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ultrasound post

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Abdominal Applications of **Tomographic Ultrasound Imaging**

Introduction

Tomographic Ultrasound Imaging (TUI) is a new technology that allows for a comprehensive sequential analysis of the desired anatomy. There are reports of TUI's clinical benefits in obstetrical studies, but to our knowledge there are no clinical reports of different applications using TUI in radiology. This article will explain the concept behind TUI and present a series of cases demonstrating the clinical benefits in abdominal applications.

Technology

TUI is a feature of Volume Ultrasound imaging which displays multiple parallel slices within a volume data set. Since the user adjusts the orientation and spacing of the slices, a specific region of interest can be readily evaluated. Displaying multiple slices at one time allows quicker and easier viewing of volume information, as well as a more intuitive way to view Volume Ultrasound images. Using mechanical volumetric 3D/4D transducers, volume data is acquired by capturing frames that are separated by a regular time interval, as the transducer head sweeps from one end to the other. The 2D slices can then be viewed either as separate images or together when projected on a volumetric cube. The acquired frames in the volume are oblique in shape along the probe sweep curvature. The spatial separation between each frame is at an angle.

Frames are processed using normalization vectors, which convert them into a set of frames that are parallel to each other. The angle between two frames will be translated to a distance between each frame. The volume angle of the sweep will determine how many frames fit inside a data set. A higher quality is achieved when the frames are spaced closer together. The algorithm will compute the number of slices and the distance between each slice.

Using the center slice as an index, the location of each slice in the volume is determined by the following equation:

Slice(n) = Slice(center) + n*D; where the value of n ranges from –(Number of Slices)/2 to +(Number of Slices)/2

The user will also specify how many of these slices appear on the screen using the display format. Raw data, which is located at a particular slice index, will be loaded and interpolated by applying gray maps. Each of these slices will then be filtered and processed. A single bitmap image will be generated that consists of all of the slices displayed per the chosen format. An orthogonal scout image will indicate where each frame is located in the volume.

Once the algorithm determines the number of slices separated by the slice distance, the application then allows for viewing between two particular slices. The user can choose the image displayed by adjusting the slice position control.

Clinical Benefits

Ultrasound has traditionally been a modality driven by images taken in non-volumetric 2D planes.

As technologies have advanced, it has now become possible to collect volumetric data. With TruScan™ architecture, the user can obtain data in a volume and manipulate the raw data after the images have been obtained. Tomographic Ultrasound Imaging (TUI) provides numerous clinical benefits to the user.

1. Dramatically decreasing the scan time for the sonographer as the entire area of interest is imaged by one volumetric sweep
2. Capturing images in planes that were not possible with conventional ultrasound
3. Displaying individual images at any angle
4. Providing concentrated evaluation of the scan area by allowing the user to define the distance between the slices
5. Allowing for a comprehensive review of anatomy with a "virtual rescan" of the volumetric data that can be obtained in any plane
6. Using the raw data to conduct a side-by-side comparison from prior studies
7. Systematically displaying images of normal and abnormal anatomy, and allowing the reviewer to have the familiarity of conventional images obtained from volumetric data sets in multiple orthogonal planes

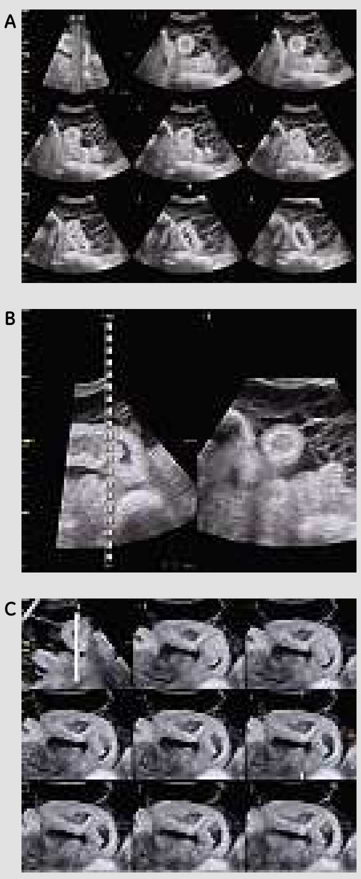

Figure A-C
TUI with slice spacing set at 0.5 mm intervals. Complex ascites and increased thickness of the small bowel wall was detected suggesting ischemic bowel.

EDITORIAL:

Heinz GLOOR
Vice President / General Manager
GE Healthcare Technologies
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Europe, Middle East & Africa

Dear Readers,

Economic circumstances and personnel availability are two main drivers requiring us to increase productivity and to achieve more economical use of the available resources.

Ultrasound is meeting this demanding challenge. Being easily transportable, non-invasive and providing unique and relevant diagnostic features, ultrasound became an essential diagnostic tool in screening and diagnosis and is today an imaging method of choice for many applications. With the introduction of GE's Volume Ultrasound imaging technology, our business fulfills these requirements even better.

Since GE introduced this state-of-the-art ultrasound technology, a fast growing number of radiologists apply and appreciate this precise, easy-to-use and very economic imaging technology. The advantages in terms of diagnostic confidence and workflow efficiency of Volume Ultrasound to physicians and patients are manifold.

Volume Ultrasound data sets contain all of the necessary information from the ROI, thus in real-time as well as off-line anytime and anywhere.

Volume Ultrasound offers even more imaging modes such as Tomographic Ultrasound Imaging (TUI), which enables the analysis and display of ultrasound images in a "sliced" way just as with CT and MR, or Contrast Enhanced Ultrasound (CEUS), an important imaging modality for oncology diagnosis.

Volume Ultrasound can be an advantage for you, the physician, and your patient. It also demonstrates GE's commitment to improve healthcare with new, innovative technology.

With this I wish you enjoyable reading about the latest scientific studies associated with Volume Ultrasound applications and their advantages written by renowned specialists in this issue of Ultrasound Post.

Yours

Heinz Gloor

Conclusion

TUI ushers in the next generation of ultrasound imaging through volumetric datasets, which when manipulated and displayed in a systematic format, allow for better imaging capabilities. The outcome of using this technology will ultimately reduce scan time and benefit patient care. TUI represents a new, faster, and more flexible approach to clinical ultrasound challenges, increasing diagnostic confidence through access to multiplanar views unobtainable in traditional scanning, as well as an intuitive display of the volume. Corroborated clinical studies will be conducted to confirm our exciting initial findings.

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Figure A-C
Using TUI a single volumetric sweep of the liver in this immunosuppressed patient demonstrated multiple hypoechoic masses. The ability to acquire all relevant diagnostic information with a single volumetric sweep improved efficiency. Biopsy results were positive for fungal infection.

Prof. Tranquart at the International Anti Cancer Treatment Conference in Paris

Contrast Enhanced Ultrasound in Cancer Diagnosis & Treatment

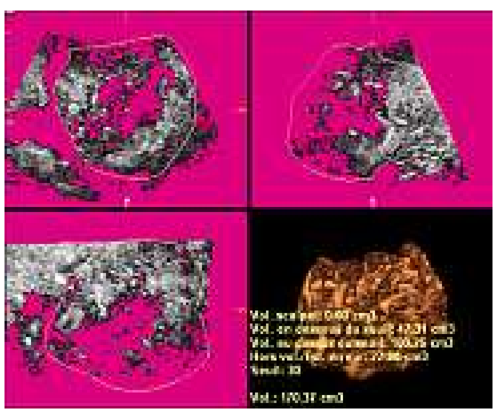
Prof. François Tranquart is the Head of "Centre d'Innovations Technologiques Ultrasons" at the CHRU Bretonneau in Tours. Always at the center of new research in ultrasound, such as elastography, contrast enhanced ultrasound and volume imaging, his team handles important research in ultrasound with focus on abdominal, vascular and breast imaging.

Appointed as one of the centers involved in the French STIC 2006 program, which aims to evaluate the pharmaco-economical impact of CEUS in daily practice, the CIT in Tours is one the most renowned French institutes concerning itself with the use of contrast enhanced ultrasound in clinical practice. Among the machines the center possesses, we are proud to count a brand new Voluson E8, and a LOGIQ 9 BT07, along with a valuable partnership in the development of products and marketing collateral.

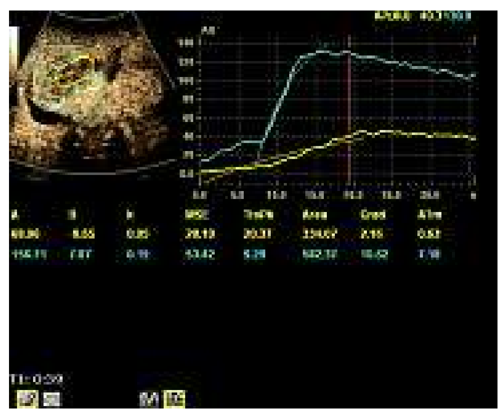
We recently met in Paris, where Prof. Tranquart was a speaker at the GE Symposium at the ICACT (International Anti Cancer Treatment) Conference on Contrast Ultrasound. Prof. Tranquart agreed to meet Ultrasound Post to discuss his vision of contrast enhanced ultrasound and summarize his experience with GE Healthcare.

ULTRASOUND POST
Prof. Tranquart, what role does ultrasound play in imaging liver lesions?

Prof. TRANQUART
Worldwide ultrasound is considered the first imaging modality for screening focal liver lesions in cancer staging or for any abdominal symptoms.
However, because of a few technical limitations, fundamental ultrasound sensitivity is lower than that of MRI & CT in detection and very poor in the characterization of the lesions, which is the next step after detection. So, for many years the accuracy of MRI and CT with contrast agents has been the gold standard in the study of liver lesions, mainly because the vascular specific patterns are clearly detectable.
The introduction of low MI contrast agents (SonoVue 2001, Bracco) combined with the developments of new ultrasound technologies changed the way we handle these patients, enabling a much clear detection of the liver lesions and a further characterization thanks to the same vascular patterns. These days the sensitivity of CEUS is truly comparable to CT & MRI with contrast agents, resulting in lower costs and an easier patient handling for several kinds of lesions, both malignant & benign (metastases, HCC or adenomas) with less costs and less discomfort for the patient.



Volume calculation of a selected area in a kidney



"Time Intensity Curve" quantification in a kidney

ULTRASOUND POST
We have been talking about CEUS since the late '90s, but where are we now with regard to the confidence in CEUS?

Prof. TRANQUART
The usage of CEUS undoubtedly faced some uncertainties in the first few years. The first CEUS, requiring high MI, were a little bit tough due to the fact that they entailed lengthy procedures which were far removed from the daily clinical usage of ultrasound.
Low repeatability along with high user and patient dependency made it tough to gain acceptance from a broader audience.
The introduction of the new agents in 2001 had a great impact: they were easy to use, well accepted and followed a standard live scanning protocol and they introduced clear vascular patterns associated with the work on lesions along with clear guidelines. All of these factors have contributed to the increased confidence in CEUS.

ULTRASOUND POST
Which guidelines are you referring to?

Prof. TRANQUART
In 2004, a European committee of clinical experts, including both radiologists and gastroenterologists, established the first European guidelines for the usage of CEUS in the study of FLL. The work promoted by EFSUMB had the aim of introducing some recommendations in their clinical use. These guidelines were quite successful and were presented by the AIUM society to the FDA to support the introduction of CEUS in USA. It was really a big deal! The success of these guidelines, printed in more than 20,000 copies and translated into 4 languages, necessitated further revision, which is now complete. A broader European committee met recently in Rotterdam to extend the guidelines to additional areas such as the pancreas, liver, kidneys, etc. and to more procedures, including some technical recommendations (studied with the US companies) for the proper use of CEUS. These new guidelines will probably be issued by mid 2007. That's a real achievement for the use of CEUS in our daily routine.

ULTRASOUND POST
What role do the ultrasound companies play in spreading CEUS?

Prof. TRANQUART
Their role is becoming increasingly important. All of these companies have developed new features and waves to increase the ratio signal/noise and provide more useful information to clinicians. Easier and reliable procedures have been developed and numerous investments have been made in educational programs in cooperation with the pharmaceutical companies. Last year, technical developments undoubtedly precipitated further changes in the importance of CEUS, as demonstrated by Volume Ultrasound and reliable quantification packages available on the LOGIQ 9 BT07.
Nowadays, the effectiveness of new targeted treatments for oncology patients needs to be evaluated at an earlier stage. Thus, because of its accuracy, non invasiveness and lower cost, CEUS is becoming the technology of choice for frequent monitoring of tumor volume and the changes in its feeding vasculature. In this objective, the availability of both volume and quantification packages on and offline is essential for the workflow in guiding clinicians in treatment planning.

ULTRASOUND POST
So, what do you feel is the role of Volume Ultrasound and how it will change?

Prof. TRANQUART
Volume CEUS will continue to be important because it can effectively change the workflow related to patient management. The rendered vascular architecture of the vessels feeding a lesion, or clear information about the relation of the lesion to surrounding tissues can help surgeons choose the best way to treat a patient, thus changing the way in which they act and enabling them to better perform follow-up exams. Acquiring a contrast volume data set and representing it in many rendering modes, obtaining re-slices or calculating volumes of a lesion over the time are all new aspects.
Now, with the latest improvements, we have reproducible access to the total volume, necrotic volume, vascular architecture, relationship with the environment and precise quantification of enhancement. This is more than other modalities can provide with a single injection with any available imaging method.
It's a great challenge and I am excited about these new possibilities and ready to explore the topic in greater depth.

A Pictorial Review

Benefits of Volume Ultrasound Imaging in the Scrotum

Introduction

Two-dimensional (2D) ultrasound imaging has long been the imaging method of choice for evaluation of the scrotum. It has advantages of being readily available for emergency exams, comparatively inexpensive and does not involve ionizing radiation. Technological advancements including CrossXBeam™ imaging, SRI (Speckle Reduction Imaging) and Coded Harmonics Imaging have resulted in exquisitely detailed images of the scrotal contents (Fig 1). Yet compared to other imaging modalities such as MR and CT, ultrasound exams remain time-consuming and operator dependent. A sonographer typically follows a laboratory protocol requiring numerous static images obtained throughout the length and width of each hemiscrotum.

Color Doppler images of each testis and epididymis, as well as spectral Doppler waveforms of the intratesticular vessels are obtained. The resulting quality of the study is dependent on the experience, skills and training of the sonographer. In many ultrasound departments, the request for scrotal sonography occurs with much less frequency than other ultrasound exams. This lengthens the learning curve for student and new sonographers.

Furthermore, scrotal exams are often ordered through the emergency room and may be performed after regular hours, when less-skilled or more recently trained staff is on duty (and experienced staff unavailable for consultation). This can result in equivocal exams, non-diagnostic exams or force the recall of patients for additional images, delaying necessary intervention. New tools available for Volume Ultrasound imaging can reduce operator dependence, add anatomic information and increase diagnostic confidence through visualization of the anatomy in imaging planes not available with standard 2D imaging. This pictorial review will illustrate the benefits of volume data sets in scrotal ultrasound. The images presented were obtained with either a volumetric transducer (4D16L or 4D10L), or a Matrix Array transducer (M12) on the LOGIQ 9 ultrasound system (GE Healthcare, Wauwatosa, WI).

Volume Ultrasound

Volume ultrasound is a method of acquiring an anatomical volume data set either through an automated 3D sweep using a volumetric transducer or through a freehand sweep with a conventional 2D transducer. Each volume data set can be manipulated to display many individual B-mode images in an infinite number of imaging planes. The volume image visualization is user selectable between Sectional, Render, VCI (Volume Contrast Imaging), and TUI. Tomographic Ultrasound Imaging (TUI) is a volume imaging tool that allows rapid and automated display of the volume into parallel slices in any plane. The number of slices and distance between slices can be easily adjusted. In scrotal ultrasound, a volume data set is acquired with an automated sweep through the testis with the volumetric transducer.

The sweep is obtained within a few seconds and a series of equidistant parallel slices are displayed on the monitor similar to computed tomography (CT) or magnetic resonance (MR).

The "A" plane is displayed by default and represents the plane in which the volume was acquired. A reference image is shown in the upper left corner of the display. To display images of the testis in the B and C planes, the user chooses the view from a touch panel. When a particular area of interest is detected, an axis point can be set on that anatomy, and with the 3D visualization changed to Sectional, three orthogonal views will be displayed. The volume data set can be reconstructed at any time to show an infinite number of planes to better display anatomical relationships.

Rendering can be applied to the volume to produce images of startling realistic quality. These images are particularly helpful when discussing the anatomy or pathology with the patient and referring physician.

Figure 1
Cross sectional ultrasound image of the testis and epididymal head in a patient with torsion of the spermatic cord demonstrates the fine anatomical detail obtainable with the bundling of advanced imaging features. A high frequency matrix array transducer (M12) that produces a very thin slice improves visualization of such small anatomical features as the edematous tubules in the epididymis (arrow). The clarity of the hydrocele is a result of improved contrast resolution associated with Coded Harmonics Imaging. By combining multiple images fired at different angles into a single displayed image, CrossXBeam enhanced the boundary definition between the epididymis, testis and surrounding tissue.
Finally, the abnormal texture within the epididymis is easily recognized because the inherent overlying speckle artifact has been removed with SRI.

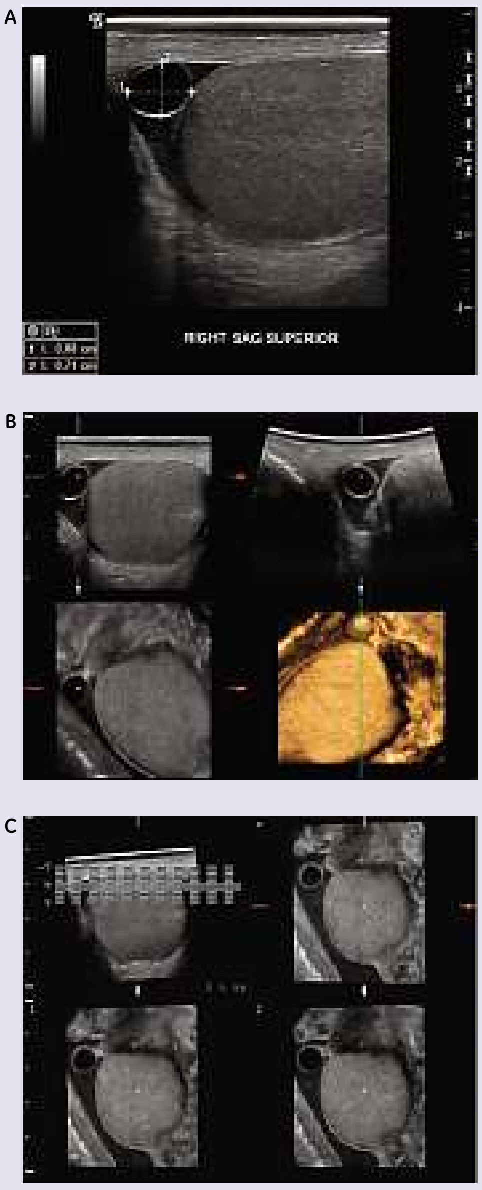


Figure 3
Cystic appendix epididymis in a 53 year old male with diabetes and left scrotal pain. Conventional 2D imaging (A) demonstrated a cystic mass slightly superior and lateral to the right testis. The left testis was unremarkable. The etiology of the cyst was not determined. The patient was rescanned with the 4D16L transducer and a 3D volume was obtained.
Sectional planes with a surface rendering (B - lower right image) demonstrated smooth walls and confirmed the extratesticular location of the cyst near the epididymal head. The corona plane image (B lower left image) demonstrated a stalk connecting the cyst to the epididymal head. The 3D Visualization was then changed to TUI of the coronal plane (C).
The distance between the slices was set to 0.6mm with the number of slices at 19 with a 2x2 display to enlarge the image. This allowed for translation through the epididymal head at very fine intervals. This improved diagnostic confidence of a pedunculated cystic appendix epididymis.

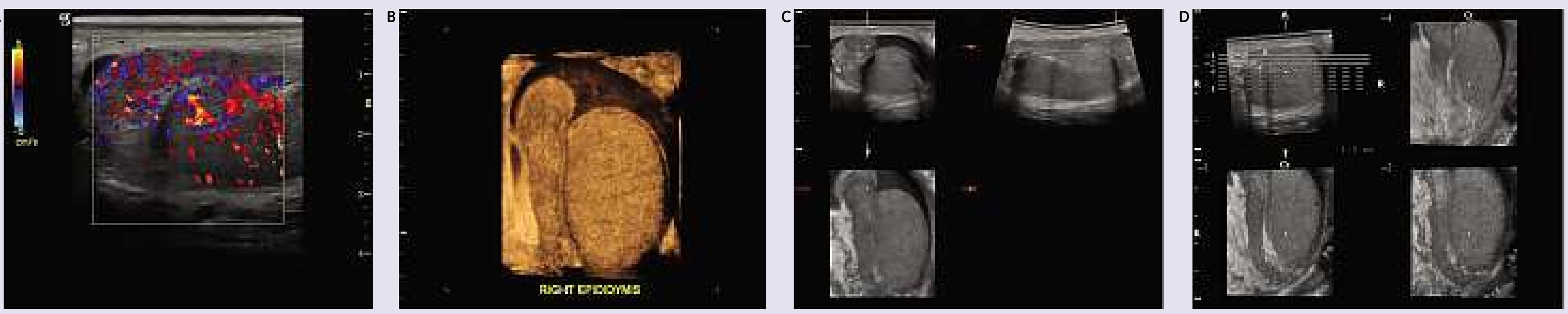


Figure 2
Right epididymitis in a 25 year old male with right testicular pain. Color Doppler imaging demonstrated hyperemic flow within the epididymis and testis consistent with epididymo orchitis (A). Standard 2D imaging was not performed. Volume Ultrasound was performed with the 4D16L transducer. Sectional planes on the right show enlargement of the right epididymis throughout its length (B). The rendered image clearly demonstrates the enlarged epididymis, testis and surrounding hydrocele (C). The data set was then manipulated to better demonstrate the tail of the epididymis and visualization was changed to TUI in the coronal plane (slightly off axis of the coronal plane). Multiple slices through the inferior aspect of the hemiscrotum show the enlarged epididymal tail (globus minor). (D) The globus minor is often difficult to identify sonographically, however the volume data set can be manipulated by adjusting the X, Y and Z planes to lay out the epididymis as it curves around the inferior aspect of the testis and then slice through the volume until the desired image is obtained.

Cindy A. OWEN, RDMS, RVT
Craig LIPMAN, M.D., Mid-South Imaging & Therapeutics, P.A., Baptist Memorial Hospital, Memphis, TN

Breakthroughs in DXA Densitometry Technology

Healthcare is a wonderful industry and GE Healthcare is dedicated to helping patients, clinicians and researchers by providing innovative technologies and strategies that help save lives.
The Lunar iDXA™ densitometer is a prime example of GE Healthcare's breakthrough strategy, with emphasis on image quality, precision, innovative applications and ease of use.

"Key to the clinical success of a new technology, is anticipating trends, listening to the customer's needs and understanding the disease. Launched in Europe at Medica 2005 [Düsseldorf (D) November 2005], I am very proud that the Lunar iDXA™ introduction is an incredible success with market uptake at key clinical and research sites throughout Europe, ... and with excellent customer satisfaction." Jef Van Dam, International Director - Lunar Densitometry.

Equipped with Lunar iDXA™ clinicians and researchers benefit from breakthroughs dedicated to bone health and beyond such as:

- High Definition Direct-Digital CZT detector: GE Healthcare's patented detector enables diagnostic confidence and excellent image quality at low dose.
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GE Healthcare - Lunar Densitometry, the #1 densitometry partner worldwide, delivers annual breakthroughs dedicated to bone health and beyond, enabling clinicians and researchers to help save lives. Lunar Densitometry Re-Imagined.

Gitte ANDREASEN, Global Marketing Manager – Lunar Densitometry

Pascal SITTER, EMEA Product Manager – Lunar Densitometry

International Academy of Medical Ultrasound DATES for 2007

TOPIC	CHAIRMAN	LOCATION	DATE
VISUS 3D/4D	Prof. A. Kratochwil	Vienna, Austria	2 - 5 April
TVI, STRAIN & MYOCARDIAL DEFORMATION	G.R. Sutherland MD PhD	Berlin, Germany	19 - 20 April
4D & MULTIDIMENSIONAL IMAGING	J. D. Kasprzak MD PhD	Berlin, Germany	27 - 28 April
ADVANCED COURSE IN MUSCULOSKELETAL ULTRASOUND	Prof. S. Bianchi Prof. C. Martinoli	Noordwijk, Netherlands	4 - 5 May
VISUS 3D/4D	Prof. A. Kratochwil	Vienna, Austria	21 - 24 May
MAMMASONOGRAPHY	Dr. C. Weismann	Salzburg, Austria	21 - 23 June
ADVANCED VISUS COURSE	Prof. Rabih Chaoui	Berlin, Germany	6 - 7 July

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CONGRESSES 2007

TOPIC	LOCATION	DATE
ESC	Vienna, A	1 - 5 September
ISUOG 2007	Florence, I	7 - 11 October
JFR	Paris, F	20 - 24 October
EUROSON / 3 LÄNDER TREFFEN	Leipzig, G	24 - 27 October
MEDICA	Düsseldorf, G	14 - 17 November
EUROECHO 2007	Lisbon, P	5 - 8 December

GE Ultrasound Offices Have Moved

Please notice that some of our European GE Ultrasound offices have moved. You will find the new addresses of the Netherlands, Italy, Finland & Estonia and GE's Lunar office in France below.

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