

혈액투석을 위한 동정맥루

Vascular Access for Hemodialysis

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허균

국내 투석환자 통계

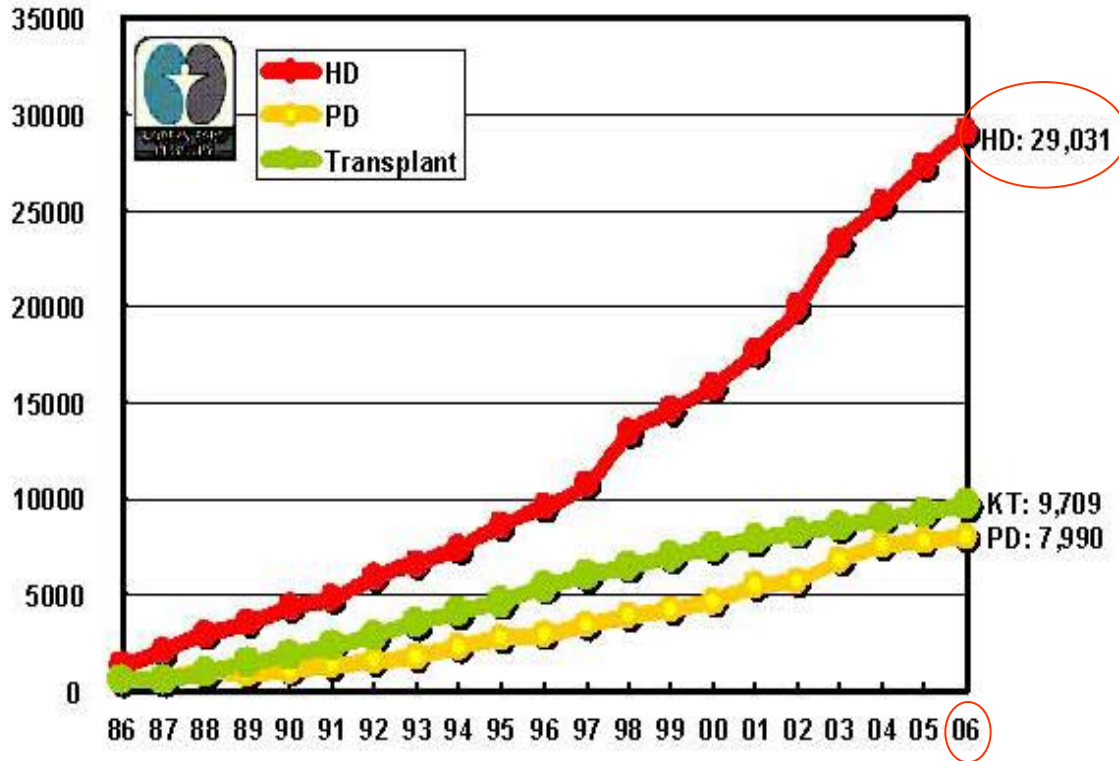


Fig 1-1. Patient numbers of renal replacement therapy at the end of 2006.

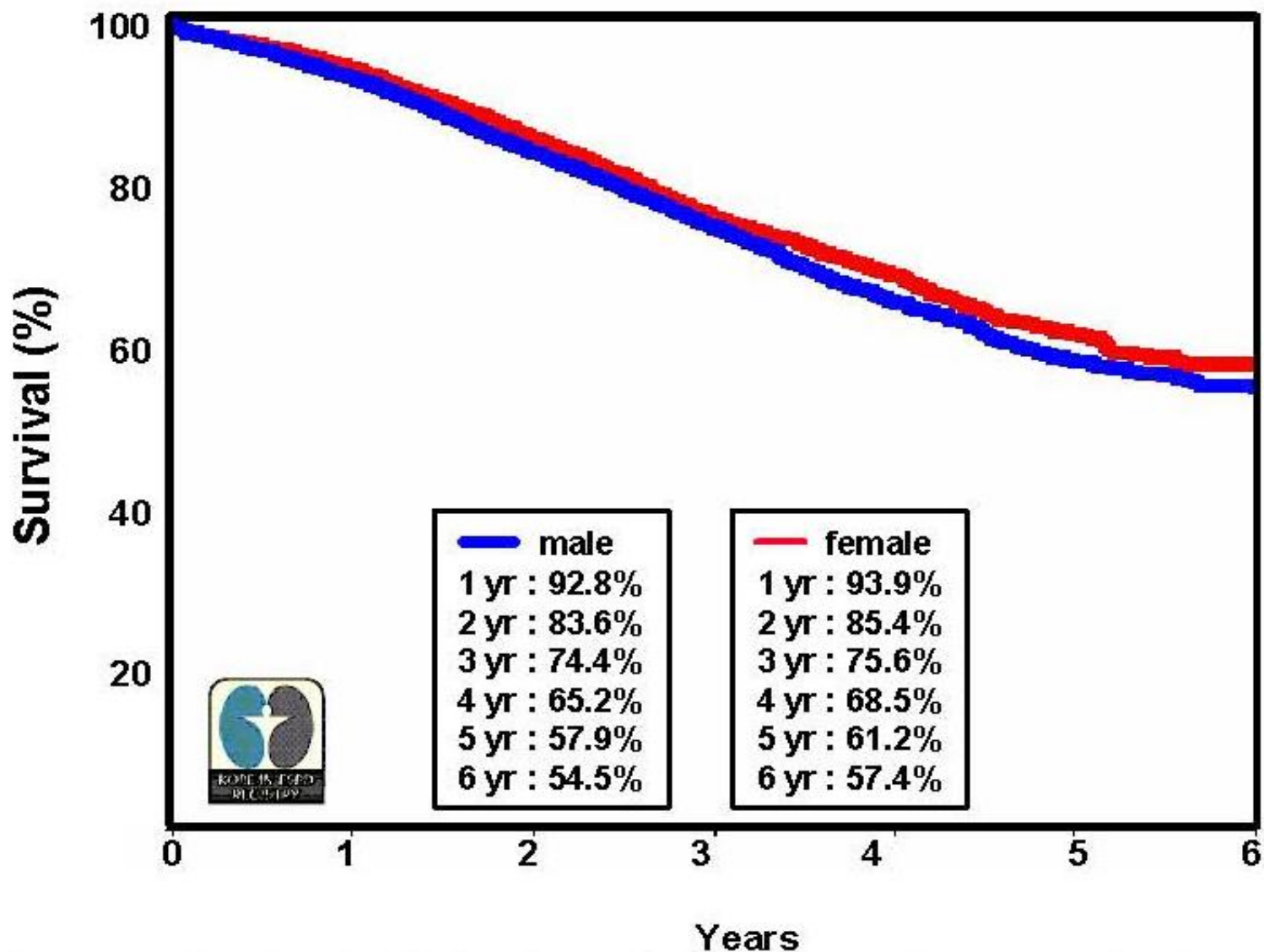


Fig.8-1. Overall registered dialysis patient survival since 2001. (Male :n=12,976, female : n=10,101).

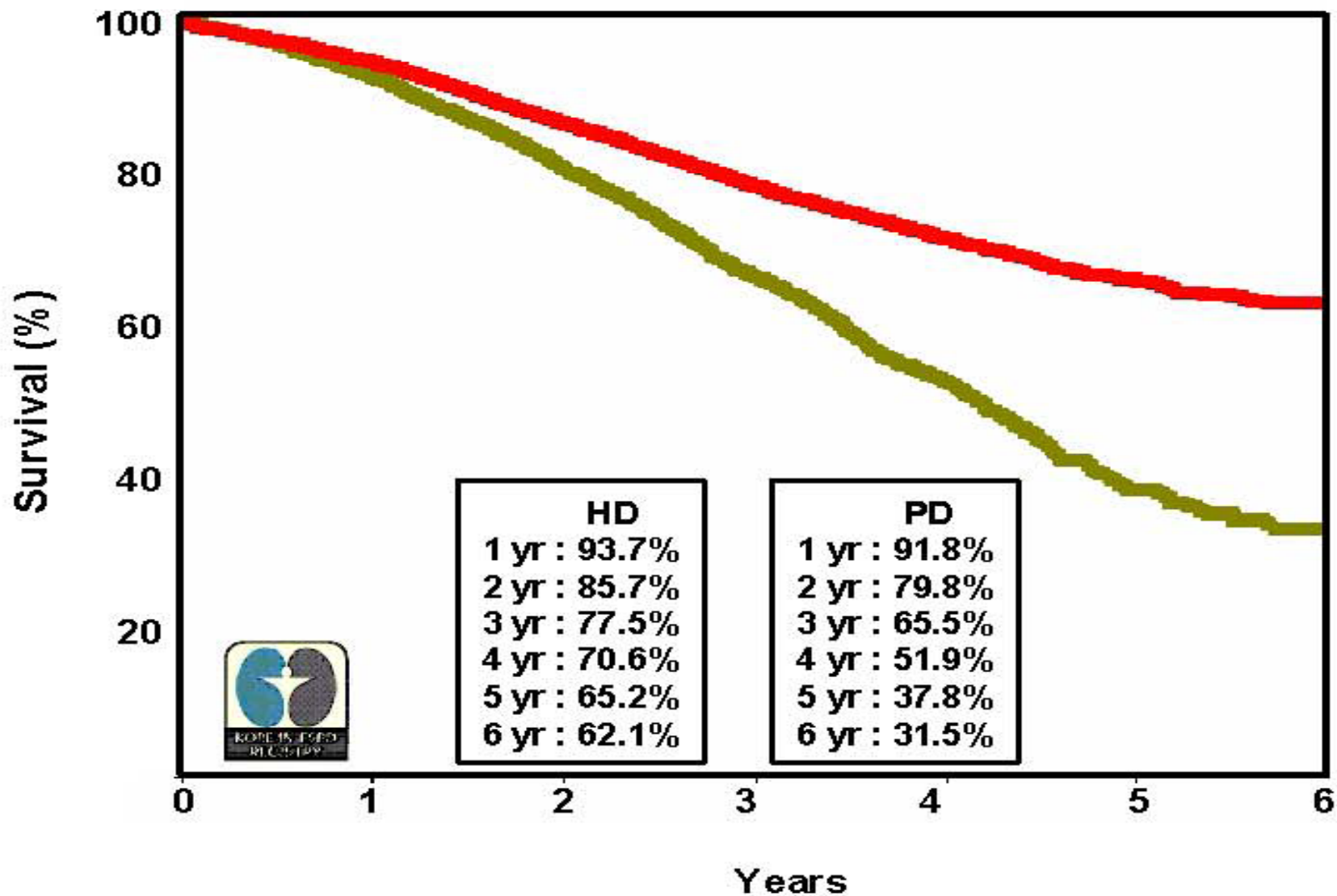


Fig 8-2. HD & PD dialysis patient survival since 2001 (HD :n=16,700, PD : n=6,377).

“투석환자들에게
혈관접근(vascular access)은
생명선(lifeline)이다”

Vascular access on ESRD

- AV Fistula
- AV Graft
- Central catheter

Vascular access on ESRD

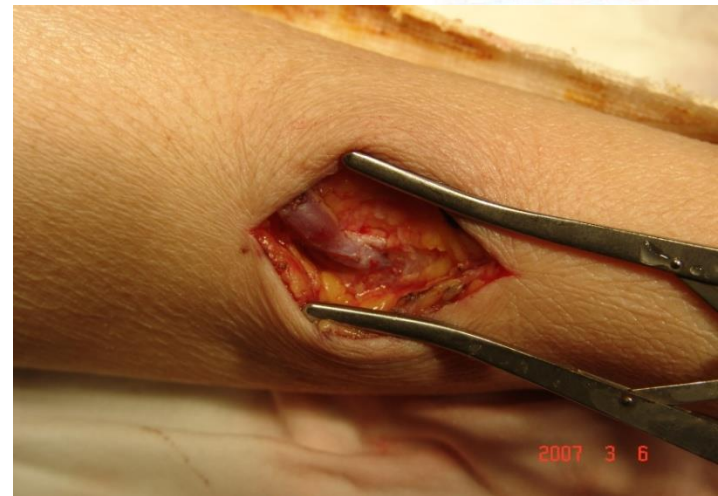
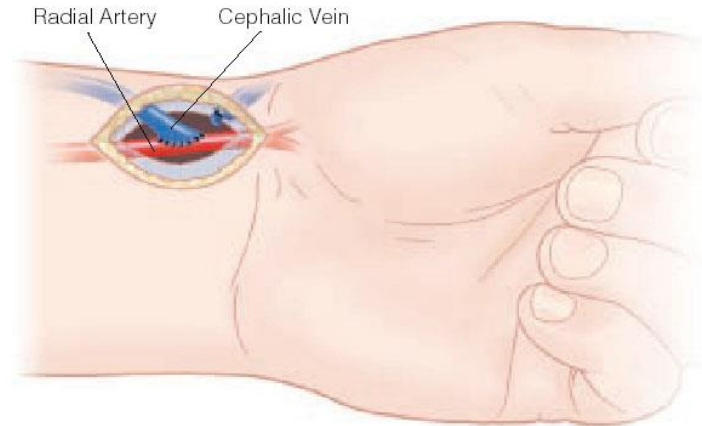
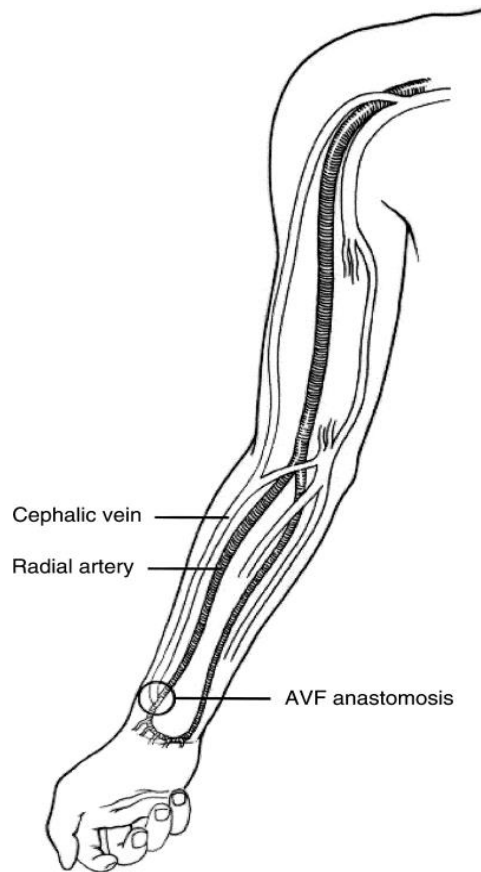
- The access should be placed distally and in the upper extremities whenever possible
- Options for fistula placement should be considered first, followed by prosthetic grafts if fistula placement is not possible
- Catheters should be avoided for HD and used only when other options listed are not available

AV Fistula

- 자신의 정맥을 이용하여 주위 동맥과 연결
- 정맥의 상태가 매우 중요
- Preferred: Fistulae (DOQI)
 - A wrist (radiocephalic) primary fistula
 - An elbow (brachiocephalic) primary fistula
 - A transposed brachial basilic vein fistula

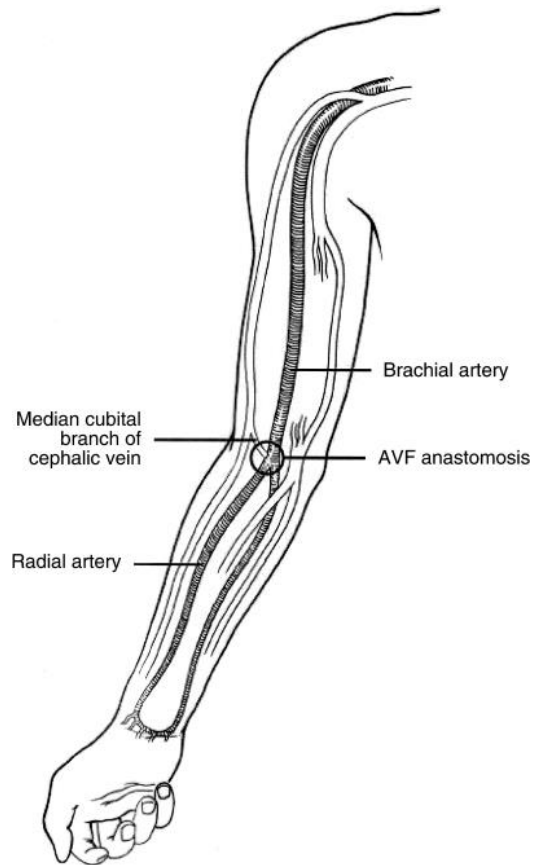
AV Fistula

– A wrist (radiocephalic) primary fistula



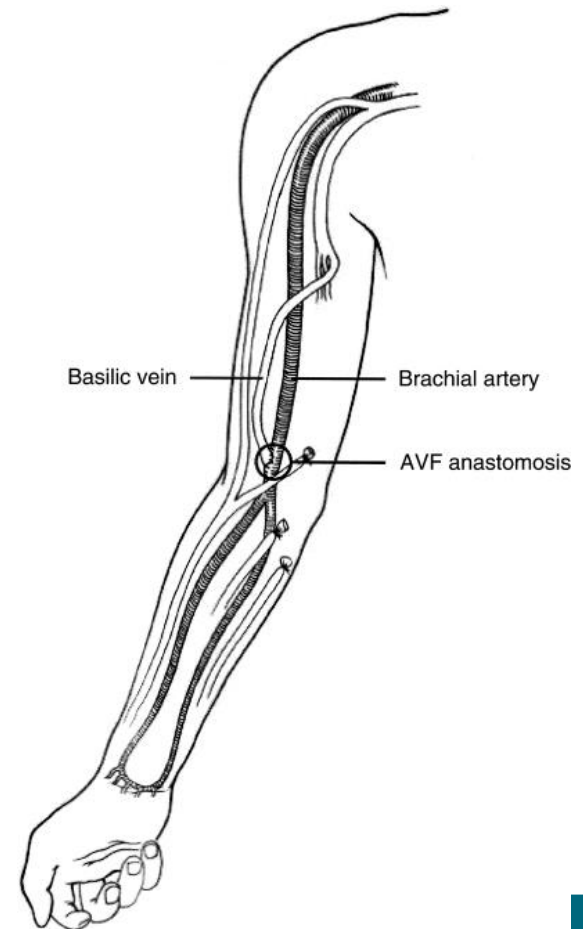
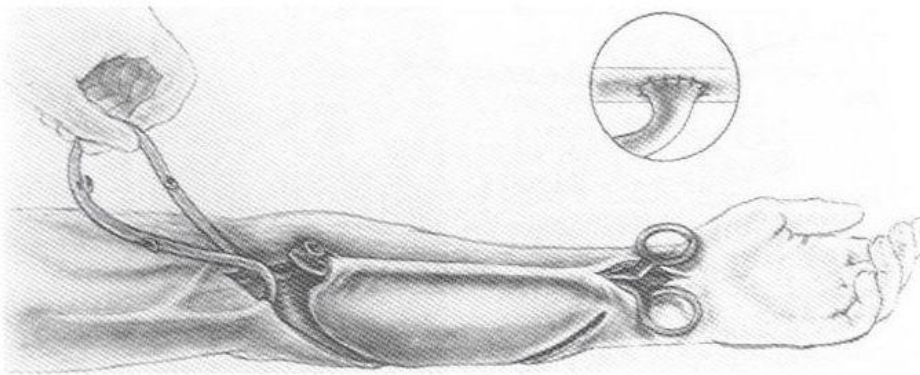
AV Fistula

- An elbow (brachiocephalic) primary fistula



AV Fistula

- A transposed brachial basilic vein fistula



AV Fistula

- The **wrist fistula** (radiocephalic) is the first choice of access type because of the following **advantages**:
 - It is relatively **simple** to create
 - It **preserves more proximal vessels** for future access placement
 - It has **few complications**. Specifically, the incidence of vascular steal is low, and in mature fistulae, thrombosis and infection rates are low

AV Fistula

- The major **disadvantage** of the wrist fistula is
 - **lower blood flow rate**
 - Comparatively **long maturation times (1 to 4 months)** must elapse after creation of these fistulae before they can be used
 - relatively **high primary failure rate (15%)**
 - **moderate secondary patency** rate at 1 year (62%).

AV Fistula

- The **elbow (brachiocephalic)** primary fistula is the second choice for initial placement of an access. Its **advantages** include the following:
 - It has a **higher blood flow** compared with the wrist fistula.
 - The cephalic vein in the upper arm usually is comparatively **easier to cannulate** and is **easily covered**, providing a potential **cosmetic benefit**.

AV Fistula

- The **disadvantages** of the elbow primary fistula include the following:
 - It is slightly **more difficult** to create surgically than a radiocephalic fistula.
 - It may result in **more arm swelling** than a radiocephalic fistula.
 - It is associated with an **increased incidence of steal** compared with a radiocephalic fistula.
 - It is associated with a greater incidence of **cephalic arch stenosis** than a forearm radiocephalic fistula

AV Graft

- **Acceptable: AVG of synthetic or biological material, such as:**
 - **Forearm loop graft**, preferable to a straight configuration.
 - **Upper-arm graft**
 - Chest wall or “necklace” prosthetic graft or lower-extremity fistula or graft; all upper-arm sites should be exhausted

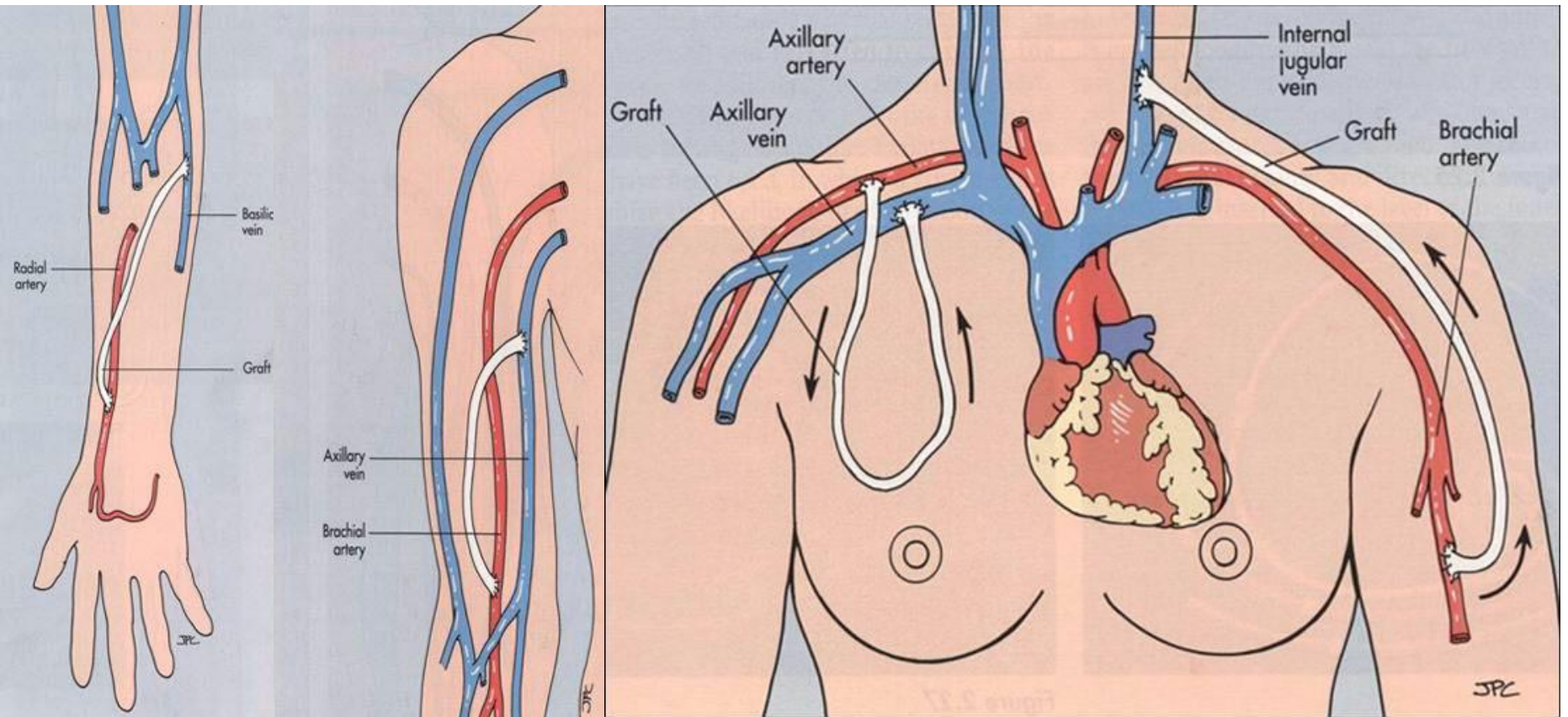
AV Graft

Forearm loop graft



AV Graft

- Others



AV Graft

- AVGs have the following **advantages**:
 - A **large surface area** for cannulation initially
 - They are technically **easy to cannulate**
 - The lag-time from insertion to **maturation is short**. For PTFE-derived grafts, it is recommended that not less than 14 days should elapse before cannulation to allow healing and incorporation of the graft into local tissues, although ideally, 3 to 6 weeks are recommended

AV Graft

- AVGs have the following **advantages**:
 - **Multiple insertion sites** are available
 - A **variety of shapes and configurations** is available to facilitate placement
 - It is **easy for** the surgeon to handle, implant, and construct the **vascular anastomosis**
 - The graft is comparatively **easy to repair** either surgically or endovascularly
- A synthetic dialysis AVG is expected to **last 3 to 5 years**

Central catheter



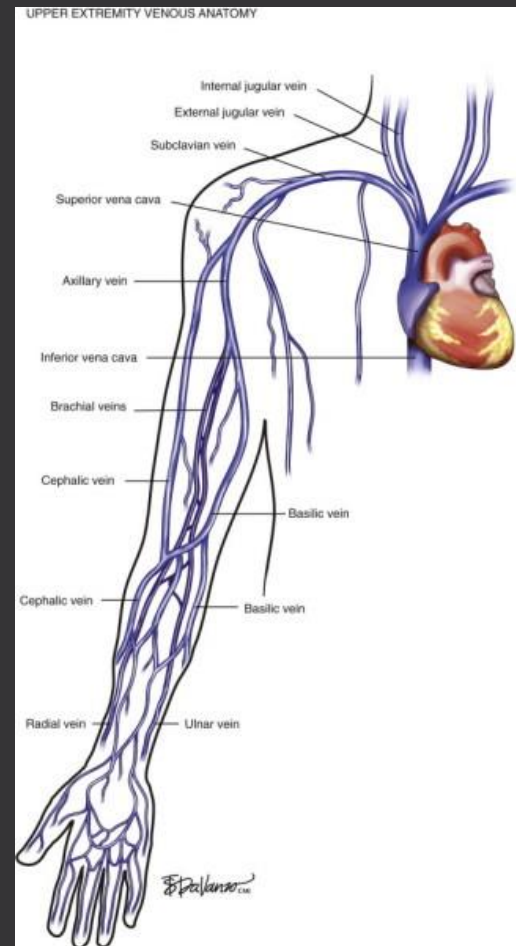
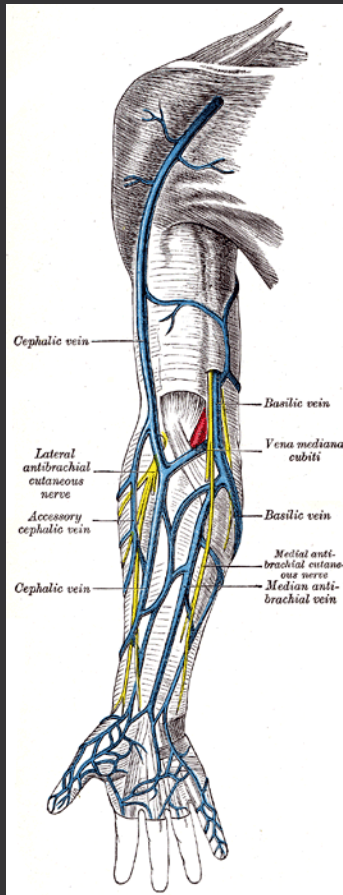
For AV access formation

환자의 혈관 상태 파악

AV fistula or AV graft

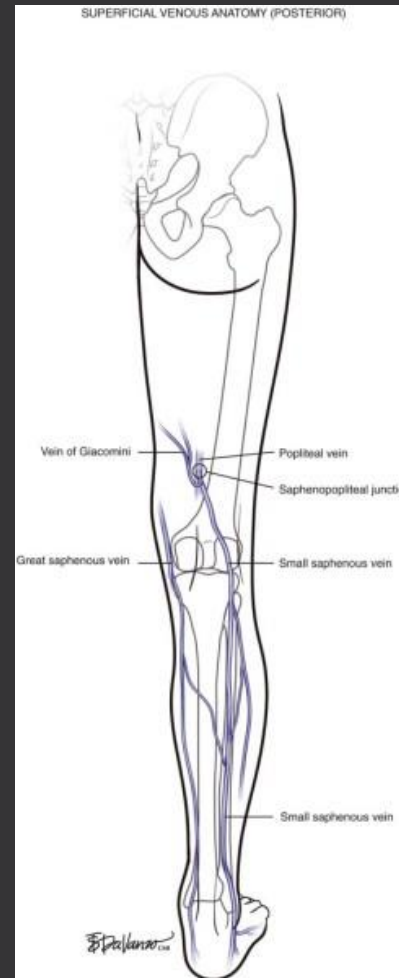
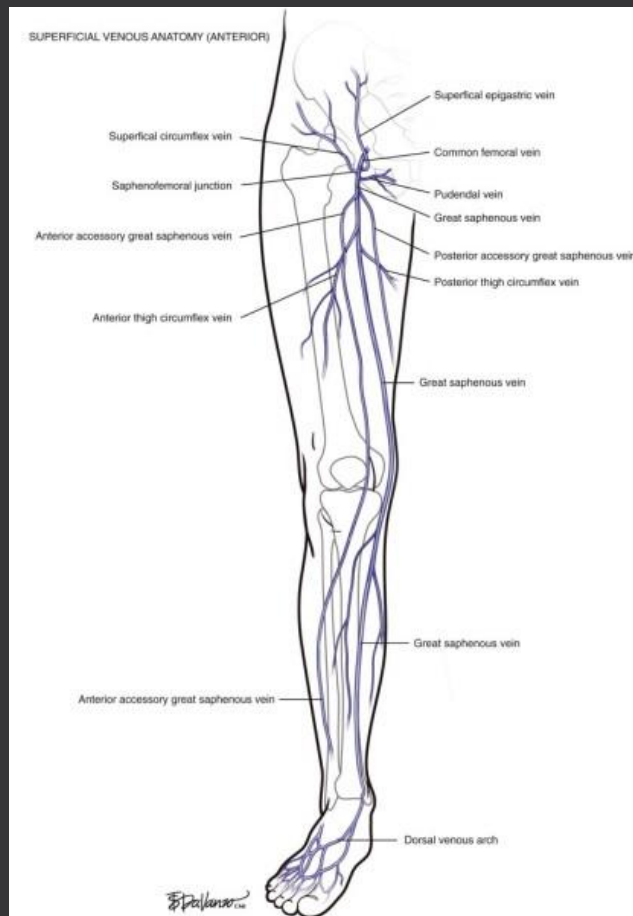
환자의 혈관상태

▣ Vein anatomy- 상지



환자의 혈관상태

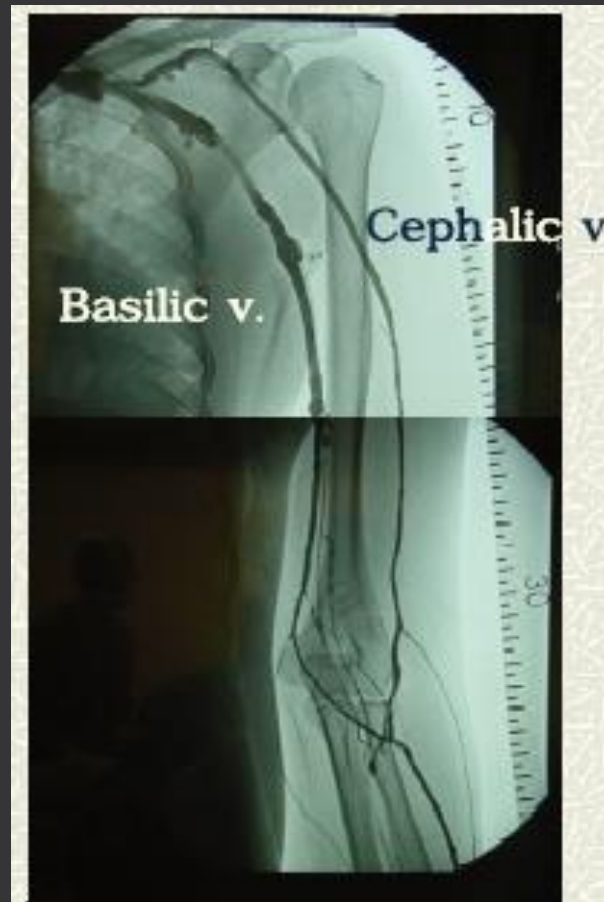
▣ Vein anatomy- 하지



환자의 혈관상태

- ▣ Sonography
- ▣ Venography
- ▣ CT angiography
- ▣ MR angiography
- ▣ Manual examination : 촉진, 타진

Example of preoperative venogram : normal findings



Sonography 유용성

- ▣ Cephalic vein 의 크기, 위치 및 상태
- ▣ Antecubital vein 및 brachial vein 상태
- ▣ Axillary vein
- ▣ Venous mapping
- ▣ Radial artery, brachial artery
- ▣ Central vein stenosis 유무를 알수 없다

▣ DOQI(Dialysis Outcomes Quality Initiative) Guideline

미국 국립신장기금에서 지원을 받아 투석을 위한 혈관 접근로와 관련된 시행 기준을 제시한 것으로 투석치료에 종사하는 의료진들은 이 기준을 따름 [1997]

NKF-KDOQI Guideline Update 2006

- ▣ 기존 38개 지침(guideline)을 8개 지침으로 바꾸어 정리

- ▣ 8개의 지침은 다시
 - ① 증거를 근거로 하는 진료지침
(clinical practice guideline)
 - ② 임상진료에 대한 권장사항
(clinical practice recommendations)
 - ③ 향후 연구방향(research recommendations)으로 나누어 정리함

2006 Updates Clinical Practice Guidelines and Recommendations



- Hemodialysis Adequacy
- Peritoneal Dialysis Adequacy
- Vascular Access

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Principles of hemodialysis access surgery

- ▣ *As far distally in the extremity as possible*
- ▣ *Autogenous preferred*
- ▣ *Evaluation of arterial inflow and venous outflow*
- ▣ *Upper extremity over lower extremity*
- ▣ *Nondominant arm over dominant arm*
- ▣ *Forearm over upper arm*
- ▣ *Types of prosthetic graft material*
- ▣ *Cuffed venous catheters discouraged*

What is the best access for hemodialysis?

- ▣ 35 years after initial description of the AV fistula, it still remains the best access for hemodialysis.

AV fistula(AVF)

Arterial diameter > 1.6 mm

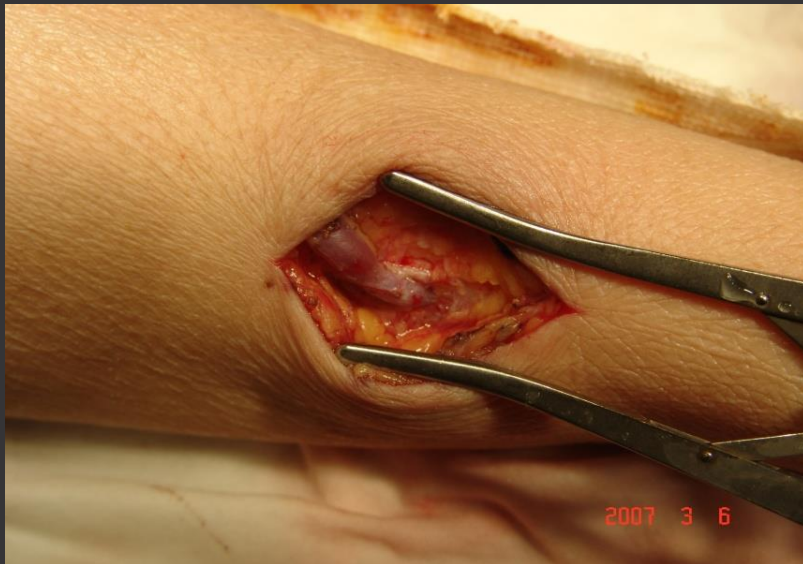
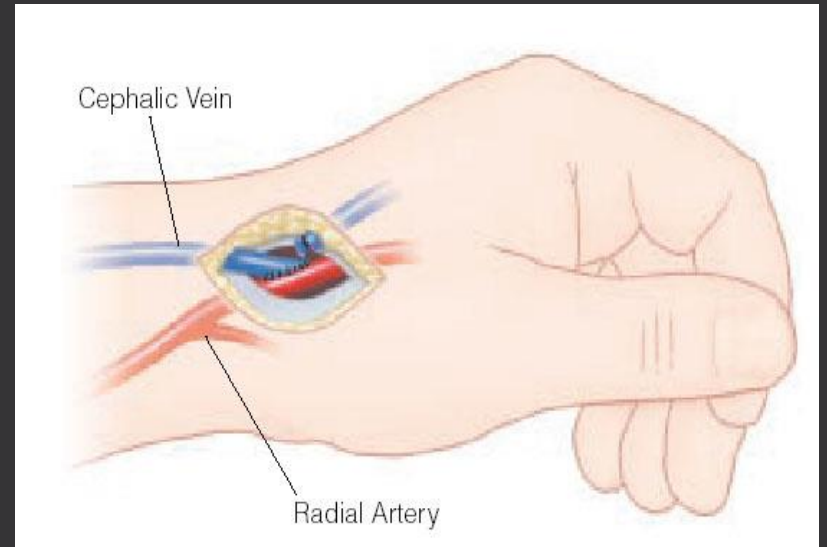
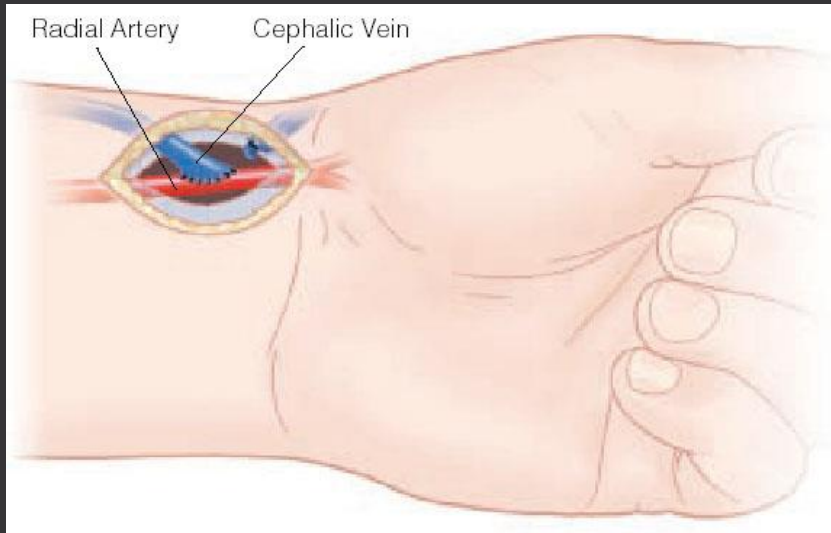
Venous diameter > 2.0-2.5 mm

Continuity with the proximal central
veins absence of obstruction

Vein condition



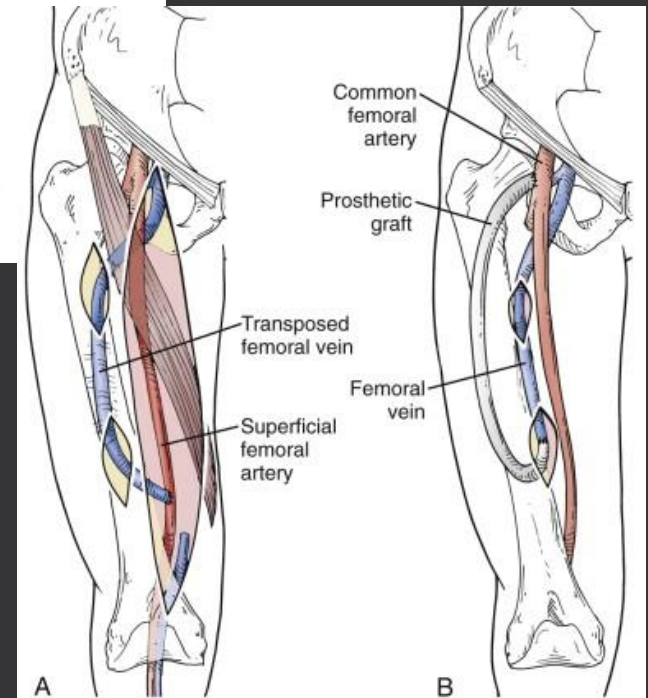
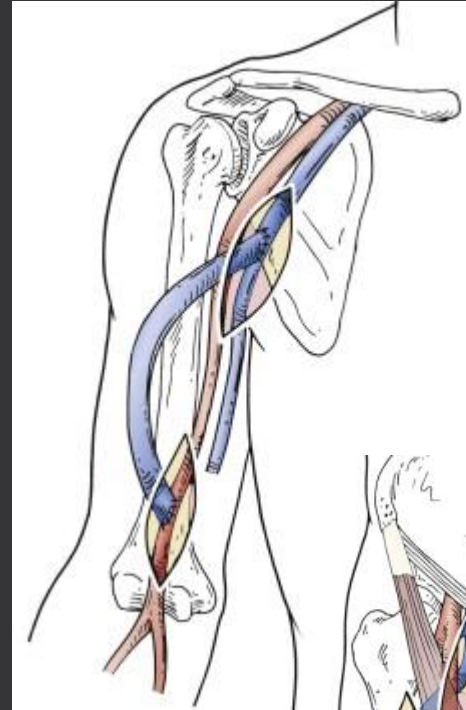
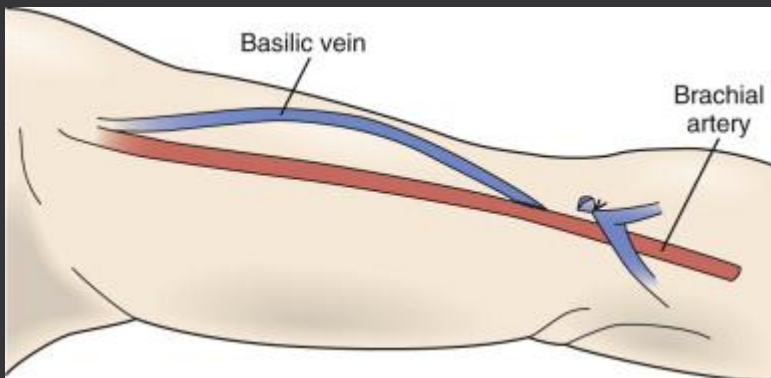
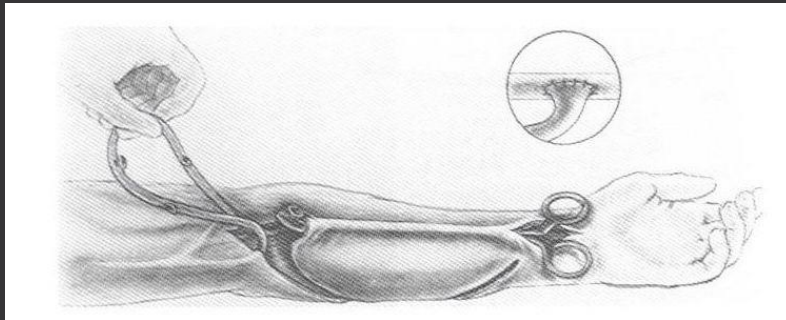
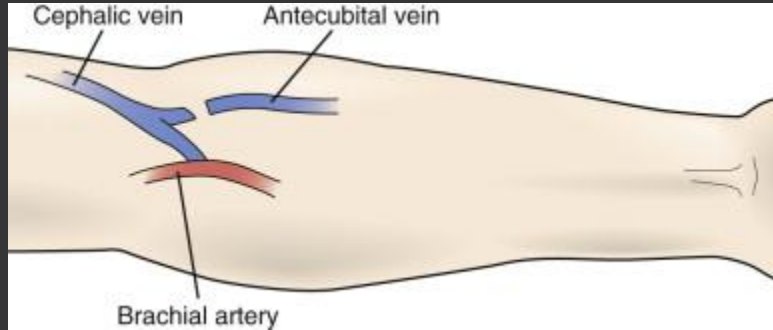
Wrist or Forearm
Radio-Cephalic AVF
(RCAVF)



Sites for AV fistula

- ▣ **2.1.1 Preferred: Fistulae. (B)**
 - **2.1.1.1 A wrist (radiocephalic) primary fistula. (A)**
 - **2.1.1.2 An elbow (brachiocephalic) primary fistula. (A)**
 - **2.1.1.3 A transposed brachial basilic vein fistula: (B)**

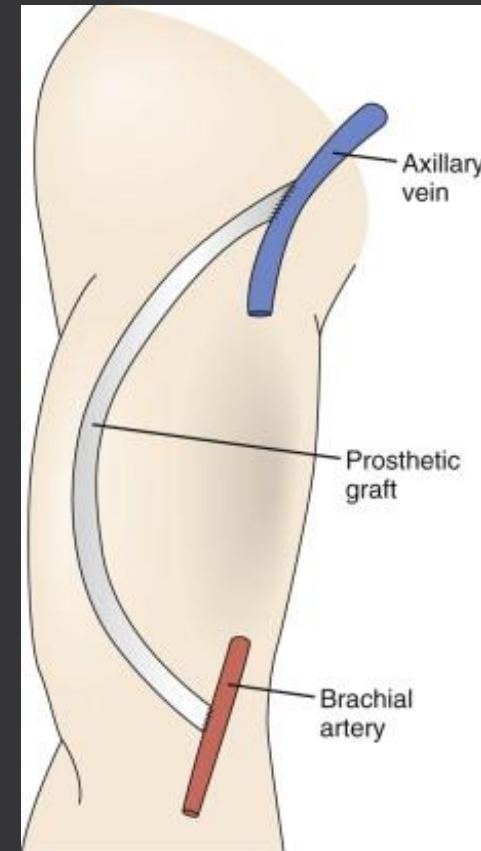
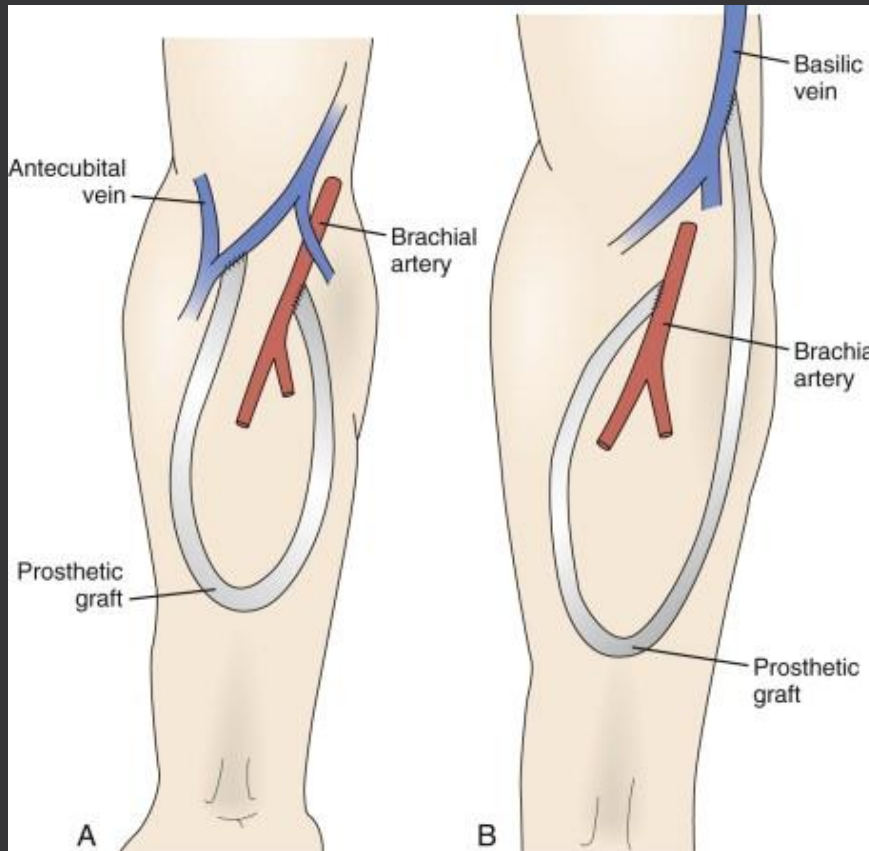
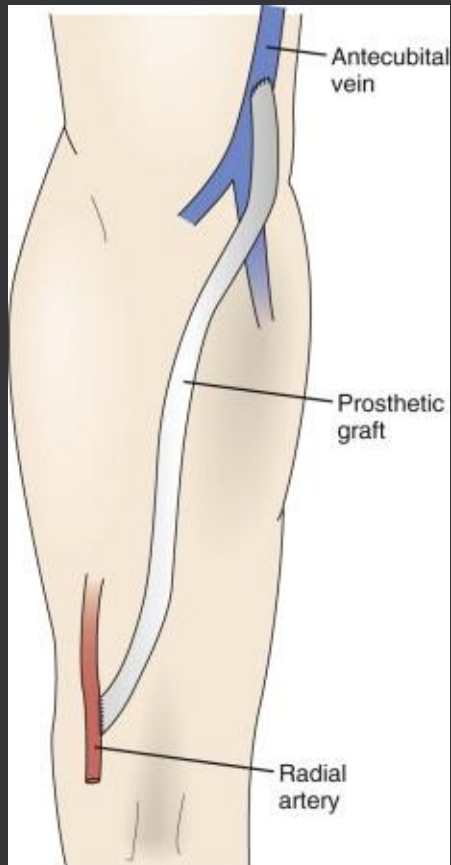
Sites for AV fistula



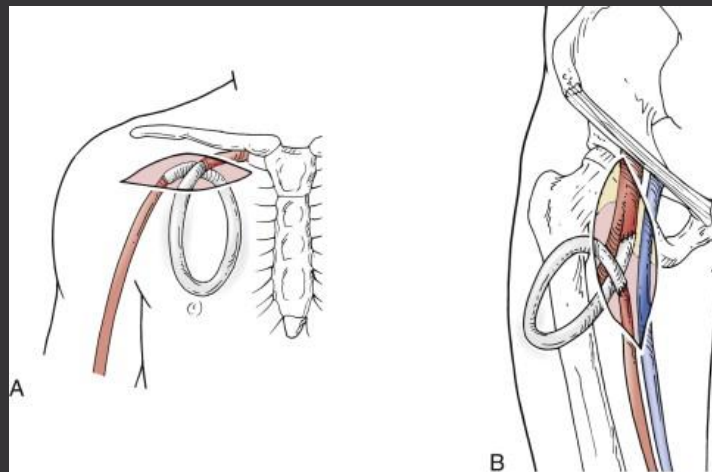
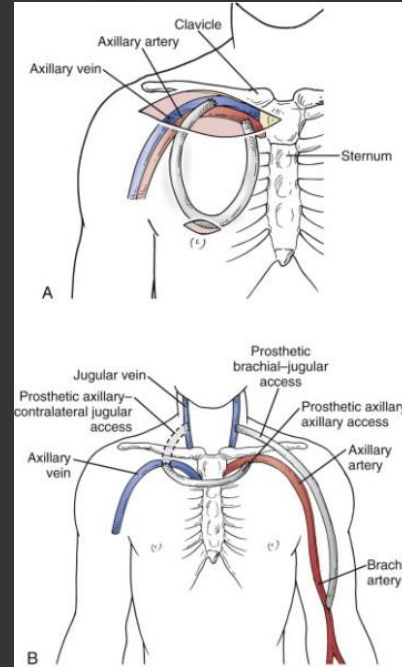
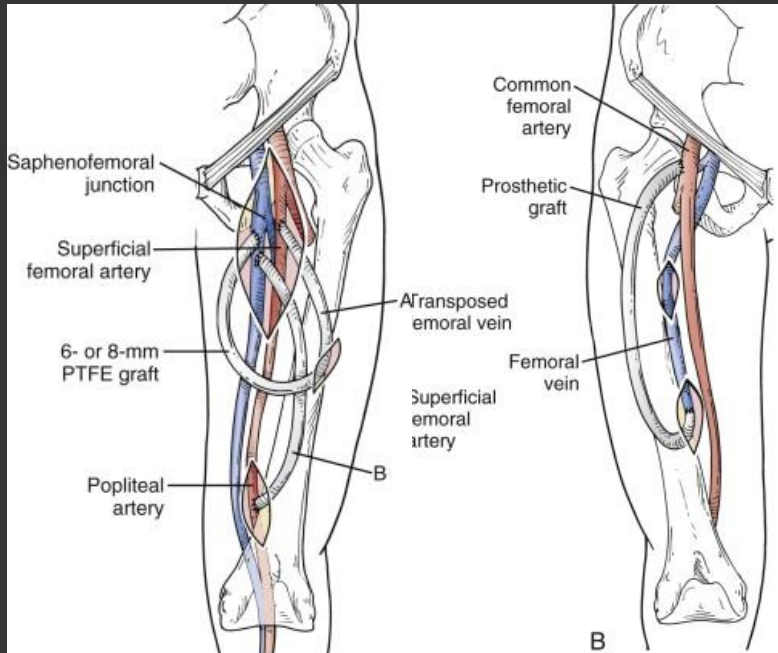
AV graft(AVG)

- ▣ **2.1.2 Acceptable: AVG of synthetic or biological material, such as: (B)**
 - 2.1.2.1 A forearm loop graft, preferable to a straight configuration.
 - 2.1.2.2 Upper–arm graft.
 - 2.1.2.3 Chest wall or “necklace” prosthetic graft or lower–extremity fistula or graft; all upper–arm sites should be exhausted.

Sites for AV graft



Sites for AV graft



Monitoring and surveillance

▣ 정기진찰(*monitoring*)

- The examination and evaluation of access by P/Ex
- 시진상 이상소견, 부종 및 주사침 삽입부의 지속적인 출혈
- 촉진상 진전(thrill)의 감소/소실 혹은 맥박(pulse)로의 변환
- 청진상 문합부 잡음(bruise)의 감소 내지는 소실

▣ 정기검사(*surveillance*)

- The evaluation of access by special instrumentation

Table 7. Flow Methods in Dialysis Access

Duplex Doppler Ultrasound (Quantitative color velocity imaging): [DDU]
Magnetic Resonance Angiography: [MRA]
Variable Flow Doppler Ultrasound (Specs USA):[VFU]
Ultrasound dilution (Transonics):[UDT]
Crit-Line III (optodilution by ultrafiltration;HemaMetrics): [OABF]
CritLine III direct transcutaneous (HemaMetrics): [TQA]
Glucose pump infusion technique [GPT]
Urea dilution [UreaD]
Differential Conductivity (GAMBRO): [HDM]
In Line Dialysance (Fresenius):[DD]

Monitoring and surveillance

Table 9. Criteria for Intervention

Degree of Stenosis	Access Pressure Ratio					
	Graft		Fistula			
	Arterial Segment	Venous Segment	Arterial Segment	Venous Segment		
<50% of diameter	0.35-0.74	0.15-0.49	0.13-0.43	0.08-0.34		
>50% of diameter						
Venous outlet	>0.75	or	>0.5	>0.43	or	>0.35
Intra-access	≥0.65	and	<0.5	>0.43	and	≤0.35
Arterial inflow	<0.3		Clinical findings	<0.13 + clinical findings		Clinical findings

Table 10. Access Flow Protocol Surveillance

Access flow measured by ultrasound dilution, conductance dilution, thermal dilution, Doppler or other technique should be performed monthly. The assessment of flow should be performed during the first 1.5 hr of the treatment to eliminate error caused by decreases in cardiac output or blood pressure related to ultrafiltration/hypotension. The mean value of 2 separate determinations (within 10% of each other) performed at a single treatment should be considered the access flow.

Graft

If access flow is <600 mL/min in a graft, the patient should be referred for fistulogram.

If access flow 1,000 mL/min that has decreased by more than 25% over 4 mo, the patient should be referred for fistulogram.

SCHBC practices

For AV access formation

↓
외래에서 초음파시행;양팔

↓
Cephalic vein 의 위치, 상태

↙
Cephalic vein을 이용하여 AVF wrist, Lt or Rt

↘
Antecubital vein or brachial vein 을 이용하여 AVG forearm, Lt. or Rt



Cephalic vein을 이용한 wrist AVF

Local anesthesia

Incision : between RA and CV

CV dissection and dilatation

CV 의 dorsal branches 보다 proximal 부위를 이용

Arteriotomy : 8-11mm

8-0 prolene, continuous running suture

Post anastomosis dilatation : manual method, branch ligation

Antecubital vein or brachial vein 을 이용한 AVG forearm

Local anesthesia

Incision : between BA and antecubital vein at cubital fossa

Graft : ePTFE 4-6mm tapered size, thin wall, thick wall

Venotomy and vein anastomosis 7-0

Arteriotomy and artery anastomosis 7-0

Post anastomosis dilatation : manual method

수술 후 추적관찰

수술 2주후 외래 F/U

초음파를 이용하여 AV access 상태 확인

AVF : mid-forearm size, Velocity, color doppler 등을 확인

AVG : velocity, color doppler, vein anastomosis 부위등을 확인

3개월뒤 투석실에서 access flow 확인

Complex AV access

Complicated AV access

Hemodialysis access: Complex

- Patients who have “outlived” the AV access option in the upper extremity
- Nearly 7% of access placements were located at a site other than the upper extremity
- Complex: become necessary when options in the upper extremity are extended

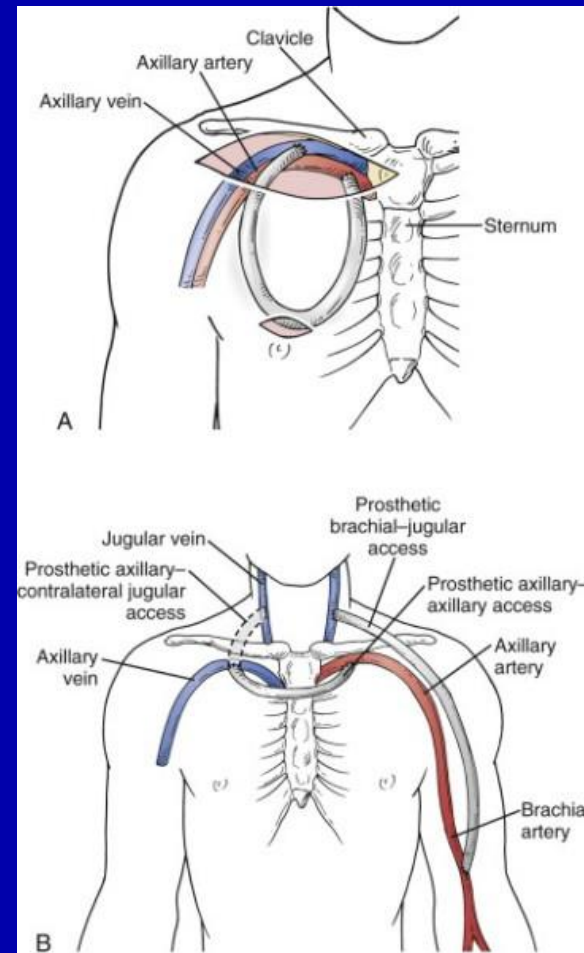
Complex access site selection

Table 73-1 -- Major Complex Access Procedures: Indications, Relative Contraindications, and Anatomic Requirements

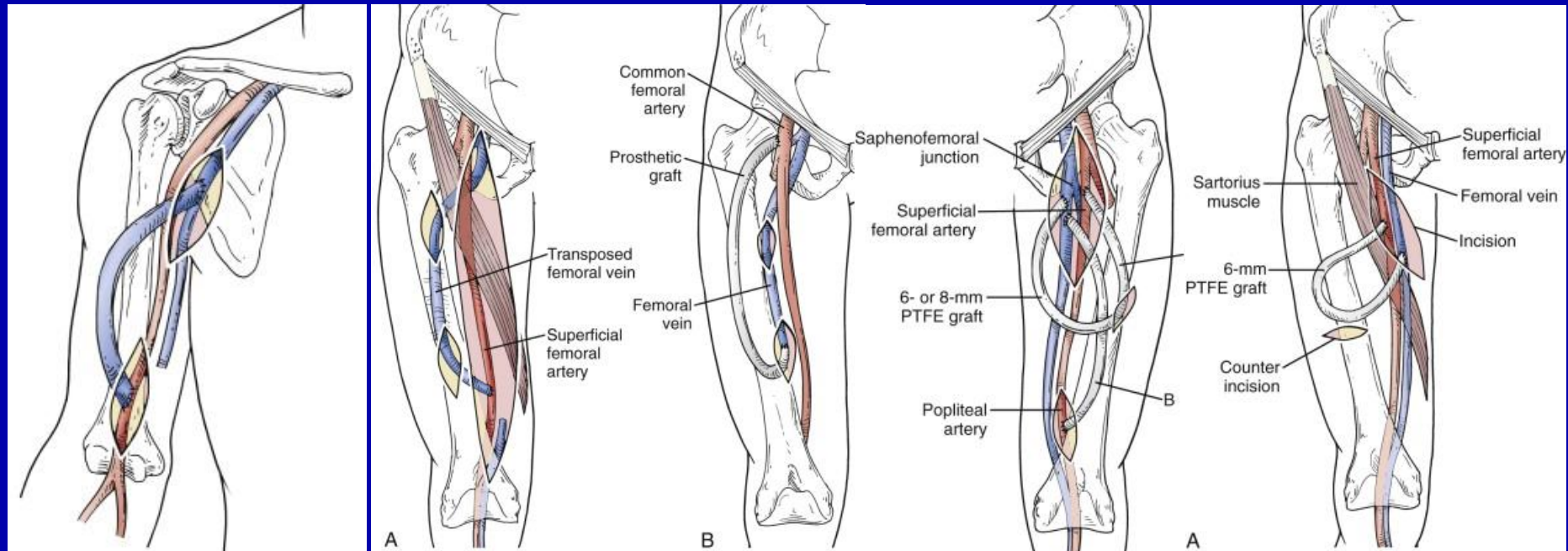
Access Procedure	Specific Anatomic Requirements	Ideal Clinical Situation	Relative Contraindications
Autogenous femoral vein transposition	Patent femoral vein >3 mm in diameter Patent, noncalcific superficial femoropopliteal artery	Pediatric or young, healthy patients Patients who are hypercoagulable with no other autogenous access options Patients at high risk for infection (poor hygiene, immunosuppressed, multiple previous access infections)	Significant obesity of the thigh Patients who are elderly or "medically fragile" Access sites for temporary catheter placement not readily available Patients at high risk for access-related ischemia of the lower extremity
Prosthetic midhigh loop femorofemoral access Prosthetic loop femorofemoral access	Patent femoral or common femoral vein Patent, noncalcific superficial femoral artery (midhigh access) or common femoral artery	Patients who are elderly or have significant medical co-morbidities	Patients at high risk for infection (poor hygiene, immunosuppressed, multiple previous access infections) Patients who are morbidly obese
Prosthetic chest wall access	Patent axillosubclavian artery and vein Patent central vein	Patients who are morbidly obese Patients at high risk for access-related limb ischemia	Patients who are reasonable candidates for autogenous or prosthetic thigh access procedures
Tunneled cuff dialysis catheter	Patent central vein	Patients who are "medically fragile" or have limited life expectancy (<6 mo) Patients in whom all alternative access procedures have been expended	Patients who are candidates for an alternative complex access procedure (autogenous or prosthetic thigh or chest wall access)

Chest wall access

- Exhaustion of all access possibilities in both arms with a patent superior vena cava, subclavian, and brachiocephalic veins
- In case of unilateral central venous stenosis or obstruction with complete exhaustion of all other access possibilities on the contralateral side
- The reasonable patency and minimal complications



Lower-extremity vascular access



Rutherford's vascular surgery, 7th

Lower-extremity vascular access

- Acceptable results in terms of patency
 - femoral vein transposition > femoral grafts.
- Autologous access
 - less infective
 - increased ischemic complications
- Further research with randomized trials is required to assess the outcomes of lower-extremity vascular access.
- Obese : abdominal pan-nus → mid thigh loop

Complications

- Stenotic
 - stenotic or obstructed access
 - Central vein stenosis
 - Primary failure :
failure to mature
- Nonstenotic
 - Infection
 - Pseudoaneurysm
 - Arterial steal syndrome
 - Neuropathy
 - Cardiopulmonary complications

Thrombotic occlusion of AV graft

- Initial thrombectomy success rates
 - Endovascular : 79%
 - Surgical : 77%
- Graft patency at 30 and 90 days
 - Endovascular : 79% and 75%
 - Surgical : 73% and 68%
- Endovascular Tx
 - tissue plasma activator (tPA), potent thrombolytic agent
 - newer thrombectomy devices
- Open surgical thrombectomy alone is not typically adequate
 - Graft revision with patch angioplasty or graft interposition,

Access thrombotic occlusion



Endovascular Tx.

Surgical Tx.



Hybrid technique

Hybrid technique

- Removal of thrombus is achieved by open balloon catheter thrombectomy
- Once the clot is removed, intra-operative angiography from the arterial inflow to the superior vena cava can be performed
- Cause of access failure
 - Balloon angioplasty
 - Surgical revision with patch angioplasty or graft interposition

Hybrid technique



Hybrid technique for thrombectomy and angioplasty. A, Through a small arteriotomy near the venous end, balloon catheters are passed proximally and distally. B, Conventional balloon catheters are used for thrombectomy. C, A sheath is then placed through the arteriotomy for fistulography and possible intervention.

AV graft infection

Segmental bypass and partial graft excision

순천향대학교 부천병원
흉부외과 허균

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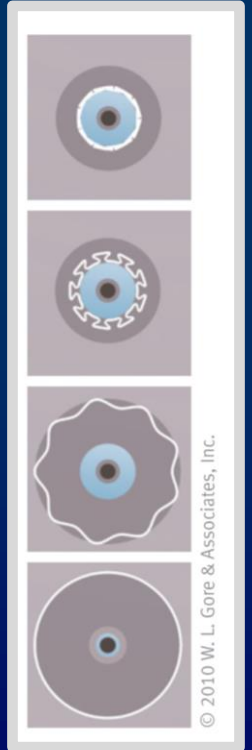
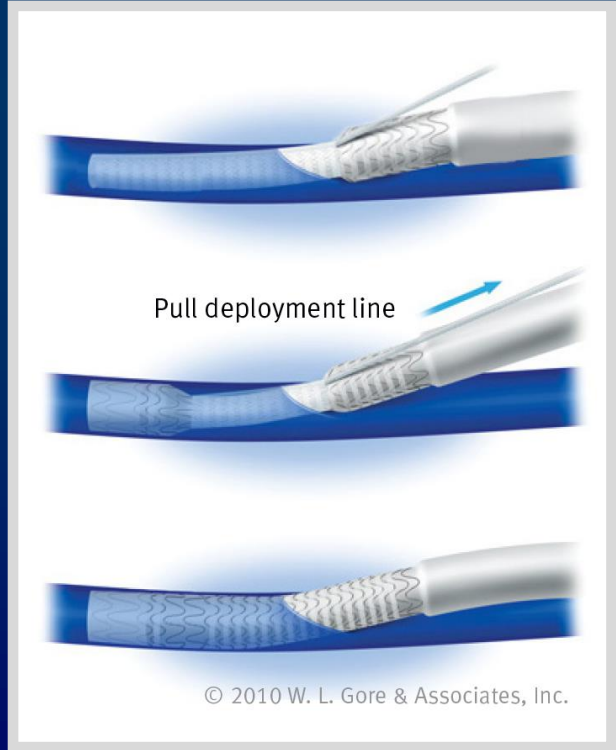
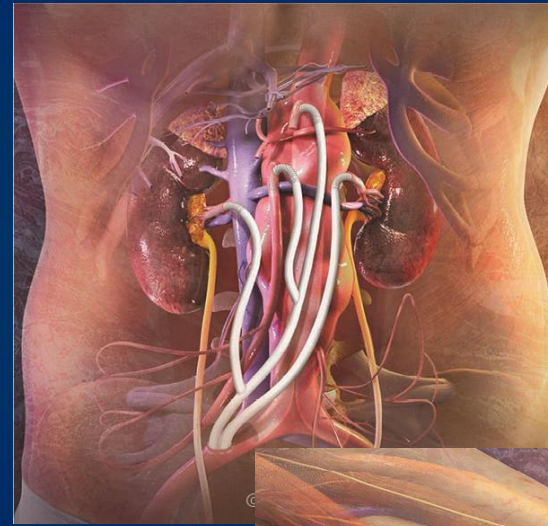
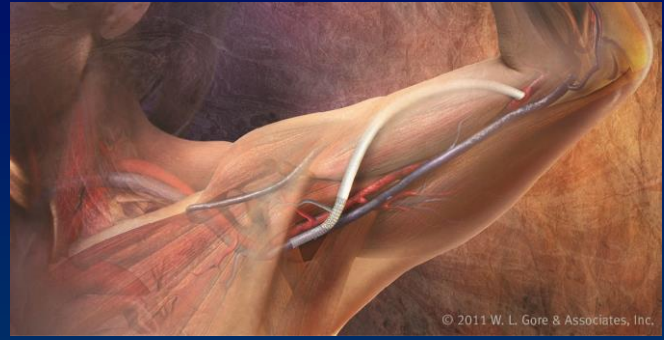
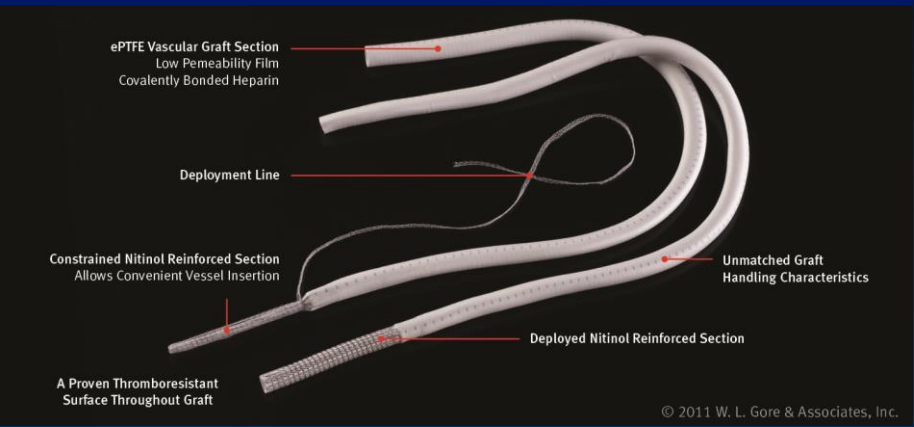


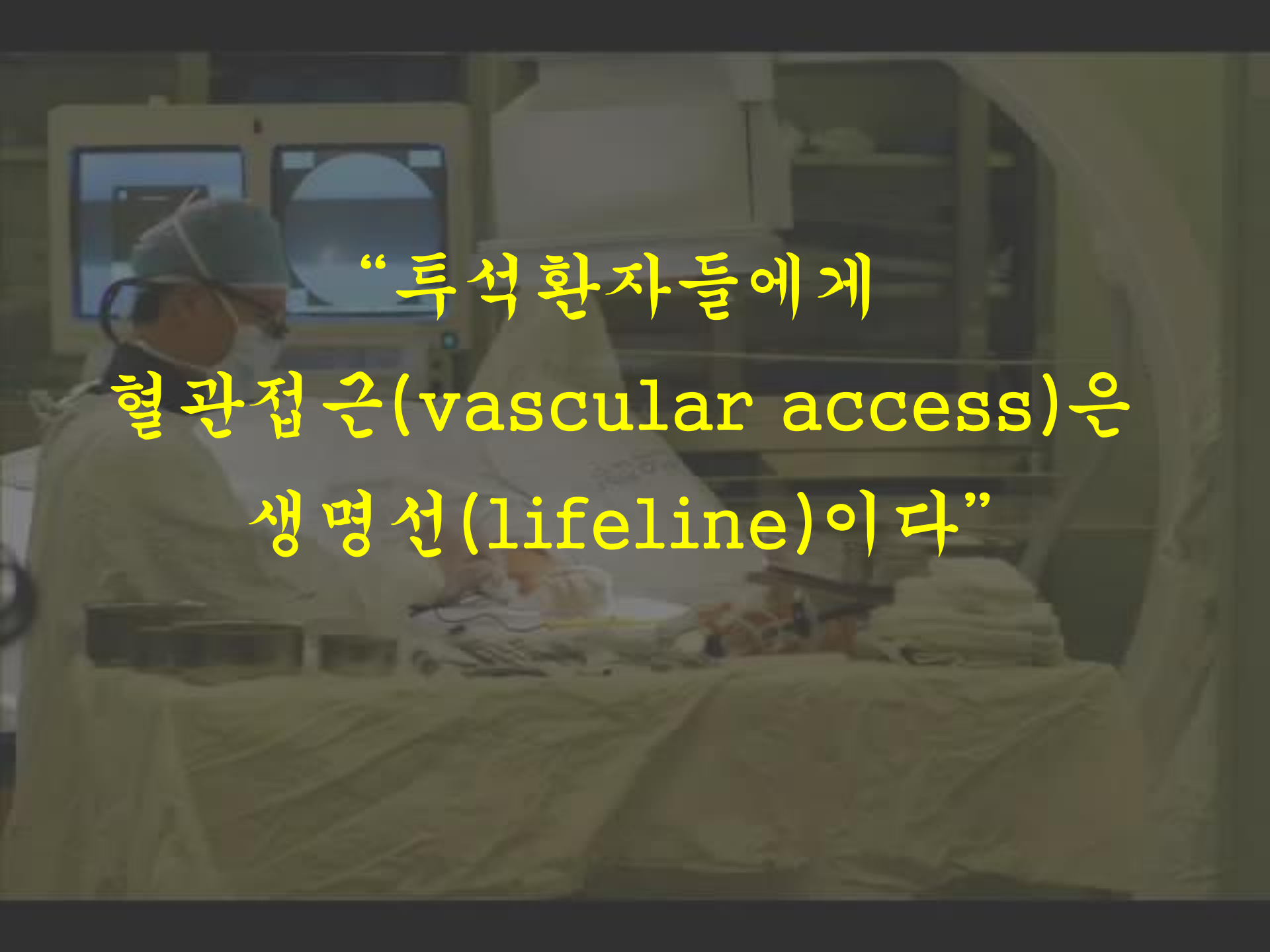
(1.0496 Cm)

L:128
W:256



Hybrid Vascular Graft





“투석 환자들에게
혈관접근(vascular access)은
생명선(lifeline)이다”