Doppler in Endoscopic Ultrasound (EUS)

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Olympus Corporation of the Americas

When Australian physicist, Christian Doppler, developed the theory of Doppler to explain the colors of stars in 1842, he could hardly have known how far this technology would go. Doppler noted that an observed frequency of an electromagnetic wave depends on the relative speed of the source and the observer.

Think of this in terms of standing still and a siren coming towards you, and then passing you. As it is approaching you, the sound will appear higher, and after it passes, it will sound lower. This is known as the Doppler Effect or the Doppler shift.[1]

The most well-known application of Doppler is Doppler radar in weather reports. Police also use portable Doppler radar guns to measure the speed of drivers.

In medical ultrasound, Doppler is used to determine blood flow, velocity, and direction of flow in vessels. This can be very useful in determining the best path for biopsies.

In endoscopic ultrasound (EUS), Doppler is the most common function used to determine blood flow. On most ultrasound processors there are four variations of Doppler. This paper will discuss the uses and differences of each and their application.

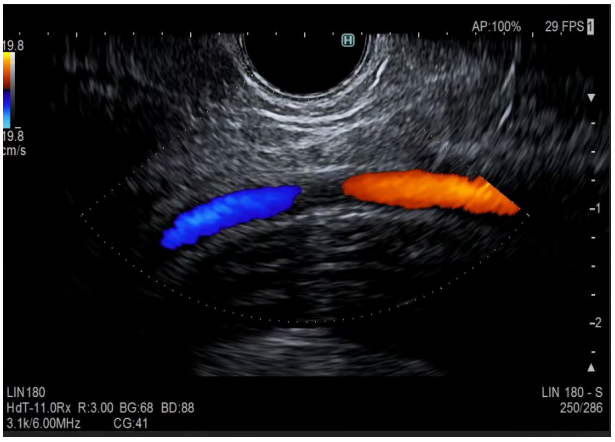
Color Flow

This Doppler modality is arguably the most recognized in the ultrasound world. When using color flow, a color map is assigned to blood flow coming towards the transducer (red) and blood flow going away from the transducer (blue).

When performing extracorporeal abdominal scanning, with the ultrasound probe oriented with the flow of the aorta coming towards the transducer and the IVC going away, red represents arterial flow and blue represents venous flow.

When using this modality in EUS, the orientation of the vessels is rarely consistent in the up and down position. Due to the orientation of the vessels to the transducer, many vessels will give an incorrect arterial and venous signal and therefore, the color map could be reversed.

While this mode can still be used to identify blood flow, it is not the most accurate for arterial and/or venous flow identification.



Color Doppler example showing blood flow coming towards the transducer (red) and then going away (blue).

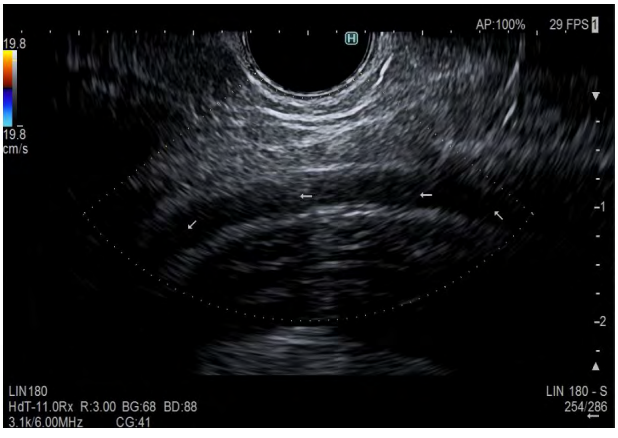


Image showing the direction of flow in relation to the previous image

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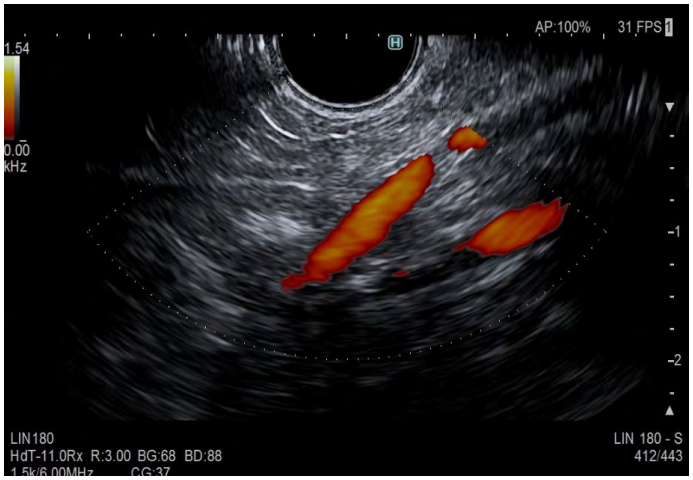
Doppler in Endoscopic Ultrasound (EUS) **(Continued)**

Power Flow

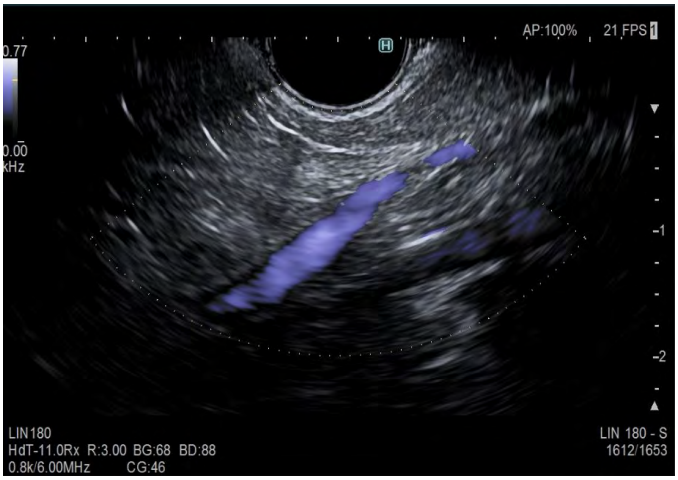
Power Flow simplifies vessel identification by representing flow with only one color: orange. However, this modality can "bleed" out of the vessel walls which can interfere with the detail of closely surrounding structures.

eFlow

eFlow is the most sensitive of the color Dopplers. It does not "bleed" like Power Flow; but rather stays within the vessel walls. eFlow also has the capability for directional flow which provides the red and blue color mapping for arterial and venous flow. This Doppler is much more sensitive and can pick up smaller, low-flow vessels that can be inherent in tumors.



Power Doppler example

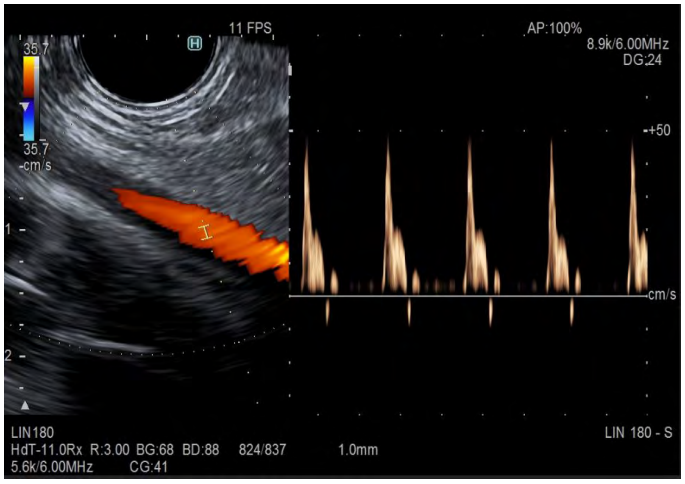


eFlow Doppler example

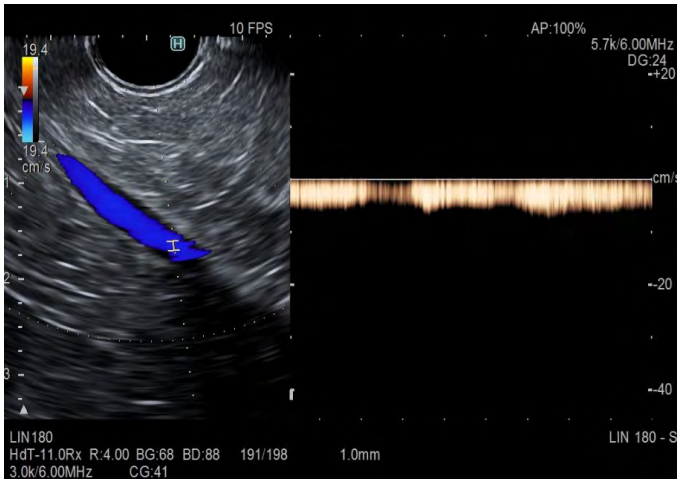
Spectral or Pulsed Wave Doppler

Spectral Doppler is the most accurate in identifying the type of blood flow in vessels, arterial or venous. It converts sound waves into wave forms, which make identification of arterial vs venous flow easy, due to each having distinct wave forms.

Using this modality, velocity of the blood flow can be measured, which can be useful in diagnosing vascular diseases such as stenosis, blockages etc.



Spectral Doppler image showing arterial flow along with Power Doppler



Spectral Doppler image showing arterial flow along with Power Doppler

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Conclusion

In summary, there are four major types of Doppler used in endoscopic ultrasound procedures: Color Flow, Power Flow, eFlow and Spectral, or Pulsed Wave, Doppler. Depending on the need, Doppler can enhance every ultrasound procedure. It can be as simple as identifying and avoiding vessels for a biopsy, in which color, power or eFlow are commonly used. eFlow will give the user less “flash” and will stay in vessel walls better. When it comes to venous or arterial landmarks for anatomy, Spectral Doppler is the most accurate. Understanding the strengths and drawbacks of each Doppler modality provides an advantage to the user for accurate disease diagnosis.

References

1. https://economictimes.indiatimes.com/definition/doppler-effect

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With over 30 years of medical imaging experience, Ron is Board Certified in both Radiology and Ultrasound.

He earned his RDMS (Registered Diagnostic Medical Sonographer) in 1998 which lead to working in diagnostic ultrasound. Ron worked at the Barnes Washington University where he was introduced to Endoscopic Ultrasound (EUS) as they implemented a new EUS service line.

For the past 20 years, Ron has been working at Olympus Corporation of the Americas, starting as a Clinical Applications Specialist (CAS) in 2001. In this role he focused on EUS/EBUS product education and support. Ron currently holds a leadership position as Senior Clinical Applications Specialist Manager for the Western U.S., managing a team of eight CAS.

Ron’s passion for Ultrasound is driven by his desire to make a difference in patient care as well as to educate physicians, nurses and techs. When not traveling for Olympus, he enjoys exploring new locations domestically and internationally.

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