New York Medical Career Training Center Title: Is Doppler Application in Obstetrics and Gynecology Very Important?

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Abstract

Doppler evaluation of ultrasonography is extremely valuable in order to assess the normal versus abnormal and also to determine the stages of function as found in the ovulatory and menstrual cycles. The amount of changes that occur during the above mentioned cycles in normal physiology and in pathology cannot be thoroughly understood unless we know the Doppler application on those organs. It needs a detailed understanding and practicing routinely in order to serve the patients with care. Most of the time due to inefficiency and lack of competency fail to detect the pathological evaluation and optimum results are not achieved. In this review article I tried to use the Doppler evaluation with explanation from my knowledge and teaching skills, I collected the information from the text books and websites as well as from my clinical experiences on obstetric and gynecology practices.

Keywords: Ovulation; Folliculogenesis; Impedance; Parity; Ectopic Pregnancy; Miscarriage; Molar Pregnancy

Introduction

Over the past years, the technology in the medical field is advancing rapidly as well the use of ultrasound. As one day a famous obstetrician was asked to name the three advantages in modern medicine. His answer was simply as “ultrasound, ultrasound and ultrasound”. We can understand the use of color flow in ultrasound by applying Doppler is a great use to evaluate the female pelvis with pregnancy and without pregnancy. We will learn the impact details of Doppler application in gynecology and obstetrics. Sonographically we will learn how to locate basic pelvic vasculature, assess a structure for low and high-impedance blood flow, indicate methodology for locating a potential ectopic pregnancy, evaluate ovarian folliculogenesis, evaluate pelvic pathology and pregnancy follow up when we use of Doppler color image to assist a physician in fetal evaluation.

Discussion

Discussion on GYN Doppler evaluation

Evaluation of female reproductive organs with Doppler application has enormous role in clinical practice. Vascularity check of the internal Iliacs, ovarian arteries, external iliac arteries, uterine arteries can only be done with maximum accuracy in transvaginal ultrasound. External iliac artery is one of the vessels that have an early reversal diastolic flow. On the other hand, internal iliac artery has continuous forward diastolic flow. The vein has Continuous flow and may have respiration variation (phasic flow). Ovarian artery has high impedance (resistant) flow and low impedance flow in luteal phase around the periphery of luteal cyst [1]. During function of corpus luteum and during first trimester no diastolic flow around immature follicle. Uterine artery in on either side of uterus and in region of cervix, main uterine arteries will be seen as they cross the floor of pelvis and approach the cervix. Arcuate branches may be seen spreading toward endometrium (high impedance flow) [2]. Diagnostic potential in endovaginal color doppler imaging increases the image quality. There is a Physi-
ological variation in pregnancy, menstrual cycle and ovarian cycle [3]. The followings are pathologies that can be diagnosed with Doppler. Ovarian tumors mostly are found post-menopausal women, the flow will be luteal (less resistance) types and too much flow indicating a tumor. Hemorrhage in the ovary, ovulation induction and Presence of a mass are causes of ovarian torsion [2]. The Doppler finding in ovarian torsion is no flow in diastole and if there is some flow the ovary may be savable [2]. Teratoma is a metabolically active benign tumor may mimic malignant masses. Pelvic congestion syndrome is markedly dilated periuterine or ovarian veins with incompetent valves. It is Commonly seen in multiparous women or women with retroflexed uterus [4]. Patient would complain of Pain on prolonged standing or post coital. Fibroids have some vascular flow which in Doppler helps distinguishing from retained product in endometrium vs. fibroid in myometrium. Active retained products have more vascularity. For ovarian carcinoma there is no significant diagnostic advances have been made in 70 years [5]. Serum tumor markers (CA 125) if elevated the person is at risk of ovarian cancer. Ultrasound examination evaluates shape and size in every six month interval if there is abnormal mass that has decreased impedance and no corpus luteum [3]. Moreover pelvic Doppler also has a great use in infertility and ovarian torsion evaluation. Vascular markings serve as a landmarks to locate the pelvic organs like ovaries which are anterior to internal iliac artery. In ectopic pregnancy whether ruptured or not a ring of fire is seen most of the time. Hypervascularity indicates inflammation and malignancy. A careful use and understanding the hemodynamics of pelvic vessels can open the doors in clinical practices.

Figure 1: Uterine artery crossing over the pelvic floor to reach the cervical region [6].

Figure 2: Uterine Artery Doppler showing low resistance flow with increase end diastolic velocity [6].
Figure 3: Ovarian artery Doppler [7].

Figure 4: Hemorrhagic ovarian cyst showing internal echoes. It is not uncommon [8].

Figure 5: Corpus luteum Doppler showing hypervascularity [9].
Figure 6: Normal ovarian Doppler [10].

Figure 7: Ovarian torsion, showing no intraovarian blood flow.

Figure 8: Ovarian torsion Doppler showing no blood flow [11].

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Figure 9: Fibroma in ovary Doppler showing low impedance flow [12].

Figure 10: Fibroids bottom image with color Doppler [13].

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Figure 11: Submucosal polyp [13].

Figure 12: Endometrial Polyp with a pedicle showing flow.

Figure 13: Ovarian Tumors with Doppler. varieties of ovarian tumors are seen clinically, some of them are cystic too.
Figure 14: Ovarian Neoplasm with varieties. Both benign and malignant types have cystic and solid types.

Figure 15: Dysgerminoma ovary grey scale. It is a counterpart of testicular seminoma.
**Figure 16:** Ovarian Dysgerminoma. It is a counterpart of seminoma of testis. It is a malignant tumor with high vascularity.

**Figure 17:** Endometrial carcinoma Doppler Increase flow, decrease impedance. It could be confused with endometrial hyperplasia and polyp. Saline sonohysterogram and diagnostic D and C can be done to R/O endometrial cancer.
**Figure 18:** Endometrial Carcinoma in grayscale, looks like multiple polyps. Color Doppler is indicated to see if there is pedicle with vascularity present in each one.

**Figure 19:** Greyscale Hydrosalpinx It looks like an anechoic tube. Needs color Doppler.

**Figure 20:** Color Doppler Hydrosalpinx. No color is seen in the tube, it is not a blood vessel.
Advantages of endovaginal examination with Doppler has extreme value over transabdominal pelvic ultrasonography in order to confirm ectopic pregnancy [14].

**Ectopic pregnancy/ectopic placentation:**

- Transabdominal ultrasound Increases diagnosis by 20%
- Endovaginal ultrasound Increases diagnosis by 95%
- Signal from choriodecidua can be seen by color doppler
- BhCG must be evaluated but is not doubling every other day.

**Discussion on Obstetric Doppler application**

Obstetrical Doppler is used to image signals from fetal heart, aorta, carotids, placenta, umbilical vessels, uteroplacental circulation from uterine vessels and arcuate arteries and so more. Blood flow in feto-placental circulation can be seen in Doppler. There are changes

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seen in different stages of pregnancy. In the first Trimester, Corpus luteum has a low impedance signal in ovary and absence of luteal flow inconsistent with viable 1st trimester pregnancy [15]. In the uterus, during the weeks of 14 - 18 are dramatic changes. For example, high impedance waveforms changed into low impedance with destruction of elastic lamina of maternal spiral arteries (invasion of Trophoblast) [16]. Uteroplacental circulation has low impedance because it has to receive blood from high impedance circuit. In the uterus, the early stage of placentation has Low impedance around implantation site (first seen at 36 - 38 days after missed period) and gradual increase to maximum velocity by 50 days [17]. There is also High impedance surrounding uterine vasculature. Doppler Color Imaging allows detection of placenta vascularity with minimized exposure time. Doppler Color imaging also can be used for first trimester complications. Retained product of conception is as an abnormal concentrated area of flow within endometrium [5]. Pseudo sac evaluation demonstrate no flow whereas a true IUP with double decidual ring should have increase flow. Molar pregnancy has increased velocity and decreased impedance [17]. It also can evaluate invasion into myometrium. In the second and third trimester, Doppler is used to assess flow in umbilical and uterine arteries (fetal aorta and carotid arteries secondary) [18,19]. It can also be used for changes in fetal and uteroplacental circulation in IUGR, maternal hypertension, fetal anemia and congenital anomalies. Also, selection of optimal sampling sites in fetus as Umbilical artery has multiple sampling sites along its course. Multiple sampling along the course of umbilical cord and finding cord loops are very important clinically to evaluate IUGR too. In congenital anomalies, renal agenesis is assessed through renal artery evaluation. Umbilical cord anomalies like single vascular cord, cord tumors and nuchal cord - associated with fetal brain asphyxia and cord loops can be evaluated through Doppler [20]. Fetal Echocardiography can detect septal defects, mitral valve and tricuspid atresia, hypoplastic left heart, endocardial fibroelastosis, pulmonic and tricuspid regurgitation. All these above anomalies can be differentiated by Doppler. Doppler can be used to detect vasa previa (cord precedes fetal head) - cord near or over internal cervical os as well as Placenta previa, Placental percreta, increta and accrete [1,21].

There is a recommendation of not to use color Doppler on the embryo during the first trimester because of increase chance of bioeffects due to SPTA intensity. SPTA intensity can go very high during Doppler [22]. Care should be taken from the beginning by strictly following the guidelines given by AIUM. Exposure time should be minimum and optimum and power should be as low as possible.
**Figure 24:** Gestational Sac Doppler. Yolk sac is seen [6].

**Figure 25:** True IUP with sub chronic Doppler [11]. Subchorionic hemorrhage with life embryo [23].

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**Figure 26:** Ectopic Pregnancy in ovary Doppler [23]. Uterus is seen on left empty.

**Figure 27:** Ectopic pregnancy in Adnexa [23]. Ring of fire is noted.
**Figure 28:** GTD (molar pregnancy) w/o doppler. Typical honeycomb appearance is seen [24].

**Figure 29:** GTD with Doppler. Higher vascularity is noticed with no fetus [24].

**Figure 30:** Retained Product of conception [24] with H/O incomplete abortion.

Figure 31: Missed abortion Doppler [11]. No cardiac activity is noted in Doppler.

Figure 32: Missed abortion pulsed wave [11]. No cardiac activity is observed.

Figure 33: Umbilical cord insertion with placenta in Doppler.
Figure 34: Velamentous cord insertion Doppler.

Figure 35: Succenturiate Lobe in Doppler [11].

Figure 36: Succenturiate Placenta.

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**Figure 37:** Placenta Vascularity in Doppler. Low impedance flow [25].

**Figure 38:** Vasa Previa in Doppler. Vessel seen over the internal os [6].

**Figure 39:** Vasa Previa in Doppler. Vessel is over the internal os [23].

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**Figure 41:** Chorioangioma in Doppler. Tumor is placenta [23].

**Figure 42:** Chorioangioma in grey scale [23].

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Figure 43: Chorioangioma in grey scale [23].

Figure 44: Twin to twin Transfusion Doppler [25].
**Figure 45**: Conjoined twins Doppler.

**Figure 46**: Umbilical Cord Evaluation Doppler Typical of saw teeth with low resistance flow [6].

**Figure 47**: Retroplacental Hemorrhage in grey scale [6].

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Figure 48: Sagittal View of Nuchal cord Doppler Umbilical cord around the neck [6].

Figure 49: Transverse view of Nuchal Cord Doppler [6].

Figure 50: Pseudo umbilical cord knot Doppler. Multiple vessels in umbilical cord seen [6].

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Conclusion

As of now, the demand of ultrasound with Doppler application is increasing for the following reasons: It is Inexpensive, quick, available, noninvasive, portable, repeatable and more over non-radiation. Ultrasound in obstetrics can be used multiple times carefully to evaluate pregnancy and the well-being of the fetus. Furthermore, we hope ultrasound in the future can be the only modality to evaluate all the diseases. Again as of now there is no reportable case found all over the world about the bioeffects caused by ultrasound within the guidelines of AIUM. We must follow the rule of ALARA, as low as reasonable and achievable, that means the exposure time and power of the beam must be optimum so that no bioeffect can arise [26-28].

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28. Should I Be Worried That I Was Diagnosed with Subchorionic Hemorrhage?” BabyQ.

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