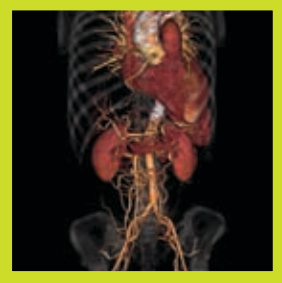
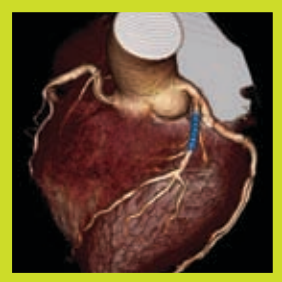


Introducing our Aquilion ONE...



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...a view
of the future

europaean
scanning centre

A NEW ERA IN DISEASE PREVENTION AND DETECTION

VISION

The European Scanning Centre Newsletter

Special Edition

Welcome to this special edition of Vision.

It has been an exciting summer for the ESC with several major developments, the most important of which is the installation of a new CT scanner, the Toshiba Aquilion ONE 640 slice CT scanner.

Despite the challenging economic climate, we remain convinced that medical practitioners continue to need high quality diagnostic imaging. The Aquilion One is the world's most powerful and advanced scanner and provides images of unrivalled sensitivity and spatial differentiation. In addition to the installation, the centre has undergone major refurbishment with the long-needed creation of a waiting room. These developments will ensure the ESC remains a leading independent imaging centre and we look forward to exploring the capabilities of this remarkable machine.

ESC acquires a 640 slice CT scanner

In order to continue to provide a first class imaging service, the ESC has recently acquired the world's most powerful CT scanner, the Toshiba Aquilion ONE™ 640 slice scanner, which has been installed alongside its EBCT scanner.

Dr Sarah Howling,
ESC's Director of Imaging
comments:

"I am seldom allowed to shop with such latitude! To create a dream list and then succeed in securing the top CT scanner available in the world is more than I hoped for when I joined the ESC in 2005. We selected the Toshiba scanner after detailed evaluation of all the CT systems on the market. The Aquilion ONE is the top of the CT premier league and a huge advance in technology. Our referring doctors are going to be amazed by the images and applications this will offer."

The Aquilion ONE is the world's first dynamic volume CT system, taking over

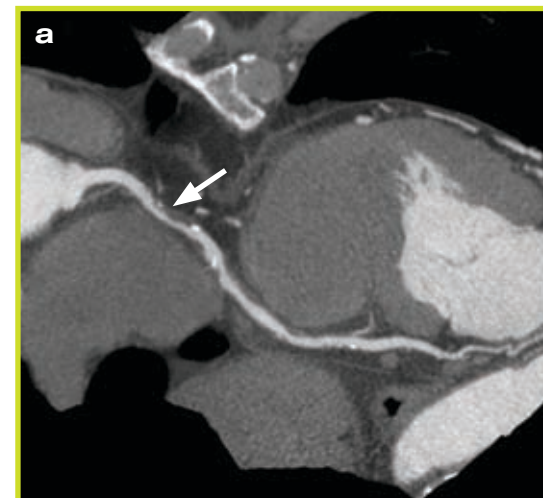


7 years to develop and at a cost of more than £500 million. With its 16cm detector, five times the size of traditional 64-slice CT scanners, and its innovative reconstruction algorithm, ConeExact, it can reconstruct 640 slices per rotation, giving unprecedented accuracy and detail. Its unique area of coverage enables scanning of most organs within one rotation, eliminating the need for helical scanning, which in turn, lowers the radiation dose dramatically (0.8 mSv for a CT angiogram compared to 2-3 for other scanners and 6-10 mSv for conventional angiograms).

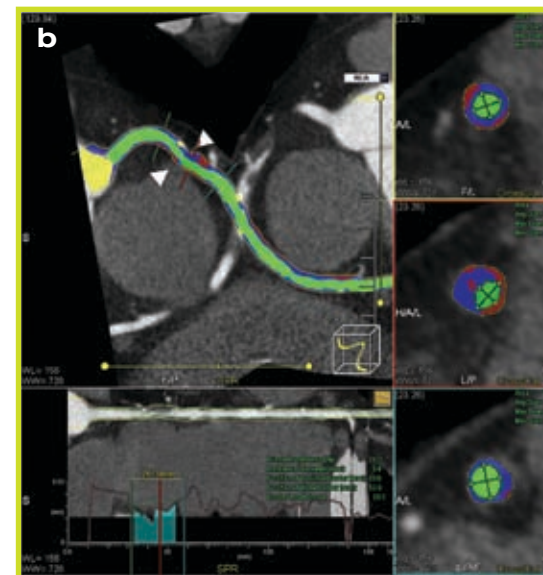
The new scanner is likely to offer numerous applications but in particular has significant advantages in cardiac, neurological, musculoskeletal, oncology and gastroenterology imaging.

Cardiac Imaging – CT angiography

Coronary CT angiography (CTA) is gaining increasing acceptance as a viable alternative to invasive coronary angiography for selected patient groups. Its advantages are speed, minimal risk of complications, and low morbidity. However, its more widespread use is presently limited by concerns about the spatial definition of current scanners, including the EBCT scanner, and also the radiation dose to patients. The Aquilion ONE scanner overcomes these limitations and in particular its high temporal and spatial resolution allows detailed imaging of all of the coronary arteries, including the distal branches, as well as clearly differentiating between soft and calcified plaque. This goal has been unachievable by conventional angiography. The proprietary software of the Aquilion



CTA from Aquilion ONE demonstrating (a) vulnerable soft cholesterol rich plaque in RCA (arrow) and (b) its extent and degree of stenosis as analysed by the software (green = normal patent lumen, blue/red = soft plaque. Far right panels show the cross-section through the artery.



Feature	Aquilion ONE scanner	64 slice scanners (including dual-source scanners)
Image acquisition per rotation	16 cm volume acquisition	3.2 cm
Spatial resolution (mm)	0.3	0.5
No. of rotations to image heart	1	8-10
Radiation dose for CT angiogram (mSv)	0.8	≈2-3
Accurate imaging and quantification of soft plaque	Yes	No
Need for beta blockade	No	Yes
Able to scan patients with arrhythmias	Yes	No
Dynamic imaging	Yes	No
Perfusion studies	Yes	No
Ability to image moving joints	Yes	No

ONE also quantifies the extent of soft plaque burden as well as accurately assessing the degree of stenosis. Such imaging capabilities are likely to transform the management of CHD by enabling practitioners to follow up the progression of soft and calcified atheromatous plaque and assess the response to aggressive preventive management.

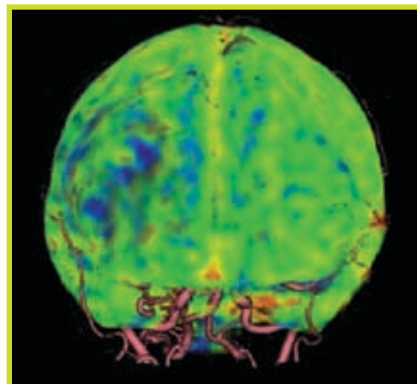
Apart from its dramatic dose reduction, another important aspect is the fact that cardiac arrhythmia or heart rates up to 130 bpm are no longer an issue as is frequently the case with helical 64 slice scanning, including dual-source scanners. This is because of the very fast speed of the image acquisition and the online assessment of the imaged RR-interval by the new system's software which ensures that image reconstruction can proceed as planned. An exciting development of the Aquilion One is its unique ability to acquire volumetric analysis of the entire heart in one rotation which allows the acquisition of perfusion

data. Current studies are exploring the use of adenosine-induced tachycardia in the functional assessment of any stenosis observed during the CT angiogram.

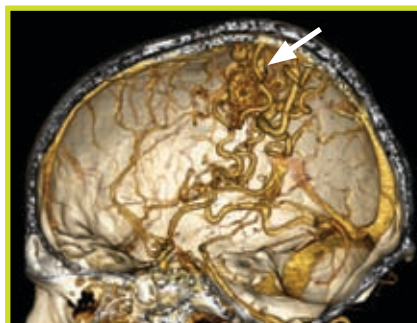
Neurology

The ability of the Aquilion ONE to acquire 16cm volumetric scans enables perfusion studies to be performed. The ESC has established close links with neurologists and neuroradiologists from the National Hospital for Neurology and Neurosurgery and sees a major role for the new scanner in cerebral blood flow imaging in patients at risk of stroke. Its ability to perform high quality cerebral CT angiography will be clinically useful in the diagnosis and follow-up of carotid stenosis, arteriovenous malformations and aneurysms.

Dr Paul Jarman, consultant neurologist at the National Hospital for Neurology and Neurosurgery says:



Cerebral perfusion study in patient with previous occipital infarct demonstrating decreased perfusion (blue)



Cerebral CT angiogram demonstrating a large arteriovenous malformation (arrow)

"This scanner should provide high quality cerebral CT angiography, an imaging modality which is likely to supersede MRI angiography and provide an alternative to invasive angiography for many patients."

Musculoskeletal

The new scanner will for the first time also allow imaging of joint kinematics, demonstrating moving joints in real time (bone, ligaments and tendons by viewing in different window width/levels). As static imaging often fails to elucidate the cause of



Representative images from dynamic imaging of a wrist and knee during joint movement, allowing elucidation of symptom aetiology.

'a major role in cerebral blood flow imaging in patients at risk of stroke'

'The Aquilion ONE...allows detailed imaging of all of the coronary arteries, including the distal branches, as well as clearly differentiating between soft and calcified plaque. This goal has been unachievable by conventional angiography.'

joint symptoms which may be due to bone impingement, this is potentially an important application for sports injuries.

Summary

In summary, the Aquilion ONE 640 slice CT scanner represents a major advance in scanning technology with unrivalled sensitivity and spatial resolution. As such, it promises to offer both patients and practitioners a viable non-invasive alternative to many invasive diagnostic procedures, and with the added advantage of also being quicker and cheaper. However, we feel this is just the start and with our talented radiography and radiologist team we are only just beginning to consider its dynamic possibilities. It is an exciting time for all of us!

Imaging the Heart - Current Status of CT Angiography

**Dr Simon PG Padley
and Dr Nevin T Wijesekera**
Department of Radiology,
Royal Brompton Hospital, London

'an oral or intravenous beta blocker is usually administered, although not required with 640 slice scanners'

'the experience of both the radiographer acquiring the images and the radiologist in reporting them is crucial to the quality of the images and thus the final report'

CT scanning has evolved hugely in the past two decades. Improvements in speed and resolution have been so significant that it is now possible to image structures as small and as rapidly moving as the coronary arteries with temporal and spatial resolution approaching that of invasive coronary angiography.



Technical background

Successive generations of MDCT scanners have rapidly evolved from 2 to 4, 8, 16, 32, 40, 64, 128, 256 and now 320 rows of detectors (such as the Aquilion ONE).

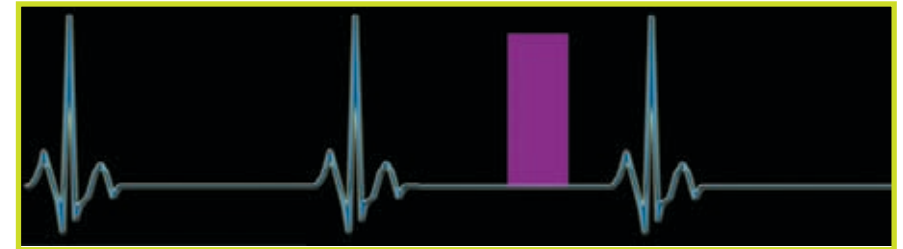
The consequent reduction in scan times renders images less susceptible to cardiac dysrhythmias.

Spatial resolution

The coronary arteries measure from 4-5mm in the left main stem to 1mm in the distal left anterior descending artery. Sub-millimetre spatial resolution with isotropic imaging (i.e. equal resolution in all three planes) is desirable to delineate sub-millimetre coronary artery branches. In order to differentiate a 10-20% stenosis, isotropic spatial resolution of 0.3mm is considered necessary only achieved by the most up to date scanners such as the Aquilion ONE.

Temporal resolution

The temporal resolution of a multi-detector CT scanner is determined by the speed of rotation of the gantry around the patient.



Prospective gating with Aquilion ONE CT angiogram scan. Image acquisition occurs during single heart beat in late diastole, thereby significantly reducing radiation exposure

Only 180° of rotation is required for image generation, so temporal resolution is equal to half the gantry rotation speed. Current technology has reduced a complete rotation to 250ms. Ideally, a temporal resolution of <50ms is needed for coronary CT angiography (CTA) to cover all heart rates. However, with new reconstruction algorithms and dual source scanners, a temporal resolution of 75ms is achievable.

ECG gating

Images are typically acquired over a number of cardiac cycles at time points when cardiac motion is least, usually in late diastole (65% to 85% of the R-R interval). This requires acquisition of data to be synchronised with the cardiac cycle by reference to a simultaneously recorded ECG.

The most commonly used ECG synchronisation techniques for cardiac CT scanning are prospective ECG triggering and retrospective ECG gating.

In prospective gating, the scan is triggered at a specified point along the R-R interval, a short pulse of x-ray is delivered and then stops, to recur at a similar time during the next cycle.



In retrospective gating, data is acquired continuously throughout the cardiac cycle, allowing images to be later reconstructed at an appropriate percentage of the R-R interval.

Radiation dose

Radiation doses in MDCT coronary angiography depends on a number of fixed and adjustable factors and now range from less than 1mSv to 5mSv on state of the art scanners, which is lower than invasive coronary angiography (typically 6 – 10mSv). The radiation exposure is higher when using

retrospective ECG gating, compared with prospective imaging, because of the continuous x-ray exposure and overlapping data acquisition.

CT Angiography: step by step

Premedication. If the heart rate is more than 65 beats/min, an oral or intravenous beta-blocker is usually administered, although not required with 640 slice scanners. Sublingual nitrates immediately before scanning help dilate the coronary arteries.

Intravenous contrast delivery. A high concentration of contrast agent is injected intravenously at a high flow rate (4-5mL/s) followed by a 40-50ml saline chaser bolus to wash out contrast from the right ventricle.

Post-processing techniques. Analysis of the resultant enormous dataset is performed on dedicated powerful workstations. As with all radiology, the experience of both the radiographer acquiring the images and the radiologist in reporting them is crucial to the quality of the images and thus final report.

Clinical applications of CT coronary angiography

MDCT is now an established alternative to cardiac catheterisation in the diagnosis of coronary artery disease (CAD). Studies have shown sensitivities of up to 97% and specificities as high as 94% for the detection

Indications for CT angiography

- Atypical chest pain
- Exclude coronary heart disease
- Equivocal exercise stress test
- Coronary artery bypass graft evaluation
- Evaluate stent stenosis
- Cardiac vein imaging to guide ablation therapy
- Anomalous coronary artery anatomy
- Congenital heart disease
- Triple rule out (pulmonary, coronary and aortic angiogram)

of haemodynamically relevant coronary artery stenoses (>50% luminal diameter reduction) using 16-slice and 64-slice CT. Whilst the positive predictive value of MDCT using 64-slice MDCT is relatively modest at only 80-85%, the negative predictive value approaches 100%, suggesting that CT can reliably rule out the presence of significant coronary artery stenoses and makes coronary CTA useful in symptomatic patients who are considered for invasive angiography but have a low-to-intermediate pre-test probability of coronary artery disease. This approach is currently favoured in NICE guidelines (due to be published early 2010). Patients whose clinical presentation suggests a high likelihood of having a stenosis remain more likely to benefit from invasive angiography, which provides the option of immediate intervention.

“Triple rule-out” coronary CT angiography is a relatively new technique that provides

non-invasive visualisation of coronary arteries with simultaneous evaluation of the pulmonary arteries, thoracic aorta, and other intra-thoracic structures that might explain signs and symptoms that overlap with an acute coronary syndrome.

Plaque imaging

A number of studies have evaluated the ability of CT to distinguish between different types of atherosclerotic plaque, with the hope that this may help identify patients at elevated risk of future coronary events. Plaques may be classified as calcified, mixed or soft, based on density measurement. The clinical application of coronary CTA for risk stratification based on plaque characterisation is not yet supported by convincing scientific evidence but is an area of much interest particularly with the ability of the latest scanners to accurately visualise and quantify the vulnerable soft cholesterol-rich plaque which may exist in the absence of calcification.

Bypass grafts assessment

CT permits non-invasive assessment of the state of previous bypass grafts, including the anastomosis and the distal native arteries. Several studies performed using 16- and 64-slice MDCT have shown that occlusion of bypass grafts and stenoses in the body of the grafts can be detected with high accuracy. Native coronary arteries are more difficult to assess since they may become heavily calcified following bypass surgery making interpretation of stenoses difficult. This limits the clinical usefulness of

CTA vs conventional angiography

Advantages

- Non-invasive
- Safer (no risk of local damage or stroke)
- Quicker - avoids day case admission
- Ability to visualise vulnerable soft plaque
- Visualise anomalous anatomy
- Comparable spatial resolution (0.3mm with 640 slice scanners)
- Lower radiation
- Cost - cheaper

Disadvantages (16-64 slice scanners)

- Unable to scan arrhythmias (AF or high heart rate)
- Lower spatial resolution (>0.5 mm)
- Prone to artefact from high coronary artery calcium deposition
- Cannot proceed to immediate therapeutic procedure e.g. angioplasty/ stent insertion

'Aquilion ONE promises to be the exception with a reported spatial resolution of 0.3mm'

'CT can reliably rule out the presence of significant coronary artery stenoses and makes coronary CTA useful in symptomatic patients who are considered for invasive angiography but have low to intermediate probability of coronary artery disease'

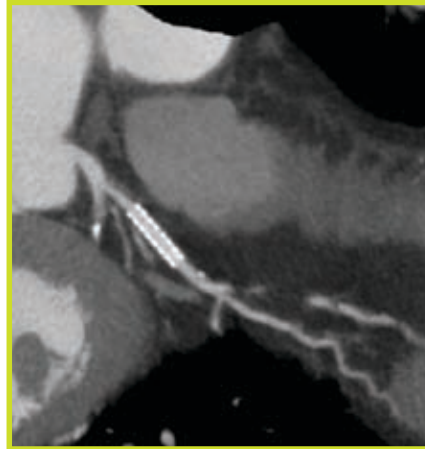
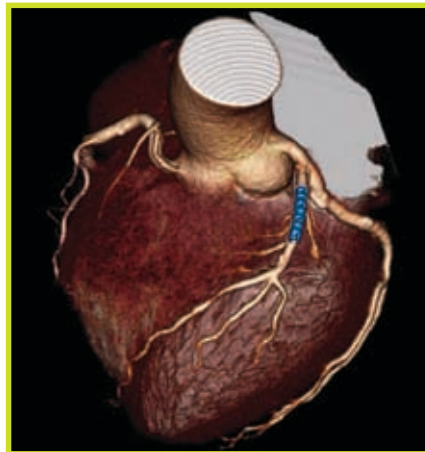


CTA of bypass grafts showing atheroma within the grafts (arrows)

coronary CTA in patients who develop chest pain after bypass surgery, as it usually will be necessary to assess the status of both the bypass grafts and the native coronary arteries. When it is necessary to re-operate, MDCT can be critical in delineating the position of bypass grafts relative to the sternum.

Coronary stents

Stent imaging is challenging due to the small size and high-density of stent material with resulting artefacts that can obscure the lumen. Accurate stent assessment depends upon several factors, including stent type and material, stent dimensions (particularly the diameter) and the vessel in which the stent has been implanted. In-stent re-stenosis can be suggested when the lumen does not appear to completely enhance but current studies using 64 slice scanners have not yet provided conclusive evidence to



CTA of a patent stent in the LAD. Image acquired using Aquilion ONE 320 detector scanner.

support the role of CT for routine follow-up of patients after coronary stent implantation, although more modern scanners have the potential to overcome this as they are less affected by artefact and can offer clearer images of the stent lumen.

Ventricular assessment

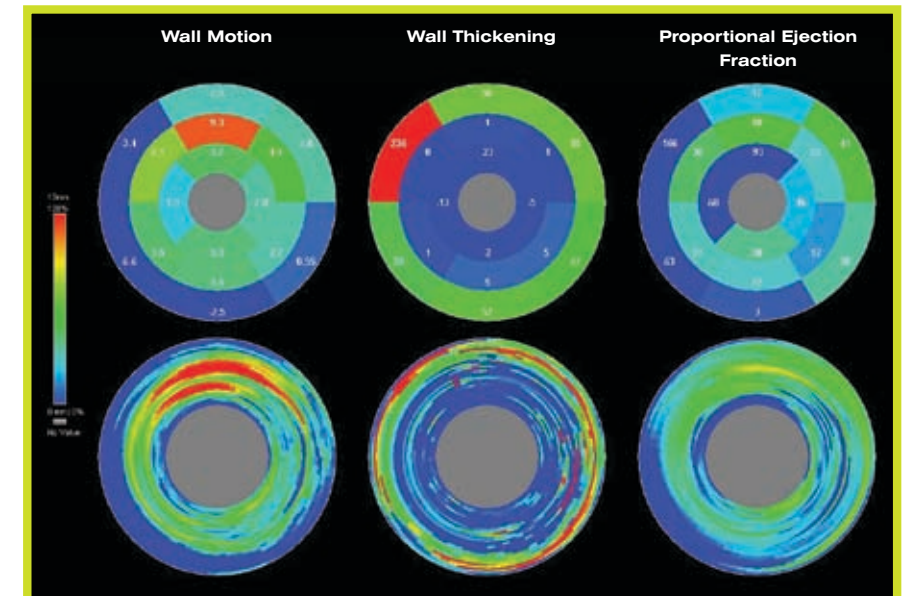
Multiphase studies allow determination of both end-diastolic and end-systolic volumes using semi-automated software and hence allow accurate calculation of stroke volume, ejection fraction and cardiac output as well as regional wall motion. There is good correlation between MDCT and cine

cardiovascular magnetic resonance (CMR). However, due to the relatively high radiation dose, MDCT is currently not recommended for the evaluation of cardiac function alone, but these data are frequently available from studies acquired for other primary indications. CT also allows global cardiac assessment in patients unsuitable for MRI.

Myocardial perfusion

An area of exciting current study is the use of contrast-enhanced CT to visualise infarcted myocardium during first-pass and late perfusion imaging. Preliminary studies assessing myocardial enhancement and

Cardiac function analysis of a patient with an anomalous LAD arising from RCA demonstrating reduced wall motion in the area from the anterior wall of the left ventricle to the apex (blue is reduced, green to red is normal). Image courtesy of Charité Hospital, Berlin using an Aquilion ONE scanner.



infarct size early after acute myocardial infarction have shown good correlation between MDCT and CMR.

Congenital anomalies

Whilst echocardiography and CMR imaging remain the techniques of choice for the assessment of patient with complex congenital heart disease, MDCT is now emerging as a viable alternative to CMR (claustrophobia, pacemakers etc). MDCT coronary angiography can also be used to identify the course of anomalous coronary arteries.

Defining pulmonary vein anatomy

Cardiac CT is routinely employed in planning of electrophysiological procedures, such as atrial fibrillation ablation since a three-dimensional CT image of the atria can be superimposed on the electro-anatomical map, improving the ability to localise the pulmonary veins and hence reduce fluoroscopy times.

Recent technical developments

Computed tomography has gone through rapid improvement during the last few years. Scanners with more detector rows allow a greater volume to be covered in one rotation of the scanner, significantly reducing breath-hold time and amount of contrast. The latest 320-detector (640-slice) scanners increase coverage and decrease overall scan time. Dual-source CT (DSCT) also offers improvements in temporal resolution. These scanners have two sets of X-ray tubes and detectors, which are mounted onto the

gantry at approximately 90° to each other, producing faster scanning and temporal resolutions of 75ms, although they are unable to image the heart in one rotation.

Summary

Computed tomography has advanced rapidly during the past years. Current MDCT technology permits reliable and accurate visualisation of the coronary arteries. The technique is firmly established but recent technological advances on a number of fronts are likely to improve the accuracy and reliability of CT for assessing coronary artery disease and, if the expected reductions in radiation dose are achieved, the spectrum of accepted clinical indications will undoubtedly expand.

Our Radiologists

In order to further enhance the quality of our reporting of the exceptional images from the new scanner, we have recently recruited several additional specialist radiologists, from many of the top institutions.

Our team of radiologists with their NHS base and expertise is:

Cardiac

Dr Simon Padley, The Royal Brompton Hospital
 Dr Paras Dalal, Harefield Hospital
 Dr Sujal Desai, King College Hospital

Chest

Dr Sarah Howling, The Whittington Hospital

Neuro

Dr Katherine Miszkziel, National Hospital for Neurology & Neurosurgery
 Dr Jane Evanson, Bart's and The London

Abdomen/pelvis

Dr Chris Harvey, Hammersmith Hospital
 Dr Chris Schelvan, St Mary's Hospital
 Dr Niall Power, Bart's and The London

Musculo-skeletal

Dr Charles House, The Middlesex and UCL Hospital
 Dr Simon Bleese, full time private

Urology

Dr Jeevan Kumaradevan, The Whittington Hospital



Toshiba and ESC sign Research Partnership Agreement

As part of the collaboration between the ESC and Toshiba Medical Systems, the two organisations have entered into a long-term Partnership Agreement.

The main features of this are:

- The ESC will become Toshiba's UK reference site and centre of excellence for CT imaging.
- The ESC will be provided with all upgrades for the new scanner for the duration of the agreement, thereby maintaining it at the cutting edge of scanning technology.
- Toshiba will support the ESC as an academic centre by jointly funding a Toshiba Research Fellow for a minimum of 3 years.



Shown here (left), Dr Paul Jenkins, Medical Director of ESC shaking hands on the agreement with (right), Dr Matthew Stork, Managing Director, Toshiba Medical Systems UK.

The results of this research will be published in peer reviewed journals and also presented at national and international scientific meetings.

Dr Paul Jenkins, Medical Director of ESC says: "We are very excited about our partnership with Toshiba and in becoming their UK reference site. The establishment of a Toshiba Research Fellow will allow us to further our aim of becoming an academic centre and we look forward to developing our clinical applications with the new scanner, particularly the role of CT angiography in both cardiac and cerebral studies as well as functional perfusion studies."

Dr Matthew Stork, Managing Director, Toshiba Medical Systems UK says: "Toshiba Medical Systems are delighted to have formed a partnership with the European Scanning Centre to work together on research in this exciting new area. We have just started exploring the benefits of dynamic volume CT. Whether it is for cardiac, neuro, abdominal, orthopaedic or other examinations, the potential implications of functional CT studies are widespread. The European Scanning Centre is an ideal partner for us, working with leading academics across many therapeutic areas providing a broad scope for research."

The Research Fellow will be based at the ESC and will carry out research in a number of agreed areas - for example myocardial and cerebral perfusion.

ESC completes its makeover

The building works at the ESC to accommodate the new scanner have resulted in a few additional changes. Gone is our old neon-lit office and now in its place is a stylishly designed new waiting room, a huge improvement on the old corridor seating which patients previously had to endure! Top interior designer, Hugh Berry, has worked his magic again and given the room a warm elegant feel but adding a hint of cosiness to make clients feel relaxed both before and after their scans. The lounge photographs on the wall are of Harley Street architecture and were taken by our consultant radiologist, Dr Sarah Howling whose love of digital imaging also extends to photography.

The refurbishments have also resulted in the creation of a new ultrasound room as well as two large and beautifully appointed consulting rooms. We are currently looking to occupy these by medical practitioners and if this is of potential interest, please contact the centre on 020 7436 5755 for further information.



Aquilion ONE 640 slice CT scans

- Abdominal
- Angiography (abdominal, carotid artery, cerebral, coronary, peripheral & pulmonary)
- Brain
- Lung scan
- Pelvic
- Renal tract
- Sinuses
- Virtual colonoscopy

Electron Beam Computed Tomography (EBCT)

- Heart scan (coronary artery calcium score)
- Bone mineral density

Ultrasound

- Abdomen & Pelvis
- Abdominal aorta
- Breast
- Carotid Doppler
- Chest wall
- Gallbladder (static & dynamic)
- Echocardiography
- Female reproductive
- Finger
- Leg veins
- Neck
- Penile Doppler
- Post micturition bladder
- Prostate (trans-abdominal & trans-rectal)
- Renal artery
- Renal tract
- Urinary flow rate measurement
- Testes
- Thyroid Gland

We offer a complete X-ray and MRI service