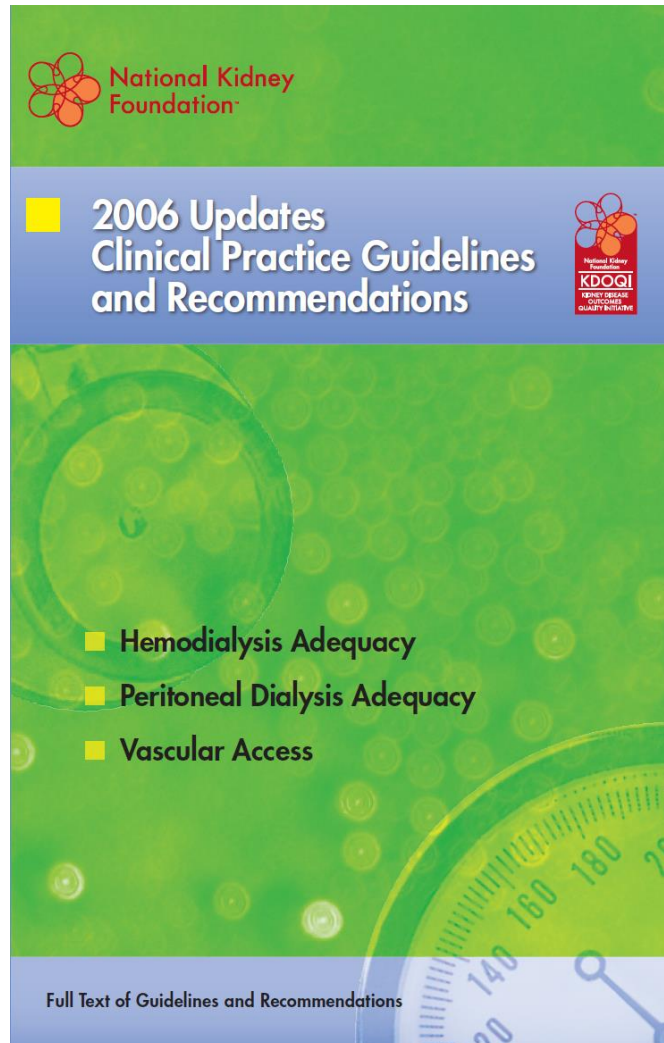


# Hemodialysis and Vascular access

**Incheon St. Mary's Hospital  
The Catholic University of Korea**

**Do Yeon Kim**

# KDOQI guideline 2006, 2015 update



National  
Kidney  
Foundation®

KDOQI®  
Kidney Disease  
Outcomes Quality Initiative

## KDOQI CLINICAL PRACTICE GUIDELINE FOR HEMODIALYSIS ADEQUACY: 2015 UPDATE



### Abstract

The National Kidney Foundation's Kidney Disease Outcomes Quality Initiative (KDOQI) has provided evidence-based guidelines for all stages of chronic kidney disease (CKD) and related complications since 1997. The 2015 update of the KDOQI Clinical Practice Guideline for Hemodialysis Adequacy is intended to assist practitioners caring for patients in preparation for and during hemodialysis. The literature reviewed for this update includes clinical trials and observational studies published between 2000 and March 2014. New topics include high-frequency hemodialysis and risks; prescription flexibility in initiation timing, frequency, duration, and ultrafiltration rate; and more emphasis on volume and blood pressure control. Appraisal of the quality of the evidence and the strength of recommendations followed the Grading of Recommendation Assessment, Development, and Evaluation (GRADE) approach. Limitations of the evidence are discussed and specific suggestions are provided for future research.

**Keywords:** Hemodialysis; Clinical Practice Guideline; hemodialysis prescription; hemodialysis frequency; initiation; adequacy; treatment time; hemofiltration; urea modeling; evidence-based recommendation; KDOQI.



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# KDOQI CLINICAL PRACTICE GUIDELINE FOR VASCULAR ACCESS: 2018

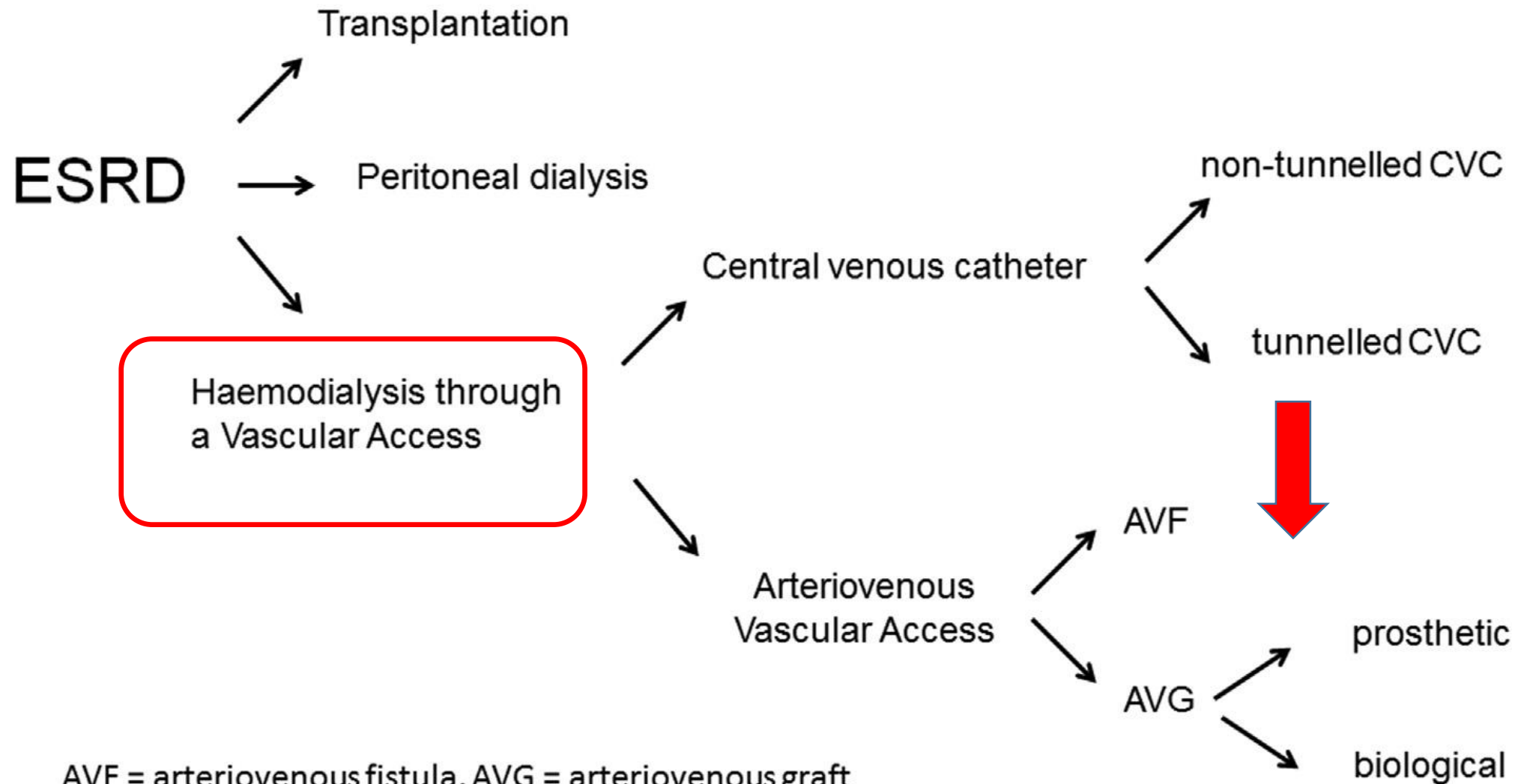
AJKD SUBMISSION DRAFT  
April 2019

- An important new concept introduced in this Vascular Access guideline update is that of the ***“ESKD Life Plan”***.
- ***This individualized and comprehensive map for dialysis modalities and vascular access for the lifetime of the patient*** is documented in this guideline, as well as the implementation tools for this guideline that will be developed by the National Kidney Foundation.

**Table 3.** Classification of chronic kidney disease based on glomerular filtration rate (GFR).<sup>8-11</sup>

Stage	Description	GFR mL/min/1.73 m <sup>2</sup>
Stage 1	Kidney damage with normal or elevated GFR	90+
Stage 2	Kidney damage with mildly decreased GFR	60-89
Stage 3	Moderately decreased GFR	30-59
투석준비단계 → Stage 4	Severely decreased GFR	15-29
투석시작단계 → Stage 5	End stage renal disease (ESRD)	<15 or on dialysis

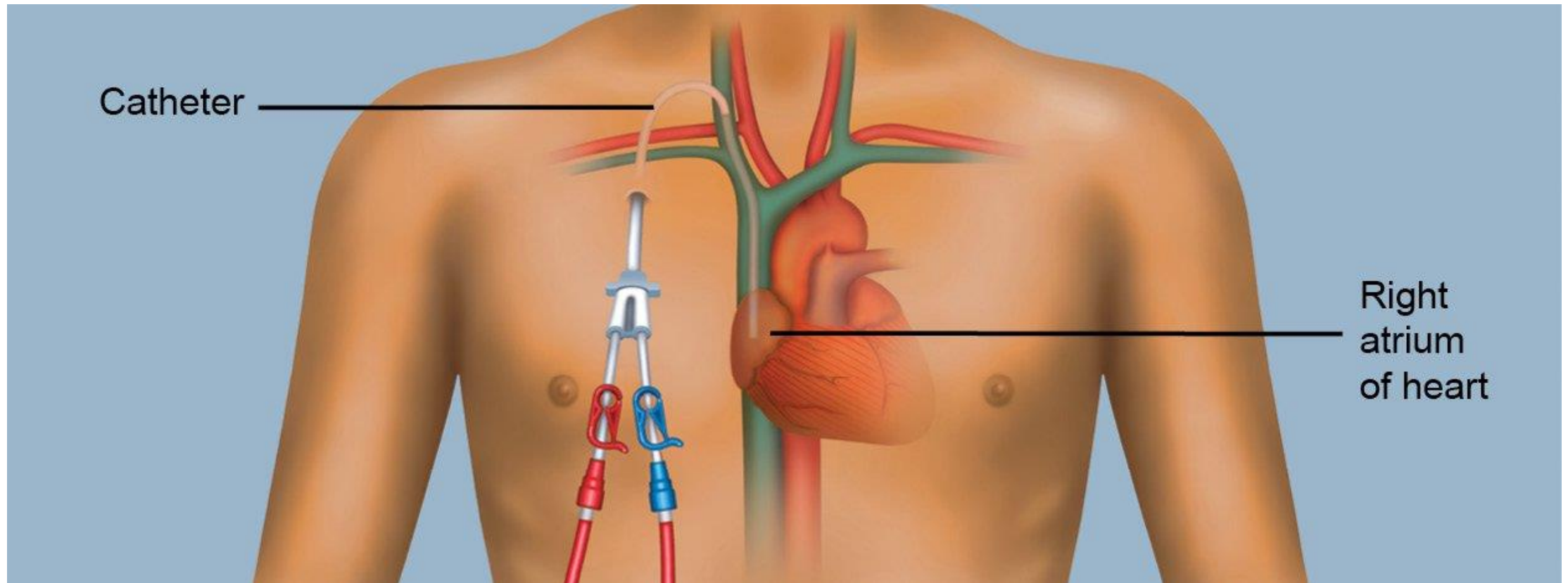
# Treatment options for patients with ESRD

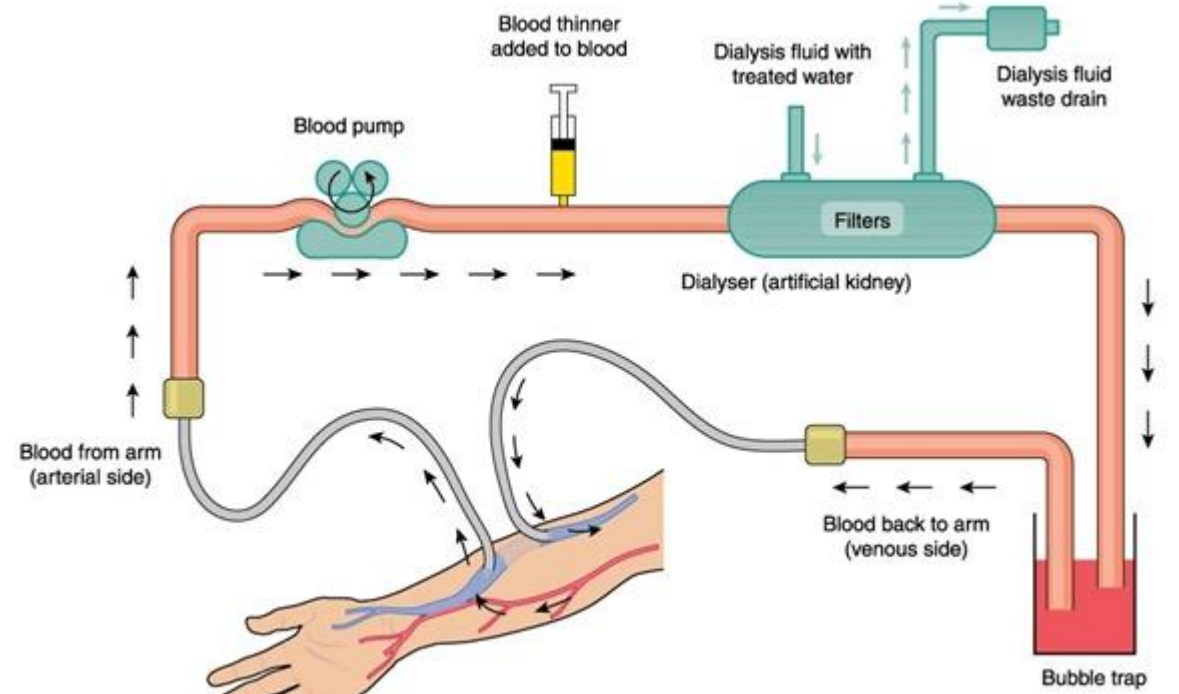
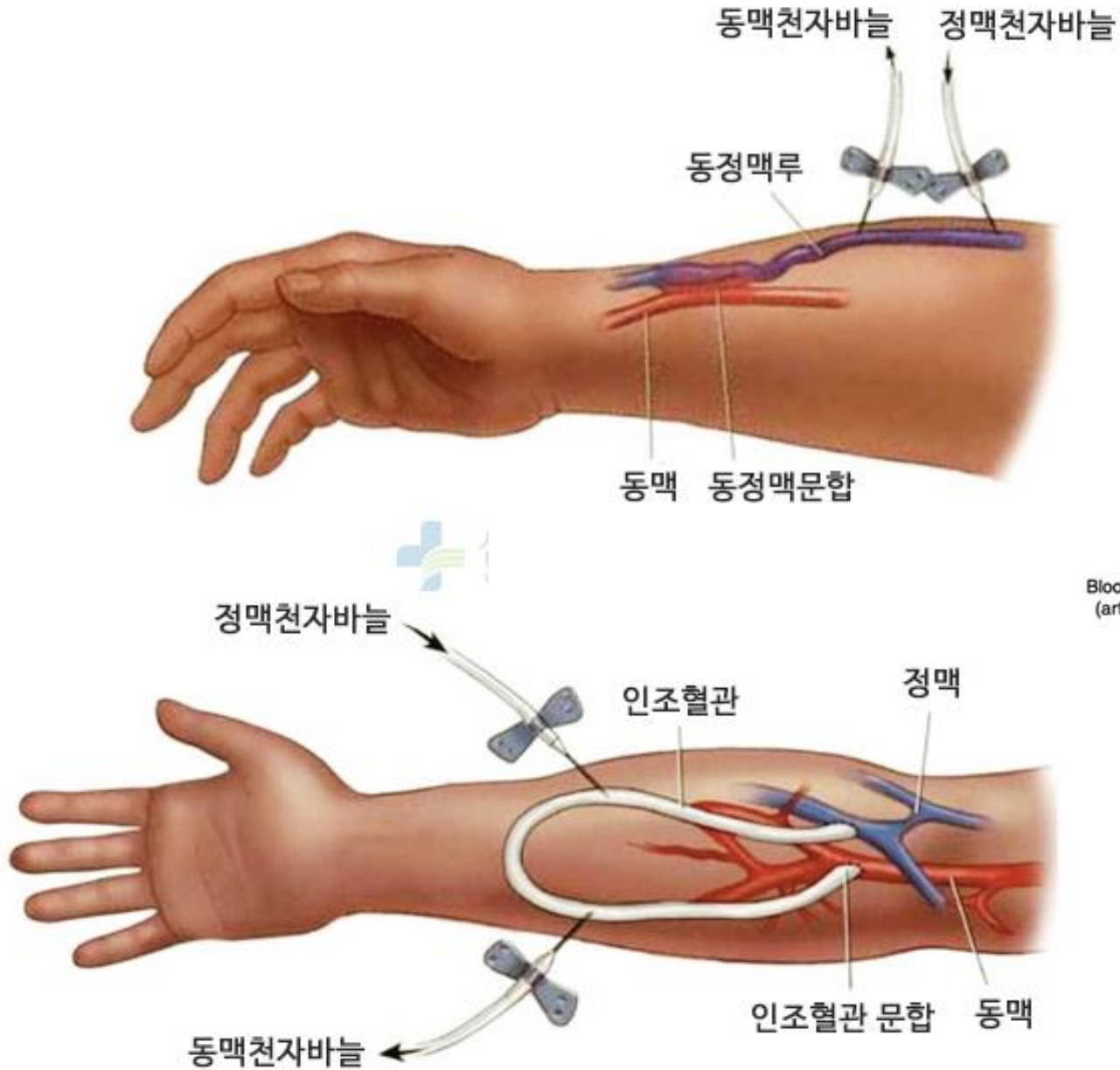


AVF = arteriovenous fistula, AVG = arteriovenous graft

ESRD = End stage renal disease, CVC = central venous catheter

# Central venous catheter for HD





# Vascular access(혈관접근)

- **For hemodialysis**
  - ; Blood flow at least 300ml/min, preferably 500ml/min.
- **Central venous catheters (CVC)**
  - ; Acute HD, or as bridging VA
- **Arterialization of a vein(AVF, arterio-venous fistula)**
  - ; Autogenous anastomosis between artery and vein
- **Interposition of a graft between an artery and a vein(AVGs, arteriovenous grafts)**
  - ; VA using a prosthetic graft



# Advantages and Disadvantages of CVC for HD

Advantages	Disadvantages
<ul style="list-style-type: none"><li>• Universally applicable</li><li>• Variety sites for placement</li><li>• Immediately available for use</li><li>• Low cost</li></ul>	<ul style="list-style-type: none"><li>• <b>Thrombosis</b></li><li>• <b>Infection</b></li><li>• Central venous stenosis or occlusion</li><li>• Low patient satisfaction</li><li>• Lower blood flow rate, long dialysis time</li><li>→ <i>Risk of morbidity &amp; mortality</i></li></ul>

# 투석혈관접근 과정

신장내과  
협진

문진 및 초음파검사를  
통한 혈관 및 수술방법  
결정  
(수술 부위, 자가 or 인  
조혈관, 손목 or 상완...,  
AVF or AVG, basilic  
vein transposition...)

수술시행(국소 or  
부위마취...)  
(Flow check,  
thrill, bruit...)

투석가능여부  
확인 후 투석시  
작  
(Maturation,  
협착부위, 상처  
확인)

# Choice of type of vascular access

- **Ideal VA**

- ; Resistant to infection and thrombosis, minimum adverse events

- **First option** : *Distal autogenous AVF* in the non dominant arm.

- Lower incidence of postoperative complications and fewer endovascular and surgical revision for AVF failure

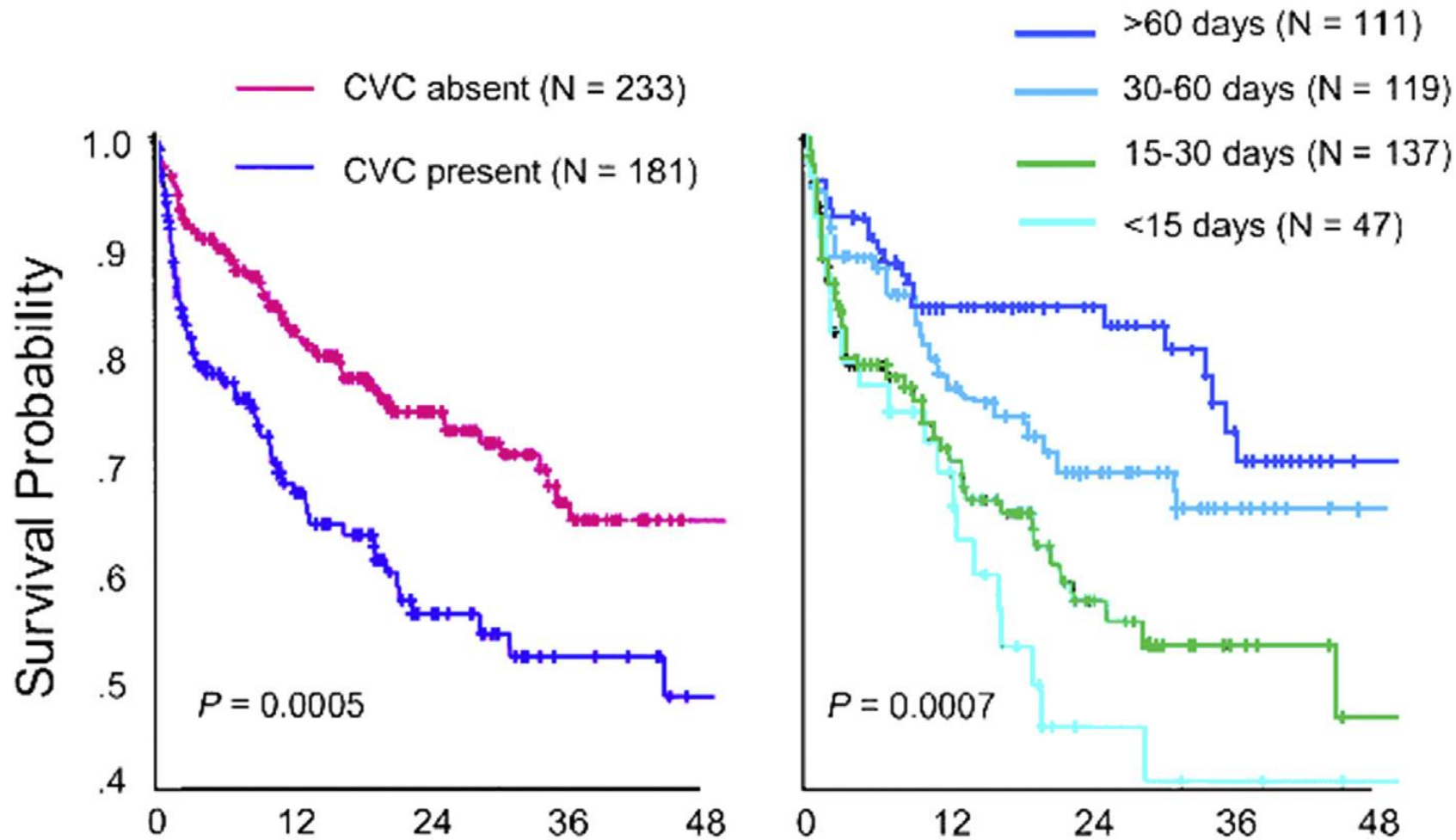
- **Next options** : *Prosthetic AVG* and *CVC(central venous catheter)*

- Higher morbidity and mortality in CVCs(infection...)

# Time of referral for VA surgery

- Importance for the outcome of the VA.
- Early referral → More well functional autogenous AVFs
- Late referral → non-maturation and need for a CVC
- **Risk factors of AVF failure**
  - HD initiation with CVC, long AVF maturation time
  - Cardiovascular disease
  - Early cannulation
- The knowledge and experience of the VA surgeon is of importance in creating predominantly AVFs and has a major impact on the outcome of surgery.

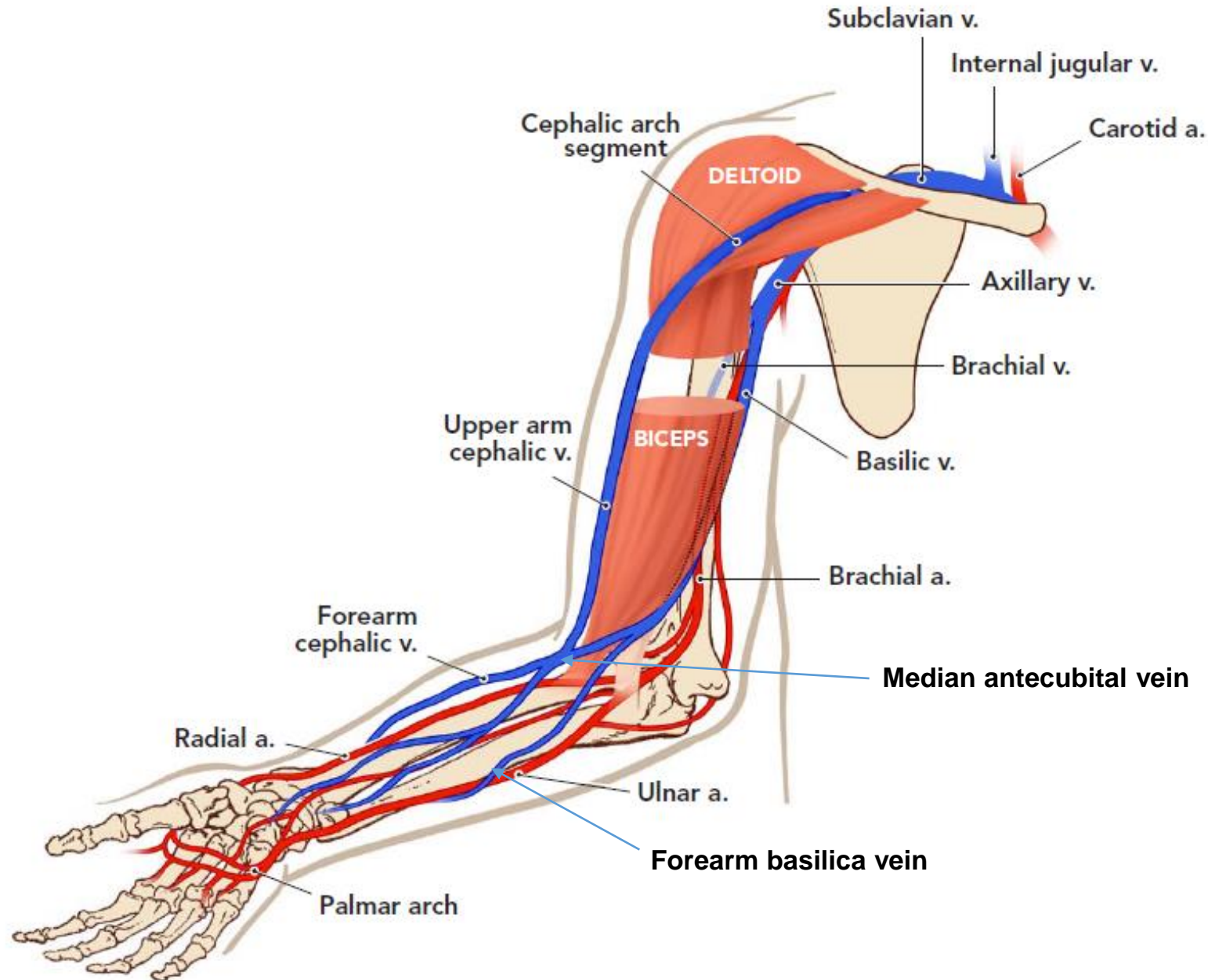
# Kaplan-Meier curves of time to AVF failure



Months from first cannulation

*J Am Soc Nephrol 2004;15:204 e9. Ravani et al.*

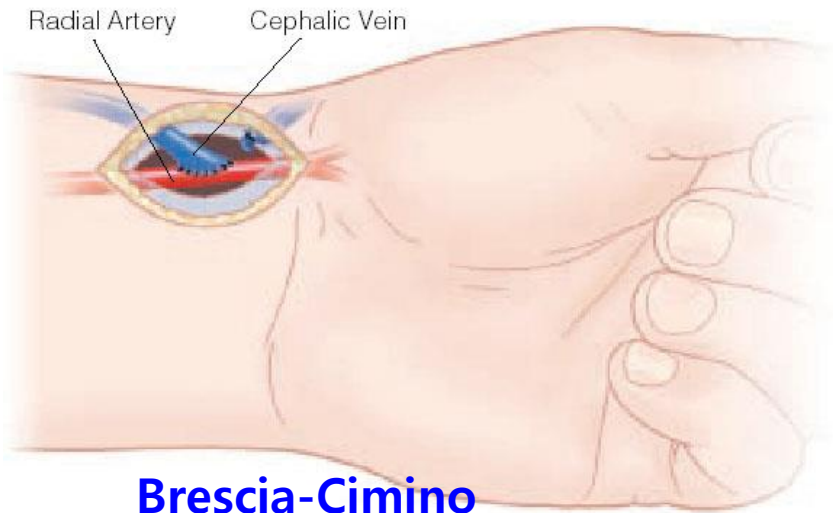
# Anatomy of Upper Extremity Vessels



# Primary option for vascular access (1)

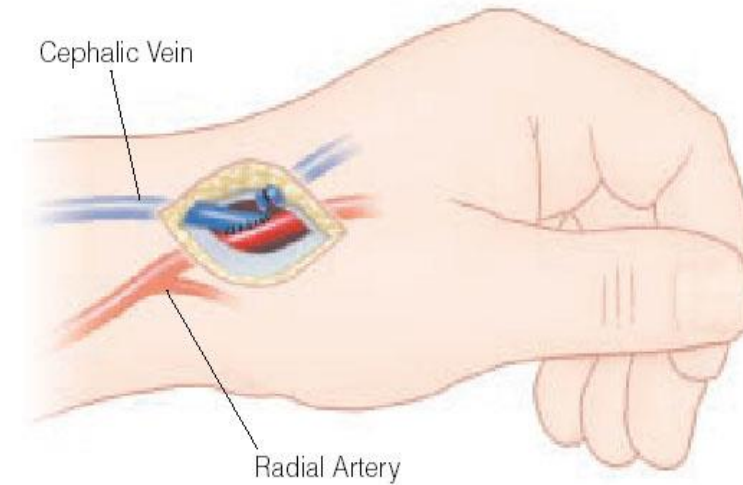
- **Autogenous arteriovenous fistula.**
- The first choice for VA creation : *Radiocephalic AVF (RCAVF)*
- **Advantages**
  - *Minimum of complications, revisions and hospital admissions*
- **Non-dominant arm**
- **A minimum internal vessel diameter**
  - *Radial artery and cephalic vein* : **2.0mm** using tourniquet
    - Successful fistula creation and maturation

# Radiocephalic AVF (RCAVF)



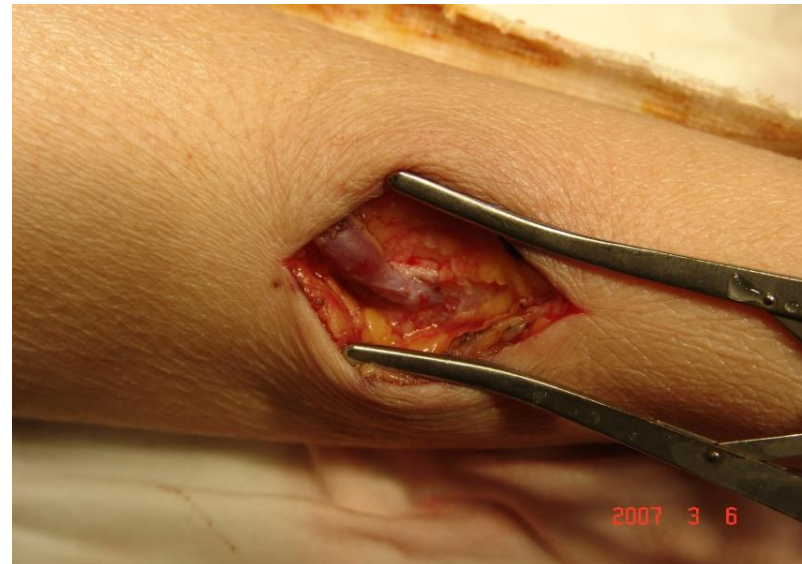
## Brescia-Cimino (radiocephalic) fistula

: An autologous fistula constructed between the radial artery and the cephalic vein at the wrist.



## Snuff-box fistula

: An autologous fistula constructed between a branch of the radial artery and an adjacent vein in the anatomic snuff box of the hand.





# Disadvantages of AVF

- **Risk of early thrombosis and non-maturation**
  - Access failure  
(17% mean early failure rate, up to 45%)
  - One year patency from 52% to 83%
- **Old age** : Maturation failure

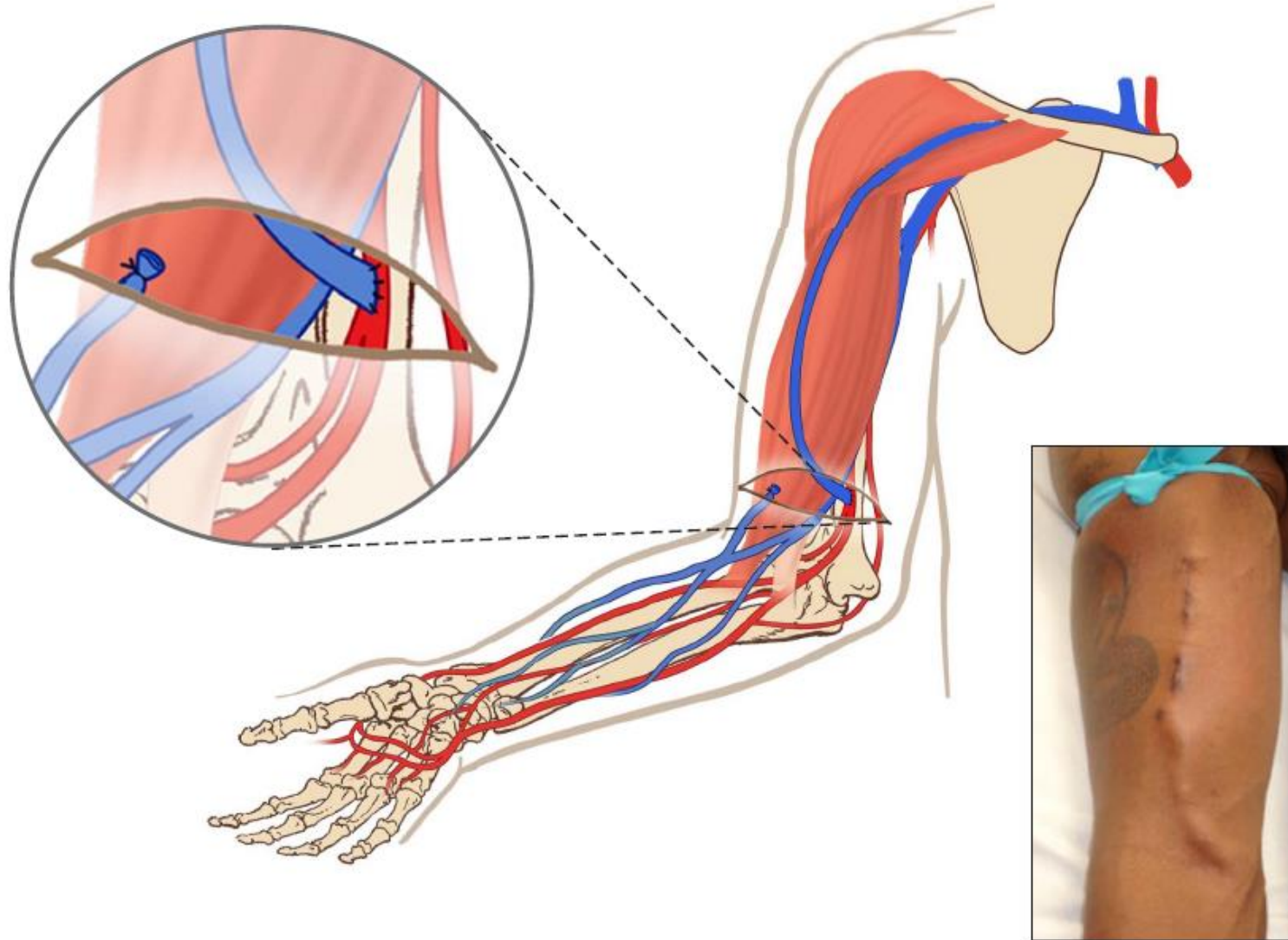
**Table 5.** Early failure and one year secondary patency rate of the radiocephalic AVF.

Reference	No. RCAVF	Early failure (%)	Secondary patency (%)
Silva et al. <sup>59</sup>	108	26	83
Golledge et al. <sup>60</sup>	107	18	69
Wolowczyk et al. <sup>61</sup>	208	20	65
Gibson et al. <sup>62</sup>	130	23	56
Allon et al. <sup>63</sup>	139	46	42
Dixon et al. <sup>64</sup>	205	30	53
Ravani et al. <sup>65</sup>	197	5	71
Rooijens et al. <sup>66</sup>	86	41	52
Biuckians et al. <sup>67</sup>	80	37	63
Huijbregts et al. <sup>56</sup>	649	30	70

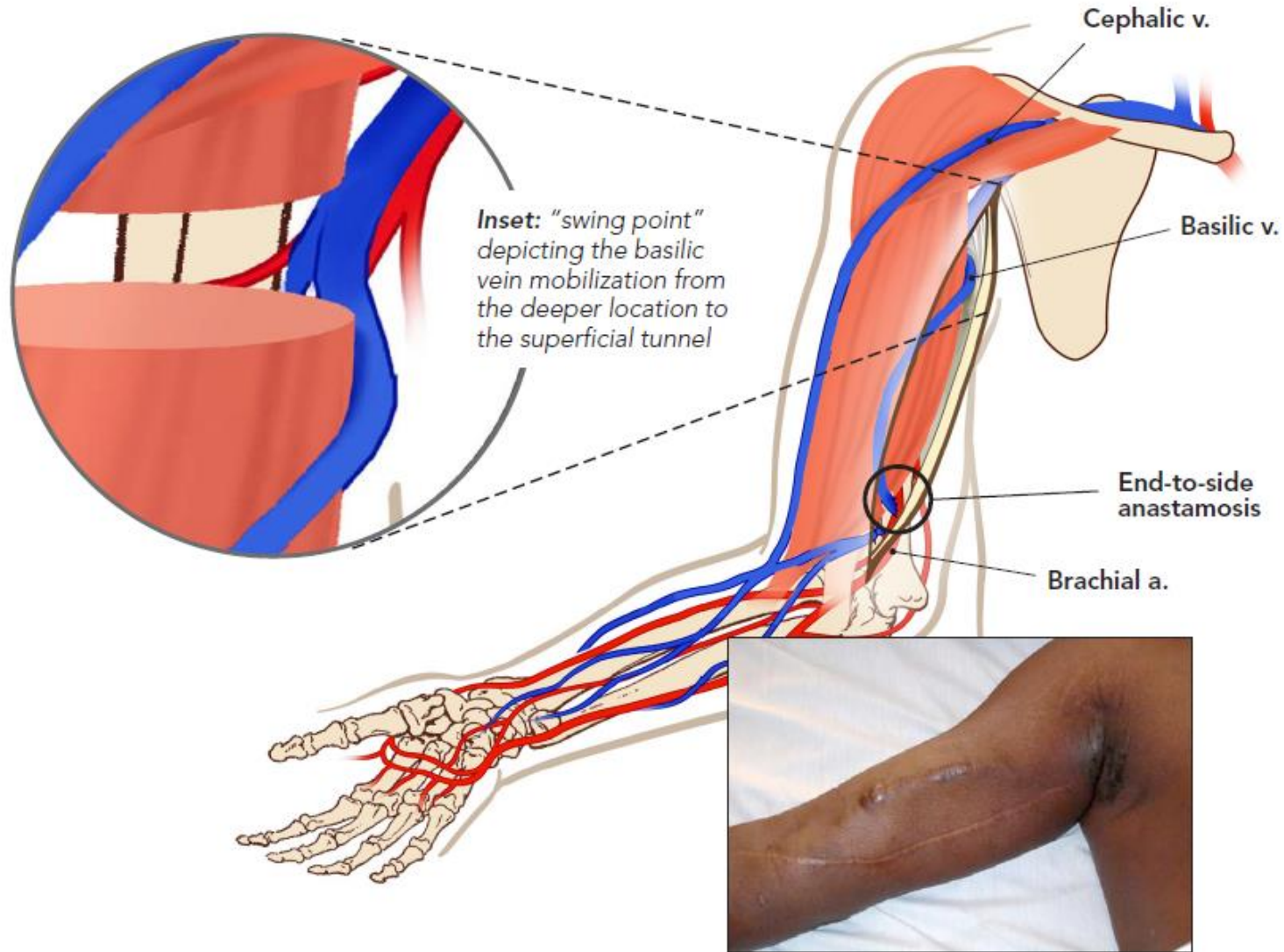
# Primary option for vascular access (2)

- **Brachial artery based AVFs**
  - ; BCAVF(brachiocephalic AVF) and BBAVF(Brachiobasilic AVF)
- **High access flow**
- **Good one year patency**
- **Low incidence of thrombosis** (0.2 events per patient/year) and **infection** (2%)
- **Reduced distal arterial perfusion and cardiac overload**
  - Risk of Steal syndrome ↑
- **Basilic vein transposition (BVT)** (upper or forearm)

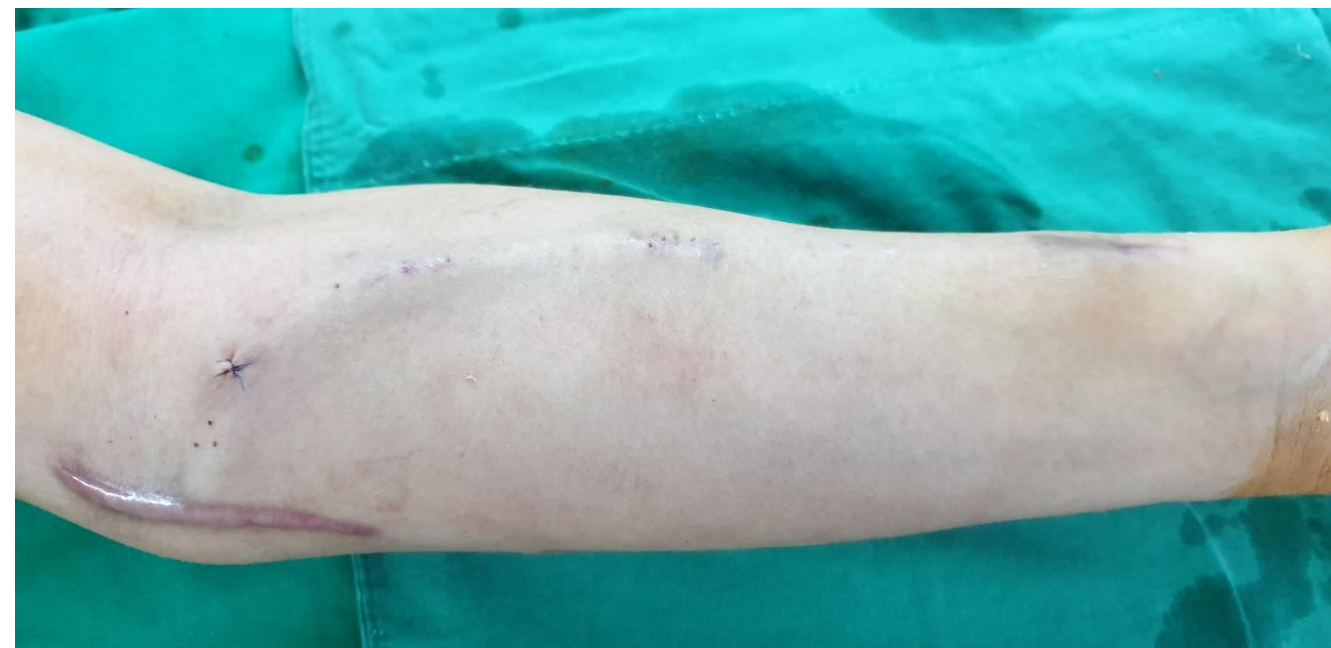
# Brachiocephalic AVF(BCAVF)



# Transposed Basilic Vein AVF(BBAVF)



# Forearm basilica vein transposition



# Variables and outcome of AVF

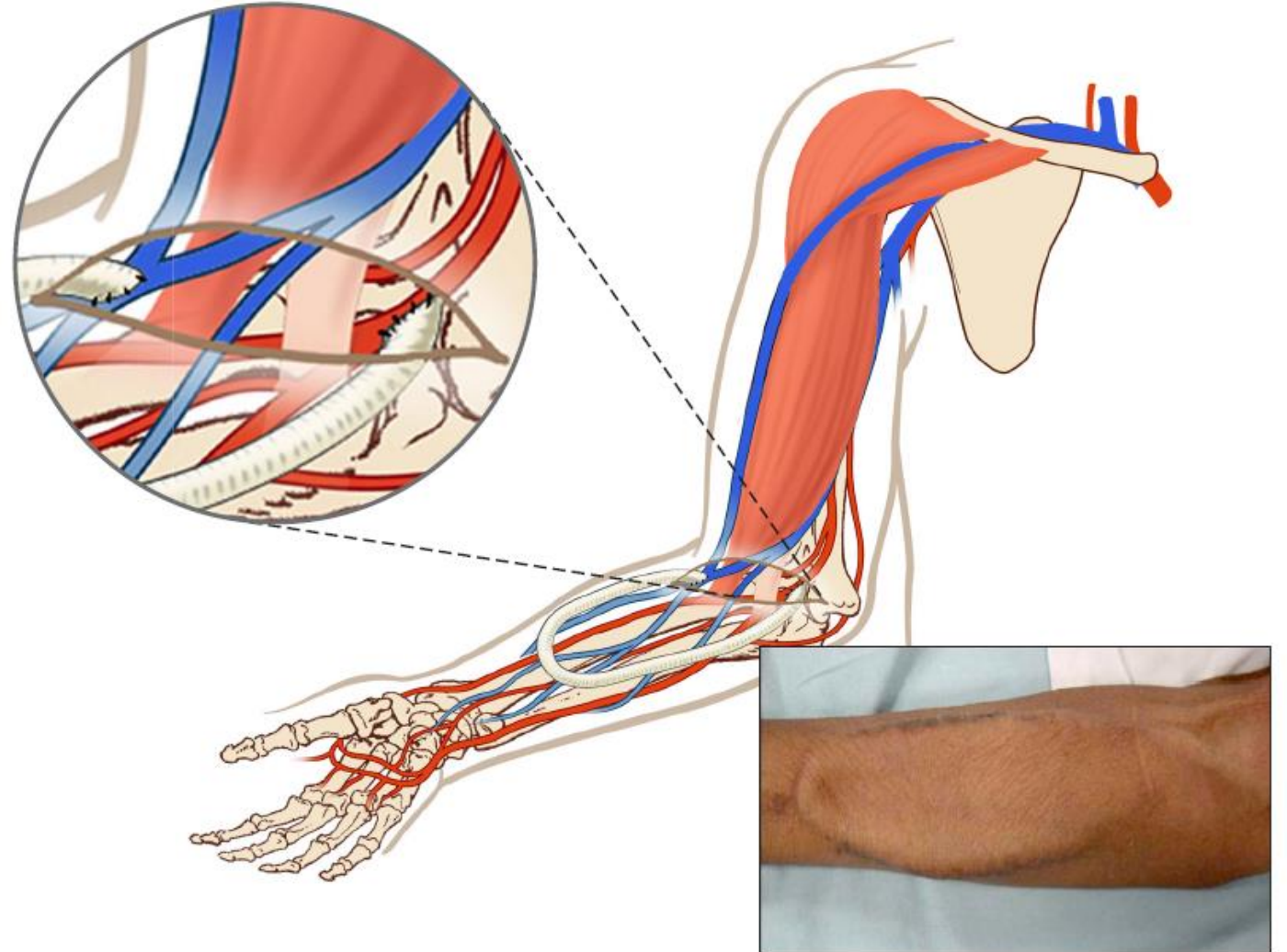
- **Age**(>65 years old)
- **DM**
- **Female**(smaller vessels, poor maturation and low long-term patency, more revision and AVG)
- **PAOD**
- **Obesity**
- **CCB, aspirin, ACEi** ; Better AVF, AVG patency
- **Anastomosis length** : Donor artery size ↓ → failure ↑

# Secondary options for vascular access

- **AVG VA with**
  - 4-6mm tapered or 6mm PTFE(polytetrafluoroethylene) graft
  - Biological material (ovine graft/Omniflow)
- **AVG**
  - Primary patency ; 1yr (40~50%), 2yr(20~30%)
  - Secondary patency : 1yr (70~90%), 2yr( 50~70%)
  - Neointimal proliferation
  - Multiple intervention (outcome ↑)
  - Infection risk
  - Elderly patients may benefit
- **Minimum outflow vein diameter** : 4mm

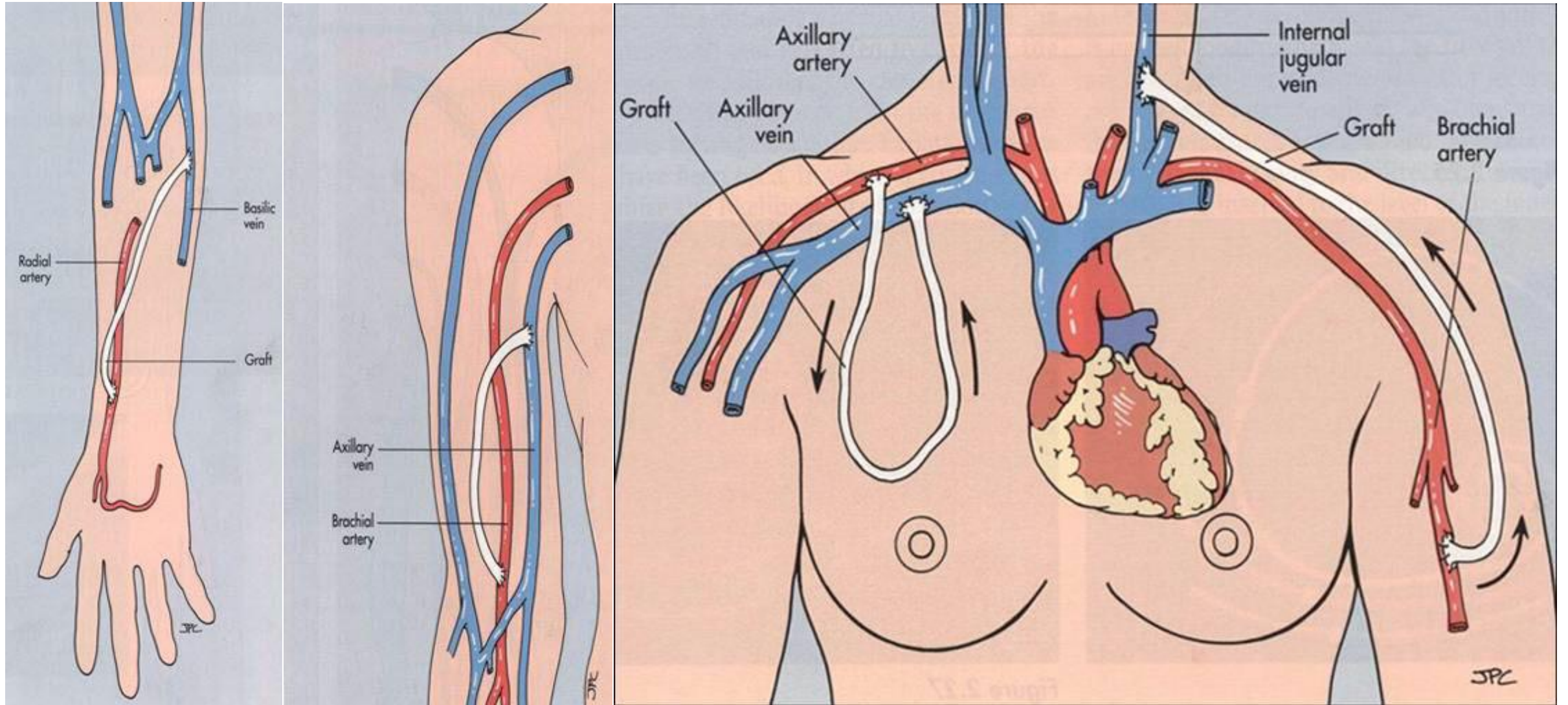
# Forearm Loop AVG

- **Anastomosis site**  
: Brachial artery  
to antecubital vein  
to cephalic vein  
to basilica vein  
to brachial vein





# Other AV Grafts



# Pre-operative assessment

- **History and physical examination**
- **Duplex ultrasound(DUS)**
- **Digital subtraction angiography (DSA)**

# History and physical examination

- **Hand dominance**
- **Previous vascular access**  
; Central venous catheters, peripherally inserted central catheter, pacemaker, defibrillator)
- **Upper and lower extremity venous thrombosis, hand ischemia**
- **Pulmonary hypertension or heart disease**
  
- **Skin conditions** : Dryness, redness and infection.
- **Upper arm swelling** (Central vein stenosis)
- **Hemiplegia** (Create VA on the paralytic side).
- **Contracture of the elbow joint**

# Duplex ultrasound sonography

- **Venous mapping** (depth and VA site)  
; Measure artery and vein diameters and stenotic lesions
- **Evaluation of maturation**(flow and diameter check)
- **The first line imaging method in suspected VA dysfunction after VA creation**  
(eg. Stenosis or thrombosis)

# Digital subtraction angiography

- Previous CVCs additional preoperative imaging of the central veins should be performed.
- Significant peripheral vascular disease and suspected proximal arterial stenosis

# Creation of Vascular Access

## - Technical aspects

- Venous preservation
- Arm exercise : Improve artery and vein diameters
- Pre or peri operative hydration
- Prophylactic antibiotics  
; cephalosporin, amoxicillin/clavulanic acid or a glycopeptide
- Anesthesia : Local or regional anesthesia
- Peri-operative anticoagulation : heparin ?
- Arteriovenous fistula configuration  
; End to side (vein to artery) anastomosis

# Summary of surgical techniques (1)

- **AVF ; *Most distal site possible***
- **Proximal AVFs** : Lower initial failure & better patency  
→ Steal syndrome ↑ , less comfortable
- **Arterial & venous diameters** : more than 2 mm
- **Non-dominant arm**
- **Pacemaker or CVC** : Contralateral side

# Summary of surgical techniques (2)

- **1<sup>st</sup> choice** : *RCAVF*
- **2<sup>nd</sup> choice**
  - : Young patients
    - BCAVF(any vein is ok~) or basilica vein transposition, AVG
  - : Old patients
    - BCAVF or AVG
- **The number of re-interventions** : Significantly higher in AVGs
- **Choice of graft** : 4-6mm tapered ePTFE
  - Can be use after 1~2 week (4 weeks)



# Peri-operative assessment

- Should be a *palpable thrill* or, at least an *audible bruit*
- *The absence of a bruit* ; Something wrong  
→ A good predictor of early AVF thrombosis or occlusion
- *Flow meter check*
  - ; Radio-cephalic fistula : about 300mL/min
  - ; AVG on brachial or BCAVF : 700~1000mL/min

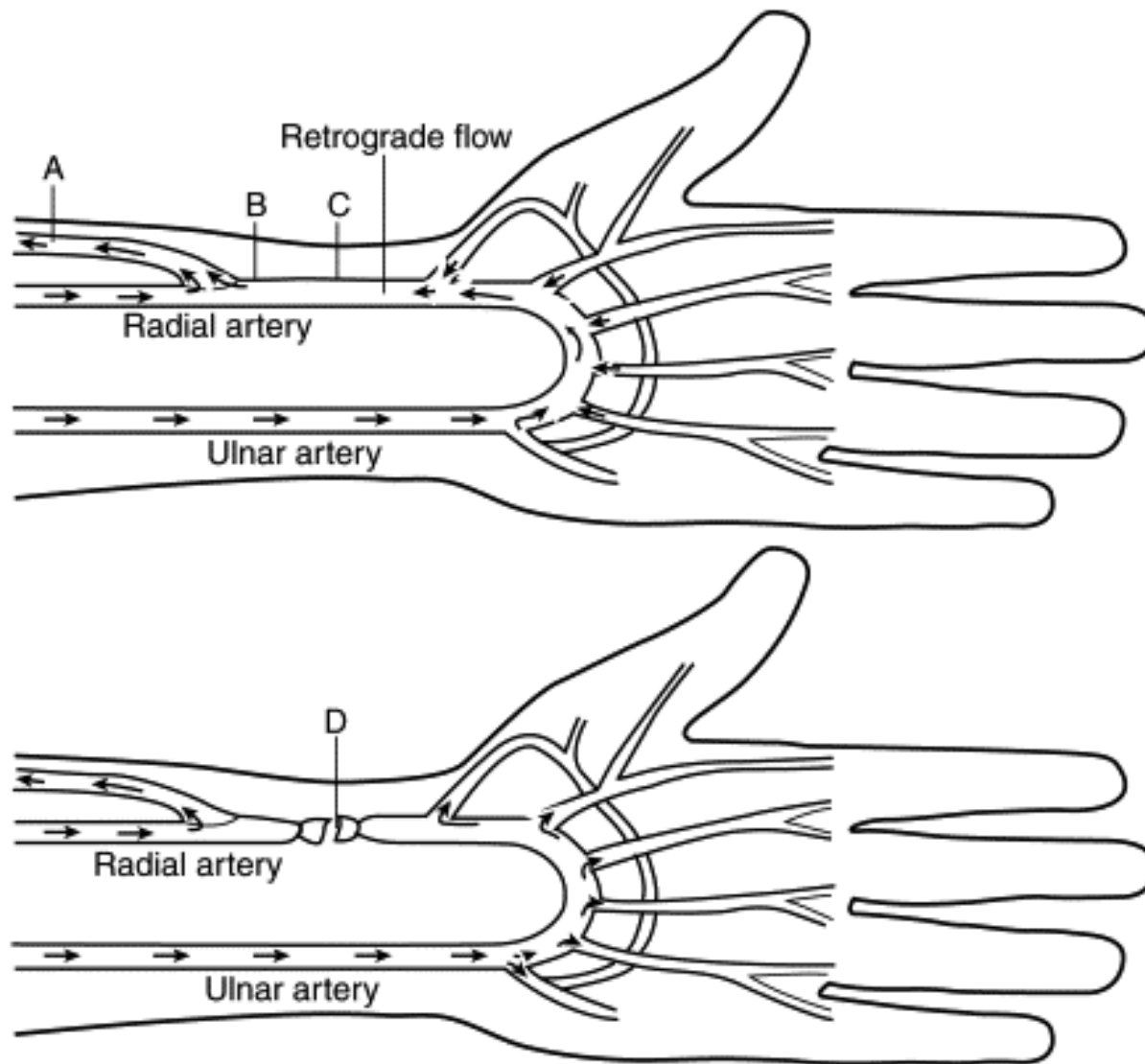
# Peri-operative complications

- Hemorrhage
- Post-operative infection
- Non-infected fluid collections
- **Vascular access induced limb ischemia : 4~9% (Stage 3, 4)**
- Early thrombosis

# AVF and Steal syndrome

## VA induced ischemia

<b>Stage 1</b>	Slight coldness, numbness, pale skin, no pain
<b>Stage 2</b>	Loss of sensation, pain during HD or exercise
<b>Stage 3</b>	Rest pain
<b>Stage 4</b>	Tissue loss affecting the distal parts of the limb, usually the digits



# Access maturation and care

- **AVF** : Preferably *4~6 weeks*
- **AVG** creation : *2~4 weeks*
- **Check points, "Rule of 6s"**
  - (1) Bruit and thrill
  - (2) Adequate venous diameter ; > 6mm
  - (3) Adequate length and depth ; < 6mm
  - (4) Adequate volume flow ; > 600 ml/min

# Management of maturation failure

- **The most common causes**
  - ; Venous, arterial or anastomotic stenosis
    - Intervention(balloon angioplasty), surgical revision
  - ; Competing veins or large patent branches
    - Branch ligation
  - ; Excessive depth from the skin
    - Superficialization
- **Hand-arm exercise**

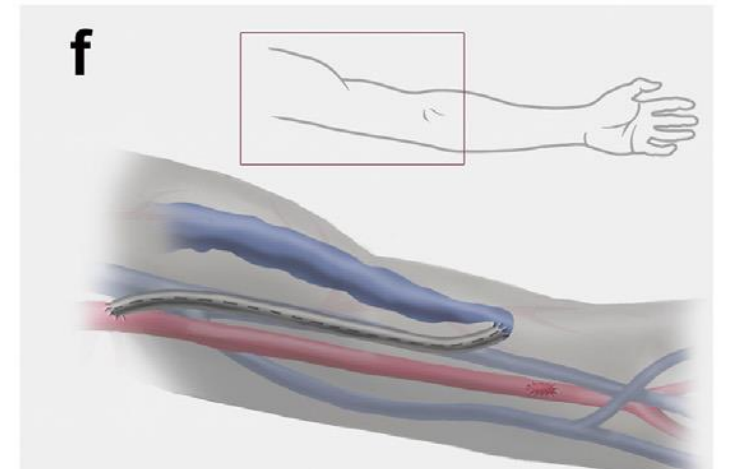
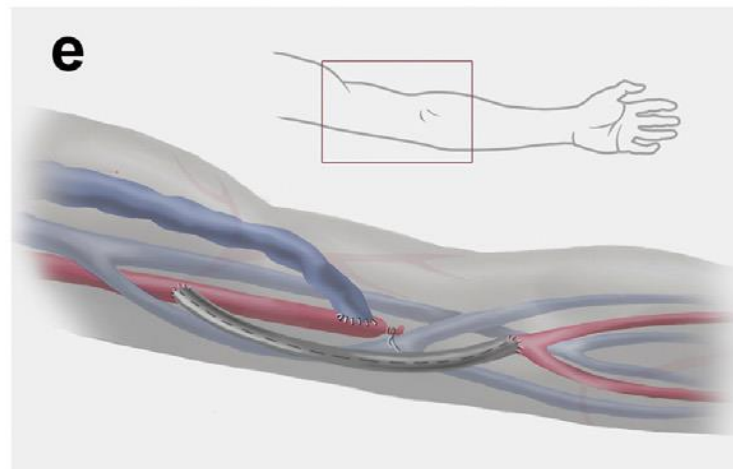
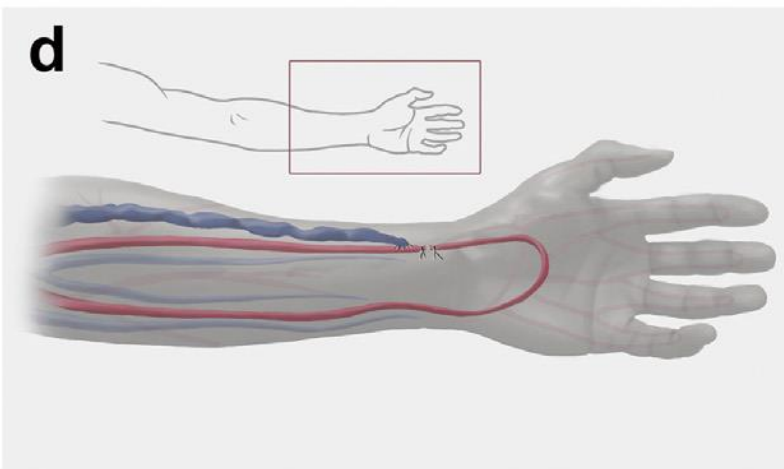
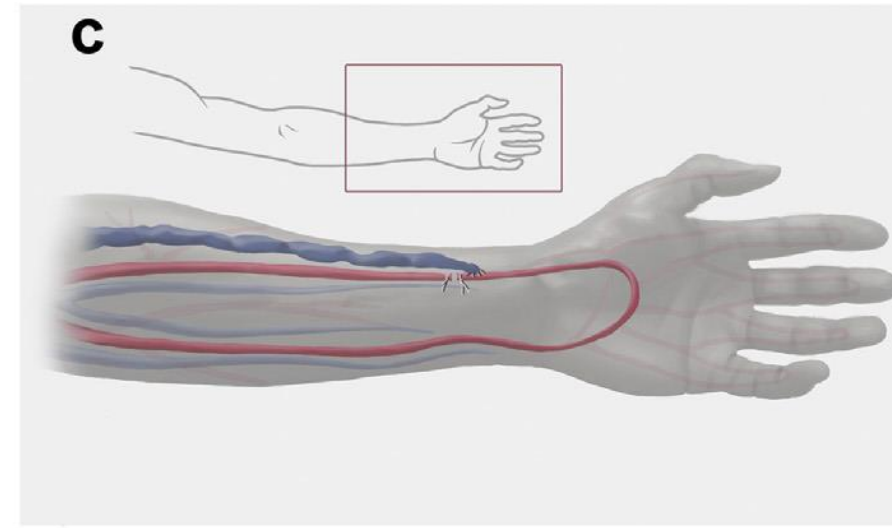
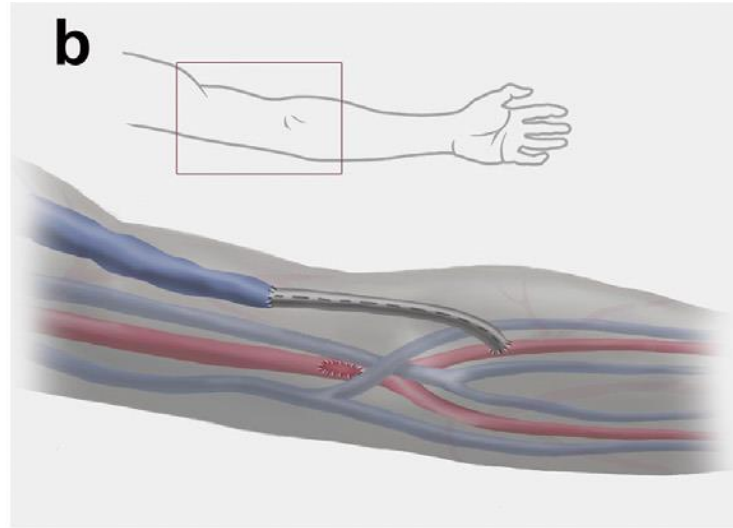
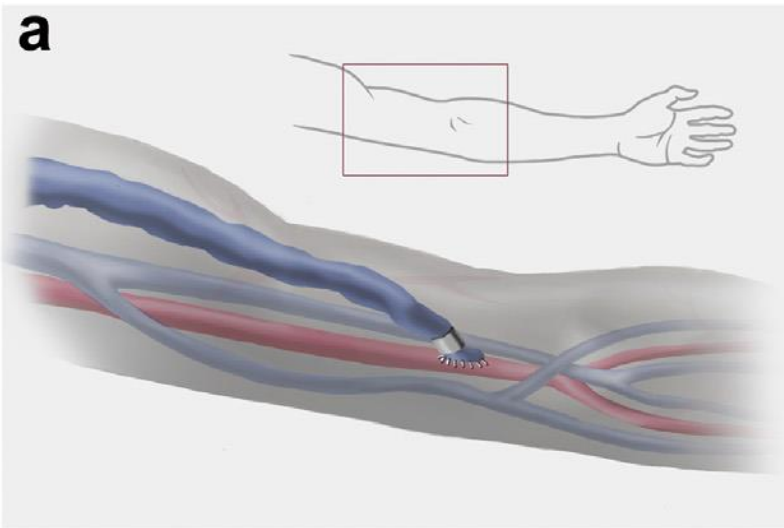
# Anticoagulation therapy

- **Reduce thrombosis but no long term benefits.**
- **Case by case....**
  - ; Aspirin, clopidogrel, cilostazol, warfarin, berasil
- **Omega-3 fatty acids** (fish oil) in improving VA function or maturation

# Late vascular access complications

- True and false access aneurysm
- Infection
- Stenosis and recurrent stenosis
  - *Inflow arterial stenosis*
  - *Juxta-anastomotic stenosis*
  - *Venous outflow stenosis*
  - *Cephalic arch stenosis*
- Thrombosis
- Central venous stenosis
- VA induced limb ischemia and high flow VA
- Neuropathy
- Non-used vascular access

# Flow reduction method in steal syndrome





# Radiocephalic AVF

- Local anesthesia
- Incision : Between radial artery and cephalic vein
- Cephalic vein dissection and dilatation
- Cephalic vein 의 dorsal branches 보다 proximal 부위를 이용
- Arteriotomy : 8-11mm
- 8-0 prolene, continuous running suture
- Post anastomosis dilatation : manual method, branch ligation

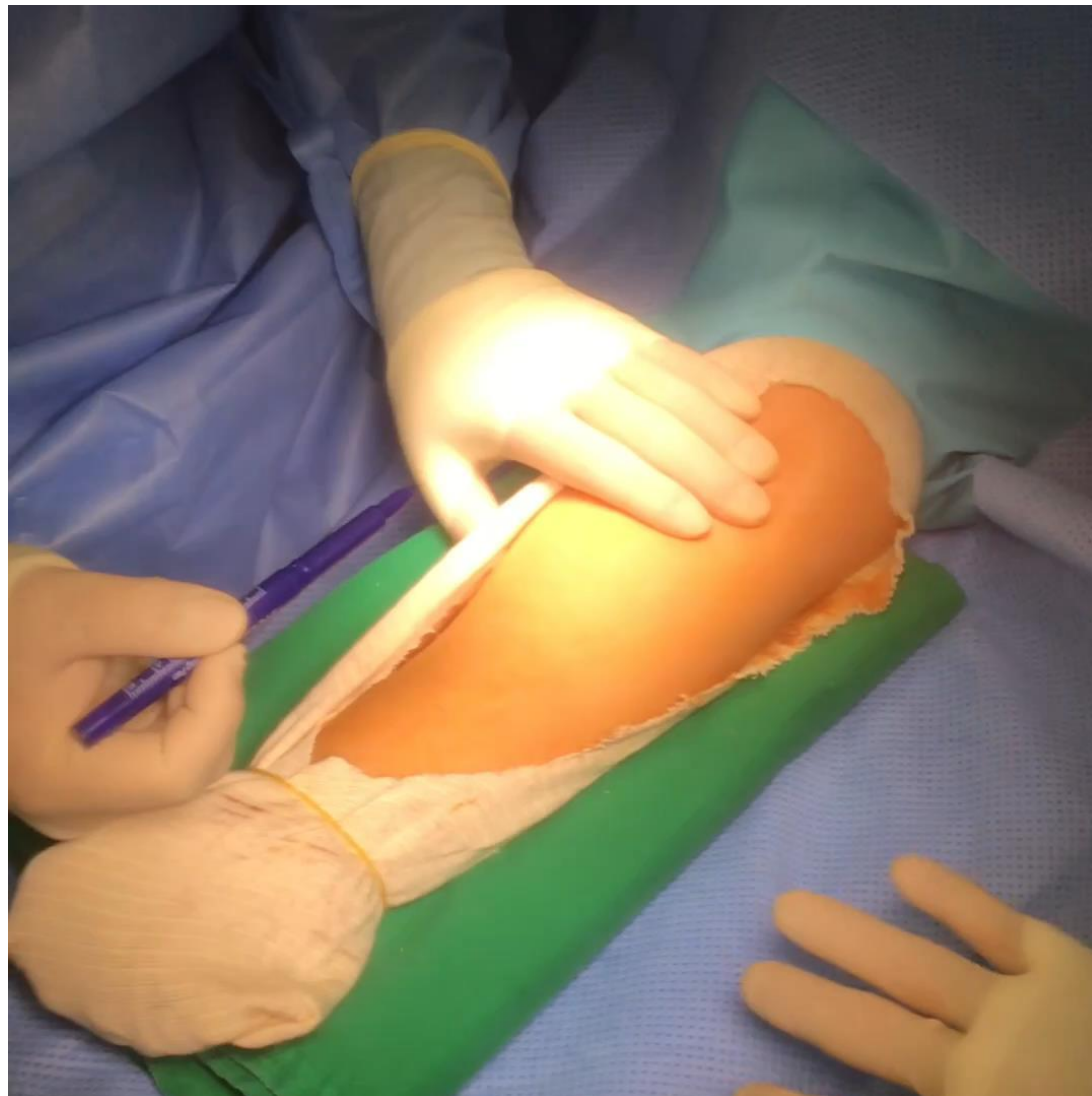
# RCAVF Video Clip



# AVG with loop graft

- Local anesthesia
- Incision : Between brachial artery and antecubital vein at cubital fossa
- Graft : ePTFE 4-6mm tapered size, thin wall, thick wall
- Venotomy and vein anastomosis 7-0 prolene
- Arteriotomy and artery anastomosis 7-0 prolene
- Post anastomosis dilatation : manual method

# Brachio-antecubital AVG Video Clip



**경청해 주셔서 감사합니다.**