Basic knowledge for catheter-based intervention

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Angiography Systems

- **Fixed angiography system**
- **Mobile C-arm system**
- **By Special Function / Purpose**
  - **Hybrid OR angiography system**
  - **3D rotational angiography (3D-RA) system**
  - **Cone-beam CT angiography system**
  - **Fusion imaging / roadmap system**

Fluoroscopy Systems

C arm system

Hybrid system

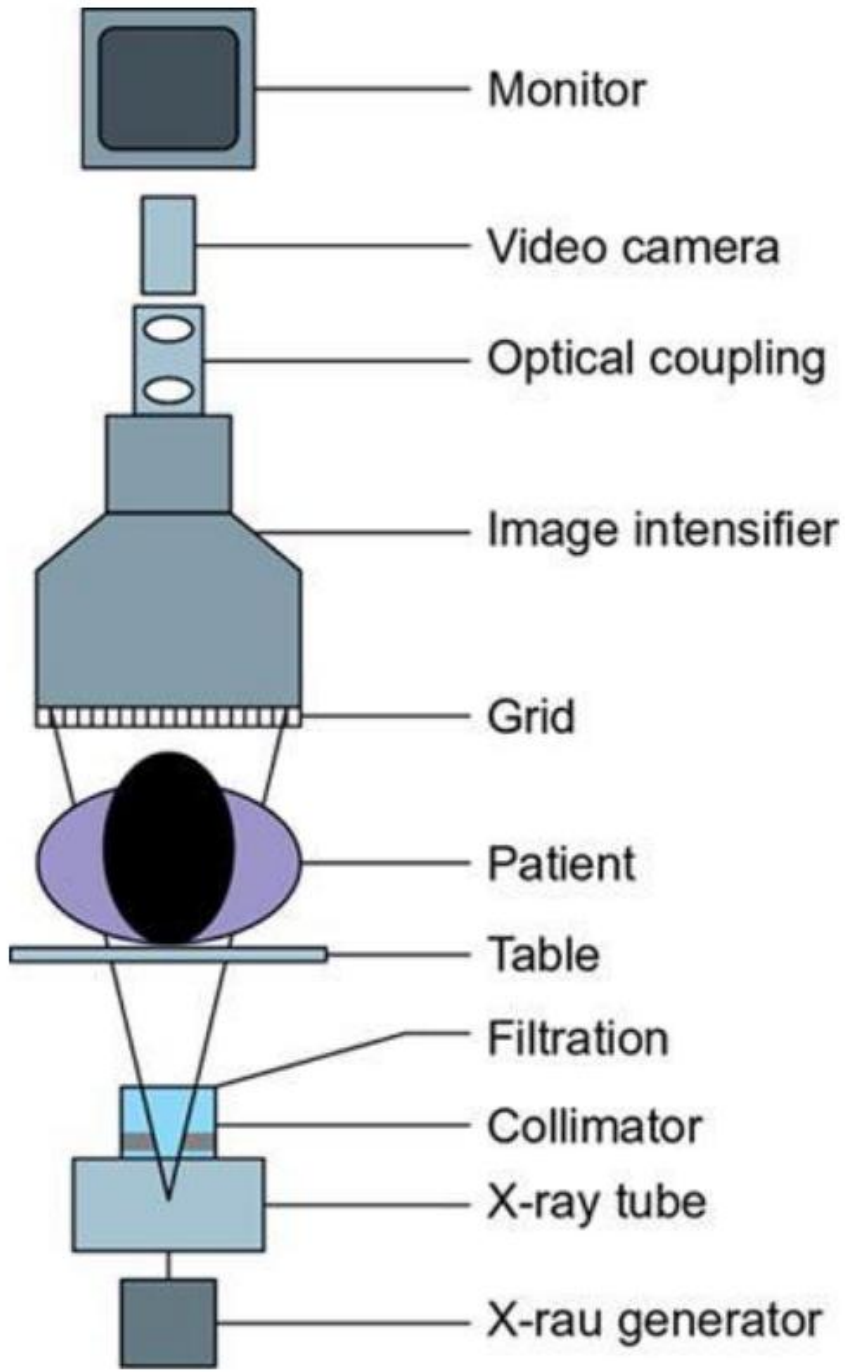
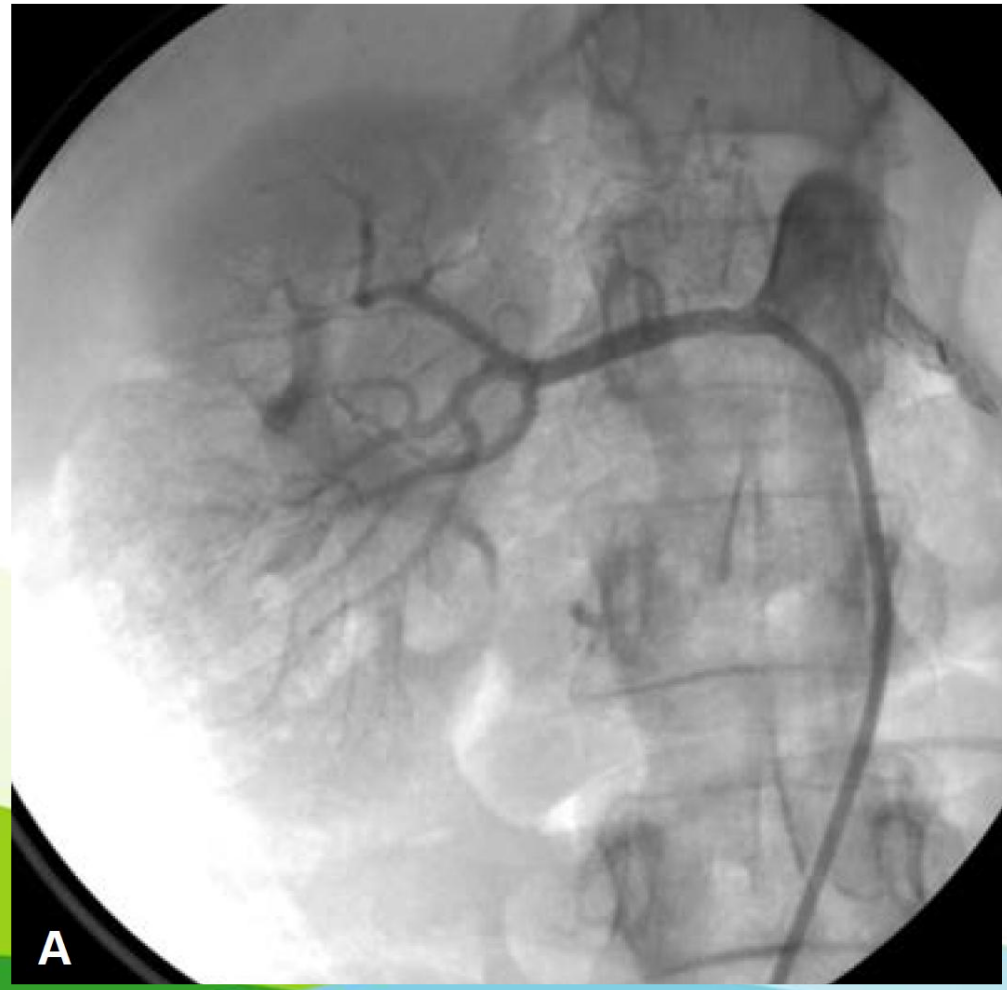


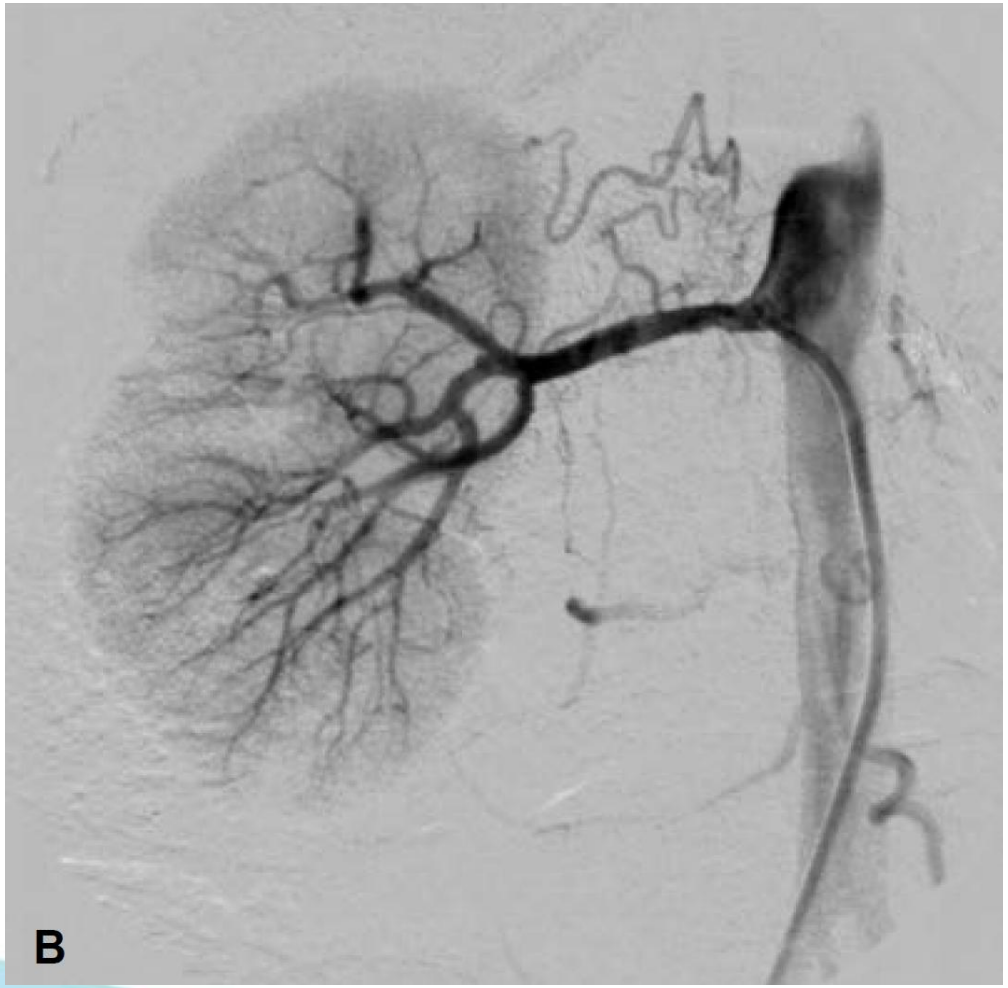
Fig. 1.7.1.1 Diagram shows the components of a fluoroscopic imaging chain.

RADIOGRAPHIC IMAGING

- **Image Intensifier : 15"**
- **Digital Subtraction Angiography vs. Cineangiography**
  - Only the contrast-filled vascular structures(DSA)
  - Multiple x-ray pictures of the contrast-filled vessel as well as the surrounding tissue(Cine)
- **Trace Subtract Fluoroscopy or Road Mapping**
  - DSA +fluoroscopic overlay image
- **Leg Imaging Capability**
  - lower extremity angiography : head to feet
  - The table should be sufficiently long
  - Long wires (260 cm to 300 cm) are frequently used

Cineangiography vs. Digital Subtraction Angiography





Road map(Trace subtract fluoroscopic image)

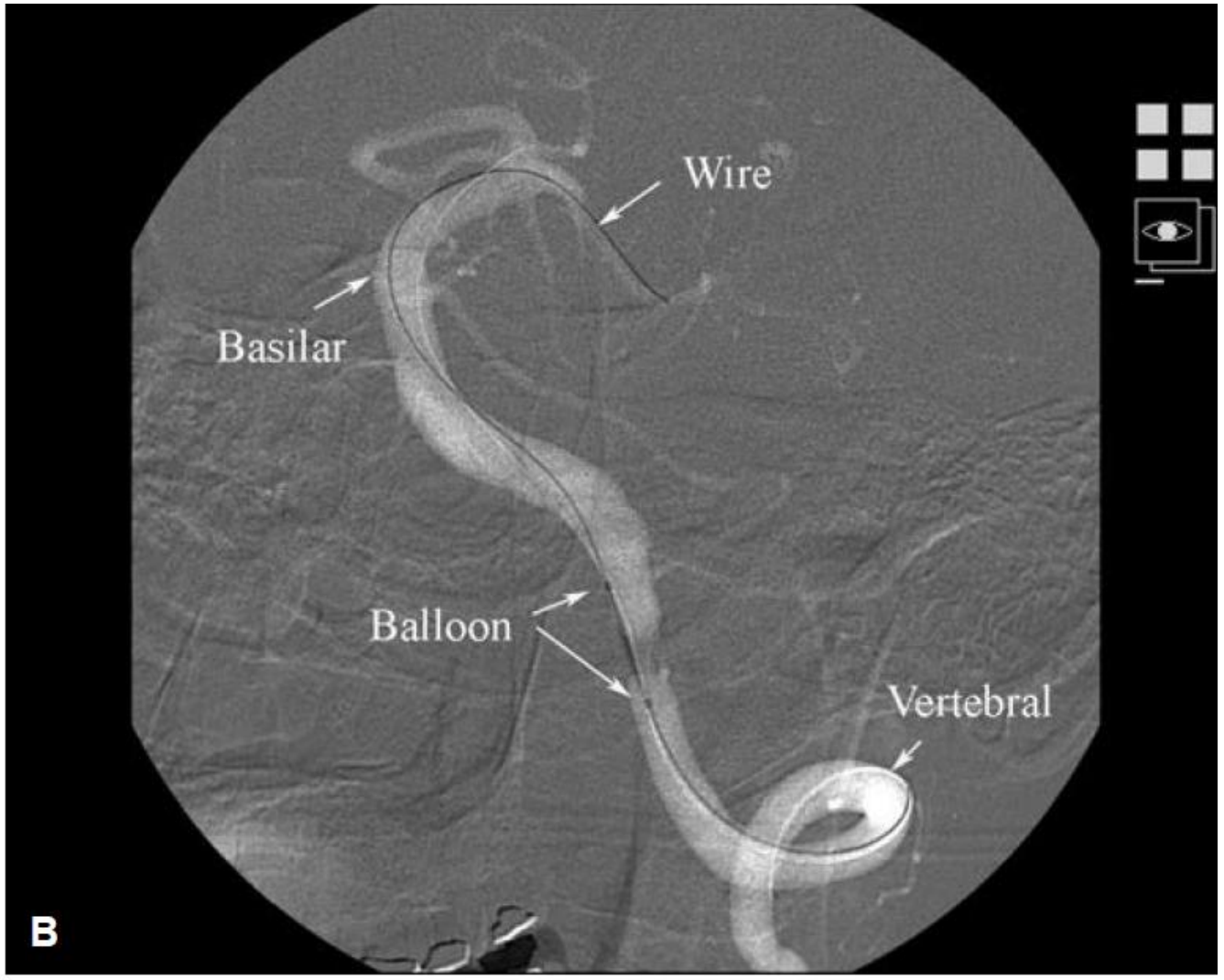


Image Intensifier(영상증폭장치)

Angiographic Projection

- Projection = X-ray tube와 detector의 상대적 위치
- 목적: 혈관 구조를 겹침 없이, 가장 명확하게 관찰
- 병변의 위치, 길이, 혈관 분지(branch), calcification 정도 파악
- AP, RAO, LAO, Cranial/Caudal
- Angiographic projection은 "**혈관 병변을 가장 잘 보여주는 카메라 각도**"

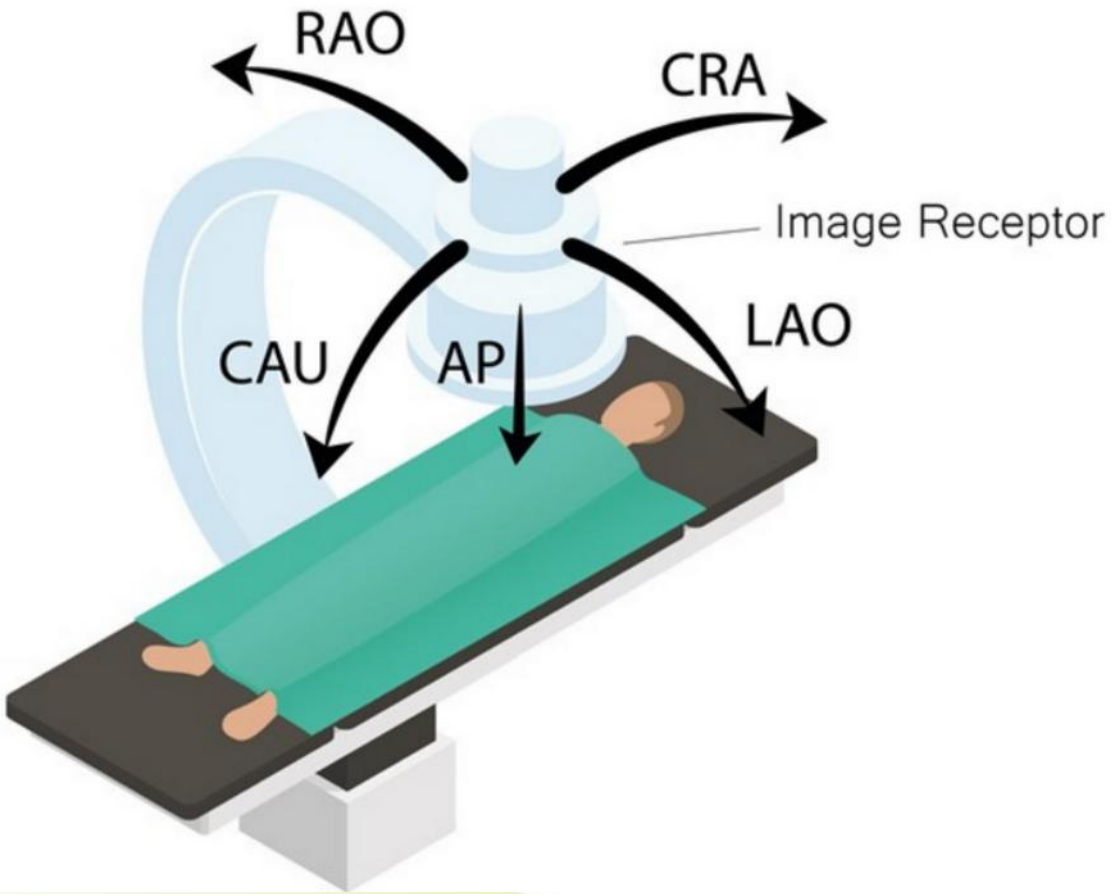
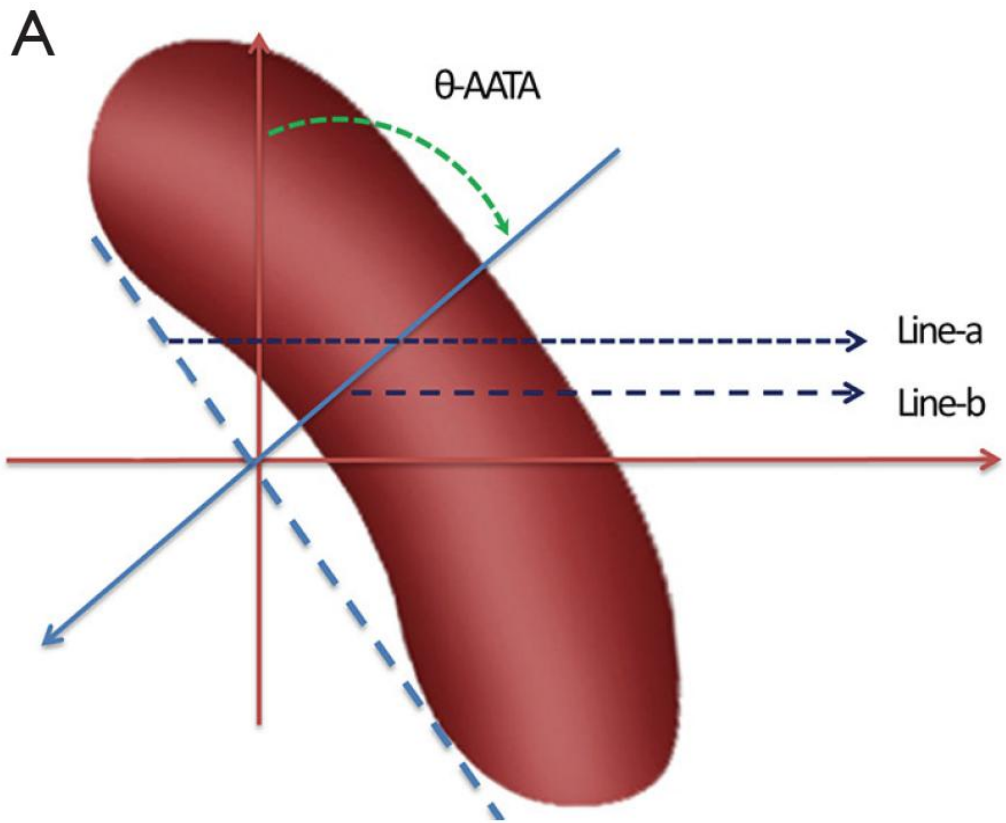


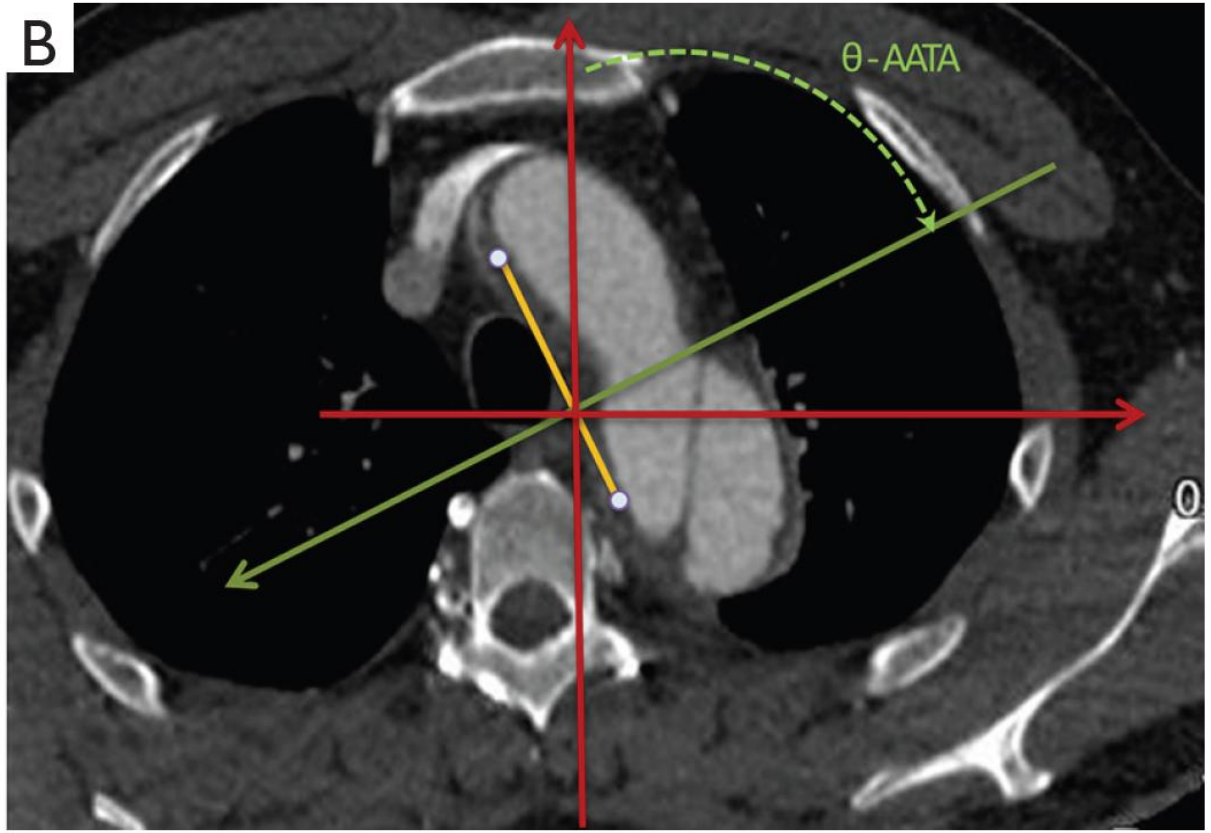
Table 19-3 Recommended Radiographic Filming Projections for Optimal Branch Separation

Location	Recommended Filming Projection
Aortic arch	30-degree left anterior oblique
Cervical carotids	AP, lateral, and 45-degree ipsilateral anterior oblique
Intracranial carotids	AP and lateral
Vertebrobasilar system	AP and lateral
Right subclavian	Right anterior oblique
Renal artery origins	AP ± 10 degrees
Celiac artery and SMA origins	Lateral
Iliac bifurcation	20- to 30-degree contralateral anterior oblique
Femoral bifurcation	20- to 30-degree ipsilateral anterior oblique
Trifurcation and tibial arteries	Anatomic AP (or 20-degree ipsilateral anterior oblique with feet in the neutral supine position)

AP, Anteroposterior; *SMA*, superior mesenteric artery.

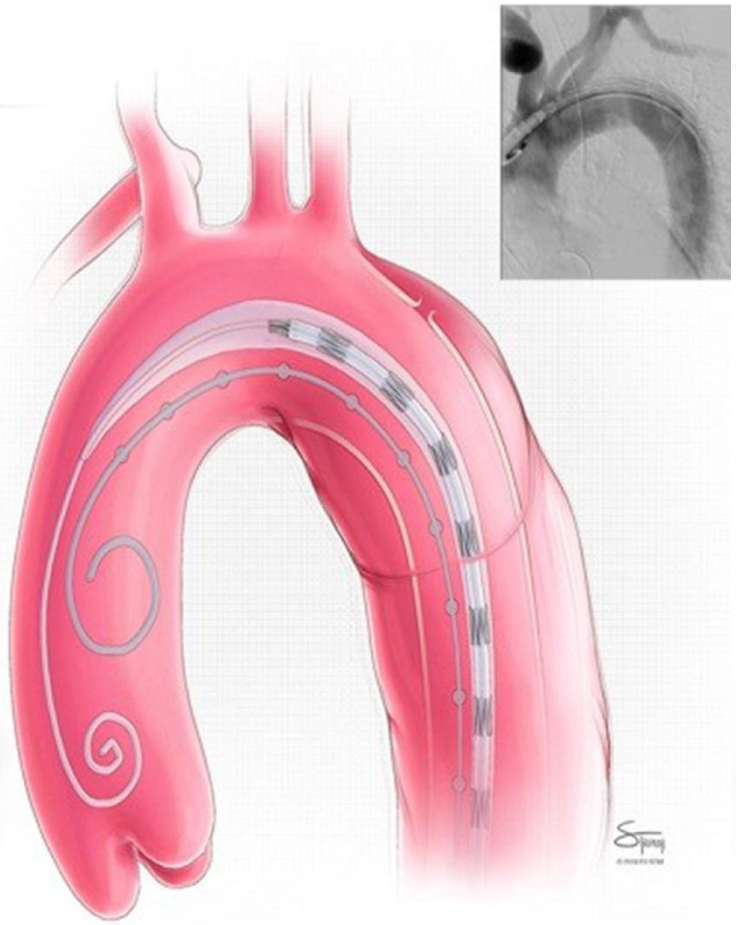
Aortic arch tangential angle(θ-AATA)





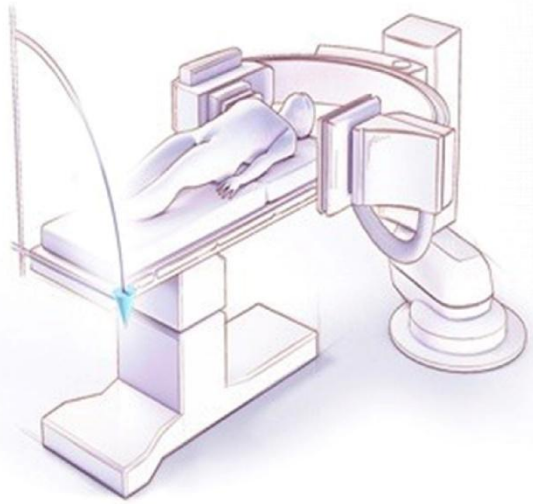
Proximal Landing Zone

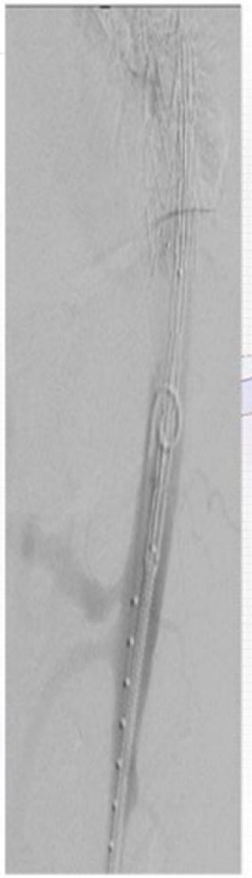
Position the image intensifier **LAO** for optimal imaging of aortic arch proximal landing zone

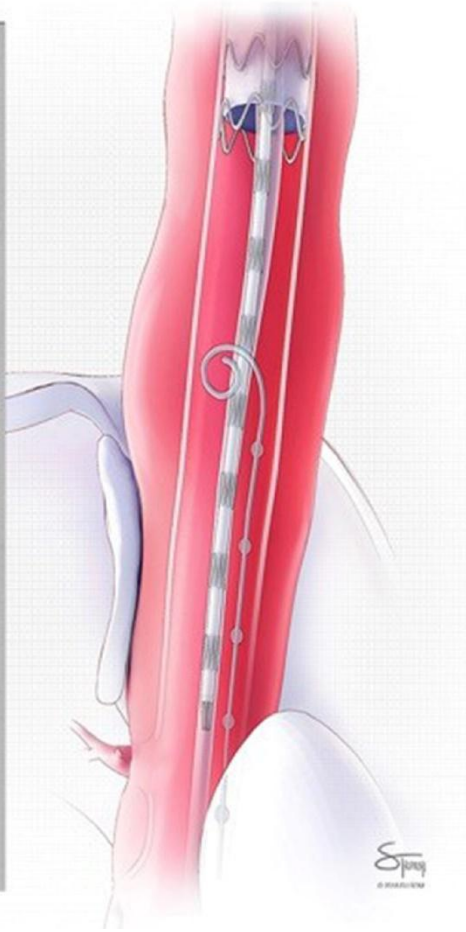


Distal Landing Zone

Position the image intensifier in **steep lateral** for optimal imaging of distal landing zone







Contrast agents (Iodinated contrast media)

시술 유형	평균 조영제 사용량 (mL)	고려사항	조영제 최소화 팁
진단 혈관조영술 (Diagnostic angiography)	30–80 mL	단일 부위 촬영, 비교적 간단한 해부학	Low frame rate, Roadmap 이용
단순 Peripheral Intervention (단일 병변, 단일 세그먼트)	80–120 mL	SFA, iliac 단일 병변	Selective catheter, 최소 영상 횟수
복합 Peripheral Intervention (다발성 병변, 양측 시술)	120–200 mL	양측 iliac–SFA, 장시간 시술	CO_2 조영술 보조, 초음파 가이드
하퇴 이하(tibial) 시술	50–100 mL	소혈관, 길고 섬세한 병변	Roadmap, selective injection, 낮은 frame
Hybrid Operation (동맥 우회술 + 중재시술)	100–180 mL	개복+중재 병행, 혈류 확인 필수	우회술 후 제한적 completion angiography
광범위 재개통 + Multi-stent 삽입	180–250 mL 이상	대동맥–양측 하지, 다수 병변	시술 전 MRA/CTA로 계획, CO_2+iodine 혼합

@ 권장 최대량
- 일반 환자: 5 mL/kg (체중 70 kg → 350 mL 이하)
- CKD 환자: 3–4 mL/kg

Devices for Injection of Contrast Agents

- Power injection
- Hand injection

Table 19-2 Typical Injection Method, Rate, and Volume of Contrast Agent for Various Vascular Regions

Location	Suggested Method	Injection Rate (mL/s)	Total Volume (mL)
Aortic arch	Power injection	20	40
Selective carotid	Hand or power injection	3-5	5-10
Selective vertebral	Hand injection	2-4	2-4
Selective subclavian or brachial	Hand or power injection	5-10	10
Abdominal aorta	Power injection	20	40
Renal or mesenteric	Hand injection	3-5	5-10
Iliac artery	Hand or power injection	10	10
Infrainguinal segments	Hand or power injection	5-10	10
Aorta to pedals, stepped run	Power injection	20	90*

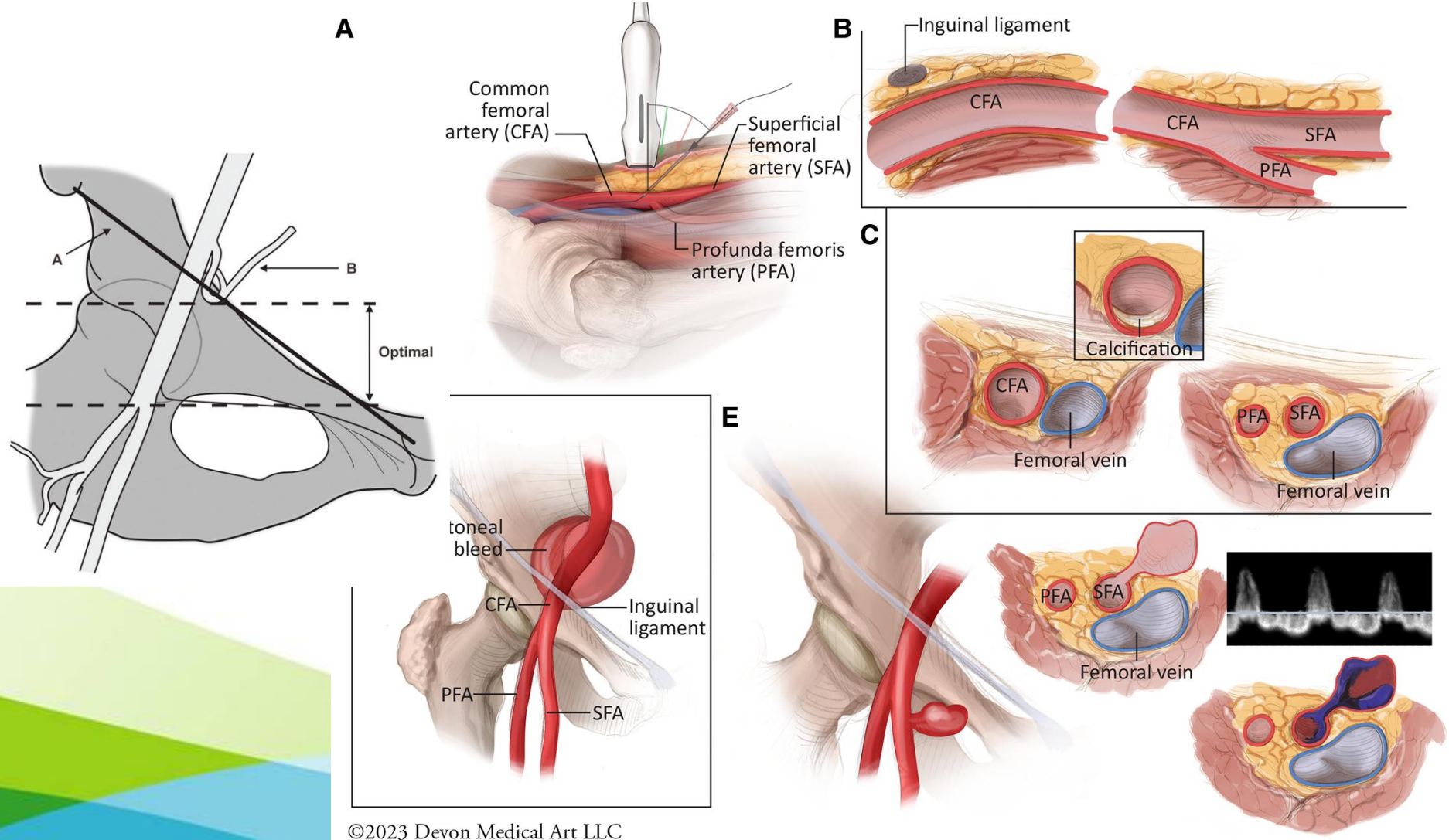
Angiographic injector

ACCESS

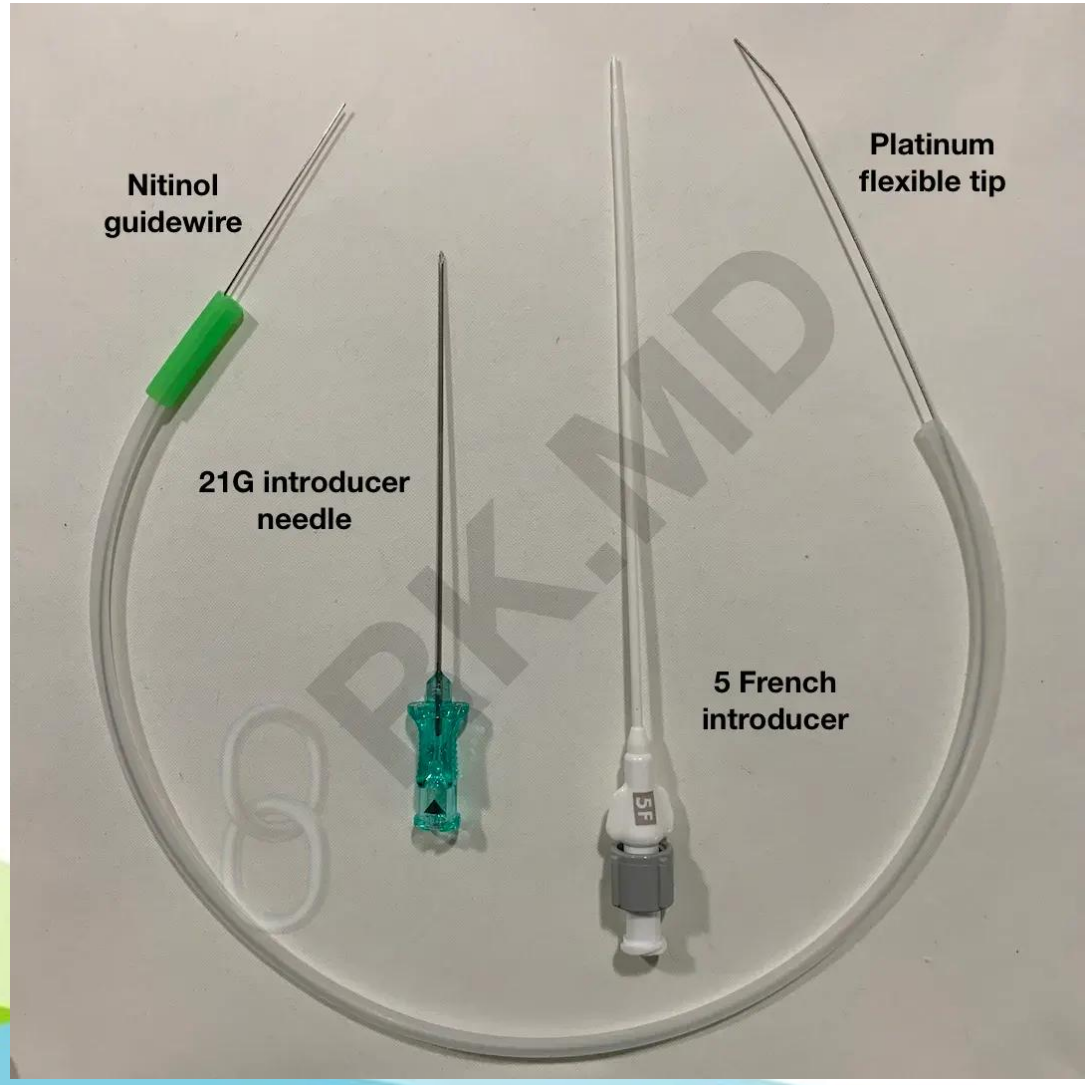
- **One of the first steps, sono or fluoroscopic guided, micro-puncture**

- **Common Femoral Artery**
  - most common access site
  - sizes of 12 Fr to 14 Fr with minimal risk for ischemia
  - Most equipment has been developed for the femoral approach
  - Antegrade (toward the foot) or Retrograde (toward the iliac artery)

Optimal femoral artery access site



Micropuncture Set



Ideal artery puncture technique

- Anatomy
- Fluoroscopic guided
- Sonoguided puncture
- Using micro puncture kit
- Optimal hemostasis method

Arterial access

WIRE SELECTION (0.035", 0.018", 0.014")

- **0.035“**
  - Subclavian, innominate, iliac, superficial femoral, and popliteal artery interventions.
- **0.018 “**
  - Renal, subclavian, and popliteal interventions.
- **0.014“**
  - Carotid, vertebral, renal, and below-knee interventions, coronary

와이어의 분류

(1) 코팅에 따른 분류

- Hydrophilic coating (친수성)

- 표면에 물과 결합해 미끄러움 ↑
- 섬세한, 구불구불한 혈관이나 만성 폐색(CTO) 진입에 유리
- 예: Terumo Glidewire

- Hydrophobic coating (소수성)

- 미끄러움은 적지만 토크 컨트롤 우수
- 정밀 조작 필요 시 적합

Wires…

(2) Tip 경도에 따른 분류

- **Soft tip :** 혈관 손상 위험 적음, 진단용 카테터 교환, 초기 접근
- **Stiff tip ;** 섬유화·석회화 병변 통과 용이, CTO(Chronic Total Occlusion) 재개통 시 유용, large device supporting

(3) 직경(길이)

- **0.014″**: 주로 관상동맥, 하퇴 이하(tibial)
- **0.018″**: 관상+말초 겸용, 세밀한 작업
- **0.035″**: 장골–대퇴–슬와 등 큰 혈관
- 길이: 150 cm~300 cm (Over-the-wire 장비 교환용은 길이 길게)

Wires

Wire Diameter	Directional Control	Tracking Capability	Support	Length (cm)	Company
WIRES 0.035″					
Stiff Angled Glidewire (3 cm or 5 cm flexible tip)	Excellent	Excellent	Good	260	Boston Scientific
Amplatz Extra Stiff w/ J-tip	Poor	Fair	Very Good	260	Boston Scientific
Amplatz Super Stiff (1 cm, 3.5 cm, 6 cm, and J-tip)	Poor	Poor	Excellent	260	Boston Scientific
Magic Torque	Fair	Good	Good	300	Boston Scientific
Wholey	Excellent	Good	Fair	260	Mallinckrodt
Lunderquist	Fair	Poor	Excellent	260	Cook
WIRES 0.018″					
Flex-T	Good	Good	Good	295	Mallinckrodt
Glidewire Gold (45 or 70 degree angle) with GT Leggiero Hydrophilic Microcatheter	Good	Excellent	Poor*	180	Boston Scientific
WIRES 0.014″					
Balance Trek	Good	Good	Fair	190, 300	Guidant

Table 1. Overview of different guidewires (0.018" and 0.014") and characteristics in endovascular peripheral arterial interventions

Manufacturer	Workhorse wire Stenotic/fibrotic lesions	CTO wire Calcified lesions	CTO wire Heavily calcified lesions
Asahi*	*Gladius 0.014/0.018* Sliding wire (intraluminal) *Gladius MG 0.014/0.018* Dissecting wire with microgap (subintimal)	*Halberd 0.014/0.018 (12 gram)* Drilling calcified lesion (preshape option) *Gaia PV 18 (7.5 gram)* Drilling lesion intraluminal	*Astato 30 0.018 (30 gram)* *Astato 40 0.014 (40 gram)* Tapered tip Penetrating and drilling calcified lesion
Abbott†	*Command 0.014/0.018 ST* Fibrotic lesion/looping (subintimal) *Command ES 0.014* More supportive variant (subintimal)	*Proceed 220T 0.014 (14 gram)* Preshape drilling calcified lesion *Winn 200T 0.014 (14.3 gram)* Tapered tip/Penetrating calcified lesion	*Connect 250T 0.018 (38.1 gram)* Tapered tip Penetrating calcified lesion
Boston Scientific‡	*V14/V18 ST* Loop/knuckle wire (subintimal)	*Victory 14 (12 gram)* *Victory 18 (12 gram)* penetrating calcified lesion	*Victory 14 (30 gram)* *Victory 18 (30 gram)* Penetrating calcified lesion
Terumo§	*Glidewire Advantage 14/18* Loop/knuckle wire (subintimal)	*Glidewire Advantage Track 14/18* Loop/knuckle wire (subintimal)	*Glidewire Advantage Track 14/18* Loop/knuckle wire (subintimal)
Cook‖	*Roadrunner Uniglide 0.018* *Approach Hydro ST 0.014* Loop/knuckle wire (subintimal)	*Approach CTO 0.014 (12 gram)* Penetrating calcified lesion	*Approach CTO 0.014 (24 gram)* Penetrating calcified lesion

CTO = chronic total occlusion; PV = peripheral vessel; ST = short tapering; ES = extra support.

* Asahi Intecc (Seto-shi, Aichi, Japan).

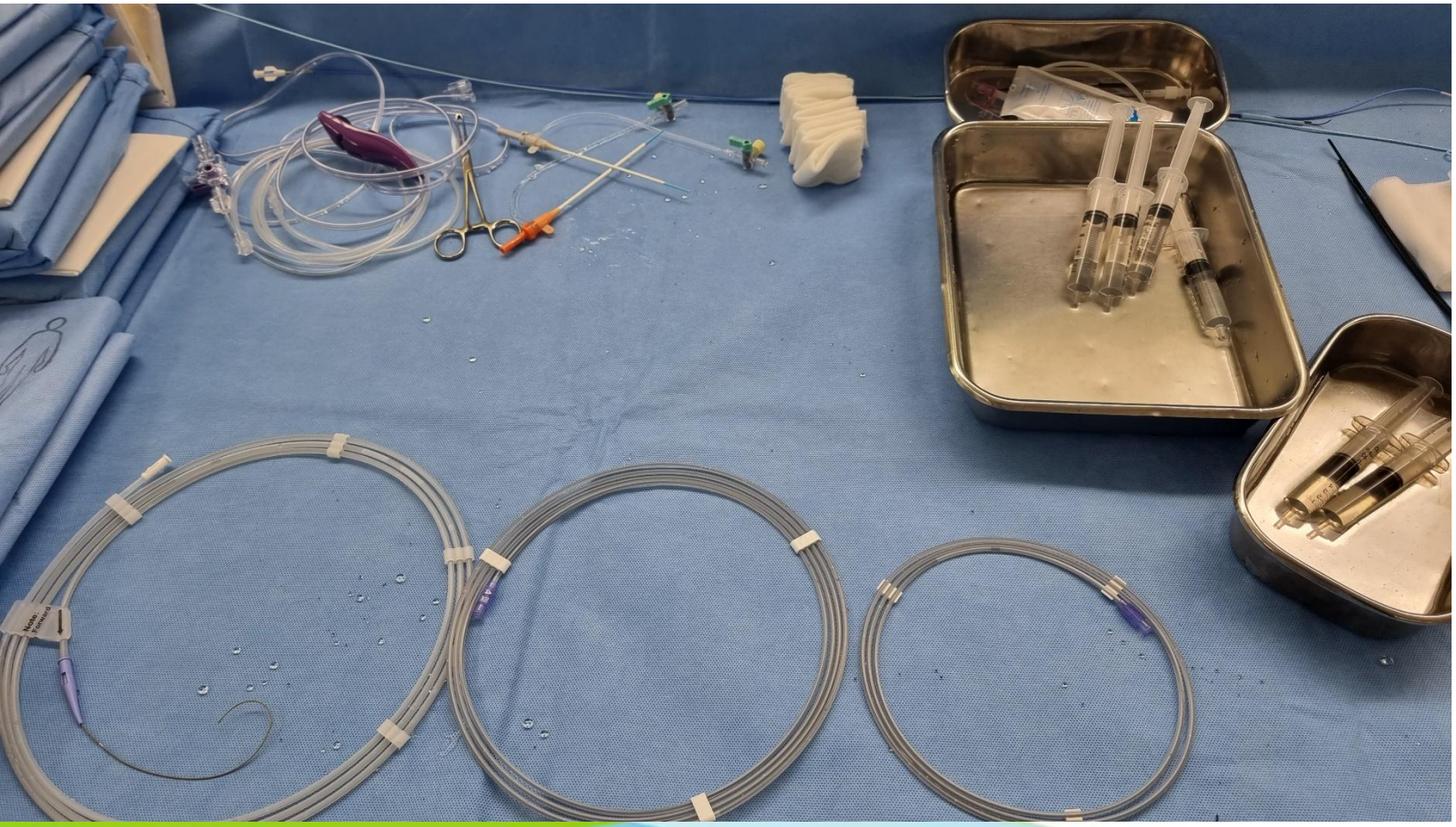
† Abbott (Chicago, IL, USA).

‡ Boston Scientific (Marlborough, MA, USA).

§ Terumo (Shibuya City, Tokyo, Japan).

‖ Cook (Bloomington, IN, USA).

Wires…



Lunderquist Wire Guides 201Cm이상 (William Cook Europe)	0.35''*260 Cm	1	EA
Micropuncture Push-Plus Introducer Set Nitinol 4.0Fr*10Cm MPIS-401-NT-SST (Cook Medical)	Nitinol 4.0Fr*10C m	1	EA
Performa Catheter All Size (Merit Medical)	JR*4.0*5F r	1	EA
Radifocus Guide Wire 200Cm미만 (Terumo)	035*150*3 *A	1	EA
Radifocus Guide Wire 200Cm이상 (Terumo)	035*260*3 *A	1	EA
Radifocus Introducer II All Size,4Fr~8Fr/7Cm,10Cm (Terumo Corporation)	5Fr, 10Cm, A type	1	EA
Radifocus Introducer II All Size,4Fr~8Fr/7Cm,10Cm (Terumo Corporation)	7Fr, 10Cm, A type	1	EA

DIAGNOSTIC CATHETERS

■ Side-hole Diagnostic Catheters

- Permit large volumes of contrast agent to be infused safely in a large artery at a rapid rate via power injection

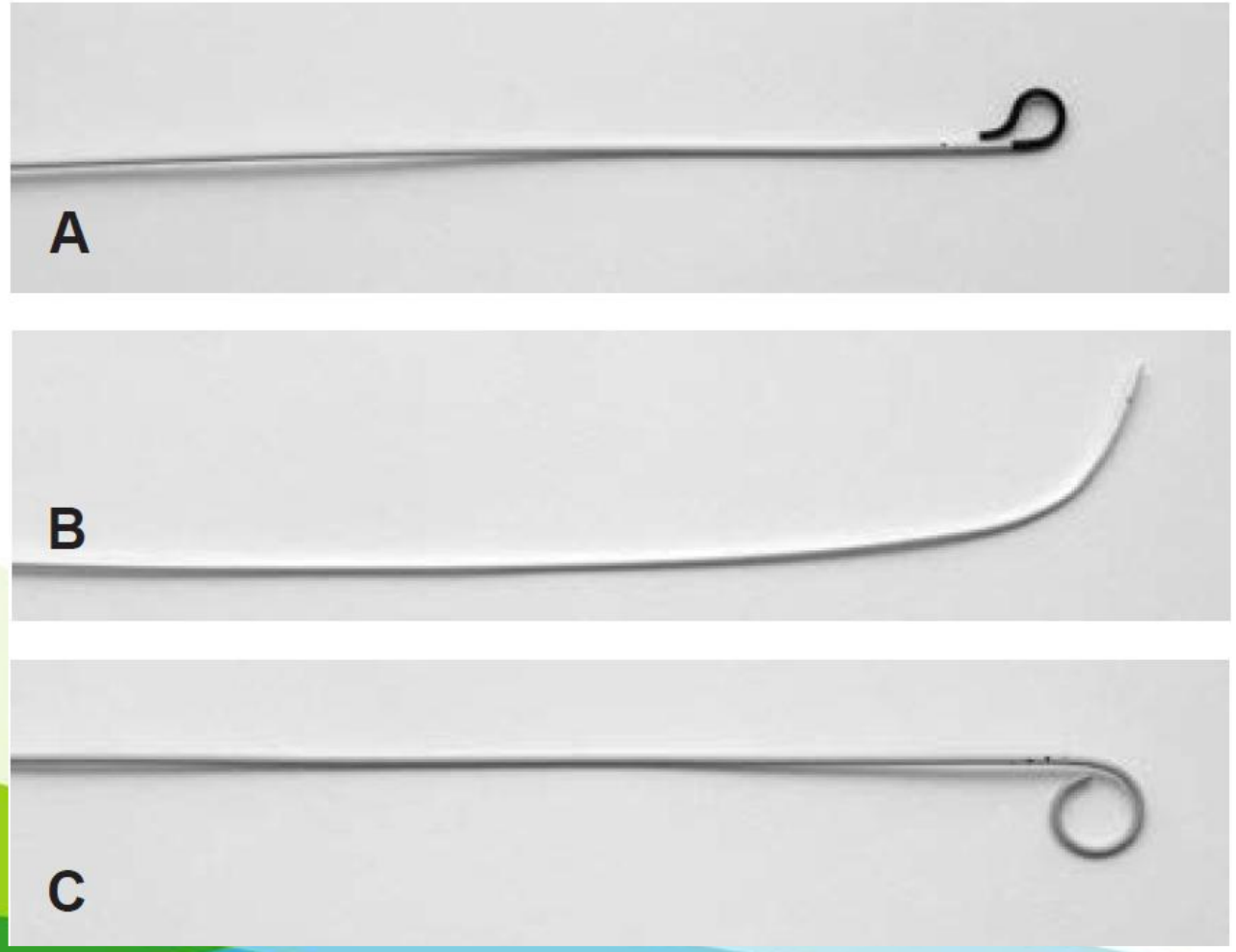
- Omniflush, Grollman, Universal Flush, Multipurpose, Pig tail

■ End-hole Diagnostic Catheters

- Selective diagnostic angiography is performed using manual injections of contrast agent through end-hole catheters

- 5Fr JR catheters…

Sample of side-hole catheters

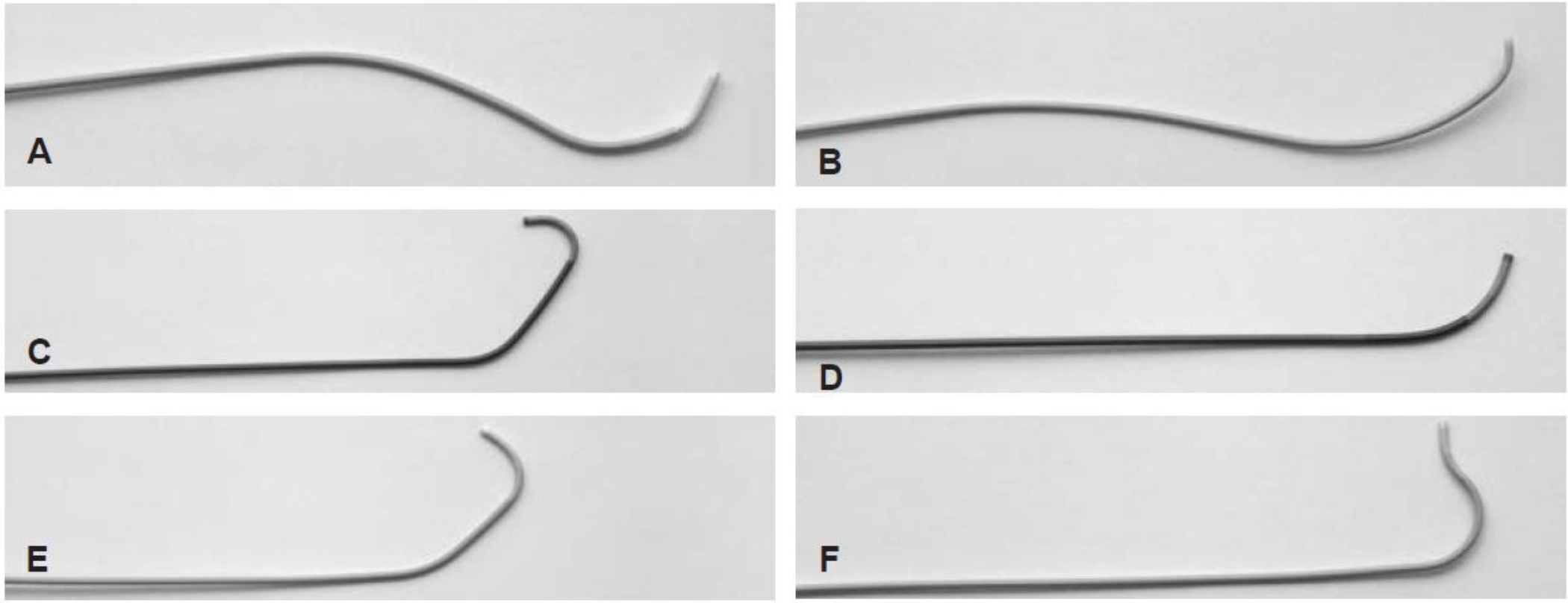


A.Omni Flush

B.Multipurpose

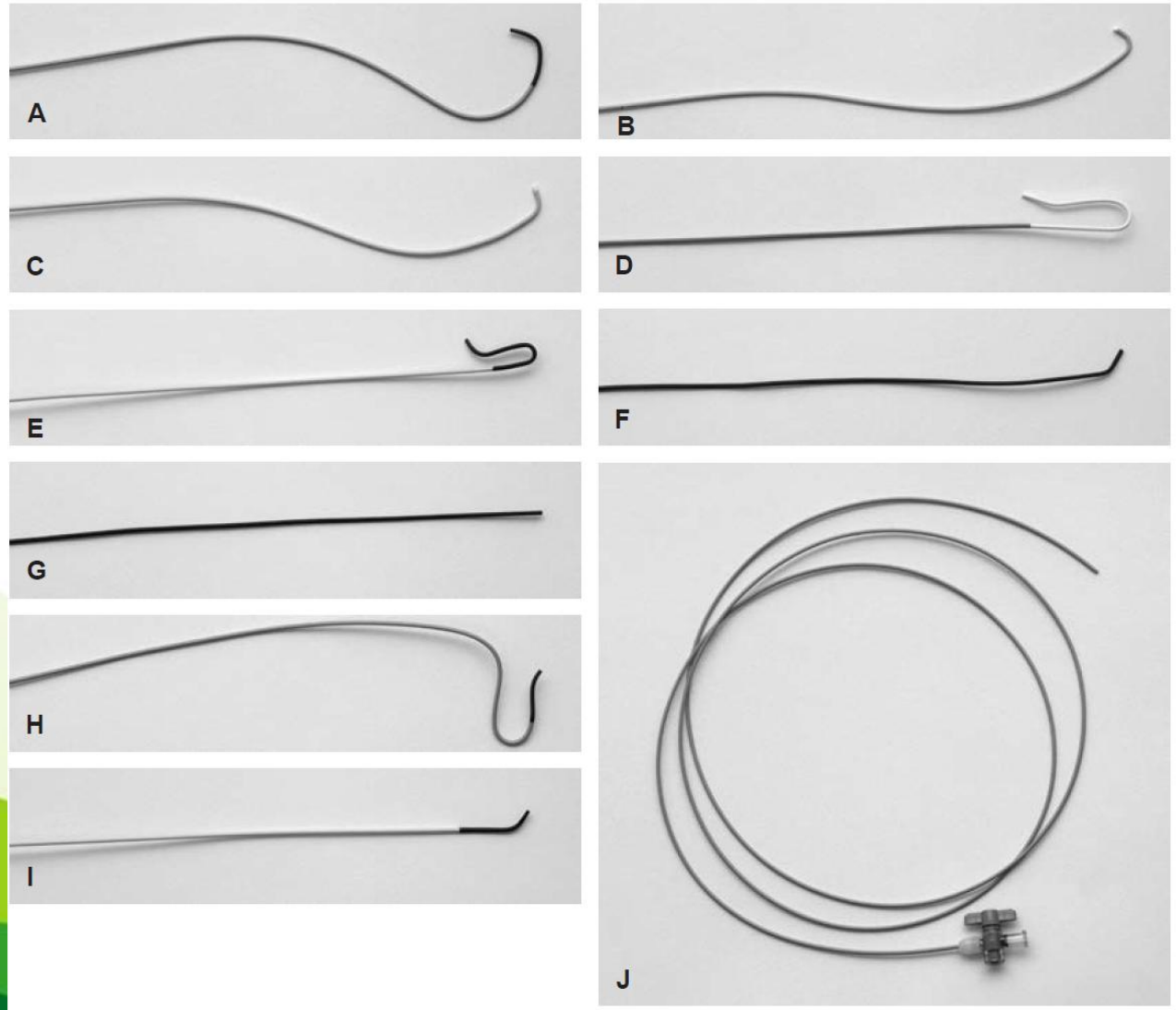
C.Pigtail

Guide catheters



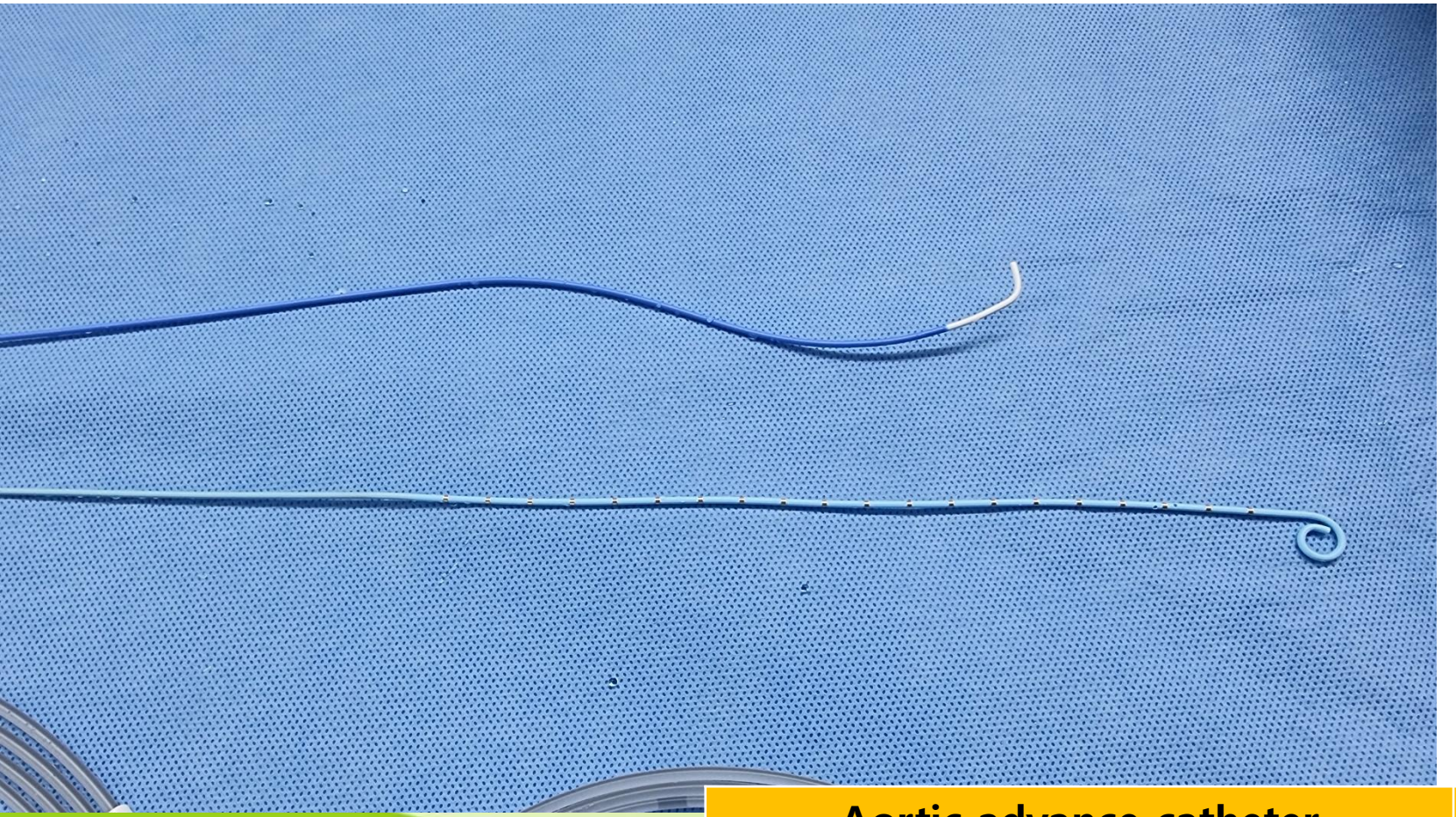
A: Headhunter (H-1); **B:** Judkins Right (JR4); **C:** Renal Standard (RES); **D:** Renal Multipurpose; **E:** Renal Double Curve (RDC); and **F:** Amplatz Right (AR1).

End-hold catheters



A: Cobra;
B: IMA;
C: Judkins Right
D: Simmons;
E: SoS
F: angled glide;
G: straight glide;
H: Vitek;
I: Berenstein;
J: red rubber.

Catheters…

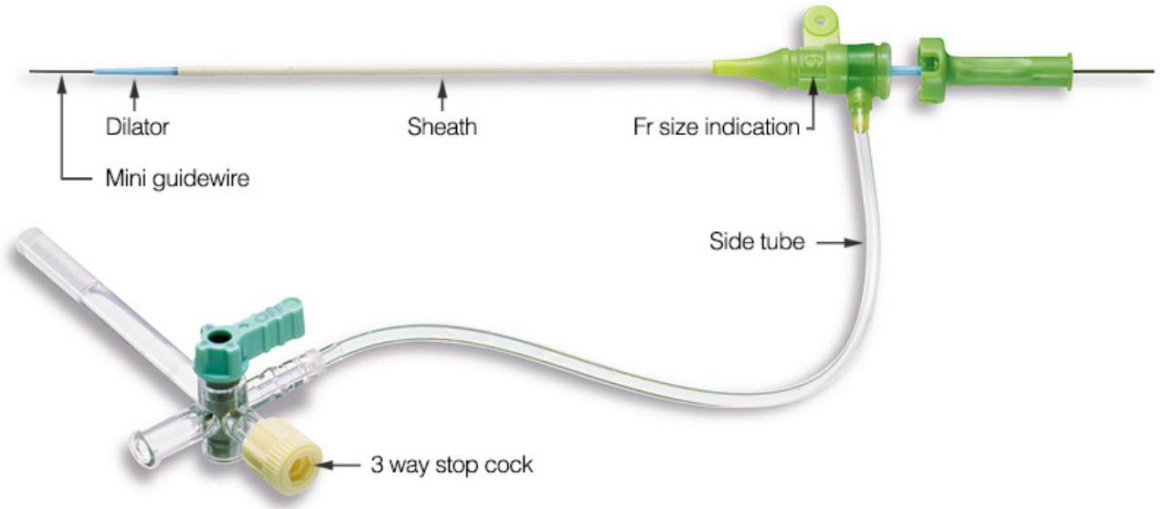


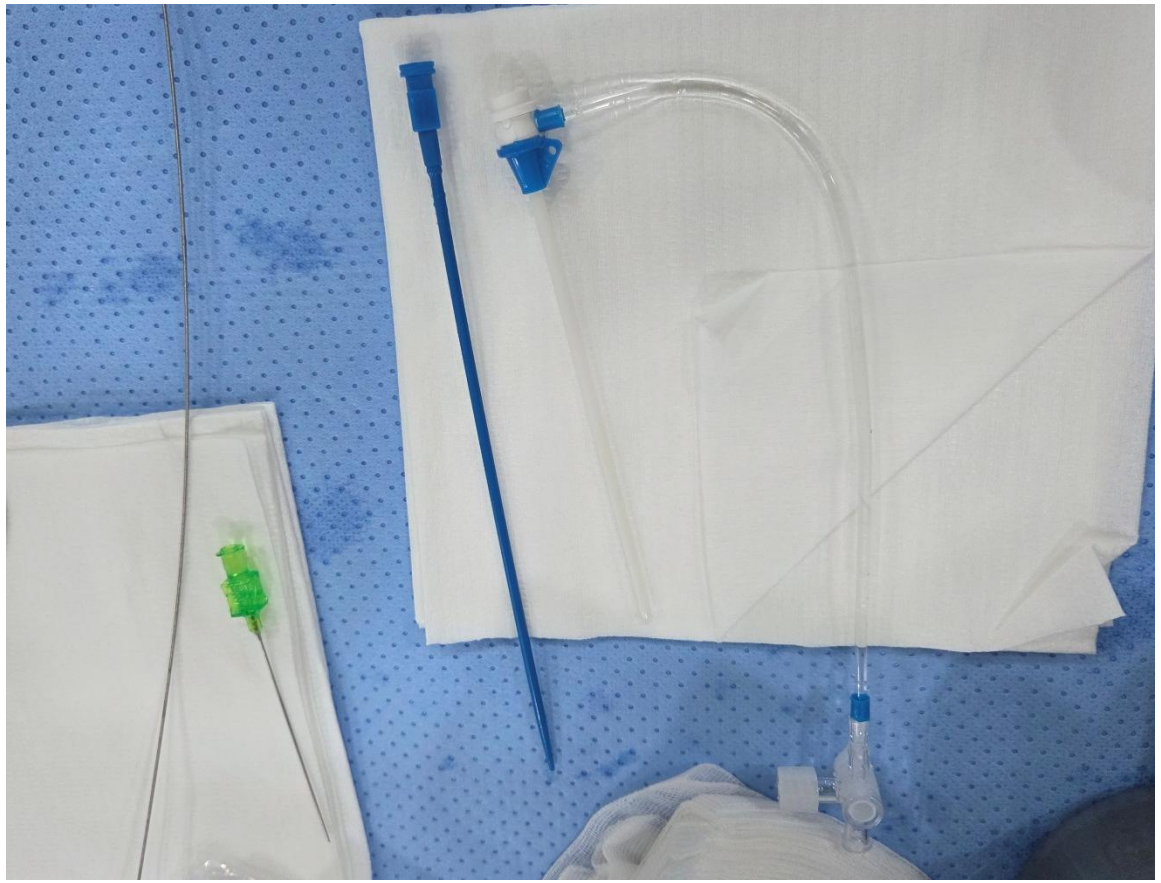
Aortic advance catheter	David, Jerkin catheter
Angiographic catheter	Pigtail (5Fr)

SHEATH

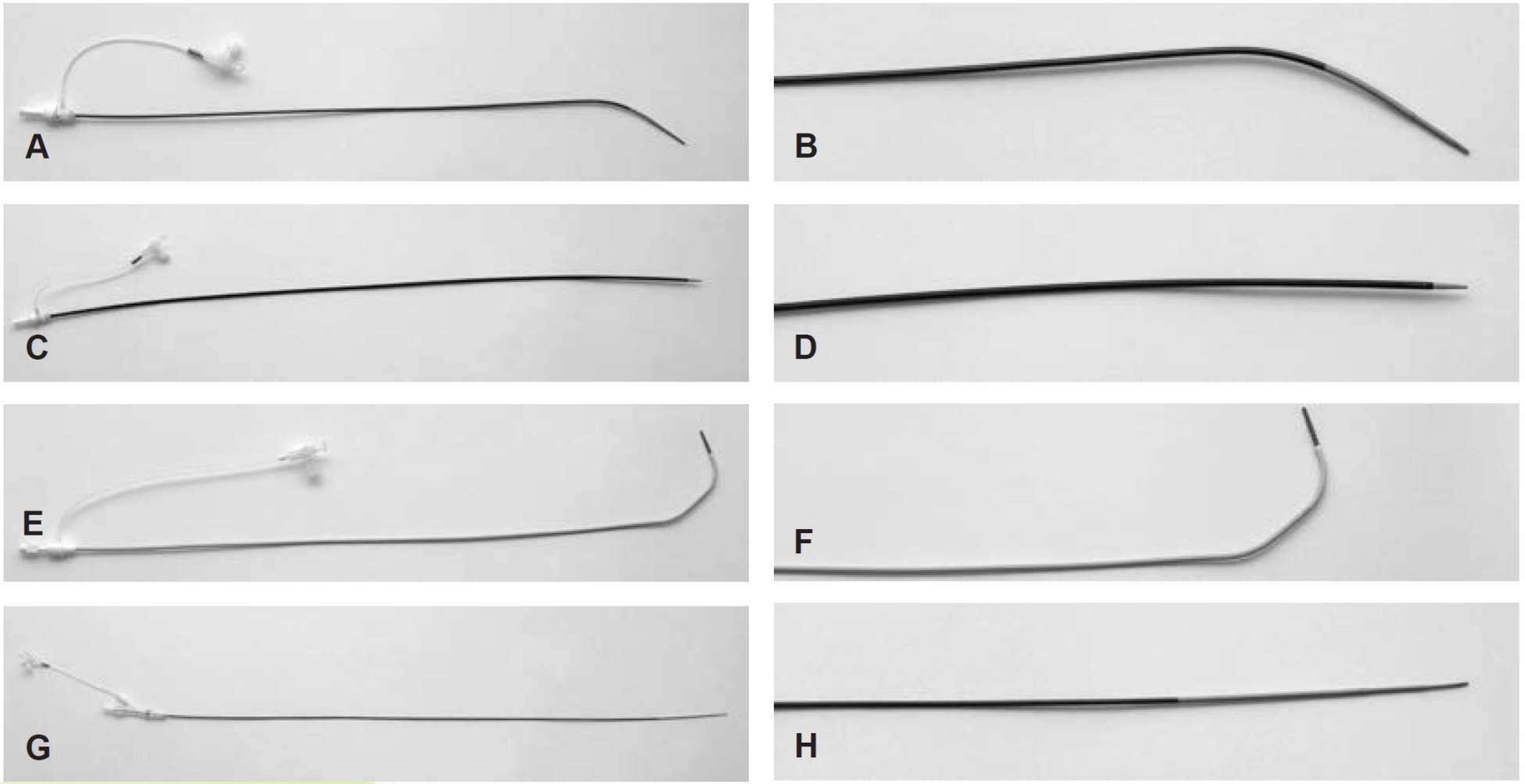
- Using either a sheath or guide-based system
- Straight or shaped sheaths are most commonly used.
- These serve as the access points for delivery of equipment
- A hemostatic valve allows blood to bleed back when the valve is open, thereby reducing the risk of air and atherosclerotic debris embolization.

Introducer sheath





Sheaths…

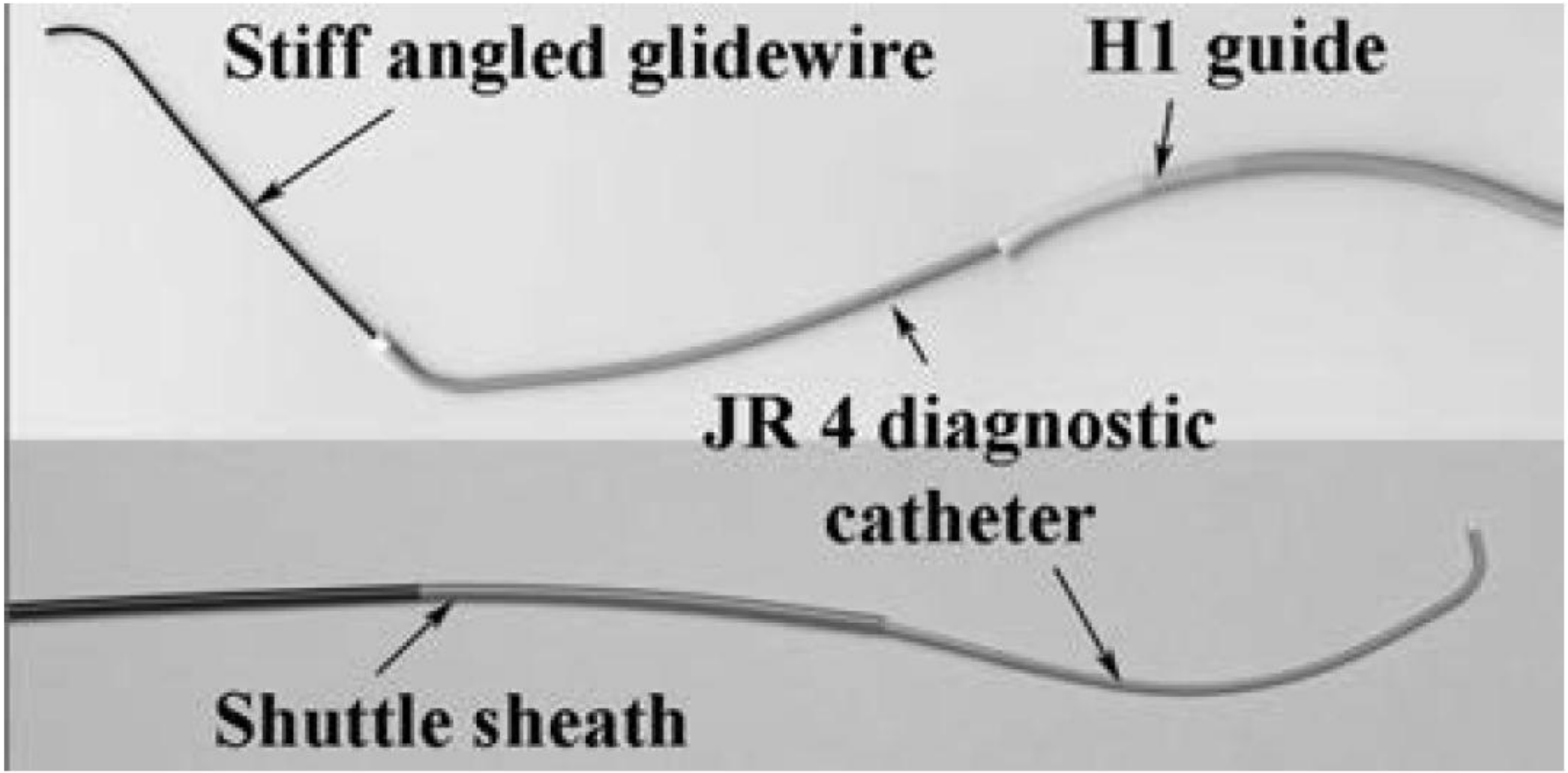


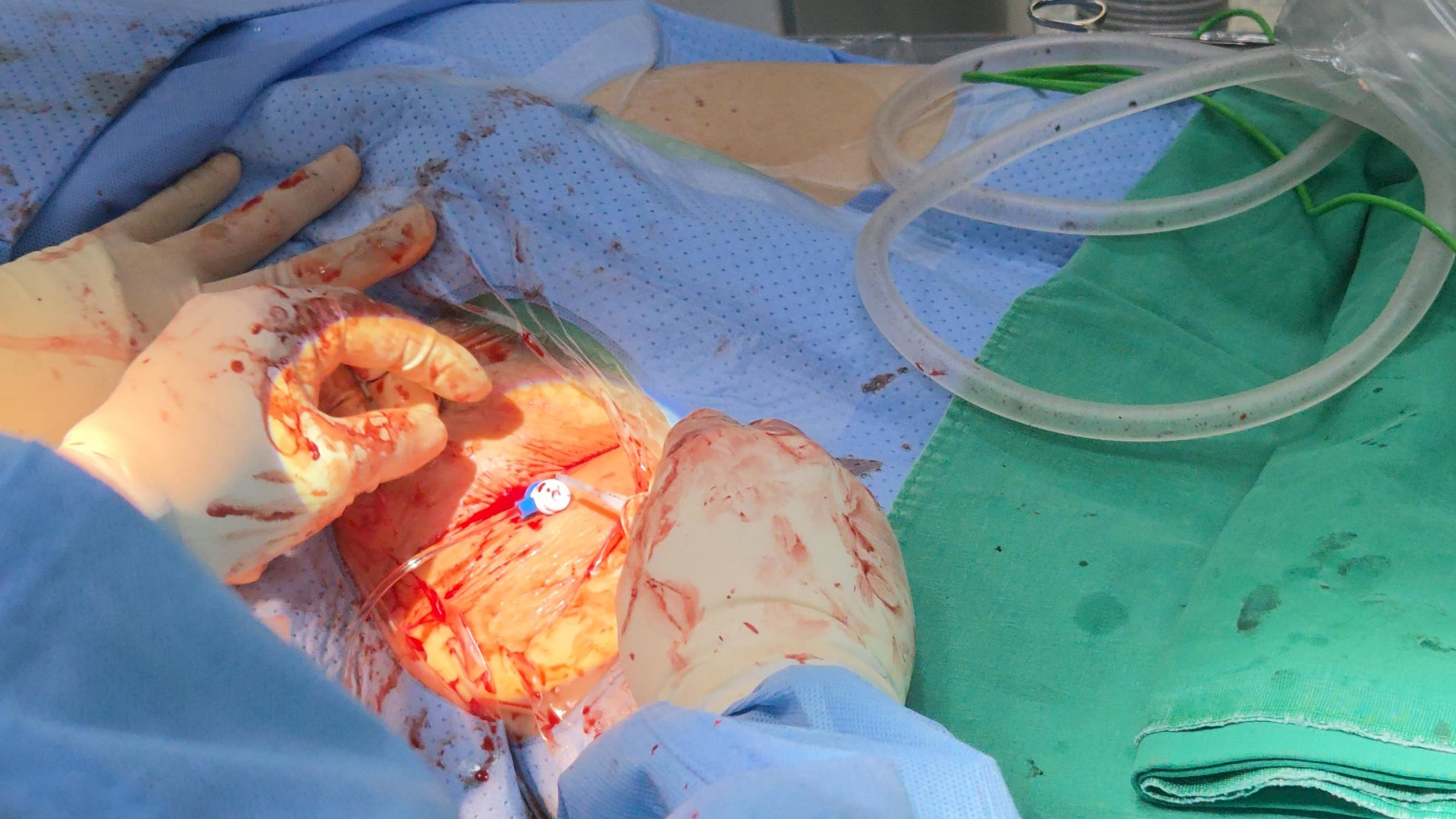
A: and **B:** Low and high magnification view of Ansel sheath; **C:** and **D:** Low and high magnification view of Raabe sheath; **E:** and **F:** Low and high magnification view of Renal Double Curve guide sheath; and **G:** and **H:** Low and high magnification view of Shuttle sheath

Telescoping Technique

- **Advancing large guiding catheters and sheaths into certain arteries** may often be quite challenging and is often made simpler by telescoping the larger guide or sheath over a smaller diameter catheter.
- It is **quite important to have a smooth transition** between the guide or sheath and the telescoping catheter when advancing these devices around corners, and in tortuous diseased vessels, in order **to minimize vessel trauma and embolization**

Telescope technique





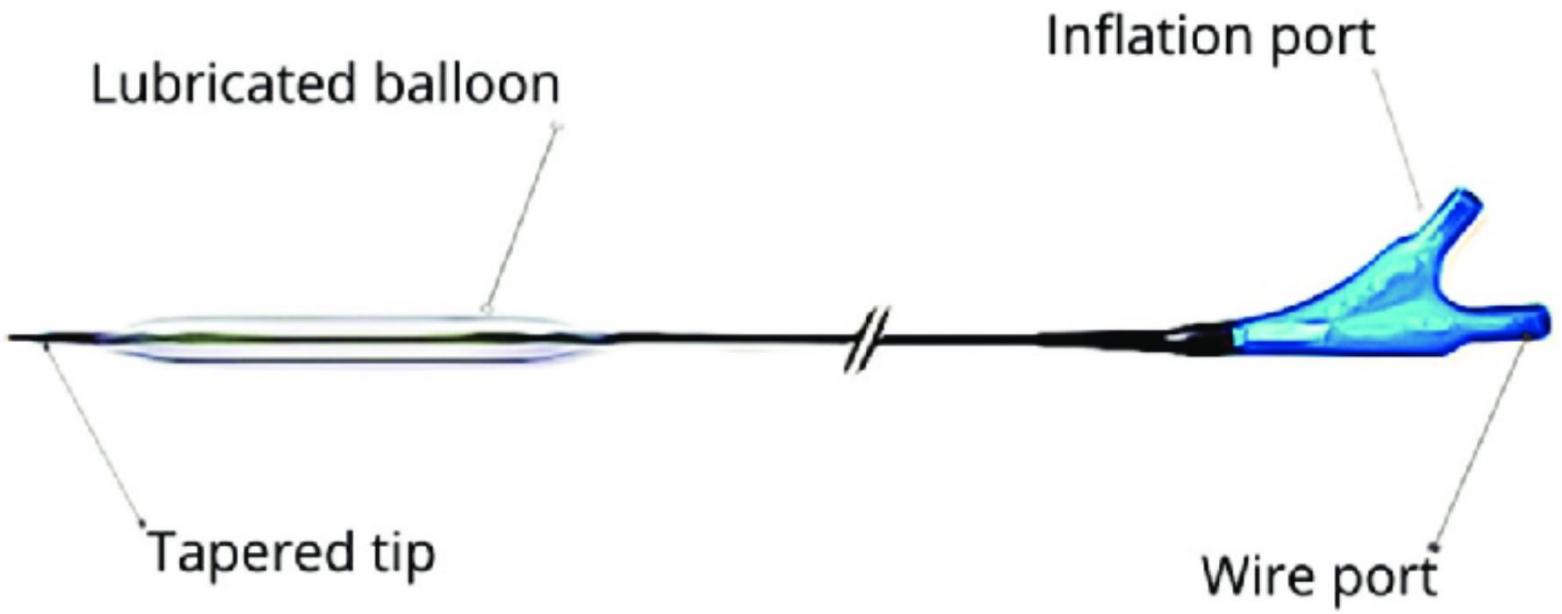
BALLOONS

- Most peripheral balloons are compliant with rated-burst pressures somewhat lower than their coronary counterparts

- To help these balloons fill and empty more effectively, a mixture of 70% saline and 30% contrast agent is used.

- The longer balloons are important when performing an SFA intervention from the brachial access site.

Balloon and inflator

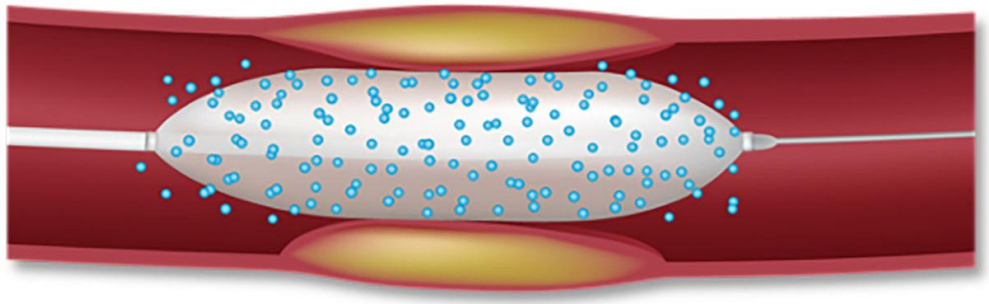


Balloon의 역할

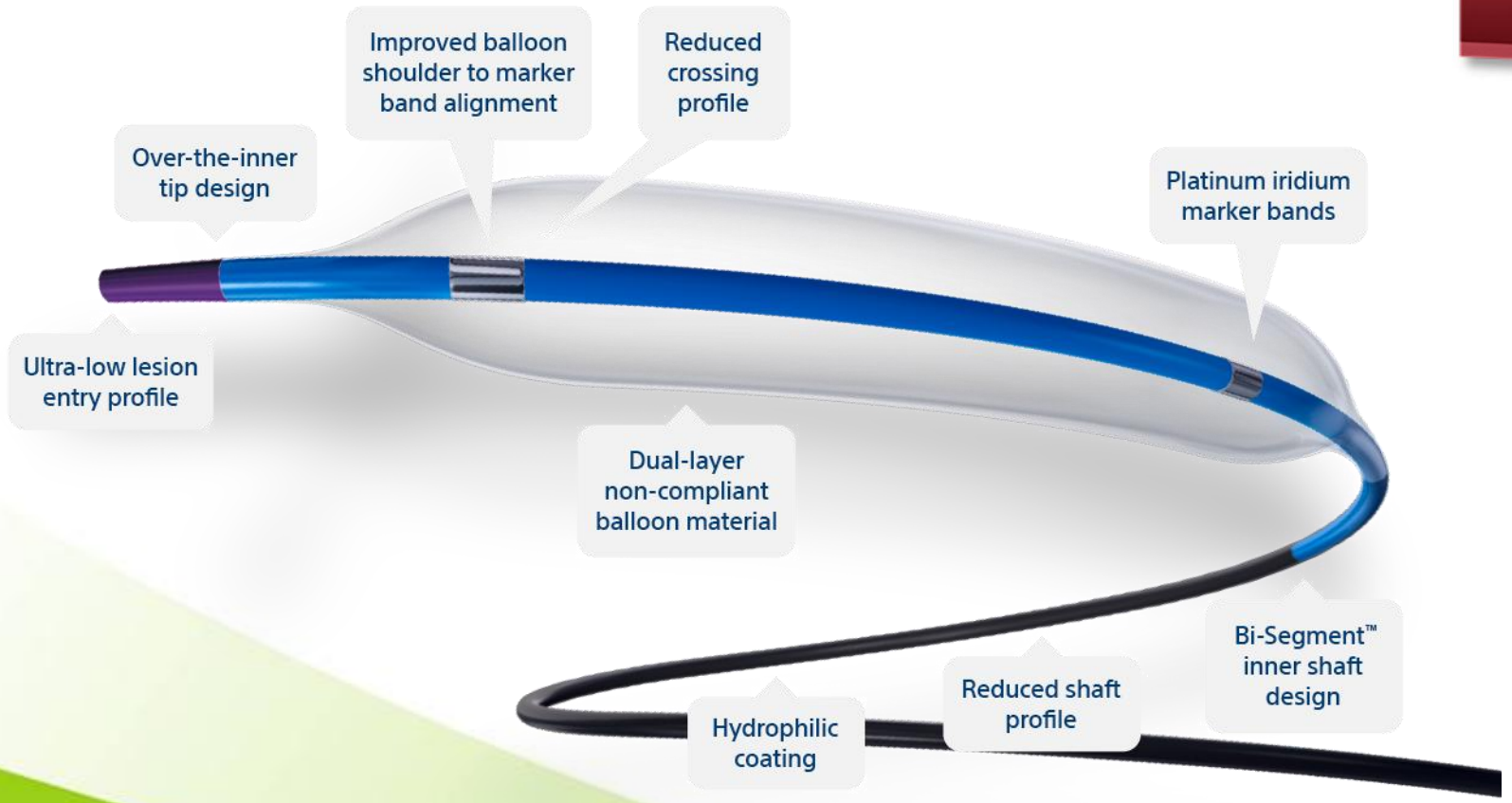
- 병변 확장으로 혈류 회복
- Stent 삽입 전 병변 준비 (pre-dilatation)
- Stent 삽입 후 확장 (post-dilatation)
- Drug delivery (Drug-Coated Balloon, DCB)

Balloon의 분류

- POBA (Plain Old Balloon Angioplasty)
- Drug-Coated Balloon (DCB)
- Cutting / Scoring Balloon
- High-pressure / Non-compliant Balloon
- Special Balloons (Long, Short)



Drug coated balloon



Cutting balloon

Balloon 선택 원칙

- Diameter: Vessel reference diameter와 1:1
- Length: 병변을 충분히 커버
- Compliance:
  - Semi-compliant → 초기 확장
  - Non-compliant → 정확한 vessel sizing, 고압 필요 시
- 병변 특성에 따른 선택 (calcified, long lesion 등)

Balloon 사용 시 주의점

- Oversizing → vessel rupture 위험
- Undersizing → residual stenosis, recoil
- 고압 사용 → dissection 가능, stent 필요할 수 있음
- 항응고제 및 항혈소판제 관리 필수

STENTS: BALLOON EXPANDABLE VS. SELF-EXPANDING, STENT GRAFTS

■ **Balloon-expandable stents**

- Require positive pressure for expansion and are typically rigid with high radial strength
- **Ideal for immobile areas of the body**, such as the subclavian, renal, mesenteric, and iliac arteries, and at ostial locations.

■ **Self expandable stent (flexible stent)**

- Nitinol stents : **flexible and memory** , Pulling back the sheath to allow stent expansion
- Carotid, axillary, and superficial femoral flex and twist whenever the neck, shoulder, and leg move

■ **Stent graft (covered stent graft)**

- **Exclude aneurysms and to treat perforations** when other more conservative options fail

Balloon Expandable Stent vs.와 Self-Expandable Stent

구분	Balloon Expandable Stent	Self-Expandable Stent
확장 방식	- 풍선 카테터가 팽창하면서 스텐트를 기계적으로 확장 - 시술자가 직접 확장 크기 조절 가능	- 스텐트 자체 탄성에 의해 자발적으로 확장 - 몸속에서 자연스럽게 팽창함
재질	- 주로 금속 합금(코발트 크롬, 니켈 티타늄 합금)	- 니켈-티타늄 합금(니티놀, Nitinol) 사용이 많음
사용 부위	- 동맥의 경직성 병변이나 칼슘화된 부위에 적합 - 관상동맥, 대동맥 등에 주로 사용	- 굴곡이 심하거나 움직임이 많은 혈관에 적합 - 말초혈관, 경동맥 등에 많이 사용
크기 조절	- 시술자가 풍선 팽창 정도를 조절해 정확한 확장 가능	- 자가 확장되지만 크기 조절은 제한적
적응증 및 특징	- 강한 압박력으로 단단한 병변에 적합 - 정확한 위치 배치 가능	- 유연성이 뛰어나며 혈관 움직임에 잘 적응 - 혈관 손상 위험 적음
단점	- 팽창 후 재협착 가능성 있음 - 혈관 손상 위험 있음	- 위치 정확도 떨어질 수 있음 - 확장력이 제한적일 수 있음

Radial force

• **정의** : 스텐트가 혈관 내에서 병변 부위를 확장하고, 혈관 벽에 가하는 **외향(방사형) 압력** 또는 힘을 의미

•**역할** : 좁아진 혈관을 충분히 확장하여 혈류를 원활하게 유지 하고혈관벽에 안정적으로 고정되어 위치 이탈 방지 혈관이 다시 좁아지는 것을 막는 기계적 지지 제공

•**중요성**
- 너무 약하면 스텐트가 혈관벽에 제대로 밀착되지 않아 위치 이동 가능성 증가
- 너무 강하면 혈관 손상, 혈관 내막 손상이나 염증 유발 가능
- 적절한 radial force가 혈관 특성과 병변 상태에 맞게 선택되어야 함

•**Balloon Expandable vs Self-Expandable 스텐트의 Radial Force 차이**:

- Balloon Expandable Stent

: 초기 radial force가 강하고, 정확한 크기로 확장 가능하지만 한 번 팽창하면 크기 조절 어려움

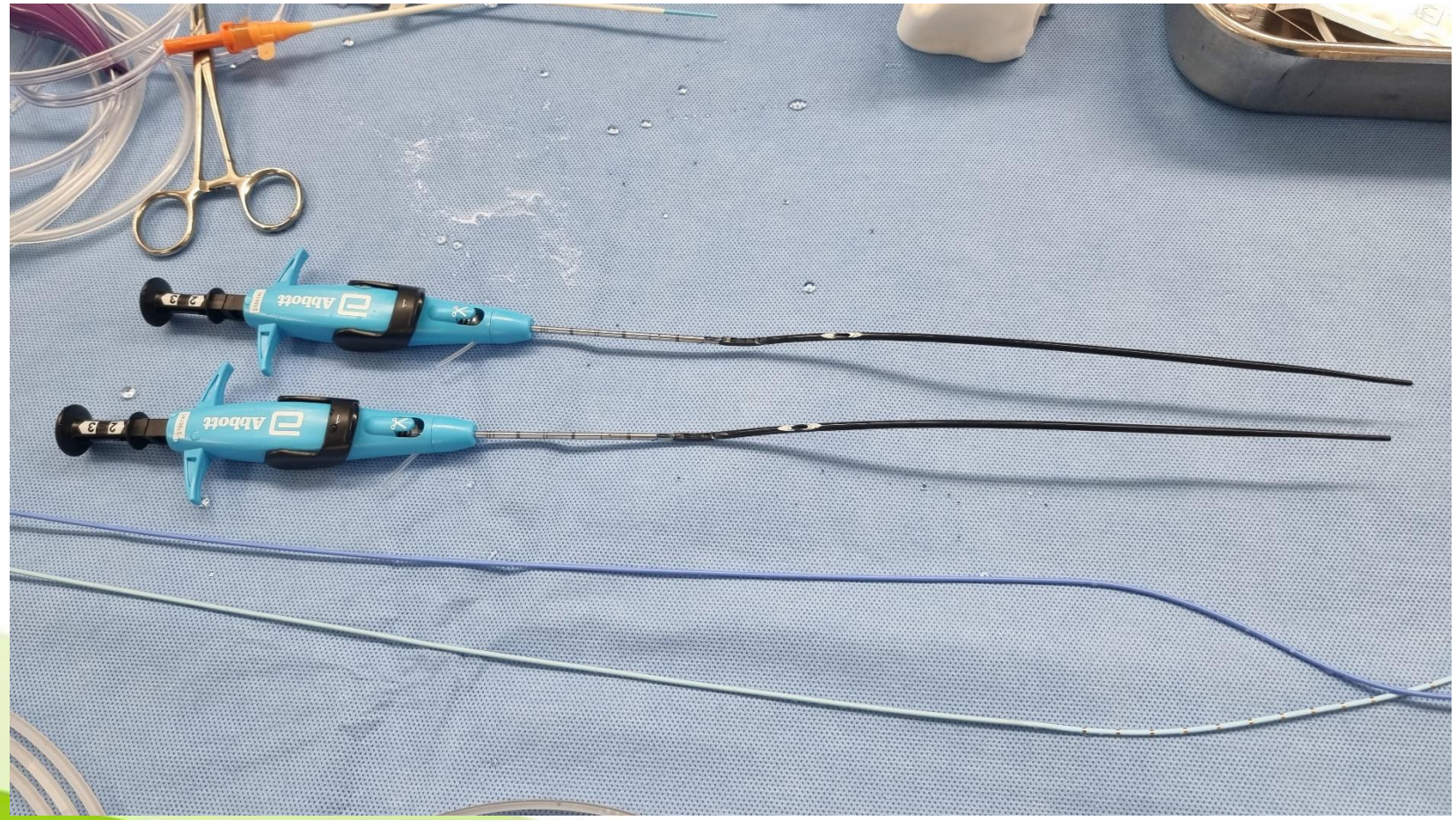
- Self-Expandable Stent

: 상대적으로 지속적이고 유연한 radial force를 제공하여 혈관의 움직임에 적응하지만 초기 압력은 비교적 낮음

Vascular Closure Devices

- Adequate hemostasis after sheath removal is critical to avoid vascular and bleeding complications
- Manual compression : smaller arterial sheaths
- Suture-Based VCD : Perclose Proglide
- Collagen Plug : Angio seal, femo seal…
- Clip-Based
- Sealant-Based

Closing device



Thank you for your attention