

**Ultrasound – Mesenteric Artery Protocol**

**PURPOSE:**

To determine the absence or presence of stenosis or aneurysm of the visceral arteries. Duplex may also be used to determine location, severity, and type of pathology present.

**SCOPE:**

Applies to all ultrasound abdominal Doppler studies performed in Imaging Services / Radiology

**INDICATIONS:**

- Abdominal pain associated with eating
- Persistent diarrhea
- Significant weight loss
- Bruit
- Postoperative evaluation
- Suspected celiac artery compression; median arcuate ligament syndrome (MALS)
- Suspected aneurysm of the mesenteric, hepatic, or splenic arteries
- Suspected vascular insufficiency of the intestines

**CONTRAINDICATIONS:**

- Open wounds; abdominal drains
- Overlying sutures/staples or bowel gas
- Rapid breathing, inability to hold breath
- Uncooperative patients

**EQUIPMENT:**

- Curvilinear transducer with a frequency range of 2-9 MHz that allows for appropriate penetration and resolution depending on patient's body habitus

**PATIENT PREPARATION:**

- Patient should be NPO for 6-8 hours prior to study

**EXAMINATION:**

**GENERAL GUIDELINES:**

A complete examination includes evaluation of the entire course of the accessible portions of abdominal aorta and major visceral arteries including the celiac artery, superior mesenteric artery (SMA) and inferior mesenteric artery (IMA).

**EXAM INITIATION:**

- Introduce yourself to the patient and explain test
- Verify patient identity using patient name and DOB
- Obtain patient history including symptoms. Enter and store data page
- Place patient in supine position.

## TECHNICAL CONSIDERATIONS:

- Always review any prior imaging, making note of abnormalities or other findings requiring further evaluation. Note relevant history (example: fibromuscular dysplasia)
- Optimize gain and display setting with respect to depth, dynamic range, and focal zones on greyscale imaging first
- Optimize color Doppler setting to show optimal flow
  - Adjust scale and gain to maximally fill the vessel of interest without artifact
    - Light color in the middle of the vessel lumen
    - Areas of aliasing due to turbulent flow should be documented
  - Use Power Doppler if suspect absent flow with color Doppler
- Optimize spectral Doppler
  - Place time-gate centrally within the vessel of interest
  - Adjust scale to extend spectral waveform (amplitude adequate for interpretation)
  - Reduce aliasing for high flow evaluation
- As much as possible, utilize angle correction of  $\leq 60^\circ$  to measure velocities
  - Angle correction should always be parallel to the vessel wall
  - For certain anatomy, may need to try from different approaches to optimize angle
- Areas of suspected stenosis or obstruction will include spectral Doppler waveforms and velocity measurements recorded at and distal to the stenosis or obstruction
- Sites of intervention (stent) will include spectral Doppler waveforms and velocity measurements within the proximal, mid, and distal stent as well as interrogation of the native vessel proximal and distal to the stent.
- Plaque should be assessed and characterized (smooth vs irregular; calcified vs noncalcified)
- Attempt to visualize inferior mesenteric artery (IMA) as a prominent IMA may indicate significant compromise of the celiac axis and/or SMA flow.
- The gastroduodenal vessel should be evaluated if it is suspected the celiac is occluded. Normal gastroduodenal artery blood flow direction is towards the feet, therefore, flow towards the head can confirm celiac disease.
- If ruling out compression syndrome, obtain velocities on inspiration and expiration.
  - For MALS (Median Arcuate Ligament Syndrome), include the following:
    - Spectral Doppler with PSV at both deep inspiration and complete expiration.
    - Document celiac artery excursion between deep inspiration and complete expiration.
      - Calculate deflection angle (DA):

$$DA = (\text{angle between celiac and aorta at inspiration}) - (\text{angle at expiration})$$

- Repeat measurements in erect position.

# UT Southwestern Department of Radiology

## IMAGE DOCUMENTATION:

- Aorta
  - Grayscale and color Doppler, transverse and longitudinal at the level of the celiac and SMA origin
  - Spectral Doppler with PSV and EDV
- Celiac
  - Grayscale and color Doppler, longitudinal
  - Spectral Doppler with PSV and EDV
    - Celiac origin
    - Hepatic artery origin
    - Splenic artery origin
  - If MALS (Median Arcuate Ligament Syndrome) is suspected, include the following:
    - Spectral Doppler with PSV at deep inspiration and complete expiration.
    - Document celiac artery excursion between deep inspiration and complete expiration
      - Calculate deflection angle (angle between celiac and aorta at inspiration – angle at expiration).
    - Repeat measurements in erect position.
- SMA
  - Grayscale and color Doppler, longitudinal
  - Spectral Doppler with PSV and EDV
    - SMA Origin
    - SMA proximal
    - SMA mid
    - SMA distal
  - If ruling out compression syndrome, obtain velocities at deep inspiration and complete expiration
- IMA (if visualized)
  - Grayscale and color Doppler, longitudinal
  - Spectral Doppler at origin with PSV and EDV
- Data Page

## PROCESSING:

- Review examination data
- Export all images to PACS
- Confirm data Imorgon (UTSW only)
- Note any study limitations (in Epic Study Note or paper communication, per Radiologist preference)

## REVISION HISTORY:

<b>SUBMITTED BY:</b>	David T. Fetzer, MD	<b>Title</b>	Medical Director
<b>APPROVED BY:</b>	David T. Fetzer, MD	<b>Title</b>	Medical Director
<b>APPROVAL DATE:</b>	11-15-2015		
<b>REVIEW DATE(S):</b>	11-12-2018		Julie Champine, MD
<b>REVISION DATE(S):</b>	01-02-2019	<b>Brief Description</b>	Updated diagnostic criteria

**US MESENTERIC DOPPLER DIAGNOSTIC CRITERIA**

Interpretation of the SMA and Celiac Axis		
Description	SMA	Celiac Axis
<b>Pre-prandial</b>		
PSV	High	High
EDV	Low	High
Flow reversal	Yes	<b>No</b>
<b>Post-prandial</b>		
PSV	Marked increase	No change
EDV	Marked increase	No change
Loss of flow reversal	Yes	N/A
<b>Velocity criteria</b>		
Normal PSV	80-200 cm/s	50-160 cm/s
Stenosis Criteria	<ul style="list-style-type: none"> <li>• PSV <math>\geq</math> 275 cm/s, predicts</li> <li>• 70% diameter reduction</li> <li>• No flow, occluded</li> <li>• EDV <math>\geq</math> to 45 cm/sec, predicts 50% stenosis (may be elevated if replaced right hepatic artery, in which case SMA waveform will be low resistance biphasic)</li> </ul>	<ul style="list-style-type: none"> <li>• PSV <math>\geq</math> 200 cm/s predicts</li> <li>• 70% diameter reduction</li> <li>• No flow, occluded</li> <li>• EDV <math>&gt;</math> or equal to 55 cm/sec, predicts up to 50% stenosis</li> </ul>

**Duplex Criteria for Mesenteric/Splanchnic Arteries:**

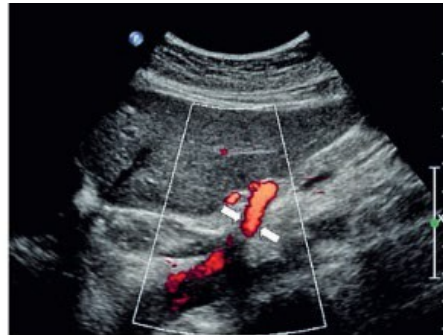
- The SMA and IMA have a high resistance flow pattern in a fasting patient due to the relatively high capillary bed resistance. This pattern usually changes after meals during which the capillary beds are wide open and flow pattern will be noted of low resistance form.
- In a normal or mildly obstructed ( $\leq$ 50%) SMA, peak systolic velocities range from 80-200 cm/s, and end diastolic flow velocity is  $\leq$  45 cm/s.
- Occlusion of the SMA is diagnosed by ultrasound when blood flow is absent in a portion of the vessel during color or spectral Doppler evaluation
- Anomalous mesenteric artery anatomy must be considered when a low-resistance flow pattern is found in an otherwise normal proximal SMA. The most common finding is a right hepatic artery originating from the SMA.
- Celiac artery flow pattern demonstrates low resistance form because the majority of flow volume is directed to the liver and spleen where capillary beds are wide open with or without food ingestion.
- In a normal or mildly obstructed ( $\leq$  50% Celiac artery, peak systolic flow velocity is 50-160 cm/s and end diastolic flow velocity of  $\leq$  55 cm/s).

**Median Arcuate Ligament Syndrome (MALS):**

- Increase in PSV during expiration (>210% change)
- >350 cm/s PSV during expiration
- 3:1 ratio of PSV (during expiration, celiac to abdominal aorta PSV)
- Deflection angle > 50° between inspiration and expiration:



**Fig 1.** Doppler ultrasound scan of a 21 year old female patient with a positive deflection angle (DA+) of the celiac trunk (arrows) of about 80° during maximum expiration.



**Fig 2.** The same case as in fig 1 during maximum inspiration.

(Modified from Gruber et al. Medical Ultrasonography 2012)

**REFERENCES:**

- ACR-AIUM-SPR-SRU Practice Guideline (Revised 2017)
- IAC Guidelines (Updated 8/2018)
- Mesenteric/Splanchnic Artery Duplex Imaging. (2010, January 25). Society for Vascular Ultrasound. Retrieved from: [http://www.svunet.org/files/positions/Mesenteric\\_1-10.pdf](http://www.svunet.org/files/positions/Mesenteric_1-10.pdf)
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