VISUALSONICS
FUJIFILM

Imaging Guide

Guide to Small Animal Thyroid Gland and Carotid Artery Imaging using the Vevo® Imaging Systems

System Compatibility: This guide contains instructions and suggestions for work on the Vevo2100, VevoLAZR, Vevo 3100 systems and transducers from the MS, MZ and MX series.

Objective

The information in this guide will review:

- Anatomy references
- Select the transducer and transducer positioning
- Recognize the imaging target in B-Mode
- Review the imaging target in other available imaging modes and list available measurements and calculations

Thyroid Gland Overview of the Research Areas and Anatomy

The thyroid gland is of interest in numerous areas of research, including thyroid cancer, nodules, and various other diseases that may affect the size or function of the gland. The Vevo 2100 imaging system is well suited for imaging this gland, and visualizing the structural changes, as well as changes in blood flow through the area. The thyroid is a gland which surrounds the trachea sitting just below the larynx; it is composed of both a left and a right gland.

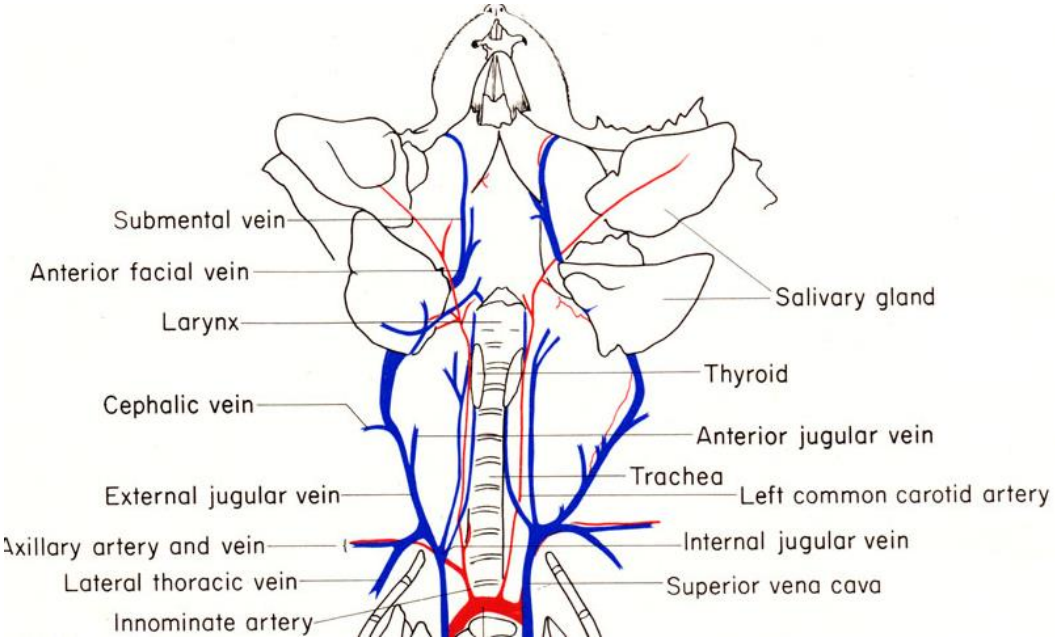

Figure 1 – Anatomical references of main vasculature and structures in the neck area
http://www.informatics.jax.org/cookbook/chapters/contents2.shtml

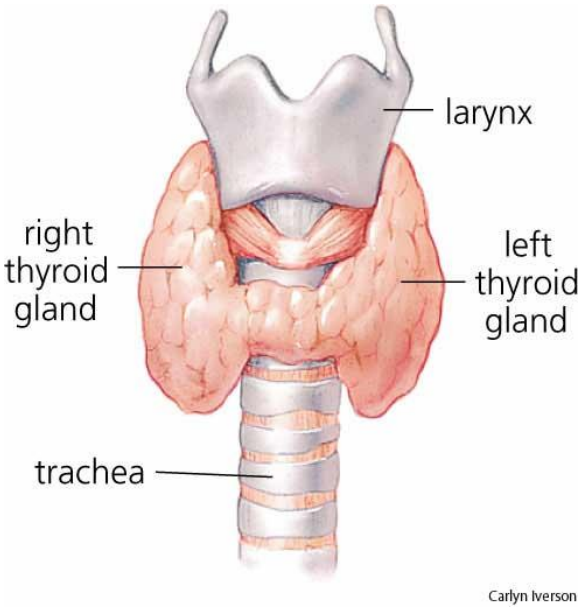

Figure 2 - Thyroid gland structure.
http://content.answers.com/main/content/img/ahd4/A4thyroi.jpg

Selecting the Appropriate Transducer for Imaging
Transducer selection for head and neck imaging in adult mice is based on the size of the animal and its health condition. Typically the transducers of choice would be 550D and 550S models (40MHz) or 700 (MHz).
For example: For young healthy mice 550S* (**40MHz**) or 700 (**50MHz**) transducers are the first choice. For older, larger mice, the best option is the 550D* (**40MHz**) transducer.

*S – Short depth of field
*D – Deep depth of field

Animal Preparation
The animal preparation shall adhere with the Institution's Animal Care Committee approved SOP.

Transducer position for imaging in the neck area

The orientation of the transducer will depend on the type of analysis required the area of interest, i.e. identify changes in the anatomy in a specific direction (linear measurement in B-Mode), identification of blood flow patterns and changes in the pattern (direction of flow in Color Doppler Mode etc.
The Vevo Integrated rail system allows for fine adjustment of the position of the transducer in order to achieve the desired imaging plane.
The landmarks for Thyroid imaging are the two carotid branches. The image below displays the transducer positioned for neck imaging. In order to observe the two carotid arteries in the transverse view, rotate the transducer with 90 degrees. Once the thyroid gland has been identified the transducer position will be adjusted depending on the imaging mode and method of analysis.

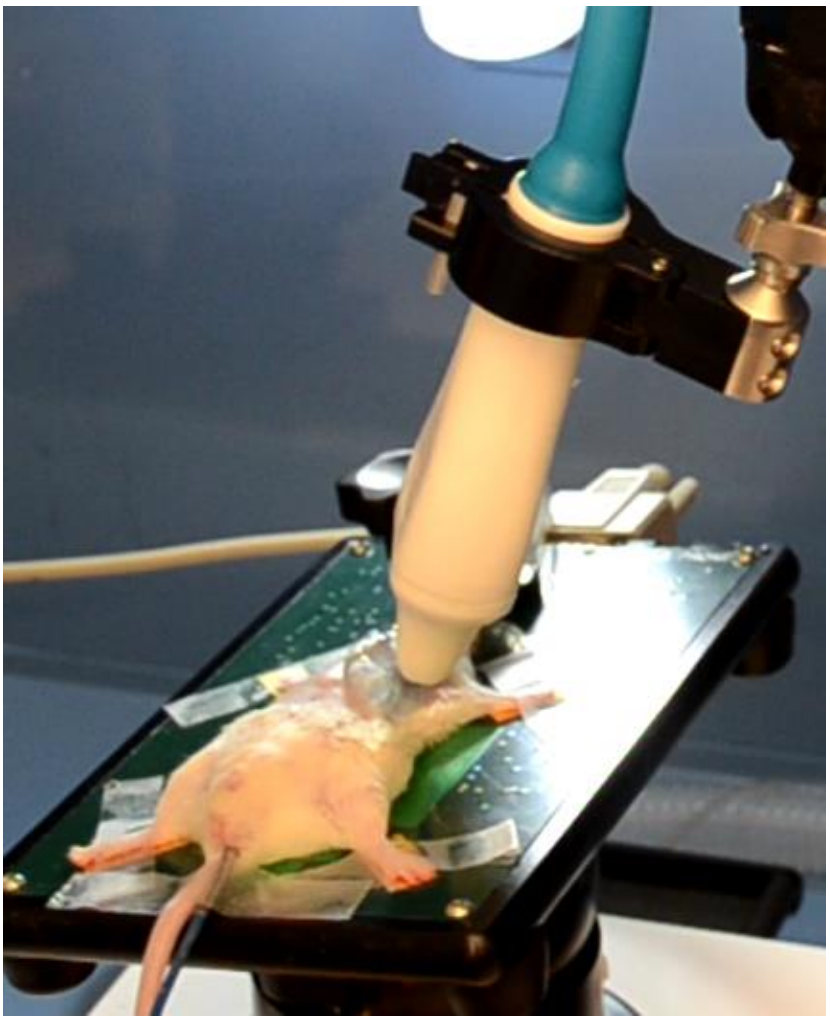

Figure 3 – Transducer positioning in the sagittal plane for imaging in the neck area

Thyroid Gland in B-Mode

The thyroid glands can be imaged either in the longitudinal axis (sagittal) or transverse axis views in B-Mode. Starting with the transducer positioned as displayed in Figure 3 the image of the thyroid will come into view at approximately 2 mm under the skin line.

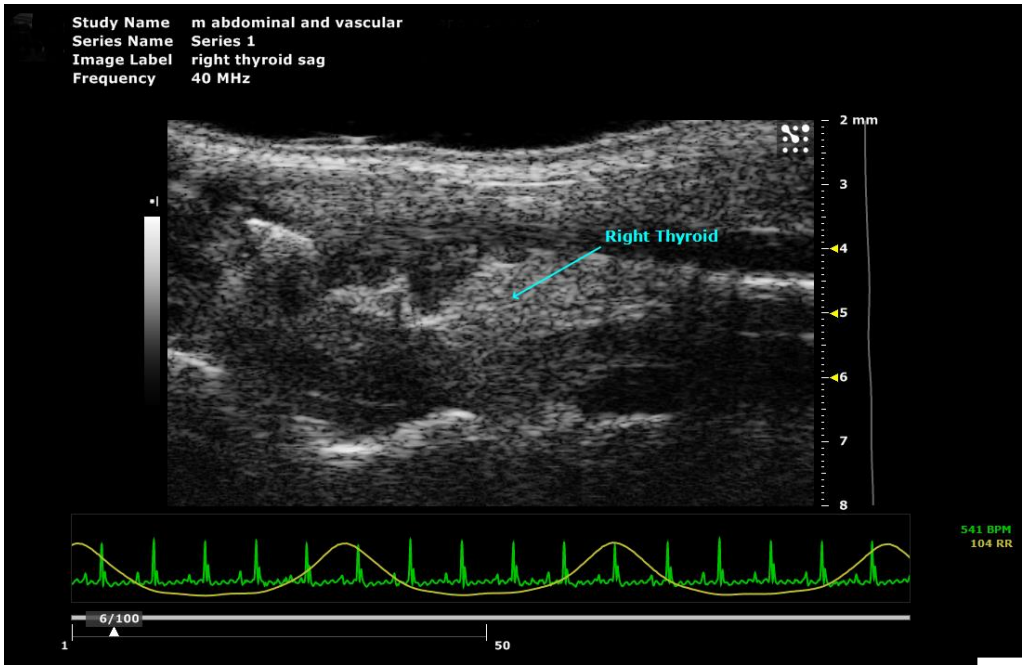

Figure 4 - B-Mode image of the right thyroid gland in the sagittal plane

Rotate the transducer 90° to obtain the transverse view with the carotid arteries as landmarks.

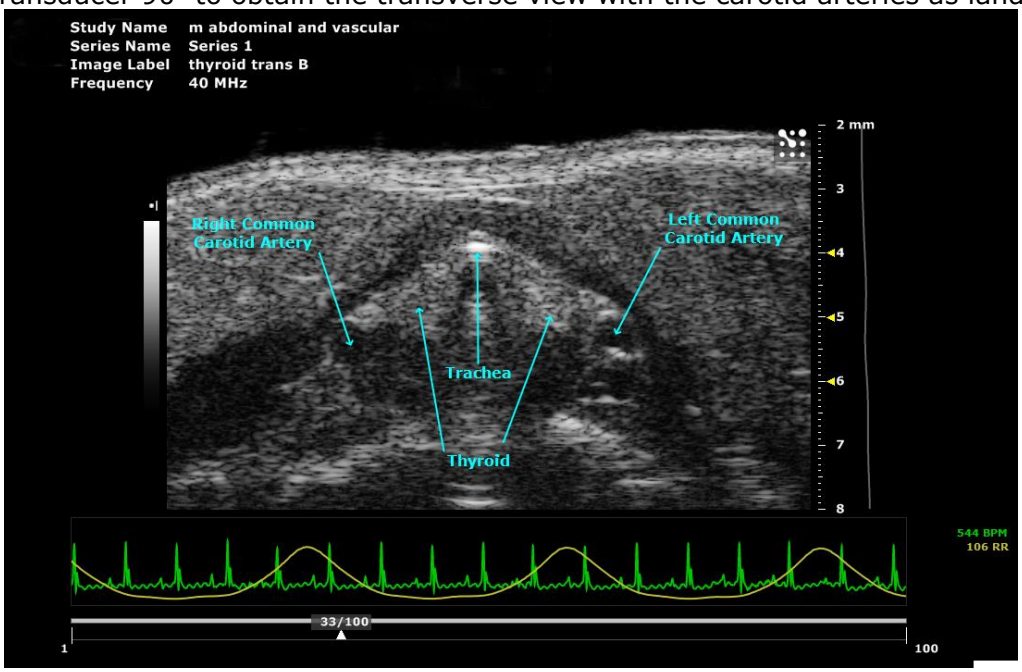

Figure 5 – B-Mode image of the thyroid glands in the transverse plane

Thyroid Gland in 3D-Mode

The 3D rendering of the thyroid glands can be used to assess size and tissue uniformity; the image in this example has been acquired starting in the transverse view with the 3D motor translate the transducer across a defined range with a set step-size.

Figure 6 - 3D rendering of the thyroid gland with the volume outlined and calculated.

Thyroid Glands in Color and Power Doppler Modes

Power Doppler Mode and Color Doppler Mode allow for detection and visualization of very small blood flow patterns and direction in the thyroids. They are additional tools that help evaluating correlations in between changes in size and blood flow patterns and perfusion. For further investigation into blood flow perfusion, imaging with contrast agents is an excellent option.

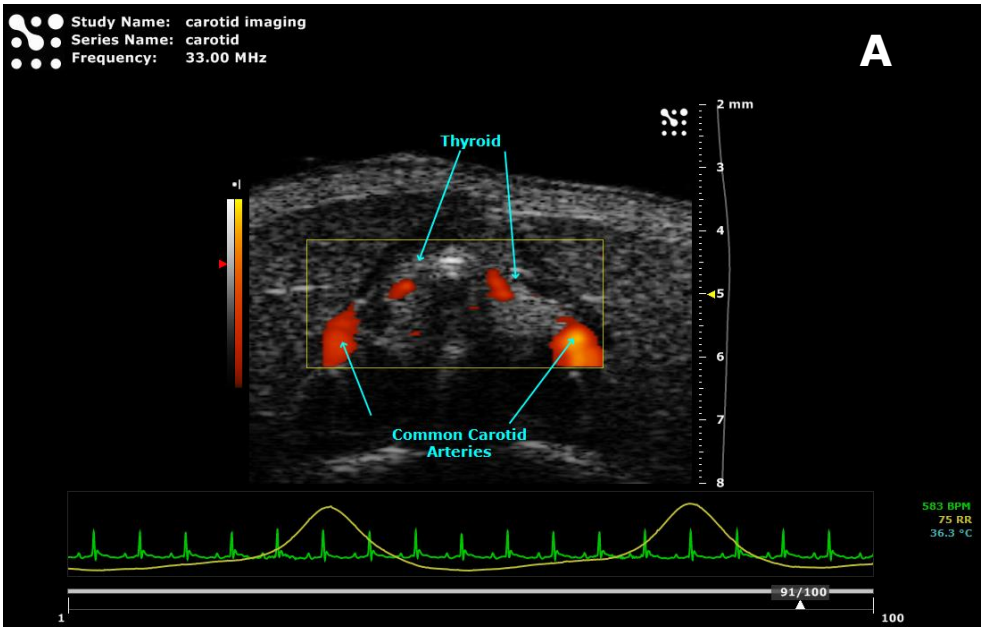

Figure 7 – Detection of small flow using Power Doppler Mode

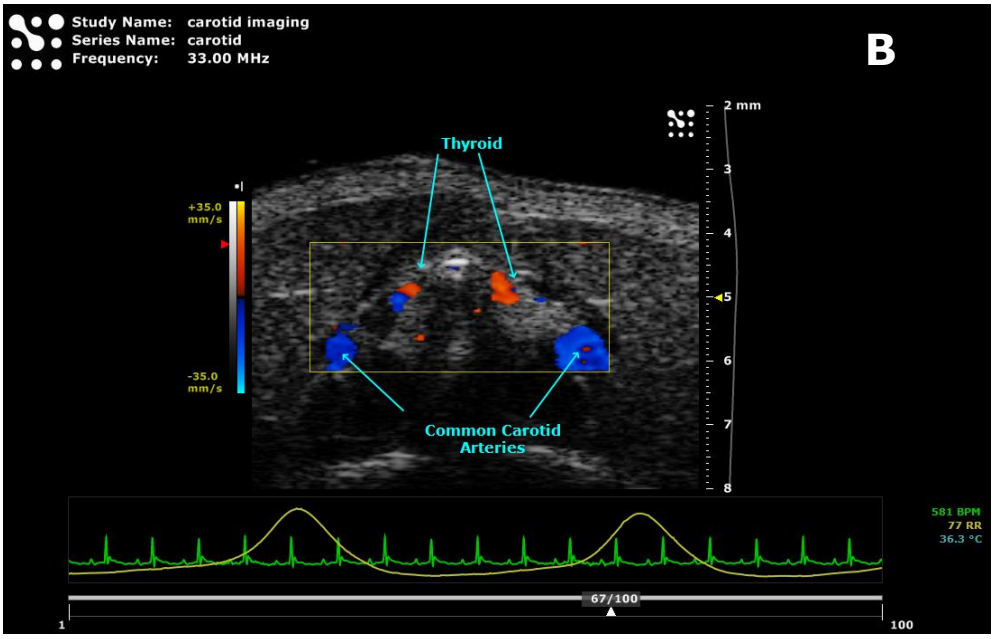

Figure 8 – Detection of small flow direction using Color Doppler Mode

Carotid Artery Overview of the Research Areas and Anatomy

Carotid arteries are of interest in numerous areas of research, including atherosclerosis and stroke models for cardiovascular disease. The Vevo systems are excellent for imaging these arteries, visualizing the structural changes, as well as changes in the wall thickness, wall motion and blood velocity profiles which will be reflected in values of the resistive index during disease progression. In mice, similarly to humans, there are two common carotid arteries, left and right and they provide the head and neck with oxygenated blood. The left common carotid artery branches off of the aortic arch while the right common carotid artery branches off the innominate artery which itself is a branch of the aortic arch. Both common carotid arteries further divide into the internal and external carotid arteries on both the left and right sides.

Carotid Arteries in B-Mode

Carotid arteries in the transverse view are a landmark for thyroid imaging as exemplified above but a comprehensive exam will also be done imaging both in the transverse and sagittal planes.

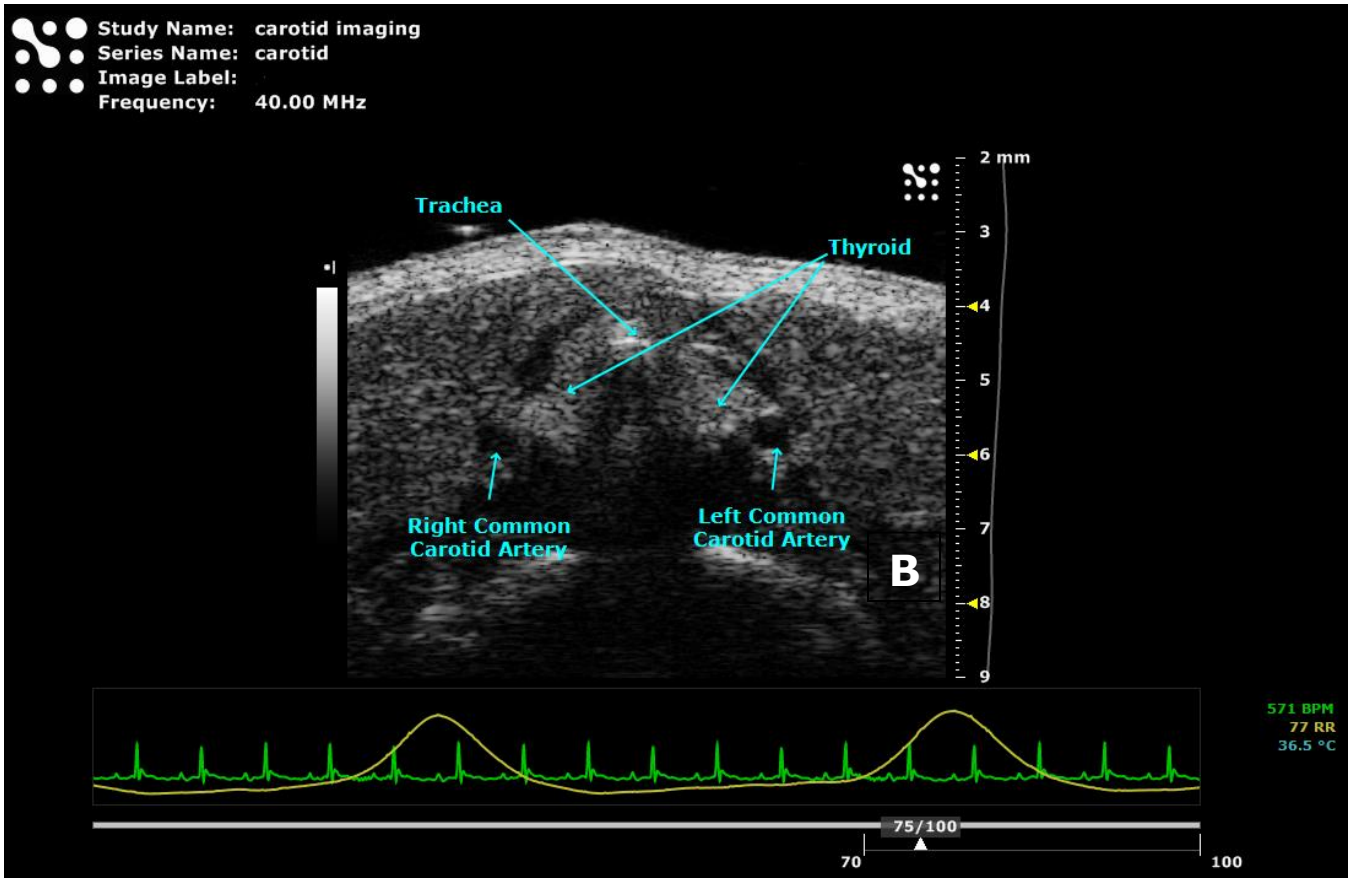

Figure 9 – B-Mode image in transverse plane with both common carotids in the view.

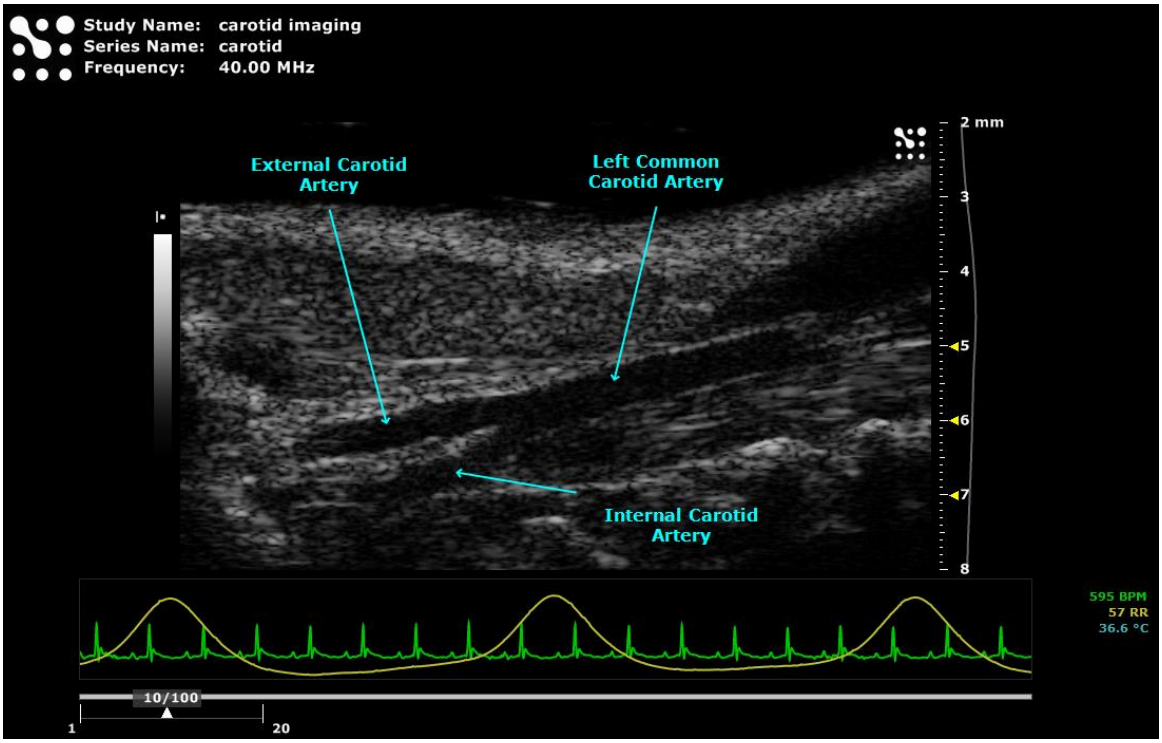

Figure 10 – B-Mode image of the Left Common Carotid at the Internal/External bifurcation in sagittal plane

Measurements and Calculations for Carotid Arteries in B-Mode

Measurements	Calculations
LCCA;d,s	N/A
RCCA;d,s	N/A
LICA;d,s	N/A
RICA;d,s	N/A
LECA;d,s	N/A
RECA;d,s	N/A

Carotid Arteries in 3D-Mode

3D B-Mode imaging can be utilized to evaluate geometrical changes with respect to other anatomical structures, to determine volumes of the arteries or on specific parts. In this example the transducer starts from the transverse plane position and translates position along the length of the arteries for a set range and step size.

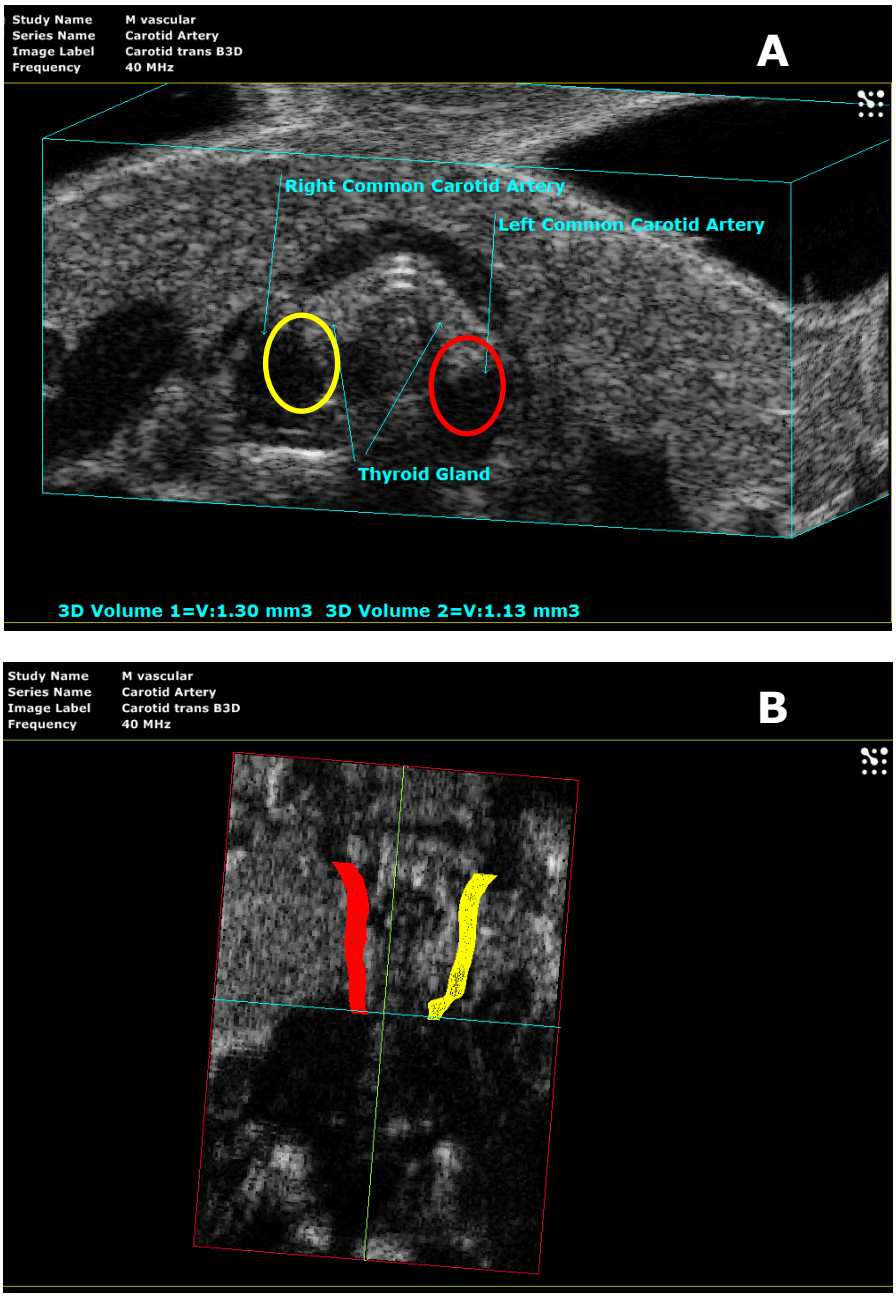

Figure 11 - 3D volumes rendering of LCCA and RCCA. **(A)** Transverse view of the outlined volumes; the left common carotid artery is shown in red (volume 1), and the right common carotid artery is shown in yellow (volume 2). **(B)** Wire frame outlines of the traced volumes in the coronal plane.

Carotid Arteries in M-Mode

M-Mode imaging can be used to analyze the wall thickness and wall movement over time. This type of analysis can provide valuable information on the elasticity of the vessel wall as it changes in diameter from systole to diastole.

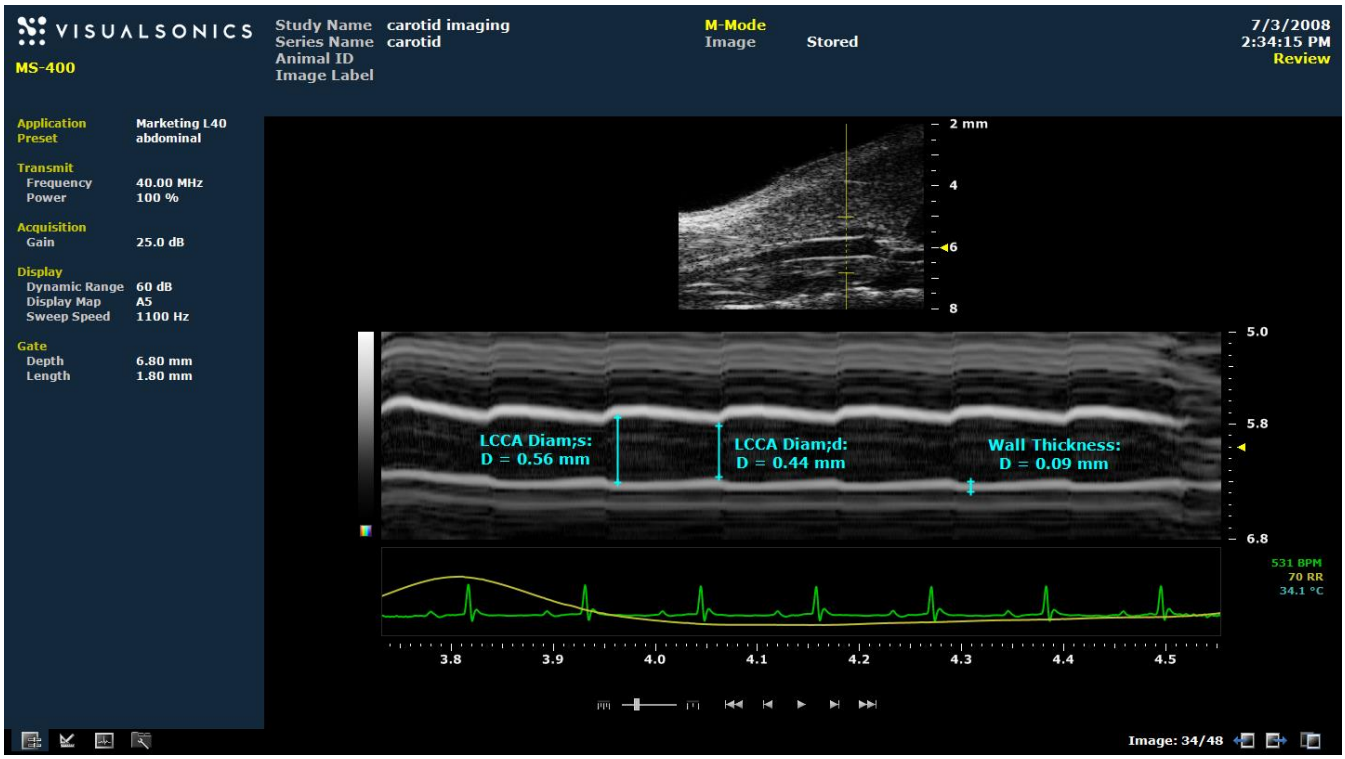

Figure 12 - M-Mode image of the left common carotid artery, showing the diameter in systole and diastole, as well as thickness of the posterior wall.

Measurements and Calculations for Carotid Arteries in B-Mode

Measurements	Calculations
LCCA;d,s	N/A
RCCA;d,s	N/A
LICA;d,s	N/A
RICA;d,s	N/A
LECA;d,s	N/A
RECA;d,s	N/A

Carotid Arteries in Color Doppler Mode

Color Doppler Mode can be used to quickly visualize blood flow through the carotid artery and can to detect any flow disturbances in the vessel or in the region of bifurcation. The direction of flow is shown according to the BART convention: Blue Away, Red Towards.
The transducer is positioned in flow with the vessel with additional beam steering.

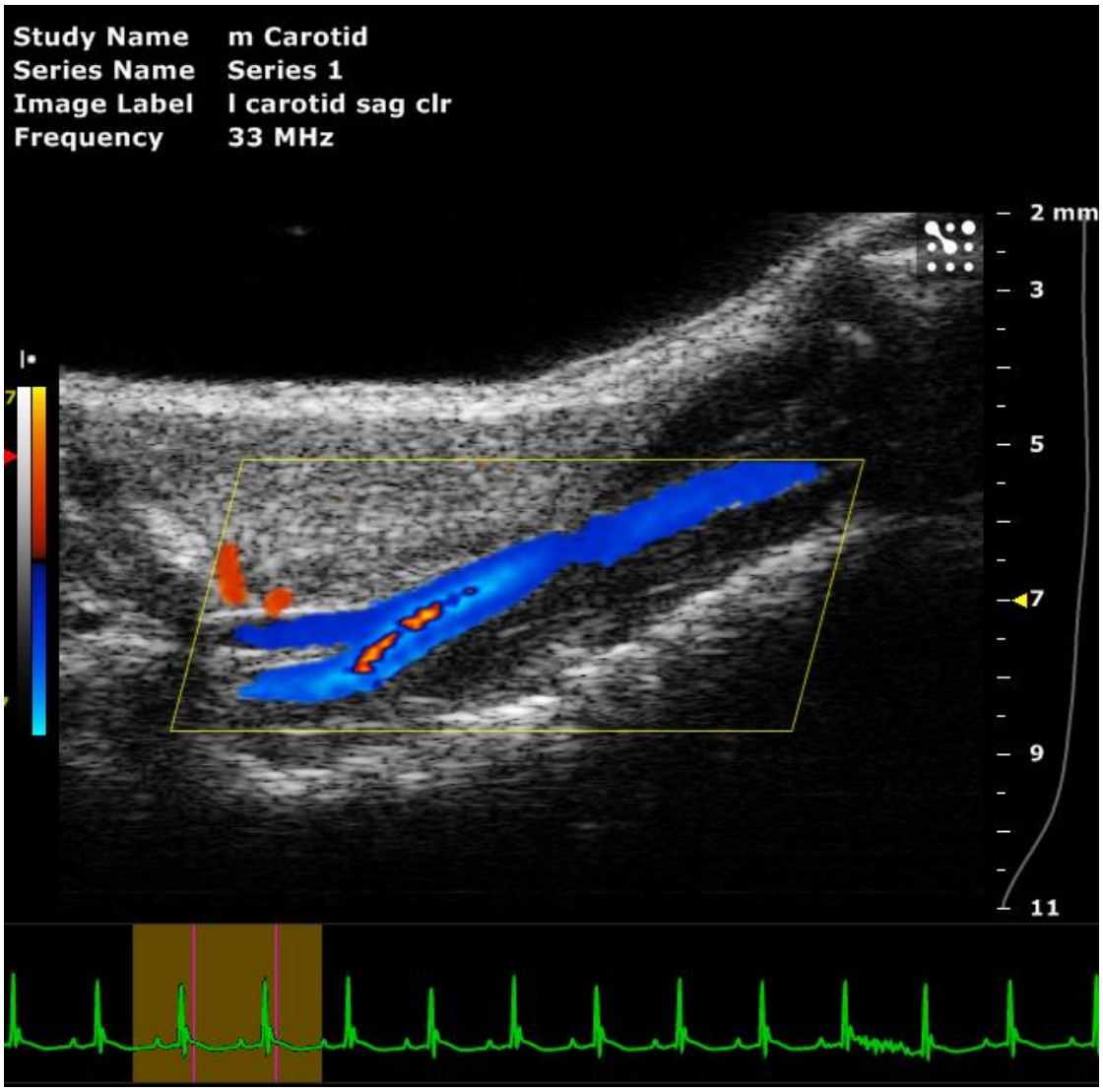

Figure 13 - Color Doppler Mode image of the left common carotid artery bifurcation with aliasing at the highest velocity points (mid flow)

Carotid Arteries in PW Doppler Mode

PW Doppler Mode is the main modality to assess blood flow velocity through the arteries and calculate the Resistive and Pulsatility Indexes.
To achieve a correct physical angle for accurate flow velocity measurements (angle between the beam and the artery of approximately 45°) the animal platform could be tilted or the transducer.

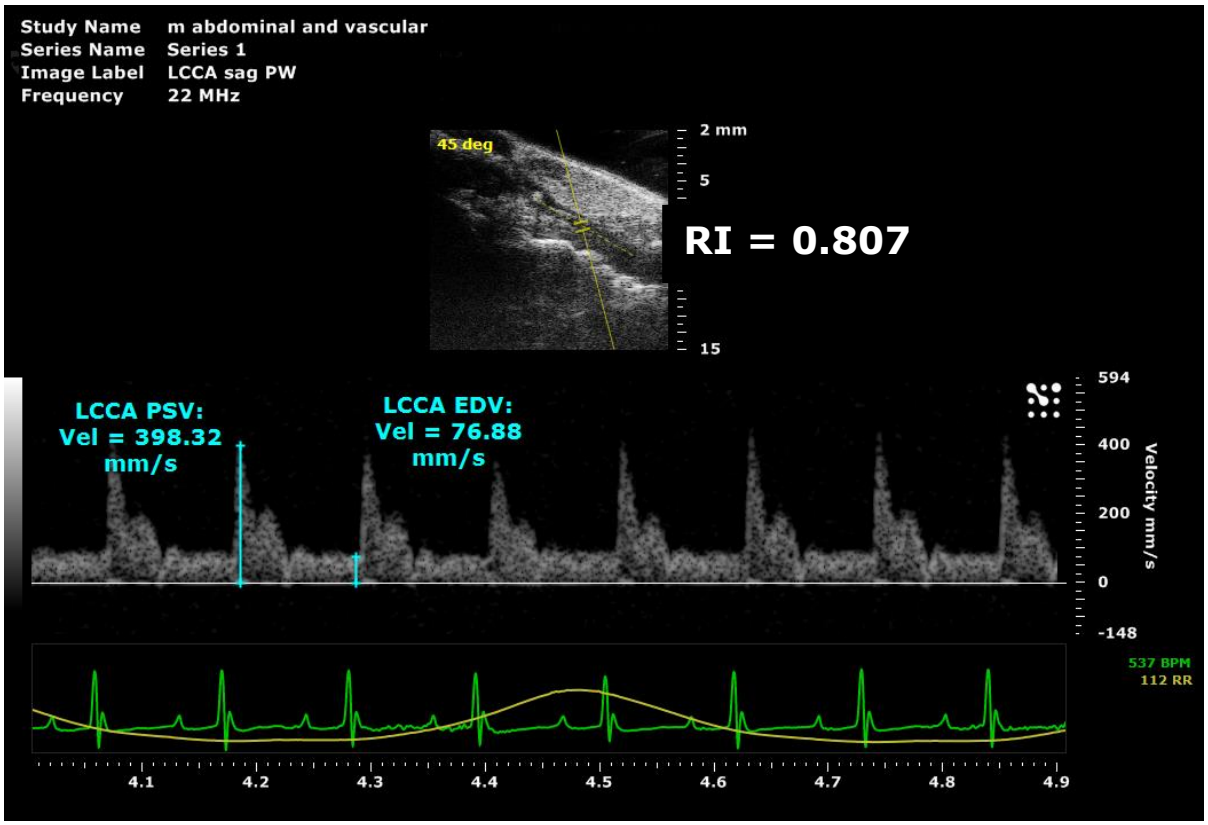

Figure 14 - PW Doppler Mode velocity profile in the **left common carotid** with Peak systolic and End diastolic measurements and the Resistive Index calculation.

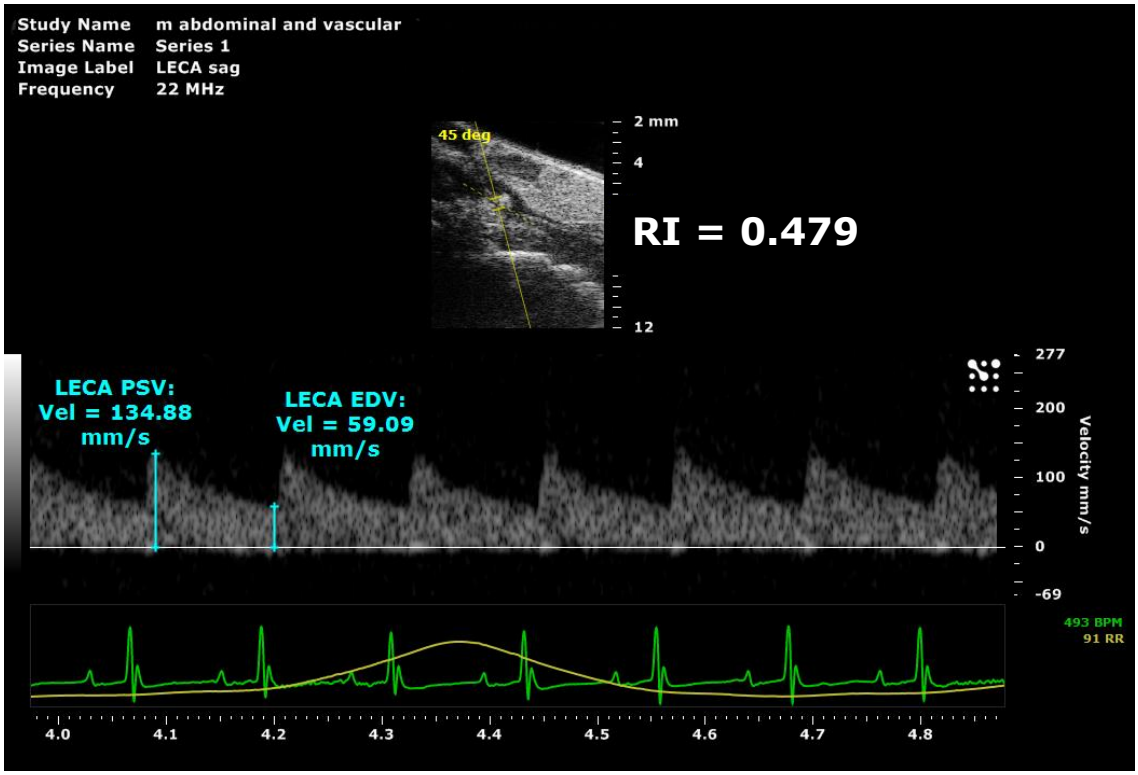

Figure 15 - PW Doppler Mode velocity profile in the **left external carotid** with Peak systolic and End diastolic measurements and the Resistive Index calculation.

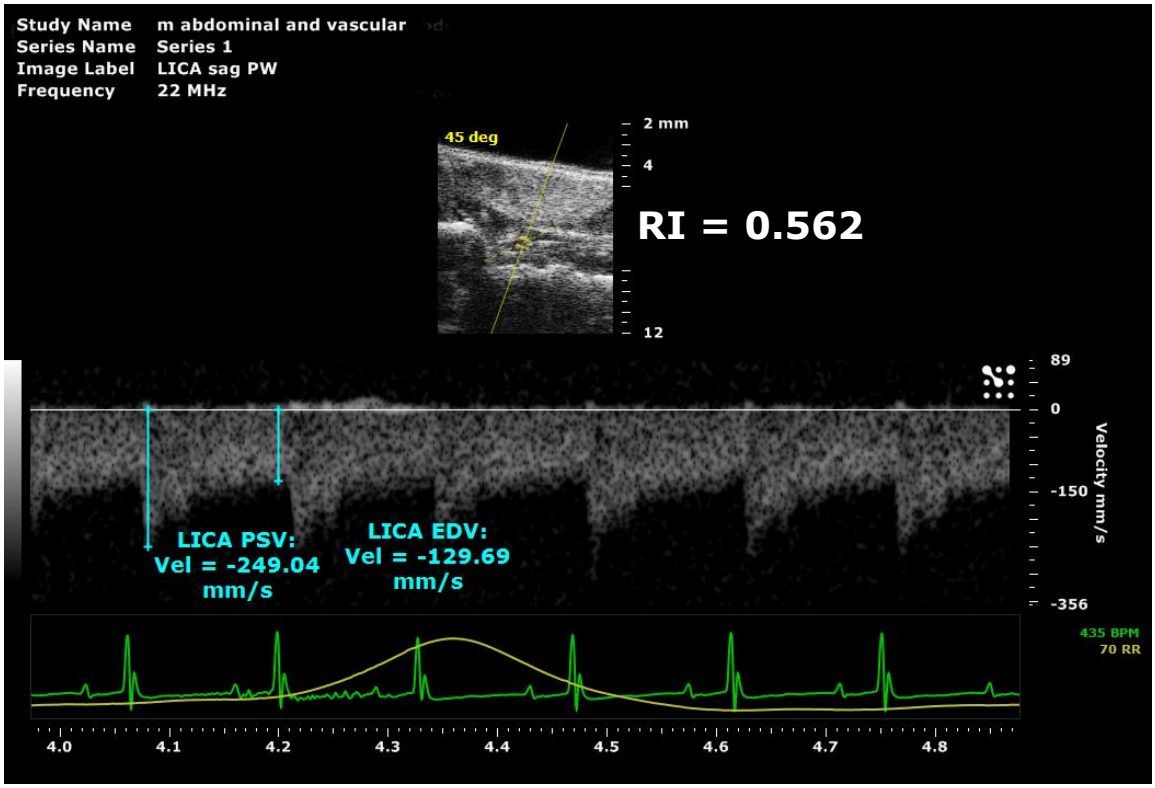

Figure 16 - PW Doppler Mode velocity profile in the **left internal carotid** with Peak systolic and End diastolic measurements and the Resistive Index calculation.

Measurements and Calculations for Carotid Arteries in PW Doppler Mode

Measurements	Calculations
LCCA PSV	LCCA RI
LCCA EDV	LCCA PI
LCCA VTI	RCCA RI
RCCA PSV	RCCA PI
RCCA EDV	LICA PI
RCCA VTI	LICA RI
LICA PSV	RICA RI
LICA EDV	RICA PI
LICA VTI	LECA RI
RICA PSV	LECA PI
RICA EDV	RECA RI
RICA VTI	RECA PI
LECA PSV	
LECA EDV	
LECA VTI	
RECA PSV	
RECA EDV	
RECA VTI	

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