Wires, Catheters, and More: A Primer for Residents and Fellows Entering Interventional Radiology

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Overview

- Radiology residents and fellows entering interventional radiology often lack knowledge regarding basic interventional equipment and nomenclature.
- This presentation is a pictorial guide that showcases basic needles, wires, catheters, and sheaths as well as their identifying features and nomenclature.

Learning Objectives

- Identify the nomenclature, appearance, properties, and uses of basic needles, wires, sheaths, and catheters used in interventional radiology.
- Recognize the interrelationships of wire diameter, needle gauge, and catheter and sheath French measurements.
- Discuss selection of the appropriate needle, catheter, wire, and sheath in practice cases that describe commonly encountered procedures in interventional radiology.

Basic Conversions and Measurements

Needle diameter is measured in gauges.

- The lower the gauge, the larger the needle.

Catheter and sheath diameters are measured in French (F) units.

- 1 F = 1/3 mm
- 1 F = 0.013 inch

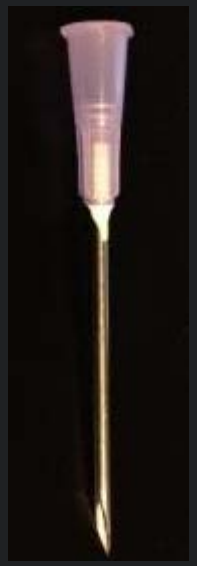
Wire diameter is measured in inches.

- 0.018 and 0.035 wires are 0.018 and 0.035 inch in diameter, respectively.

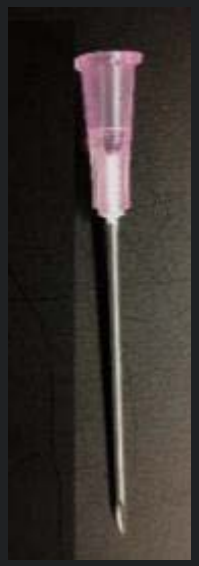
Needles

- Needles are color coordinated.
- Must have a 22-gauge or larger needle for an 0.018-inch wire.
- Must have an 18-gauge or larger needle for a 0.035-inch wire.
- 21-, 19-, and 18-gauge needles are often used for arterial and venous access.
- 22- and 21-gauge needles can be used for small targets (eg, small abscesses, calices, and small vessels).
- Larger needles (eg, 18 gauge) can be used for bigger targets (eg, large abscesses, larger vessels that are easily accessible) and biopsies.

Needles

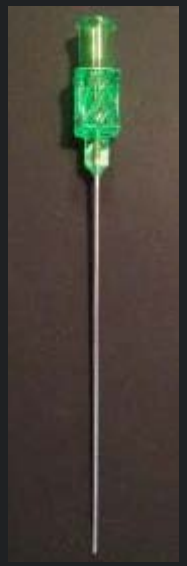


16 gauge



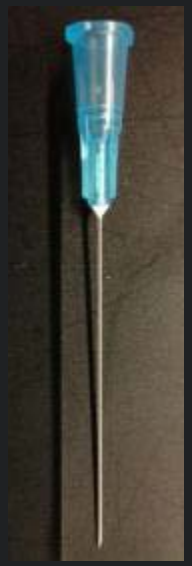
18 gauge

20 gauge*



21 gauge

22 gauge*



25 gauge

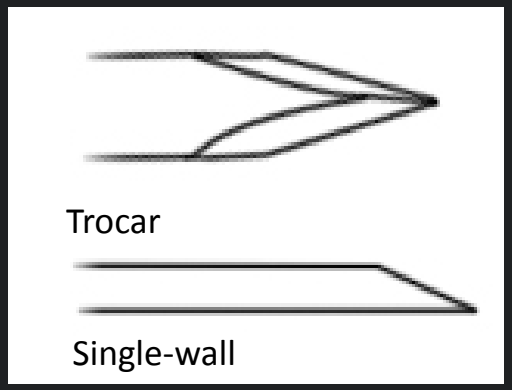
Chiba needle
22 gauge

Trocar needle
21 gauge

*Safety lock attached. (All needles shown are produced by Cook Medical, Bloomington, Ind.)

Needles

- Single-wall: Hollow core without an inner cutting needle to fill the lumen. There is a single beveled (angled) edge with a small notch on the hub that corresponds to the bevel. These are the most commonly used needles for interventional procedures. They are more steerable than trocar needles because a beveled needle will bend away from the bevel.
- Trocar: Two-part needle system with an outer beveled or nonbeveled cannula and a removable inner sharp three-sided trocar needle (*trois carre* = three sided). Not steerable because of the three-sided tip. Commonly 18 or 21 gauge and 10, 15, or 20 cm in length.



- Chiba: Two-part high-gauge needle system with a beveled edge that allows steering. Commonly 20 or 22 gauge and 15 or 20 cm in length. Used for biliary and renal access.
- Echo-tip trocar: Rough tip that increases visualization at ultrasonography (US).

Wires

Wires have three main properties: diameter, stiffness, and hydrophilic or nonhydrophilic composition.

There are three basic types of wire categorized according to the above properties:

- Access wire: simple short wire; used for access and often quickly exchanged
- Maneuver wire: often floppier body; tip is often curved, floppy, and hydrophilic; commonly used to subselect vessels
- Rail wire: stiff; provides a stable platform for exchanges, balloons, stents, and maintaining access

Wires

- Hydrophilic wires: useful in a fluid environment and when a narrow area must be traversed and less resistance is desired (eg, in small vessels, in the pylorus for percutaneous gastrostomy).
  - Hydrophilic wires are slippery when wet and sticky when dry (flush them and keep them wet).

- Nonhydrophilic wires: easier to grip, do not become sticky, may offer more resistance when traversing narrow areas.

Wires

- Both hydrophilic and nonhydrophilic wires are used for vascular work; however, hydrophilic wires are often used to maneuver through smaller vessels.
- Must use at least a 22-gauge needle or 3-F catheter or sheath for an 0.018-inch wire.
- Must use at least an 18-gauge needle or 5-F catheter or sheath for a 0.035-inch wire.
  - Can get access initially by using a Cope wire introduction system (Cook Medical). Start with a 21- or 22-gauge needle, then place a Cope wire through the needle. Next, exchange the needle for a 5-F catheter or sheath over the Cope wire. Remove the Cope wire and place the desired 0.035-inch wire.
- Wires can be placed through a torque device to help grip and steer the wire.

Torque device (Abbott Vascular; Abbot Park, Ill)

Wires Commonly Used at Our Institution

Diameter	Hydrophilic		Nonhydrophilic	
	- ---Stiffness--- +		- ---Stiffness--- +	
0.018”	Glidewire	V18	 Nitrex	 Cope
	- ---Stiffness--- +		- ---Stiffness--- +	
0.035”	 Glidewire	 Stiff Glide	Road Runner	 Bentson
			 New Yorker  Rosen	 Amplatz
				 Lunderquist  Meier

Wires

Hydrophilic 0.018-inch

- Glidewire (Terumo Medical, Somerset, NJ): maneuver wire with curved or straight tip; torque device can be used to help maneuver the wire; black.

- V18 (Boston Scientific; Marlborough, Mass): rail wire; very stiff; floppy end but not curved; gray.

Wires

Hydrophilic 0.035-inch

- Glidewire (Terumo Medical): commonly used maneuver wire; torque device can be used to help maneuver the wire; black.

- Stiff Glide (Terumo Medical): commonly used maneuver or rail wire; as stiff as Amplatz wire (Boston Scientific); comes in a blue reel, which differentiates it from regular Glidewire; black.

- Roadrunner (Cook Medical): rail wire; very stiff; floppy tip; white.

Wires

Nonhydrophilic 0.018-inch

- Nitrex (ev3; Plymouth, Minn): not curved but used as a maneuver wire; very flexible; gold.

- Cope (Cook Medical): very commonly used access wire; comes in a micropuncture kit; gray.

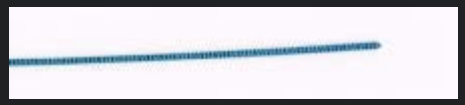
Wires

Nonhydrophilic 0.035-inch

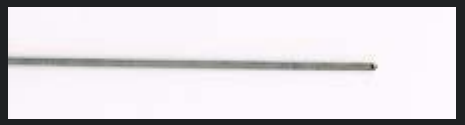
- Bentson (Cook Medical): very floppy tip; could be used to maneuver or as a rail wire; relatively stiff; green.

- New Yorker (Cook Medical): floppy portion of the tip is stiffer than Bentson wire; can be used to maneuver or as a rail wire; green.

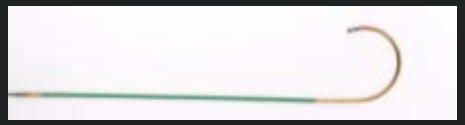
- Rosen (Cook Medical): stiff curved tip; rail wire; green. *J wire* is a generic term for wires with this curved tip, and there are many types. A J wire is a standard component of central line kits.



- Amplatz (Boston Scientific): floppy tip; very stiff; rail wire; blue.



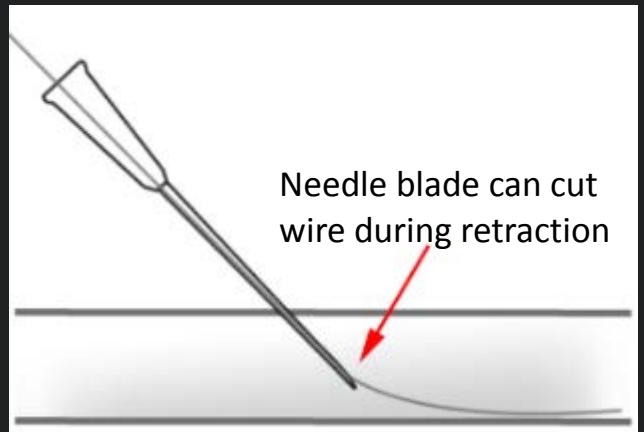
- Lunderquist (Cook Medical): incredibly stiff; rail wire; gray.



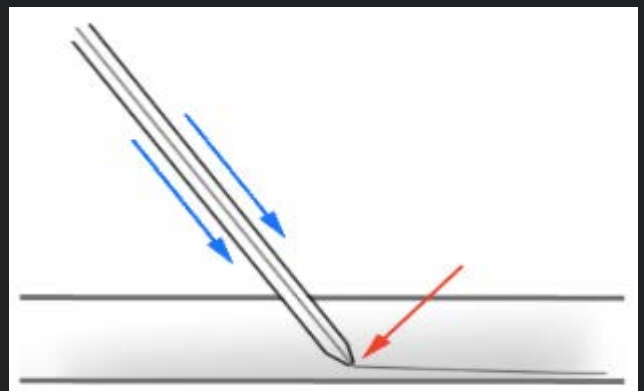
- Meier (Boston Scientific): somewhat floppy tip; very stiff; rail wire; green and gold.

Wires

Troubleshooting



Shearing (arrow)



Kinking (blue arrows = forward pressure, red arrow = kink in line)

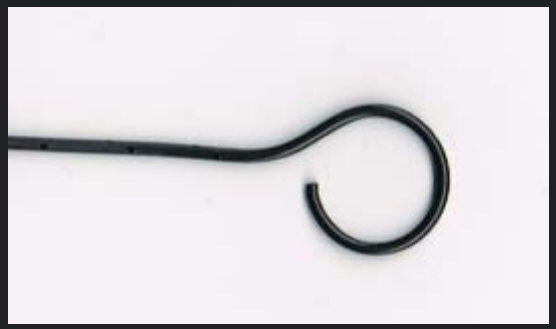
- Shearing: If a wire is retracted too forcibly through a bladed needle or retracted when in soft tissue instead of a vessel, the wire can shear off and will be retained in the patient. If you cannot advance or retract the wire, you may need to retract the needle and wire together to prevent shearing. Shearing can happen with Cope wires as well as with the coating of hydrophilic wires.
- Kinking: If you try to force a stiff dilator or catheter at too acute an angle, you can potentially kink a nonglide wire. The kink does not go away and makes it difficult to advance the catheter. Solutions are to exchange out the wire or pull back on the wire so that the kink is inside the catheter or sheath. This straightens it out somewhat, and you can sometimes advance the catheter to where you need it.

Catheters

- There are numerous catheter types; we describe the most commonly used types at our institution.
- Main distinctions: end hole versus side hole, selective versus nonselective, glide versus nonglide, catheter diameter and shape.
- Many come in hydrophilic and nonhydrophilic forms. Glide catheters are more floppy (less supportive) but glide more easily through vessels.
- Always advance a catheter over a wire because advancing the catheter without a wire can scrape and damage the vessel lumen.

Catheters

General (Nonselective)

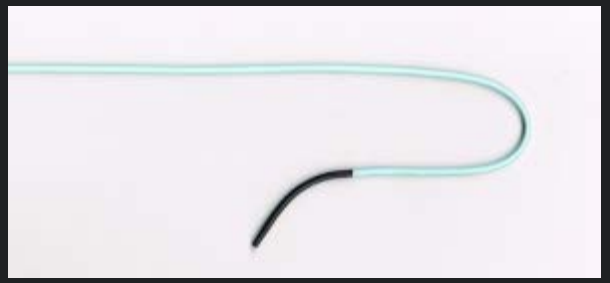


- Pigtail or Omniflush (Angiodynamics, Latham, NY): pigtail end; multiple side holes on the straight and curved portions of the catheter; used for venography and arteriography.

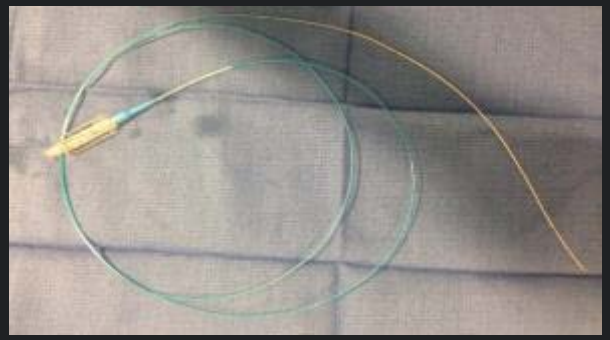
Catheters

Selective

- Glidecath (Terumo Medical): hydrophilic; many tip types; commonly a 45° angle; very commonly used.



- Simmons (Angiodynamics): reverse curve; very commonly used for celiac, superior or inferior mesenteric, and renal arteries; Sim 1–3 catheters have different lengths of the reverse-curve component, with Sim 3 being the longest.

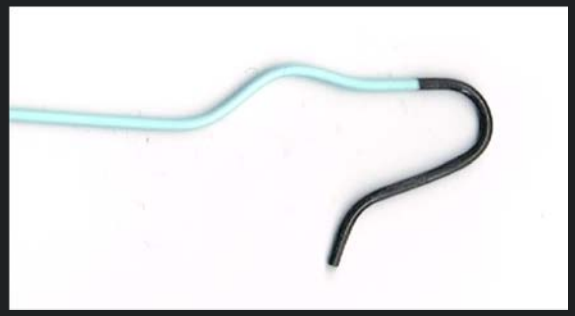


- Microcatheter (Renegade; Boston Scientific): often used as a delivery catheter (for beads or coils); Renegade is 3 F and can fit inside a 5-F catheter; used with a microwire (≤0.014 inch). (Photograph courtesy of Vicki Migues, RT, Johns Hopkins Hospital, Baltimore, Md.)

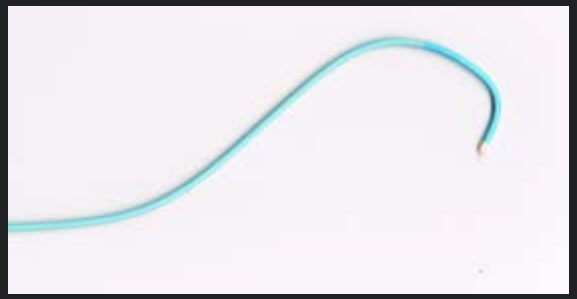
Catheters

Selective

- SOS (Angiodynamics): reverse curve; curved tip is different from Simmons catheter but has many of the same uses. (Photograph courtesy of Vicki Migues, RT, Johns Hopkins Hospital, Baltimore, Md.)



- Mikaelson (Angiodynamics): shape helps anchor the catheter in place by increasing opposition against the aortic wall.



- Cobra (Cordis; Fremont, Calif): similar uses to those of SOS and Mikaelson; decreased curve allows easier advancement over a wire.

Sheaths

- Sheath assembly: Always flush sheath before use. Dilator fits in sheath. Sheath and dilator slide over a wire.

- Sheath French size is a measure of its INNER diameter (and determines which size catheter can fit in the sheath), unlike catheter size, which is measured according to the outer diameter.

- Select the sheath size based on the goal of the procedure. The packet insert of the interventional device (eg, balloon or stent) describes which sheath size is needed.

Sheaths

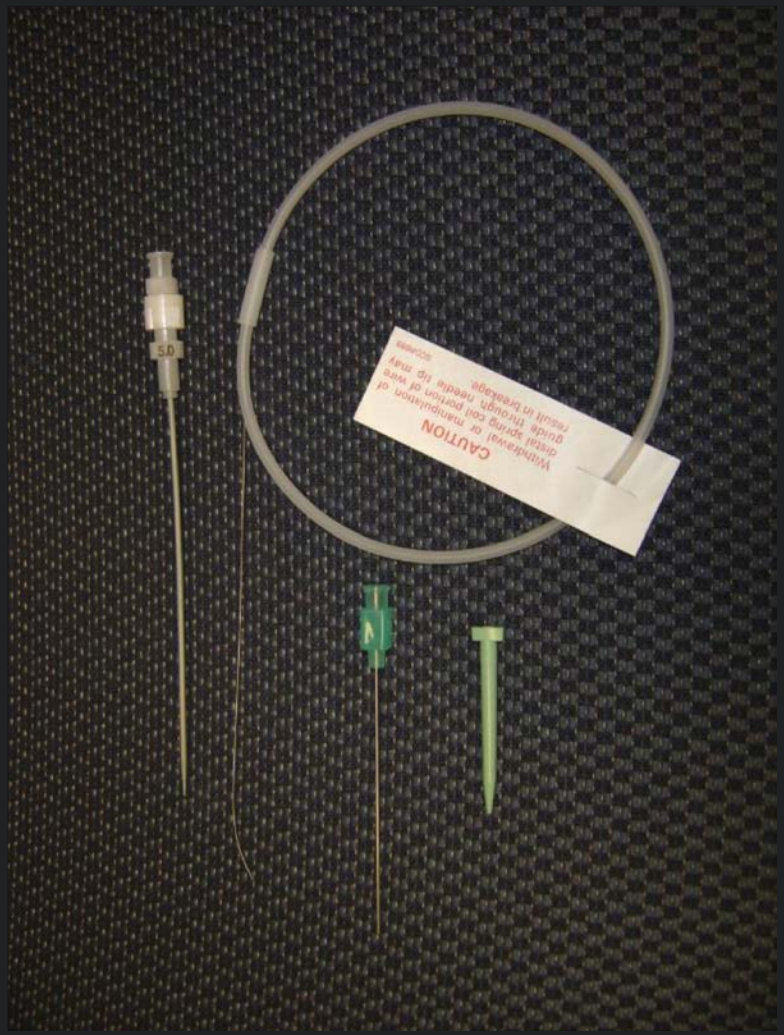
- Sheaths lend support and provide controlled access.
- Can be curved or straight.

- 4-F sheath = red
- 5-F sheath = gray
- 6-F sheath = green
- 7-F sheath = orange
- 8-F sheath = blue
- 9-F sheath or larger = black

Sheath with dilator (Terumo Medical). (Photograph courtesy of Vicki Migues, RT, Johns Hopkins Hospital, Baltimore, Md.)

- Always advance the sheath over the inner dilator.

Micropuncture Set

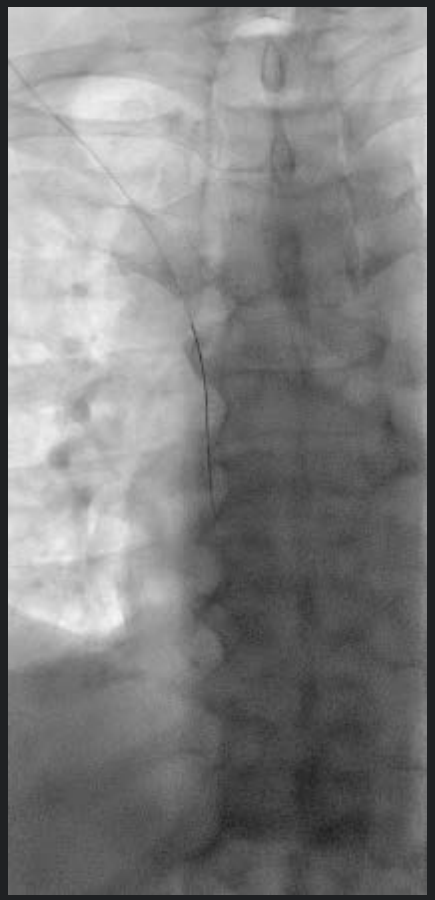


Micropuncture set (Cook Medical). (Photograph courtesy of Vicki Migues, RT, Johns Hopkins Hospital, Baltimore, Md.)

- A basic micropuncture set is used for initial access in most vascular procedures.
- Generally includes a 21-gauge needle, 5-F (sometimes 4-F) sheath, and 40-cm-long 0.018-inch Cope wire.
- General steps (Seldinger technique):
  - Get access with 21-gauge needle
  - Place Cope wire through needle
  - Remove needle over Cope wire and replace with micropuncture sheath
  - Remove guidewire and advance 0.018-inch wire of choice through 5-F sheath

Case 1: Tunneled Hickman Catheter

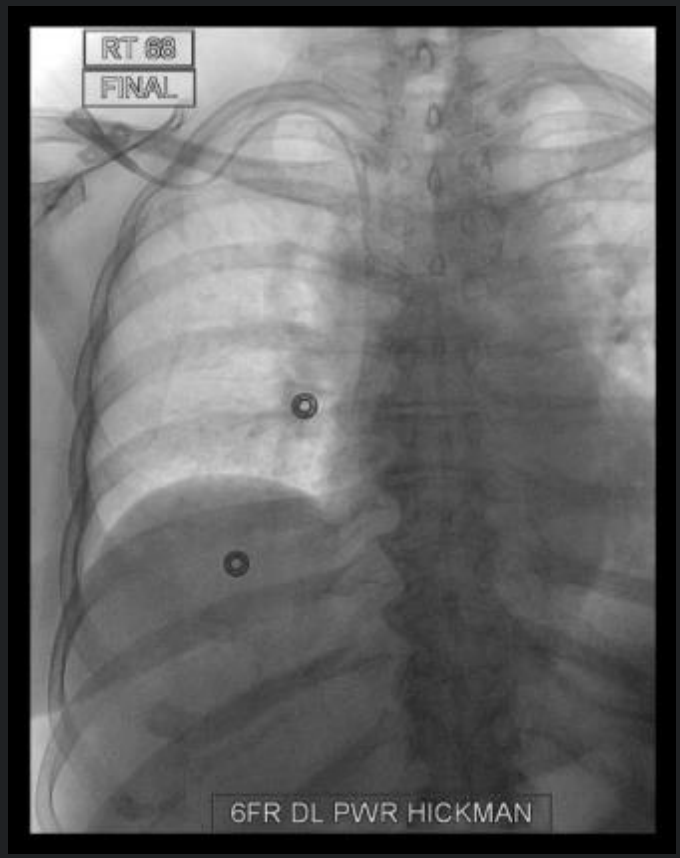
- Gain access to internal jugular vein with micropuncture set:
  - 21-gauge needle into internal jugular vein
  - Cope wire into needle
- Keeping the Cope wire in place, remove the needle over the wire. Advance the 5-F micropuncture sheath over the Cope wire.
- Advance the Cope wire to the superior cavoatrial junction (left image) and clamp wire at the hub. Remove the Cope wire and clamp and set them aside to measure catheter length. Place a J wire (from central line kit), advance it to the inferior vena cava, and lock it with a flow switch (right image).
- Identify where the skin incision will be made to place the Hickman catheter (various methods; generally two to three finger widths below the junction of the medial and middle one-third of the clavicle). Make a 1-cm skin incision along the chest wall in this area.



(Case continues.)

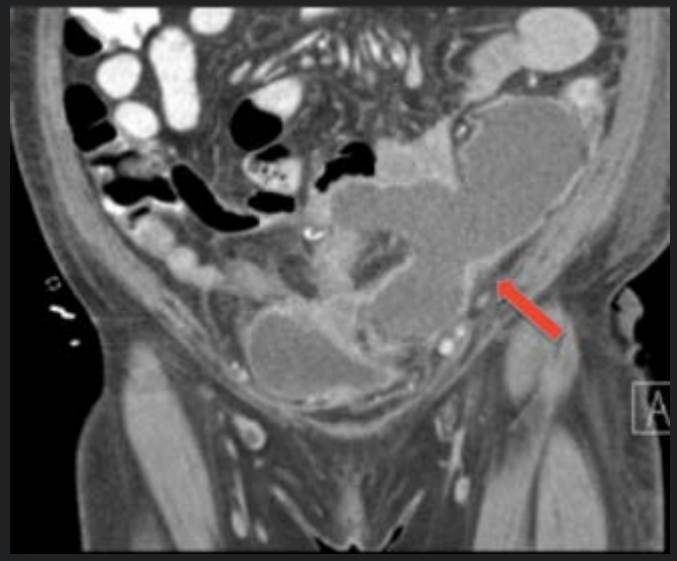
Case 1: Tunneled Hickman Catheter

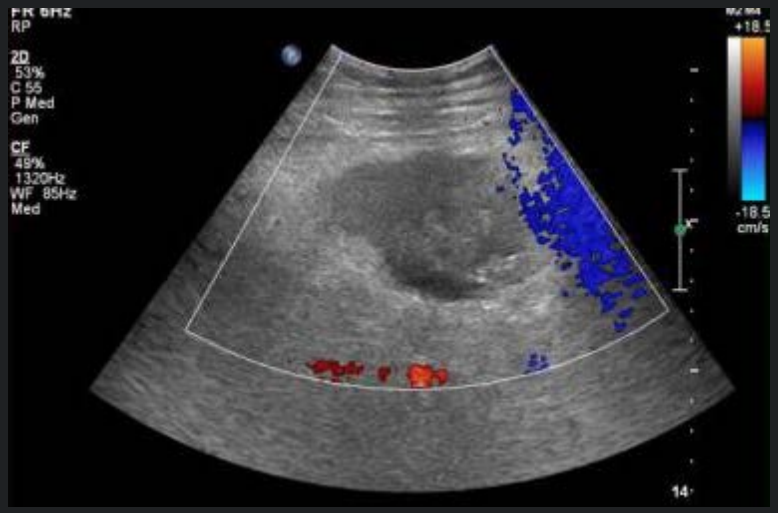
- Cut the Hickman catheter to the appropriate length by measuring the distance from the skin incision site to the 5-F sheath hub. Measure the length of the Cope wire (set aside earlier) from the tip to the clamp. Add these lengths to get the distance from the skin incision site to the superior cavoatrial junction. Cut the Hickman catheter to this length.
- Connect a blunt tunneling device to the Hickman catheter and use blunt dissection to connect the skin incision to the venotomy site.
- Pull the tunneling device and catheter through the venotomy site.
- Exchange the micropuncture sheath for a peel-away sheath (from central line kit) over the J wire.
- Place the catheter through the 5-F peel-away sheath and peel the sheath away while holding the catheter in place. (Sheath size may vary by manufacturer.)
- Confirm catheter tip position at the superior cavoatrial junction (image at right).



Case 2: Abdominal Abscess Drainage

- Identify abscess at computed tomography (CT) (red arrow in top image) or US (bottom image).
- For an accessible large abscess, use an 18-gauge trocar needle.
  - Large trocar needle is easy to visualize at US or CT.
  - Does not flex and is easier to maneuver.
  - Can place a 0.035-inch wire through the needle without having to increase the needle size.





(Case continues.)

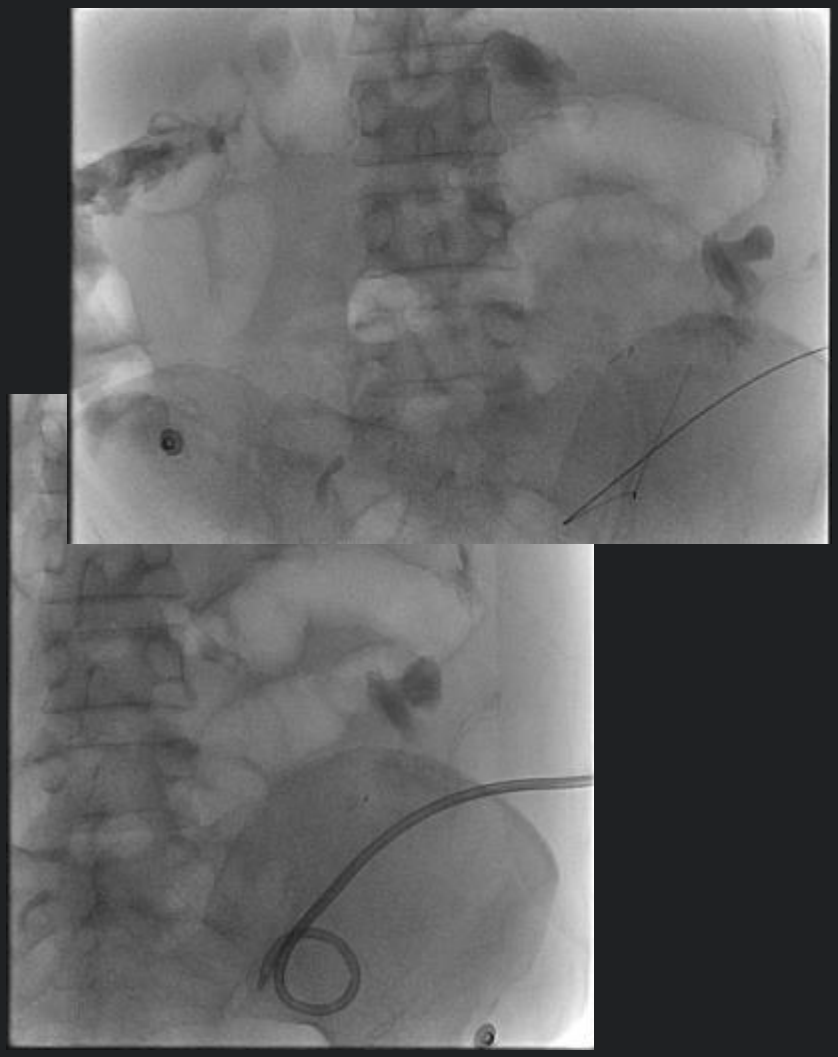
Case 2: Abdominal Abscess Drainage

- For a small abscess or with a small access window, start with a 21- or 22-gauge trocar or nontrocar needle.
  - More difficult to see a small needle, but less harm is done with multiple needle sticks.
  - Confirm access by aspiration of pus or with injection of contrast material.
  - Increase to a 0.035-inch wire with use of a micropuncture set as previously described.

(Case continues.)

Case 2: Abdominal Abscess Drainage

- 0.035-inch wire of choice is Rosen or Amplatz (both are very stable and provide an excellent platform for drain placement). Place wire into the collection (top image).
- Remove needle and place desired drainage catheter over the wire. May require serial dilations.
- Remove wire.
- Under fluoroscopic guidance, inject contrast material through the drain to confirm drain placement.
- Secure the catheter loop by pulling the attached string. Suture the drainage catheter into position for security (bottom image).



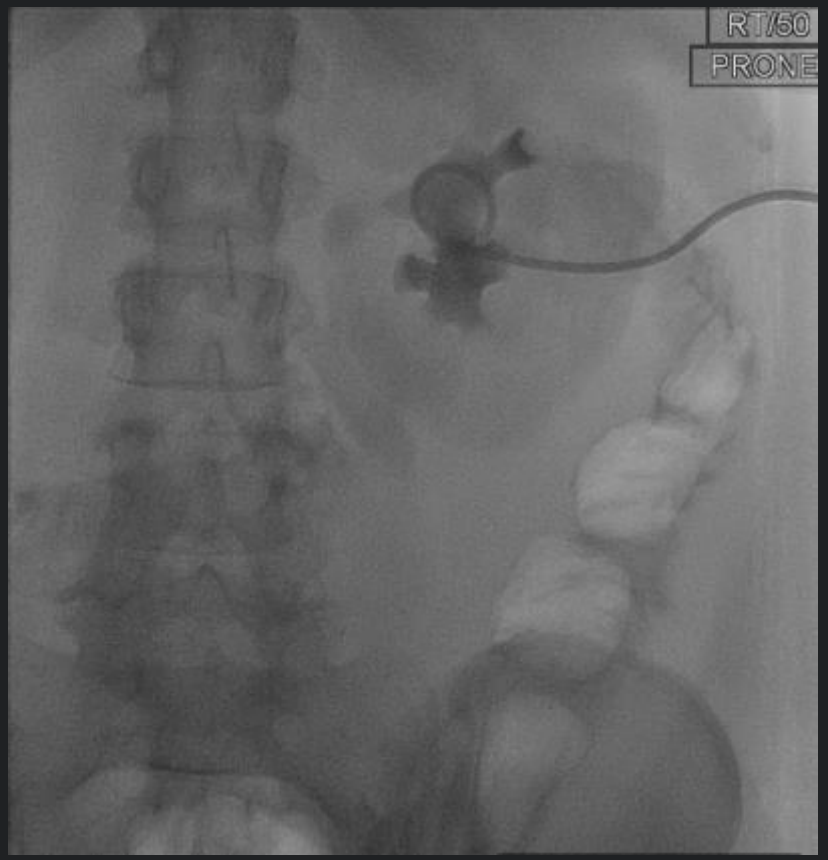
Case 3: Percutaneous Nephrostomy

- Identify the calyx of interest at US, ideally a posterior or peripheral calyx to avoid renal hilar blood vessels (top image).
- Place a 21-gauge trocar or 22-gauge Chiba needle into the calyx with US guidance. Inject contrast agent to confirm placement into the calyx and place an 0.018-inch Nitrex wire (bottom image). Place a 5-F sheath over the wire and exchange for a 0.035-inch Amplatz wire.
- If an 18-gauge needle is used, an Amplatz wire can be directly placed into the calyx (an 18-gauge or larger needle is needed to directly place a 0.035-inch wire).

(Case continues.)

Case 3: Percutaneous Nephrostomy

- Advance the Amplatz wire through the renal pelvis and into the ureter.
- Exchange the catheter for the needle over the Amplatz wire.
- Allow the pigtail catheter to form its natural pigtail loop in the renal pelvis. Confirm its final position with contrast-enhanced fluoroscopy.
- Once the 0.035-inch Amplatz wire is in place and the 5-F sheath (if used) is removed, place an 8-F pigtail catheter over the wire. Serial dilations may be needed.
- Secure the catheter loop by pulling on and then locking the string (image at right).



Case 4: Liver Chemoembolization

- Gain access with micropuncture set:
  - 21-gauge needle into femoral artery
  - Cope wire into needle (top image)
- Exchange needle for a 5-F sheath over the Cope wire.
- Placing a 5-F sheath allows you to remove the Cope wire and place a 5-F Sim or SOS catheter (excellent for celiac axis stability) over a 0.035-inch glide wire (excellent for vessel maneuverability).
- Guide the Sim or SOS catheter and glide wire to the celiac axis and inject contrast agent (bottom image).

(Case continues.)

Case 4: Liver Chemoembolization

- Once in the celiac axis, exchange the 0.035-inch glide wire for a microcatheter over a microwire to subselect the hepatic artery of interest (left hepatic artery in image at right).
- Inject microbeads.
- After delivery of the chemoembolic agent, inject contrast agent intravenously by hand to confirm adequate vessel stasis.

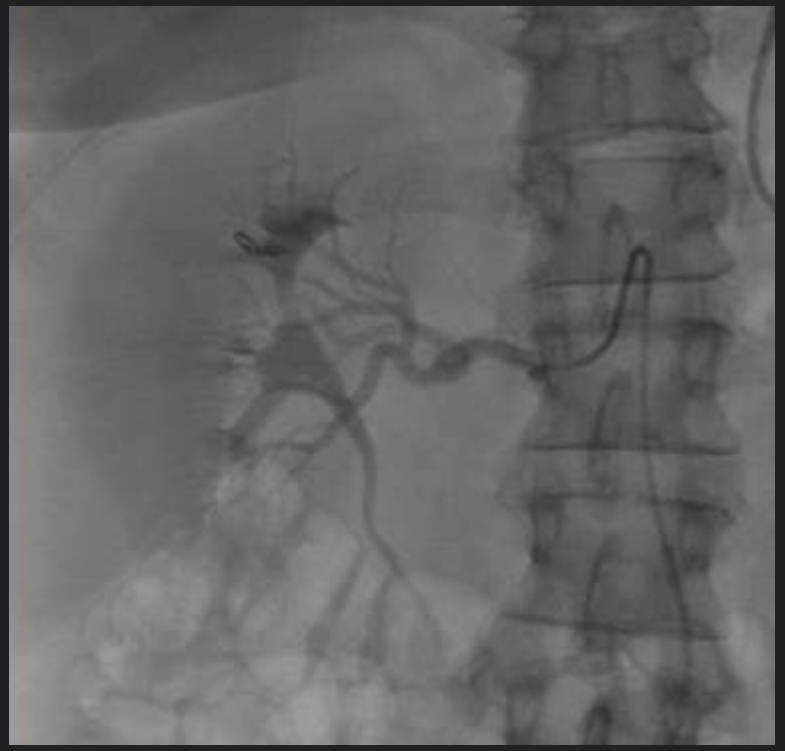
Case 5: Renal Arterioplasty

- Identify the stenosed renal artery at angiography. The balloon chosen should match the diameter of the normal renal artery. For example, if the renal artery measures 3 mm at the stenosis and 7 mm elsewhere, a 7-mm balloon is required. Read the package insert for the 7-mm balloon to determine what size French sheath is needed.
- Gain access with micropuncture set:
  - 21-gauge needle into femoral artery
  - Cope wire into needle (image at right)
- Exchange needle for 5-F sheath over Cope wire.
- Place Bentson wire into 5-F sheath to provide stability for exchange of sheath.
- Exchange 5-F sheath for desired sheath (size described in package insert).

(Case continues.)

Case 5: Renal Arterioplasty

- Remove the Bentson wire and place a Sim or SOS catheter (good for renal artery access) over a 0.035-inch glide wire (good for vessel maneuverability). Guide the catheter and glide wire to the renal artery (image at right).

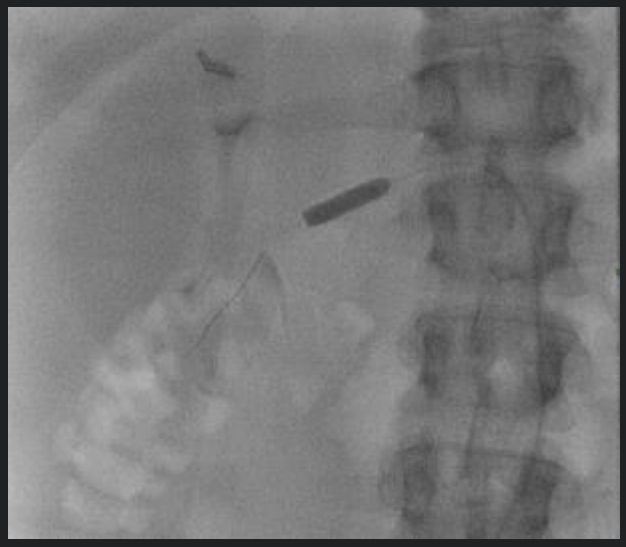


(Case continues.)

Case 5: Renal Arterioplasty

- After the catheter and glide wire are in the renal artery, exchange the glide wire for an Amplatz wire, which provides a more stable platform over which to pass the balloon (top image).

- Insert the balloon over the Amplatz wire and dilate the balloon in the renal artery (bottom image).



Conclusion

- Needles: 18-, 19-, and 21-gauge needles are most often used for vascular work; 18-gauge and larger bores are used for abscess drainage or biopsy.
- Wires: selected according to size, shape, hydrophilic or nonhydrophilic property, and strength.
  - 0.018-inch wires need a 22-gauge or larger bore needle for introduction.
  - 0.035-inch wires need at least an 18-gauge needle or 5-F catheter (placed with a 21- or 22-gauge needle and exchanged over an 0.018-inch wire) for introduction.
  - Select maneuvering wires for small vessels, tight spaces, or difficult curves. Select rail wires for stability.
- Sheath diameter is based on the internal diameter of the sheath.
- Always advance a catheter or sheath over a wire or dilator to avoid vessel injury.

Suggested Readings

Kadir S. Teaching atlas of interventional radiology: non-vascular interventional procedures. New York, NY: Thieme Medical, 2006.

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