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TOSHIBA MEDICAL SYSTEMS JOURNAL

CT
Aquilion PRIME, the world's first 80-row CT scanner

Ultrasound
2D and 3D ultrasound capabilities

X-Ray
First Infinix VF-i/SP with 30 x 30 cm FPD installed in Europe

MR
Non-Contrast-Enhanced MRA by 3T MRI

VISIONS

17·2011

Aquilion PRIME, Toshiba's new 160-slice multislice CT scanner incorporating the latest technologies from the flagship Aquilion ONE scanner.

TOSHIBA MEDICAL SYSTEMS

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Dear reader,

Toshiba's business mission is to contribute to society through innovative healthcare solutions by developing advanced, value-added medical technologies, products and systems supported by excellent service.

Last year we celebrated the 80th anniversary of Toshiba's medical business. During these 80 years, we have continued to reinvent ourselves, not only because we want to stay connected with you, but also because we embrace the idea of strengthening our bonds so that we can be sure to provide what you need tomorrow, as well as what you want today. This is the way we emphasize our commitment to partnering with you; our valued customers from all over the world.

It is my pleasure – as President and CEO of Toshiba Medical Systems Corporation – to present to you this new, exciting edition of VISIONS. As usual, you will find many articles about innovative products, advanced technologies and special applications, such as the Aquilion PRIME; the next generation 160-slice multi detector CT scanner and the latest addition to our Aquilion family. The system is equipped with key features, for example Adaptive Iterative Dose Reduction (AIDR) that lowers the noise level up to 50% and reduces the patient dose up to 75% compared to conventional scanners. Read about the world's first installations in the Rode Kruis hospital in the Netherlands and Mount Elizabeth Hospital in Singapore.

The message is clear: Toshiba innovates! Even more – our innovations are environment-friendly, a fact which does not go unnoticed. We are proud to inform you that Toshiba Corporation ranks no. 10 in the most recent Newsweek list of the world's greenest companies. A major achievement while we are happy to contribute to a sustainable society with our ECP and Excellent ECP products.

I hope that VISIONS magazine – and the online version – shows you today's possibilities to further enhance the quality in clinical examinations and will inspire you in your daily practice as a medical professional.

I wish you a successful ECR 2011 which we hope, will include a visit to our booth #315 in Expo C.

Kind regards,

Satoshi Tsunakawa
President and Chief Executive Officer
Toshiba Medical Systems Corporation

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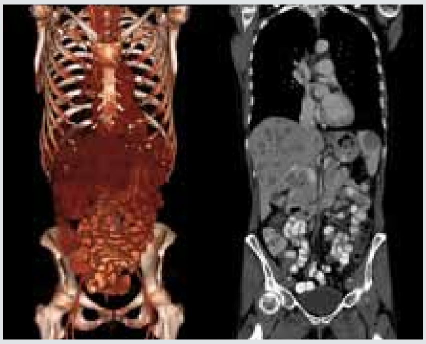

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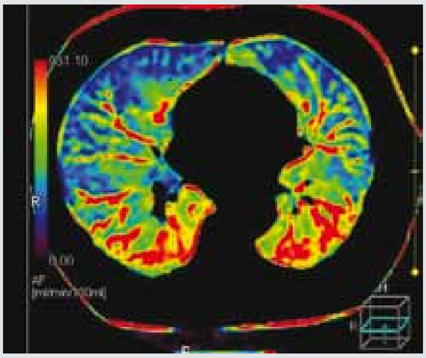

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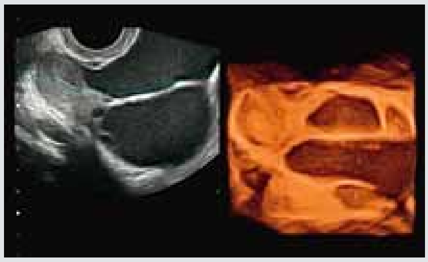

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Introducing the Aquilion PRIME

The world's first 80-row CT scanner receives a warm welcome

Toshiba recently launched the world's first 80-row CT scanner: the Aquilion PRIME. This versatile new system is already being welcomed by physicians who are finding that it offers them greater clinical flexibility and gives exceptional image quality at the lowest possible dose within seconds. The Aquilion PRIME significantly improves dose effectiveness and clinical efficiency, enabling better quality results and minimizing costs.

The first Aquilion PRIME system in the world was installed and is already in use in the Rode Kruis hospital in Beverwijk, the Netherlands. Visions spoke to Ulco Umans, Radiologist and Medical Manager Radiology, and Robert Nanne, Manager Radiology, at the hospital about their experiences with Toshiba's latest addition to the Aquilion family.

VISIONS: *The Rode Kruis hospital in Beverwijk is the first in the world to install an Aquilion PRIME. What was the reason to choose this system from Toshiba?*

Ulco Umans: We have enjoyed a long and constructive partnership with Toshiba which was key in our decision to purchase the Aquilion PRIME. Partnership between hospitals and manufacturers that supply our equipment has become a far more critical factor in purchasing than it used to be, say ten years ago. Today we work together with suppliers, such as Toshiba, in two-way relationships, carrying out research projects with equipment and playing an important role in helping steer their innovations.

Our hospital is already equipped with several Toshiba systems, including our previous CT scanner, X-ray and ultrasound equipment. From these, we know that Toshiba systems are high quality, employ innovative, yet reliable technology and are supported with an outstanding service package for the life of the machines.

Robert Nanne (l) and Ulco Umans (r)

Interview with Ulco Umans, Radiologist and Medical Manager Radiology, Robert Nanne, Manager Radiology, Rode Kruis hospital, Beverwijk, the Netherlands

Robert Nanne:
" We did indeed consider several other options with **other vendors***, but they simply* **couldn't top the offer from Toshiba.***"*

We were looking to replace our CT system – a 4-slice Toshiba Asteion Multi - which was ten years old. Our medical imaging team of 20 technicians needed a system which could offer a greater range of options so that they could broaden the scope of patient care offered here. The Aquilion PRIME allows us to perform a far wider range of routine and complex examinations efficiently, quickly and at low dose.

The Rode Kruis hospital is a relatively small facility. We have 406 beds and space is very limited for equipping our diagnostic suite at this location. We cannot expand the space available and so have to rely on only one CT machine. Therefore it was vital that the system selected offered ultimate reliability.

What we really like about Toshiba's equipment is that it is developed incrementally – building new innovation into a technology platform which is proven to be robust and reliable. This reassures us that any new product from Toshiba will be dependable, as well as technologically advanced. The Aquilion PRIME leverages the technology of the Aquilion ONE and is ideal for a wide range of examinations including sophisticated cardiac, body perfusion and dual energy examinations.

Robert Nanne: I should add that we did indeed consider several other options with other vendors, but they simply couldn't top the offer from Toshiba. The Aquilion PRIME represented the ultimate quantum leap in our progression. We actually feel quite honored to have the world's first system here at Rode Kruis.

VISIONS: *Could you describe the installation of the new system?*

Ulco Umans: Toshiba's installation team ensured that we were well prepared to receive the new system. They worked with us to explore every aspect of installation before a plan was agreed and implemented. Because of the age our hospital - it was founded in the early 1930s - and certain physical and operational features of the Aquilion PRIME, a number of important modifications to our CT room had to be made before installation could start.

Robert Nanne: However, from start to finish, the installation took just three weeks, the first two weeks of which were needed to prepare the site. This is quite remarkable considering that the building preparations to accommodate the new machine are included.

In particular, the power requirements of the machine are higher than our previous machine and we had to adapt some older aspects of our hospital's infrastructure to ensure that these could be met by laying some additional electrical cabling. We also had to ensure that the floor of the room could withstand the additional weight of the machine. We strengthened the floor of the room after having consulted the Toshiba Site Planning group.

The actual installation of the system and its calibration took just four days. No time was wasted

Toshiba's installation team in action

– it was a question of out with the old and in with the new. To maintain the continuity of our services Toshiba offered a mobile system during the total period of installation. A perfect solution.

Ulco Umans: We were able to consult Toshiba's expert team of technicians at any time on any issue. The accessibility and collaboration of staff was superb. Because this was the first Aquilion PRIME to be installed worldwide, there was a great deal of interest from Toshiba as well as from our own staff. We received a lot of VIP visitors from all over the world during the course of installation which added to the excitement of receiving the very first machine of its kind.

VISIONS: *You have quite a large team of specialists. How was training organized?*

Robert Nanne: Training started even before installation. We needed to ensure that all 4 staff using the machine were acquainted with it and comfortable operating it as soon as possible to minimize any gap in service provision. The training was provided on an individual basis by Toshiba experts on site. Our specialists quickly picked up the techniques – the machine is easy to operate. Toshiba has put considerable thought into ensuring that the system is as user-friendly as possible.

Ulco Umans:
"The Aquilion PRIME allows us to **perform** *a far wider range of routine and complex* **examinations efficiently, quickly and at low dose.**"

VISIONS: *What are the main clinical benefits offered by the system?*

Ulco Umans: One of the biggest advantages is the fact that the system has broadened our scope of patient care. We now have the possibility to use the system for cardiac examinations for example. With the aid of Aquilion PRIME's SURECardio software, we can quickly pick out and assess vascular images only at the click of a button.

Robert Nanne: Dose reduction capabilities of the Aquilion PRIME are outstanding. Reductions of up to 70% have been achieved with the system using Adaptive Iterative Dose Reduction - AIDR. Together with experts from Toshiba and Leiden University Medical Center, I have been integrally involved in investigating the benefits of AIDR with this machine. To maximize AIDR's dose saving effects Toshiba has integrated the AIDR technology into the Automatic Exposure Control package SUREExposure 3D. Less dose is needed to maintain high image quality at lower levels than ever before.

This is a particularly important development. Dose reduction is a key issue for continuous improvement of patient care in the healthcare industry, especially here in the Netherlands since we are a leading country in continuous dose reduction.

Aquilion PRIME, the world's first 80-row CT scanner

VISIONS: *Beyond dose reduction, what other kind of savings is the Aquilion PRIME helping you to achieve?*

Ulco Umans: The performance, speed and ease of use of the system enable us to achieve large increases in throughput. We have already achieved a 25% reduction in the examination time for patients which has had a significant effect on improving patient throughput. Aquilion PRIME has a large gantry opening of 78 cm allowing fast and easy system set-up. Toshiba's unique in-room scan control, called Handy Snap, allows us to instantly start scanning while closely observing the patient. This allows us

to improve patient care, especially for pediatric and trauma patients and benefits workflow so that we can examine more patients in a shorter space of time

Robert Nanne: I should like to add that the Aquilion PRIME is an excellent example of Toshiba's environmental vision. Like the Aquilion ONE the PRIME gantry gains energy from slowing down the gantry rotation speed, this energy is used for powering other components like couch and computers. With a hybrid CT we as department can contribute to a better environment.

VISIONS: *What is the service package from Toshiba like?*

Ulco Umans: The service we have received from Toshiba over the years is far more than we expected. Service is available immediately on any issue and Toshiba's service staff always have such a positive, can-do approach to problemsolving. This is a great reassurance since we will be using the machine for a long time. I know this is quite exceptional amongst vendors.

Robert Nanne:
"**Dose reduction** *capabilities of the Aquilion PRIME are outstanding. Reductions of* **up to 70% have been achieved.**"

VISIONS: *What else does the Aquilion PRIME bring to the hospital?*

Ulco Umans: Working with cutting edge systems like the Aquilion PRIME makes radiology such an exciting field. Another side effect is that investing in such equipment helps us to attract the most highly skilled radiology staff and keep them! As you might understand this is vital in today's competitive environment.

Robert Nanne: The system is so advanced that it brings added value to our department. In the next seven years the hospital may be relocating but we will definitely be taking the Aquilion PRIME with us and based on Toshiba's performance we may even consider purchasing additional systems from Toshiba for the new location.

VISIONS: *Thank you!*

The Rode Kruis hospital in Beverwijk, the Netherlands

Aquilion PRIME: Expansion in Medical Imaging

D.L.T. Busscher

D.L.T. Busscher, MD
Rode Kruis hospital,
Beverwijk,
the Netherlands

Introduction

The Aquilion PRIME, the new member of the Aquilion family of CT scanners, opens up new possibilities in medical imaging. The first PRIME was installed at the Rode Kruis hospital, Beverwijk, the Netherlands, several months before launch.

The Aquilion PRIME

The Aquilion PRIME is a multislice helical CT system with an 80-row detector capable of generating 160 slices per non-helical rotation using the coneXact™ reconstruction algorithm. Unlike techniques such as flying focal spot this method to double the number of slices does not increase unnecessary radiation exposure. With a consistent detector design of 0.5 mm, Aquilion PRIME covers up to 4 cm in the Z-axis.

High-speed rotation allows rapid data acquisition and shortens scan times, while the fast reconstruction unit further improves throughput, reducing the time required for diagnosis. Aquilion PRIME incorporates a variety of functions based on technologies that were developed for Aquilion ONE with the aim to significantly reduce patient dose, including Active Collimator, AIDR (Adaptive Iterative Dose Reduction), SUREExposure 3D and Boost3D.

AIDR uses an iterative algorithm to reduce image noise while maintaining details and structural edges. The patient dose can be significantly reduced without negatively affecting image quality.

From the first users

The Rode Kruis hospital in Beverwijk in the Netherlands is a medium-sized 406-bed facility which serves as teaching hospital for several disciplines. Located close to a steel industry area, the hospital was the first institution in the Netherlands to establish a dedicated centre for burn victims and today is the national referral centre. Situated only 30 km west of the Dutch capital Amsterdam, the

The Aquilion PRIME with 80-row detector and 0.5 mm detector width covering up to 4 cm in the Z-axis

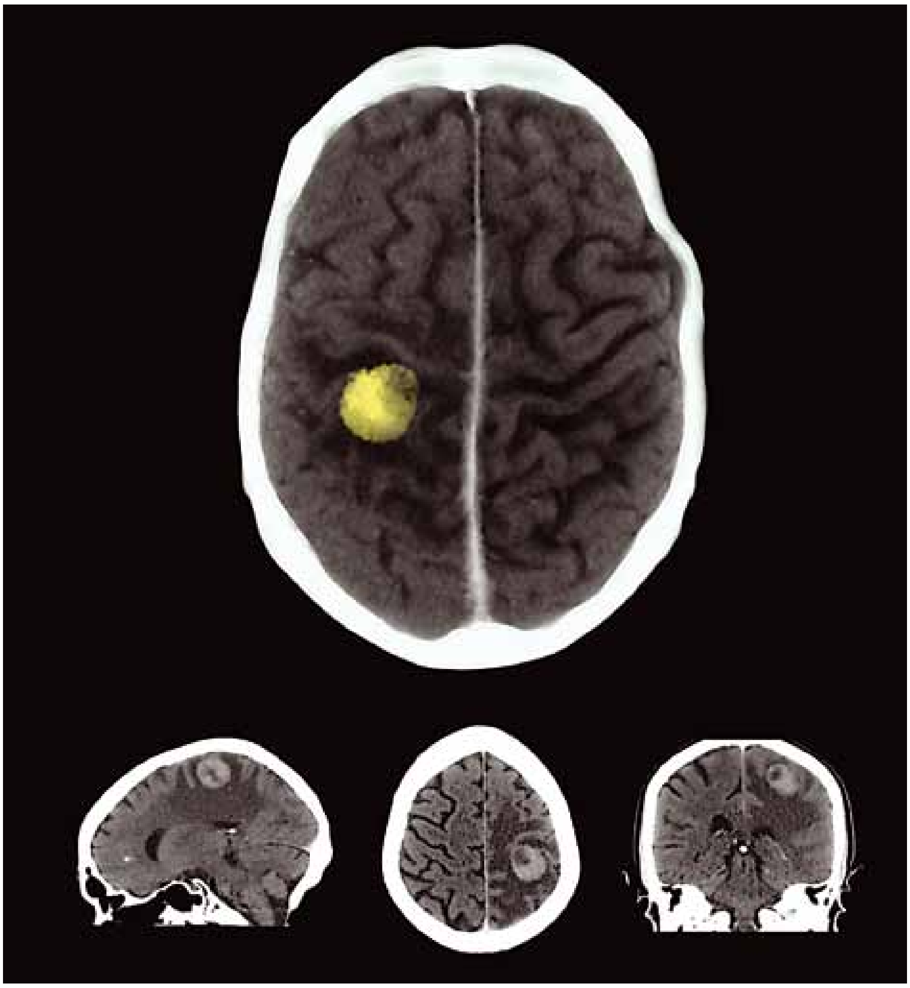
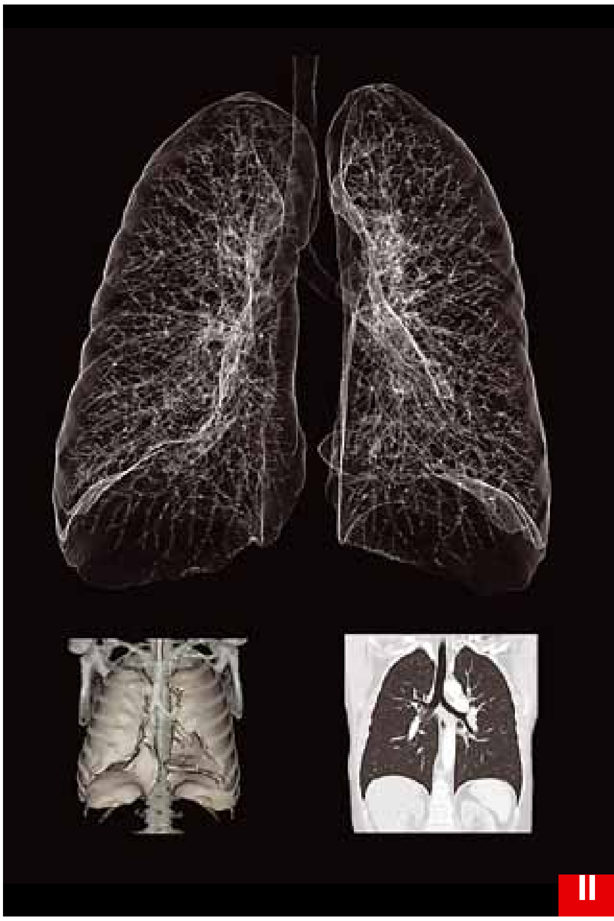


Fig. 1: CT scan of the brain showing a large metastasis

Fig. 2: CT scan of the thorax displayed in coronal view and 3D volume rendering



Rode Kruis hospital provides healthcare for 140,000 people in Beverwijk and the surrounding suburbs. The radiology department counts eight radiologists, 37 radiological technicians and eight administrative employees.

The Aquilion PRIME has been in full operation in Beverwijk since November 2010.

Dr. Umans (Radiologist and Medical Manager Radiology) and Robert Nanne (Manager Radiology): Since almost a decade there has been a good cooperation between our department and Toshiba. Our positive experience and thus satisfaction with Toshiba's service of our angiographic equipment (Infinix) and multipurpose fluoroscopy unit (Ultimax) and the low downtime of all the equipment have strengthened our trust in the company.

Our previous CT, the Toshiba Asteion Multi, a 4-row scanner, had served us for almost ten years and the time had come to replace it with a more up-to-date scanner. One of the requirements for the new scanner was that it be equipped with at least 64 detector rows. Our thoracic radiologists and cardiologists wanted to offer CT cardiography. With the old 4-row scanner we could handle approximately 25 scans during a working day. Since our staff is also in charge of emergency scans, it became increasingly difficult for them to fulfill all scan requests on time and with good quality. In addition, the Dutch government puts substantial pressure on healthcare

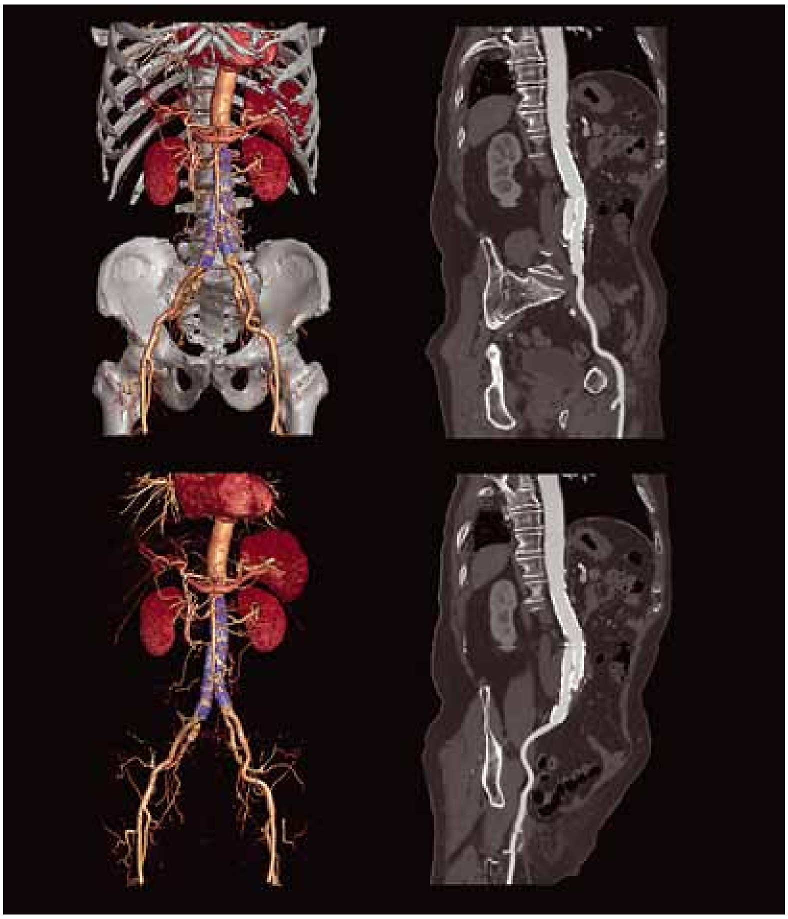


Fig. 3: CT scan of the abdominal aorta with stent prostheses shown in curved MPR and 3D volume rendering

Acknowledgment
The author wishes to thank John van Gulik and Jeroen Tijhaar for providing the clinical images and Yvonne Hoogeveen for help with the preparation of the manuscript.

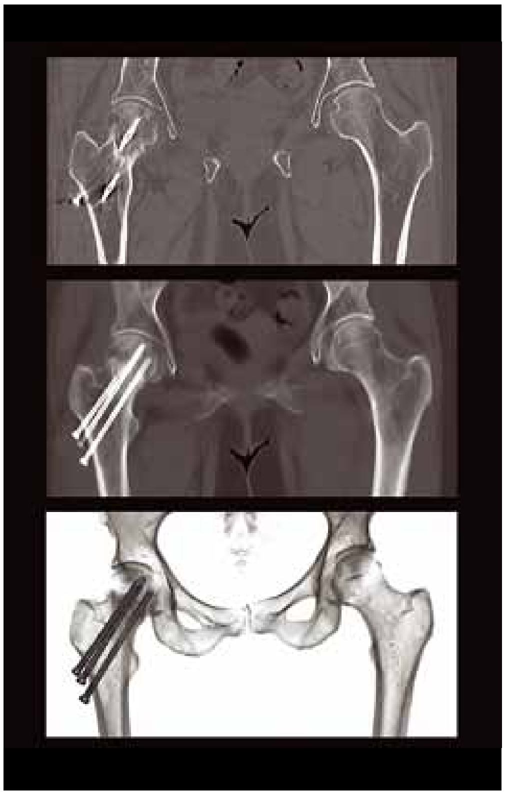


Fig. 4: CT scan of the pelvis with metal screws in the hip shown in coronal view and 3D volume rendering

providers to lower the radiation dose in all X-ray examinations. Therefore, we were very enthusiastic when Toshiba gave us the opportunity to be the first hospital worldwide to use their new Aquilion PRIME CT scanner.

One of the additional advantages of choosing a Toshiba scanner in our case was the graphic interface which is the same as that of the Asteion Multi. We were delighted to see that due to the short reconstruction time after only two months of using the PRIME our performance had increased to 40 scans during a 9-to-5 working day. It is a pleasure for radiologists and technicians alike to work on the post-processing station to produce magnificent reconstructions in 3D or MPR mode. The clinicians are very impressed by the information that can now be extracted from the reconstructed data.

First clinical results

The clinical images presented here were acquired using low-dose clinical protocols with Adaptive Iterative Dose Reduction (AIDR).

The effective patient doses range from 1.5 mSv for thorax examination to 6 mSv for abdominal aorta examinations.

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Did you know?

- 120 Sites - The number of Toshiba manufacturing sites worldwide that have environmental management systems in place.
- 99,500 Tons - The amount of end-of-life products that were recycled by Toshiba Group worldwide in 2009.
- 33 Tons - Amount per year Toshiba has reduced cardboard waste by reusing cardboard packaging for shipping CT couch covers.
- Toshiba's current Aplio™ MX ultrasound system uses 30% less power than ultrasound systems manufactured in 2001.
- Toshiba's current EXCELART Vantage™ MR system uses 35% less power than MR systems manufactured in 2001.
- Toshiba's Aquilion® ONE CT system uses 75% less power than CT systems manufactured in 2001.
- Aquilion® ONE CT system power consumption can be regenerated. Energy is converted back into the system as electricity rather than heat to power the couch and gantry.
- In a newly constructed building in Japan, Toshiba has installed wastewater recycling, energy-saving lights and a rainwater harvesting system to help reduce Toshiba's environmental footprint.
- Toshiba has been selected as a member of the Dow Jones Sustainability World Index for the 11th consecutive year since 2000.
- Toshiba is ranked #10 on Newsweek's 2010 Green Rankings Global 100 list, the highest of all medical imaging vendors.
- Toshiba Medical Systems had it's first elaborate factory water treatment facility in the late 70's!

TOSHIBA eco style

The ECO style logo, which is intended to challenge the imagination, is formed of three circles that represent the three facets of our environmental management: Greening of **Processes**, Greening of **Products**, and Greening of **Technologies**.

Processes

All activities of the company must be constantly reviewed for optimum performance. Apart from manufacturing, these are also processes such as freight, transport, heating of buildings, service activities, etc.

Products

The key factor for our type of products is energy consumption. Solutions must be sought to reduce power requirements as much as possible. However, reduction of weight, use of alternative materials, omission of hazardous substances, possibilities such as "second Life" are also part of this challenge.

Technologies

Toshiba is active in the field of Energy Technology which covers improved energy sources, battery efficiency, bio cells or nuclear power.

AEC Comparison With and Without Iterative Dose Reduction Technique: a Phantom Study

R. Irwan[1], C. Verlooij[1], R. Joemai[2], R. Nanne[3]

Roy Irwan

Robert Nanne

Introduction

There has been continuous progress in dose reduction technologies across all major CT manufacturers, in particular in the field of iterative algorithms. The main goal, however, remains the same: to minimize the radiation dose according to the ALARA (As Low As Reasonably Achievable) principle.

Adaptive Iterative Dose Reduction (AIDR), described by Joemai[1], is a sophisticated iterative algorithm which has been designed to work in both the raw data and reconstruction domains (Fig. 1). The collective AIDR process results in robust noise reduction which is essential for achieving ultra low dose examinations for routine clinical imaging.

Lowering the X-ray exposure and therefore reducing the number of photons reaching the detector results in a decrease in signal-to-noise ratio in raw data. The AIDR algorithm first analyses the noise in the raw data and then adaptively applies noise correction based on the photon count. This process, in effect, increases the signal-to-noise ratio, particularly with low-dose acquisitions.

After raw data noise correction is applied, a primary reconstruction is performed. AIDR uses an iterative data enhancement algorithm in the reconstruction domain. This algorithm adapts to different organs which maximizes the noise reduction without compromising spatial resolution.

The final process involves a weighted blending of the iterative and the primary reconstruction to create the AIDR image. As a result of this blending, the AIDR images retain a natural appearance as if they were acquired with standard exposure parameters. Furthermore, Automatic Exposure Control (AEC) systems on CT scanners have been a subject of great interest over the past years[2-4]. Therefore, in this paper, we describe a new phase of AIDR which is now integrated in the Toshiba AEC, SUREExposure 3D, which modulates the tube current in both xy- and z- directions. A thorough comparison of the physics of AECs from different manufacturers has been performed[2].

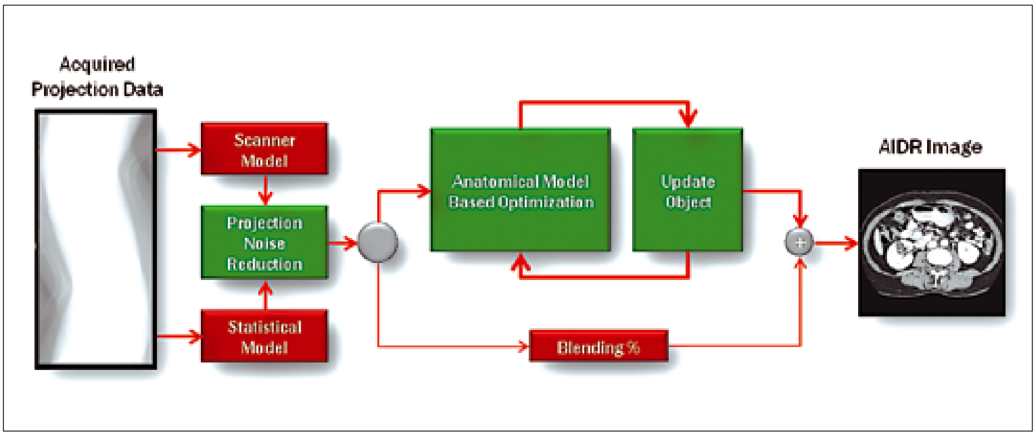
The aim of our study is to demonstrate the behavior of AEC with and without AIDR and to evaluate the resulting dose reduction and image quality with the use of an anthropomorphic phantom.

Materials and methods

Materials

The anthropomorphic torso phantom (Fig. 2) was scanned with the 80-detector row MDCT scanner Aquilion PRIME located at Rode Kruis Hospital, Beverwijk, the Netherlands. This new scanner has a z-coverage of up to 4 cm and can generate 160 slices in one axial rotation with double slice mode as described in[5]. Unlike other techniques, such as flying focal spot, this method to double the number of slices does not produce unnecessary additional radiation.

Fig. 1: Schematic diagram of Adaptive Iterative Dose Reduction (AIDR) which includes both raw data and reconstruction domains to reduce the dose while maintaining best possible image quality.



[1]Toshiba Medical Systems Europe, Zoetermeer
[2]Leiden University Medical Center, Leiden
[3]Rode Kruis Hospital, Beverwijk

Furthermore, an active collimator is available in this scanner to minimize over-radiation by the helical pre- and post-acquisition ranges. This active collimator is controlled by slits which open and close at the beginning and end of each helical scan. The dose reduction is up to 20% depending on the scan range.

The phantom is 100 cm long with anatomical structures allowing various CT imaging techniques including helical scanning. It contains synthetic bones, brain with cerebral ventricles, lungs with pulmonary vessels, and many other specific types of organs are embedded. Each individual organ has particular Hounsfield Units corresponding to that of the human body[6].

Fig. 2: Anthropomorphic phantom closely resembling a real human body[6]

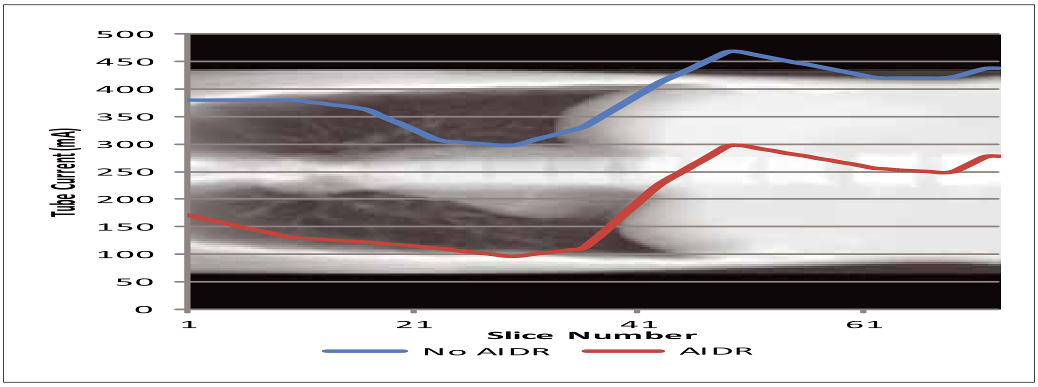


Figure 3a: mA values along the phantom measured with non-activated AIDR (blue) and activated AIDR (red).

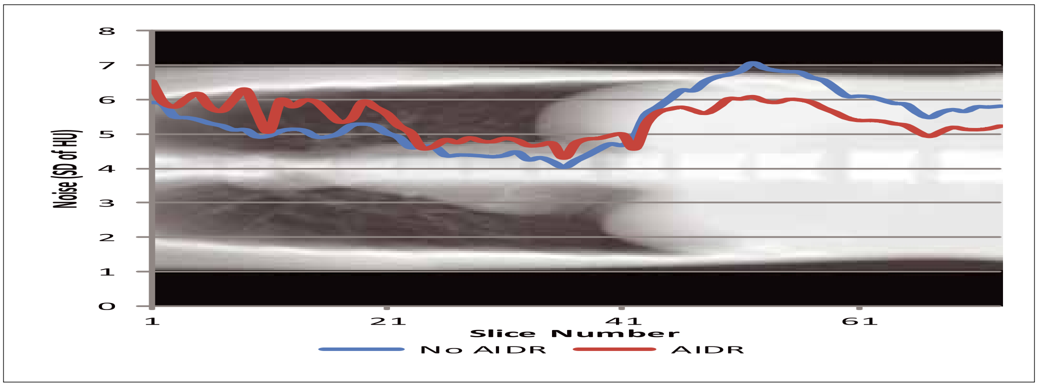


Figure 3b: Measured SD along the phantom: with AIDR non-activated (blue) and with AIDR activated (red)

Methods

During CT acquisitions the phantom was centered according to a clinical routine CT examination, i.e. supine position, sagittal midline, and at the isocenter of the gantry (Fig. 1b). This position was to ensure reproducible image quality and optimum performance of SUREExposure 3D resulting in minimal dose. The scanning direction was head first. The scan and reconstruction protocols are summarized in Table 1.

Tube Voltage [kV]	120
Tube Current [mA]	modulated
Rotation Time [s]	0.5
Collimation	80 × 0.5 mm
FOV [mm]	320
Matrix	512 × 512
Pitch	0.8
Reconstruction Kernel	FC12

Table 1: Scan and reconstruction parameters on Aquilion PRIME

We performed two tests with SUREExposure 3D activated using Standard Deviation (SD) = 5 and with AIDR being activated as well as non-activated. The lower and upper tube current limits were set for both tests to 80 and 500, respectively.

Details of the radiation dose were obtained for each CT scan from the dose record. From the DLP values it was possible to estimate the variation in radiation dose by calculating the difference of the DLP with AIDR relative to the DLP without AIDR:

$$\textit{dose reduction} = \frac{DLP - DLP_{AIDR}}{DLP} \times 100\%$$

where the mean mA was used in both DLP calculations.

To assess the image quality, the image noise was compared in images obtained from scans performed with and without AIDR activated. Image noise is measured by placing regions of interest (ROIs) and looking at the SD of the fluctuations in CT-numbers. The ROIs were placed in a soft tissue simulating ma-

Figure 4a: Reconstruction with AIDR non-activated

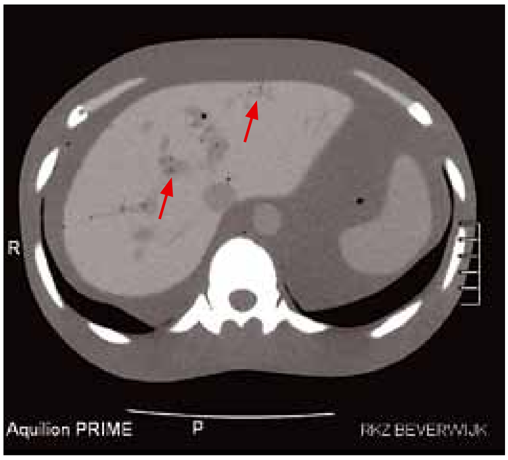


Figure 4b: Reconstruction with AIDR activated. The SD was set to 5 for the mA modulation in both scans. Red arrows indicate preservation of small objects.

terial of the phantom, and finally from each slice the median noise value was stored. The higher SD value, the more image noise is present.

Results

Figure 3a shows the mA values per slice without (blue) and with (red) AIDR. Image quality (SD) was also measured per slice and is displayed in Fig. 3b.

In terms of subjective method to assess the image quality, we present in Figs. 4a and 4b to visually compare two reconstruction methods. Small objects (red arrows) have obviously been preserved while the noise is reduced at lower mA.

The dose reduction is calculated according to Eq. (1) above with DLP of 464 mGy*cm without AIDR and DLP of 135 mGy*cm with AIDR activated, resulting in:

$$\textit{dose reduction} = \frac{464 - 135}{464} \times 100\% = 71\%$$

The dose reduction reported in this phantom study agrees well with that of a clinical study reported earlier in[1].

Conclusion

There are many possibilities to attain significant dose reduction. We have presented AIDR which has been integrated into SUREExposure 3D. The results demonstrated that low-dose AIDR images were comparable to standard dose images for which AIDR was non-activated in terms of SD and visual assessment.

Dose reduction of more than 70% was achieved while maintaining highest image quality possible using Automatic Exposure Control, which agrees well with the clinical study reported earlier. This agreement confirms the functionality of the integration of AIDR into SUREExposure 3D, which can be used in clinical routines for any exams. In clinical exams the degree of dose reduction will vary due to the adaptive nature of the AIDR algorithm. Typically, the degree of dose reduction ranges from 67–73%.

Finally, we conclude that iterative algorithms have opened up new possibilities for clinical CT applications such as perfusion studies, both with temporal uniformity and minimized patient dose, reducing a possible dose penalty.

Acknowledgments

We thank Toshiba Medical Systems Corporation, Japan, for providing Fig. 1 and peer-reviewing this paper and Henk de Vries for his constructive feedback.

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Ultra Helical Scanning – Fast Acquisition of CT Images

R.M.S. Joemai

Raoul M.S. Joemai

Introduction

Since the introduction of clinical CT great improvements in scan time, patient comfort and resolution have been made. The first clinical CT scanner dates from 1972 and was developed by Godfrey Hounsfield. It required an acquisition time of 5 minutes and reconstruction of one image took 7 minutes[1]. In the following years CT systems improved rapidly and by 1976 acquisition time for one CT image had decreased to 5 seconds with a reconstruction time of 40 seconds[2].

Scanning entire body parts was still difficult at that time due to the long scan time, and image quality was limited by the thick slices of the traditional CT systems. Helical CT scanning was realized by introducing continuous table motion during the scan. Helical acquisitions improved the performance of traditional CT by offering larger coverage and better 3D image quality. With helical CT entire organs can be scanned within a single breath-hold.

In 2007, Toshiba introduced the Aquilion ONE™ system which allows for volumetric scanning. The volumetric 320-detector row CT scanner has a coverage of 160 mm and can be used to scan entire organs within one axial acquisition that takes 0.35 s. There are two options for scanning a larger range than 160 mm with the Aquilion ONE: 1 - wide volume acquisition, 2 - helical acquisition.

Helical scanning can be performed with acquisition configurations of 64 x 0.5, 100 x 0.5 and 160 x 0.5 mm (number of active detector row times scanned slice thickness). The last two are known as ultra-helical acquisition configurations.

Helical CT is still generally applied in clinical practice with rotation times of about 0.35 s and a scanned slice thickness of 0.5 mm. Scanning a region of 1400 mm would take with a 4, 16, 64 and 160 detector row CT scanner at equal pitch 350, 88, 22 and 9 seconds respectively (Fig. 1).

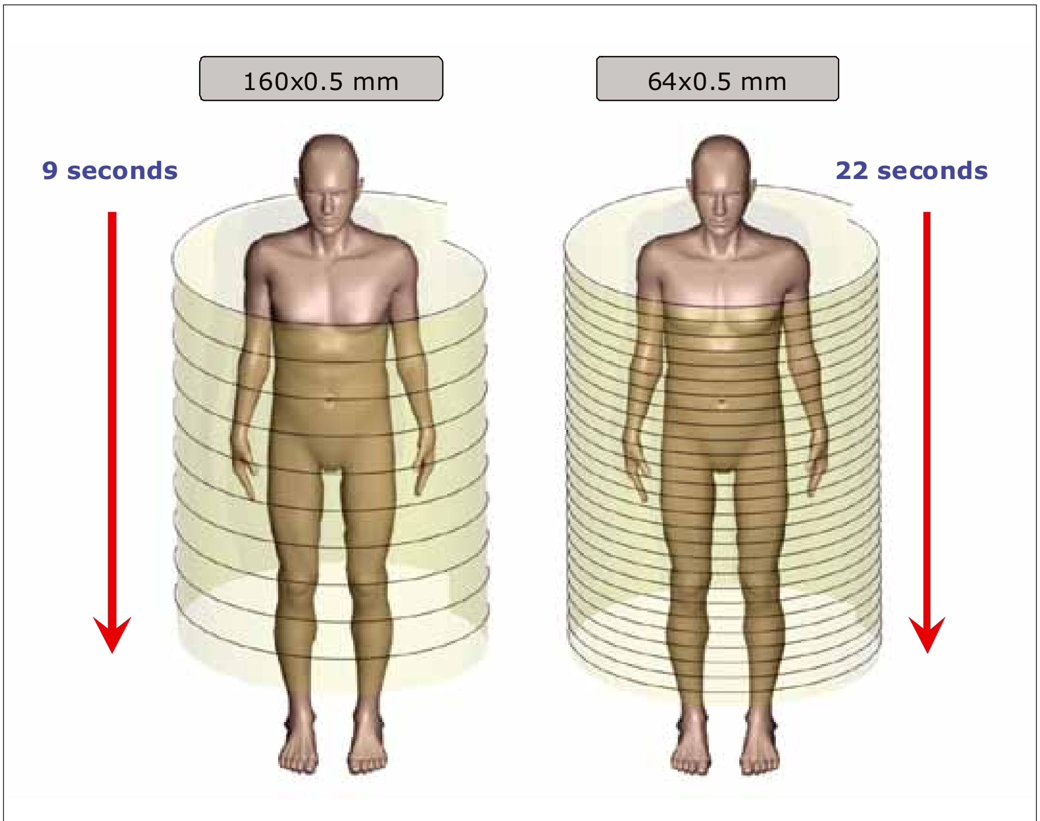

Fig. 1: Illustration of 64 x 0.5 mm and 160 x 0.5 mm scanning. With ultra-helical (left) the same region can be scanned with fewer rotations and less time.

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Fig. 2: Scan time of three scan lengths at normal and ultra-helical

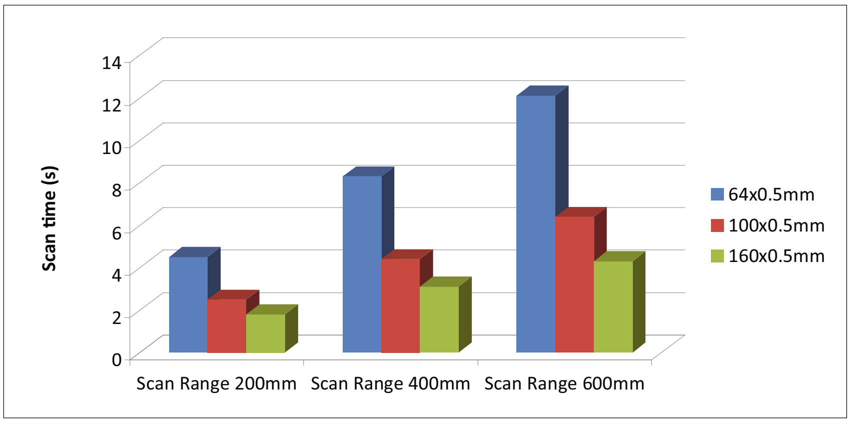
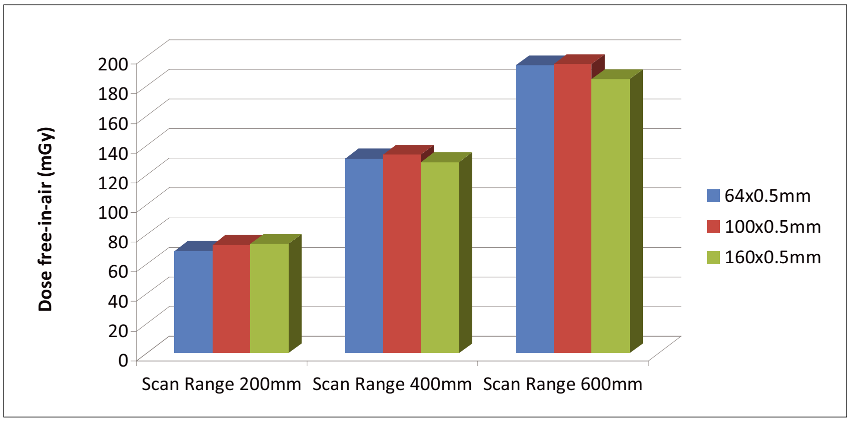


Fig. 3: Measured dose during acquisitions at different scan lengths and acquisition collimations



Overranging is a well known phenomenon in helical CT and originally caused some unnecessary radiation exposure, particularly when acquisition configurations were used with a wide acquisition collimation and high numbers of active detector rows. The excessive radiation exposure that resulted from overranging limited the development of helical scanning using more than 64 active detector rows. Therefore a helical acquisition with for example 160 x 0.5 mm was previously undesirable.

To overcome this issue, the Toshiba Aquilion ONE CT scanner is equipped with an active collimator which eliminates unnecessary radiation exposure caused by overranging in helical acquisitions. The active collimator optimizes the collimation width during the acquisition; starting and finalizing the scan with a closed collimator and at optimized collimation width during the scan. With the implementation of the active collimator it became possible to develop the ultra helical acquisition techniques.

Purpose of this study was to compare radiation dose of standard helical scanning with ultra helical scanning and to demonstrate the performance of ultra helical acquisitions with a clinical case.

Materials and methods

Acquisition protocol

Acquisitions were performed on the Aquilion ONE CT scanner (Toshiba Medical Systems, Nasu, Japan) at three helical acquisition configurations: 64 x 0.5 mm (normal helical), 100 x 0.5 mm (ultra-helical 1), 160x0.5 mm (ultra-helical 2). The imaged scan ranges were 200, 400 and 600 mm for each acquisition configuration. Acquisition protocols were the same as those used in clinical practice, and the effective tube current (mAs per slice) was kept constant for each acquisition. The acquisition parameters are shown in Table 1.

Table 1: Acquisition parameters

Acquisition Collimation (mm)	*Tube Voltage (kV)*	*FOV (mm)*	*Rot Time (s)*	*Tube Current (mA)*	*Eff mAs*	*Pitch*
64 x 0.5	120	400 (L)	0.5	200	121	0.83
100 x 0.5	120	400 (L)	0.5	250	121	1.03
160 x 0.5	120	400 (L)	0.5	240	121	0.99

Fig. 4: Application of ultra helical in clinical practice. This scan was performed within 5 seconds using an ultra helical acquisition

Dose measurements
Dose measurements were made free-in-air with a 102 mm pencil ionization chamber (model CP-4C; Capintec, Ramsey, NJ) connected to a dosimeter (model 35050A; Keithley Instruments, Cleveland, Ohio). The ionization chamber was fixed to a supporting stand that was positioned on the floor. The ionization chamber was aligned along the central axis of the scanner so that the axis of rotation of the scanner coincided with the center of the ionization chamber. Dose measurements were similar as those described in the paper by Van der Molen et al.[3].

Results

Differences in scan time for these three acquisition configurations are provided in Fig. 2 which shows that the scan time decreased substantially for the ultra-helical acquisitions, it decreased with 64% using 160 x 0.5 mm compared to 64 x 0.5 mm at a scan length of 600 mm. Ultra-helical acquisitions provide coverage of entire body parts within a few seconds. The dose free-in-air increases as expected for longer scan lengths but the effect of overranging, which is predominantly expected for ultra helical acquisitions, was not observed in the measurement results. This indicates excellent performance of the active collimator. Moreover, dose measurements showed similar dose levels for acquisitions using ultra-helical acquisition collimations (Fig. 3).

Clinical case

Fig. 4 shows a scan of a patient which was used as reference for the initial condition before treatment by chemotherapy. The scan was performed from the shoulders to the pelvis with a scan length of 680 mm. Acquisition collimation was 160 x 0.5 mm at a scanning Field of View of 400 mm and the scan time was less than 5 seconds.

Conclusion

Ultra-helical scanning with 160 x 0.5 mm is now an attractive option since whole body scanning of trauma patients can be performed in less time compared to helical acquisitions. But also CT angiography scans can be performed with the same image resolution but less contrast injection and with minimized patient motion.

Results have shown that measured dose for 160 x 0.5 mm ultra-helical is similar to 64 x 0.5 mm helical scanning. Also for small scan lengths, similar radiation dose was observed for ultra-helical.

Previously, the only possibility to minimize overranging was by selecting a smaller acquisition collimation and a low pitch. Now, with the active collimator, overranging is no longer a limiting factor for helical CT scanning. Fast scanning with acquisition collimation of 160 x 0.5 mm can be performed at optimized radiation exposure to patients.

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CT Perfusion Imaging: The Best of Both Worlds

J.H. Reid, J.T. Murchison, E.J.R. van Beek

Introduction

A few years ago, the idea of combining the spatial and temporal accuracy of CT with the recognised benefits of mapping regional perfusion for routine diagnosis was a dream. With the advent of wide-area detector CT that dream has become a reality.

The idea of assessing physiological phenomena using CT perfusion is not a new one with Leon Axel proposing a method for measuring cerebral blood flow just 8 years after Hounsfield introduced the first CT[1]. Because of technological limitations early attempts were largely confined to research studies of the brain and kidneys[2]. The introduction firstly of spiral and then multislice scanners has enabled assessment of perfusion in increasing volumes of tissue.

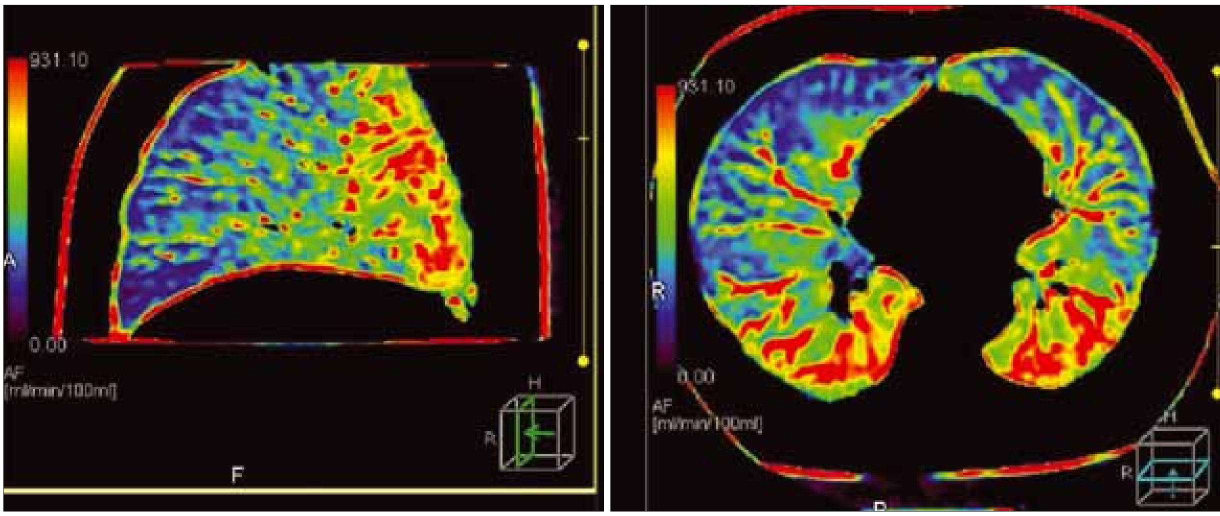

Fig. 1: The perfusion maps in this patient with normal perfusion demonstrate the normal physiological gradient throughout the lung in a subject in the supine position. Note higher perfusion (warmer tones) in the more dependent portions of the lung.

In the era of cerebral thrombolysis for acute cerebral ischaemia, perfusion imaging is gaining further impetus[3,4]. In this clinical setting, CT perfusion can provide crucial additional information to the standard brain scan and CT cerebral angiogram. The 16 cm detector of the Aquilion ONE provides sufficient coverage in a single rotation for many selected organs in addition to the brain, such as heart and kidneys, but also for a significant portion of organs, including the liver and pulmonary circulation.

CT lung perfusion imaging has in the past been proven in various research models[5]. Most recently, the power of CT lung perfusion imaging in early detection and quantification of lung diseases in human subjects was demonstrated in a study requiring central line injection and with limited z-axis coverage[6].

Another recent application, using dual energy CT perfusion methodology, has been applied to the in vivo diagnosis of ground glass opacification and pulmonary embolism (PE)[7-10]. In the latter study, dual-energy CT was employed to detect and quantify perfusion defects, obstruction score and RV/LV ratio in acute pulmonary embolism in a single scan volume without the need for subtraction techniques which are prone to motion misregistration artefacts. Using dual energy this is possible by employing the material decomposition theory[11]. In this paper, we show that perfusion imaging can be considered as an excellent alternative diagnostic tool to dual energy.

It is well recognised that conventional CT pulmonary angiographic (CTPA) follow-up will underestimate the presence, size and significance of perfusion abnormalities as a cause for thromboembolic pulmonary hypertension. In the past, this diagnosis required scintigraphy as an additional test to provide this perfusion data[12].

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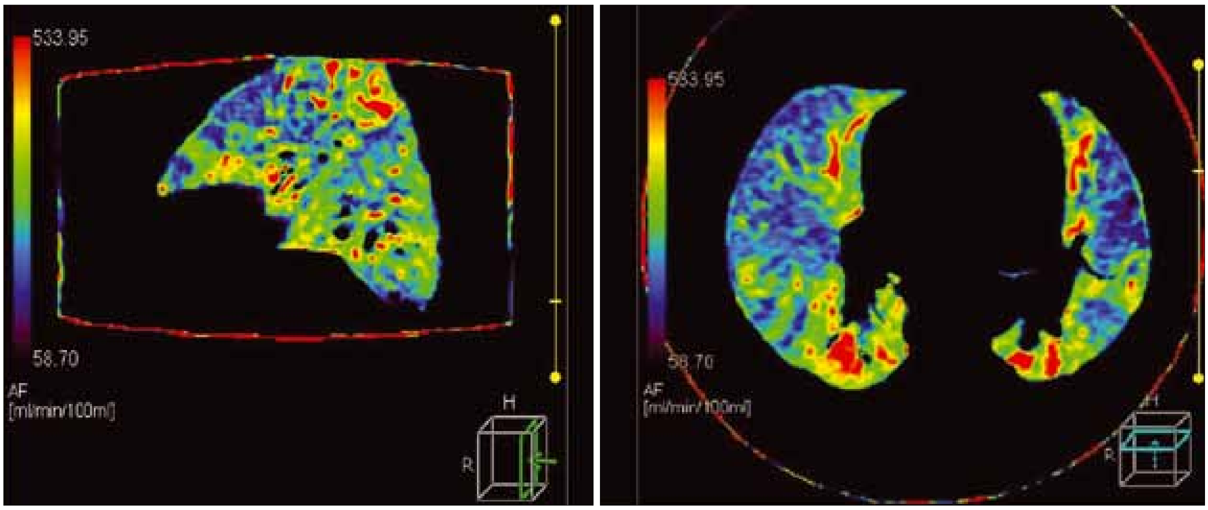

Fig. 2: This patient, who previously sustained a massive pulmonary embolism, remained symptomatic 3 months after the inital event. Despite an apparently normal conventional CT pulmonary angiogram, there are areas of strikingly reduced perfusion in the infero-posterior regions of the lungs. Some of these areas demonstrate segmental distribution and are likely to represent chronic post-thrombotic occlusion.

It is in the scenario of pulmonary embolism follow-up that our institution has initially explored the possibility of utilising the 16 cm z-axis coverage offered by Toshiba's Aquilion ONE to provide novel functional perfusion data and at the same time provide anatomical data on presence of residual thrombi.

Technique

The CT perfusion technique uses a peripheral intravenous injection of 70 ml of iodinated contrast (Iomeron 400 mg I/ml, Bracco) followed by 30 ml saline flush at the same injection rate.

The scan range is set to 160 mm using intermittent dynamic volume acquisition with a low dose protocol of 100 kV, 100 mA, a 400 mm field of view and a rotation time of 0.5 s. Scans are obtained from 5 s to 20 s after start of injection at 2 s intervals.

This method is capable of yielding low-dose CT pulmonary angiography data in addition to providing the dynamic data required to obtain perform perfusion analysis.

Initial results

Figure 1 shows a patient referred for possible hepato-pulmonary syndrome. The images clearly demonstrate the gravity-dependent perfusion as expected in a normal distribution pattern. The lung has relatively homogeneous perfusion in the non-dependent areas.

Figure 2 shows a patient who was evaluated three months after a large central pulmonary thromboembolic event. This patient was still on oral anticoagulant therapy, but did not receive fibrinolytic therapy at the initial event. The study again demonstrates the gravity-dependent effects on the perfusion, but at the same time shows peripheral perfusion defects. The same study was evaluated for the presence of pulmonary embolism, which could not be demonstrated down to sub-segmental level. Based on this observation, it would appear that microvascular disease causes persistent perfusion abnormalities, and this could be a sign for the future development of long-term complications, such as chronic thromboembolic pulmonary hypertension.

Conclusion

CT perfusion utilising wide-area coverage has the potential to study physiological effects of lung and pulmonary vascular diseases. This work is to be expanded in the near future.

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Enhancing Options in Radiology

First Toshiba Infinix VF-i/SP 30 x 30 cm Flat Panel Detector installed in Europe

In response to the continual and rapid development of cardiac and vascular care Toshiba launched its latest vascular imaging system in March last year – the Infinix VF-i/SP Shared Cardiac and Vascular Lab with 30 x 30 cm Flat Panel Detector (FPD) and extra small FPD housing. Since then, radiologists, vascular surgeons and cardiologists from all over Europe have welcomed the enhanced versatility and superior image quality offered by the system. Global orders for the new Infinix VF-i/SP with 30 x 30 cm FPD have already topped 60 units.

Dr. Anton van den Biezenbos is a radiologist at Gelre Hospital in Zutphen, the Netherlands, where the very first Infinix VF-i/SP with 30 x 30 cm FPD sold in Europe, was installed in October 2010. He told VISIONS how the new system is enabling Gelre's specialists to perform a wider range of procedures with greater ease and increased efficiency.

VISIONS: *Could you tell us about Gelre Hospital?*

Dr. van den Biezenbos: Gelre Hospitals is actually a group of hospitals and clinics that operate together to serve the towns of Zutphen, Apeldoorn, Epe and Lochem in Gelderland, the biggest province of the Netherlands. The group has a total capacity of 925-beds. It includes the facilities of Gelre Hospital in Zutphen, which offers a wide range of clinical services. I have been working as a radiologist at the Gelre Hospital group for 11 years.

Gelre Hospital in Zutphen now operates from a brand new building which was opened in October 2010. The new facility features a state-of-the-art Cath Lab that enables us to provide increased options for diagnostics and interventional procedures. One of the most advanced appliances acquired for the facility is the new Toshiba Infinix VF-i/SP with 30 x 30 cm FPD that was installed in the autumn of 2010 and was ready for use with the opening of the new building.

Dr. Anton van den Biezenbos:

"The system is outstanding

for interventional work. The image quality in particular brings great benefits here".

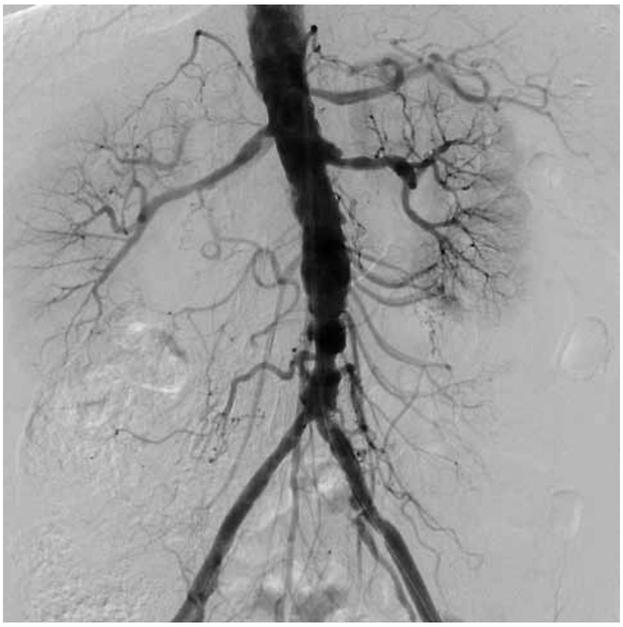
Toshiba's Infinix VF-i/SP in the angio intervention lab at Gelre Hospital, Zutphen

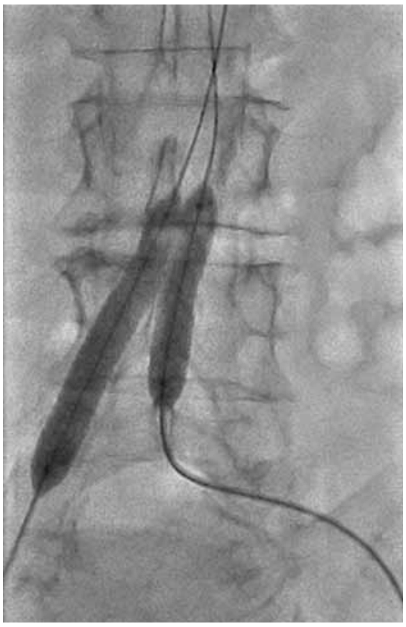
The control room of Toshiba's Infinix VF-i/SP interventional angiography system at Gelre Hospital, Zutphen

VISIONS: *Why did you choose Toshiba's Infinix VF-i/SP Shared Cardiac and Vascular Lab with 30 x 30 cm FPD?*

Dr. van den Biezenbos: The system was actually introduced to me by my colleagues in cardiology who were very enthusiastic about its specifications and the excellent service offered by Toshiba. Its 30 x 30cm FPD and extra small FPD housing enable the steep angulations required in many examinations performed in cardiac imaging. Its detector size, its maneuverability and its ability to produce high resolution images also sounded superb for other diagnostic and intervention procedures.

We needed a system which could offer excellent results across a wide range of disciplines, coupled with optimal reliability and affordability. The facilities of the new Cath Lab at Zutphen are designed for use by both the Intensive and Coronary Care Units. Radiologists, cardiologists and the pain management group all share use of the equipment. We immediately recognized that the Infinix VF-i/SP with 30 x 30 cm FPD could meet the diverse needs of the whole medical imaging team here and enable us to offer a





Digital Subtracted Angiography and high quality fluoroscopy imaging with Toshiba's Infinix-i-series.

Gelre Hospital's new building at Zutphen has been in use since late 2010

wider range of procedures, work more efficiently and elevate patient care.

I have worked with Toshiba equipment in other hospitals but was not completely aware of how advanced Toshiba's package of technology and service is until I was introduced to the Infinix VF-i/SP. This system was definitely the right choice for our new Cath Lab.

VISIONS: *Now that you have been using the system for a while, what has really impressed you about it?*

Dr. van den Biezenbos: The image quality that we can achieve with the new system is absolutely top. Toshiba's Advanced Image Processing (AIP) technologies with Super Noise Reduction Filter (SNRF) ensure this with no lag.

The system is outstanding for interventional work. The imag quality in particular brings great benefits here. Stent placement, for example, can be done with far greater ease and precision.

Positioning the system is extremely easy and we can achieve a far greater range of coverage as well as difficult angulations, if necessary. We can utilize the space optimally. Even with several specialists and lots of equipment in the room, we can still access the patient easily. The speed of adjustment is quicker, too, with the high-speed C-arm on the Infinix VF-i/SP.

Overall, the system is so simple to operate that minimal training was required. Everything can be adjusted with one hand, using Toshiba's Hyperhandle tableside console. Toshiba has put great effort into making the system as user-friendly as possible.

VISIONS: *What do your colleagues say about the machine?*

Dr. van den Biezenbos: I have heard nothing but positive comments about the system from fellow radiologists, cardiologists and other staff using the machine.

Not only are our staff delighted with the quality of images and increased flexibility of the machine in terms of its ease-of-use and the new clinical options that it provides, but in general, it is delivering significant economic benefits.

We have been able to improve patient throughput thanks to the parallel processing capability of the system. During one examination, we can already prepare for the next scheduled patient.

With such a large and diverse team of experts using the system at Zutphen we can also save a significant amount of time and boost productivity by quickly readjusting the settings of the system, using the pre-programmed preferences established for each procedure and physician. The Infinix VF-i/SP can store virtually any number of customized examination types for any number of operators.

VISIONS: *Does the system enhance treatment options at Zutphen?*

Dr. van den Biezenbos: Yes. With the new system we can consider carrying out new interventional vascular procedures here for which we currently have to transfer patients to our Apeldoorn site. For example, endovascular coiling for treatment of intracranial aneurysms and endovascular aorta repair are now possible at Zutphen with the Infinix VF-i/SP and it may be possible in the future to treat cerebral infarction through interventional means with the system.

In cardiology, too, we can now perform procedures for which we previously had to transfer the patients to other locations – even academic hospitals for some of the more complex procedures. Thanks to the versatility of the Infinix VF-i/SP, the cardiology team is able to introduce biventricular pacemaker implantation, intra-aortic balloon pump insertion and are exploring procedures to treat pulmonary hypertension with the machine, together with the pulmonary team. Including the new procedures, we have estimated that we will carry out 1400 procedures with the new system per year.

VISIONS: *Can you suggest any improvements to the system?*

Dr. van den Biezenbos: No. It's absolutely top! We are completely satisfied with the system. It is a pleasure to work with the Infinix VF-i/SP and also to work together with Toshiba.

VISIONS: *Thank you!*

New energy-saving flip-flop circuit

Toshiba has developed a new flip-flop circuit using 40nm CMOS process that will reduce power consumption in mobile equipment. Measured data verifies that the power dissipation of the new flip-flop is up to 77% less than that of a conventional flip-flop and that it achieves a 24% reduction in total power consumption when applied to a wireless LAN chip. A flip-flop is a circuit that temporarily stores one bit of data during arithmetic processing by a digital system-on-a-chip (SoC) incorporated in mobile equipment. As a typical SoC uses 100,000 to 10 million flip-flops they are an essential part of an SoC design. A typical flip-flop incorporates a clock buffer to produce a clock inverted signal required for the circuit's operation. When triggered by a signal from the clock, the clock buffer consumes power, even when the data is unchanged. In order to reduce this power dissipation, a powersaving design technique called clock gating is widely used to cut delivery of the clock signal to unused blocks. However, after applying the clock gating, the flip-flop active rate, a measure of data change rate per clock, is only 5-15%, indicating that there is still plenty of room for further power reduction. To save power, Toshiba changed the structure of the typical flip-flop and eliminated the power-consuming clock buffer. This brings with it the problem of data collision between the data writing circuitry and the state holding circuitry in the flip-flop, which Toshiba overcame by adding adaptive coupling circuitry to the flip-flop. A combination of an nMOS and a pMOS transistor, this circuitry adaptively weakens state-retention coupling and prevents collisions. The simplification of the basic flip-flop configuration reduces the transistor count from 24 to 22, and the cell area is less than that of the conventional flip-flop.

New R&D programme in healthcare imaging IT launched

Toshiba Medical Visualisation Systems (TMVS) will launch a new R&D programme in healthcare imaging informatics technology at its Edinburgh facility. The clinical applications to be developed by TMVS will provide cutting edge medical imaging solutions to improve the quality of treatment provided to patients and to reduce the cost of providing that treatment. With this new programme the Edinburgh facility is well positioned to become the leading centre of its kind within the company. It will be responsible for building and developing everything needed for world class clinical applications, from image analysis algorithms and clinical development frameworks to increase productivity to clinical applications of medical imaging modalities.

The project is being supported by an approx £3 million R&D grant from Scottish Enterprise and will allow the company to grow its R&D capability in Scotland, creating 26 new jobs.

"Toshiba could not be more pleased with its decision to establish a key global R&D centre based in Scotland. Our access to top talent, universities and research collaborators, coupled with the terrific support and vision of the Scottish government has been outstanding," said Fredric J. Friedberg, President, TMVS.

Magic figures – Toshiba produced its 25.000th CT scanner

Since Toshiba released Japan's first whole-body CT system in 1978, many medical facilities both in Japan and overseas have bought and use the advanced, high-quality products in everyday practice. Late last year the 25,000th system was manufactured and a special event to celebrate the achievement was organized.

Helical CT made it possible to scan a wide range and multislice CT enabled highly accurate diagnostic imaging within a single breath-hold. Subsequently, innovative concepts such as "one rotation per organ" and "dynamic volume scanning" that were realized in Aquilion ONE revolutionized diagnostic CT systems.

In a very competitive environment we are accelerating our research and development to release systems that continue to advance healthcare. The next milestone – the 30,000th system – is already in sight.

History of Toshiba CT production

The first CT system was developed in 1972 by Godfrey Hounsfield, a British electrical engineer. In 1974, EMI Ltd., the British company that first produced a commercial CT system, entered a sales agreement with Toshiba, who started selling the systems in Japan and delivered the first CT system to Tokyo Women's Medical University in 1975.

1978 Japan's first CT head scanner developed and released, followed by Japan's first whole-body CT system
1982 1000th system produced
1985 First system capable of continuous scanning at 1 rotation per second produced
1986 US patent for a helical CT system obtained
1989 Improved operability by embedding scanning criteria in software
1990 Worldwide first helical CT option installed. 5,000th system produced
1993 Helical CT system containing high-performance solid state detector developed and released
1994 Helical CT system with 1 rotation per second scan speed released
1998 10,000th system produced
1999 4-row multislice CT system with industry's smallest slice width (0.5 mm) released
2002 16-row multislice CT system released
2003 15,000th system produced
2004 Worldwide first 64-row 0.5 mm multislice CT system released
2007 20,000th system produced
2007 Aquilion ONE, world's first 320-row system, released
2010 25,000th system produced

Groundbreaking – external hard disks with USB 3.0

Toshiba is among the first companies worldwide to invest in the new USB 3.0 technology. The first external hard disks using this new standard will be launched in early 2011. With a transfer rate of 570 MB per second they are extremely well suited for large back-ups or for the transfer of huge amounts of data.

Their capacity is convincing, as well. The STOR.E STEEL S offers between 500 GB and 1.5 TB depending on the model. The STOR.E ALU 2S provides even higher capacity. Within the first half of 2011, the 2.5 inch model with up to 1.5 TB will be followed by a 3.5 inch version offering up to 3 TB. The new hard disks are handsomely designed: the super-slim cases with fine steel or aluminium covering look good on any desk. And they come with a real treat: direct access to the Toshiba Market Place where many useful and entertaining applications wait for the customers.

"Carmen" in 3D - Toshiba, RealD and the Royal Opera House partner for Bizet's masterpiece

A story of love, passion and betrayal – George Bizet's "Carmen" is one of the most popular operas of all times and soon to be a major 3D motion picture. Toshiba Corporation is very proud to join the Royal Opera House at London's Covent Garden and RealD Inc. in this exciting production. Toshiba will support the promotional activities inter alia by offering 3D Blu-ray Discs of Carmen in 3D with select 3D-enabled Toshiba brand consumer electronics. "Carmen in 3D is a rich and immersive performance delivering a refreshing and innovative approach to a timeless work of art, creating a sense of really being at the theatre," said Masaaki Osumi, Corporate Senior Vice President, President and CEO, Visual Products Company at Toshiba Corporation. "As an innovator in 3D, including the world's first glasses-free 3D LCD TVs, Toshiba is delighted to ally with RealD, a 3D industry leader, and the world renowned Royal Opera House. We hope we will drive forward the 3D market in both hardware and content, through the promotion of this extraordinary film."

A co-production by RealD and London's internationally renowned Royal House, Carmen in 3D is slated for release worldwide on 5 March 2011, exclusively in RealD-3D equipped theatres. The release will mark the first time that an opera has been filmed and shown in theatres in state-of-the-art digital 3D. Georges Bizet's Carmen has been captivating audiences since its debut in 1875. Filmed in 3D during two performances at the Royal Opera House, Carmen in 3D is a feature film depicting acclaimed director Francesca Zambello's updated interpretation of the opera classic. Directed for cinema by Julian Napier and produced by Phil Streather, with memorable performances by Christine Rice (Carmen), Bryan Hymel (Don José), Aris Argiris (Escamillo), and conducted by Constantinos Carydis, Zambello's hugely successful production of Carmen was a hit with London audiences and critics and promises to delight audiences around the world with its timeless music and encompassing 3D visuals.

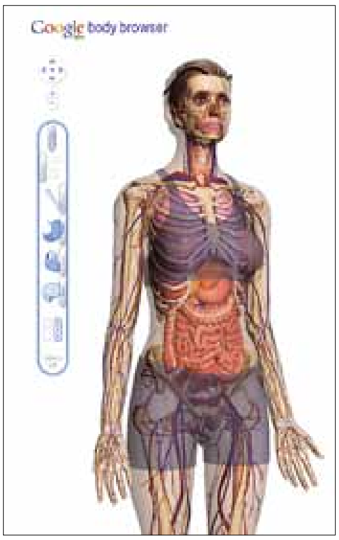
Body Browser– Google Body lets you discover your anatomy in 3D

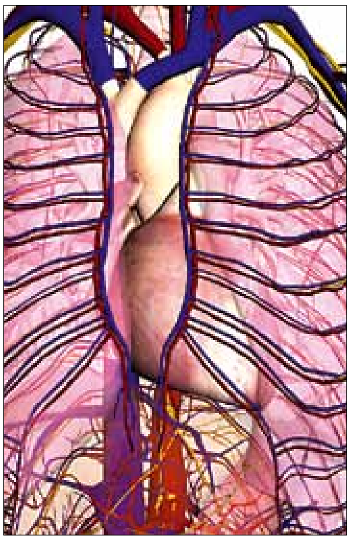
Google has just released BODY BROWSER, a WebGL application that lets you discover the human body the same way you can discover the world in Google Earth - from any angle.

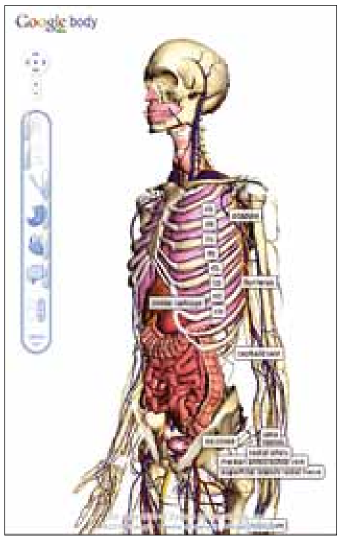
Google Body is a detailed 3D model of the human body. You can peel back anatomical layers, zoom in, and navigate to parts that interest you. Click to identify anatomy, or search for muscles, organs, bones and more. You can also share the exact scene you are viewing by copying and pasting the corresponding URL.

A web browser that supports WebGL, such as the new (free and publicly available) Google Chrome Beta, is required. Medical students and the educational community will find this new Google application quite useful. Visible Body had already attempted to revolutionize anatomy education, but did not provide the application free of charge.

http://bodybrowser.googlelabs.com/







Scanning ancient mummies with the Aquilion

Some unusually old patients recently presented at the radiology department of the public hospital in the Argentinean district of Malvinas Argentinas: three Egyptian mummies dating from 332 BC to 395 AD required a CT scan and their "minders", researchers at the Museum of Natural Sciences of La Plata, considered the hospital's Aquilion 64-row CT system the perfect equipment for this sensitive examination. Guillermo Mac Clay, Toshiba application specialist in Argentina, was on site to witness the procedure.

The CT images revealed quite unexpected findings. For example, one mummy thought to be a child turned out to be an adult, and the cause of death could be also determined. In addition, the images of a mummy of a young woman showed sophisticated dental prostheses – an indication that she must have been a person of high rank. Researchers and radiologists alike were extremely impressed by the outstanding quality of the images acquired by the Aquilion 64. The study attracted a great deal of interest since it was the first such research project conducted in South America and because it provided important new information about ancient Egypt. The results of the study were reported by the media throughout Argentina.

Dr. Abramzon & team

The hospital Malvinas Argentinas also operates an Asteion 4-row system. Dr. Fernando Abramzon, director of the radiology department and leader of this collaborative research project, underlined that he is extremely satisfied with the quality of the Toshiba systems.

Awards for the diagnostic ultrasound system Aplio MX

The Aplio MX offers excellent diagnostic imaging capabilities while minimizing the environmental impact – a fact which earned high praise and was most recently recognized with the Japanese Eco-Product Award.

The design concept of the Aplio MX is to be friendly to people and the environment. The system's 4D imaging functions offer improved diagnostic capabilities while reducing power consumption by 35% and shortening examination time. Moreover, the compact operating panel and PC board rack structure reduce the weight of the system by 32% compared to the equivalent Toshiba product manufactured in 2001. Due to its low space requirements, the Aplio MX can be used bedside. This is the second Eco-Products Award Toshiba received for its medical equipment. In 2007, the Aquilion 64-row CT scanner won the award.

The Eco-Products Awards

The Eco-Products Awards, established in 2004, promote eco-friendly products in Japan. They recognize and support companies and organizations that offer products and services which are less harmful to the environment and provide consumers with information on such products and services.

Non-Contrast-Enhanced MRA by 3T MRI:

Imaging of the torso region with multiphase transmission

I. Aoki

3T scanners have previously been used on the central nervous system and have captured many clinically useful images. Some areas however have been more challenging to adapt for routine scanning on 3T. Therefore many issues had to be addressed to ensure high image quality when imaging the torso. In particular, there have been significant issues with non-contrast-enhanced MRA, including deficient delineation of blood vessels. A new technology has been developed for improving images of the torso, abdomen and non-contrast-enhanced MRA. Non-contrast-enhanced MRA utilizes the high SNR of 3T scanners and is becoming increasingly routine. This article provides an overview of the progress and prospects for this new technology.

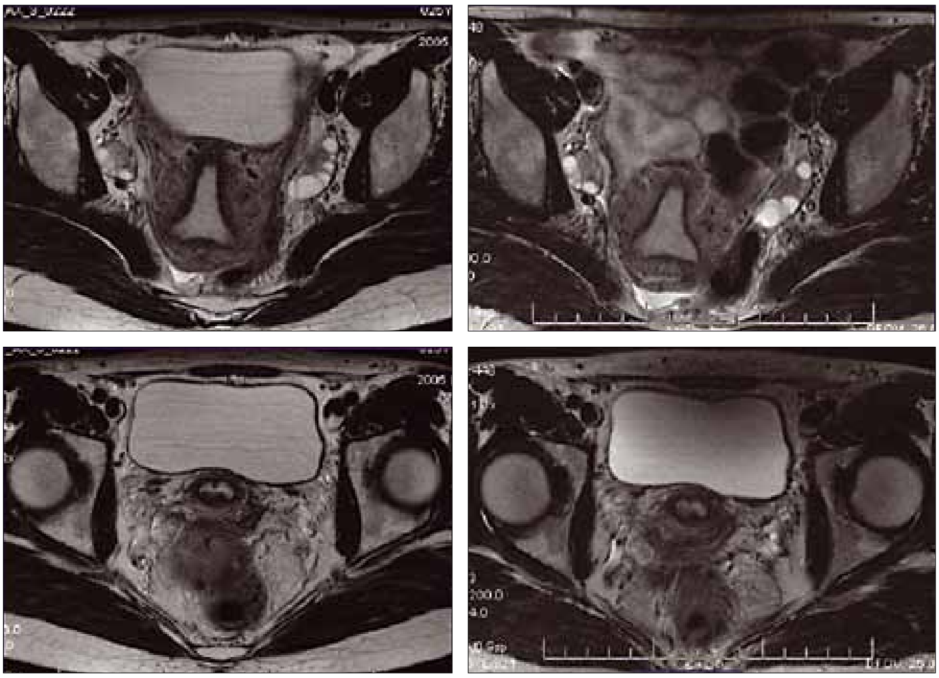
Features of 3T scanners

Switching from a 1.5T scanner to a 3T scanner generally produces the following changes to the images produced:

- Improvement in the signal-to-noise ratio (SNR)
- Increase of the specific absorption rate (SAR)
- Increase of the magnetic susceptibility effect
- Chemical shift increase
- Change in contrast

The SNR, which depends on the strength of the magnetic field, is enhanced in 3T scanners and is expected to improve spatial resolution and temporal resolution. In reality, however, high-definition images are not always obtained due to uneven sig-

Fig. 1: A comparison of static magnetic field and RF inhomogeneity between a 1.5T and 3T scanner



Ikuo Aoki, MR Division, Toshiba Medical Systems Corporation

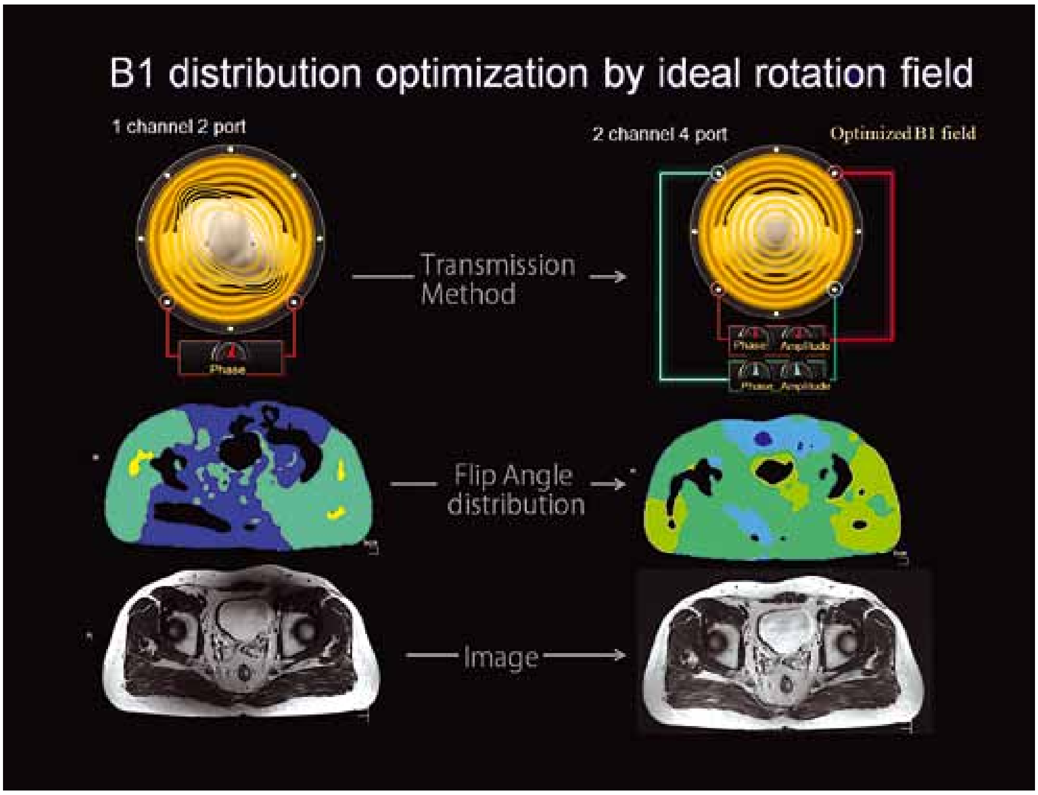


Fig. 2: Optimization of the B1 distribution according to the ideal rotational field

nal response caused by inhomogeneity in the static magnetic field (B0) and the RF field (B1) as well as other factors. Currently 3T scanners have an SNR 1.2 to 1.8 times that of 1.5T scanners at most when imaging the abdominal region.

Meanwhile, the SAR is proportional to the square of the strength of the static magnetic field (B0). Furthermore, the duty cycle, which is the RF pulse frequency per unit of time, proportional to the number of slices and inversely proportional to the TR, is restricted by the SAR. Consequently, the imaging conditions must be modified, such as reducing the flip angle (FA), extending the repetition time (TR) and/or reducing the number of slices. The advantages of 3T MRI cannot be exploited under such circumstances, making it impossible to obtain the high resolution images that were originally expected of 3T scanners. Even the contrast effects that are routinely obtained

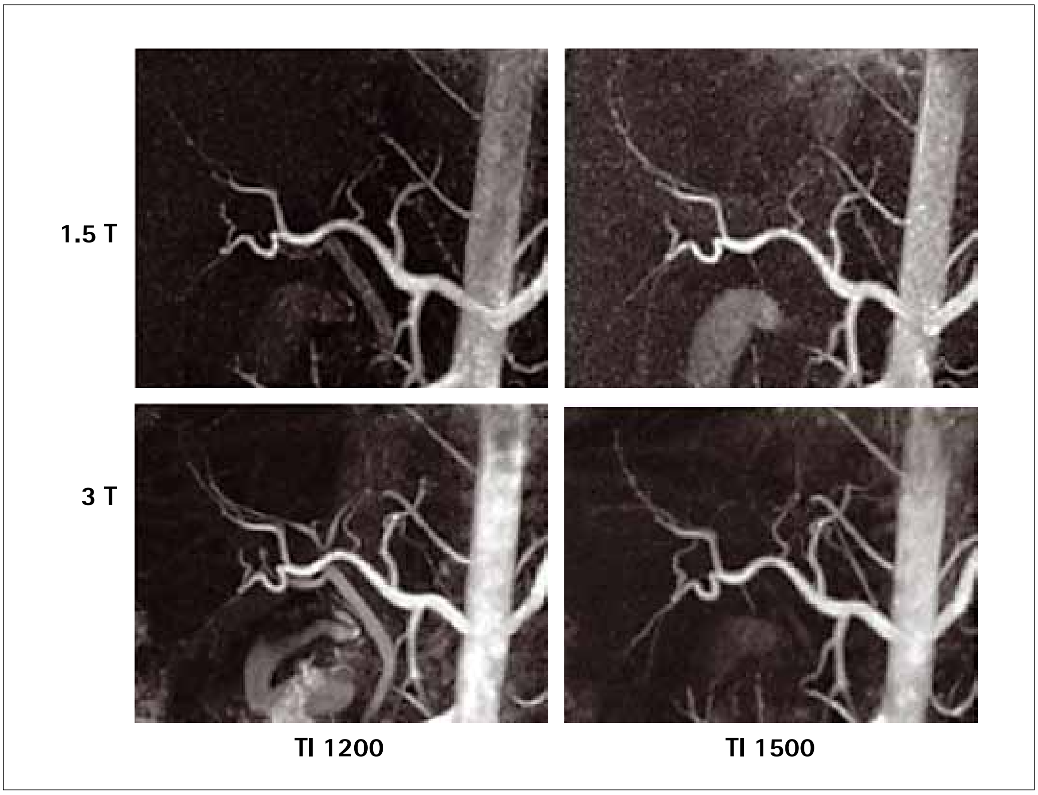


Fig. 3: Non-contrast-enhanced MRA of the hepatic artery utilising multiphase transmission

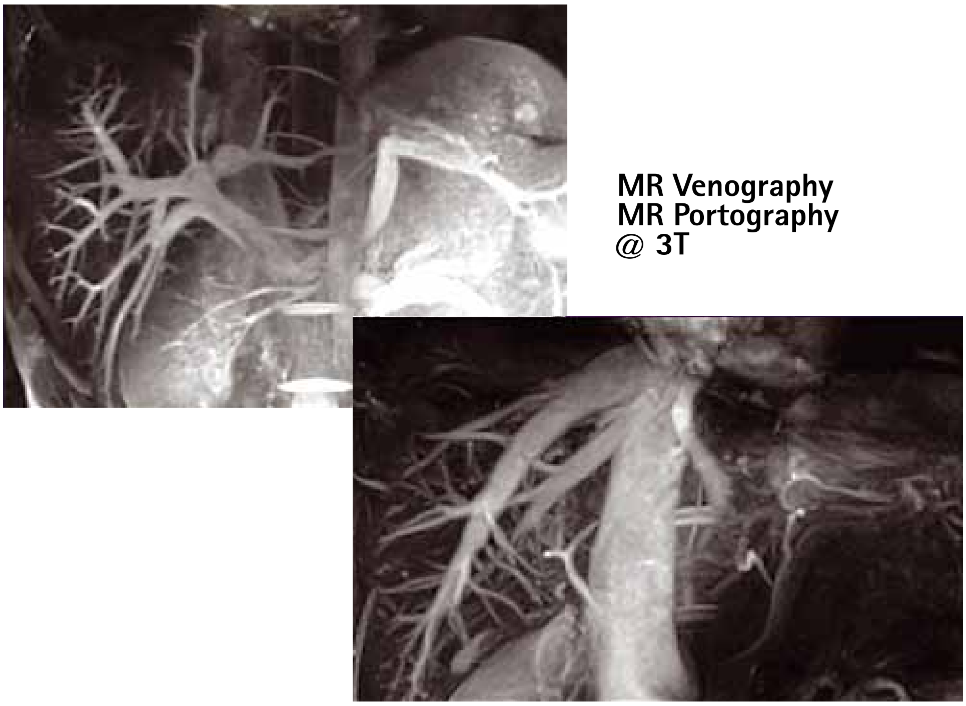


Fig. 4: Non-contrast-enhanced MRA of the portal vein and hepatic artery utilising multi-phase transmission

by 1.5T scanners further deteriorate. Thus, it has been impossible to obtain satisfactory image quality in the torso using 3T scanners.

The issue of RF field (B1) inhomogeneity in high magnetic fields

It is difficult to maintain magnetic field homogeneity in devices with high magnetic fields. RF field (B1) inhomogeneity is particularly problematic in the torso due to the dielectric effect. This leads to an increase in signal strength fluctuation and image degradation. Traditionally this has been resolved by using dielectric pads. By placing such dielectric material on the surface of the body excess RF signals are absorbed, thereby improving inhomogeneous signal intensity. This inhomogeneous signal is not an issue in 1.5T scanners. When imaging is performed without using a dielectric pad, for example in cases of ascites, the SNR in the core of the body decreases as shown in the bladder in Figure 1. Even if a dielectric pad is used, magnetic field in-homogeneity may remain and not be completely resolved.

Fig. 5: High-precision 3D non-contrast-enhanced MRA

High-performance RF signal technology

The high-performance RF signal technology known as multiphase transmission was developed to resolve this issue (Fig. 2). Multiphase transmission is a technology that improves B1 homogeneity by transmitting a for its phase and amplitude precisely adjusted signal. In addition, by increasing the number of power supply ports in an RF coil, the ideal current distribution is achieved and the B1 inhomogeneity, which is attributed to the electrical characteristics of the human body, is reduced. This controls fluctuations in signal intensity and stabilizes image quality for the first time leading to a greater degree of freedom in selecting imaging conditions. With the frequently used two-port transmission the uneven signal intensity in an image, which is attributed to uneven RF transmission, still persists. However, with four-port transmission B1 distribution is much more uniform and uneven signal intensity is significantly improved.

For example, in the past a full bladder would result in noticeable variation in signal intensity, whereas now variation-free images can be captured in a similar manner to an empty bladder (Fig. 2).

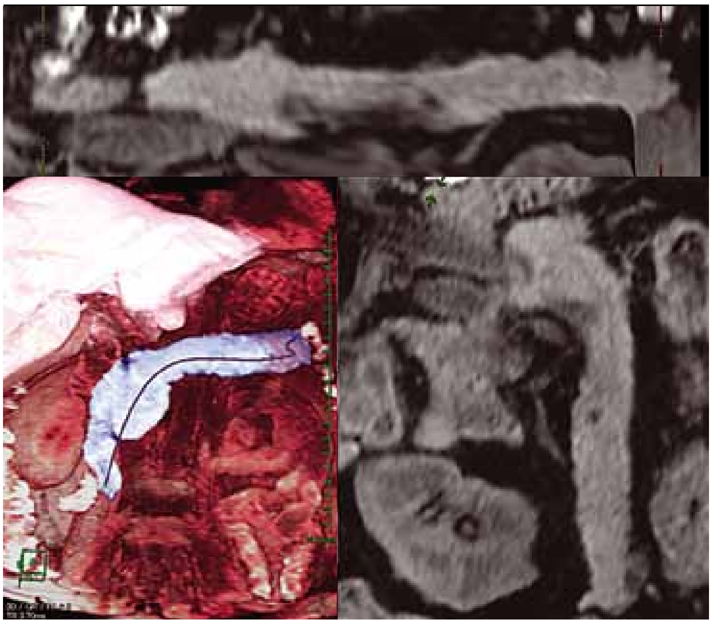


Fig. 6:
3D image of the pancreas

Expectations for 3T non-contrast-enhanced MRA

For 3T scanners Time Of Flight (TOF) has traditionally been used as the non-contrast-enhanced MRA technique. TOF enables images that harness a high SNR to be captured, particularly in the brain. Conversely, there are many problems with non-contrast-enhanced MRA of the torso which, as discussed in the previous section, prevent reliable image quality. However, images of the torso can now be captured by non-contrast-enhanced MRA due to the benefits of the increased performance provided by recent improvements to RF transmission technology.

Non-contrast-enhanced MRA using 3T MRI is expected to result in the following:

- Improvement in the SNR
- Improvement in spatial resolution (MR arteriography)
- Reduced imaging time (MR venography and MR portography)

Although 1.5T scanners provide adequate image quality with regard to MR venography and MR portography, 3T scanners enable the imaging time to be reduced, and increase the degree of freedom in imaging.

Contrast improvement in non-contrast-enhanced MRA due to background signal suppression

In 3T scanners tissue-unique T1 values are longer than those for 1.5T scanners. This enables background signals to be suppressed in images with a long TI. For example, in MRA of the hepatic artery using a 1.5T scanner, the signal in the liver parenchyma, which forms the background signal following TI recovers, resulting in reduced contrast of blood vessels. In 3T scanners, with a long TI, the background signal is suppressed due to prolongation of T1 values, which is expected to improve contrast of blood vessels.

As Figure 3 shows, in the case of a 1.5T scanner, at a TI of 1200 ms, the signal in the liver parenchyma is low and contrast is preserved, but the blood vessels are not visualized to the periphery. When TI is changed to 1500 ms to improve visualization of the peripheral vessels, although they are visualized to the periphery, the signal in the liver parenchyma rises, and the delineation of the hepatic artery is less than optimal. Conversely with a 3T scanner, the contrast effect is clear all the way to the periphery of the hepatic artery due to suppression of the background signal, even with a long TI.

Improvement in spatial/temporal resolution

In MR venography and MR portography, clinically acceptable images can be obtained even if the imaging time is reduced by up to two-thirds (Fig. 4).

Under 3T MRI, higher definition images and shorter imaging time can be expected compared to 1.5T scanners as a result of the enhanced SNR. However, in the past, images captured at certain examinations were not of a quality that could be used satisfactorily in routine practice, and the much anticipated high SNR could not be utilized.

The present situation will be resolved by introducing this new technology. The potential ability of 3T scanners, even in the torso region, will probably be maximized in the future by the new RF transmission technology known as multiphase transmission. Greater improvements in image quality and reduced imaging time can be expected for non-contrast-enhanced MRA of the torso for which expectations are particularly high (Fig. 5).

By combining dimensional volume rendering attained by CT diagnosis with various three-dimensional processing techniques, 3T MRI might lead to a paradigm shift in diagnostic imaging of the abdomen in the near future (Fig. 6).

This article is an excerpt provided by Toshiba Medical Systems Corp. based on the content of a seminar presented at the 69th Annual Meeting of the Japan Radiological Society of 2010 entitled, "Next-Generation Three-Tesla MRI That is Safe for Patients: Innovation in Three-Tesla Imaging of the Abdomen" (Dr. Hiroyoshi Isoda, Radiology and Nuclear Medicine Service, Kyoto University Hospital).

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1 Miyazaki, M., V.S. Lee. 2008. Nonenhanced MR Angiography. Radiology 248(1): 20–43.

The Practical Application and Clinical Use of Modern 3D Ultrasound Technology in Gynaecology

B. Smith

Introduction

3D volumetric ultrasound is shown to be of tremendous value particularly in gynaecology and associated clinical areas. The combination of modern 3D technology and high resolution transvaginal scanning provides increased anatomical and clinical detail. Furthermore it offers considerable benefits from a practical point of view. Nevertheless, its role in gynaecological ultrasound has yet to be fully realised.

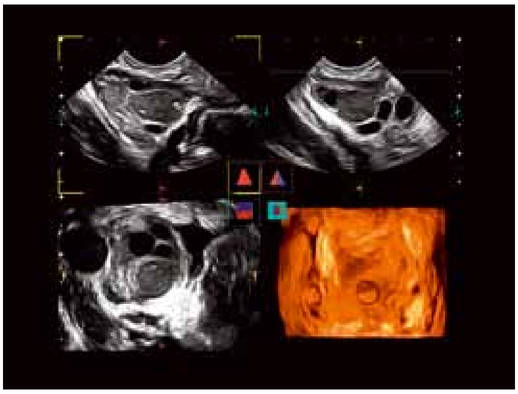
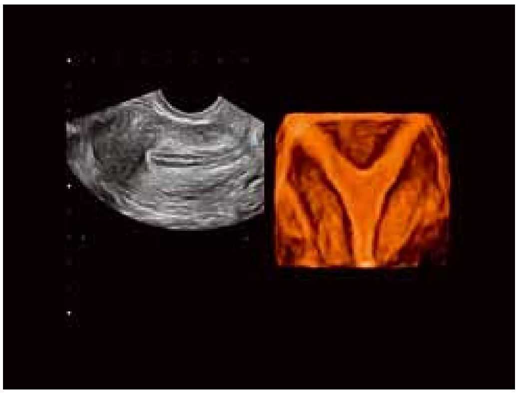
A single automated sweep of the ultrasound beam through a selected volume of tissue or specific organs produces a wealth of diagnostic information. Rapid acquisition and storage of ultrasound data, speedy retrieval of stored data and easy manipulation of retrieved images considerably reduce examination times. This has obvious positive implications both for the patient as well as the management of busy scan lists.

Advances both in transducer design and IT capability have generated high quality 3D imaging particularly when used with transvaginal scanning (TVS). As a result, 3D technology is now an integral part of gynaecological ultrasound in leading scan units. To date 4D (i.e. real-time 3D) scanning has had little to offer in terms of gynaecological ultrasound.

Volumetric facilities are now incorporated within most ultrasound systems. The principal operational controls and functions are similar from system to system, although terminology may obviously vary from one to another.

3D image formats

The so-called sweep scan produces a volume of ultrasound data. This can be displayed in the following formats.

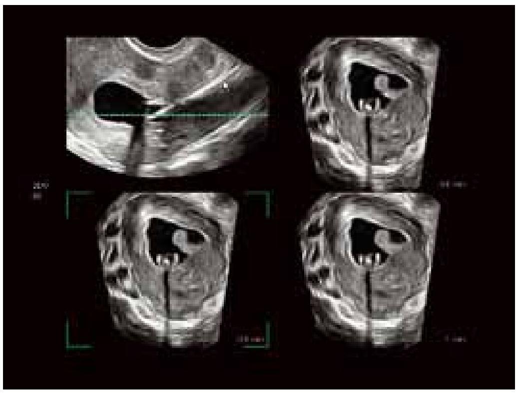


Fig. 1: 3D imaging formats of a multifollicular ovary containing an endometriotic cyst

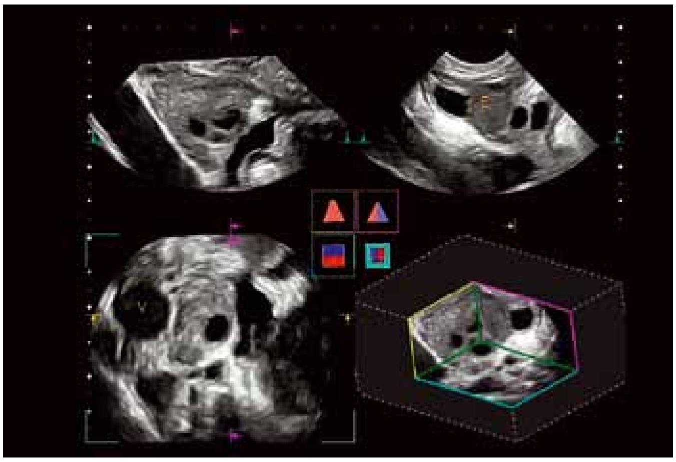


Fig. 1a: Compound image (x, y, z components + BVI) demonstrating antral follicle distribution, ovarian stroma, endometriotic cyst (E) and internal iliac vessel (V).

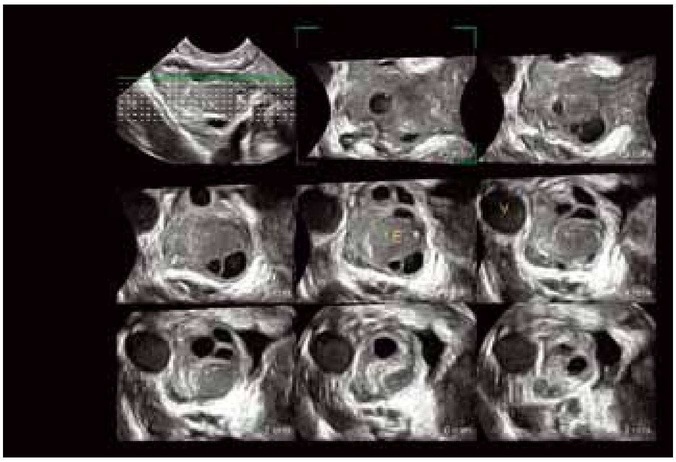


Fig. 1b: Multi View images from the x component of Fig. 1a displaying the complete ovarian morphology and associated features. The extent of the endometriotic cyst (E) is completely demonstrated. The ovarian capsule is outlined and para-ovarian structures such as the pelvic vessel (V) are easily separated from ovarian features.

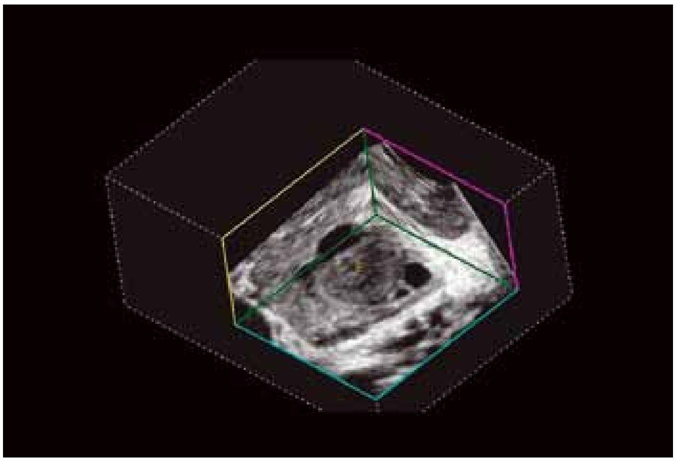


Fig. 1c: Block volume clearly delineating the endometriotic cyst (E) and preservation of normal, healthy ovarian tissue.

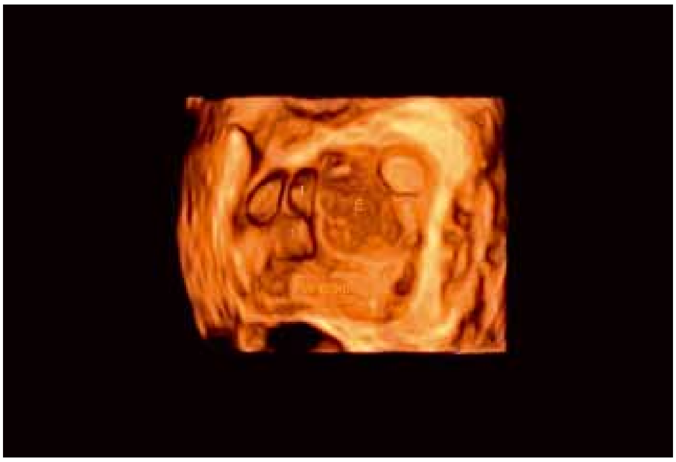


Fig. 1d: Surface rendered image of endometriotic cyst content (E) and cavities of multiple follicles (f). Normal ovarian stroma (ov. strom) is very obvious.

Compound imaging

The compound image consists of standard x, y and z image components (i.e. parasagittal, transverse and coronal anatomical planes). An additional image is also displayed, usually in surface rendered or block volume format (Fig. 1a and 2a).

The four displays within the compound image are quickly assessed and if satisfactory are instantaneously stored at the press of a button. The stored information is transferred to the system memory or hard disc. This data can be retrieved at any stage for further manipulation and evaluation of anatomical planes. The retrieved ultrasound data can then be displayed and recorded in a number of ways or further image formats.

Multi-planar imaging

Multi-planar imaging (MPR) comprises of the x, y and z (parasagittal, transverse and coronal) components of a given Compound Image. This allows a specific structure or area within an organ to be viewed simultaneously in three orthogonal planes, i.e. 3D slices at right angles to one another. MPR provides increased anatomical information and greatly improved delineation of pelvic structures within a single image display.

Multi View

Multi View images (also known as tomographic ultrasound imaging, TUI) consist of tomographic sections through any of the individual MPR image planes. Multi View provides very effective analysis of anatomical details and associated clinical information within any localised region of the pelvis or specific organ. It enhances clinical communication to a considerable extent and offers valuable support to ultrasound scan reporting (Fig. 1b, 3b and 6b).

Block volume imaging

Block volume imaging (BVI) displays internal, orthogonal anatomical planes within a given block volume. Its practical and diagnostic value is lim-

Fig. 2: 3D imaging formats of a normal uterus and uterine cavity

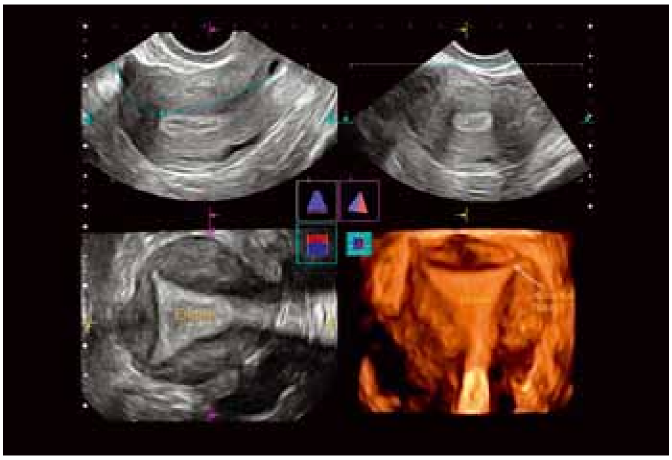


Fig. 2a: Compound image (x, y, z components + SRI) demonstrating a normal endometrial cavity (Endom). Note the interstitial portion of the uterine tube (I) visualised on the rendered image.

Fig. 2b: A surface rendered image in Cavity Mode clearly highlights the interstitial tube (I).

Fig. 3: Bicornuate uterus

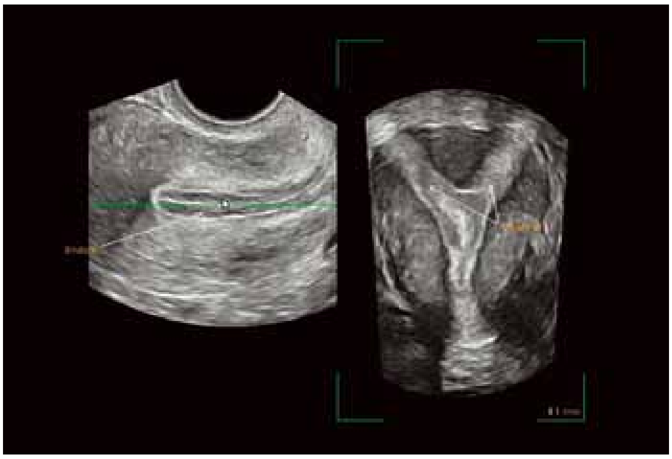


Fig. 3a: Composite image of a parasagittal 2D section of the uterus and endometrial cavity (Endom) and coronal MPR of an obvious bicornuate cavity (Bicorn Ut).

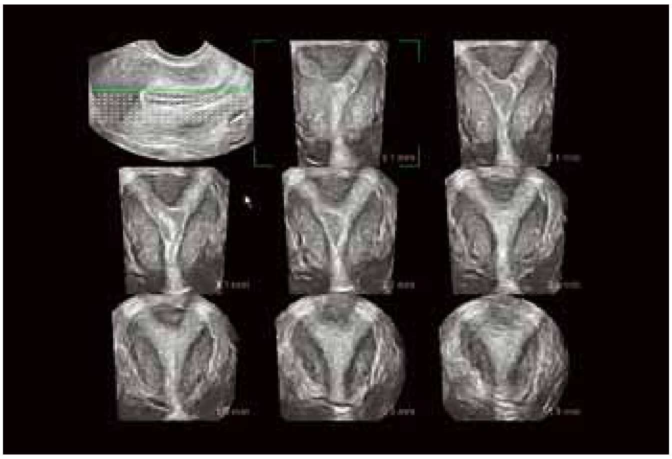


Fig. 3b: Multi View coronal sections outlining the extent of the anatomical malformation.

ited but it can be useful when displaying adjacent features which lie in a random manner in different anatomical planes (Fig. 1c).

Surface rendering

Surface rendered images (SRI) display anatomical structures with a visual 3D effect. SRI provides greater delineation and increased visual impression of the physical nature of pelvic lesions. It can demonstrate the nature of cavities as well as give an impression of the external features of structures. In addition, it allows the separation of pelvic organs to be visualised with greater clarity (Fig. 1d and 9d).

4D ultrasound

4D ultrasound utilises advanced IT capability to produce real-time 3D SRI ultrasound imaging. Its role in obstetric scanning and creating image recordings of the baby is well established but its clinical impact to date appears to be relatively limited. This is currently reflected in general pelvic scanning with little application in terms of gynaecological ultrasound to date.

3D colour Doppler imaging

Advanced 3D technology incorporates colour Doppler (power Doppler) imaging. 3D reconstruction of imaging planes and volumetric studies demonstrate blood flow within tissues down to the capillary level and the vascular nature of pelvic lesions. The ability to show tissue vascularity is important in the assessment of diffuse disease and detection of high risk pathological changes in particular. Blood flow indices can provide quantitative measurement of tissue vascularity within a selected volume.

Fig. 4: 3D – TVS SIS or "fluid ultrasound" demonstrating a normal uterine cavity.

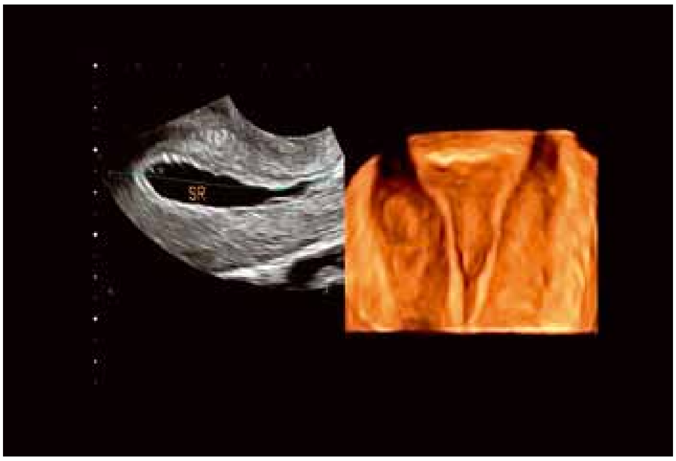


Fig. 4a and 4b: Composite parasagittal 2D and surface rendered 3D images of the uterine cavity. The SRI reference plane (SR) has been shifted and slightly curved in Fig. 4b to accommodate both the uterine cavity and cervical canal. As a result the rendered image clearly demonstrates the complete cavity from the internal os to fundus compared to only the cavity of the uterine body in Fig. 4a.

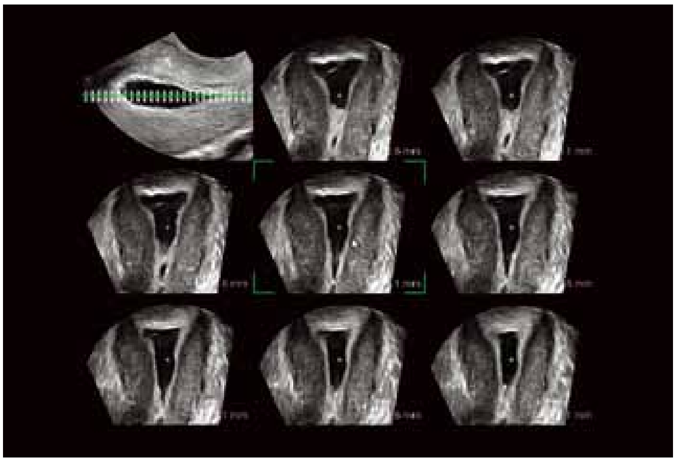


Fig. 4c: Multi View coronal sections fully demonstrate the extent and nature of the uterine cavity in a single image.

Principles of 3D volumetric imaging

A conventional 2D (TVS) ultrasound image or sector is usually generated by electronically steering a narrow ultrasound beam through the body tissues. The size of the 2D image, or anatomical slice, depends upon the 2D sector angle and depth of field of view selected.

A 3D volume is created by generating a rapid series of 2D scan sweeps, each very slightly displaced perpendicular to the direction of the scan sweep. A large number of sequential 2D anatomical slices are built up to produce in effect a 3D volume. The size of the volume will be determined by the distance between first and final 2D anatomical slice creating the volume, i.e. 3D sector angle, as well as the 2D sector angle utilised and depth of field selected.

The volume information acquired is displayed straight away usually in the form of a stored Compound Image for direct viewing. The ultrasound data stored can then be transferred to the system memory or a server for future interrogation or simply deleted if not required.

Practical aspects

Technical considerations

3D (TVS) ultrasound scanning is both convenient and straight-forward from a practical point of view. The basic technical requirements of a modern 3D system include the following:

- Uncomplicated, user-friendly controls for acquisition and storage, retrieval, post-scan manipulation and image recording of ultrasound information.
- Simple initiation of a single, automated 2D scanning ("survey") sweep of the area of interest. A stable, high quality greyscale image maintained throughout the survey sweep.
- Rapid acquisition and viewing of stored scan information. Immediate transfer of acquired ultrasound data to the system memory or a server or deletion of stored data if not required.
- Uniform spatial and contrast resolution in the greyscale image in all anatomical planes within the ultrasound volume.
- Accurate geometric registration of echo point sources within the 3D volume.
- Rapid, easy retrieval of stored ultrasound data. It is important to notice that the quality of 3D imaging reflects that of the fundamental 2D greyscale performance levels of the ultrasound system. Correct utilisation of 2D system controls and greyscale pre-sets is essential in order to maximise the diagnostic information provided by 3D ultrasound technology.

3D volumetric technology presents considerable benefits from a practical point of view:

Fig. 5: 3D – TVS SIS demonstrating an endometrial polyp and submucosal fibroids encroaching on the uterine cavity.

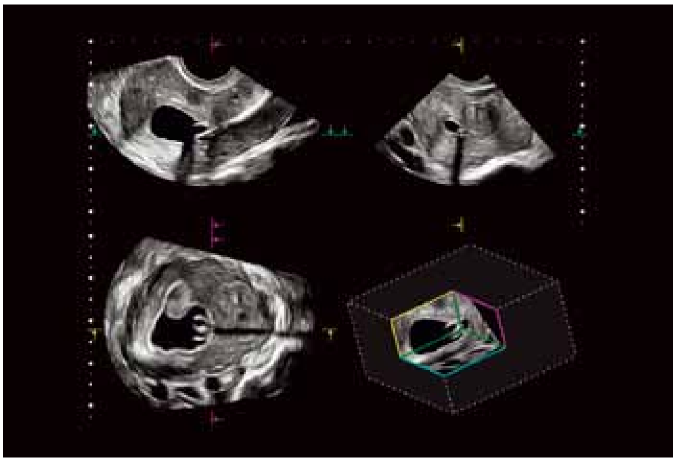


Fig. 5a: Compound image (x, y, z components + BVI) demonstrating the relevant clinical features.

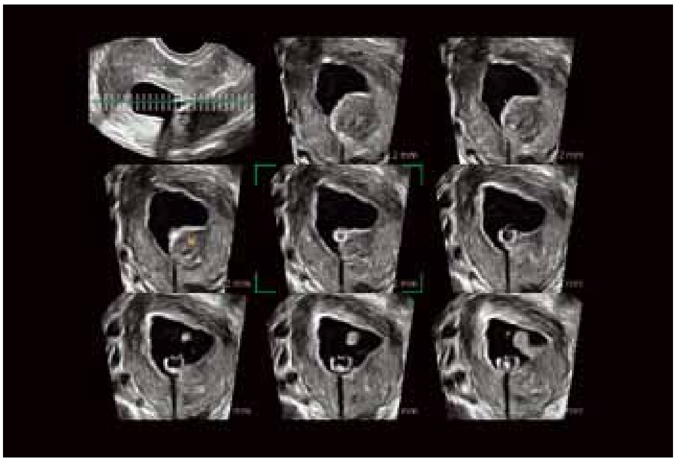


Fig. 5b: Multi View coronal sections showing the position and nature of the polyp (P) and indentation of the cavity by the mid-uterine fibroid (M).

Fig. 5c: Composite parasagittal 2D and surface rendered 3D sections. Adjustment of the reference plane (SR) produces a localised rendered image of the mid-upper cavity with encroaching fibroids (M) and polyp (P) delineated.

- Reduces scanning time and length of the ultrasound examination.
- Reduced examination time for the patient and exposure to ultrasound energy.
- Promotes the concept of post-scan evaluation.
- Reduces probe movement as part of TVS in order to acquire ultrasound information and therefore causes less discomfort particularly with patients presenting with pelvic pain.
- More efficient and cost-effective storage and archiving of image material compared to conventional 2D image recording.

Scanning issues

3D ultrasound scanning involves in practice holding the TVS transducer stationary and initiating the single 3D survey sweep. The survey sweep produces the 3D volumetric data which can then be stored once the Compound Image has been assessed.

It is important to ensure the correct use of 2D controls in order to maintain optimal 3D detail. These include selection and utilisation of transducer frequency, focal length and zone, 2D sector angle, frame rate/PRF, image size etc. as well as sensitivity controls and greyscale preset functions.

The survey sweep allows (2D) visualisation of the area of interest as the system collects the 3D data. This in itself can be of considerable diagnostic and practical value. It is therefore important that a constant level of greyscale imaging is maintained throughout the duration of the 3D sweep.

Acquisition and storage of 3D volumes

The 3D sampling box or sector is superimposed upon the realtime 2D image.

The survey or 3D sweep should be adjusted to cover the area of interest only. This involves appropriate selection of both 3D sector angle and the depth of the 3D sample sector or box. The detail obtained from ultrasound images derived from the stored 3D data largely depends upon the following factors:

- Correct use of 2D greyscale controls
- 3D sector angle
- 3D sweep speed
- Depth of 3D sample sector

The selection of 3D sector angle, sweep speed and sampling box size greatly influences frame rates and hence line density within the 3D image volume. These are important considerations in the ability to maximise 3D image quality. The absence of tissue movement problems in general pelvic scanning, certainly compared with ultrasound of the fetus, allows slower sweep speed and improved 3D image definition. 3D sweep scans can typically take 4–8 seconds in gynaecological ultrasound.

Fig. 6: ART stimulated multifollicular ovary

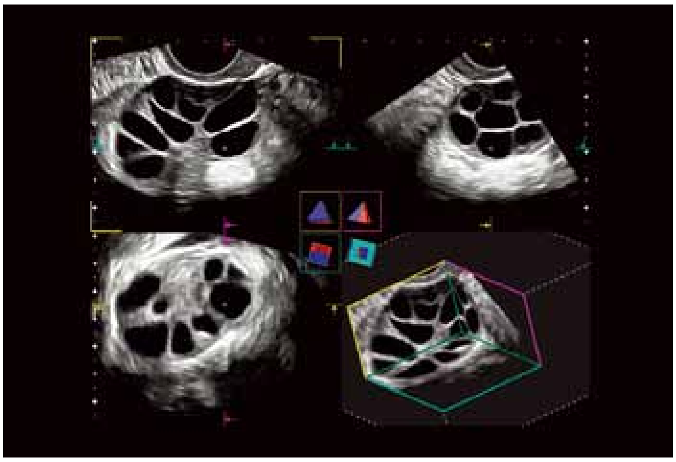


Fig. 6a: Compound imaging (x, y, z components + BVI) provides immediate visualisation of the number, distribution and relative sizes of stimulated follicles.

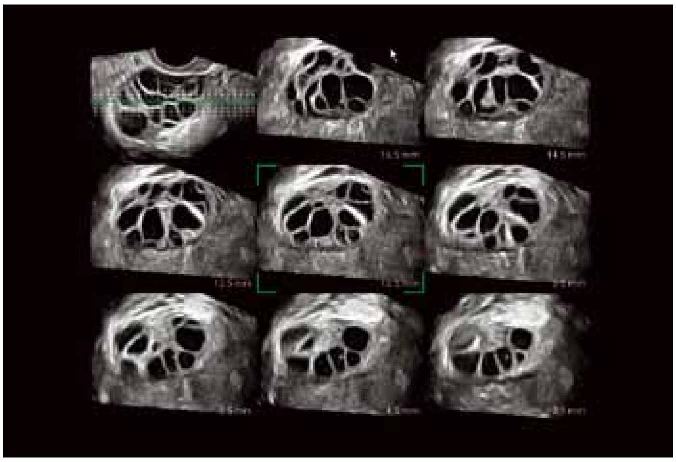


Fig. 6b: Multi View delineates multiple follicles – the facility to scroll through the retrieved tomographic sections enables rapid evaluation and speedy measurements of developing ovarian follicles. This proves to be a considerable asset in terms of the monitoring and measurement of ovarian follicle response to ART stimulation.

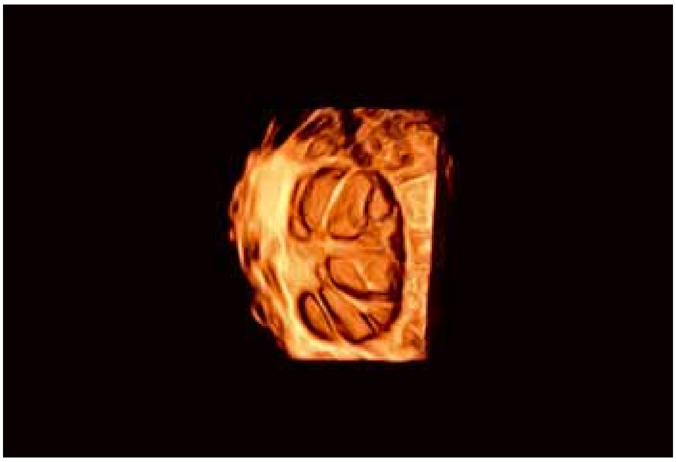


Fig. 6c: Surface rendered images of the ovary highlighting individual follicles with considerable clarity.

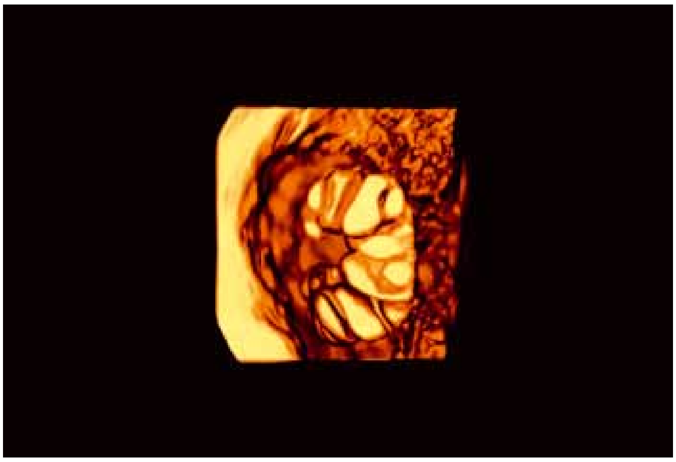


Fig. 6d: Cavity Mode further enhances visualisation and provides precise delineation of the multiple follicles.

The acquired ultrasound data is usually immediately displayed in the form of a stored Compound Image. This can be manipulated and/or converted into other forms of 3D imaging if required. Otherwise the volume data can be very quickly transferred to the system memory, hard disc or server, or otherwise instantaneously deleted.

Retrieval and manipulation of 3D volumes

Stored volumetric data is usually retrieved in the Composite Image format. All components can be manipulated simultaneously or independent of one another.

MPR images can be rotated in any geometric plane. It is also possible to scroll through the volume thickness in any one of the anatomical planes. Alternatively, Multi View will generate a series of tomographic images within that plane. The number of image slices as well as the distance between slices making up the Multi View format can be varied.

The greyscale characteristics of the retrieved MPR and/or Multi View can be varied by means of a number of post-processing options. This allows particular features or tissue changes to be visually enhanced in order to highlight diagnostic findings.

Similarly, the surface rendered image (SRI) can be geometrically manipulated. There are also post-processing options specific to SRI again serving to visually outline structures with greater clarity. These include:

- Cavity Mode: This essentially reverses the greyscale or selected colour mapping, i.e. making cystic regions lighter and solid regions darker (inversion, see Fig. 6).
- Threshold Control: This is basically a control which determines the level to which ultrasound information is suppressed for surface rendering (mainly low level clutter and noise).

A combination of algorithms, typically available in most systems, enables adjustment to be made regarding colour, surface textured appearances, transparency of structures etc. within the rendered volume.

The SRI reference plane (SR) determines the thickness or at what depth the rendered image is visualised. The level can be adjusted under visu-

Fig. 7: Perimenopausal ovary with an intact follicular cyst (C^1) and remnants of a collapsing, clot-filled cyst (C^2)

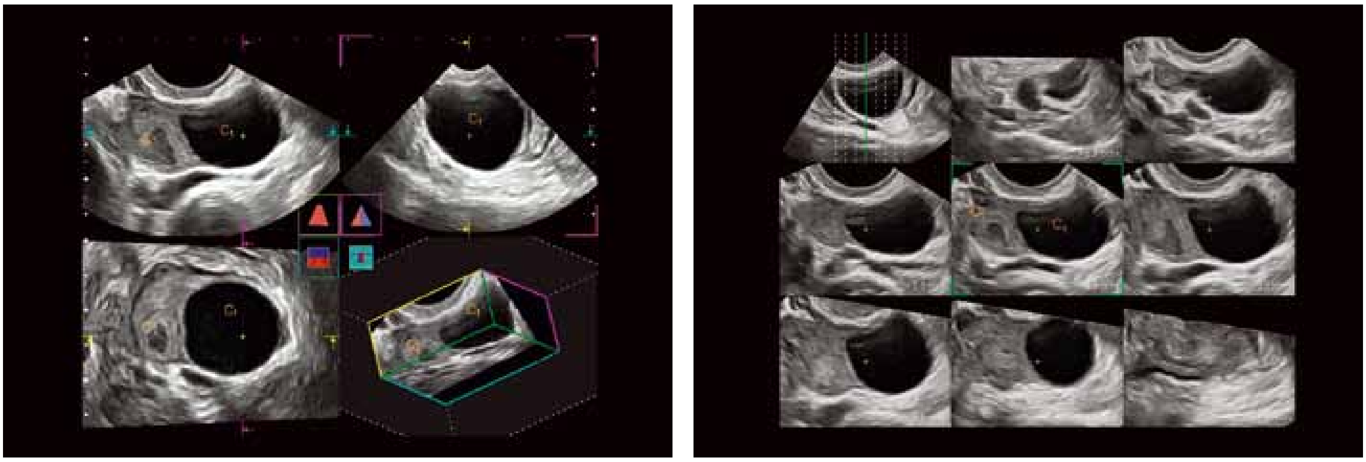


Fig. 7a and 7b: Compound imaging (x, y, z components + BVI) and Multi View sections provide complete details of ovarian morphology and associated lesions. The functional cysts are seen quite separately from one another. The nature of the ovarian stroma can be easily evaluated. The absence of antral follicles remains consistent with patient age.

al control and the shape of the SR can be curved in order to demonstrate non-linear anatomical sections (Fig. 4 and Fig. 5c).

Clincial aspects

Uterus

3D reconstruction of the uterus and uterine cavity in coronal section is a considerable asset particularly with access to Multi View formats. The anatomy of the uterus and presence of uterine lesions prove to be much more recognisable even to the untrained eye in this image plane.

The shape and size of the uterine cavity is clearly demonstrated and anatomical malformation readily identified in the coronal plane. The combination of MPR and Multi View formats provide precise location of IUD/IUS devices in-utero and confirms the presence, size, position and nature of intracavital lesions such as polyps, fibroids, adhesions etc. (Fig. 2 and 3).

The utilisation of 3D TVS technology as part of Saline Infusion Sonohysterography (SIS), or "fluid ultrasound", procedures increases the diagnostic effectiveness of ultrasound examination of the endometrium and uterine cavity. MPR, Multi View and manipulation of SR (coronal) displays present very detailed studies of the distended cavity and any associated pathologies. In a number of clinical units, 3D TVS SIS has proven to be an appropriate alternative to diagnostic hysteroscopy with obvious advantages to both the clinic and patient (Fig. 4 and 5).

3D TVS provides more elaborate evaluation of endometrial changes. The introduction of 3D colour Doppler is shown to be extremely useful in terms of identifying high risk changes as well as gauging the extent of endometrial malignancy. Volumetric assessment of blood flow changes within the myometrium also demonstrates diffuse benign disease. This has increased our ability to confirm the likelihood of adenomyosis in particular and has been an important element in the early detection of endometriosis.

3D volumetric ultrasound has had a major clinical impact in other areas of gynaecology. More comprehensive examination of the myometrium, uterine cavity and endometrium greatly assists investigation of fertility issues and possible causes of recurrent miscarriage.

Ovaries

3D volumetric ultrasound presents the ideal imaging modality for examining ovarian morphology. MPR, Multi View and a choice of surface rendered displays offer very precise imaging of follicle patterns and stromal distribution within the ovary. This has proved invaluable both in the assessment of gynaecological disease as well as the investigation of fertility and ovulatory issues (Fig. 6 and 7).

Improved delineation and interrogation of ovarian lesions provides a more reliable diagnostic impression of their nature. 3D imaging formats accurately gauge the preservation of normal, functional ovarian tissue in the presence of large lesions. This remains crucial in terms of clinical management and choice of surgical techniques if indicated. The introduction of 3D colour Doppler differentiates between high and low risk lesions with far greater diagnostic confidence.

The additional use of SRI facilities not only outlines pelvic structures with greater clarity but

Fig. 8: Adherent ovary with extensive adnexal/pelvic adhesions and loculated fluid collections.

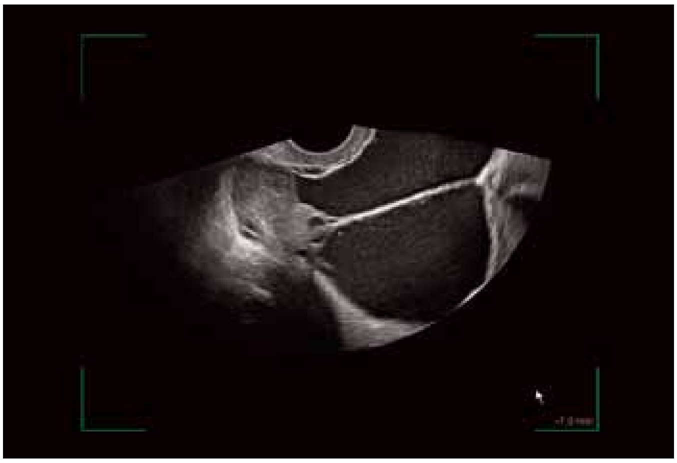


Fig. 8a: Localised 2D image of the adnexal region shows a complex mass.

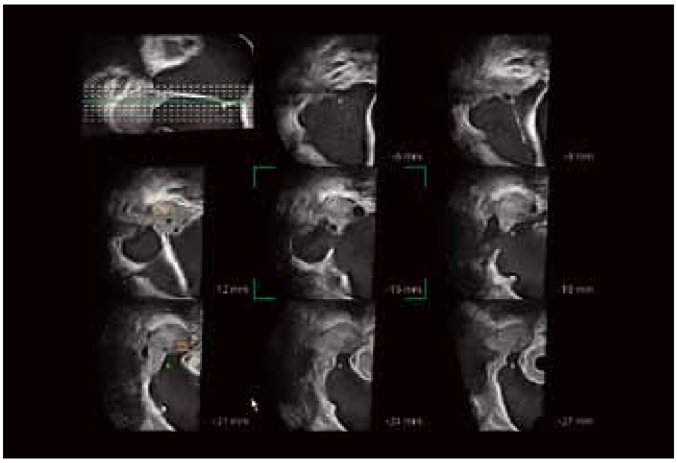


Fig. 8b: Multi View sections through the area outlined in Fig. 8a clearly demonstrate the ovary (Ov) adherent to the pelvic sidewall with numerous, extensive bands of adhesions. Associated loculated fluid contains clot which has probably resulted from spill from the collapsed corpus luteum (CL) just visible within the ovary.

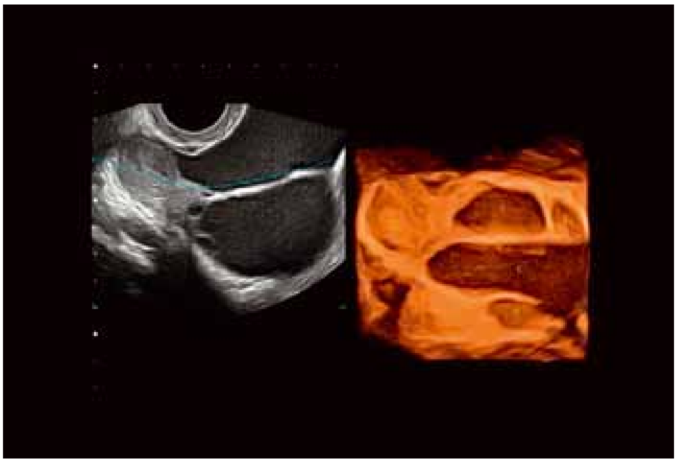


Fig. 8c: Composite image of 2D and SRI 3D images. The rendered image highlights remnants of the corpus luteum (CL) and visualises the fluid cavities (c) resulting from the multiple bands of adhesions clearly evident.

can distinguish between ovarian and adjacent para-ovarian features with more certainty. This is particularly useful in examination of the adnexal regions and associated pathologies involving the Fallopian tube.

Pelvis (general)

Complex, diffuse gynaecological disease affecting adjacent organs or structures within the pelvic cavity are very often difficult to evaluate by conventional 2D TVS ultrasound scanning. This might include for example chronic PID, extensive pelvic endometriosis or the spread of malignancy.

The facility to retrieve 3D ultrasound data and carefully examine different anatomical planes using a choice of 3D imaging formats is a tremendous benefit in these cases. Individual, neighbouring structures involved with the spread of disease can be recognised more easily and the extent of the disease estimated with greater diagnostic accuracy (Fig. 8 and 9).

3D volumetric ultrasound is a particular asset for those patients presenting with moderate to severe endometriosis. These patients experience considerable discomfort during a conventional TVS ultrasound examination. The ability to restrict probe movement to a minimum is a major consideration especially in these cases and also for any patient experiencing significant pelvic discomfort. The TVS probe is held still in order to carry out 3D scan sweeps and gently repositioned in only a selected number of locations in order to interrogate all areas of interest.

Post-scan evaluation

Scan reporting

Modern 3D volumetric ultrasound promotes the possibility of post-scan evaluation. The speed of system operation and quality of stored images makes it convenient and reliable to consider reporting of ultrasound examinations at a later time after the scan has been completed.

The survey sweep itself should be adequate to serve as an initial evaluation of relevant structures or areas of interest in a large number of cases. Minimal scanning only is sometimes required to view the pelvic structures and select relevant areas for speedy acquisition and storage of scan details. As a result, scanning times are considerably reduced certainly in more straightforward, non-complex cases.

The facility to connect the ultrasound system to a suitable IT workstation means reporting of scans can be easily carried out remotely and at anytime following completion of the scan or scan list. This has practical advantages certainly in the management of busy scan lists and regarding efficiency of

Fig. 9: Early tubal ectopic pregnancy (5+ weeks gestation) and associated haematosalpinx

Fig. 9a: Multi View coronal sections confirm an obvious decidual esponse but no intra-uterine pregnancy sac was identified.

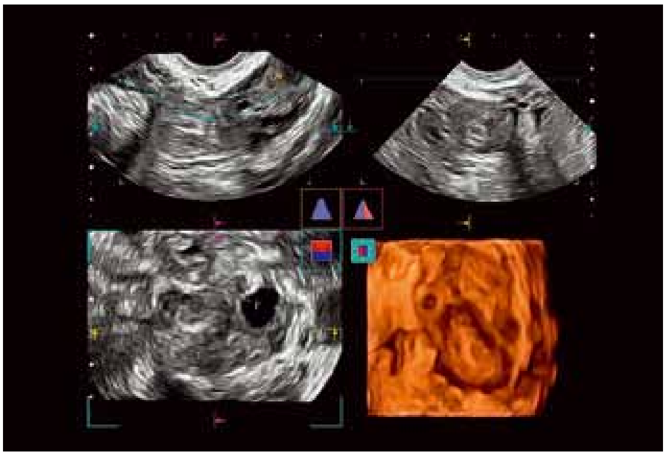


Fig. 9b: Compound imaging (x, y, z + SRI) identifies the ovary (Ov), a para-ovarian mass (T), a fimbrial cyst (F) with an early extra-uterine pregnancy sac (G) outlined on the rendered image. Manipulation of the anatomical planes allows more effective examination and recognition of relevant structures.

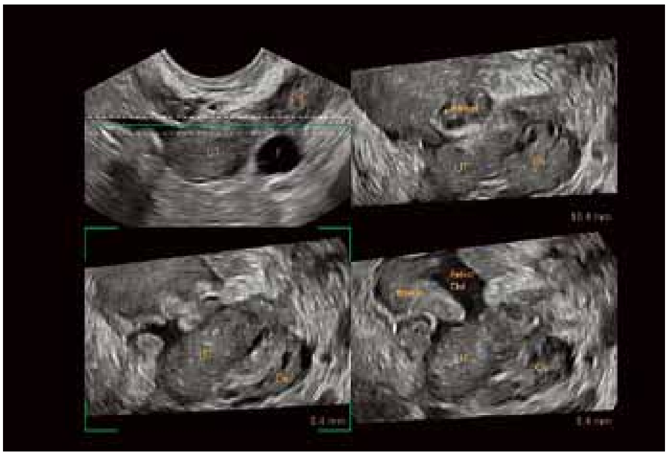


Fig. 9c: Localised Multi View sections show the distended, blood-filled uterine tube (UT) immediately adjacent and probably adherent to the ovary (Ov). The fimbrial cyst (F) is again well seen and free fluid (clot) present within the pelvic/adnexal region.

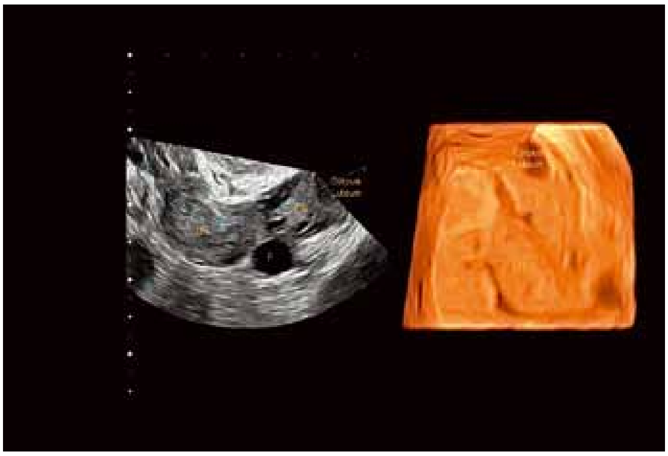


Fig. 9d: Composite image of an individual MPR section showing the tubal mass (T), fimbrial cyst (F) and ovary (Ov) and surface rendering of the adnexal structures. The rendered image shows the convoluted nature of the tube (UT) and its attachment to the ovary (Ov).

patient throughput. In addition, it has been shown that post-scan evaluation of 3D images in more complex clinical cases, especially those involving extensive, diffuse pelvic change, is extremely useful in terms of accuracy of diagnosis.

Clinical communication

Ultrasound images remain an essential part of ultrasound scan reporting. Standard 2D grey-scale images can be difficult to interpret both in terms of the anatomy and clinical features shown, particularly to the untrained eye.

3D reconstruction, especially the use of MPR, Multi View and volume rendering, can make the content of the ultrasound image much more apparent. Multi View coronal sections of the uterus or SRI of the adnexal region for example result in much more obvious detail as part of the images used to support written texts.

Volumetric imaging formats produced from the retrieved data can be of value to referring clinicians in terms of pre-surgical planning. 3D volumetric ultrasound reconstruction in modern systems can be utilised in a similar manner to MRI regarding image interpretation and clinical communication.

Aquilion RX – the next generation 16-slice CT scanner

Toshiba has rolled out Aquilion RX, a new 16-slice scanner which incorporates the latest dose-saving technologies based on iterative dose reduction.

It offers maximum performance for customers who need to perform a wide variety of routine clinical examinations in a streamlined workflow with the objective of delivering the best diagnostic quality at a minimal level of radiation exposure.

New product features

"Ultra-low-dose examinations"

Using AIDR, image noise levels can be reduced by up to 50%. At comparable quality, the dose can be lowered by up to 75% compared to conventional scanners. Images iteratively processed with AIDR assure superb image quality at the minimum dose.

"Ultra-flexible workflow"

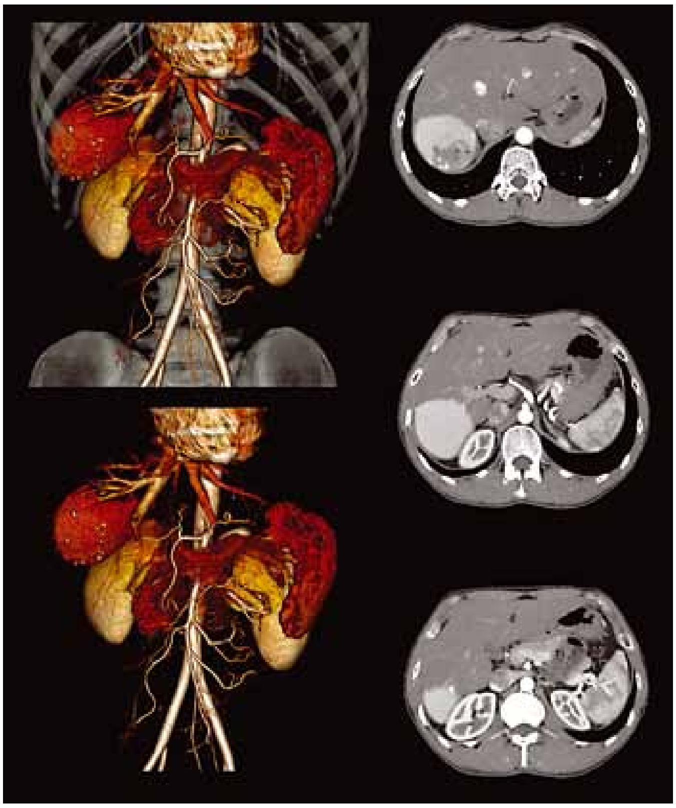
A new computer platform for Aquilion RX provides a 60% faster reconstruction time. SUREXtension, a thin-client display station, makes it possible to review images anywhere in the hospital without relying on a PACS system, increasing patient throughput and shortening waiting times.

"Quantum detector technology"

Aquilion RX incorporates Toshiba's exclusive Quantum Detector technology. The 0.5-mm element size and state-of-the-art reconstruction guarantee highly detailed imaging. Using the full width of the detector, fast scanning over a long range can be achieved in the case of emergencies or if there are breath-holding restrictions.

"Wide Application range"

The sophisticated suite of applications implemented in Aquilion RX supports all the clinical needs that a 16-slice scanner is expected to meet. A powerful 7.5-MHU tube ensures that scans can be performed without leading to unnecessary waiting times.



CT scan of a liver tumor made with Toshiba's Aquilion RX

Aquilion RX, Toshiba's new 16-slice detector CT scanner incorporating the latest dose-saving technologies based on iterative dose reduction

2D Sonographic Evaluation of Fetal Facial Clefts

L. Wilhelm

Introduction

With an incidence of about 1:1000 births, facial clefts are among the most frequently occurring congenital malformations[1,2]. They can take on various forms, but from a pathophysiological point of view cleft lip and palate (CLP) significantly differ from isolated cleft palate (CP). In CLP the defect always starts at the lip and extends to a variable degree in a dorsal direction (lip notch, cleft lip, CLP (hard palate only or hard and soft palate)). Isolated cleft palate always starts at the uvula (uvula bifida as the mildest form) and to a variable extent proceeds along the midline in anterior direction. It either affects only the soft palate or the soft and hard palate. Both CLP and CP can occur as isolated malformations or as components of chromosomal or syndromal disorders[7].

While prenatal detection of CLP during a differentiated ultrasound examination is usually fairly unproblematic, it is significantly more difficult to evaluate the palate structures involved in CLP to assess the extent of the malformation.

The major challenge is the detection of isolated cleft palate. The prenatal detection rate of isolated cleft palate approaches zero (0 – 1.4 %)[3-8] which shows that obviously at present there are no satisfactory sonographic indicators available to confirm the existence of isolated cleft palate. Because of its dome-shaped structure, the palate cannot be visualized in its entirety in 2D. Moreover, the surrounding osseous structures further complicate the evaluation due to imaging artifacts in the region of interest.

Presenting different case studies, this paper will not only show that CLP and CP can be diagnosed in 2D but also how to perform this examination.

Fig. 1: Frontal facial view with depiction of lips, nose with nostrils and chin

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Case studies

1) Normal findings

Lips are best evaluated in a frontal view with depiction of the upper lip, lower lip and nose with nostrils (Fig. 1), which in most cases allows confirmation of the integrity of the upper lip.

The integrity of the maxilla is evaluated in the axial view at the level of the upper jaw which also allows checking the continuity of the upper lip (Fig. 2). The hard palate, however, cannot be depicted in this way, since it is partly out of plane and ultrasound artifacts prevent an evaluation behind the bone.

Fig. 2: Axial view at the level of the upper jaw with depiction of the unremarkable maxilla (↓)

Fig. 3: Frontal view of the neck with depiction of the uvula (○ "equals sign"). The key structure to find the uvula in this view is the epiglottis (↓).

Fig. 4: Depiction of the uvula (⊜) as a typical "equals sign" in a tilted, more posterior transverse view at the level of the base of the skull

Fig. 5: Depiction of the soft palate (↓) with uvula (⊜) in a median sagittal view

Fig. 6: Depiction of the entire palate in a median sagittal view with neck extended. Hard palate (↓) soft palate (↓) with uvula (⊜).

Fig. 7: Depiction of a lip defect on the left side in frontal view (↓)

Fig. 8: Axial view at the level of the upper jaw with confirmation of an intact maxilla (○)

Fig. 9: Unremarkable uvula (○) in a frontal view through the pharynx

Fig. 10: Depiction of an intact palate (↓) with uvula (○) in a median sagittal view

Fig. 11: Postpartum image with confirmation of the isolated lip defect

Fig. 12: Depiction of an extensive lip defect (↓) on the right side in a frontal view

Fig. 13: Depiction of a discontinuity in the maxilla (↓) in axial view at the level of the upper jaw

Fig. 14: Detection of the absence of palate structures including the uvula (↓)in a median sagittal view

Fig. 15: Detection of the absence of the uvula in a frontal view through the pharynx (◯) ; epiglottis (↓)

Fig. 16: Postpartum image with confirmation of the prenatal diagnosis. The visible clip (↓) is not a palate structure, but a device used for orthodontic therapy.

Fig. 17: Depiction of lip involvement (↓) in a frontal view with CLP on the left side

Fig. 18: Detection of the maxillary defect (↓) in axial view

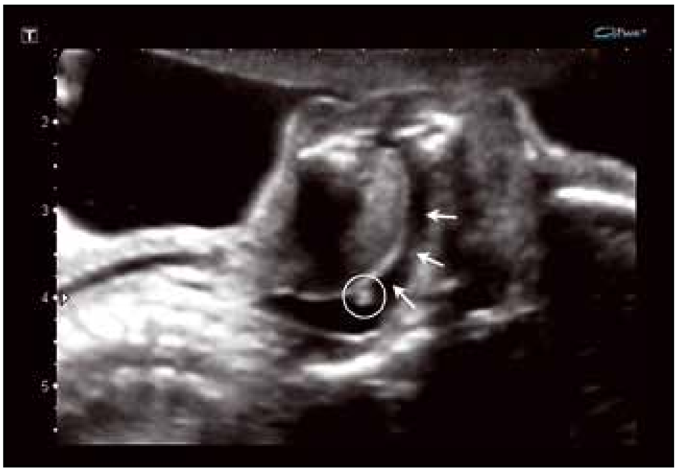

Fig. 19: In a median sagittal view only one palate structure can be depicted that stands out as an uvula (◯) . Otherwise, it is not possible to visualize a portion of the soft or the hard palate (↓).

Because direct and complete evaluation of the entire palate is impossible, the relevant parts of the palate have to serve as reference points while the typical pathophysiology of the different types of clefts has to be taken into consideration. Confirmation of an intact upper lip rules out a cleft palate in CLP. An unremarkable uvula rules out isolated cleft palate, because with isolated cleft palate the uvula

Fig. 20: In a frontal pharyngeal view the split uvula is detected as double " equals sign". This confirms the involvement of all structures of the palate. In the region of the soft palate the cleft is only very narrow.

Fig. 21: Depiction of a bilateral lip defect (↓), on the right more extensive than on the left

Fig. 22: Axial view with detection of maxilla involvement on the right (↓), while the maxilla on the left side is depicted without any loss of continuity (O).

Fig. 23: Detection of the absence of palate structures in a median sagittal view (↓). This shows the involvement of the entire palate in this CLP.

is the structure which is always affected (with the exception of submucous clefts). Clefts in the area of the soft palate are situated along the midline in both CLP and CP. Both the depiction of the uvula in frontal or transversal view through the pharynx (Fig. 3 and 4) as the typical "equals sign" and the depiction of the soft palate in the median sagittal view (Fig. 5) succeed very often and thus facilitate ruling out isolated cleft palate 9. If in these cases the upper lip is intact, the hard palate must also be intact. Visualization of the hard palate in sagittal view is more difficult because of the ultrasound angle and only succeeds in fetuses with the neck extended (Fig. 6).

2) Isolated cleft lip

In the frontal view at the level of the lips, the defect on the left side of the upper lip can be depicted (Fig. 7). The next structure to be evaluated is the maxilla which can easily be visualized in axial view without any loss of continuity (Fig. 8). Both the uvula (as a typical "equals sign", Fig. 9) and the entire palate in sagittal view (Fig. 10) are unremarkable. Thus, in this case the cleft lip can be confirmed without any involvement of the jaw and the palate. Figure 11 shows the postnatal image of this lesion.

Fig. 24: Detection of the absence of the uvula (○) above the epiglottis (↓)

Fig. 25: Postpartum image which confirms the prenatal diagnosis.

Fig. 26: Frontal view with depiction of an unremarkable oral-nasal region

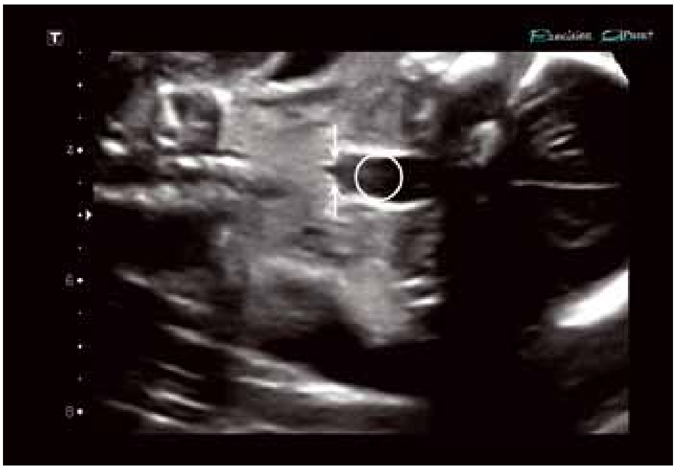

Fig. 27: While examining the pharyngeal space, the uvula (○) cannot be visualized above the epiglottis (↓).

Fig. 28: Detection of the absence of the palate structures in a median sagittal view (↓) resulting in the certain diagnosis of an isolated cleft palate

Fig. 29: Postnatal image with depiction of the isolated cleft palate (hard and soft palate)

3) Unilateral CLP

In frontal view a large defect of the upper lips on the right side can be easily visualized (Fig. 12). The axial view at the level of the upper jaw shows the continuity loss of the maxilla and confirms the involvement of the jaw (Fig. 13). The absence of visible palate structures in the median sagittal view confirms palate involvement (Fig. 14). This is supported by the fact that the uvula cannot be detected (Fig. 15). The postpartum image confirms the prenatal diagnosis (Fig. 16).

4) Unilateral CLP with detection of a split uvula

The frontal view shows a cleft in the region of the left upper lip (Fig. 17) which is not as extensive as in the previous case. Moreover, the defect in the maxilla, which is seen in the axial view, is not very extensive (Fig. 18). The anterior portion of the soft palate cannot be depicted in median sagittal view, but an uvula can be seen (Fig. 19). The examination of the uvula in frontal view through the pharynx shows a completely split but very closely spaced uvula (double "equals sign", Fig. 20). The diagnosis was confirmed after birth, but postpartum images for this child were regrettably unobtainable.

5) Bilateral CLP

The frontal view shows a bilateral cleft of the upper lip. The defect is more pronounced on the right side than on the left side (Fig. 21). In the axial view the right-side defect of the maxilla can be depicted while the continuity on the left side is completely preserved (Fig. 22). The median sagittal view with absent depiction of soft palate structures confirms the involvement of the entire palate (Fig. 23). This is supported by the inability to detect the uvula in the frontal view through the pharynx (Fig. 24). The postpartum image confirms the prenatal diagnosis of CLP with bilateral lip involvement as well as jaw and complete palate involvement on the right side (Fig. 25).

6) Isolated cleft palate (CP)

The frontal view of the face shows the integrity of the upper lip but no cleft (Fig. 26) while the exploration of the pharynx does not show an uvula (Fig. 27) which indicates isolated cleft palate. In median sagittal view neither parts of the soft palate nor the hard palate can be depicted (Fig. 28) which points at a more extensive isolated cleft palate. This was confirmed postpartum (Fig. 29).

Conclusion

The consistent and systematical exploitation of the 2D ultrasound capabilities allows the comprehensive diagnosis of fetal facial clefts and of the extent of CLP, including palate involvement. This had previously been a major challenge. The systematic exploration of the fetal pharyngeal space focusing on finding and depicting the uvula allows the investigator to detect an indication of isolated cleft palate which previously had been viewed as essentially undiagnosable. An unremarkable uvula, which can be depicted as a typical "equals sign", rules out isolated cleft palate. If the uvula cannot be detected, the soft palate must be depicted in sagittal view. If the soft palate cannot be depicted, isolated cleft palate can also be diagnosed with certainty.

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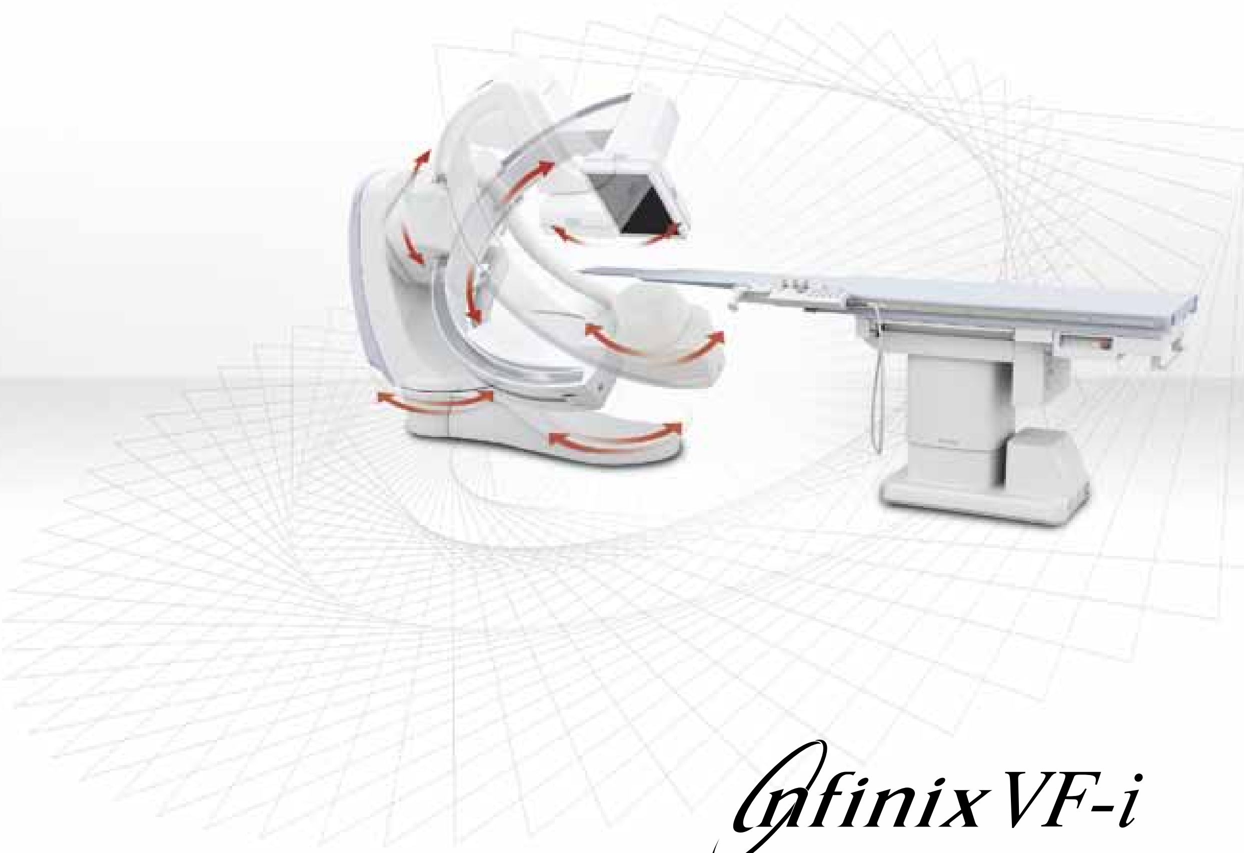

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