Transverse Aortic Constriction (TAC):
DFVS, a non-invasive technique to measure changes in flow velocity through the left and right carotid arteries

Measurements of blood flow velocity are a proven index of cardiovascular function in preclinical animal models. A great alternative to using invasive techniques such as blood pressure catheters and implantable devices is the Doppler flow velocity system (DFVS) by Indus Instruments. The DFVS has a miniature handheld probe which is ideal for measuring small vessels and has a small footprint allowing it to be easily shared between multiple labs. Furthermore, due to its non-invasiveness, investigators can longitudinally monitor changes that occur due to aging, disease progression, remodeling or pharmacological interventions.

Importantly, large bodies of literature exist to support the translational relevance of rodent flow velocity data to clinical findings, making DFVS measurements highly transferable from bench to bedside. In this review, we discuss the most common applications of DFVS in cardiovascular research.

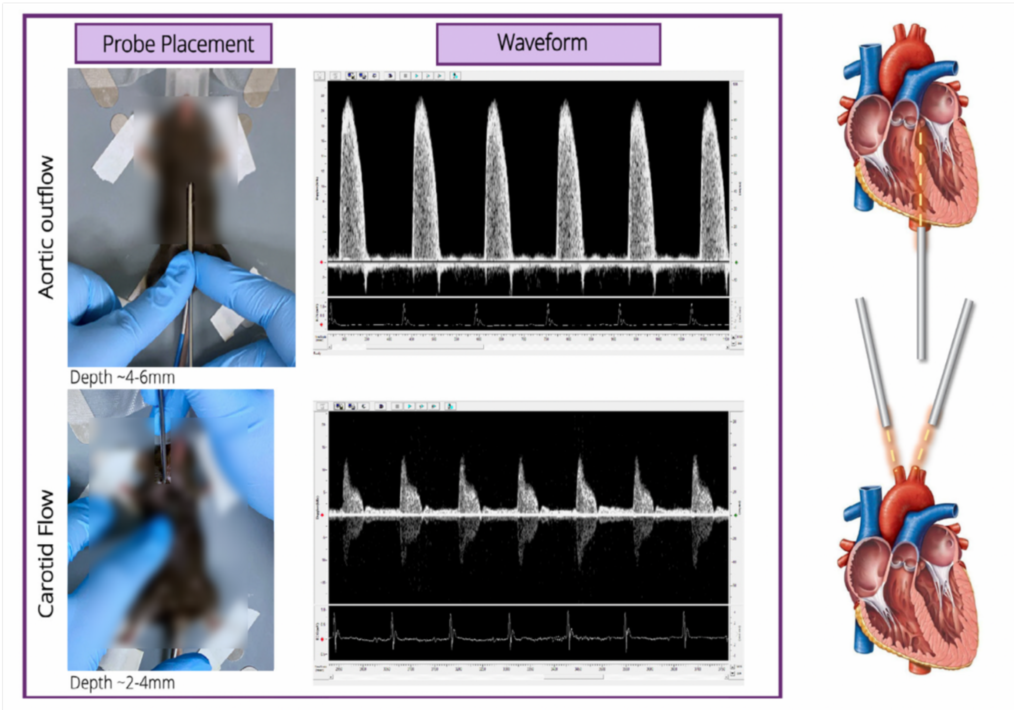
The transverse aortic constriction (TAC) banding model results in left-sided heart failure through pressure overload partial occlusion of the transverse aorta. This procedure often leads to cardiac hypertrophy, a common compensatory mechanism in heart failure and in some animals, will result in heart failure over time. **The DFVS can be used to confirm TAC surgery and to stratify animals based on tightness of the band.** Additionally, the system can be used to assess the changes in cardiac function as a model of heart failure develops.

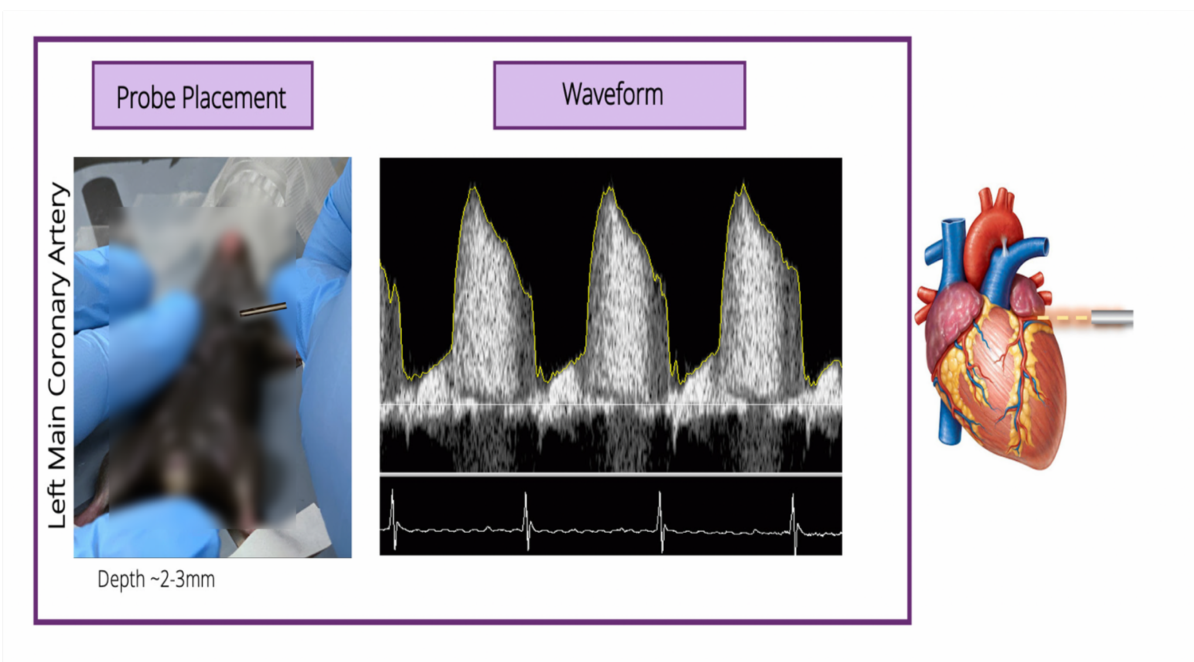
The small size of the single element probes make it easier to acquire the flow velocity spectrums on small animals, also allowing for smaller angles between the probe and the velocity. These smaller angles help improve the accuracy and reproducibility of the acquired measurements, removing some of the variability and difficulty in acquiring flow signals caused by larger imaging-based probes.

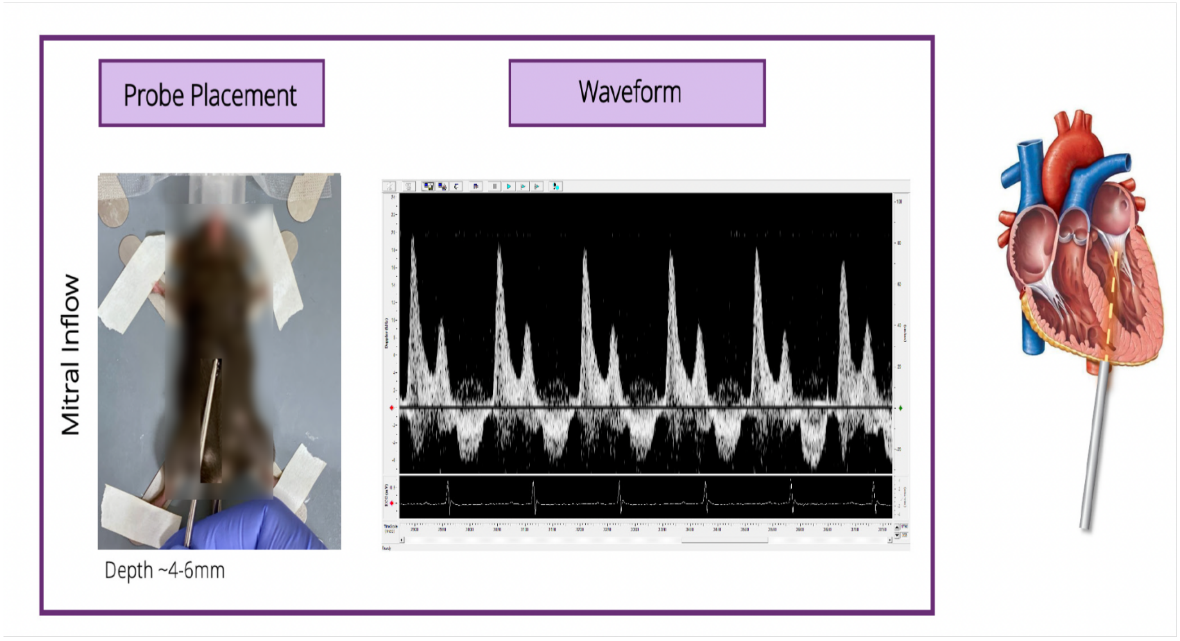
Specifically, the DFVS can be used to assess flow through the carotid arteries. If the TAC band is placed in the correct location, the flow between right and left carotids will be drastically different. The benefit of stratification comes into play when looking at therapeutic efficacy of a compound. If all different tightness of bands and severity of developing outcomes on cardiac function are lumped together, the effects of the compound may not be immediately evident due to the variability in results. In stratifying animals, the power of the study is increased.

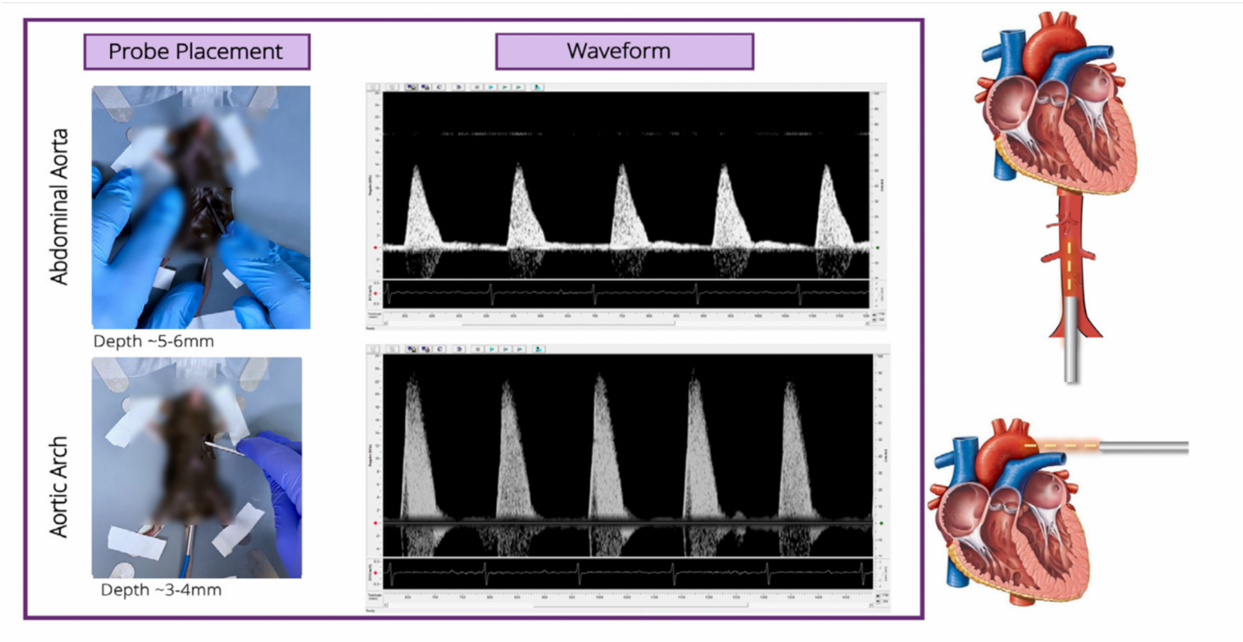
Finally, the DFVS can be used to assess the changes in systolic and diastolic cardiac function as a result of the TAC band. By doing this, a researcher can confirm surgical success, stratify their animals and monitor the developing changes in cardiac function. Flow velocity can be measured through the mitral valve to evaluate diastolic function and flow through the aortic valve as a measure of systolic function.

A recording of this procedure can be seen here.


Probe Placement
Waveform
Aortic outflow
Depth ~4-6mm
Carotid Flow
Depth ~2-4mm


Probe Placement
Waveform
Left Main Coronary Artery
Depth ~2-3mm


Probe Placement
Waveform
Mitral Inflow
Depth ~4-6mm


Probe Placement
Waveform
Abdominal Aorta
Depth ~5-6mm
Aortic Arch
Depth ~3-4mm

If you're interested in using the DFVS to study TAC, check out this Scintica webinar presented by Dr. Malek Mohammadi where she provides an overview of the surgical protocol of neonatal transverse aortic constriction (nTAC) including postsurgical monitoring and ways to confirm the surgery using Doppler measurements and echocardiography. Furthermore, she discusses troubleshooting of some common problems that you may face during the surgery and employing Doppler flow velocity and echocardiography. The full protocol including video of the surgery is published at Nature Protocols and is available online:Malek Mohammadi, M., Abouissa, A. & Heineke, J.

A surgical mouse model of neonatal pressure overload by transverse aortic constriction. Nat Protoc (2020). https://doi.org/10.1038/s41596-020-00434-9

A recording of this procedure can be seen here.

Links related with this content:

Video Procedure

https://www.youtube.com/watch?v=dpDhsKlv49E

Webinar

https://www.scintica.com/neonatal-model-of-transverse-aortic-constriction-ntac-to-induce-pressure-overload/

Publication

https://doi.org/10.1038/s41596-020-00434-9