

Sonography-based Automated Volume Count (SonoAVC): an efficient and reproducible method of follicular assessment

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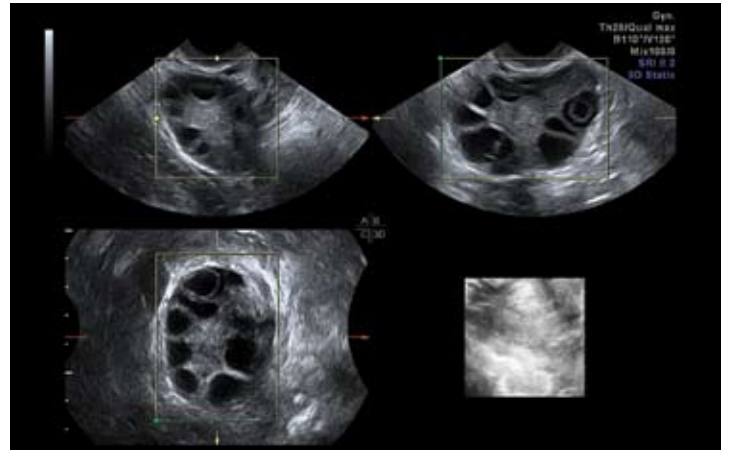
Volume imaging enables SonoAVC

Volume Ultrasound is a method of acquiring an anatomical volume dataset. Each volume dataset can be manipulated to display high-definition, multi-dimensional 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.

The SonoAVC identifies individual follicles and generates the following parameters: volume, the relaxed diameter or d(V) the mean diameter, and the X, Y and Z diameters. In order to obtain these measurements the region of interest box should be adjusted to include the ovary. Care should be taken to ensure that the region of interest (ROI) is large enough to encompass the entire ovary (Figure 2a). Once the ROI is accepted, SonoAVC will automatically identify the ovarian follicles and determine the volumetric parameters for each follicle (Figure 2b). 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 3). Furthermore, increasing or decreasing the growth will increase or decrease the volume of each selected follicle (Figure 4). 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 (Figure 2c) will decrease the potential number of non-ovarian follicles that are identified by SonoAVC.

Figure 2a: Use of the region of interest (ROI) box to define the ovary



The ROI box is adjusted to ensure that the entire ovary is included in the ROI. Care must be taken to ensure that the amount of non-ovarian tissue which is included in the ROI box is kept to a minimum.

Figure 2b: Use of the SonoAVC to automatically identify and measure ovarian follicles

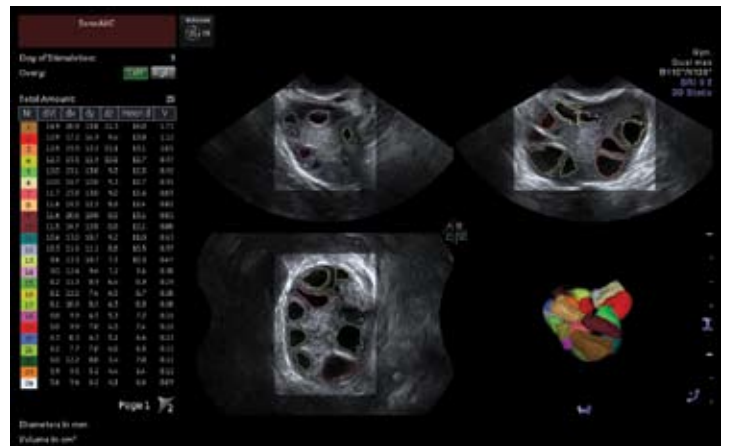
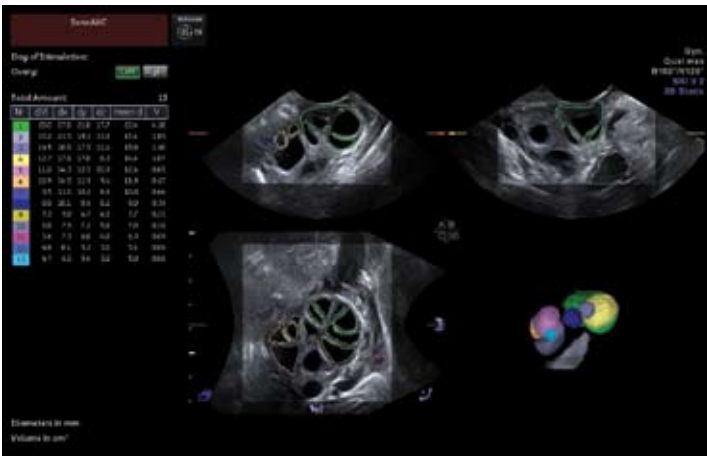
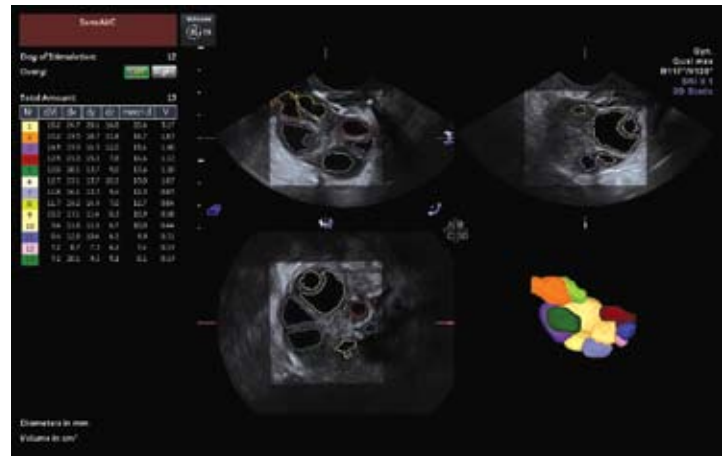


Figure 3: Use of the separation function

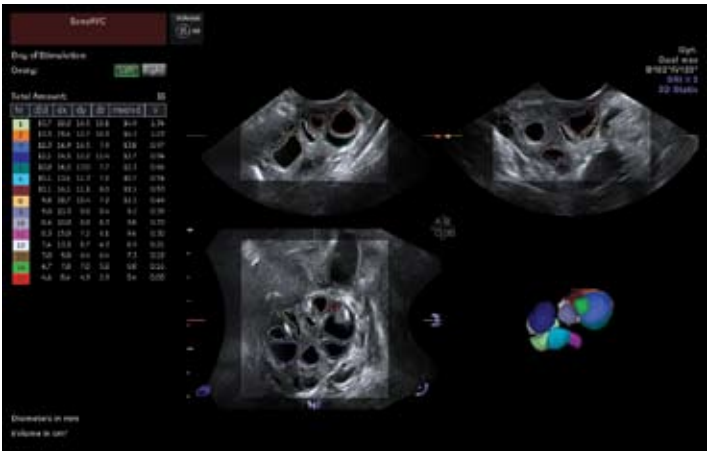


The separation function is set to mid. As can be seen by the large area outlined in green, several follicles are grouped together as one.

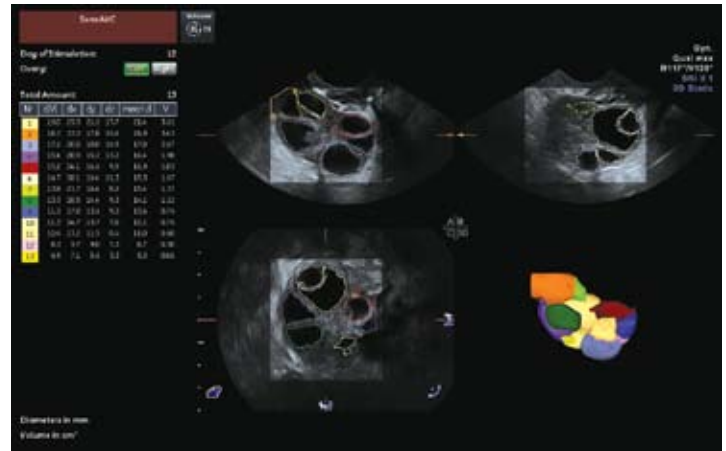
Figure 4: Use of the growth function



The growth function is set to minimum. As can be seen SonoAVC underestimates the borders of the ovarian follicles.



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.



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

Volumetric Parameters

SonoAVC will automatically calculate multiple volumetric parameters for each selected follicle (Figure 5). For each follicle the measurement parameters include the following:

Mean diameter - calculated from an average of the x, y and z diameters

X, Y, and Z diameter - calculated using a best fit ellipsoid model

Volume measurement (the follicular volumes and d(V)s) - measured using the actual follicles as depicted by SonoAVC. For each follicle, d(V) is defined as the diameter of a perfect sphere, given that the volume of the sphere is equal to the calculated follicular volume. Therefore, the d(V) represents what the diameter of the follicle would be if there was no external pressure on the follicle.

Reporting capability

The SonoAVC report includes all of the above volumetric parameters for each ovary and all follicles (Figure 5). In addition, a graphing function provides the user an overall impression of the number and size of the follicles in each ovary. The graph displays the day of stimulation on the x-axis. The y-axis can display the mean follicular diameter, the follicular volume or the relaxed follicular diameter (Figure 6).

Figure 5: The follicular volumetric parameters

Ovary: Left Total#: 18							Ovary: Right Total#: 15						
Nr	d(V)	dx	dj	dz	mn. d	V	Nr	d(V)	dx	dj	dz	mn. d	V
	mm	mm	mm	mm	mm	cm ³		mm	mm	mm	mm	mm	cm ³
1	14.5	24.3	19.4	9.3	17.7	1.59	1	12.2	14.9	12.6	10.3	12.6	0.96
2	12.1	14.8	12.5	10.2	12.5	0.93	2	12.2	15.7	13.5	10.3	13.2	0.94
3	12.1	15.7	13.5	10.1	13.1	0.93	3	10.4	12.8	10.5	9.6	11.0	0.59
4	10.4	12.7	10.4	9.7	10.9	0.58	4	10.3	12.2	11.7	9.6	10.9	0.57
5	10.3	12.2	11.9	8.5	10.9	0.57	5	10.1	13.7	10.3	8.4	10.8	0.54
6	10.0	13.5	10.2	8.3	10.7	0.52	6	9.9	14.3	10.9	6.7	10.7	0.50
7	9.7	14.3	11.0	6.5	10.6	0.48	7	9.6	14.4	9.3	7.6	10.4	0.46
8	9.4	14.3	9.1	7.4	10.2	0.43	8	9.3	12.7	9.2	7.5	9.8	0.41
9	8.9	11.7	9.0	7.3	9.3	0.37	9	7.0	10.6	8.2	4.7	7.8	0.18
10	7.2	10.7	8.3	4.8	7.9	0.19	10	6.9	10.3	6.7	5.9	7.7	0.17
11	6.7	10.8	7.0	4.7	7.5	0.16	11	6.8	10.9	7.0	4.7	7.5	0.16
12	6.6	10.0	6.7	4.9	7.2	0.15	12	6.8	10.1	6.8	5.1	7.3	0.16
13	6.5	8.7	6.4	5.2	6.8	0.14	13	6.7	9.0	6.7	5.4	7.0	0.16

The report displays the volumetric parameters for the right and left ovarian follicles.

The report includes a graphic display of the number and size of each ovarian follicle. The top graph includes the right ovarian follicles and the bottom graph includes the left ovarian follicles. The Y-axis can be adjusted to display either the relaxed follicular diameter (d(V)), the mean follicular diameter (mn.d), or the follicular volume (V).

SonoAVC graphic report

Figure 6a: Relaxed follicular diameter d(V)

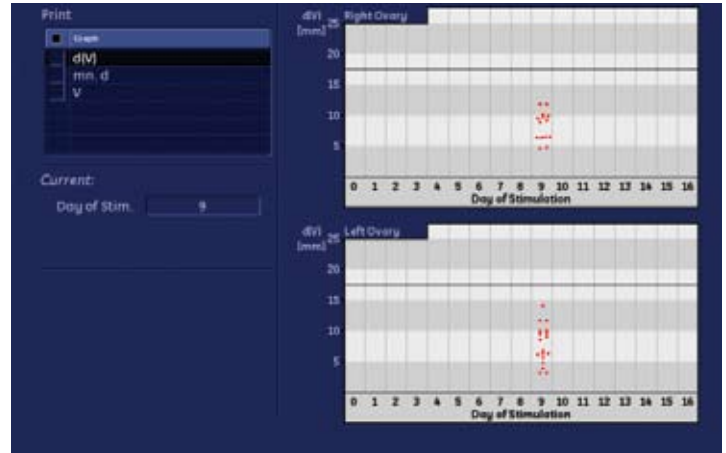


Figure 6b: Mean follicular diameter (mn.d)



Figure 6c: Follicular volume (V)



Conclusions

A reproductive endocrinologist utilizing the Voluson™ E8 and the proprietary SonoAVC automated software can dramatically increase the utility of 3D ultrasound and follicular assessment. SonoAVC standardizes follicular measurements and decreases intra-observer and inter-observer variability⁵. In addition, SonoAVC increases the efficiency of follicular monitoring^{4,5}. The software eliminates the need to measure the diameters of each individual follicle and the graphic display gives the user the ability to quickly assess the number of follicles and their volumetric parameters. SonoAVC offers a reproducible and efficient way to monitor follicular development in patients undergoing controlled ovarian hyper-stimulation^{4,5,6}. Based upon our experience with SonoAVC, the software has the potential to automate follicular assessment and enhance the efficiency and reproducibility of ultrasound follicular monitoring.

About the Author's Institution

The Jones Institute for Reproductive Medicine is world renowned for its success in treating all types of endocrine and fertility problems. Services provided by the Institute include endocrine and infertility and endocrine evaluation, ovulation induction, artificial insemination, in vitro fertilization, and sperm and pre-embryo cryopreservation. Specialized reproductive surgery is available with experience in laser surgery, microsurgery, hysteroscopy (office and inpatient), as well as treatment for congenital anomalies and endometriosis. Consultation services are available for pelvic pain, heavy menstrual flow, and other gynecologic problems.

References

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

- 1 Forman RG, Robinson J, Yudkin P, Egan D, Reynolds K, Barlow DH. What is the true follicular diameter: an assessment of the reproducibility of transvaginal ultrasound monitoring in stimulated cycles. *Fertil Steril.* 1991;56:989-92.
- 2 Benacerraf BR, Shipp TD, Bromley B. Improving the efficiency of gynecologic sonography with 3-dimensional volumes: a pilot study. *J Ultrasound Med.* 2006;25:165-71.
- 3 Abuhamad A. Automated multiplanar imaging: a novel approach to ultrasonography. *J Ultrasound Med* 2004;23:573-576
- 4 Deutch TD, Abuhamad AZ, Matson DO, Bocca S, Stadtmayer LA, Oehninger SC. Clinical evaluation of a novel automated follicular assessment software program in women undergoing controlled ovarian hyperstimulation for in vitro fertilization using three dimensional sonography. *Fertility and Sterility* 2007; 88:S80
- 5 Deutch TD, Abuhamad AZ, Matson DO, Bocca S, Stadtmayer LA, Oehninger SC. Automated calculation of ovarian follicular diameters using three dimensional sonography in women undergoing in vitro fertilization (IVF): a prospective evaluation of a novel software. *Fertility and Sterility* 2007; 88:S80
- 6 Deutch TD, Abuhamad AZ, Bocca S, Stadtmayer LA, Oehninger SC. Automated assessment of follicular volumetric parameters using three dimensional sonography: a prospective validation of a novel software program. *Fertility and Sterility* 2007; 88:S81

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