Webinar Q&A Report:

Doppler Flow Velocity Measurements for Cardiovascular Research

Q: How do you identify the correct location for measuring from a specific vessel? In our models, sometimes the heart in not in their normal position.

Tonya Coulthard /Anilkumar Reddy: During the training and the subsequent practices it may take a bit longer to properly orient the probe and place the sample volume in the correct location. This is because locating the sample volume in a given vessel is primarily done by recognizing the waveform shape and timing along with knowledge of cardiovascular anatomy in general and function of the specific vessel of interest. The shapes of the waveforms in major vessels are very distinct. By observation of the shape of the waveform, listening for the correct sound, and making fine adjustments of the probe placement and orientation one can ensure they are in the correct location for measuring a specific vessel. Even when the anatomy is unconventional, knowing where it differs from "normal" will help you to locate the specific vessel/blood flow vector of interest. Please note that many peripheral resistance vessels will have similar looking shapes of the waveforms and that proper orientation and knowledge of the anatomy will be the key to measuring some of these signals.

Q: Is there any way to see the structure (image) or only the Doppler flow signal?

Tonya Coulthard /Anilkumar Reddy: Our system can only measure Doppler flow velocity signals. The signals that are captured are of high quality with very minimal error and are displayed as distinct waveforms that can be associated with a specific blood vessel or location in the heart from where the signals are sampled. The knowledge of anatomy is used to determine the approximate location on the blood vessels.

Q: We use very large mice (>50g) in our cardiac echo experiments. How would the Doppler probes perform with these fatty mice? We do have issues with fat around the heart.

Tonya Coulthard /Anilkumar Reddy: Our Doppler probes work without any issue on the larger sized fatty mice. We have measured signals in fatty mice (up to 75g) and had no problems in getting the signals comparable to what we would get in mice of normal weights. Almost all arterial vessels in mice, rats, and similar sized animals are within 10 mm of their skin surface and therefore are within the range of depth that can be measured by the Doppler probes. With regards to the distances, they are slightly

larger in rats than in mice, but within the range provided. The exception is the distance of the aortic root/ascending aorta and mitral valve/orifice locations from the xiphoid process which in rats exceeds 10 mm. However, these two locations can be measured from as follows. The aortic outflow velocity can be measured from the right supra-sternal border location and the mitral inflow velocity signal can be measured from between 4-5th or 5-6th ribs on the left side of the animal's chest. Furthermore, we also have been able to make measurements in naked mole-rats some of which can weigh up to 80 grams and in Damaraland mole-rats that can weigh up to 280 grams.

Q: Can this system measure cardiac output? If so, how does the data compare to Echo?

Tonya Coulthard /Anilkumar Reddy: We typically use peak aortic outflow velocity, measured at the aortic root, as an index of cardiac output (CO; with the assumption that aortic diameter is not different between two groups of subjects). We can also estimate CO using the following steps:

CO = SV x HR, where SV is stroke volume and HR is heart rate.

SV = SD x CA, where SD is area under the flow velocity curve and CA is the cross-sectional area of the aortic lumen

CA is calculated using an estimate of aortic radius using the allometric equation:

Aortic Radius (cm) = 0.18 x $W^{3/8}$, where W is body weight in kg (e.g. 25 g mouse = 0.025 kg)

Aortic radius estimate of a 25 g mouse = 0.18 x $(0.025)^{3/8}$ = 0.045 cm = 0.45 mm

We always use aortic flow velocity as an index of CO and have not systematically compared it with CO derived from echocardiographic measurements.

Q: What range of frequencies is possible to use with this device? Is it possible to use frequencies less than 10 and 20 MHz?

Tonya Coulthard /Anilkumar Reddy: Our system currently offers probes for use at 10 and 20 MHz only. The 10 and 20 MHz frequencies were carefully selected to optimize signal penetration depths of up to 1 cm in small animal models (including but not limited to mice, rats, zebrafish, etc.) and the system is designed with this in mind. However, if you have Doppler (Inphase and Quadrature) audio outputs from a clinical system that you would like to process, then you can connect them to our Digitizer and have those signals sampled/digitized, processed and displayed.

If you have additional questions for Ms. Tonya Coulthard or Dr. Anil Reddy regarding content from his presentation or wish to receive additional information on the Indus Instruments Doppler Flow Velocity System, please contact them by email:

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