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technical development and medical research –
NEWS and FACTS.

2007 / 3rd edition **No. 18**

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Introducing "SonoAVC": Automatic Volume Calculation in Gynecology

Ultrasound is used on a daily basis to identify pathology and confirm normality. This requires a subjective interpretation of the image display which can be modified according to the object or area of interest. Objective assessment of an ultrasound image requires some form of measurement to be made which should be performable in a reproducible manner and provide a valid result. Ultrasound is open to interpretation therefore and dependent upon the observer regardless of whether a subjective or objective examination is being made. Objective examination at least allows assessments by different observers (inter-observer) and by the same observer (intra-observer) to be analyzed mathematically. This can be used to define standards and to audit practice. Automatic data analysis has the potential to remove any observer bias and to reduce the time needed for measurements but must be both valid and reliable.

SonoAVC (Automatic Volume Calculation: GE Healthcare Ultrasound, Austria) is a new software program that identifies and quantifies hypo echoic regions within a three-dimensional dataset and provides automatic estimation of their absolute dimensions, mean diameter, and volume. SonoAVC is easy to use.

Once a three-dimensional dataset of the volume of interest has been acquired it literally takes a touch of a button to activate the algorithm.

SonoAVC identifies each and every individual volume by giving it a specific color and provides automated measurements of its mean diameter (relaxed sphere diameter), its maximum dimensions (x, y, z diameters), and its volume. Because each different volume is separately color coded SonoAVC is an ideal tool to study follicles within the ovary (Figure 1). Follicle tracking is used to follow the development of a single follicle in natural cycles or in artificial cycles where drugs are used to induce monofollicular recruitment. This is relatively straight-forward but follicle tracking becomes more difficult when there is multifollicular recruitment as in IVF treatment. The validity and reliability of measurements of follicular diameter are likely to reduce as the number of follicles increases. The time required for these measurements also increases which may also adversely affect measurement reliability. Automated measurement of follicular size could potentially address both of these issues.

Preliminary work using SonoAVC to automatically measure follicles has shown that it is extremely accurate and can be applied in a reliable fashion. The work, which was presented at the 14th World Congress of Ultrasound in Obstetrics & Gynecology in Florence this month, examined the reliability and validity of SonoAVC in women having IVF treatment. The studies

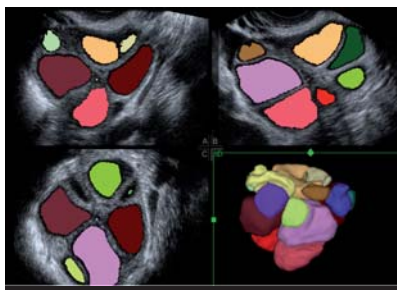


Figure 1: The color-coded follicles and their individual measurements can be seen within two different stimulated ovaries during IVF treatment

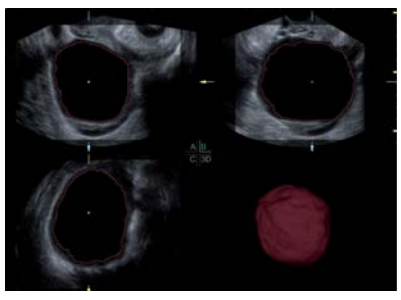


Figure 2: SonoAVC can be used to delineate and quantify the volume of an ovarian cyst which allows tracking over time

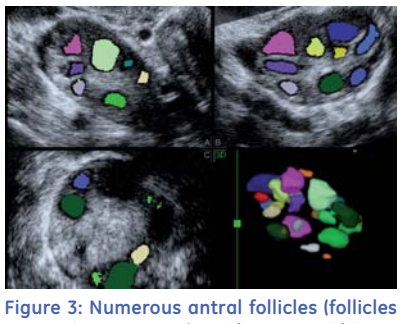
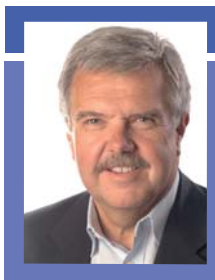


Figure 3: Numerous antral follicles (follicles measuring 2-10 mm) can be seen within an unstimulated polycystic ovary

EDITORIAL:



Heinz GLOOR

Vice President / General Manager
GE Healthcare Technologies
Ultrasound & PCD
Europe, Middle East & Africa

Dear Readers,

Sometime in early 1989, a group of ingenious engineers in the little village of Zipf, Austria invented a way to display sonography images in 3D. The general public was impressed, but the impact on the medical community was surprisingly small at that time. None but a few obstetricians and radiologists recognized any clinical value in the 3D imaging of fetuses, but nevertheless, this small group had a vision of the future and the role this technology could play in the field of medicine.

So the engineers continued research and development and, not long thereafter, came up with software-based applications that could use these 3D images to calculate volumes. This was the beginning of a tremendous success story, the birth of Volume Sonography, otherwise known as the Voluson platform.

The pioneers in the early days included Prof. Alfred Kratochwil from Vienna, Dr. Christian Weismann from Salzburg and Dr. Bernard Benoit from Monaco. They pushed 3D ultrasound to the next level by working with GE engineers in Zipf. Suddenly, it was possible to visualize fetus malformations at an earlier stage than ever before. This talented group developed new tools to not only diagnose fetal heart anomalies but to also make it possible to use multiplanar ultrasound guidance to view human anatomy in ways never before imagined. Then, of course, they started to introduce these new applications to their colleagues, and the rest is, as they say, history.

Today, 18 years later, 3D ultrasound can be displayed in real time. In professional circles, it is known as Volume Ultrasound and has become an indispensable tool in numerous medical disciplines. No longer does the medical profession consider this technology just a non-intrusive way to provide prospective parents a 3D peak at their baby.

GE Healthcare has been a supporter of Volume Ultrasound and its different applications right from the very beginning, and we are proud to say that we introduced important applications such as STIC, B-Flow and Inversion Mode and were also involved in establishing the International Academy of Medical Ultrasound and the VolusonClub.

We are still on the cutting-edge of providing better human healthcare coverage. Our latest innovation is SonoAVC mode, which automatically identifies and measures follicles and increases the efficiency of ultrasound follicular monitoring by eliminating the need to measure each individual follicle separately. SonoAVC will be introduced at the ISUOG 2007 in Florence, Italy. You will find more information about SonoAVC in this edition of the Ultrasound Post, at our GE ISUOG booth, and during our Lunch Symposium on Monday the 8th as well as during various "Meet the Expert" sessions on Tuesday the 9th and Wednesday the 10th.

I cordially invite you to attend. I hope you enjoy reading this issue, and I am looking forward to meeting you in Florence.

Yours

showed that the software provides estimates of follicular volume that are almost identical to 'true measurements' made by collecting the fluid from the follicle at the time of egg collection. SonoAVC also provided more reliable estimation of the mean follicular diameter than measurements made from 2D and 3D data and even out-performed Virtual Organ Computer-aided AnaLysis (VOCAL) which itself has been shown to be an extremely accurate technique for volume calculation. The software can also be used to quantify the size of an ovarian cyst (Figure 3), identify antral follicles within an unstimulated ovary (Figure 4), and to examine early pregnancy where it can differentiate between the gestation sac and yolk sac (Figure 5) or different gestation sacs in the case of multiple pregnancy (Figure 6). Dr. Nick Raine-Fenning, an Associate Professor of Reproductive Medicine and Surgery at the University of Nottingham in the UK, who led the research said *"SonoAVC provides a glimpse into the future of what ultrasound could, and hopefully, will offer. Automated measurements, if accurate and calculable in a reliable manner, have great potential as they can improve clinical throughput and enhance quality control simultaneously. We will see an increasing emphasis on standards in ultrasound over the next few years and intelligent software, such as SonoAVC, could be one way to achieve this. I am sure there is much more work to be done but this is an exciting and encouraging first step."* SonoAVC (Automatic Volume Valculation) has been developed by GE Healthcare Ultrasound in association with K plus Competence Center (Advanced Computer Vision) and part funded by the K plus Program.

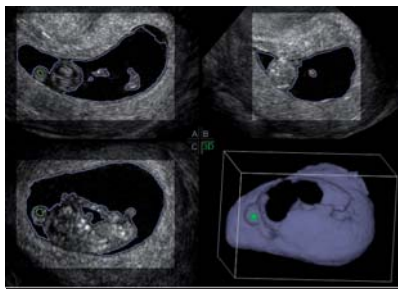


Figure 4: A singleton fetus at 10 weeks gestation can be seen in the C plane (lower left image) within its gestation sac, colored purple and measuring 20.84 mls, and separate to the yolk sac, colored green and measuring 0.02 mls

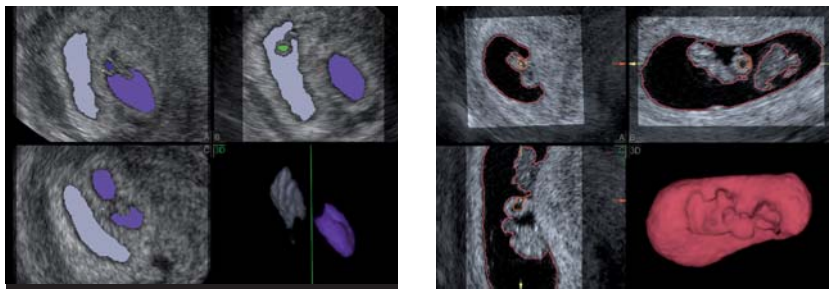


Figure 5 /6: The two separate gestation sacs and yolk sacs of a diamniotic twin pregnancy are readily identifiable as separate structures in contrast to the single gestation sac of a monozygotic twin pregnancy shown in Figure 6.

N. RAINE-FENNING, K. JAYAPRAKASAN, J. CLEWES, I. JOERGNER, S. DEHGHANI BONAKI

Technique, Assessment and Clinical Application in Fetal Cardiology

B-Flow Imaging and STIC

This article is an excerpt of an extensive scientific work for GE's White Paper Collection by Dr. Paolo Volpe, specialist in the field of fetal cardiology. If you are interested in the complete white paper, you can order it at the Ultrasound Post email address totally free of charge.

In the first report, the study objective was to estimate whether the use of 4D ultrasound with B-flow imaging and STIC might improve prenatal diagnostic accuracy in the assessment of the size and anatomy of the central pulmonary arteries and in the identification of the sources of pulmonary blood flow in a case series of fetuses with pulmonary atresia and ventricular septal defect (PA-VSD), as compared to 2D and color Doppler echocardiography.
Along with the presence of extra-cardiac and genetic anomalies, the prognosis of PA-VSD is influenced by the anatomy of pulmonary arteries and by the sources of pulmonary blood supply. The pulmonary vascular bed may be supplied with blood flow from a ductus arteriosus (DA), from major aortopulmonary collateral arteries (MAPCA), or from a combination of both.

Further, the central pulmonary arteries can be 'confluent' or 'non-confluent' on the basis of the presence or the absence of free communication with each other. A detailed appreciation of the defect obviously helps in providing fully informative prenatal counseling. In fact, surgical planning and prognosis are strongly dependent on a correct and exhaustive characterization of the anatomic anomaly. The most favorable arrangement is that in which the RPA and LPA are confluent and are supplied by the DA. In the second major pattern, the central pulmonary arteries are confluent and coexist with MAPCA. The third pattern is the complete absence of the central pulmonary arteries, the lungs being supplied directly by multiple MAPCA. This last pattern, associated with absent central pulmonary arteries, has the worst prognosis and is the most difficult to treat in postnatal life. Whereas conventional 2D ultrasound is not always able to adequately assess the anatomy of the pulmonary arteries and the sources of pulmonary blood flow, as also reported by other case studies, 4D echocardiography with B-flow imaging and STIC is always capable of correctly visualizing very small vessels and pulmonary blood flow in fetuses with PA-VSD (Figure 1). This finding, although limited to a small sample size, shows that B-flow and STIC might be used to improve and help detail the diagnosis of some fetal cardiac defects.

Since this technique is especially crucial for identifying and tracking the route of thin vessels with low blood flow velocity, it also theoretically has the potential of facilitating the prenatal diagnosis of isolated total anomalous pulmonary vein connection (TAVPC), which is hard to make using 2D US. For this reason, we have recently performed a study on a fetal case series of isolated TAVPC in the attempt to evaluate the reliability of 2D and color Doppler echocardiography in the prenatal diagnosis and characterization of this anomaly, and to explore whether the use of 4D ultrasound with B-flow and STIC would improve prenatal diagnostic accuracy. The essential feature of this CHD is that all the pulmonary veins (PVs) drain into a site other than the morphological left atrium.

It can be categorized by the site of drainage in supracardiac, cardiac, infracardiac and mixed. The prognosis of isolated TAPVC is influenced by the accuracy and the timing of diagnosis - either prenatally or in postnatal life - which is especially critical in the presence of an obstruction. In fact, obstructed TAPVC represents one of the few real emergencies in pediatric cardiological practice, and requires immediate surgery within hours of birth. Unfortunately, prenatal diagnosis of isolated TAPVC is rare.

Also in this study, 4D ultrasound with B-flow imaging and STIC were able to facilitate and detail the anatomical features of this CHD (Figure 2), thus supplying additional information with respect to 2D fetal sonography.

In conclusion, B-flow features have been recently introduced in commercial equipment, and the images, especially when combined with STIC, may be impressive (Figure 3). Some reports have shown its ability to provide additional diagnostic information for the assessment of some CHDs.

These rendered images may be especially helpful for assisting operators who counsel parents about the nature, prognosis, and post-natal management of these fetal cardiovascular defects. However, it should be emphasized that manipulating volumes acquired with STIC and B-flow requires a substantial learning curve.

Paolo VOLPE MD

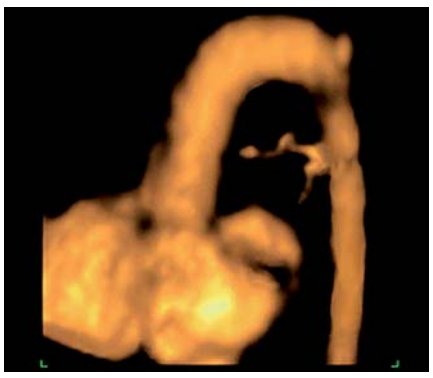


Figure 1: US with B-flow imaging and STIC of the aortic arch and descending aorta, showing the rise of 2 small MAPCAS (hard to see by conventional echocardiography) from the thoracic aorta.

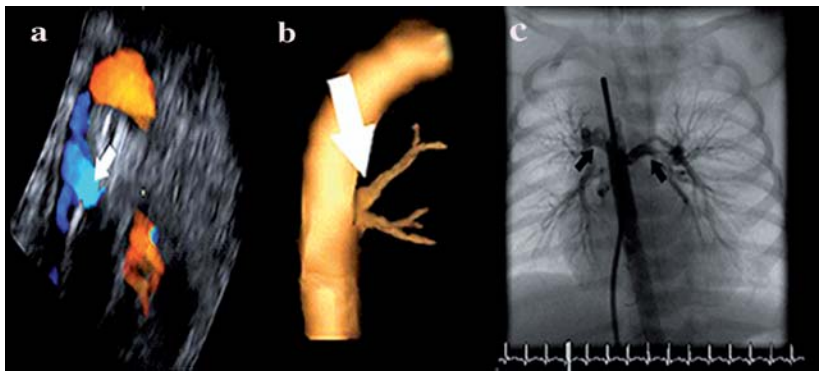


Figure 2: B-flow STIC imaging. a) Normal connection of pulmonary veins (PV) to the left atrium (LA). All 4 PVs are clearly recognized. b) B-flow STIC imaging of isolated supracardiac total anomalous pulmonary vein connection. The figure shows the drainage of each individual pulmonary vein (PV) into the confluence, which appears large and tortuous (arrows).

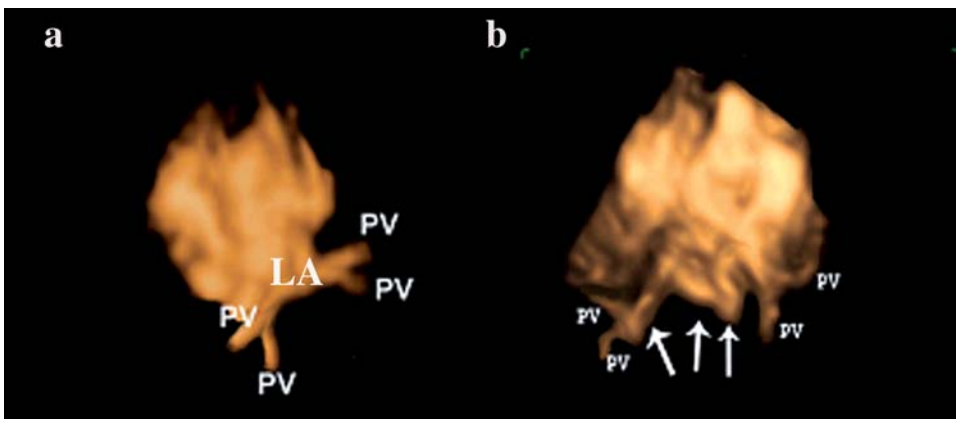


Figure 3: Pulmonary atresia and ventricular septal defect. a) Post-natal echocardiography. One small MAPCA arising from the descending aorta (arrow) is shown. It was missed during conventional prenatal echocardiography and was instead detected using the B-flow and STIC technique (b), and confirmed by cardiac catheterization (c), along with the presence of a second small MAPCA that had been also missed using two-dimensional post-natal sonography. In (a), the arrow indicates the MAPCA. In (b) and (c), the arrows indicate both MAPCAs and their ramifications.

Efficient and Reproducable Method of Follicular Assessment

SonoAVC – Sonography-based Automated Volume Calculation

This article is an excerpt of an extensive scientific work for GE's White Paper Collection by Todd D. Deutch and Alfred Z. Abuhamad, about volume calculation of follicles. If you are interested in the complete white paper, you can order it at the Ultrasound Post email address totally free of charge.

SonoAVC automatically identifies and measures follicles within a 3D volume (Figure 1). SonoAVC standardizes the process of follicular assessment and decreases inter-observer and intra-observer variability. SonoAVC increases the efficiency of ultrasound follicular monitoring by eliminating the need to measure each individual follicle.

Volume imaging enables SonoAVC

Volume ultrasound is a method of acquiring an anatomical volume dataset. Each volume dataset can be manipulated to display high-definition, multidimensional images that can be viewed in any plane. Automated SonoAVC, in conjunction with volume ultrasound, allows the user to automatically identify, measure and analyze ovarian follicles during stimulation.

Individual ovarian follicles are identified with the following parameters:
volume, the mean diameter, the diameter and the X, Y and Z axis. Care should be taken to ensure that the region of interest (ROI) is large enough to encompass the entire ovary. Once the ROI is accepted, SonoAVC will automatically identify the ovarian follicles and determine the volumetric parameters for each follicle.

Next the user pages through the ovarian volume and deselects any non-ovarian follicles. Increasing separation will increase the software's ability to differentiate each individual follicle (Figure 2).

Furthermore, increasing or decreasing the growth will increase or decrease the volume of each selected follicle (Figure 3). Once optimization of the volume has been completed for both the left and the right ovary, the ovarian data is added to the report.

Another tool to aid in follicular assessment is the application of VOCAL (Virtual Organ Computer-aided AnaLysis), which decreases the potential number of nonovarian follicles identified by SonoAVC.

Todd D. DEUTCH
Alfred Z. ABUHAMAD

Using SonoAVC on the Voluson E8 ultrasound system:

- A transvaginal ultrasound is performed using a 3D imaging probe (RIC 5-9 or RIC 6-12)
- Optimize the gain and harmonics for optimum image quality
- Select 3D imaging mode, adjust quality settings
- Adjust volume angle to include entire ovary and acquire volume
- Adjust 3D box over area of interest
- Select SonoAVC to evaluate the ovarian follicles
- Increase or decrease growth or follicular separation
- Select follicles manually if they are not identified
- Display report and chart

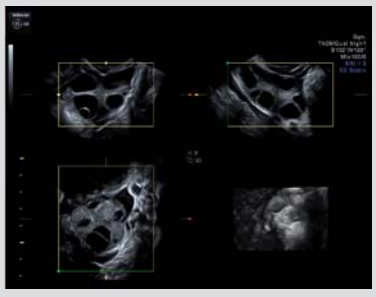


Figure 1a: The SonoAVC automatically finds and measures the ovarian follicles. Render mode view of the ovary before the use of SonoAVC.

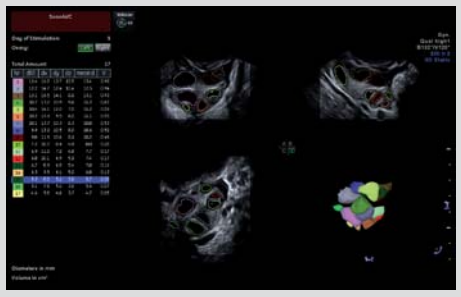


Figure 1b: The SonoAVC automatically finds and measures the ovarian follicles. Render mode view of the ovary after the use of SonoAVC to automatically find and measure the ovarian follicles.

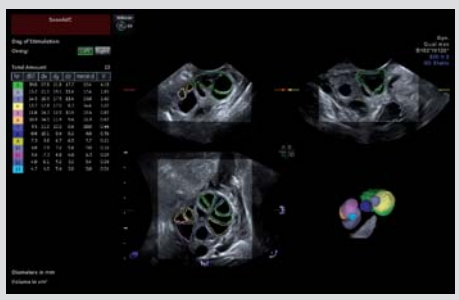


Figure 2a: Use of the separation function. The separation function is set to mid. As can be seen by the large area outlined in green, several follicles are grouped together as one.

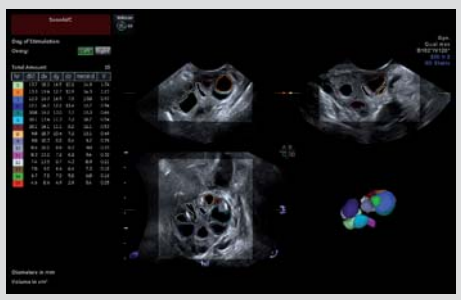


Figure 2b: Use of the separation function. The separation function is set to maximum. The follicles that were previously grouped together as one have now been separated out. SonoAVC can now recognize and measure each individual follicle.

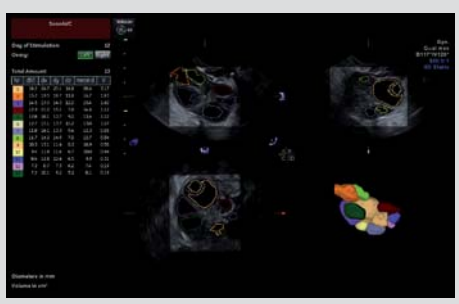


Figure 3a: Use of the growth function. The growth function is set to minimum. As can be seen SonoAVC underestimates the borders of the ovarian follicles.

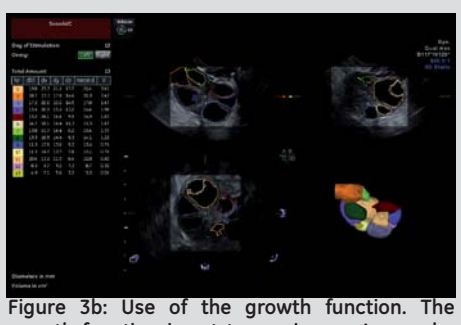


Figure 3b: Use of the growth function. The growth function is set to maximum. As can be seen SonoAVC now overestimates the borders of the ovarian follicles.

One Year **Voluson**Club – from Idea to Success Story

In the beginning, there was just an idea. The idea was to expand GE's customer support program and pool the power of Voluson users worldwide in order to allow Voluson users to exchange experiences and increase the clinical value of the Voluson platform.

After a short conceptual phase, GE established the **Voluson**Club as it exists today. This occurred only a year ago and since then, the **Voluson**Club has grown to 2630 registered members worldwide; up to 200 new members register every month. The advantages of **Voluson**Club membership are numerous, varied and immediate. Club members not only have access to the latest scientific studies in the form of White Paper Collections, they can also order educational DVDs recorded live at the renowned International Academy of Medical Ultrasound in Vienna, Austria – totally free of charge. Members can relax in **Voluson**Club Lounges at the most important medical congresses across the world and are invited to **Voluson**Club User Days where they get to hear about the latest technical developments and innovations. **Voluson**Club members can also develop networks in the group and teach each other: So far, more than 1350 clinical images and movies have been uploaded onto the club website where members discuss the latest findings online. On top of this, there are also regional offers such as a 10% discount off the 3D/4D Ultrasound course in Germany during 2007.

There are so many advantages to being a **Voluson**Club member that we can't list them all here. To get the whole scoop on the **Voluson**Club, visit the website at
www.volusonclub.net and register – totally free of charge – and start accomplishing more in your field now.
As an example of what's currently available from the **Voluson**Club website, check out the educational DVD with Prof. Rabi Chaoui on the topic "Fetal Heart Assessment with STIC (Spatio-Temporal Image Correlation)". It's the second DVD in the education lecture series recorded at the IAMU. And the **Voluson**Club highlight at the 17th World Congress on Ultrasound in Obstetrics & Gynecology in Florence is a quiz at the **Voluson**Club Lounge at the GE booth. Each day of the congress, someone will win a full 4D View software package and the book "Ultrasound of Congenital Fetal Anomalies" by Prof. D. Paladini and Dr. P. Volpe. The grand prize to be awarded on the final day is a VISUS course in Vienna, flight and hotel included – one more reason to participate as a **Voluson**Club member.

GE Healthcare **PROGRAM**

17th World Congress on Ultrasound in Obstetrics and Gynecology

7 - 11 OCTOBER 2007

FLORENCE, ITALY

We are looking forward to presenting you the latest Voluson innovations at the GE Healthcare booth No 37 at ISUOG 2007.

VolusonClub members will be served in the **Voluson**Club Lounge during Congress hours.

Bring your **Voluson**Club member card and meet Voluson users from around the globe.

Monday 8th of October - 12.45 - 13.45 – Lunch Symposium

Clinical application of the latest developments in Volume Ultrasound

Chairmen: Pr. G. PILU

Lectures:

- Pr. D. PALADINI – Fetal Heart Early Assessment
- Dr. B. BENOIT – New Ultrasound Tools in Obstetric Examination
- Dr. A. ABUHAMAD – Automation in Ultrasound – the Latest Developments

Tuesday 9th of October - "Meet the expert" session

10.30 - 11.15 – Fetal Heart Assessment + Live Scanning
PR. R. CHAOUI

11.45 - 12.15 – ViewPoint - IT Solution to Optimize Your Workflow
"small room"

13.00 - 14.00 – Advanced Features Application in Obstetric Assessment
DR. B. BENOIT

14.30 - 15.30 – Ultrasound Examination of the Central Nervous System
PR. G. PILU

15.30 - 16.00 – ViewPoint - IT Solution to Optimize Your Workflow
"small room"

16.00 - 16.30 – Volume Ultrasound - Standard and New Tools for Gynecology Examination
DR. N. RAINE-FENNING

Wednesday 10th of October - "Meet the expert" sessions

10.30 - 11.15 – Fetal Heart Assessment + Live Scanning
DR. G. DEVORE

11.30 - 12.30 – Advanced Features Application in Obstetric Assessment
DR. B. BENOIT

11.45 - 12.15 – ViewPoint - IT Solution to Optimize Your Workflow
"small room"

13.00 - 14.00 – Ultrasound Examination of the Central Nervous System
PR. G. PILU

14.15 - 15.15 – Volume Ultrasound - Standard and New Tools for Gynecology Examination
DR. N. RAINE-FENNING

15.00 - 16.00 – ViewPoint - IT Solution to Optimize Your Workflow
"small room"

15.30 - 16.00 – STIC in the Fetal Heart Assessment
PR. R. CHAOUI

GE Hosts Unique Education Tool
2D to 4D Color Altas – The Normal and Abnormal Fetal Heart

The education tool hosted by GE is a DVD representing the first publication that includes a full description of the normal heart and of most congenital heart diseases, analysed using 2D, color Doppler and 4D echocardiography (STIC). For each heart defect, all the relevant echocardiographic views are described, along with interactive and visual help functions. Original 4D volumes used to produce the clips are enclosed, so that anyone can open and navigate the volume to reproduce the clips. In fact, a 4D View demo version for opening and manipulating the STIC volumes is included. A user-friendly online tutorial explaining how to use the dedicated software and change the rendering settings is also available.

The education DVD can be useful both for the beginner, who will find full anatomic descriptions of the abnormal cases and for the expert, who wants to review his/her knowledge and navigate STIC volumes containing virtually all congenital heart defects, many not normally seen at a typical practice.

The DVD, "Normal and Abnormal Fetal Heart – 2D to 4D Color Atlas" by D. PALADINI and P. VOLPE can be ordered at the VolusonClub website www.volusonclub.net.

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