

VASCULAR ACCESS IN HEMODIALYSIS

TEMPORARY :

- CENTRAL VENOUS CATHETER :
 - SUBCLAVIAN VEIN
 - INTERNAL JUGULAR VEIN
 - FEMORAL VEIN

PERMANENT:

- ARTERIOVENOUS FISTULA (AVF)
- GRAFTS
- PERMANENT CATHETER

PLANNING AND CHOICE OF VASCULAR ACCESS

- DIALYSIS ACCESS PLANNING SHOULD START IN CKD **STAGE G4** (GLOMERULAR FILTRATION RATE [GFR] 15–30 ML/MIN)
- THE **RATE OF DECLINE OF GFR** OVER TIME IS PERHAPS THE BEST PREDICTIVE GUIDE TO TIMELY REFERRAL AND ACCESS PLACEMENT.
- THE COMPONENTS REQUIRED FOR PATIENT-FOCUSED ACCESS PLANNING ARE:
 - 1) TIMELY AND APPROPRIATE REFERRAL
 - 2) EDUCATION
 - 3) PATIENT HISTORY AND PHYSICAL EXAM
 - 4) SUPPORTIVE INVESTIGATIONS

TIMELY AND APPROPRIATE REFERRAL

- **TIMELY REFERRAL** , INCREASES THE LIKELIHOOD FOR PLACING A NATIVE VEIN AVF AND REDUCES THE LIKELIHOOD OF TEMPORARY CVC PLACEMENT.
- WHEN GFR APPROACHES 30 ML/ MIN (CKD STAGE G4), PATIENT EDUCATION ABOUT CKD
- ARTERIOVENOUS (AV) ACCESS CREATION, THIS WILL DEPEND ON THE PATIENT'S **AGE, RATE OF CKD PROGRESSION, AND PROGNOSIS**

PATIENT AND VASCULAR ACCESS HISTORY

- HISTORY WILL SHED LIGHT ON POTENTIAL COMPLICATIONS THAT MAY OCCUR, SUCH AS FAILURE OF AN AVF TO MATURE, POTENTIAL FOR HIGH CARDIAC OUTPUT FAILURE OR AVG-ASSOCIATED STEAL SYNDROME, AND WILL NAVIGATE THE ACCESS OPERATOR TO EITHER PREEMPTIVE INTERVENTION OR CONSIDERATION OF AN ALTERNATE ACCESS
- “VESSEL-FOCUSED” HISTORY INCLUDES DETERMINING THE TYPE AND NATURE OF **PAST ACCESS PROCEDURES** (ESPECIALLY CVCS, PICC LINES, AND PACEMAKERS), PAST ACCESSSES (INTERVENTIONS REQUIRED TO FACILITATE OR MAINTAIN ITS PATENCY AND REASONS FOR LOSS), BREAST AND AXILLARY DISSECTION SURGERY, CHEST RADIATION, AND EMERGENCY VASCULAR CUT-DOWNS
- FACTORS THAT MAY AFFECT THE PERITONEUM, SUCH AS THE PRESENCE OF SIGNIFICANT PRIOR **ABDOMINAL SURGERIES**, MAY LEAD ONE TO EXCLUDE PD AND FOCUS ON HEMODIALYSIS VA.

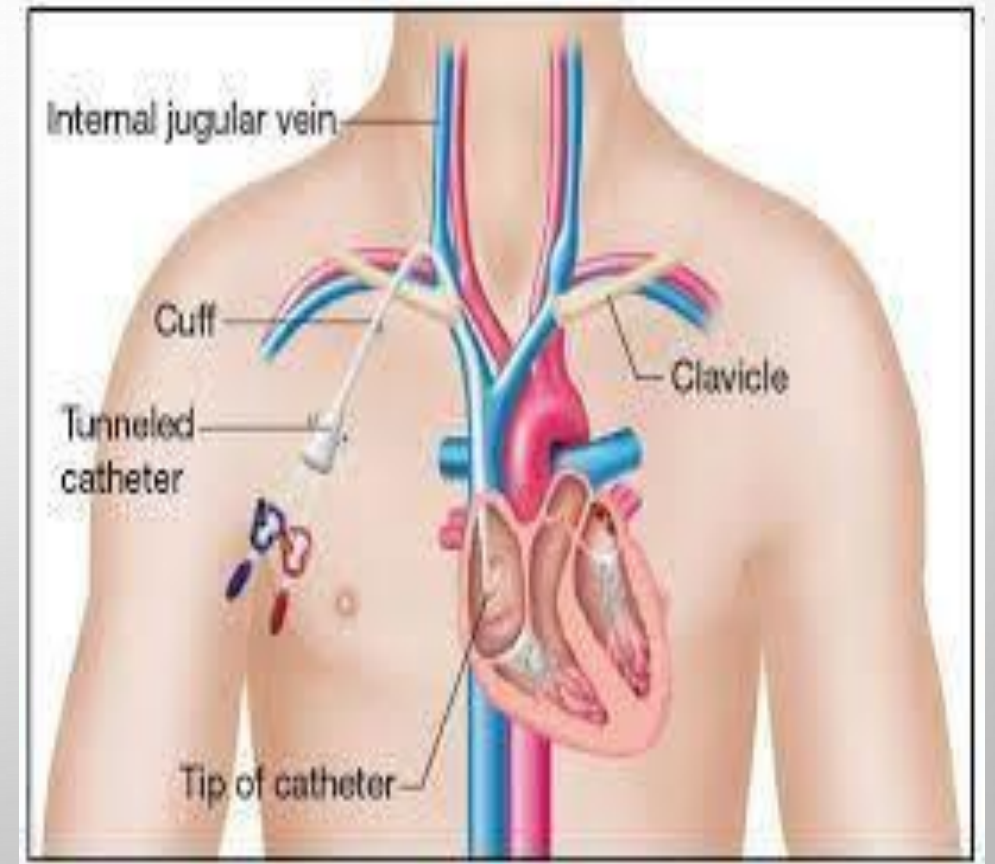
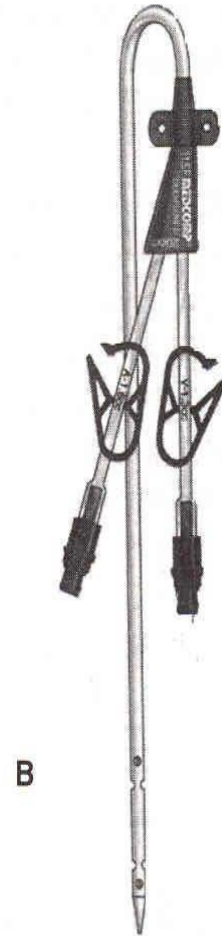
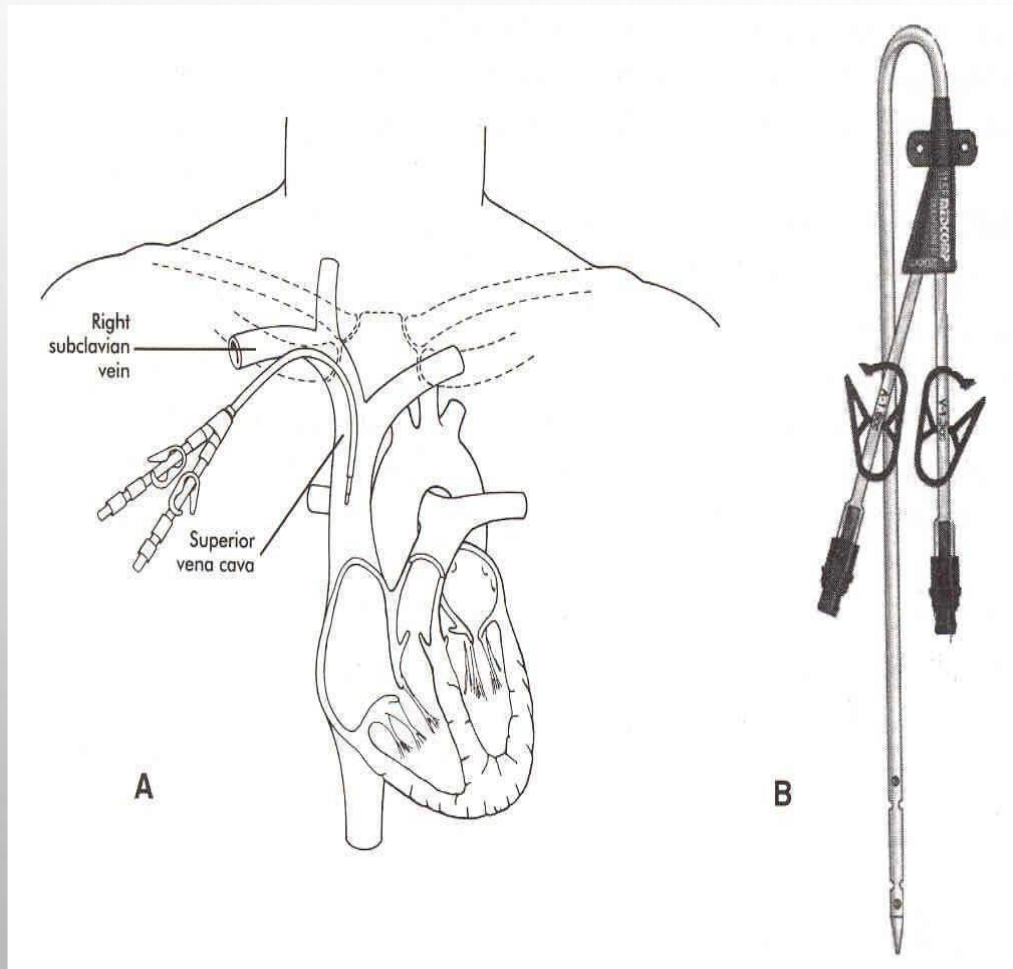
PHYSICAL EXAMINATION

- THE EXAMINATION MUST TAKE INTO CONSIDERATION THE SIGNIFICANCE OF PREVIOUS CHEST AND ABDOMINAL SURGERIES (FOR PD), PACEMAKERS, PRESENCE OF EDEMA, AND COLLATERAL VEIN FORMATION THAT MAY SUGGEST **CENTRAL VEIN PATHOLOGY**.
- THE HEMODIALYSIS VA EXAM REQUIRES A **RELAXED** PATIENT IN A COMFORTABLE ENVIRONMENT.
- THE ARTERIAL ASSESSMENT INCLUDES EVALUATION OF PULSE QUALITY, SEGMENTAL BLOOD PRESSURE, AND THE **ALLEN TEST**.
- **DUPLEX ULTRASOUND** MAY BE USED TO CLARIFY OR CONFIRM CONCERNS OF VESSEL INTEGRITY

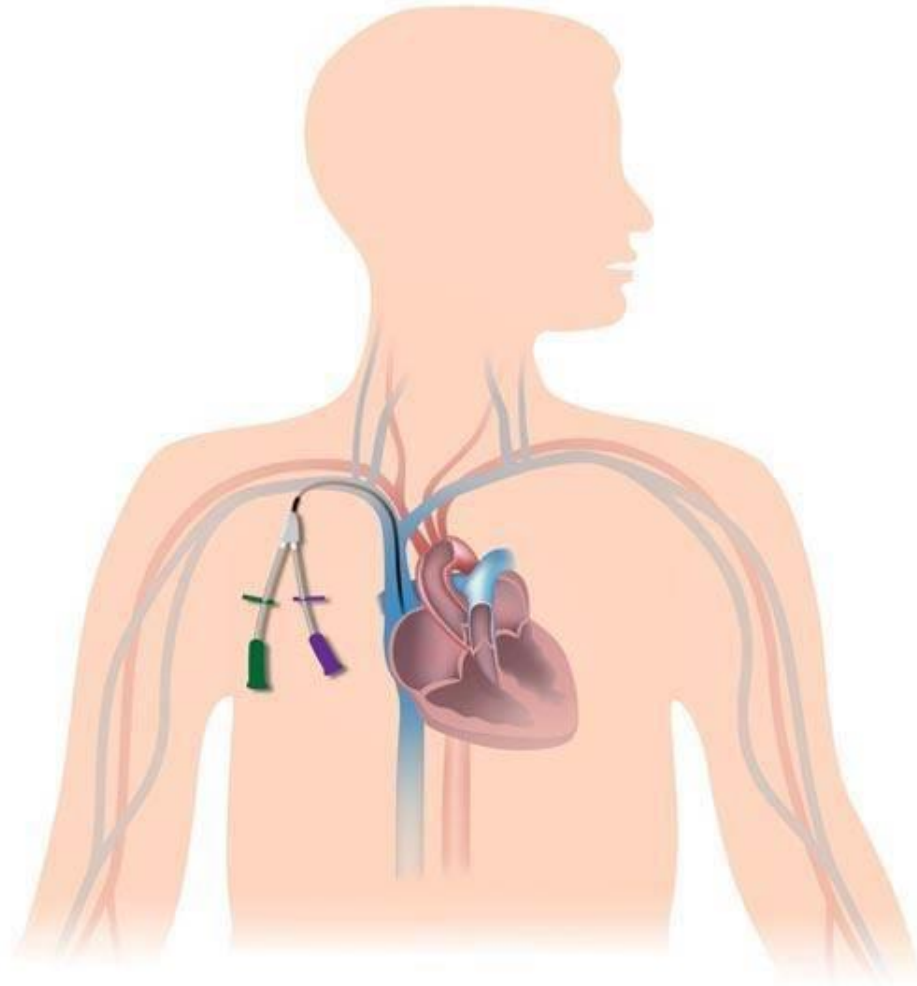
SUPPORTIVE INVESTIGATIONS

- SURGEON SHOULD PERFORM THE **DUPLEX ULTRASOUND** OR BE PRESENT TO DIRECT THE SEQUENCE OF EXAMINATION STEPS AND MARK THE SKIN, DOCUMENTING VESSEL SIZE, INTENDED SURGERY SITES, AND ANATOMICAL VARIATIONS
- IF THE PHYSICAL EXAM OR DUPLEX ULTRASOUND ASSESSMENT RAISES CONCERNS WHERE CONFIRMATION OR CLARIFICATION OF VASCULAR ANATOMY IS WARRANTED, INVASIVE IMAGING USING CONTRAST DYE OR CO₂ ANGIOGRAPHY (AS APPROPRIATE) IS WARRANTED.

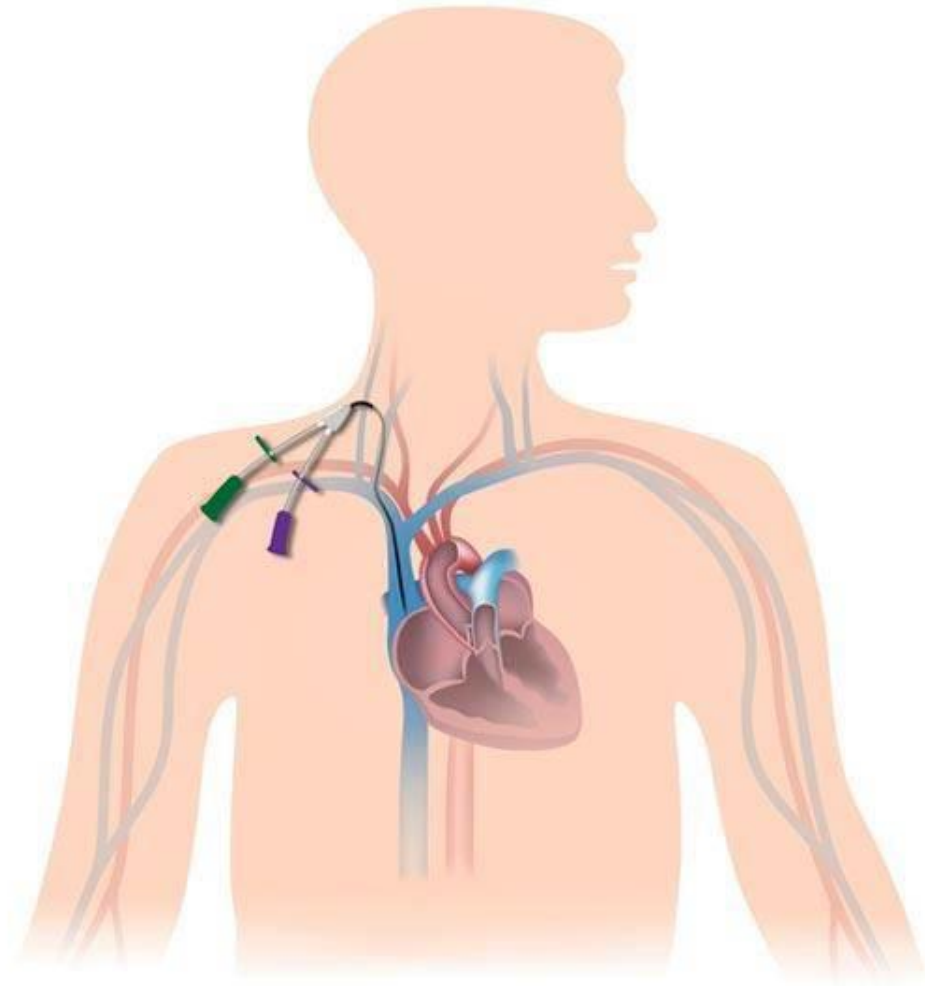
CENTRAL VENOUS CATHETER



Central Venous Catheter



Subclavian vein insertion



Internal jugular vein insertion

Preference	Vein	Comments
1	Internal jugular*	Right side preferred
2	Femoral vein	Ensure adequate catheter length
3	Subclavian	Lowest infection risk of all locations Trendelenburg position during insertion may decrease the risk of air embolism Only use if no further access is possible on that extremity
4	Lumbar	A location of last resort when no other access site available.

Indications for vascular catheter:

- Acute renal failure.
- Dialysis for overdose.
- ESRD with no access.
- ESRD with failure of access.
- Peritoneal dialysis with complications.
- Transplant patients require HD.
- ESRD who lost all possible access.
- Heart failure patients.
- Plasmapheresis and Hemoperfusion.

ACUTE HEMODIALYSIS CATHETERS

- **SITE OF CATHETER INSERTION**
- CAN BE INSERTED INTO THE JUGULAR, SUBCLAVIAN, AND FEMORAL VEINS
- **ROUTINE USE-LIFE OF CATHETERS**
- THE LIMITS ON USE-LIFE ARE CAUSED BY INFECTION **INTERNAL JUGULAR** CATHETERS ARE SUITABLE FOR **2 TO 3 WEEKS** OF USE
- **FEMORAL** CATHETERS ARE USUALLY USED FOR A SINGLE TREATMENT (AMBULATORY PATIENTS) OR FOR **3 TO 7 DAYS** IN BED BOUND PATIENTS

DOUBLE LUMEN CUFFED TUNNELED CATHETERS

- ARE PRINCIPALLY CONSTRUCTED OF SILASTIC/SILICONE AND OTHER SOFT FLEXIBLE POLYMERS, WHICH ARE LESS THROMBOGENIC THAN POLYMERS USED IN ACUTE CATHETERS.
- REQUIRE FLUOROSCOPY FOR INSERTION DUE TO THEIR LARGER SIZE AND TO THE CONFIRMATION OF TIP LOCATION.

DOUBLE LUMEN CUFFED TUNNELED CATHETERS

- ALLOW FASTER BLOOD FLOWS THAN ACUTE CATHETERS, USUALLY BLOOD PUMP SPEEDS OF 400 ML/MIN
- ACTUAL BLOOD FLOW RATES ARE ALMOST ALWAYS LOWER THAN THOSE REPORTED BY THE BLOOD PUMP(20%-30%)
- COMPARE TO FISTULAS OR ARTERIOVENOUS GRAFTS, MOST PATIENTS REQUIRE AN INCREASE IN TREATMENT TIME OF APPROXIMATELY 20 PERCENT TO ACHIEVE EQUIVALENT UREA REMOVAL.
- CUFFED TUNNELED CATHETER SURVIVAL IS HIGHLY VARIABLE, 74 PERCENT 1-YEAR AND A 43 PERCENT 2-YEAR CATHETER SURVIVAL

Early and immediate complications

- Arterial puncture.
- Venous perforation.
- Bleeding & hematoma.
- Pneumothorax.
- Hemothorax & Hemomediastinum.
- Air embolism.
- Arrhythmia and cardiac arrest.
- Cardiac chamber perforation.
- Pericardial Tamponade.
- Injury to adjacent structures: Nerves, Trachea,..etc.

Schwab SJ, Beathard G: The hemodialysis catheter conundrum: Hate living with them, but can't live without them. *Kidney Int* 56: 1-17, 1999.

Walsh SB, Ekbal N, Brookes J, Cunningham J: Tinnitus after hemodialysis catheter placement. *Kidney Int* 74: 688, 2008.

Muthuswamy P, Alausa M, Reilly M: The effusion that would not go away. *N Engl J Med* 345: 756-759, 2001.

Late Complications

- Thrombosis.
- Fibrin sheath formation.
- Infection.
- Vascular thrombosis and stricture.
- AV fistula.

DOUBLE LUMEN CATHETER COMPLICATIONS

- **CENTRAL VEIN THROMBOSIS AND STENOSIS**
- OCCUR MORE OFTEN WITH SUBCLAVIAN (40 TO 50 PERCENT OF CASES IN SOME STUDIES) THAN WITH INTERNAL JUGULAR INSERTIONS (UP TO 10 PERCENT)
- THE K/DOQI GUIDELINES THEREFORE RECOMMEND AVOIDING PLACEMENT IN THE SUBCLAVIAN VEIN, UNLESS NO OTHER OPTIONS ARE AVAILABLE

CATHETER (CVC) DYSFUNCTION INTERVENTIONS

- FLUSH EACH LUMEN WITH 10 ML OF NORMAL SALINE
- REVERSE LINES USING ASEPTIC TECHNIQUE
- IF FLOW PROBLEM PERSISTS, LIKELY THROMBUS IN LUMENS, ON THE WALL OF THE VESSEL OR A FIBRIN SHEATH. USE THROMBOLYTIC AGENT PER MD ORDER
- MAY NEED TO CHANGE THE CATHETER
- ALL CATHETERS “LOCKED” WITH SOME ANTICOAGULANT TO PREVENT THROMBUS. FIRMLY INFUSE TO THE VOLUME OF THE LUMENS, THEN QUICKLY RECLAMP LUMEN TO PREVENT NEGATIVE PRESSURE IN CATHETER PULLING BLOOD IN THE SIDE HOLES

DOUBLE LUMEN CATHETER COMPLICATIONS

- RECOMMENDATIONS:
- ALL PERSONNEL SHOULD BE ADEQUATELY TRAINED IN **ASEPTIC TECHNIQUES** AND ABOUT THE IMPORTANCE OF ROUTINE **HAND HYGIENE** BEFORE AND AFTER PATIENT CONTACT.
- TOPICAL USE OF POVIDONE -IODINE ON THE CATHETER **HUBS**
- WE RECOMMEND THAT THE CATHETER EXIT SITE SHOULD BE CLEANED WITH CHLORHEXIDINE 2%.
- NURSES OR TECHNICIANS ROUTINELY WEAR NONSTERILE **GLOVES** AND A **MASK** WHEN DIALYSIS CATHETERS ARE ACCESSED

Fibrin Sheath



Hemodialysis catheter infection

Rate of uncuffed cath. infection:

- 8% by 2wks.
- 25% by 1 month.
- 50% by 2 months.

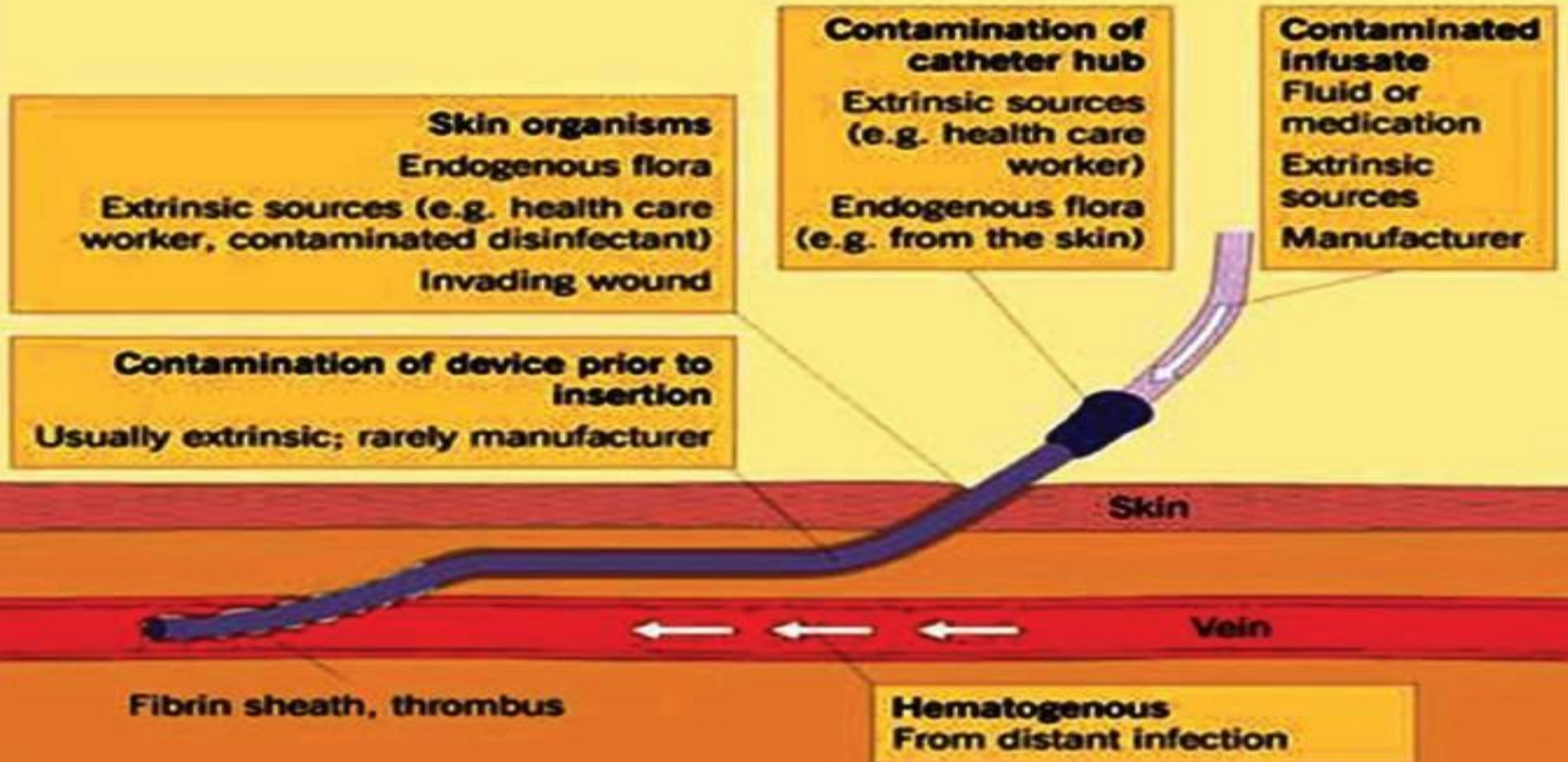
Catheter related septicemia is 2 -20%.



FECTION
INFE



POTENTIAL ROUTES OF INFECTION



Catheter Dysfunction signs

- $Q_b < 300\text{ml/min.}$
- Art. Pressure < -250 .
- Ven. Pressure > 250 .
- $URR < 65$, $K_t/V < 1.2$.
- Unable to aspirate blood freely. (Late sign).
- Frequent pressure alarms.

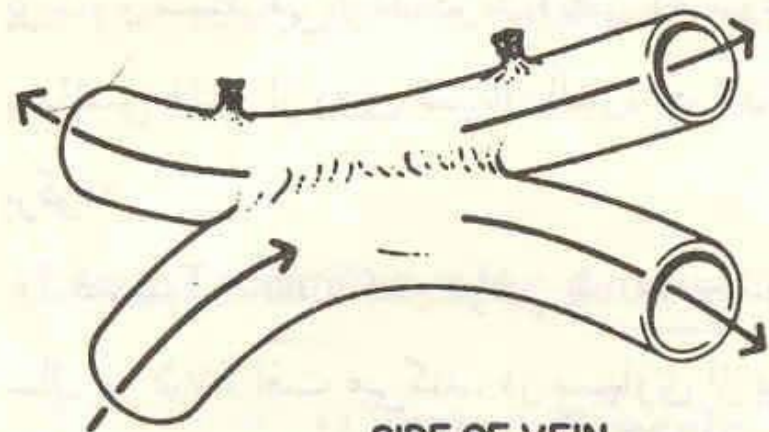
AVF

- WHEN VENOUS ACCESS IS REQUIRED, ONLY THE **DORSAL** ASPECT OF THE HAND SHOULD BE USED.
- PATIENTS ALREADY UNDERGOING HEMODIALYSIS CAN HAVE BLOOD DRAWS **DONE DURING** THEIR HEMODIALYSIS SESSION TO PRESERVE VEINS
- IMPORTANTLY, ADEQUATE ARTERIAL INFLOW IS NECESSARY FOR AVF MATURATION AND PROLONGED PATENCY
- ALTERNATE ACCESS, SUCH AS VIA FEMORAL CATHETERIZATION, SHOULD BE USED IN CKD PATIENTS WHO MAY NEED VA IN THE FUTURE

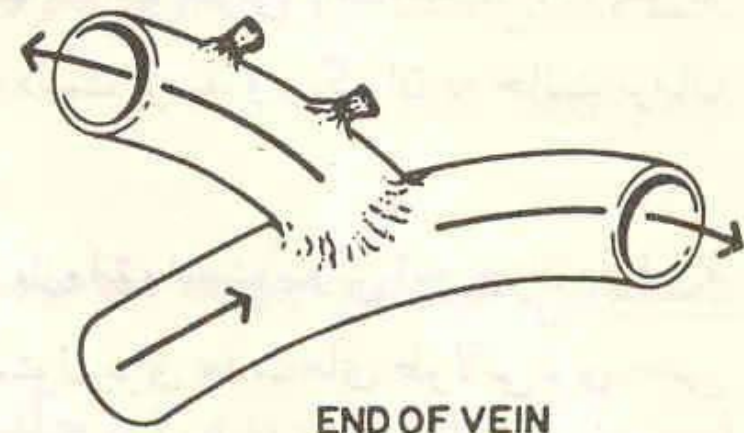
Is New AVF Mature? Use the KDOQI “RULE of 6’s”

Vein *MUST* Mature *PRIOR* to the *FIRST* cannulation

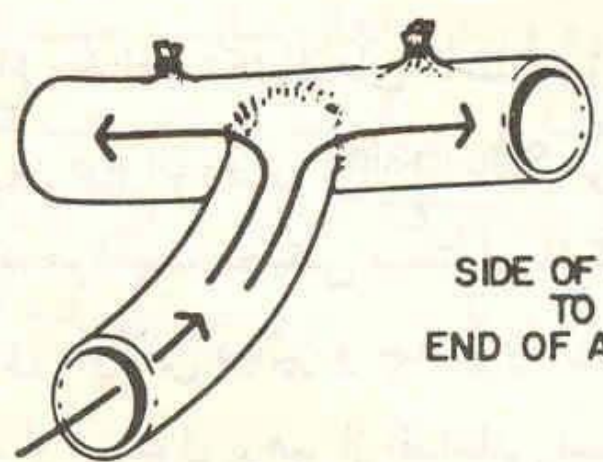
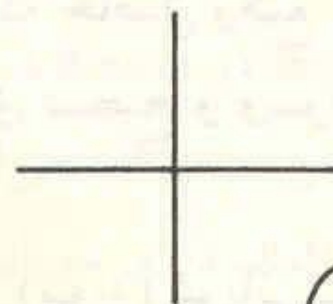




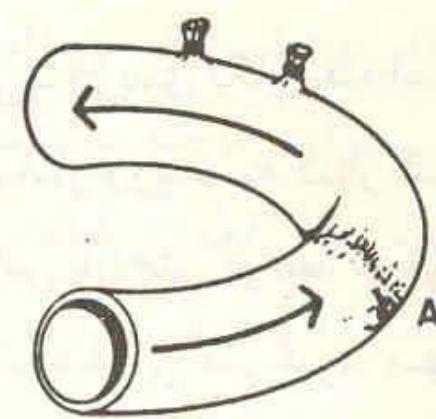
SIDE OF VEIN
TO
SIDE OF ARTERY



END OF VEIN
TO
SIDE OF ARTERY



SIDE OF VEIN
TO
END OF ARTERY



END TO END
ARTERY TO VEIN

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FISTULAS

- FISTULAS ARE RELATIVELY SIMPLE TO CREATE, AND DIFFERENT TYPES OF AUTOGENOUS ARTERY-VEIN ANASTOMOSIS ARE POSSIBLE
- IT CAN PROVIDE RELIABLE, LONGSTANDING ACCESS FOR HEMODIALYSIS WITH **MINIMAL** COMPLICATIONS
- THE MOST FREQUENT AVF COMPLICATIONS INCLUDE **MATURATION FAILURE** (20%–60%), THROMBOSIS, ANEURYSM , AND STEAL SYNDROME

- REDUCE THE PATIENT'S FEAR OF THE INITIAL CANNULATION
- •WORDS ALONE CAN EITHER CAUSE OR REDUCE FEAR, SO CHOOSE YOUR WORDS WISELY! (DON'T USE WORDS LIKE "STICK" OR "PUNCTURE.")
- •MAY NEED TO ADJUST DIALYSIS TIME TO AVOID RUSHING BY THE STAFF (EG, MIDWEEK OR MID SHIFT TREATMENTS MIGHT BE BEST)
- ASK PHYSICIAN IF HEPARIN DOSE SHOULD BE MODIFIED
- •USE 17-GAUGE NEEDLES INITIALLY
- •USE SALINE-FILLED FISTULA NEEDLES WITH SYRINGES ATTACHED (OPTIONAL)
- •USE A TOURNIQUET

- PERMITS PRE-PUMP ARTERIAL PRESSURE (AP) MONITORING,
- WHICH WILL HELP TO DETERMINE IF THE FISTULA HAS A GOOD ACCESS FLOW.
THE PRE-PUMP AP **SHOULD BE ≤ -250** MM HG AT A 200 BLOOD FLOW RATE (BFR) WITH A 17-GAUGE NEEDLE.
- EXCESSIVELY NEGATIVE PRE-PUMP AP = POOR AVF INFLOW
- 17-GAUGE NEEDLE IS STRONGLY RECOMMENDED FOR INITIAL CANNULATION
- A FISTULA MAY APPEAR AND FEEL READY TO CANNULATE, BUT THE VESSEL WALL MAY STILL BE FRAGILE AND UNABLE TO TOLERATE THE NEEDLE PUNCTURE
- THE SMALLER NEEDLE GAUGE HELPS TO **DECREASE INJURY** TO THE VESSEL AND PREVENTS A LARGE INFILTRATION, HEMATOMA, COMPRESSION OF THE VESSEL, AND POSSIBLE CLOTTING OF THE AVF SHOULD ANY CANNULATION COMPLICATION OCCUR (IE , INFILTRATION)

Match Needle Gauge to Blood Flow Rate (BFR)

Needle Gauge	Maximum BFR
17-gauge	< 300 mL/min
16-gauge	300-350 mL/min
15-gauge	350–450 mL/min
14-gauge	> 450 mL/min

CATHETER REMOVAL

- ONCE THE PATIENT HAS HAD 6 SUCCESSFUL TREATMENTS WITH THE AVF, THE REGISTERED NURSE (RN) SHOULD OBTAIN AN ORDER TO HAVE THE CATHETER REMOVED
- SUCCESSFUL= GETTING 2 NEEDLES IN, NO INFILTRATIONS, AND REACHING THE PRESCRIBED BFR THROUGHOUT THE TREATMENT FOR 6 TREATMENTS

- CHECK FISTULA DAILY FOR A THRILL AND BRUIT
- CHECK FOR SIGNS AND SYMPTOMS OF INFECTION OR OTHER COMPLICATIONS
- IF POSSIBLE, THE PATIENT SHOULD WASH THE ACCESS WITH ANTIBACTERIAL SOAP BEFORE COMING TO THE CHAIR
- STAPH IS THE LEADING CAUSE OF INFECTION IN DIALYSIS PATIENTS

Forearm Fistula Exercises

BALL SQUEEZE

As soon as the pain from surgery has subsided, start arm exercises by squeezing a rolled-up washcloth or a “stress” ball. Squeeze, and release rapidly for 10 minutes, 6 times a day. Additionally, you may use your other hand to squeeze the bicep of your fistula arm. This hinders blood return and causes the fistula to dilate because of increased pressure and blood in the vein.



CLOTHES PIN GRASP

Using a clothespin, squeeze open and allow to close repeatedly for 5 minutes, 6 times daily.

FINGER TOUCHES

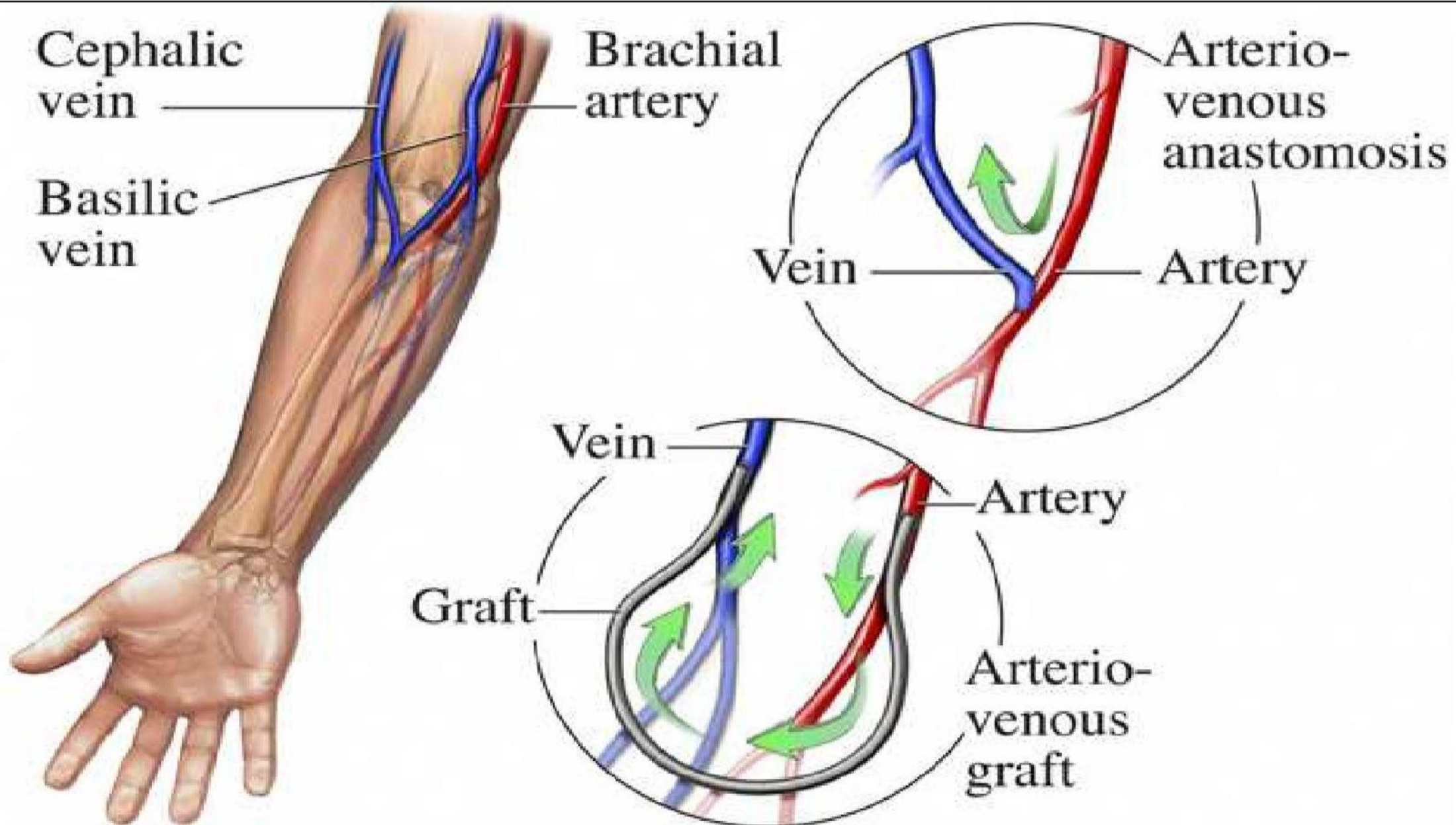
Lastly, another good exercise to help strengthen and develop your fistula are finger tip touches. Touch each finger to the tip of your thumb, opening up your hand after each touch. Touch tips to thumb repeatedly for 5 minutes, 6 times a day.



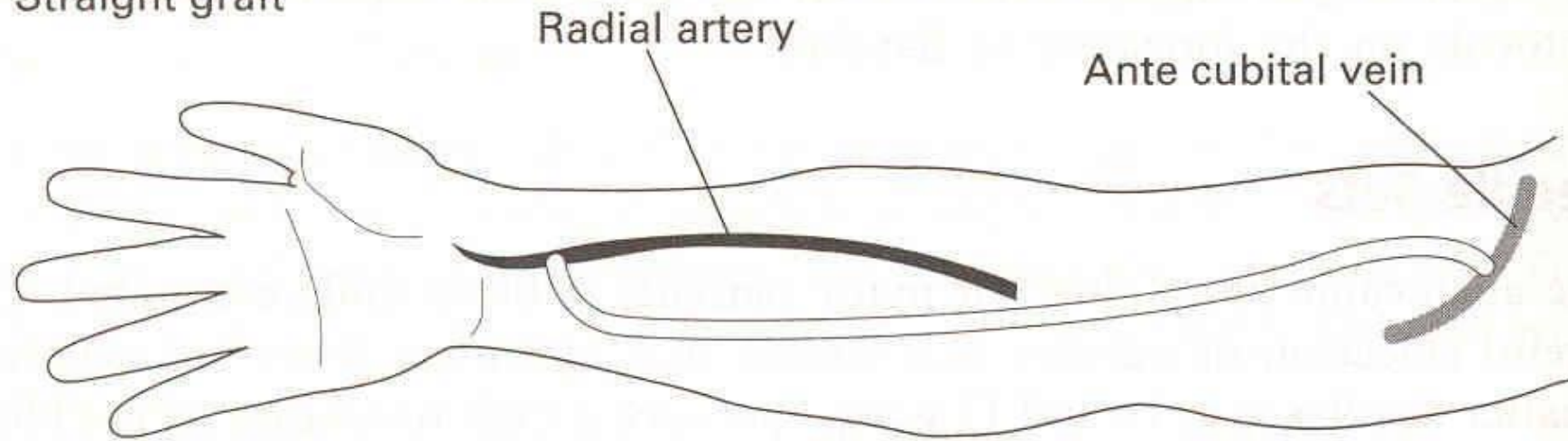
GRAFTS

- AN AVG IS A **PROSTHETIC** INTERPOSITION BETWEEN AN ARTERY AND A VEIN. GRAFTS ARE TYPICALLY CATEGORIZED AS **SYNTHETIC OR BIOLOGIC**. THERE ARE A VARIETY OF GRAFT MATERIALS, TYPES, AND CONFIGURATIONS
- GRAFTS HAVE A LOWER EARLY FAILURE RATE IN COMPARISON TO AVF AND CAN BE USED **SOON** AFTER CREATION
- THE MOST COMMON COMPLICATION OF AVG IS THE DEVELOPMENT OF **NEOINTIMAL HYPERPLASIA** THAT LEADS TO RECURRENT STENOSIS AND THROMBOSIS
- ANOTHER IMPORTANT COMPLICATION IS **INFECTION**. PREVIOUSLY, GRAFTS HAVE BEEN SHOWN TO HAVE A SIGNIFICANTLY GREATER INFECTION RISK THAN FISTULAS (UP TO 10-FOLD HIGHER), BUT MORE CURRENT DATA HAVE SHOWN EQUIVALENT INFECTION RISK.

Transposed Basilic vein Arteriovenous Fistula & Graft



Straight graft



Loop graft

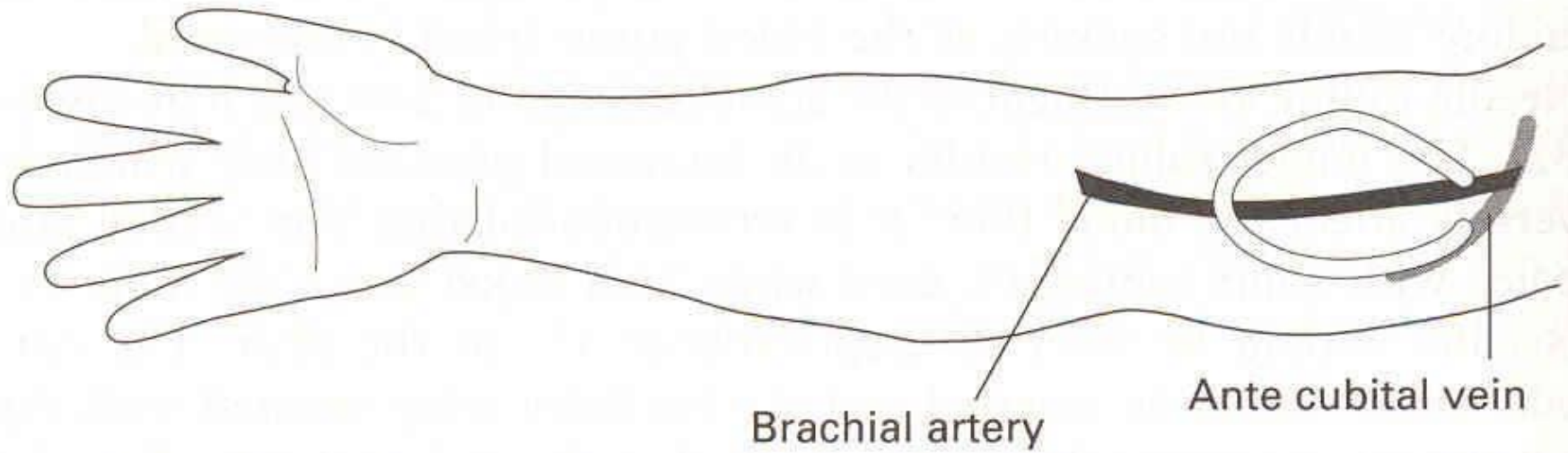


Fig. 7.3 Arteriovenous graft configuration.