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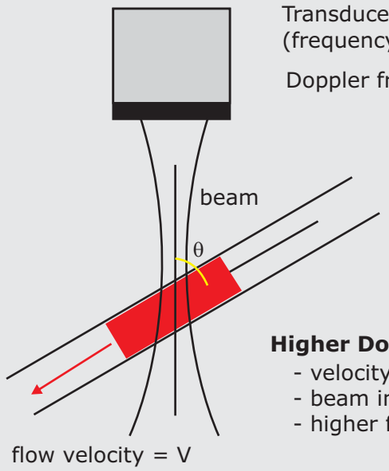
# Basics of Color Doppler Ultrasound and Applications

## Introduction

Color Doppler is the most demanding diagnostic technology for doctors in the current scenario. It gives the information of flowing blood in terms of its Velocity, Direction, Acceleration Time duration etc. Generally it indicates the blood flow direction with Red color if the blood is flowing towards the transducer, and with Blue color when the blood is moving away from the transducer. Doctors are able to diagnose many diseases with the help of Color Doppler technology.

## Basic Principle

Doppler ultrasound measures the movement of the scatterers through the beam as phase change in the received signal. The resulting Doppler frequency can be used to measure velocity if the beam/flow angle is known.




$$\text{Doppler frequency (f d)} = \frac{2, \text{ft. V. cos } \theta}{c}$$

fd - doppler shift
c - is speed of sound in tissue
ft - transmited beam
V - Velocity of the blood
θ - angle of incidence between the ultrasound beam and the direction of the flow

**Higher Doppler frequency is obtained if:**
- velocity is increased
- beam in more aligned to flow direction
- higher frequency is used

**The size of the Doppler signal is dependent on:**

1. Blood velocity
2. Ultrasound frequency
3. Angle of incidence

**TEE (Trans Esophagus Echocariography) probe**

**Applications:** cardiac

**Liner probe**



**Applications:** Breast, small parts, nerve, vascular, venous access, musculoskeletal, biopsy guidance.

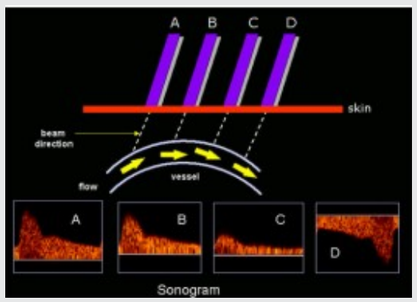



Figure: Effect of the Doppler angle in the sonogram

(A) Higher-frequency Doppler signal is obtained if the beam is aligned more to the direction of flow. In the diagram, beam (A) is more aligned than (B) and produces higher-frequency Doppler signals. The beam/flow angle at (C) is almost 90° and there is a very poor Doppler signal. The flow at (D) is away from the beam and there is a negative signal.

## Types of Transducers

**Convex probe**

**Applications:** Abdominal, Obstetrics, Gynecology, Regional nerve block, Procedure and Biopsy guidance

**Micro-convex probe**

**Applications:** Abdominal, Urology, vascular, Pediatric cardiology, pediatric abdominal, neonatal heads

**Transvaginal probe**

**Applications:** Obstetrics, gynecology

**Endorectal probe**

**Applications:** Obstetrics, gynecology

## Types of Doppler

**Color Doppler (CD)**
Color Doppler is an ultrasound imaging mode, which visualizes the presence, direction and velocity of flowing blood in a wide range of flow conditions.

**Color Power Doppler (CPD)**
CPD is a type of Color Doppler to visualize the presence of detectable blood flow. The flow information is based on the amplitude or strength of echoes received from moving cells and not frequency shifts.

**Directional Color Power Doppler (DCPD)**
Directional Color Power Doppler combines power (amplitude) of Doppler signal with directional (phase) information to encode direction and variations in blood flow.

**Spectral Doppler :**
Spectral Doppler refers to the combination of either continuous wave Doppler or pulsed Doppler with a spectral display. Spectral Doppler provides a quantitative analysis of the velocity and direction of blood flow.

**Continuous Wave Doppler**
Continuous Wave (CW) Doppler is an ultrasound imaging mode, which records blood flow velocities along the length of the beam. Continuous wave Doppler uses different crystals to send and receive the signal.

**Pulse Wave Doppler (PWD):**
Evaluates blood flow velocities in a range specific area along the length of the sound beam.

**Transcranial Doppler (TCD):**
Transcranial Color Doppler sonography allows evaluating the presence and flow direction of vessels as well as their relationships to surrounding structures.

**Imaging Modes:**

| | |
|---|---|
| A (Amplitude) Mode | For Eyes |
| B/BB (Bright /Double Bright) Mode | For Abdominal & Pelvic organs |
| BC (Compound Bright) Mode | For Abdominal & Pelvic organs |
| M (Motion) Mode | For Cardiac Analysis |

**Advance Imaging Processing Technology:**

| | |
|---|---|
| DPDBF | (Double Phase Digital Beam Forming) |
| THI | (Tissue Harmonics Imaging) |
| TDI | (Tissue Doppler Imaging) |
| TSS | (Tissue Speed of Sound) |
| SRA | (Speckle Reduction Algorithm) |

## Different Medical Applications

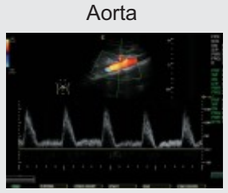
Ultrasound can be applicable for different medical analysis like, Abdominal, Obstetrics, Gynecology, Urology, Cardiology, Vascular, Musculoskeletal and Small body parts

Liver

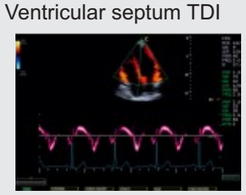
Pancreas

Kidney

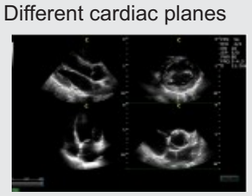
Aorta



Ventricular septum TDI



Different cardiac planes



LV short axis

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