

# HEMODIALYSIS ACCESS US PROTOCOLS

## **PURPOSE:**

- To evaluate an AV fistula or graft for thrombosis or stenosis, to assess for AV fistula maturity, to assess for peri fistula/graft complications.

## **INDICATIONS:**

- Hemodialysis access blood flow inadequate for dialysis (flow volume less <500-600 mL/min or flow volume decrease of >25).
- Patients who develop persistent ipsilateral upper-extremity edema or pain after access placement or during hemodialysis.
- Patients with delayed maturity (>6 weeks) of a surgically created AVF.
- Patients suspected of having a pseudoaneurysm, AV fistula/graft stenosis, peri graft soft-tissue infection or adjacent fluid collection.
- Patients with decreased or absent thrill or abnormal bruit over hemodialysis access.
- Patients with clinical signs or symptoms of hand/digit ischemia typically during or immediately following hemodialysis but that may occur at other times.
- Access collapse during hemodialysis.
- Prolonged bleeding (>20 min) from access needle sites.
- Unexplained decrease in delivered dose of hemodialysis (Kt/V). Kt/V is the product of dialyzer clearance and time divided by volume of water in the patient.
- Repeated difficult cannulation.
- Thrombus aspiration during hemodialysis.
- Elevated venous pressure >200 mmHg on a 300 mL/min pump.
- Elevated recirculation time >15%.
- Follow-up after intervention.

## **EQUIPMENT:**

- 5-7 MHz linear probe

## **PATIENT PREPARATION & ASSESSMENT:**

- Introduce yourself to the patient.
- Verify patient identity via two patient identifiers (name and date of birth) per hospital policy.
- Explain the examination, its purpose and how long it will take.
- Answer any questions the patient may have regarding the examination.
- Obtain patient history including symptoms, signs, risk factors and other relevant history.

## **GENERAL GUIDELINES/COMMENTS:**

- It is preferred that examinations be performed >24 hrs since patient's last hemodialysis to minimize flow disturbances related to hemodialysis.

- Use copious ultrasound gel and pay careful attention to limit pressure applied by the transducer will minimize deformity of the vein, which may affect measurements of the vein diameter.
- Optimize equipment gain and display settings with respect to depth, dynamic range and focal zones while imaging vessels.
- Add color Doppler to supplement grayscale images with proper color scale to demonstrate areas of high flow and color aliasing.
- Use power Doppler to validate low flow states or occlusions.
- Set spectral Doppler gains to allow a spectral window and optimized to reduce artifacts.
- Cursor sample size will be small and positioned parallel to the vessel wall and/or direction of blood flow.
- A spectral Doppler angle of 45-60 degrees or less will be used to measure velocities. Note exceptions to these angles on the technologist worksheet.
- Send the measurements screenshot page if your machine is capable.
- Any deviations from the standard protocol and any limitations to the examination should be documented on the technologist worksheet for future reference and for repeatability in follow-up studies.
- Report preliminary critical findings to the referring clinician when appropriate (i.e. immediate medical attention may be warranted) and according to hospital policy.
- AV fistulas are preferred over grafts. Forearm is preferred over upper arm which is preferred over leg for access site. Arm preference for an AV fistula: nondominate arm over dominate arm and forearm over upper arm.
- Order preference for an AV fistula anatomy: radial artery to cephalic vein, brachial artery to cephalic vein, brachial artery to basilic vein and brachial artery to brachial vein.
- Order preference for PTFE grafts: brachial artery to antecubital vein, brachial artery to basilic vein, axillary artery to axillary vein and femoral artery to great saphenous vein or common femoral vein.

### **EVALUATION OF AV FISTULA FOR DYSFUNCTION/STENOSIS:**

- Note anatomy (what artery is connected to what vein) and label artery and vein accordingly on images.
- Document longitudinal spectral Doppler image with flow volume (mL/sec) measurement in the brachial artery 2 cm proximal to the antecubital fossa. Obtain 3 flow volume measurements.
- Document longitudinal grayscale, color Doppler and spectral Doppler with PSV measurement images at the following locations:
  - 1) Feeding artery 2 cm proximal/upstream to the anastomosis/fistula.
  - 2) At the anastomosis/fistula.
  - 3) Draining vein 5 cm distal/downstream from the anastomosis/fistula (proximal vein).
  - 4) Draining vein 10 cm distal/downstream from the anastomosis/fistula (mid vein).
  - 5) Draining vein 15 cm distal/downstream from the anastomosis/fistula (distal vein).
- Document longitudinal spectral Doppler with flow volume (mL/sec) measurement image at the draining vein 10 cm distal/downstream from the anastomosis/fistula. Obtain 3 flow volume measurements.
- Document transverse grayscale images with measurement of any accessory veins arising from the draining vein within 15 cm of the anastomosis/fistula.
- Assess the feeding artery and draining vein along their lengths and document longitudinal grayscale, color Doppler and spectral Doppler with PSV measurement images at any stenosis. Also document a longitudinal spectral Doppler with PSV measurement image 2 cm proximal to the stenosis (to calculate PSV ratio).
- Assess the deep veins for DVT every 2 cm along their length. Document transverse grayscale split-screen without and with compression and longitudinal spectral Doppler waveform images of the brachial, axillary and subclavian veins (only on the side of the fistula).
- Document images of any fluid collection, hematoma or pseudoaneurysm per routine protocols.

## **EVALUATION OF AV FISTULA FOR MATURITY:**

- Note anatomy (what artery is connected to what vein) and label artery and vein accordingly on images.
- Document longitudinal spectral Doppler image with flow volume (mL/sec) measurement in the brachial artery 2 cm proximal to the antecubital fossa. Obtain 3 flow volume measurements.
- Document transverse grayscale images with measurement of the diameter of the feeding artery 2 cm proximal/upstream to the anastomosis/fistula.
- Document longitudinal grayscale, color Doppler and spectral Doppler with PSV measurement images at the following locations:
  - 6) Feeding artery 2 cm proximal/upstream to the anastomosis/fistula.
  - 7) At the artery/vein anastomosis.
  - 8) Draining vein 5 cm distal/downstream from the anastomosis/fistula (proximal vein).
  - 9) Draining vein 10 cm distal/downstream from the anastomosis/fistula (mid vein).
  - 10) Draining vein 15 cm distal/downstream from the anastomosis/fistula (distal vein).
- Document transverse grayscale images with measurement of the vein diameter and distance between skin and superficial wall of the draining vein at the following locations:
  - 1) Draining vein 5 cm distal/downstream from the anastomosis/fistula.
  - 2) Draining vein 10 cm distal/downstream from the anastomosis/fistula.
  - 3) Draining vein 15 cm distal/downstream from the anastomosis/fistula.
- Document longitudinal spectral Doppler with flow volume (mL/sec) measurement image at the draining vein 10 cm distal/downstream from the anastomosis/fistula. Obtain 3 flow volume measurements.
- Document transverse grayscale images with measurement of any accessory veins arising from the draining vein within 15 cm of the anastomosis/fistula.
- Assess the feeding artery and draining vein along their lengths and document longitudinal grayscale, color Doppler and spectral Doppler with PSV measurement images at any stenosis. Also document a longitudinal spectral Doppler with PSV measurement image 2 cm proximal to the stenosis (to calculate PSV ratio).
- Assess the deep veins for DVT every 2 cm along their length. Document transverse grayscale split-screen without and with compression and longitudinal spectral Doppler waveform images of the brachial, axillary and subclavian veins (only on the side of the fistula).
- Document images of any fluid collection, hematoma or pseudoaneurysm per routine protocols.

## **DOCUMENTATION OF AV GRAFTS:**

- Note anatomy (what artery is connected to what vein) and label artery and vein accordingly on images.
- Document longitudinal spectral Doppler image with flow volume (mL/sec) measurement in the brachial artery 2 cm proximal to the antecubital fossa.
- Document transverse grayscale images with measurement of the diameter of the feeding artery 2 cm proximal/upstream to the anastomosis/fistula.
- Document longitudinal grayscale, color Doppler and spectral Doppler with PSV measurement images at the following locations:
  - 1) Feeding artery 2 cm proximal/upstream to the arterial/graft anastomosis.
  - 2) At the arterial/graft anastomosis.
  - 3) Mid aspect of the graft.
  - 4) At the graft/venous anastomosis.
  - 5) Draining vein 5 cm distal/downstream from the venous anastomosis (proximal vein).
  - 6) Draining vein 10 cm distal/downstream from the venous anastomosis (mid vein).
  - 7) Draining vein 15 cm distal/downstream from the venous anastomosis (distal vein).

- Document longitudinal spectral Doppler with flow volume (mL/sec) measurement image at the draining vein 10 cm distal/downstream from the venous anastomosis.
- Document transverse grayscale images with measurement of any accessory veins arising from the draining vein within 15 cm of the venous anastomosis.
- Assess the feeding artery and draining vein along their lengths and document longitudinal grayscale, color Doppler and spectral Doppler with PSV measurement images at any stenosis. Also document a longitudinal spectral Doppler with PSV measurement image 2 cm proximal to the stenosis (to calculate PSV ratio).
- Document images of any fluid collection, hematoma or pseudoaneurysm per routine protocols.
- Assess the deep veins for DVT every 2 cm along their length. Document transverse grayscale split-screen without and with compression and longitudinal spectral Doppler waveform images of the brachial, axillary and subclavian veins (only on the side of the fistula).

### **COMMENTS:**

- Signs of a mature AV fistula: flow volume  $\geq 500$ -600 mL/min, vein diameter  $\geq 4$ -6 mm, vein  $\leq 6$  mm below skin surface.
- Signs of  $>50\%$  stenosis include:  $>50\%$  luminal narrowing at grayscale imaging; peak velocity of  $>400$ -500 cm/sec at stenosis; velocity ratio  $>3.0$  at AVF anastomosis,  $>2.0$  in draining vein,  $>3.0$  at AVG arterial anastomosis,  $>2.0$  at AVG venous anastomosis; draining vein flow volume  $<600$  mL/min or  $\geq 25\%$  decrease compared to prior. A velocity ratio  $>3.0$  at the AVG venous anastomosis suggests  $>75\%$  stenosis.
- Clinically significant accessory veins divert more than 25% flow or have a diameter one-third that of the AVF draining vein.

### **REFERENCES:**

- ACR–AIUM–SRU Practice Parameter for the Performance of Vascular US for Postoperative Assessment of Hemodialysis Access – <https://www.acr.org/-/media/ACR/files/practice-parameters/postopdialysis.pdf>.
- Hemodialysis Access: US for Preprocedural Mapping and Evaluation of Maturity and Access Dysfunction - <https://doi.org/10.1148/rg.230053>.
- Multimodality Imaging Evaluation of Arteriovenous Fistulas and Grafts: A Clinical Practice Review - <https://doi.org/10.21037/cdt-22-439>.
- Role of Doppler Ultrasonography in the Evaluation of Hemodialysis Arteriovenous Access Maturation and Influencing Factors - <https://doi.org/10.1177/1129729820965064>.