

**Ultrasound – Dialysis Access Evaluation**

**PURPOSE:**

To determine patency of a dialysis fistula or graft and/or other associated abnormalities that may be present.

**SCOPE:**

Applies to all ultrasound Dialysis Access Evaluation studies performed in:

- UT Southwestern Zale-Lipsky University Hospital, William P. Clements Jr. University Hospital, and all University Hospital-based Clinics Imaging Services (UTSW)
- Parkland Health and Hospital System Department of Radiology (PHHS)

**INDICATIONS:**

- Pseudoaneurysmal dilatation
- Pulsatile thrill
- Loss or decrease of thrill
- Excessive bleeding post dialysis
- Hand pain, coolness (steal syndrome)
- Venous hypertension

**CONTRAINDICATIONS:**

- Skin breakdown where the graft is exposed
- Extreme hypotension (flow volume and velocities may be affected)
- Bandages
- Significant edema
- Significant obesity
- Immediately post-access for dialysis before bandages can be removed, at the discretion of the ordering APP and/or radiologist

**EQUIPMENT:**

- Commercial duplex Doppler ultrasound system
- Linear transducer with a frequency range from 3.5-10 MHz

**PATIENT PREPARATION:**

- Upper Extremity fistula/graft: Patient positioning is often supine Arm should be relaxed and extended out to the side
- Thigh fistula/graft: Patient positioning should be supine.

**EXAMINATION:**

**GENERAL GUIDELINES:**

- A complete examination includes evaluation of the entire course of the accessible portions of each vessel/graft
- Variations in technique must be documented

**EXAM INITIATION:**

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

**TECHNICAL CONSIDERATIONS:**

- Equipment gain and display settings will be optimized while imaging vessels with respect to the depth, dynamic range, and focal zones
- Color-flow Doppler images with proper color scale to demonstrate areas of high flow and color aliasing
- 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 will include spectral Doppler waveforms and velocity measurements from the proximal, mid, and distal sites
- An angle of 60 degrees or less must be used to measure velocities
- Doppler angle should always be parallel to the vessel wall

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### DOCUMENTATION:

- Document the inflow artery and the outflow vein of the fistula/graft
- Document any fluid collections

### Fistula Evaluation:

1	Native inflow artery, 2 cm prox to anastomosis	Long, with and without color
2	Native inflow artery, 2 cm prox to anastomosis	Spectral Doppler w/ PSV measurement
3	Native inflow artery, 2 cm dist to anastomosis	Long, with and without color
4	Native inflow artery, 2 cm dist to anastomosis	Spectral Doppler w/ PSV measurement
5	Fistula anastomosis	Long, with and without color
6	Fistula anastomosis	Diameter measurement in grayscale
7	Fistula anastomosis	Spectral Doppler w/ PSV measurement
8	Outflow vein, 2 cm from anastomosis	Long, with and without color
9	Outflow vein, 2 cm from anastomosis	AP Diameter measurement in grayscale
10	Outflow vein, 2 cm from anastomosis	Representative distance of anterior wall to skin
11	Outflow vein, 2 cm from anastomosis	Flow volume
12	Outflow vein, 2 cm from anastomosis	Spectral Doppler w/ PSV measurement
13	Outflow vein, 5 cm from anastomosis	Long, with and without color
14	Outflow vein, 5 cm from anastomosis	AP Diameter measurement in grayscale
15	Outflow vein, 5 cm from anastomosis	Representative distance of anterior wall to skin
16	Outflow vein, 5 cm from anastomosis	Flow volume
17	Outflow vein, 5 cm from anastomosis	Spectral Doppler w/ PSV measurement
18	Outflow vein, 10 cm from anastomosis	Long, with and without color
19	Outflow vein, 10 cm from anastomosis	AP Diameter measurement in grayscale
20	Outflow vein, 10 cm from anastomosis	Representative distance of anterior wall to skin surface
21	Outflow vein, 10 cm from anastomosis	Flow volume
22	Outflow vein, 10 cm from anastomosis	Spectral Doppler w/ PSV measurement
	<b>FOR BRACHIOCEPH AVF ONLY</b>	
23	Long Cephalic vein at Cephalic Arch	Long, with and without color
24	Long Cephalic vein at Cephalic Arch	Spectral Doppler w/ PSV measurement

**NOTE:** Minimal representative images of the fistula are listed above and should include additional documentation of any pathology that may be present

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### Line/Straight Graft Evaluation

1	Native inflow artery, 2 cm prox to anastomosis	Long, with and without color
2	Native inflow artery, 2 cm prox to anastomosis	Spectral Doppler w/ PSV measurement
3	Native inflow artery, 2 cm dist to anastomosis	Long, with and without color
4	Native inflow artery, 2 cm dist to anastomosis	Spectral Doppler w/ PSV measurement
5	Arterial anastomosis	Long, with and without color
6	Arterial anastomosis	Diameter measurement in grayscale
7	Arterial anastomosis	Spectral Doppler w/ PSV measurement
8	Arterial/Prox end of graft	Long, with and without color
9	Arterial/Prox end of graft	APDiameter measurement in grayscale
10	Arterial/Prox end of graft	Flow volume
11	Arterial/Prox end of graft	Spectral Doppler w/ PSV measurement
12	Venous/Distal end of graft	Long, with and without color
13	Venous/Distal end of graft	APDiameter measurement in grayscale
14	Venous/Distal end of graft	Flow volume
15	Venous/Distal end of graft	Spectral Doppler w/ PSV measurement
16	Venous anastomosis	Long, with and without color
17	Venous anastomosis	Diameter measurement in grayscale
18	Venous anastomosis	Spectral Doppler w/ PSV measurement
19	Outflow vein, 2 cm from anastomosis	Long, with and without color
20	Outflow vein, 2 cm from anastomosis	AP Diameter measurement in grayscale
21	Outflow vein, 2 cm from anastomosis	Flow volume
22	Outflow vein, 2 cm from anastomosis	Spectral Doppler w/ PSV measurement
23	Outflow vein, 5 cm from anastomosis	Long, with and without color
24	Outflow vein, 5 cm from anastomosis	APDiameter measurement in grayscale
25	Outflow vein, 5 cm from anastomosis	Flow volume
26	Outflow vein, 5 cm from anastomosis	Spectral Doppler w/ PSV measurement

**NOTE: Minimal representative images of the straight graft are listed above and should include additional documentation of any pathology that may be present**

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### Loop Graft Evaluation

1	Native inflow artery, 2 cm prox to anastomosis	Long, with and without color
2	Native inflow artery, 2 cm prox to anastomosis	Spectral Doppler w/ PSV measurement
3	Native inflow artery, 2 cm dist to anastomosis	Long, with and without color
4	Native inflow artery, 2 cm dist to anastomosis	Spectral Doppler w/ PSV measurement
5	Arterial anastomosis	Long, with and without color
6	Arterial anastomosis	Diameter measurement in grayscale
7	Arterial anastomosis	Spectral Doppler w/ PSV measurement
8	Arterial/Prox end of graft	Long, with and without color
9	Arterial/Prox end of graft	AP Diameter measurement in grayscale
10	Arterial/Prox end of graft	Flow volume
11	Arterial/Prox end of graft	Spectral Doppler w/ PSV measurement
12	Arterial Mid graft	Long, with and without color
13	Venous/Dist end of graft	Long, with and without color
14	Venous/Dist end of graft	AP Diameter measurement in grayscale
15	Venous/Dist end of graft	Flow volume
16	Venous/Dist end of graft	Spectral Doppler w/ PSV measurement
17	Venous anastomosis	Long, with and without color
18	Venous anastomosis	Diameter measurement in grayscale
19	Venous anastomosis	Spectral Doppler w/ PSV measurement
20	Outflow vein, 2 cm from anastomosis	Long, with and without color
21	Outflow vein, 2 cm from anastomosis	AP Diameter measurement in grayscale
22	Outflow vein, 2 cm from anastomosis	Flow volume
23	Outflow vein, 2 cm from anastomosis	Spectral Doppler w/ PSV measurement
24	Outflow vein, 5 cm from anastomosis	Long, with and without color
25	Outflow vein, 5 cm from anastomosis	AP Diameter measurement in grayscale
26	Outflow vein, 5 cm from anastomosis	Flow volume
27	Outflow vein, 5 cm from anastomosis	Spectral Doppler w/ PSV measurement

**NOTE:** Minimal representative images of the straight graft are listed above and should include additional documentation of any pathology that may be present

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## **PROCESSING:**

- Review examination data
- Export all images to PACS
- Note any study limitations

## **CHANGE HISTORY:**

<b>STATUS</b>	<b>NAME &amp; TITLE</b>	<b>DATE</b>	<b>BRIEF SUMMARY</b>
<b>Submission</b>	Mark Reddick, MD	<b>6/9/2016</b>	Submitted
<b>Approval</b>	David Fetzer, MD, Director	<b>6/20/2016</b>	Approved
<b>Review</b>	Eddie Hyatt	<b>12/15/2018</b>	Reviewed
<b>Revisions</b>	David Fetzer	<b>1/2/2019</b>	Updated Diagnostic Criteria
	Christine Chen	<b>11/10/19</b>	Added tables with measurements to correspond to protocols uploaded into US machines. Removed 10 cm outflow vein measurement from graft evaluation.
	Rehan Quadri, Skye Smola	<b>7/3/23</b>	Divided protocol image requirements into AVF, AVG Loop, and AVG Straight/Line; added reference anatomical images of AVF, AVG, and HeRO Grafts

**US DIALYSIS ACCESS DIAGNOSTIC CRITERIA**

<b>Normal Access</b>	<b>Findings</b>
Flow Pattern	Hyperdynamic in nature with low resistance
PSV	Range 100-400 cm/s
EDV	Range 60-200 cm/s
Diameter	Uniform throughout without masses/aneurismal dilatation
Volume	Range 500-1600 ml/min
Intimal Hyperplasia	Minimal
<b>Fistula/Graft Flow Volume Range</b>	
Normal Fistula/Graft	500-1600 ml/min
Compromised Graft	≤500 ml/min
Venous Hypertension/CHF	>1600 ml/min
<b>Fistula Stenosis Abnormal Findings</b>	
Flow Velocity	>400 cm/s with presence of stenotic fistula/inflow artery ratio 3.0 or greater indicates >50% stenosis
Flow Ratio	>3.0 velocity ratio between the AVF and the inflow artery or access vein and outflow vein indicates outflow stenosis of >50%
<b>Graft Stenosis Abnormal Findings</b>	
Mild	Focal increase in velocity within the body of the graft <50% from one segment to the next, flow turbulence noted distal to stenotic segment
Moderate	51-99% increase in flow velocity from one segment to the next, flow turbulence noted distal to stenotic segment
Severe	100% or greater increase in flow velocity from one segment to the next, turbulence noted distal to stenotic segment (Hemodynamically significant with <b>&gt;50% diameter reduction</b> )

**Dialysis Access Interpretation:**

- Arterial steal is suggested when a marked reduction (>50%) in the PPG waveform’s pulsatility and amplitude is noted when compared to the opposite limb with digital pressure of 60 mmHg or less in the limb used for the dialysis access.

**APPENDIX:**

**Classification of stenosis and their associated ultrasound imaging findings**

<b>Classification</b>	<b>Velocity (cm/s)</b>	<b>Imaging Characteristics</b>
<b>Normal</b>	<ul style="list-style-type: none"> <li>* Mid graft PSV &gt; 150 cm/s</li> <li>* Anastomosis PSV &gt; 300 cm/s,</li> <li>chaotic, disorganized flow</li> </ul>	<ul style="list-style-type: none"> <li>* No visible narrowing</li> <li>* Distended outflow veins</li> <li>* Aneurysms, puncture sites,</li> <li>perigraft fluid may be visible</li> </ul>
<b>Moderate stenosis</b>	<ul style="list-style-type: none"> <li>* Ratio of PSV at stenosis to PSV at 2 cm beyond stenosis &lt;3</li> </ul>	<ul style="list-style-type: none"> <li>* Decrease in lumen diameter</li> <li>* Echogenic narrowing</li> <li>* Wall abnormalities</li> </ul>
<b>Severe stenosis</b>	<ul style="list-style-type: none"> <li>* Marked velocity acceleration at stenotic area</li> <li>* Ratio of PSV at stenosis to PSV 2 cm beyond stenosis &gt;3</li> </ul>	<ul style="list-style-type: none"> <li>* Intraluminal echogenicity with &lt;2 mm lumen or &gt;50% diameter reduction</li> <li>* Marked reduction in lumen diameter with color Doppler</li> </ul>
<b>Inflow stenosis</b>	<ul style="list-style-type: none"> <li>* Increased PSV at the site of the stenosis with monophasic and diminished waveforms distally</li> <li>* Flow acceleration with graft compression at the outflow anastomosis</li> </ul>	<ul style="list-style-type: none"> <li>* Intraluminal echogenicity &lt;2 mm lumen at velocity acceleration</li> </ul>
<b>Outflow stenosis</b>	<ul style="list-style-type: none"> <li>* Mid graft PSV &lt; 100 cm/s</li> <li>* Distal vein PSV &gt; 300 cm/s</li> <li>* Velocity at the proximal anastomosis will diminish in proportion to severity of venous outflow stenosis</li> </ul>	<ul style="list-style-type: none"> <li>* Intraluminal echogenicity with &lt; 2 mm lumen at velocity acceleration</li> <li>* Prominent outflow veins around outflow</li> </ul>
<b>Occlusion</b>	<ul style="list-style-type: none"> <li>* No Doppler signal</li> </ul>	<ul style="list-style-type: none"> <li>* Intraluminal echogenicity</li> <li>* Graft walls collapsed</li> <li>* Occluded vein may not be visible</li> </ul>



[Ultrasound Evaluation Before and After Hemodialysis Access | Radiology Key](#)

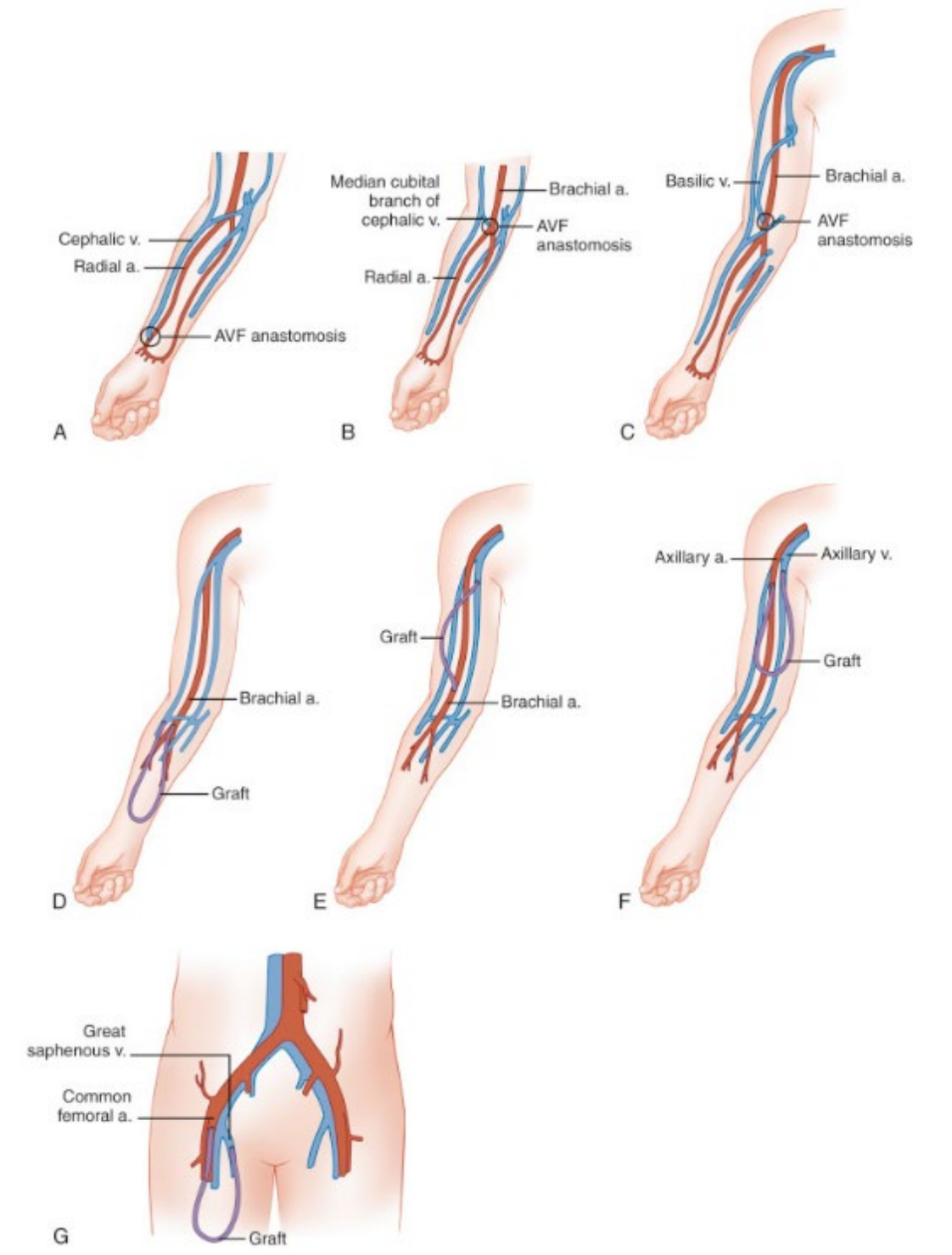
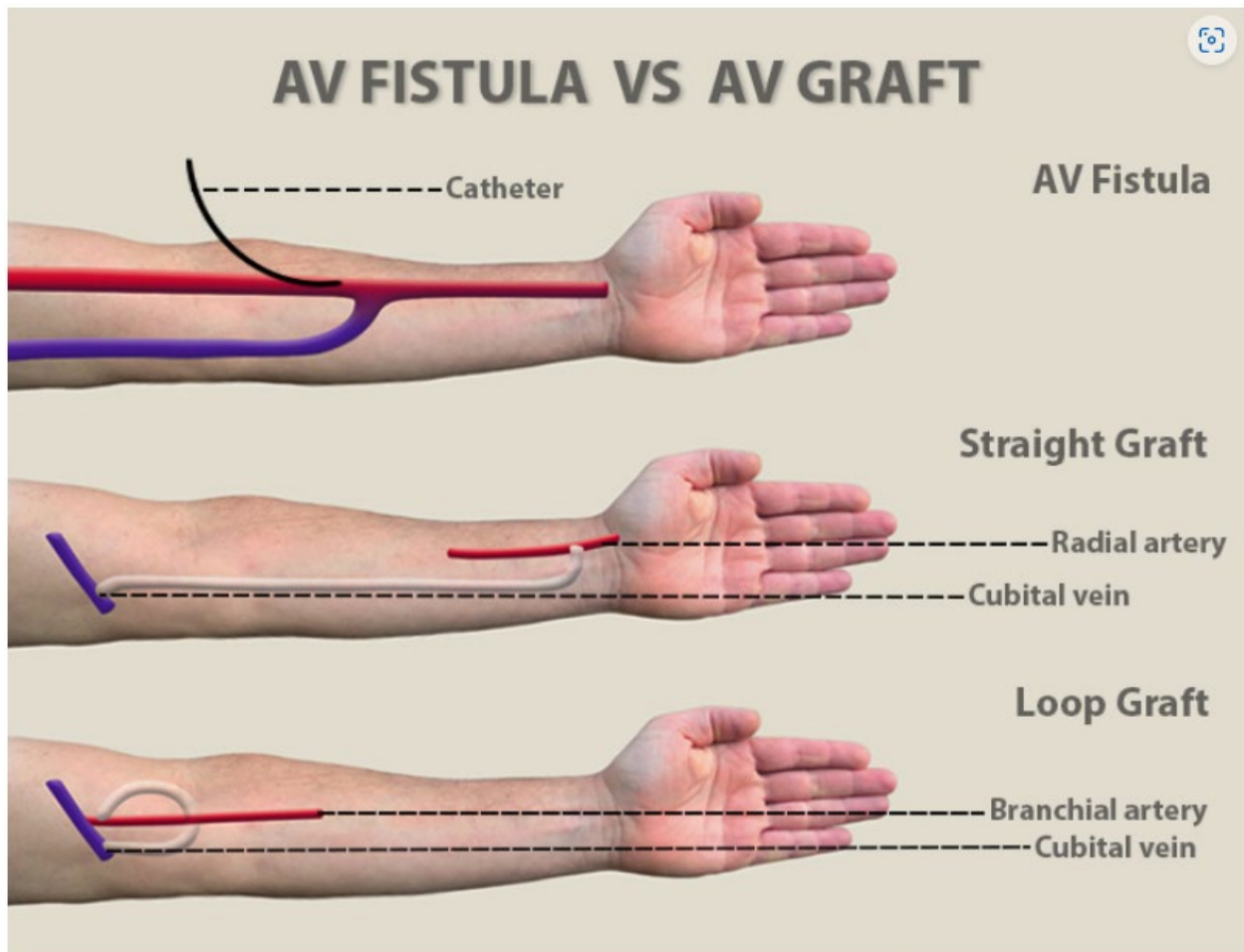


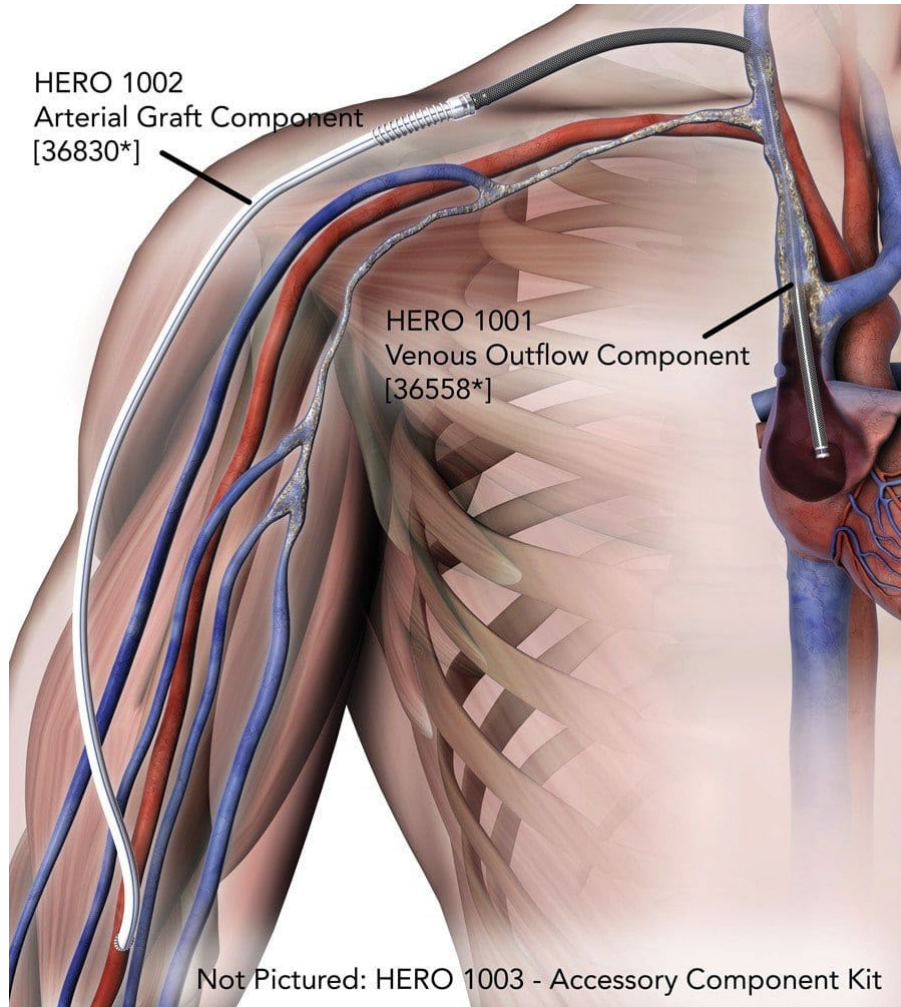
FIG. 14.1

Anatomic drawings of the most common hemodialysis access points. The three most common arteriovenous fistulas (AVFs) are radiocephalic fistula at the wrist (A), brachiocephalic fistula at the antecubital fossa (B), and brachio-basilic vein transposition (C). The four most common grafts are forearm loop graft (D), upper arm straight graft (E), axillary loop graft (F), and thigh graft (G). a., Artery; v., vein.

[AV Fistula vs. AV Graft - Vein & Endovascular Medical Care \(astraveinvascular.com\)](http://astraveinvascular.com)



HeRO Graft - [HeRO® Graft Reimbursement - Merit Medical; https://vimeo.com/153259990](https://vimeo.com/153259990)



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