Three-Dimensional Power Doppler in obstetrics and gynecology

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Abstract
The paper briefly describes the use of three-dimensional Power Doppler technique (3D PD), both in obstetrics and gynecology. The Power Doppler in 3D presentation seems to be a valuable non-invasive method of estimation of blood flow perfusion through the fetal organs and placenta. In gynecology 3D PD might be helpful in extension of knowledge of tumor biology, and also in the therapy monitoring with neoangiogenesis inhibitors.

Key words: power doppler, three-dimensional ultrasound, fetus, gynecology

The use of Doppler technique in medicine began on the turn of the 1950s and 1960s. The following years until the present times have been faced with a constant development and improvement of not only the Doppler tools but also imaging techniques. At present, in Doppler procedure are used devices that work in the system of: continuous wave (Continuous Wave Doppler) 1960s [1], pulsed wave (Pulsed wave Doppler) year 1970 [3], Colour Doppler (Color Doppler Velocity) year 1985 [4, 5], Power Doppler (Power Doppler, Color Doppler Energy), year 1992 [6, 7] as well as three-dimensional Power Doppler, (3DPower Angio Doppler, 3D Color Doppler Energy), year 1998 [8, 9].

The three-dimensional Power Doppler is based on three-dimensional reconstruction of vessels image, received from Power Doppler system. The intensity of three-dimensional Angiography Doppler signal is directly dependent from blood flow velocity [8]. It enables the quantitative evaluation of vessels in the area of studied clot due to the use of angiohistogram function in which the three-dimensional vascularization and blood flow indices are counted automatically:
– Vascular Index, VI, that characterizes vessels’ density;
– Flow Index, FI, that characterizes blood flow intensity;
– Vascular Flow Index VFI, that evaluate simultaneously the vessels and perfusion.

The vascular index VI reflects the number of vessels in the studied clot. Measurement of VI has its value in recognizing the areas of intensive and weak vascularization. The flow index FI characterizes the high velocity of flow typically seen in vascular anomalies such as: artery – arterial fistula. The vascular flow index VFI index is a connection of both indices mentioned above and allows the identification of weak vascularization areas, small blood flow velocities as well as intensive vascularization areas and high blood flow velocities in different area [10].

The technique of conventional Color Doppler or two-dimensional Power Doppler are used as qualitative evaluation of blood flow, however they do not let for the evaluation of vessels architecture in studied area. The high sensitivity and the independence from the insonance angle caused, that 3D Power Angio Doppler technique became useful for reconstructing and imaging the vessels [11].

The three-dimensional Color Doppler Energy, despite that the youngest, constantly tries to prove its usefulness in obstetrics and gynecology. Therefore, from the time of its introduction until today it is applied in the fetal defects diagnostics as well as in gynecological illnesses [12-15].

It the placental vascularization studies with use of three-dimensional Power Doppler the lack of relation between value parameters FI, VI, VFI and gestational age was observed as well as rapid decrease of placental perfusion after 38 weeks in normal pregnancy [16, 17]. In pathological pregnancy the flow through placenta was considerably lower [16]. Taking into account the tissue ultrasound absorption which depends on patient’s abdominal coats thickness as well as the placental position, there are significant problems with parameters standardization of 3D Power Angio Doppler [18, 19] (Fig. 1 and 2).
In fetal cerebral circulation 3D Power Doppler presented perfusion increase proportional to gestational age in normal pregnancies [16, 20, 21]. In pathological pregnancies with the intrauterine growth restriction the significant growth of 3D Angio Doppler perfusion indices was observed which can be the proof of fetal circu-lar redistribution in case of anoxaemia [16, 21] (Fig. 3).

The 3D Power Doppler perfusion indices of fetal lungs increase rapidly after 33 week of pregnancy, which is related to their maturation. In pregnancies with dys-functions the fetal lungs indices were considerably lower, than in normal pregnancies [16, 22].

As in the case of cerebral circulation the 3D Color Doppler Energy studies of renal vessels presented perfusion increase proportional to gestational age [23]. The use of the three-dimensional Power Doppler studies in obstetrics evokes some controversy as far as the pathological and clinical interpretation of measured values and indices is concerned [24-27]. The improvement of this method is undoubtedly one of the biggest challenges that face prenatal medicine explorers.

Power Doppler in 3D presentation is more and more often used in gynecology with the aim of differentiating tumour changes.

The studies of vascular flow indices in 3D Power Doppler and the Doppler sonoangiography enlarges the exactitude of ultrasonography applied in the endometrial polyps' diagnostics and membrane hyperplasia of uterine cavity. A considerable increase of 3D Angio Doppler indices was observed in case of endometrium cancer as compared with gentle hyperplasia. The value of indices grew directly in proportion to the degree of advance process. The result of the study suggesting low risk of cancer can allow the renouncement from unnecessary scooping out in the patients with bleeding from uterus [32-35].

The 3D Power Doppler studies let for the precise demonstrating of the range of egg sac tumor morphological features. The results suggest, that the use of three-di-mensional ultrasonography in chosen cases can allow for the exact evaluation of the peccant tumor existence risk as well as the verification of possible operation indi-
cations [29, 30] (Fig. 4). The sensibility of 3D Color Doppler Energy to prognose the occurrence of egg sac tumors was 75%, adding 3D Power Doppler to RMI (Risk of Malignancy Index) it enlarged sensibility to 99% [28, 31].

The Power Doppler in 3D presentation is a valuable non-invasive method of blood flow evaluation in many tumours, which can lead to early tumours detection or recognition in the future, to extensive knowledge of tumor biology, and also to the therapy monitoring with neoangiogenesis inhibitors.

References


