# Ultrasound – Mesenteric Artery Protocol

**PURPOSE:**
To determine the absence or presence of stenosis or aneurysm of the central visceral arteries. Duplex also used to determine location, severity, and type of pathology present.

**SCOPE:**
Applies to all ultrasound abdominal Doppler studies performed in:

- UT Southwestern University Hospitals and Clinics, Imaging Services (UTSW)
- Parkland Health, Department of Radiology (PHHS)

**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 (SMA stenosis)

**CONTRAINDICATIONS:**

- Open wounds; abdominal drains
- Overlying sutures/staples or bowel gas that completely limits visualization
- Rapid breathing, inability to hold breath, uncooperative patients

**EQUIPMENT:**

- Curvilinear transducer with a frequency range of 1-9 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 the abdominal aorta and major visceral arteries including the celiac artery, superior mesenteric artery (SMA) and inferior mesenteric artery (IMA).

**EXAM INITIATION:**

- Review prior imaging, particularly previous CT, MR, or catheter angiograms
- 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)
    - For **MALS**, review CT or other imaging noting focal narrowing of the proximal celiac artery by the Median Arcuate Ligament of the diagram. Is usually associated with post-stenotic dilatation.
    - Evaluate prior imaging for dilated left renal or left gonadal veins, which may indicate Nutcracker (left gonadal vein entrapment by the SMA), for which a different order/assessment/protocol is available.
- 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 or MicroFlow 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 $\leq 60^{o}$ 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 non-calcified)
- If ruling out compression syndrome, 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 (<50%) SMA, peak systolic velocities range from 80-200 cm/s, and end diastolic flow velocity is < 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 (< 50% Celiac artery, peak systolic flow velocity is

50-160 cm/s and end diastolic flow velocity of < 55 cm/s).

- 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 artery** should be evaluated if celiac occlusion is suspected. Normal gastroduodenal artery blood flow direction is towards the feet, therefore, flow towards the head can confirm celiac disease.
- If ruling out **MALS** (Median Arcuate Ligament Syndrome), obtain velocities on inspiration and expiration.
    - 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 = (angle between celiac and aorta at inspiration) - (angle at expiration)*

        - Repeat measurements in erect position.

**IMAGE DOCUMENTATION:**

| Anatomy | Grey Scale | Color Doppler | Waveform | PSV/EDV | Angle^ |
|---|---|---|---|---|---|
| **Mesenteric Doppler:** | | | | | |
| Trans Aorta: At Celiac Artery | X | X | | | |
| Trans Aorta: At SMA | X | X | | | |
| Long Aorta Prox near Celiac Origin | X | X | X | X | |
| Celiac Artery: Origin# | X | X | X# | X# | |
| Common Hepatic Artery (CHA): Origin | X | X | X | X | |
| Splenic Artery: Origin | X | X | X | X | |
| SMA: Origin | X | X | X | X | |
| SMA: Prox | X | X | X | X | |
| SMA: Mid | X | X | X | X | |
| SMA: Distal | X | X | X | X | |
| IMA: Origin | X | X | X | X | |
| **If concern for MALS*, ALSO obtain the following:** | | | | | |
| Celiac Artery: Supine Origin w/ Deep Inspiration | X | X | X# | X# | X |
| Celiac Artery: Supine Origin w/ Complete Expiration | X | X | X# | X# | X |
| Celiac Artery: Erect Origin w/ Deep Inspiration | X | X | X# | X# | X |
| Celiac Artery: Erect Origin w/ Complete Expiration | X | X | X# | X# | X |
| **# Multiple spectral measurements before, at, and after any stenosis may be needed to find highest PSV**<br>*** MALS = Median Arcuate Ligament Syndrome**<br>**^ Calculate Deflection Angle (DA) between Inspiration and Expiration in each position** | | | | | |

- Data Page

**PROCESSING:**

- Review examination data
- Export all images to PACS
- Confirm data transmission to Imorgon
- Note any study limitations in Epic Study Note

**REVISION HISTORY:**

| | | | |
|---|---|---|---|
| **SUBMITTED BY:** | David T. Fetzer, MD | **Title** | Medical Director |
| **APPROVED BY:** | David T. Fetzer, MD | **Title** | Medical Director |
| **APPROVAL DATE:** | 11-15-2015 | | |
| **REVIEW DATE(S):** | 11-12-2018 | | Julie Champine, MD |
| **REVISION DATE(S):** | 01-02-2019 | **Brief Summary** | Updated diagnostic criteria |
| **2/24/24** | Skye Smola, David Fetzer, MD | | Updated Protocol documentation and removed SMA inspiration & expiration |

**US MESENTERIC DOPPLER DIAGNOSTIC CRITERIA**

| Description | SMA | Celiac Axis |
|---|---|---|
| **Pre-prandial** | | |
| **PSV** | High | High |
| **EDV** | Low | High |
| **Flow reversal** | Yes | No |
| | | |
| **Post-prandial** | | |
| **PSV** | Marked increase | No change |
| **EDV** | Marked increase | No change |
| **Loss of flow reversal** | Yes | N/A |
| | | |
| **Velocity criteria** | | |
| **Normal PSV** | 80-200 cm/s | 50-160 cm/s |
| **Stenosis Criteria** | • PSV > 275 cm/s, predicts 70% diameter reduction<br>• No flow, occluded<br>• EDV > 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) | • PSV > 200 cm/s predicts 70% diameter reduction<br>• No flow, occluded<br>• EDV ≥ to 55 cm/sec, predicts up to 50% stenosis |

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

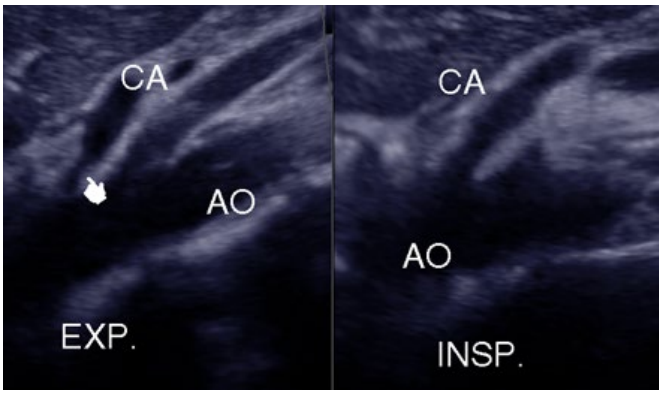
- Increase in PSV during expiration (>210% change)
- >350 cm/s PSV during expiration
- 3:1 ratio of PSV (during expiration, celiac to abdominal aorta PSV)
- Deflection angle > 50° between inspiration and expiration:

**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.

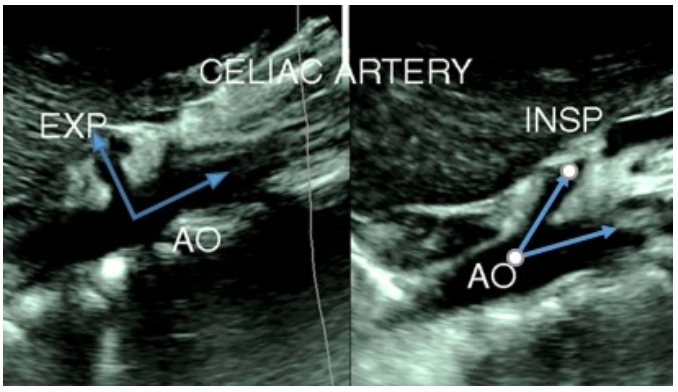
**Fig 2.** The same case as in fig 1 during maximum inspiration.

(Modified from Gruber et al. Medical Ultrasonography 2012)

**MALS) Narrowing of the Celiac Trunk on inspiration and expiration:**



**(MALS) Measuring the Celiac Trunk angle during inspiration and expiration:**




**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: McPharlin, M., Rumwell, C., (n.d.). Vascular Technology. Education for the Sonographic Professional.
- Gruber H et al. Ultrasound of median arcuate ligament syndrome: a new approach to diagnosis. Medical Ultrasonography 2012;14(1):5-9.
- Rumwell, C., McPharlin, M., (2000) Vascular Technology. (p 47). Pasadena, California: Davies Publishing.
- Zierler, R. (2010). Strandness's Duplex Scanning in Vascular Disorders 4th edition. Philadelphia, Pennsylvania: Lippincott Williams & Wilkins.
- Daigle, R. (2009). Techniques in Noninvasive Vascular Diagnosis An Encyclopedia of Vascular Testing 3rd edition. Littleton, Colorado: Summer Publishing, LLC.