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Editorial

Three – Dimensional Power Doppler in Gynaecology

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Introduction

In recent years, two significant developments have taken place in diagnostic ultrasound techniques. The first of these is power Doppler imaging and the other is multiplanar imaging with three-dimensional (3D) reconstruction.

Initially, 3D reconstruction was applied to surface rendering of anatomical features. Technological progress has lead to almost photographic quality of images including detailed multiplanar illustration of blood vessels in 3D.

Color Doppler Imaging

In Color Doppler principle is applied to enable vascular flow to be identified in a color-coded display which indicates the direction of flow. In simple terms, blood flowing towards the ultrasound transducer is conventionally depicted in a band of colors ranging from deep red (low velocity) to bright yellow (high velocity). Similarly, flow in a direction away from the transducer is indicated by a band of colors ranging progressively from deep blue (low velocity) to cyan (high velocity).

Thus Color Doppler imaging illustrates only the direction of flow, color-coded mean velocities and the range of the mean velocities.

Power Doppler Imaging

Power Doppler adds a 4th parameter - amplitude or energy. In this case, the amplitudes of reflected signals from each "clump" of red blood cells within the vessels are recorded and displayed in a different color scale. The higher the clump density, the higher the signal amplitude and the brighter the displayed color.

Thus power doppler imaging detects amplitude which is related to density.

Power Doppler Imaging therefore gives high detectability of low velocity-flow and therefore gives better representation of vascularity in any defined region of the scanned area.

Three Dimensional Imaging

The development of 3D scanning aparatus has introduced the possibility of visualizing vascularity in three dimension. Whether an abdominal or an intracavity ultrasonic transducer assembly is used, it is now possible to generate within a few seconds, a complete 3D volume data set composed of soft tissues and blood vessels which can be displayed simultaneously in 3 orthogonal planes.

The vessels are clearly defined in color against a background of a soft tissue gray-scale echoes and this can be manually rotated to reveal the total vascular network.

Application in Gynaecology
Assessment of ovarian Tumor Angiogenesis

Physiological angiogenesis is seen in folliculogenesis, embryogenesis and implantation, chronic inflammation and benign-neoplasms. Luteal cysts usually exhibit straight regular branching vessels. In case of malignant neoplasms, neovascularisation is seen in the form of several tangles or coils with more complicated branching. The resolution of current power doppler is sufficient to detect the vessels of around 1 mm in diameter. Hence, 3D power doppler is a promising tool in the evaluation of angiogenesis of pelvic tumors, especially when a malignant neoplasm is suspected.

Assessment of Uterine Neoplasm
Benign Uterine Neoplasms

The unique 3D vascular pattern of the uterine leiomyoma has the following characteristics:

1) A typical "Vascular Ring" is always visualized at the periphery of the uterine leiomyoma.
2) One or more tortuous and dilated hilar vessels are seen to supply the mass.
3) The blood vessels within the mass connect to the peripheral vascular ring in perpendicular rather than a concentric fashion or pattern.

The vascular pattern of adenomyosis can be recognised by:

1) Randomly scattered vessels with distorted or even absent uterine vascular configuration.
2) In the focal type of adenomyosis, there is no peripheral vascular ring. Instead a hilar blood vessel with regular branching is seen mimicking a "tree" pattern.

Malignant Uterine Neoplasms

Detoured vessels with uneven diameters that run along the surface and between the lobulations of the masses are generally observed. The angioarchitecture is chaotic.

Application in Assisted Reproduction

With the advent of 3D Power Doppler Sonography, 3d imaging of relevent vessel and quantitative assessment of vessel density and difussion within a specified area have become possible.

This may share more light on the fact that implantation rates in IVF-ET have not risen beyond 10-15% despite recent advances.

Among the potential factors determining IVF success, embryo quality and uterine receptivity are considered to be the most important. The favourable endometrial milieu is thought to be necessary for successful implantation.

Among the potential uterine predictors of implantation measurable by ultrasonography are endometrial thickness and volume, endometrial pattern as well as blood flow in the uterine and sub-endometrial arteries.

Three Dimensional Power Doppler examination of the sub-endometrial areas may reflect the possible interaction between the overall blood supply in the sub-endometrial arteries and the subsequent pregnancy rates. The vascularization index (VI) reflects the vessel density, the flow index (FI) reflects the intensity of blood flow and the vascularization flow index (VFI) specifies both vascularization and perfusion.

Assessment of the prognostic value of sub-endometrial blood flow on the day of ovum pickup in prospective IVF studies have shown no significant difference between the pregnant and the non-pregnant group with regard to sub-endometrial PSV, VI, VFI. However, significantly higher FI Values were observed in conception cycles compared to non-conception cycles ($P<0.05$), suggesting that a better degree of intrauterine perfusion at the time oocyte retrieval indicated a more favourable endometrial milieu.

Analysis of sub-endometrial blood flow may prove to be a valuable diagnostic tool in predicting the outcome of assisted reproduction therapy. Further studies are needed to evaluate whether the management on the basis of these results may lead to higher implantation rate.

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