place, it is now possible to perform diagnoses and treatment with much greater precision than before. Senior Physician Ljubisa Borota is responsible for interventions at the neuro-angiography lab, where the work often, if not always, requires quick reactions.

"The time factor plays a very important role in our work, and thanks to the new system we can perform our interventions with the speed they require. For example, haemodynamics is presented much better than before, making it easier to both diagnose and carry out the actual intervention. Ultimately, this can mean the difference between life and death. For us, this is a new technology with many innovative solutions which promises evolution and improvement of the analysis of the blood flow, 3D reconstructions, and dynamic visualization of cerebral vascular structures. But despite its many new features, the system is intuitive and easy to use".

Ljubisa Borota is convinced that the sharp, high-quality images now produced result in more reliable diagnoses and treatment. The primary aim is to treat acute bleeding caused by ruptured aneurysm using a coiling methodology – thin platinum wires are inserted into the vascular bulge, thereby stopping the blood flow. This reduces the risk of re-rupture or prevents it completely. Patients with acute stroke may also benefit from the new equipment, as it allows for endovascular thrombectomy, by which the thrombus is pulled out through a catheter introduced through the groin.

"Our new angiographic apparatus has relatively low irradiation dose which is of paramount significance not only for patients but also for the staff with is daily exposure to radiation. The amount of contrast is also significantly lower than before. And thanks to the exceptional image quality, we do not need to run several series, which in itself results in significantly lower radiation dose and the use of less contrast agent."

According to Ljubisa Borota, other major advantages include better workspace and more rapid patient flow, resulting in shorter waiting times.

Ljubisa Borota and colleagues also have high expectations of what the new X-ray lab can lead to in terms of research. Elna-Marie Larsson is Professor of Neuroradiology, and although her focus is not primarily angiography, she looks forward to the new opportunities.

Media attended the opening of the new Infinix VF-i/BP for neuro-angiography

> **"One must remember, however, that everything we do shall ultimately benefit the patient. This is why integration and collaboration is so important. Vascular X-ray is not just plumbing; we must always consider the end organ, which is the brain."**

Uppsala occupies a leading position in both clinical work and research in the area of neuroscience, and the future looks bright. This is not least due to the fact that everyone strives towards the same goal, says Elna-Marie Larsson. She particularly mentions the importance of two colleagues in making the operation work so well, namely Assistant Professor Johan Wikström, head of the Neuroradiology section, who has a special interest in neurovascular research, and Adel Shalabi, Head of Department, Centre for Medical Imaging.

"In Uppsala, we have very advanced equipment, highly competent personnel, and very skilled clinicians and researchers. One must remember, however, that everything we do shall ultimately benefit the patient. This is why integration and collaboration is so

Senior Physician Ljubisa Borota and Elna-Marie Larsson, Professor of Neuroradiology

important. Vascular is not just plumbing; we must always consider the end organ, which is the brain. The new angiography lab gives us very high quality images, but we also have other methods for looking at blood vessels and vascular malformations. An optimal combination and utilization of our methods – neuroangiography, MR, CT and PET – will also be optimal for the patient."

There are many examples of exciting research and clinical work where the new X-ray lab plays an important role, even across different disciplines.

Professor Pär Gerwin's area of research is vascular biology. He is also responsible for Sweden's only multi-disciplinary clinic, which receives patients with vascular anomalies from all over the country.

"Patients with vascular malformations are often misunderstood by conventional healthcare, not out of malice but simply because they are very rare. Our multi-disciplinary centre in Uppsala brings together a variety of specialties, such as ENT physicians, plastic surgeons, vascular surgeons, dermatologists and paediatric surgeons who, after conferring, make decisions concerning diagnosis and treatment. The new lab, with its high image quality and rotation abilities, is a very good supplement when it comes to treatment," says Pär Gerwin.

The treatment involves injecting substances that shrink the malformation. Especially when the defects are close to airways or large vessels, it is of utmost importance to ensure that the needle tip is correctly positioned. And by also running a 3D rotation afterwards, it is possible to determine how much of the deformity was actually reached.

It may also happen, however, that a vascular malformation is so badly located in the brain that it cannot be reached with catheter techniques. Uppsala has a unique opportunity to treat such cases with stereotactic proton radiotherapy. Here, the new neuro-angiography equipment can determine exactly where the abnormality is located. This information can be transferred to the proton beam device, thereby creating very exciting future opportunities in this area as well.

Professor Pär Gerwin's area of research is vascular biology