

HDlive in Assisted Human Reproduction

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ABSTRACT

Summary: The evaluation of the following assisted human reproduction situations using HDlive are described: natural cycles and corpus luteum, IVF stimulated cycles, gynecological pathologies related with infertility and Müllerian malformations.

Keywords: HDlive, Natural cycles, Corpus luteum, Ovulation induction, Polycystic ovarian disease and Müllerian malformations.

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INTRODUCTION

After the first published use of ultrasound to identify growing follicles;¹ this technique has rapidly evolved in the field of assisted reproduction techniques (ART). The introduction of high-resolution endovaginal probes and recent developments in the volumetric sonography has allowed in detail evaluation of uterine and ovarian morphology.

Ultrasound evaluation is currently considered an essential tool in the diagnosis of primary and secondary infertility and ART related procedures (controlled ovarian stimulation monitoring, oocyte recovery and US-guided embryo transfer).²

Recently, the HDlive volumetric ultrasound technology software (Voluson E8, GE) has been described as an innovative tool, providing a realistic anatomical visualization of pelvic organ structures. The introduction of a movable virtual adjustable light source and software that calculates the propagation of light through structures in relation to the light direction allows illumination of the desired area of interest and the detection of anatomic structures.³ In ART clinical practice, image quality is extremely important

when describing normal structures, but also in order to delineate the origin and extension in case of pathologic findings. HDlive gives the operator the opportunity to create lighting and shadowing effects increasing depth perception, providing extraordinary image clarity, eliminating redundant structures and revealing fine details. Herein we described some potential uses of this novel technique on the field of assisted human reproduction.

HDlive in Natural Cycles and Corpus Luteum Evaluation

Timed sexual intercourse (with or without the concomitant use of ovulation induction medication) remains a valid conservative infertility treatment.⁴ Transvaginal ultrasound is often used to monitor follicular growth in order to predict ovulation and timed coitus. HDlive allows a clear visualization of the dominant follicle early in the cycle and the digital elimination of artifacts and redundant structures delimitates a better region of interest for evaluation⁵ (Figs 1 and 2). HDlive allows the combined use of many digital tools for image enhancing: digital cut, zoom and light position allows for a clear and detailed visualization of the growing follicle, therefore, even small structures such as the cumulus complex can be visualized within the growing follicle (Fig. 3) this finding is reassuring of an adequate ovarian follicular development.

Adequate ovulation is a mandatory for achieving pregnancies in spontaneous cycles. Women having regular menses (cycles of 28 ± 7 days) are basically normoovulatory. First-line studies for infertile couples includes the evaluation of a correct ovulation and luteal phase; the measurement of progesterone levels (P4) in the middle of the luteal phase is the most used test to determine ovulation,⁶ however, US scans is also a valuable tool due to its capacity is monitoring follicular development, detection of the dominant follicle and visualization of the corpus luteum after ovulation (Fig. 4). The acquisition of high quality images combined with robust digital imaging editing software, increases diagnosis confidence in complex cases [e.g. reticular corpus luteum (*see* Fig. 2)].

HDlive in IVF Stimulation Cycles

Ultrasound is an essential monitoring tool for IVF cycles.⁷ Basal transvaginal US is useful to predict the ovarian response and to tailor FSH dosage according to the ovarian

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reserve in terms of number of antral follicle count (Fig. 5). Once under FSH stimulation the ultrasonographic monitoring allows for a timely administration of medication to

prevent spontaneous LH surge and also to proceed with the final follicular maturation when at least two follicles reaches 17 mm in diameter (Fig. 6). HDlive shows realistic pictures

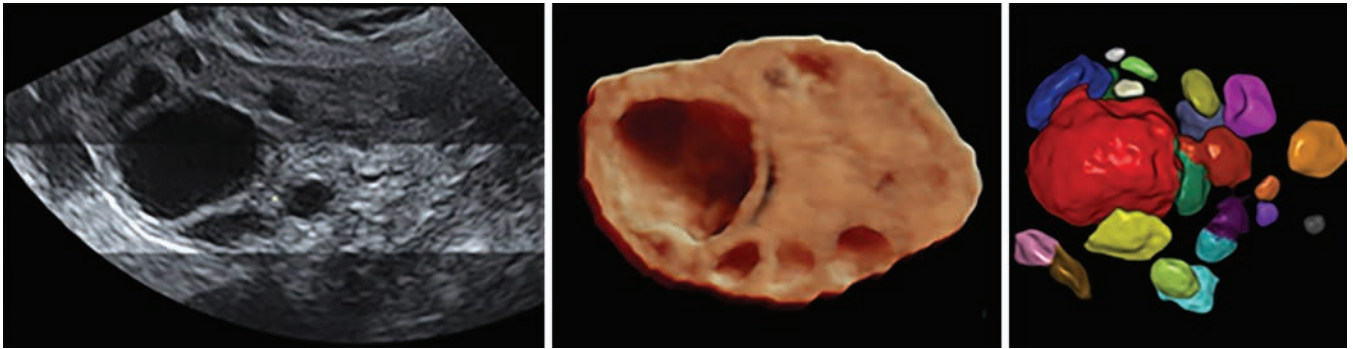


Fig. 1: Ovarian US multimodal view showing a dominant follicle in a regular menstruating 22-year-old woman (7th day of cycle). From left to right: conventional 2D ultrasound, HDlive, automatic volume calculation view. HDlive allows a clear visualization of the region of interest: dominant follicle, the antral follicles periferically and also the medullar ovarian zone, whereas surrounding redundant structures were eliminated

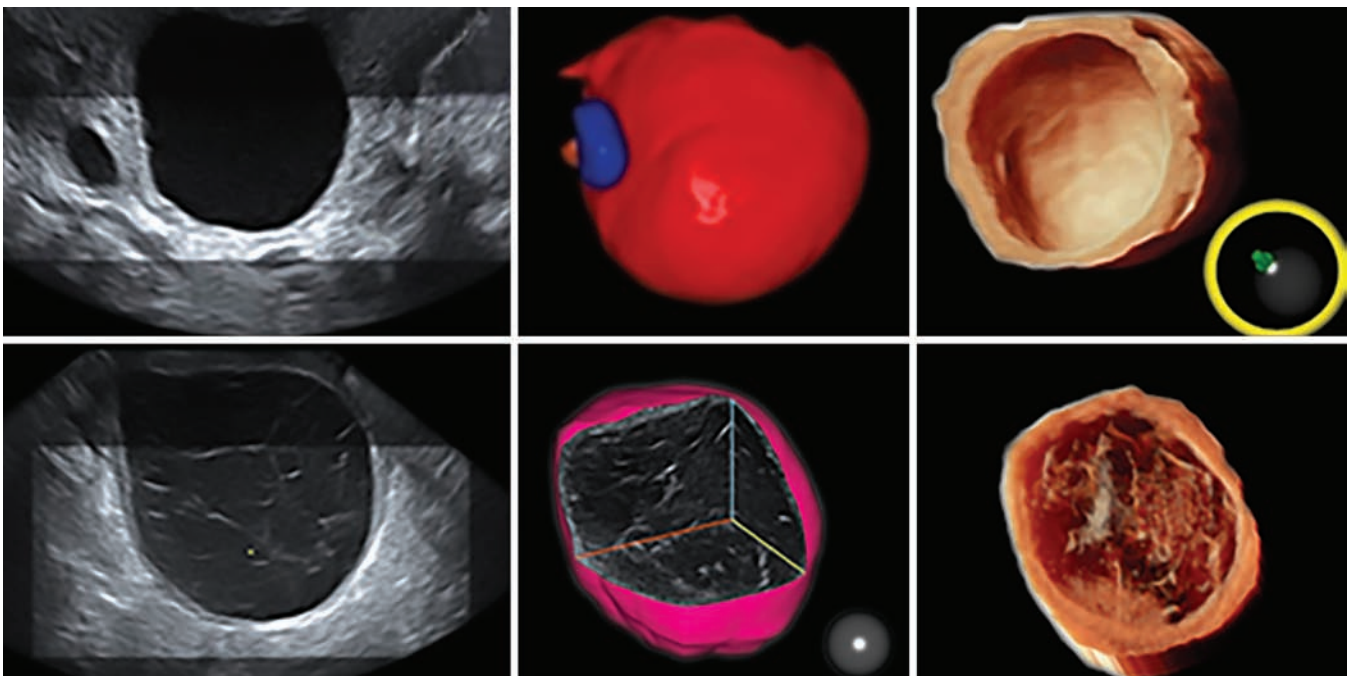


Fig. 2: Multimodal view of a dominant follicle in a 32-year-old woman in spontaneous cycle. Upper row from left to right: 2D US showing the dominant follicle and an antral follicle. Automatic volume calculation (AVC) showing the volumetry of the findings. HDlive of the dominant follicle. Bottom row from left to right: the same case under ultrasonographic view of a reticular corpus luteum on a late luteal phase confirming ovulation seen in conventional 2D US, AVC and HDlive.

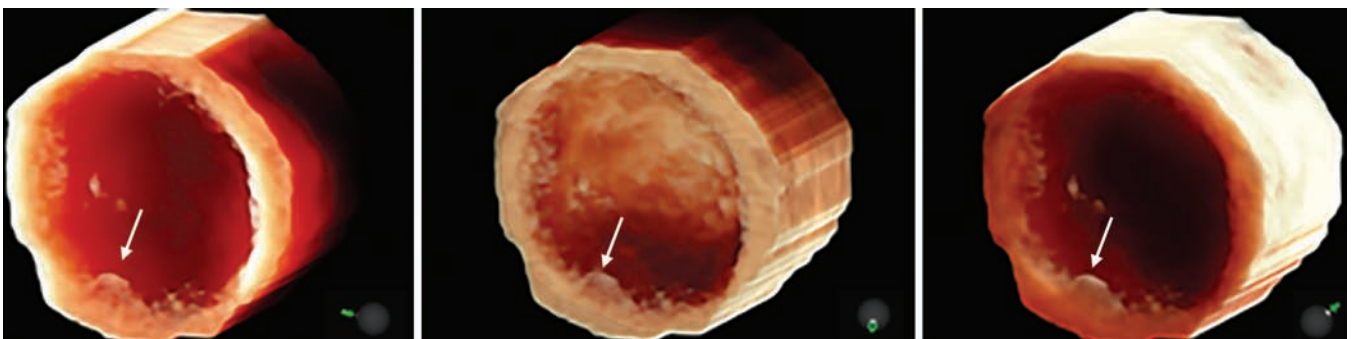


Fig. 3: HDlive imaging of the dominant follicle on the 12th day of spontaneous menstrual cycle. The magic cut software allows a detailed exploration of the region of interest, in this case, we clearly observe the growing follicle and also the cumulus complex can be seen within the follicle (yellow arrows). Notice the different HDlive virtual light positioning (green arrows)

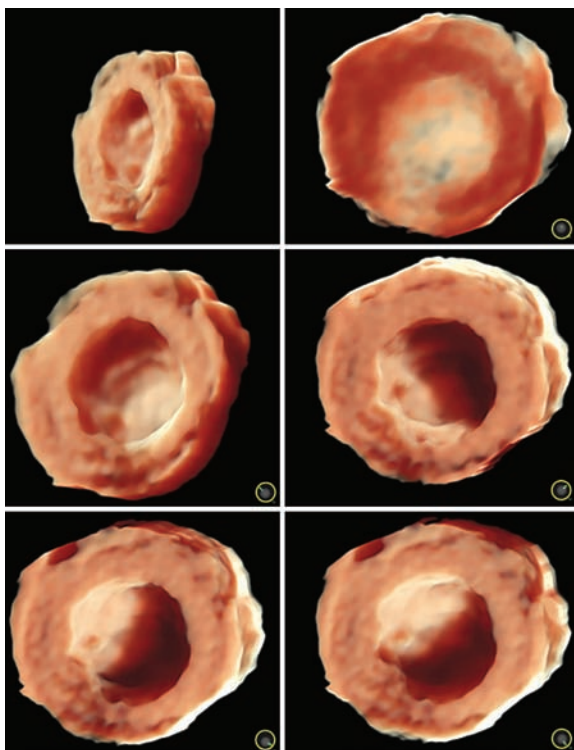


Fig. 4: HDlive view of a corpus luteum. Notice the different positions of the virtual light that gives different shadows and images. The translucency mode is showing in the upper right image

of the stimulated ovaries, the natural photo-like pictures may also serve to explain the follicular development process to patients.

HDlive Evaluation of Gynecological Pathologies Related with Infertility

Several gynecological conditions may impair fertility potential. Ultrasonography, especially transvaginal, is an essential component of the initial fertility work-up.

Polycystic ovarian syndrome is present in up to 30% of female infertility. In 2003 the Rotterdam consensus established the ultrasonographic criteria to diagnose this pathology,⁸ while 2D ultrasound is enough to make a correct diagnosis, the evaluation with HDlive allows a better image quality of this condition, enhancing diagnosis confidence (Fig. 7).

A complete evaluation of the uterine cavity will allow for a correct diagnosis of anatomical distortions of congenital pathologies (e.g. fibroids or Müllerian malformations). Müllerian malformations are present in higher prevalence in infertility patients,⁹ this congenital condition sometimes is difficult to diagnose. Figure 8 represents the case of a

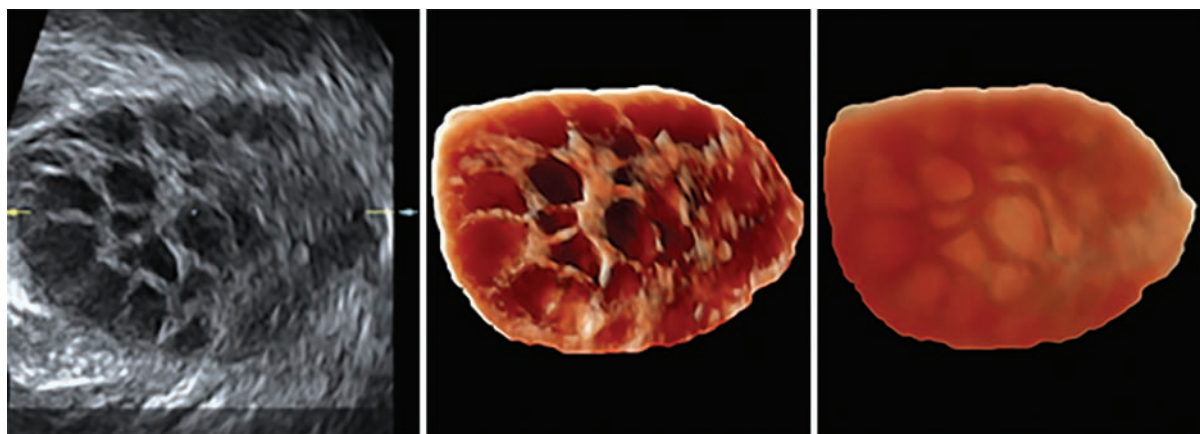


Fig. 5: Comparative ovarian view 2D vs HDlive. The figure shows a basal comparative US (day 3 of menses) of a patient with polycystic ovarian appearance. From left to right: 2D US, HDlive and HDlive in translucency view

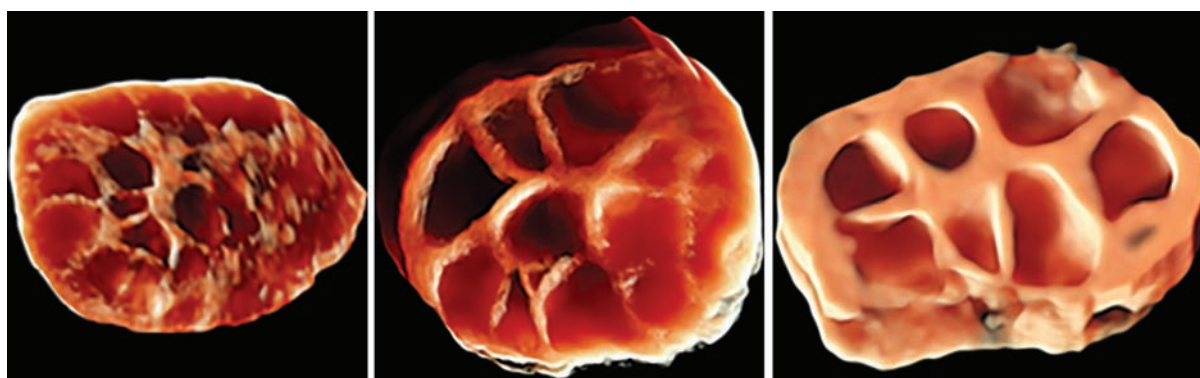


Fig. 6: HDlive in ovarian stimulation. Left: Basal US scan immediately before starting FSH for ovarian stimulation (day 2 of menstrual cycle). Center: US control 6 days after FSH estimation, notice the multifollicular development in a photo-like image. Right: HDlive view of a stimulated ovary in IVF cycle

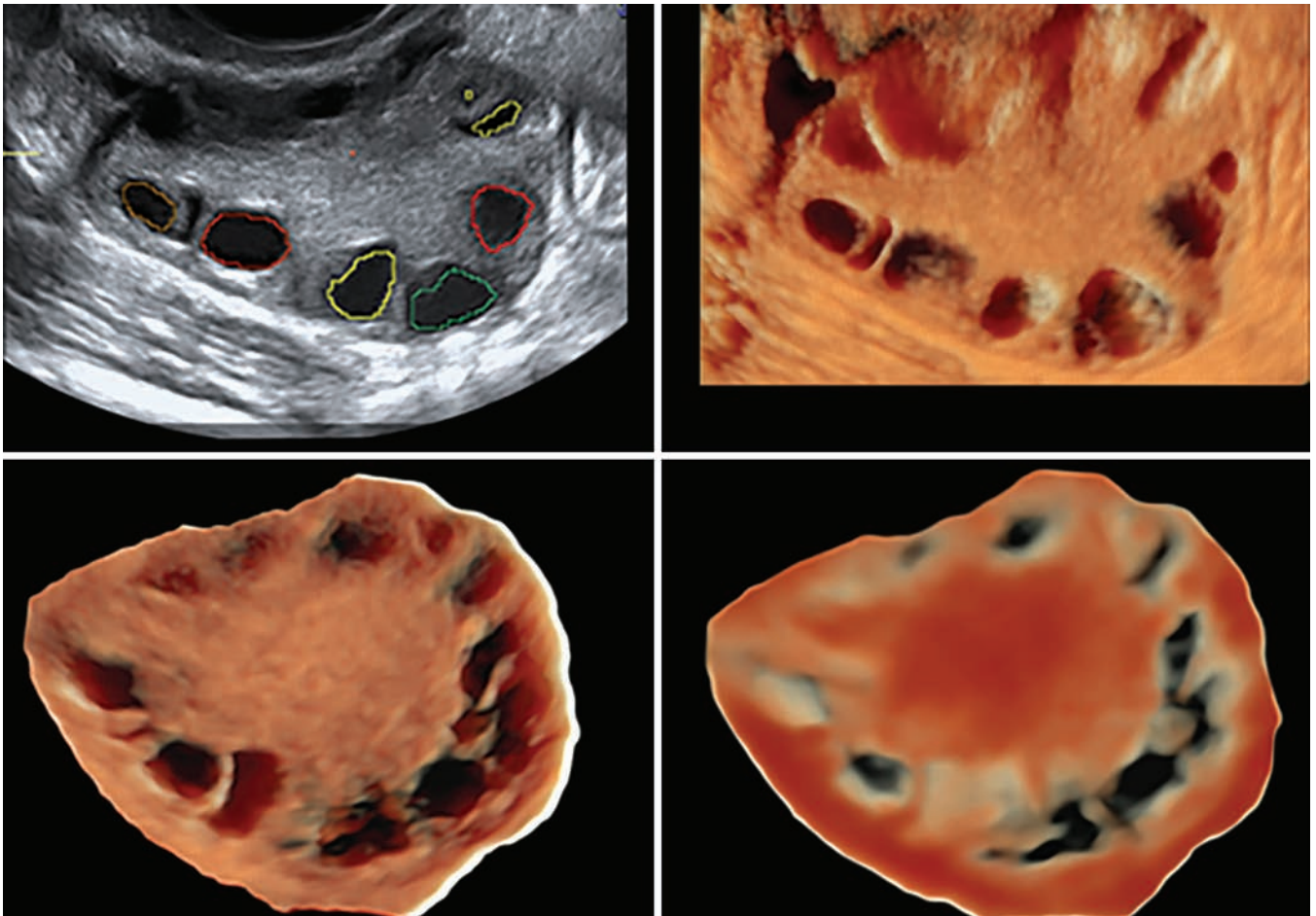


Fig. 7: Ultrasonographic evaluation of a polycystic ovary. Upper left: 2D ultrasound evaluation depicting antral follicles surrounding a hyperecogenic ovarian medullar zone. Upper right: HDlive view of the same case showing a natural-resembling ovarian appearance. Bottom row: the same ovary after the elimination of redundant structures, clearly showing the peripheral distribution of the follicles and a dense medullar zone. Bottom left: translucency view

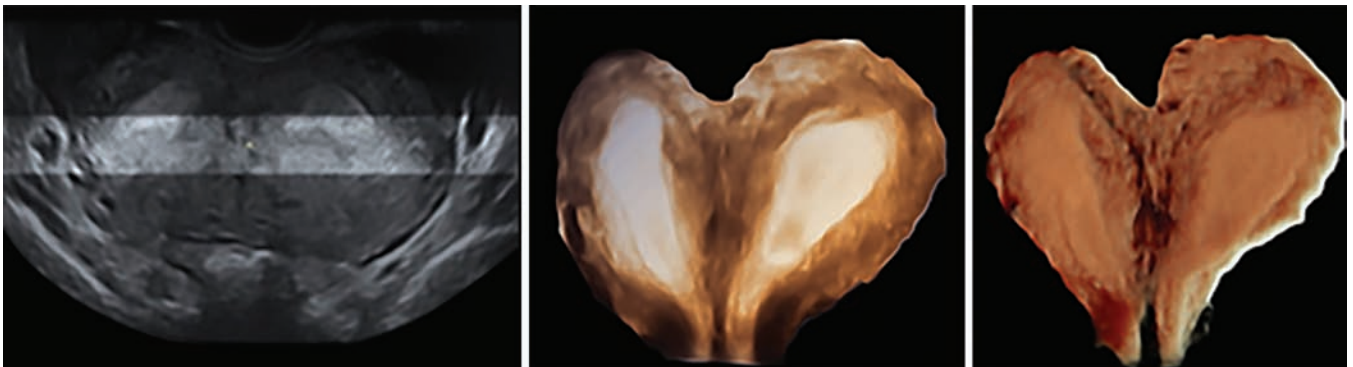


Fig. 8: Ultrasonographic evaluation in a case of Müllerian malformation. Left: 2D US showing a transversal view of the uterus. Middle: 3D US in a coronal plane clearly showing the two-hemiuterus and a complete longitudinal septum. Right: HDlive depicting the endometrial area, notice the higher surface for implantation in the right hemiuterus compared to the left side

32-year-old patient diagnosed with primary infertility and a didelphys uterus. The 3D ultrasonographic analysis, including HDlive, allows a clear diagnosis of the pathology, but also help us to decide the most suitable site for placing the embryos in the current case the right hemiuterus seems to have the endometrial surface with the best potential for implantation, after IVF one single blastocyst was transfer to the right side and the patient achieved an ongoing pregnancy.

HDlive represents an innovative improvement in three-dimensional ultrasonography evaluation of the infertile woman. HDlive rendering modes provides anatomically realistic depiction of spontaneous and stimulated ovarian cycles and normal and abnormal gynecological structures; moreover, HDlive images seem to be more readily discernible than those obtained by conventional 2D sonography. The exact role of this remarkable technology remains to be established in the clinical practice of ART.

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