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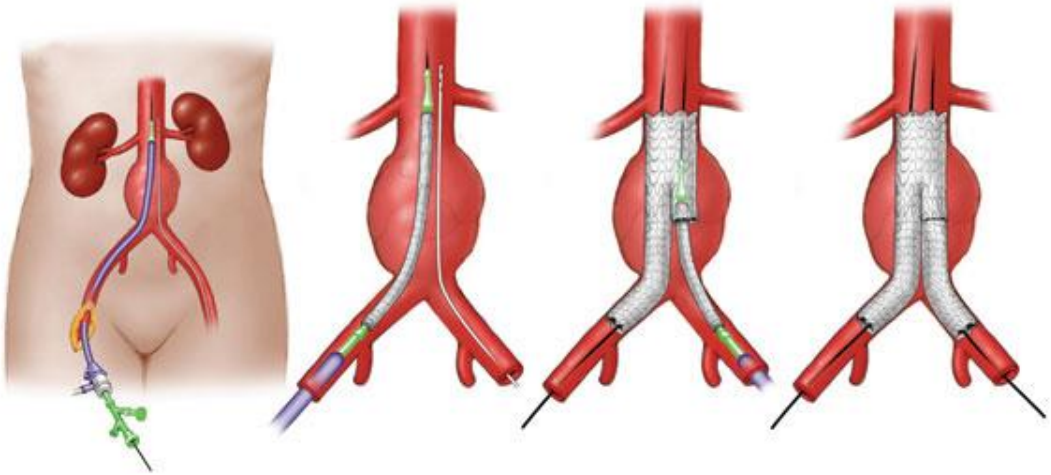

Basic Tools for Interventional Radiology and How to Perform Endovascular Repair of Aortic Aneurysms

Professor Mark E. O'Donnell

DipSEM(GB&I) MB BCH BAO(Dist) MFSEM(UK) MFSEM(RCSI&RCPI) MFSTEd MMedSc(Dist) MD ECFMG RPVI(ARDMS) FRCSEd(Gen&VascSurg) FEBVS(Hon)

Consultant Vascular and Endovascular Surgeon, Belfast Health and Social Care Trust and Visiting Professor, Sport and Exercise Sciences Research Institute, Faculty of Life and Health Sciences, Ulster University, Northern Ireland.

Northern Ireland Vascular Trainee Teaching Program

Royal Victoria Hospital – Wednesday 27th September 2017

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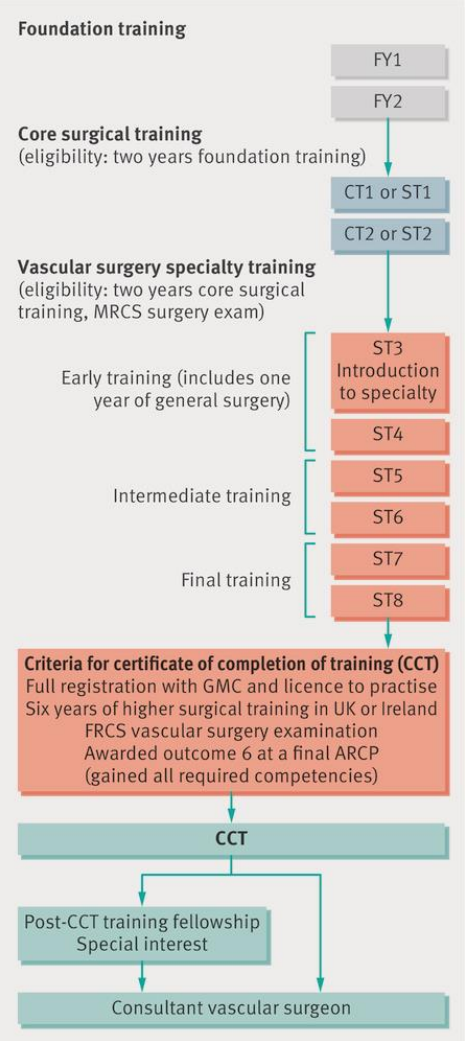
THE WORLD UNIVERSITY RANKINGS 2017 TOP 150 YOUNG

Learning Outcomes

- Basics of Interventional Radiology.
- Revision – Why treat an AAA?
- How to perform EVAR.
- Patient follow-up following EVAR.

Vascular Surgery Training



Al-Saudi, Boyle, Harkin *BMJ Careers* 2016

Aortic Aneurysm Disease - Vascular Surgery Curriculum

- Diagnosis and management including operative management of abdominal and peripheral aortic aneurysms. Have knowledge of both open and endovascular repair of aortic aneurysms.

- Recognise and know the principles of treatment of patients with ruptured abdominal aortic aneurysms.

- Aortic Aneurysm Index Procedures;

  - Elective open repair tube graft.
  - Elective open repair bifurcated graft.
  - Endovascular repair.
  - Ruptured aneurysm repair.

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Elective Aneurysm Treatment

	ST4	ST6	ST8
OBJECTIVE			
Assessment and management of elective aneurysms			
KNOWLEDGE			
Anatomy of aorta and main branches	4	4	4
Pathology of aortic aneurysms (atherosclerotic inflammatory, mycotic, collagen disorders, post-dissection, vasculitic)	3	4	4
Aortic dissection	2	3	4
Thoracoabdominal aneurysms	2	3	4
Pathology of other aneurysms (popliteal, visceral, carotid, subclavian, false aneurysms)	2	3	4
Investigation – US, CT A, MRA and PET	3	4	4
Treatment options (medical, open, EVAR, hybrid)	2	3	4
CLINICAL SKILLS			
History and examination, palpation of aorta	3	4	4
Assessment of comorbidity, cardiorespiratory/renal	3	4	4
Endovascular planning	2	3	4
Ability to recognise/manage postop. complications: bleeding, thrombosis, embolism, organ failure, endoleak, infection	2	3	4
TECHNICAL SKILLS			
Open repair infrarenal AAA	1	3	4
Inflammatory AAA repair	1	2	3
Internal iliac aneurysm repair	1	2	3
Juxta-renal AAA repair	1	2	3
Supra-renal AAA repair	1	2	3
Thoraco-abdominal aneurysm open repair	1	2	2
Thoraco-abdominal aneurysm hybrid repair	1	2	2
Popliteal aneurysm repair	1	3	4
Visceral aneurysm repair	1	2	3
Carotid aneurysm repair	1	2	3
Subclavian aneurysm repair	1	2	3
Repair femoral false aneurysm	2	3	4
Re-operation for infected graft	1	2	3
Endovascular repair infrarenal AAA	1	2	3
Internal iliac artery/aneurysm coiling	1	1	2
Aorto-uniliac stent-graft, iliac occluder & crossover graft	1	2	3
Juxta-renal or suprarenal AAA – fenestrated /branched stent	1	1	2
Thoracic aneurysm/dissection stentgraft	1	1	2
Correction of endoleak	1	1	1
Stenting of peripheral/visceral aneurysm	1	1	1

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Assessment and management of emergency aneurysms			
KNOWLEDGE			
Risk factors for aneurysm rupture	4	4	4
Appropriate/timely investigation of an emergency aneurysm (acute/ruptured)	3	4	4
Open and endovascular treatment options	3	4	4
Surgical methods of immediate aortic control - supra- coeliac and infrarenal	3	4	4
Intra-abdominal compartment syndrome	3	4	4
CLINICAL SKILLS			
History and examination	4	4	4
Assessment of co-morbidity	3	4	4
Selection of patients for conservative management, open or endovascular repair	2	3	4
Recognise/manage complications	2	3	4
TECHNICAL SKILLS			
Open repair ruptured infrarenal AAA	1	2	4
Suprarenal/supracoeliac clamp	1	3	4
Femoral thrombectomy and or additional lower limb revascularisation.	1	2	4
Balloon control of aorta	1	2	4
Endovascular repair ruptured infrarenal AAA	1	2	3
Endovascular stenting of acute aortic dissection	1	1	2
Endovascular stenting of acute aortic transection	1	1	2
Aorto-uniliac stent-graft, iliac occluder and crossover graft	1	2	2

Emergency Aneurysm Treatment

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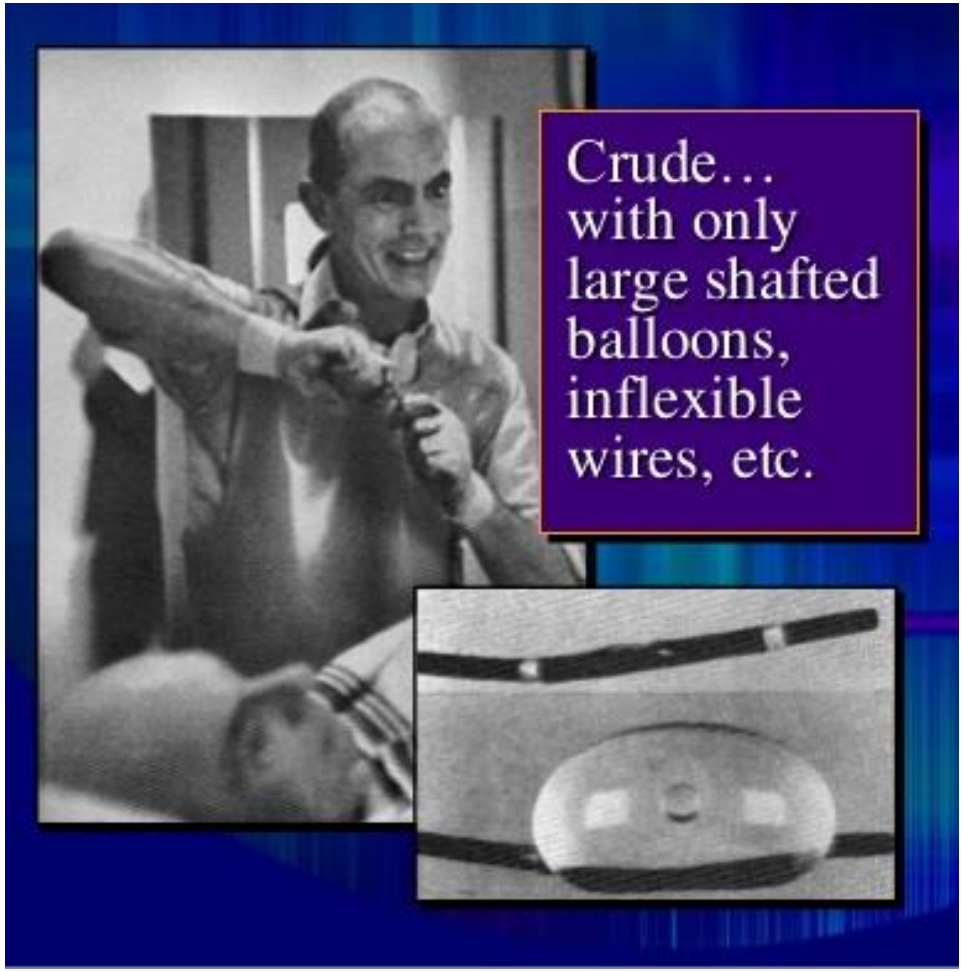
Basics of Interventional Radiology

Basics of Interventional Radiology

- Theatre Set-Up / Radiation Safety / Contrast.
- Arterial Access.
- Wires.
- Sheaths.
- Catheters.
- Balloons / Stents.


Crude…
with only
large shafted
balloons,
inflexible
wires, etc.

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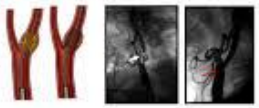
Simultaneous Hybrid Revascularization by Carotid Stenting and Coronary Artery Bypass Grafting

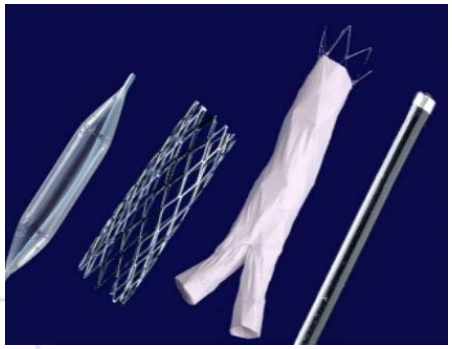
Carotid stenting *(interventional radiology)*

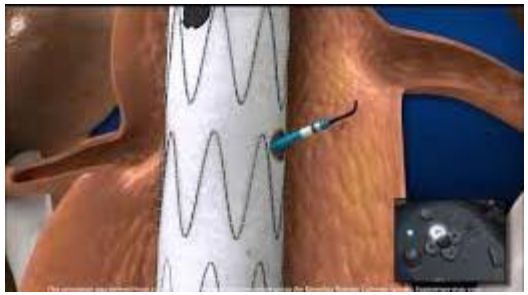
+

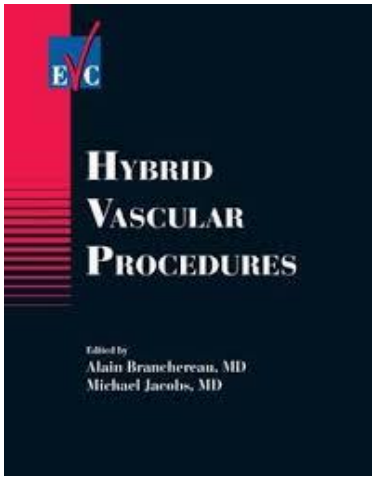
CABG

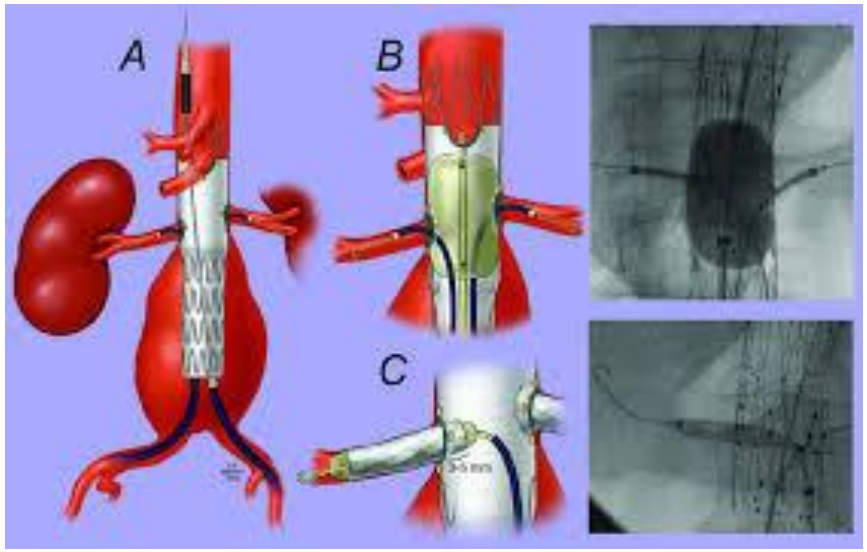


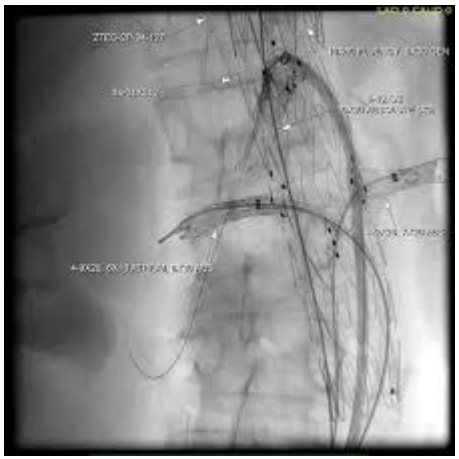
Chiariello L et al. TOR VERGATA











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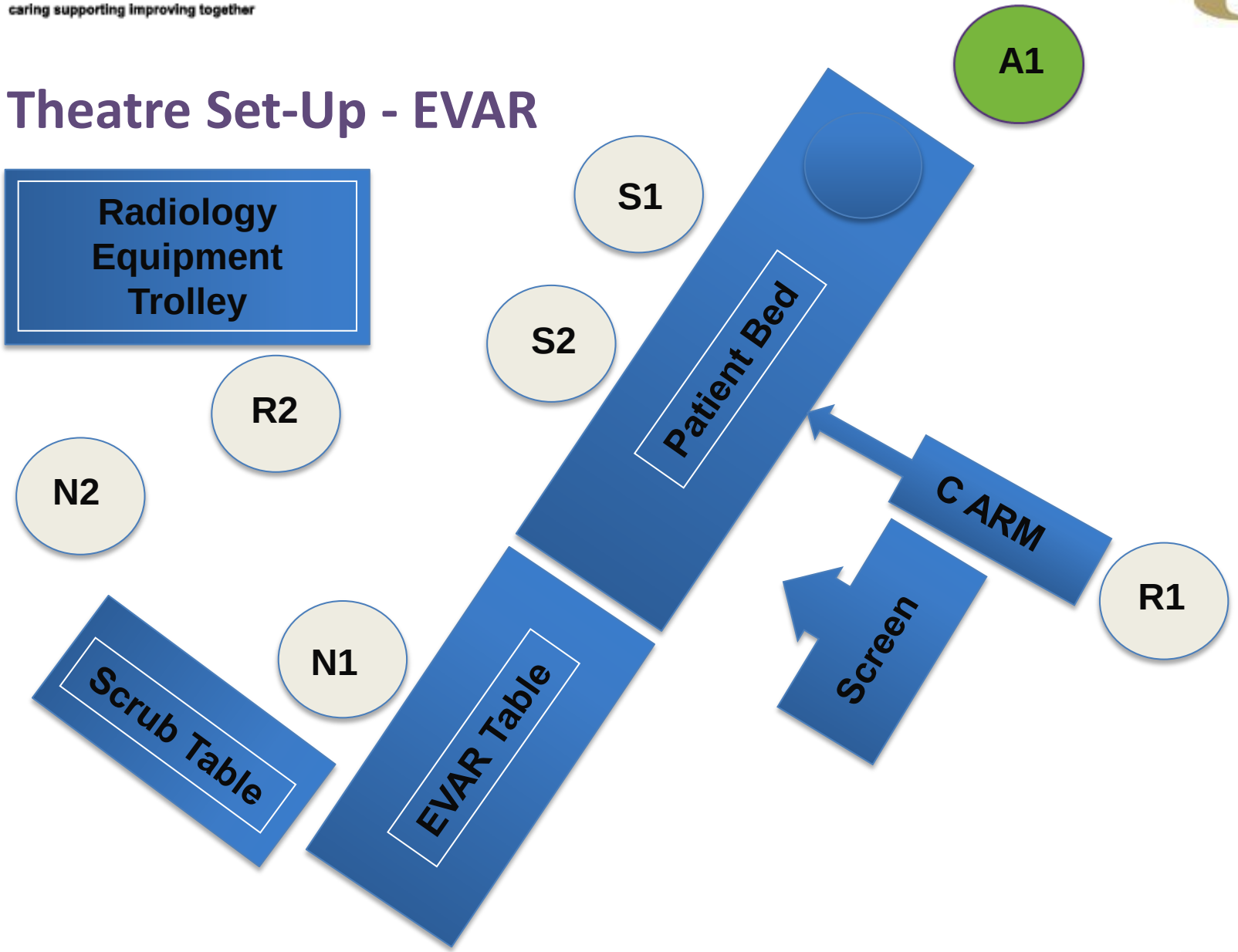
Theatre Set-Up - Patient Positioning

- Angio table - radiolucent.

- Supine.
- Head at anaesthetic end.
- Table rotated accordingly:
  - Abdominal procedure for Aortic-Iliac Segment.
  - Lower limb procedure for SFA to distal vessels.

Theatre Set-Up - EVAR



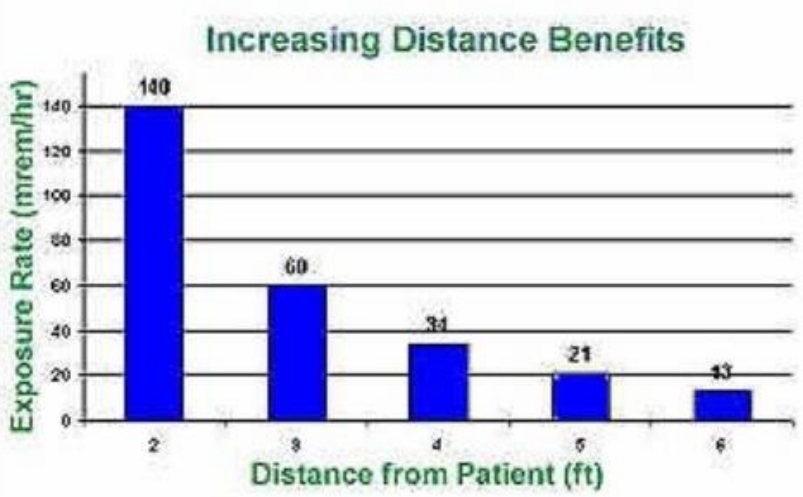
Radiation Safety

- Basic lead aprons.
- Maximise distance from c-arm.
- Awareness of difference between “fluro” and a “run”.
- Lack of operating table lead !!!

Radiation Safety

You Do The Math !

- Doubling your distance from the X-ray tube reduces your exposure by a factor of four.
- Tripling your distance from the X-ray tube reduces your exposure by a factor of nine !!!!



Intravenous Contrast

- Radiocontrast agents are used to enhance the visibility of internal structures in X-ray-based imaging techniques such as CT and fluroscopy.
- Radiocontrast agents are typically iodine or barium compounds.
- Iodinated agents are used intravascularly and may be ionic or non-ionic.

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- Magnetic resonance imaging (MRI) functions through different principles and thus utilizes different contrast agents which work by altering the magnetic properties of nearby hydrogen nuclei.

Intravenous Contrast

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ALWAYS KNOW RENAL FUNCTION PRIOR TO ADMINISTATRAION OF ANY CONTRAST AGENT

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Intravenous Contrast

- Iohexol (Omnipaque 350) – Non-ionic.

- Iodixanol (Visipaque 320) - Non-Ionic.

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- Know renal function and diabetic status prior to administering.

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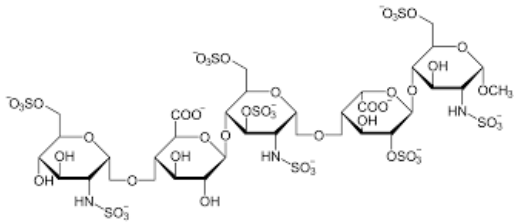
Carbon Dioxide.

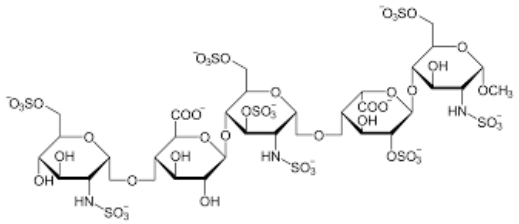
Heparin



- Heparin is a glycosaminoglycan which influences the coagulation cascade mainly through an interaction with antithrombin III (AT-III).

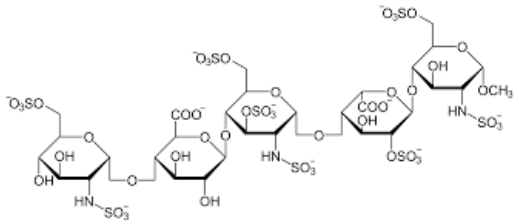
- This combination of enzyme and inhibitor inactivates coagulation enzymes, mainly thrombin (IIa) and Xa.

Heparin



- Heparin is a glycosaminoglycan which influences the coagulation cascade mainly through an interaction with antithrombin III (AT-III).
- This combination of enzyme and inhibitor inactivates coagulation enzymes, mainly thrombin (IIa) and Xa.
- Heparin is heterogeneous in its size and weight of molecules, its effect on coagulation, and its pharmacokinetic effects.
- These facts explain why heparin has a nonlinear effect on coagulation.

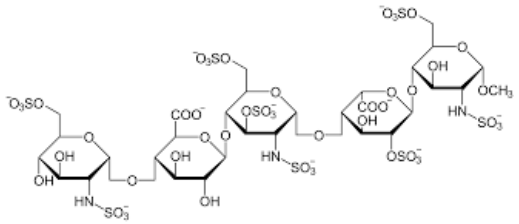
Heparin



- The higher molecular weight molecules of heparin are subject to a faster biological clearance from the blood.

- This faster clearance also causes accumulation of lower molecular weight molecules in vivo. These molecules, however, exhibit low activity on AT-III and are therefore of less clinical influence on coagulation.

Heparin



- Heparin binds non-specifically to proteins and cells in the blood of the patient which can lead to further limitation on its clinical effect leading to low bioavailability at low doses.

- A short plasma half-life creates a large variability in anticoagulant effect amongst patients with vascular disease.

So why do we give heparin?

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- Heparin is used as a peri-procedural prophylactic antithrombotic agent to prevent distal and proximal arterial thromboembolic complications.

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- To reduce the formation of thrombus on catheters and to prevent the formation of blood clots within catheters.

So why do we give heparin?

- Heparin is used as a peri-procedural prophylactic antithrombotic agent to prevent distal and proximal arterial thromboembolic complications.
- To reduce the formation of thrombus on catheters and to prevent the formation of blood clots within catheters.
- Heparin is also used during peripheral angiography as a flushing solution on the side port of a sheath, mostly diluted with saline (hepsal), and to coat catheters and wires.

So what about LMWH ?

So what about LMWH ?

- Compared to heparin, LMWH does not enhance platelet aggregation and is less sensitive to neutralisation by activated platelets and demonstrates a;
  - Higher antithrombotic activity.
  - Higher bioavailability.
  - Longer half-life than heparin.

- Also heparin-induced-thrombocytopenia caused by LMWH is less frequent.

- LMWH proved to reduce major bleeding complications, while not increasing ischemic study endpoints.

Wiersema *Scientifica 2016*

Arterial Access

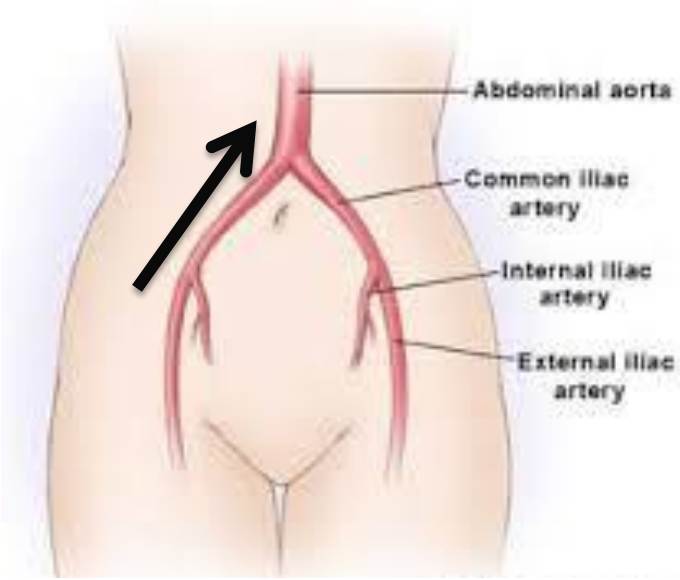
- Any vessel.

Arterial Access

- Any vessel.
- Any direction:

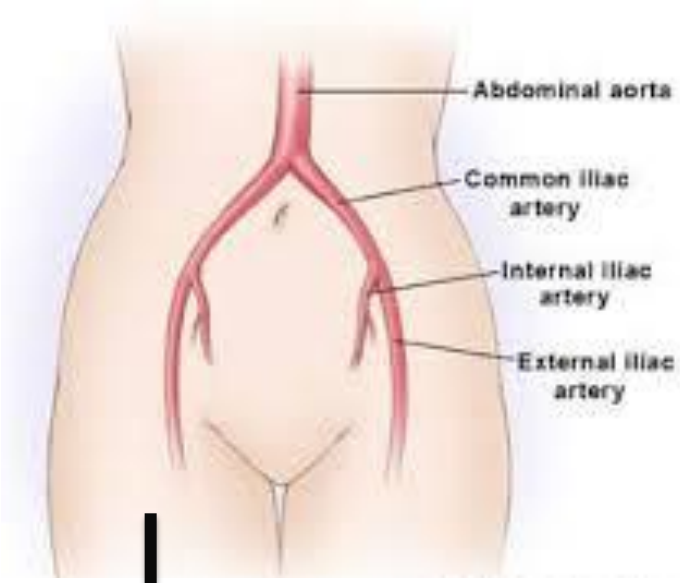
Arterial Access

- Any vessel.
- Any direction:
  - Retrograde.



Arterial Access

- Any vessel.
- Any direction:



- Antegrade.

Arterial Access – Any Vessel

- Skin shaving may be required.
- Local, Regional or General Anaesthetic.
- Small transverse incision or during open procedure.
- 19G Needle insertion – no requirement for syringe as arterial flow should be evident.

NEEDLES

Needles	Diameter (gauge)	Maximum Guidewire Diameter (in.)	Common Length
Seldinger	18	0.038	2 ¾ inch
	19	0.025	
	20	0.021	
	21	0.018	
Potts	18	0.038	2 ¾ inch
	20	0.021	
Amplatz (with 5 Fr Teflon sheath over cannula)	18 20	18-gauge sheath accepts 0.038	2 ½ inch
Butterfly venipuncture	19	0.028	Various
	21	0.021	
Jelco IV (with Teflon sheath)	18	0.035	Various
	20	0.025	
Syringe Needles	18	0.025	Various
	20	0.021	
	21	0.018	
Percutaneous Transhepatic Cholangiography	22 (black hub) 23 (green hub)	0.018	20 cm
Sheath Needle	16G sheath (19-gauge stylet)	0.038	24 cm

Wires – Access or Directional

- Size:
  - 035, 018, 014.
  - Usually mandated by vessel size and by type of adjunct procedure eg. Angioplasty / stenting.

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  - 60cm through to 300cm.

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- Stiffness:
  - Prelude, Bentson, J-wire
  - Terumo Glidewire
  - Rosen
  - Amplatz
  - Meier, Lunderquist

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- Stiffness:
  - Prelude, Bentson, J-wire → Access
  - Terumo Glidewire → Occlusions
  - Rosen → Up and Over
  - Amplatz → Tortuosity
  - Meier, Lunderquist → EVAR

Initial Access Wires

- Atraumatic soft wires.
- Wires that won't be traumatised with passage through needle.
  - Prelude.

  - Bentson.

  - J-wire.

Directional Wires

- Wire tip shape can be modified.
- Can be passed through embolectomy balloons / aspiration catheters.

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  - Glidewire.

  - V18 wire.

Sheaths

- Haemostatic conduits.
- Placed within arterial to avoid repeated access trauma for endovascular instruments.

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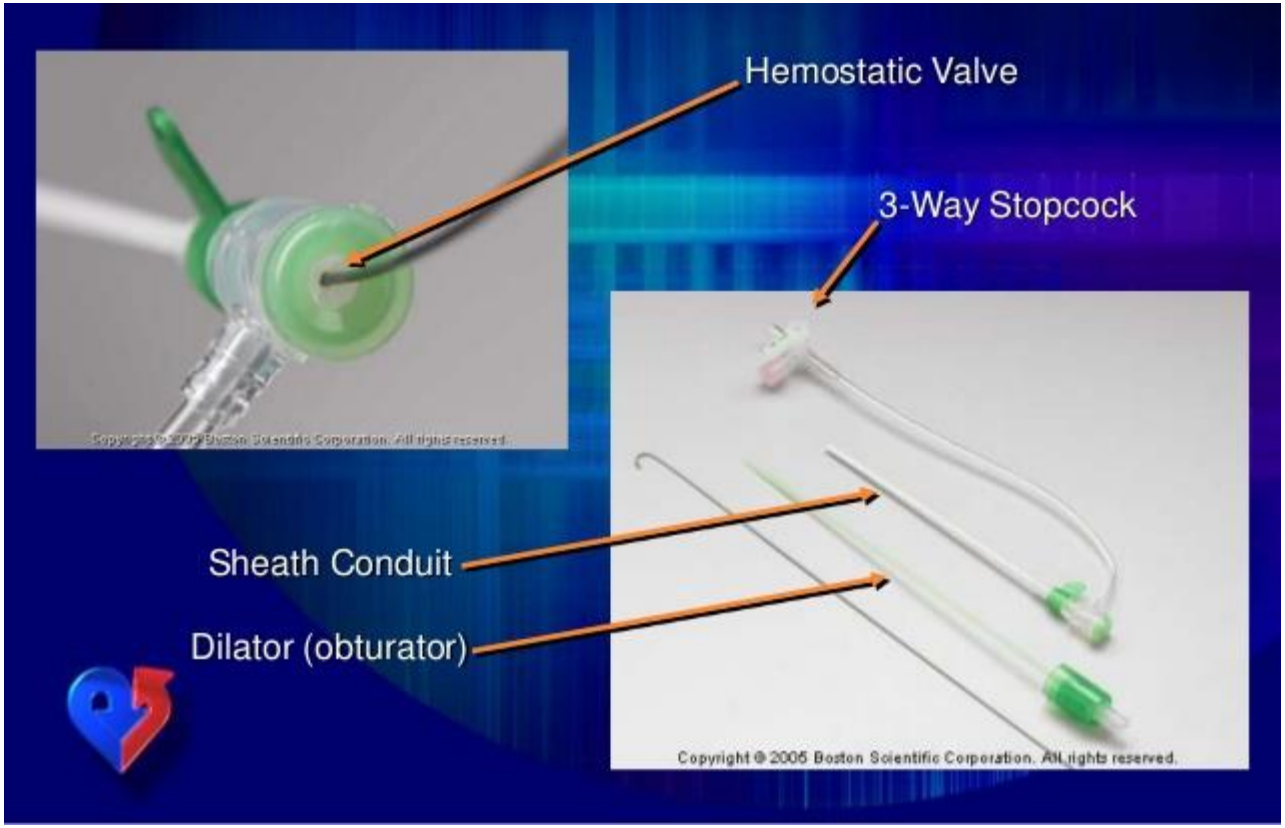
- Size:
  - 4Fr through to 22/24Fr.

Sheaths

- Haemostatic conduits.
- Placed within arterial to avoid repeated access trauma for endovascular instruments.
- Size:
  - 4Fr through to 22/24Fr.
- Length:
  - Short – renal AVF or difficult lower limb cases.
  - Standard.
  - Long – intra-abdominal cases or up/over cases.

Sheath Construction



Sheath Sizes

Peripheral and coronary sheaths have a universal color code

Universal color coding

- 4 Fr = red
- 5 Fr = gray
- 6 Fr = green
- 7 Fr = orange
- 8 Fr = blue
- 9 Fr = black
- 10 Fr = violet
- 11 Fr = yellow

Sheaths are measured inner diameter in french size (1fr = .33mm)

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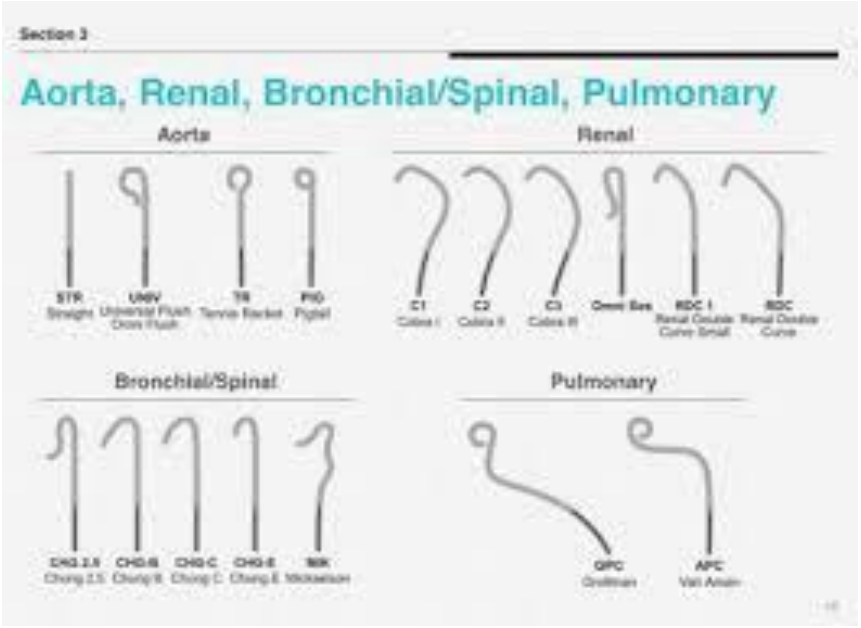
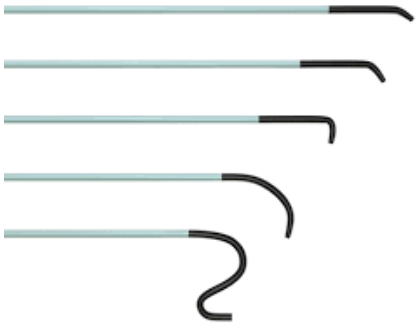
Divide Sheath Size by Three to Calculate Size in Millimetres

A 9Fr Catheter will need at least a 3mm vessel to pass into

Catheters

Catheters





- Size.
- Shape.

Catheters

1. Straight
   - End holed
   - Flush
2. Rim
3. JB2
4. IMA
5. Pig
6. Omni
7. Head Hunter
8. Simmons/VTEK
9. Cobra 2
10. Berenstein
11. Grollman

Catheters

- UF.

Catheters

- UF.

- Pig-tail.

Catheters

- UF.

- Pig-tail.

- Van Shee / Berenstein.

Catheters

- UF.

- Pig-tail.

- Van Shee / Berenstein.

- Omni.

Catheters

- UF.

- Pig-tail.

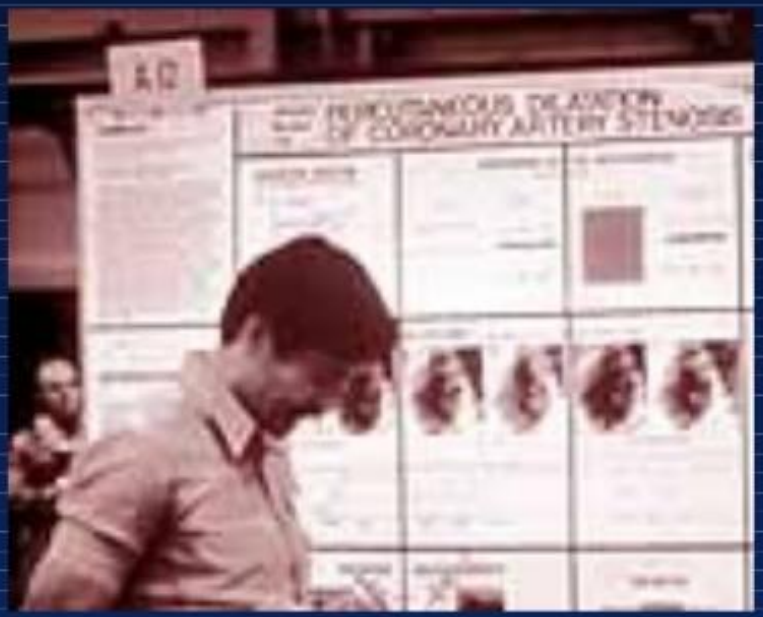
- Van Shee / Berenstein.

- Omni.

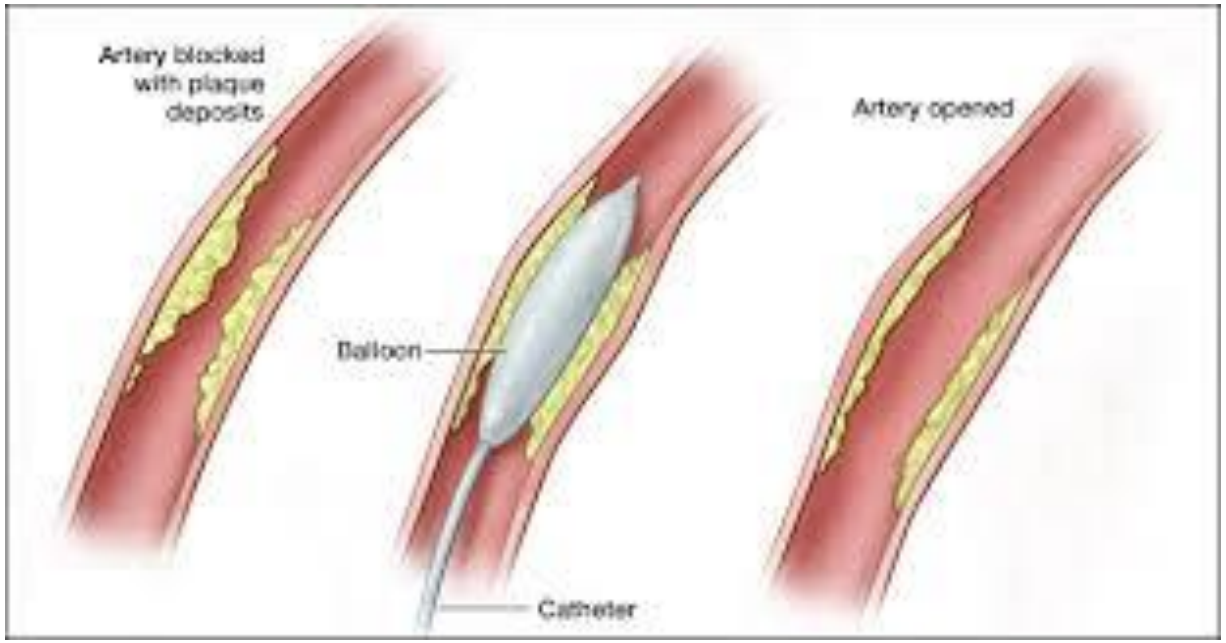
- Cobra.

Balloon Angioplasty

- **1974** — Andreas Gruentzig performs first peripheral human balloon angioplasty
- **1976** — Gruentzig presents results of animal studies of coronary angioplasty at AHA meeting



Balloon Angioplasty



Balloon Angioplasty

- The Encore Inflation Device is a latex free, high pressure inflation device designed to exert pressure for balloon inflation and deflation.
- It features an inflation capability of 20cc. It comes complete with a pressure gauge with a large printed dial and a finger latch mechanism for 1-step locking and pressure release.
- Remember to fill with half and half …….

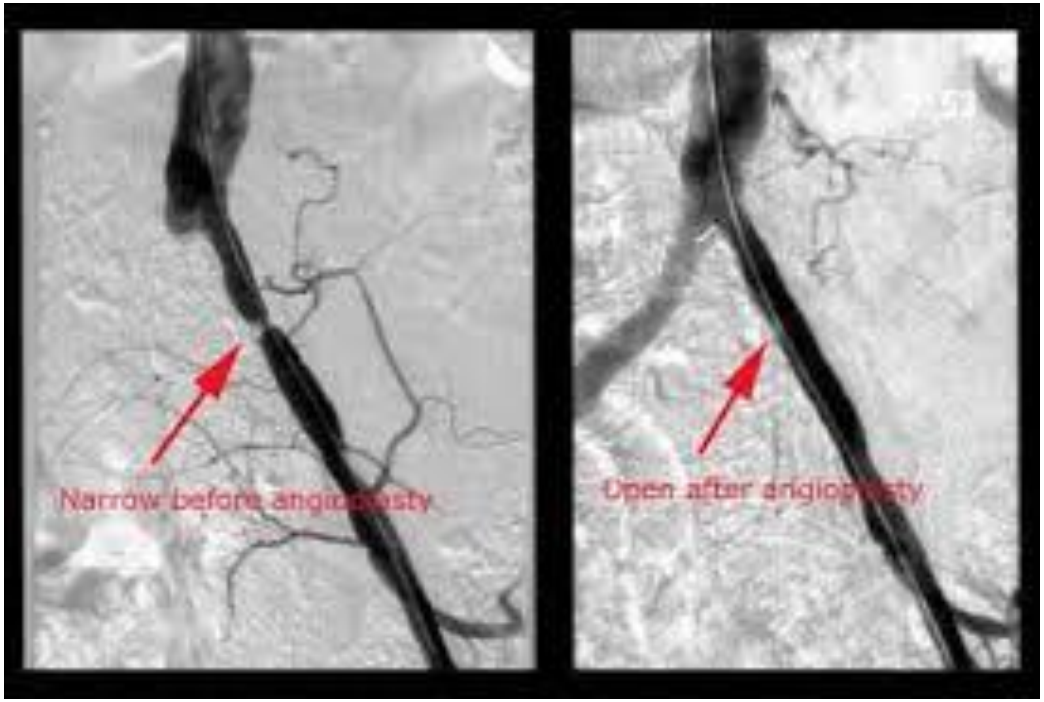
Balloon Angioplasty

- The Encore Inflation Device is a latex

Review Absolute and Burst Pressures on Angioplasty Card

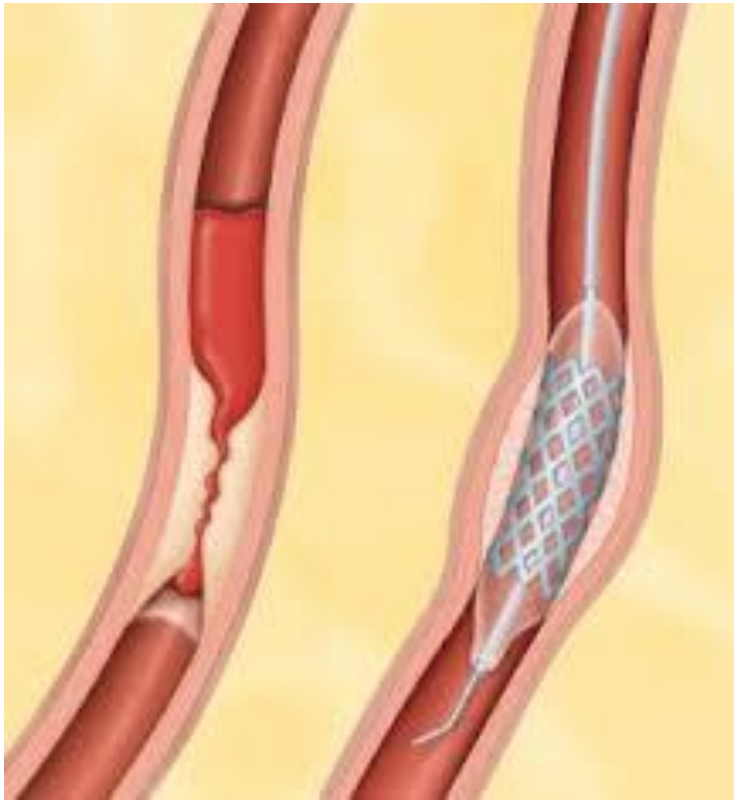
- Remember to fill with half and half …….

Balloon Angioplasty

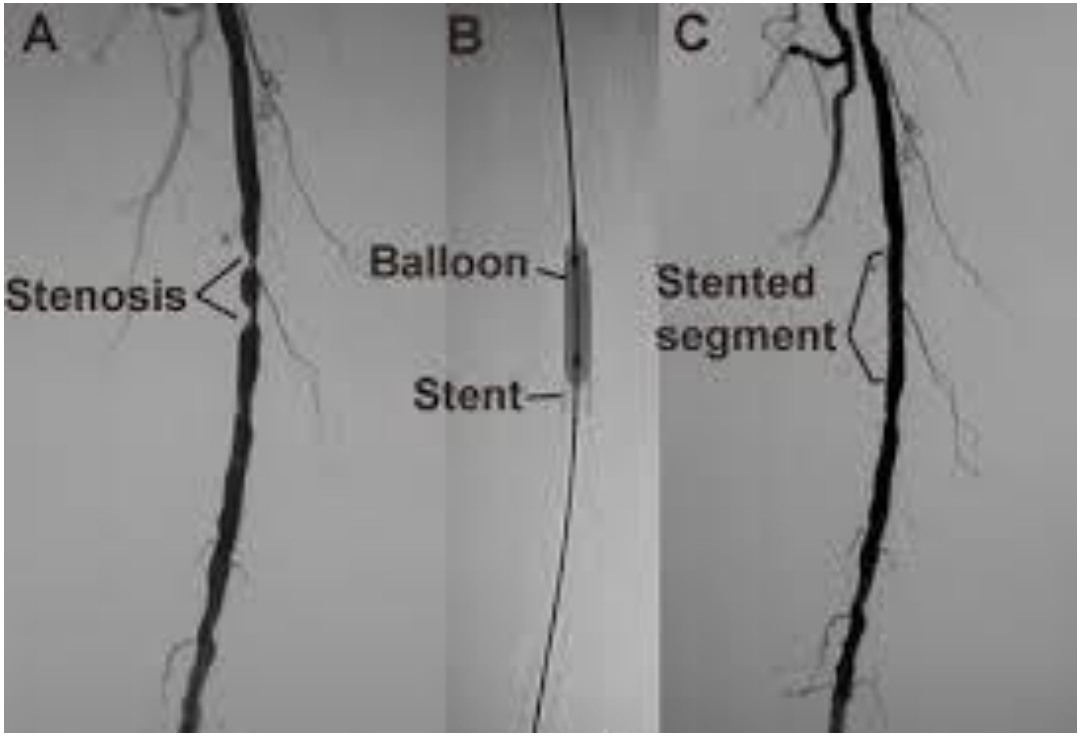


Drug-Coated Balloon Angioplasty

Stents



Stents



Stents


Why Drug-Eluting Stents?
First Bare Metal Stent was implanted 1987
Set the stage for stents to be regulated by CDRH (with review of CMC by CDER)
First DES approved in US (Cypher™) in 2003
Drug/polymer matrix is applied to a scaffold that props the artery open.
Drug slowly elutes further reducing restenosis
In some cases, the remaining metal is endothelialized in the arterial wall

Stents

Post-procedural care

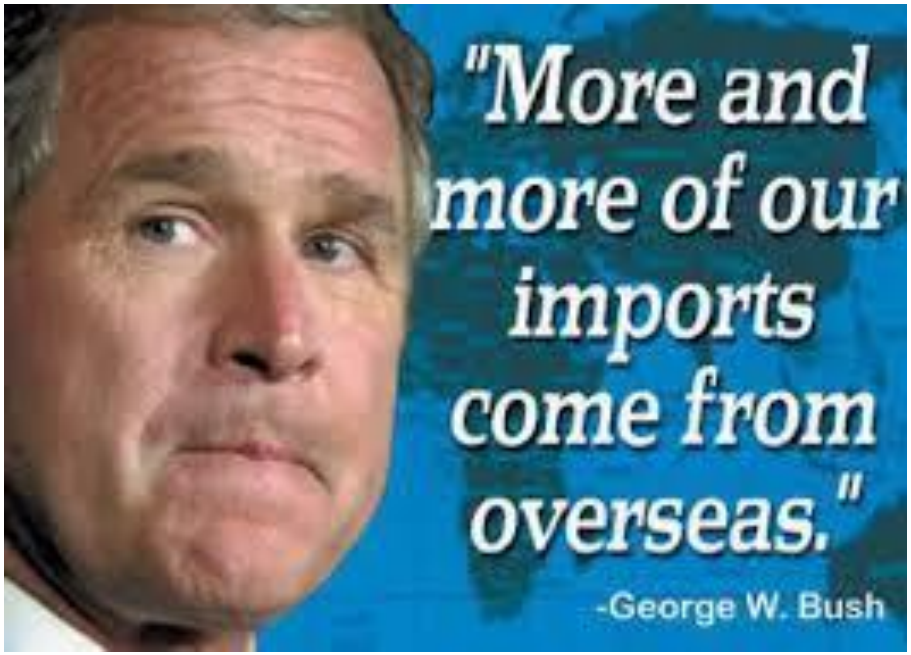
- Consider protamine if required.
- Closure of vessel:
  - Suture mediated.
  - Device mediated – Starclose, Proglide.
- Post-procedural bed rest duration.
- Medical Therapy:
  - Aspirin, clopidogrel or both.
  - Warfarin.
  - Statin.

Post-procedural care

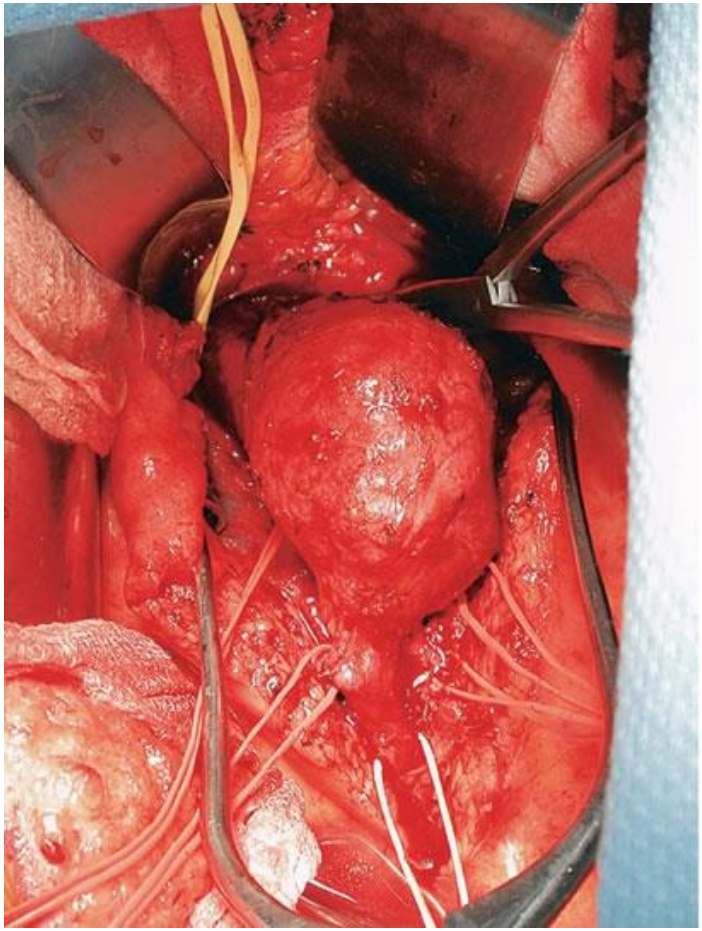
- Consider protamine if required.
- Closure of vessel:
  - Suture mediated.
  - Device mediated – Starclose, Proglide.
- Post-procedural bed rest duration.
- Medical Therapy:
  - Aspirin, clopidogrel or both.
  - Warfarin.
  - Statin.

Problems !!!

- Cannot stick vessel.
- Cannot progress wire.
- Cannot get sheath in.
- Vessel dissection.
- Vessel perforation.


"More and more of our imports come from overseas."
-George W. Bush

Why Treat AAA ??



Why Treat AAA ??

- Risk of AAA rupture;
  - Below 5cm <2%
  - 5cm to 5.9cm 5%
  - 6cm to 6.9cm 6.6%
  - 7cm to 7.9cm 20%
  - Greater than 8cm 30-50%

Why Treat AAA ??

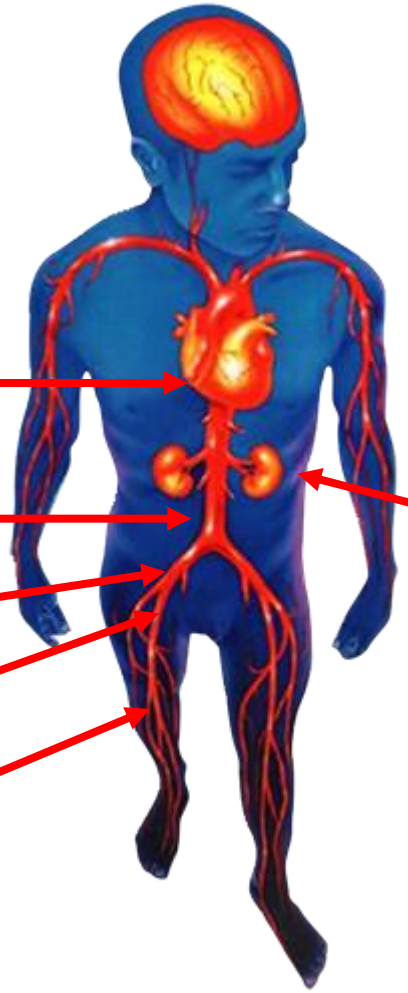
- Risk of AAA rupture;
  - Below 5cm <2%
  - 5cm to 5.9cm 5%
  - 6cm to 6.9cm 6.6%
  - 7cm to 7.9cm 20%
  - Greater than 8cm 30-50%

- UK Small Aneurysm Trial;
  - Multicentre RCT across 93 UK hospitals.
  - 1276 patients between 60-76 with AAA between 4.0 and 5.5cm.
  - Safe to monitor AAA up to 5.5cm unless tender or growth rates >1cm per year.

Lancet 1998; 352: 1649-55

Aneurysm Treatment Thresholds ?

Aneurysm Thresholds



Thoracic Aorta 6cm

Abdominal Aorta 5cm

Iliac 4cm

Femoral 3cm

Popliteal 2cm

2cm Visceral Aneurysms
- Splenic
- Hepatic
- Renal

Belfast Health and Social Care Trust
caring supporting improving together

Ulster University

AAA > 5.5cm - What's Next ?

Medical Review and Optimisation

- Out-patient clinic visit - *"End-of-bed-o-gram";*
  - Systemic evaluation and past medical history.
  - How far can you walk ?
  - Risk Factor Modification - Smoking cessation, blood pressure, fasting glucose and lipids.
  - Best Medical Therapy – Antiplatelets and lipid lowering medication.

- Anaesthetic Assessment;
  - Cardiorespiratory function – ECHO / PFT's'.
  - Further optimisation – medical / procedural – PCI.

Belfast Health and Social Care Trust
caring supporting improving together

Ulster University

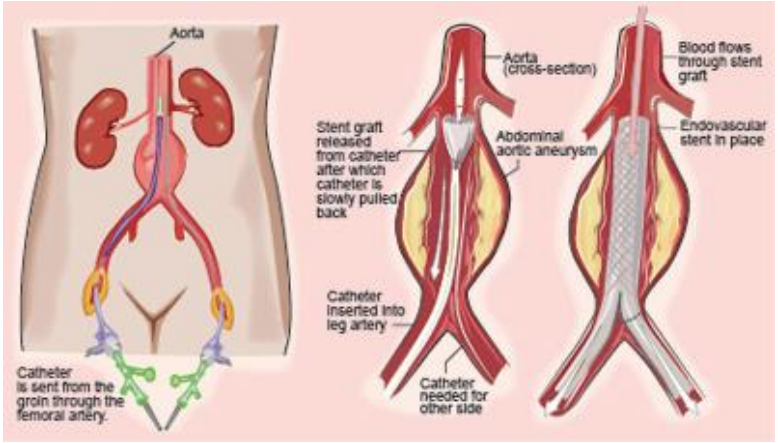
What are you going to consider next?

CT Angiography

What are your patient's options?

Endovascular Repair

- Repair through an incision in the groin with expandable prosthesis under fluoroscopic guidance
- Requires both surgical and radiological assistance
- Significantly reduced morbidity.
- Long term result unknown
- Hospital stay 2 days, Recovery time 1-2 weeks



Open AAA Repair

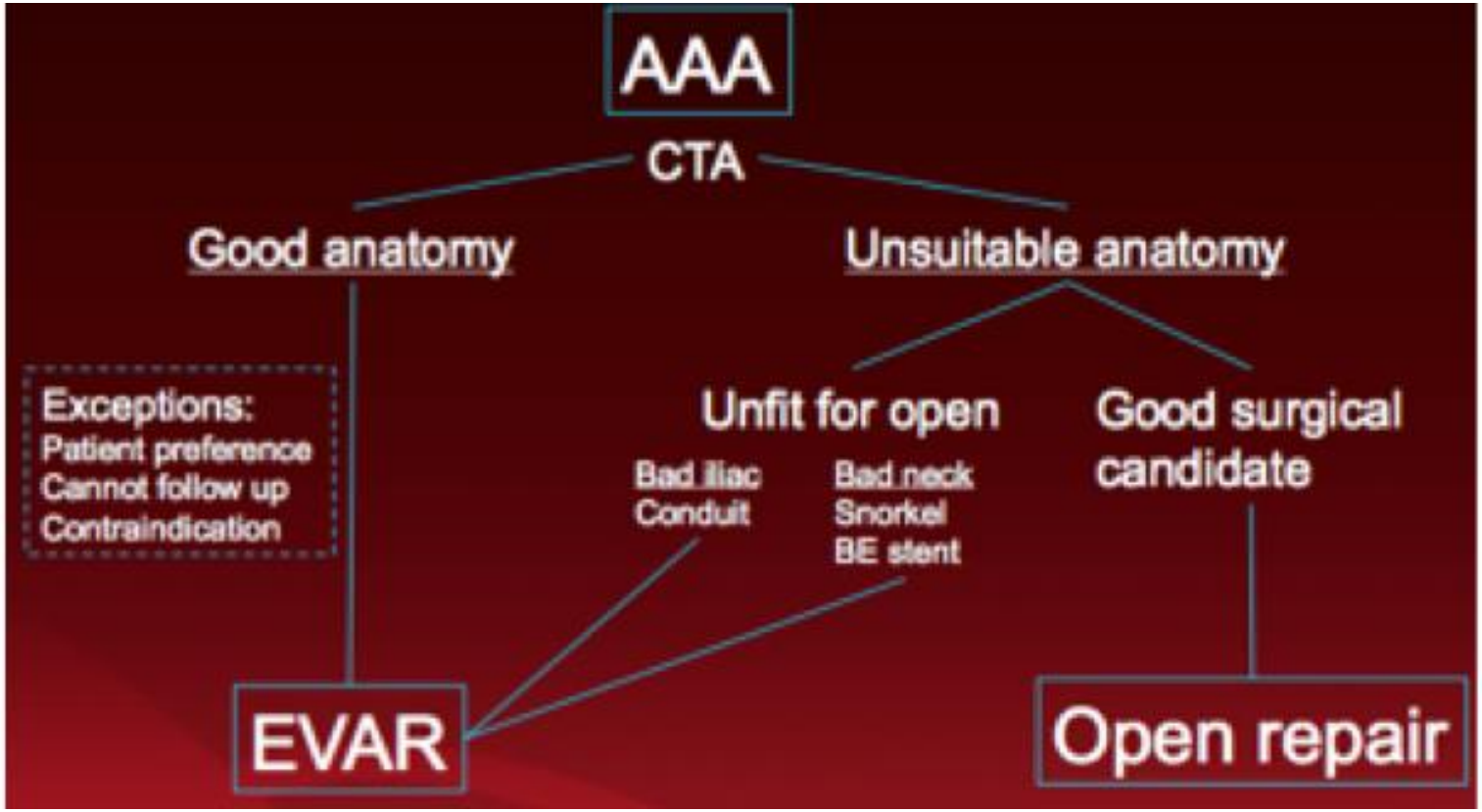
- Replace diseased aorta with artificial artery.
- Requires 7 day hospital stay.
- Recovery time 3-6 months.
- Proven method with good long term results.

Comparison of Open AAA repair and EVAR

Open Repair	Endovascular Repair
Mortality rates < 5%	Mortality rates < 2%
Significant morbidity	Low morbidity
ICU = 1-3 days Total length of stay = 5-10 days	ICU = 1 day Total length of stay = 1-3 days
Proven durability	Questionable durability
Long-term freedom from reintervention (90-92%) and compli-cations (80.6-85%)	Lower freedom from reintervention (72-87%) and complica-tions (48-83%)
Less total average cost	Greater cost due to surveillance and aneurysm-related procedures
ICU = intensive care unit	

Gallardo & Schneider *Vascular Disease Management* 2012;9(6):E90-E96

AAA Repair Algorithm



Gallardo & Schneider *Vascular Disease Management* 2012;9(6):E90-E96

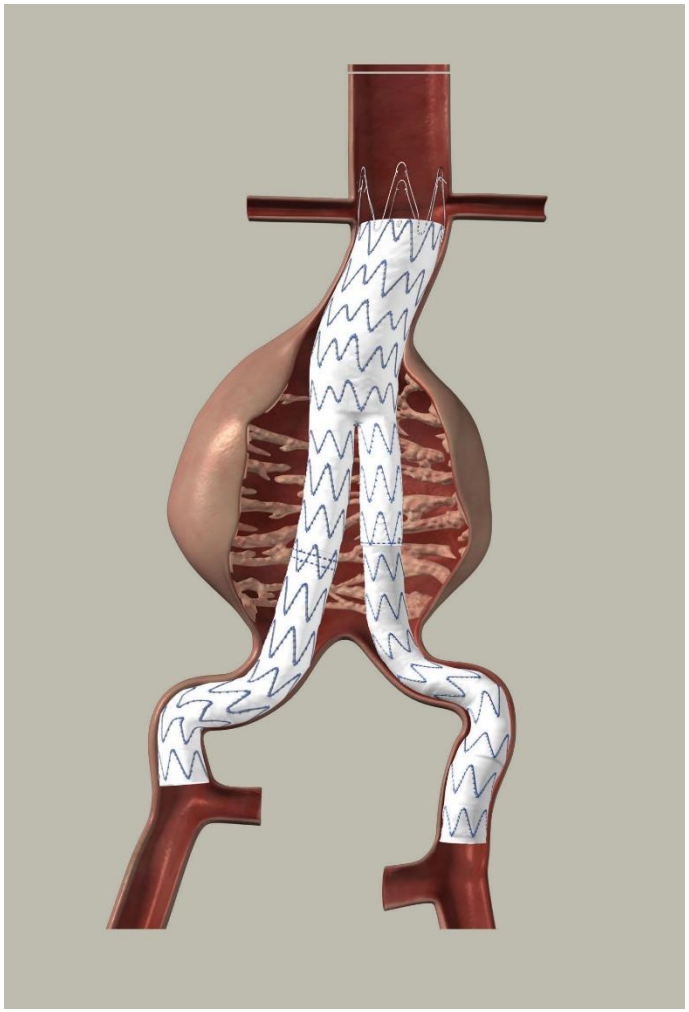
EVAR Planning

EVAR Planning

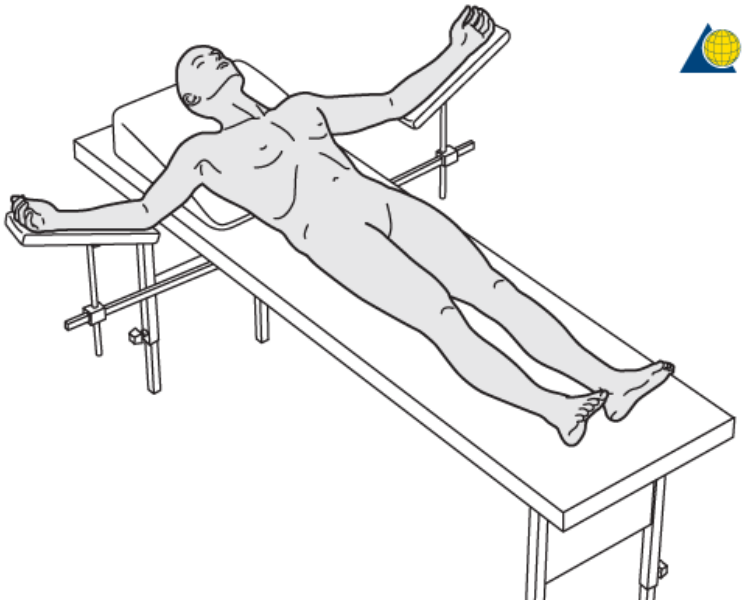
EVAR Procedural Consent

- General Local Complications;
  - Pain, Bruising, Bleeding, Wound infection.
- Systemic Complications;
  - Cardiovascular, Respiratory, Thromboembolic.
  - Renal.
- Procedural Specific Complications;
  - Graft sepsis.
  - Graft occlusion.
  - Distal arterial ischaemia.
  - Post-operative radiological follow-up.
  - Risk of secondary interventions.

How to perform EVAR

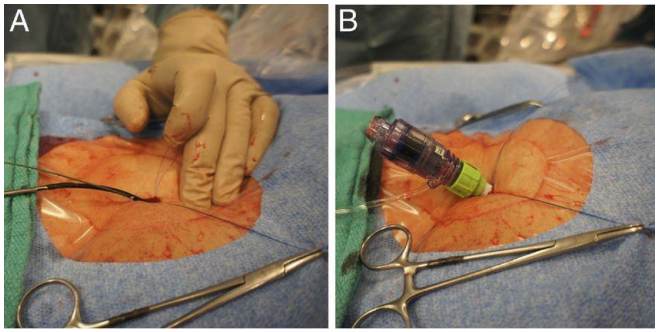


1 - Patient Positioning



- As for open AAA repair;
  - Supine.
  - Arms out.
- GA or LA.
- Urinary catheter.
- Antibiotics.
- Skin shaving and preparation.
- Drapes as for open AAA with extra long sheet for EVAR table.

2 – Femoral Artery Access



- Can be open or percutaneous.
- Open :
  - Vertical groin incision.
  - Dissect down onto inguinal ligament.
  - Identify and sloop CFA, SFA and PFA.
  - Evaluate quality of vessels for EVAR access.
- Percutaneous;
  - Review CTA before.
  - Small transverse incision.
  - Ultrasound guided access.
  - Needle / Wire / Sheath.
  - Femoral angiogram.
  - Maintain wire and remove sheath.
  - Insert 2 x Perclose ProGlides at 10- and 2-O'Clock or a single Prostar.
  - Secure sutures and maintain correct order.
  - Progressive insertion of dilators then large sheaths 16F /18F and 14F.

Webb & Wood J Am Col Card Lancet 2012;60(6): 352: 1649-55

3a – Endovascular Access – Ipsilateral Side – Main Body

- Open exposure of common femoral artery;
  - 19G needle.
  - Bentson wire to abdominal aorta.
  - Exchange of needle for 7Fr Sheath.
  - Remember to pinch the artery during this exchange for haemostasis.
  - Get into habit of using a damp Raytec to wipe wires.

3b – Endovascular Access– Ipsilateral Side – Main Body

- Open exposure of common femoral artery;
  - Place a Berenstein catheter over the Bentson wire to place catheter in thoracic aorta under constant fluroscopy.
  - Exchange Bentson wire for stiff Lunderquist wire.
  - Position Lunderquist wire just distal to left subclavian artery with continual fluroscopy.
  - Mark external position of Lunderquist wire on scrub trolley.

3c – Endovascular Access – Contralateral Side

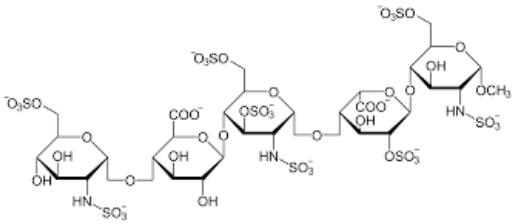
- Open exposure of common femoral artery;
  - 19G needle.
  - Bentson wire to abdominal aorta.
  - Exchange of needle for 7Fr Sheath.
  - Remember to pinch the artery during this exchange for haemostasis.
  - Get into habit of using a damp Raytec to wipe wires.

3d – Endovascular Access – Contralateral Side

- Open exposure of common femoral artery;
  - 19G needle.
  - Bentson wire to abdominal aorta.
  - Exchange of needle for 7Fr Sheath.
  - Remember to pinch the artery during this exchange for haemostasis.
  - Get into habit of using a damp Raytec to wipe wires.

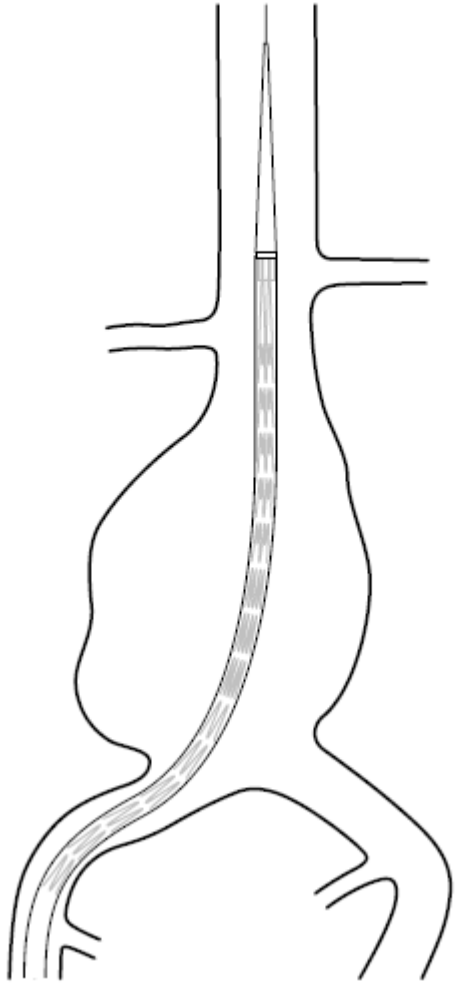
  - Insert measuring pig-tail catheter and place at level of renals adjacent to first lumbar vertebrae.

4 - Heparin



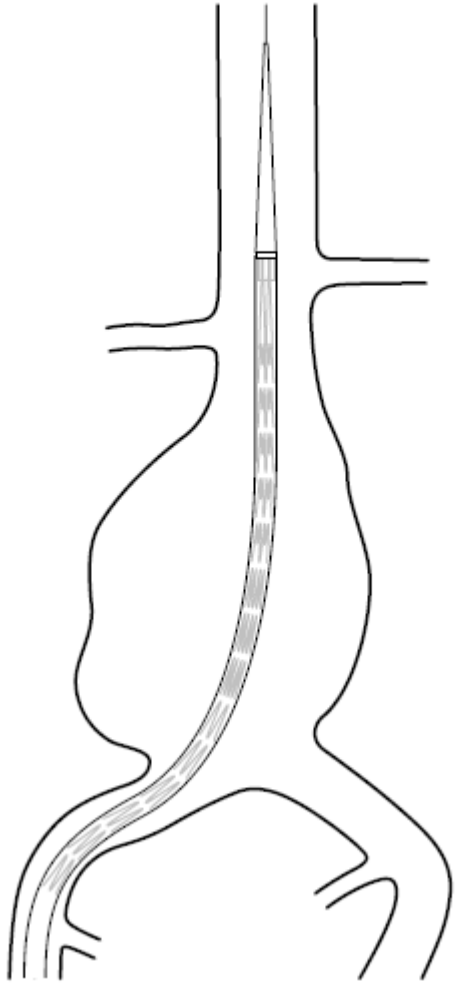

Heparin
Sodium Injection
1000 USP units
10 mL Multiple
FOR IV OR SC
Baxter
Heparin
Sodium Inj. USP

5 – Introduce the stent graft



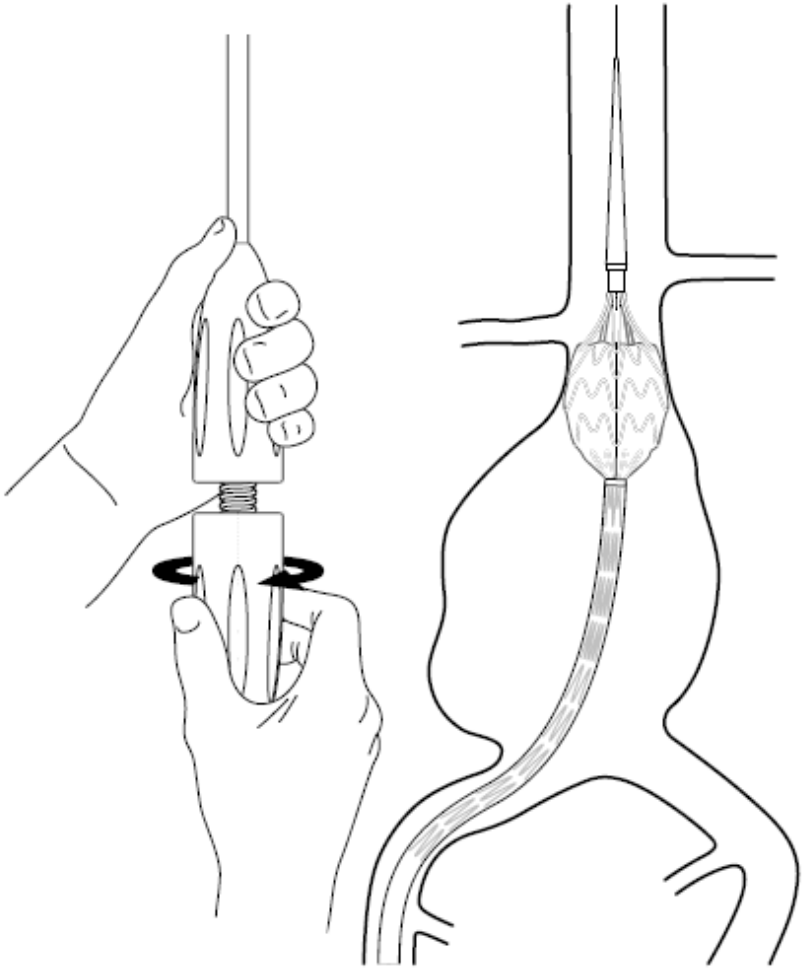
- Exchange out the 7Fr sheath.
- Pinch the artery for haemostasis.
- Wipe the wire with wet swab.
- Activate the hydrophilic coating on stent sheath with hepsal flush.
- Place the Endurant stent graft over the Lunderquist wire.
- Follow stent insertion under constant fluroscopy.

6 – Angiogram



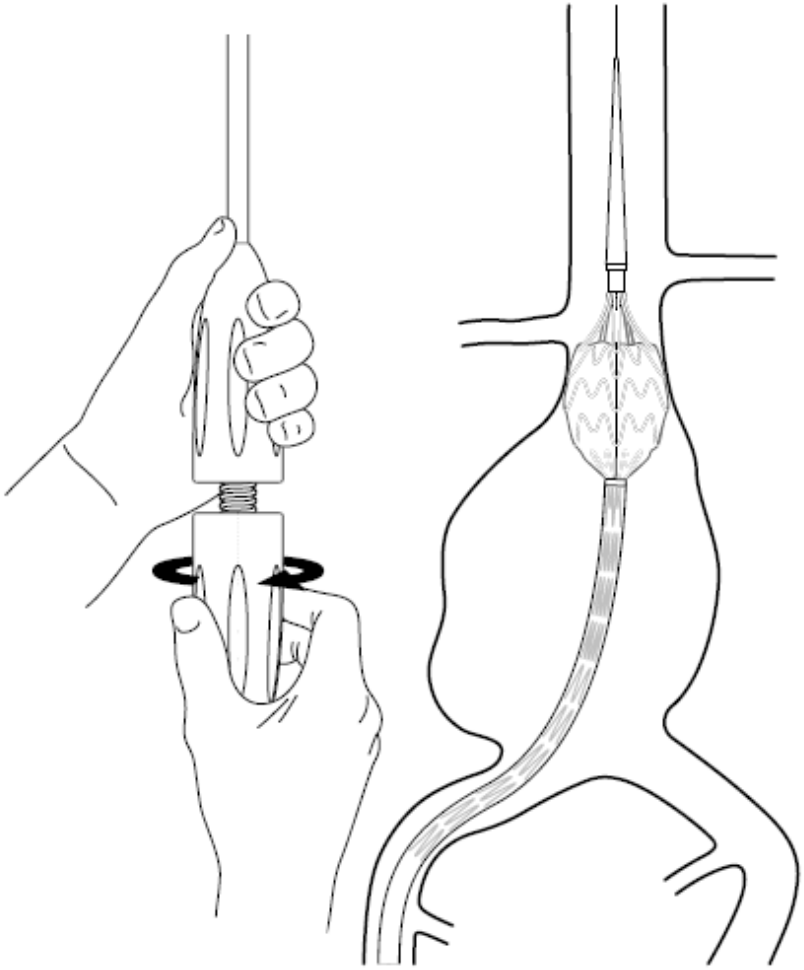
- Perform an angiogram via a pigtail catheter inserted via the contralateral side.
- Mark the lowest renal on the c-arm screen.
- Position endovascular stent carefully under fluoroscopic imaging to just above lowest renal artery.

7 – Deploy the proximal end of the endograft



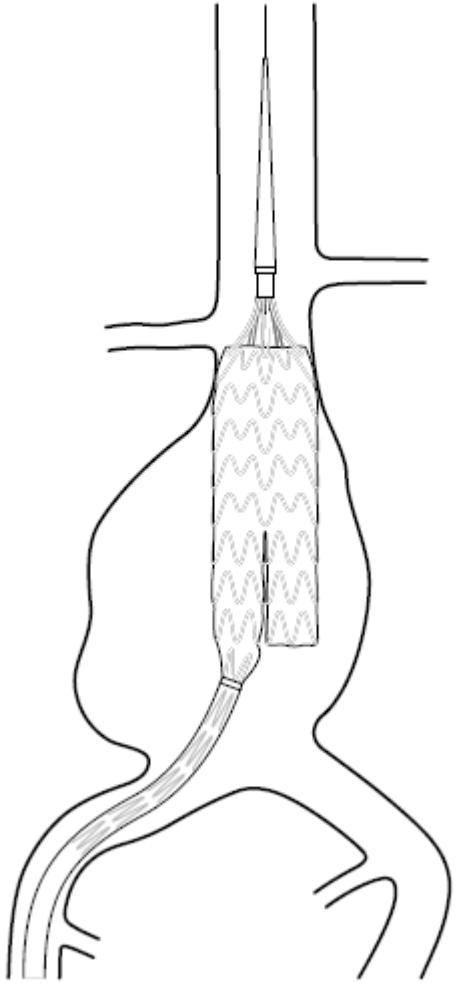
- Commence stent deployment maintaining constant position of stent by holding grey proximal delivery handle with left hand.
- Turn the blue slider counter-clockwise to uncover proximal portion of stent.
- Perform another check angiogram to ensure deployment below renal.

7 – Deploy the proximal end of the endograft



- Commence stent deployment maintaining constant position of stent by holding grey proximal delivery handle with left hand.
- Turn the blue slider counter-clockwise to uncover proximal portion of stent.
- Perform another check angiogram to ensure deployment below renal.
- It is natural for stent to withdraw slightly during this phase due to “water-hammer effect” of aorta. Hence commencement of deployment slightly higher often occurs.
- Note it is easier to withdraw stent downwards during this phase than pushing it back in.

8 – Continue stent deployment until gate open



- Continue stent deployment until contralateral gate opens by continual turning of the blue slider counter-clockwise.

9 – Cannulate the Gate

- Via the 7Fr Sheath on the contralateral side;
  - Insert a Bentson wire into the Pig-Tail Catheter.
  - Withdraw the pig-tail catheter into the aneurysm sac until below the level of the open gate.
  - Try and pass the Bentson wire up-through the gate.
  - Once placed within the gate pass the Pig-Tail up through the gate into the stent.
  - At this stage confirm presence within the contralateral limb by a) injecting contrast, b) twirling the Pig-Tail and c) reviewing the contralateral limb in two oblique views.

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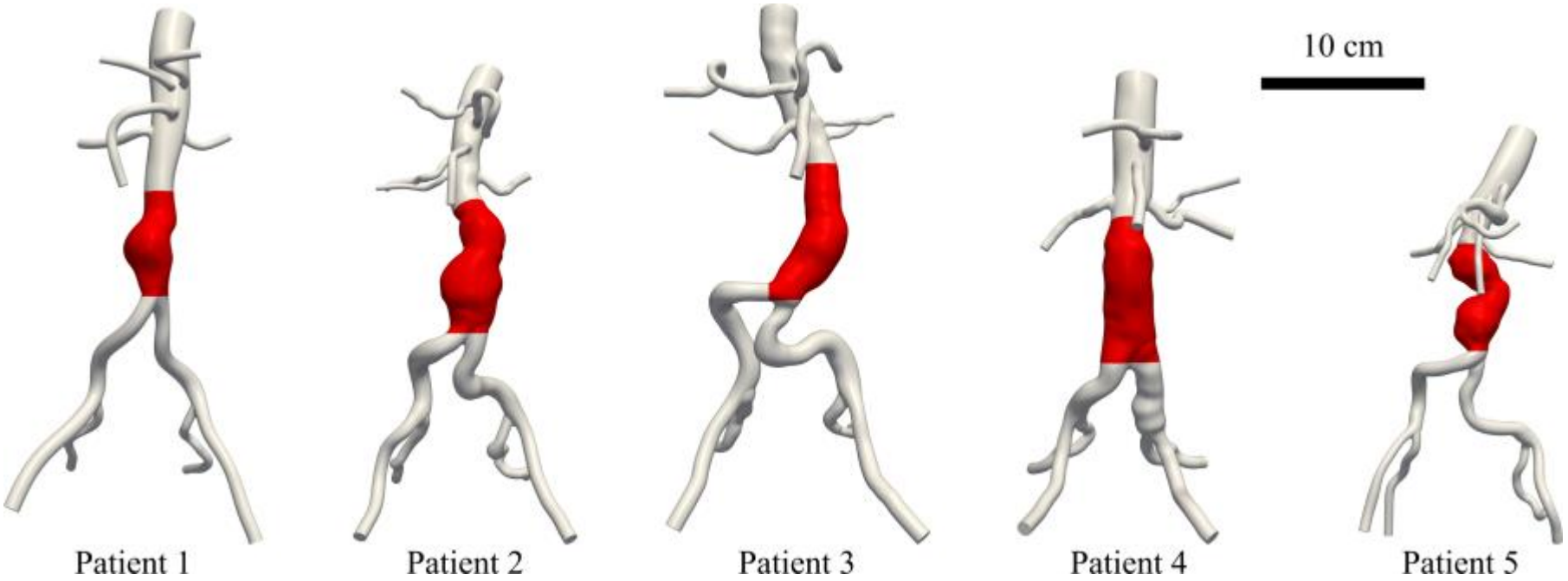
  - At this stage confirm presence within the contralateral limb by a) injecting contrast, b) twirling the Pig-Tail and c) reviewing the contralateral limb in two oblique views.

  - Be Aware of Wire and Catheter Adjuncts;
    - Terumo glidewire.
    - Berenstein / Cobra / Omni-Sauze catheters.

9 – Cannulate the Gate

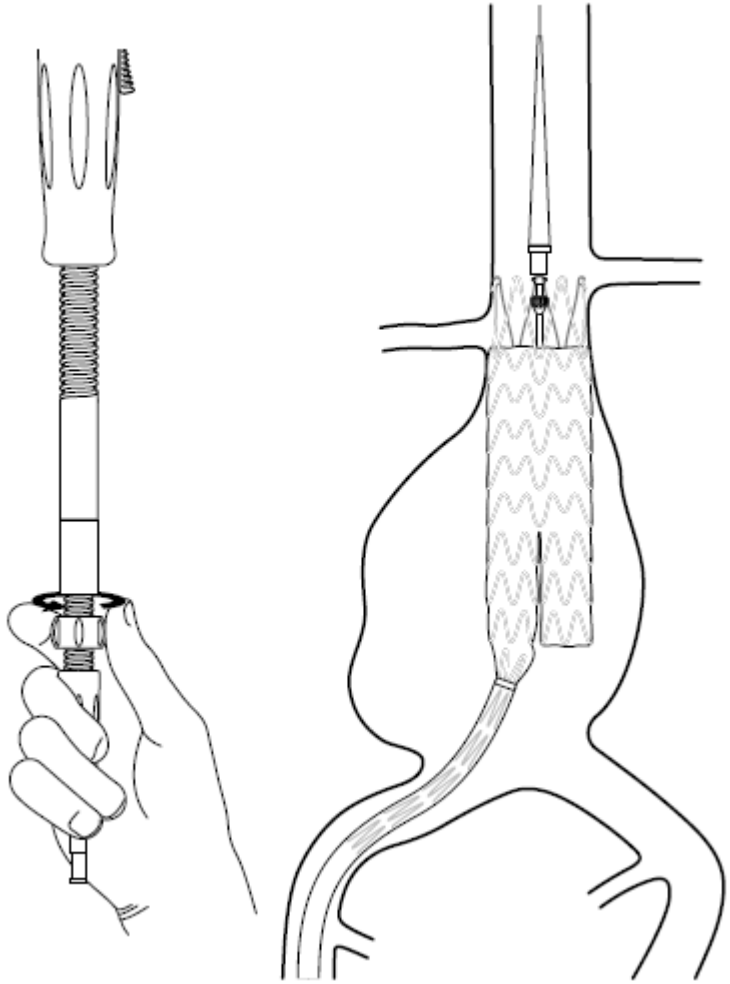
- Via the 7Fr Sheath on the contralateral side;
  - Place the pig-tail at the level of the aortic arch similar to the ipsilateral side.
  - Exchange the Bentson wire for a Lunderquist wire and insert as far as the previously made mark on the scrub trolley.



STEPS 9 AND 10 MAY BE REVERSED

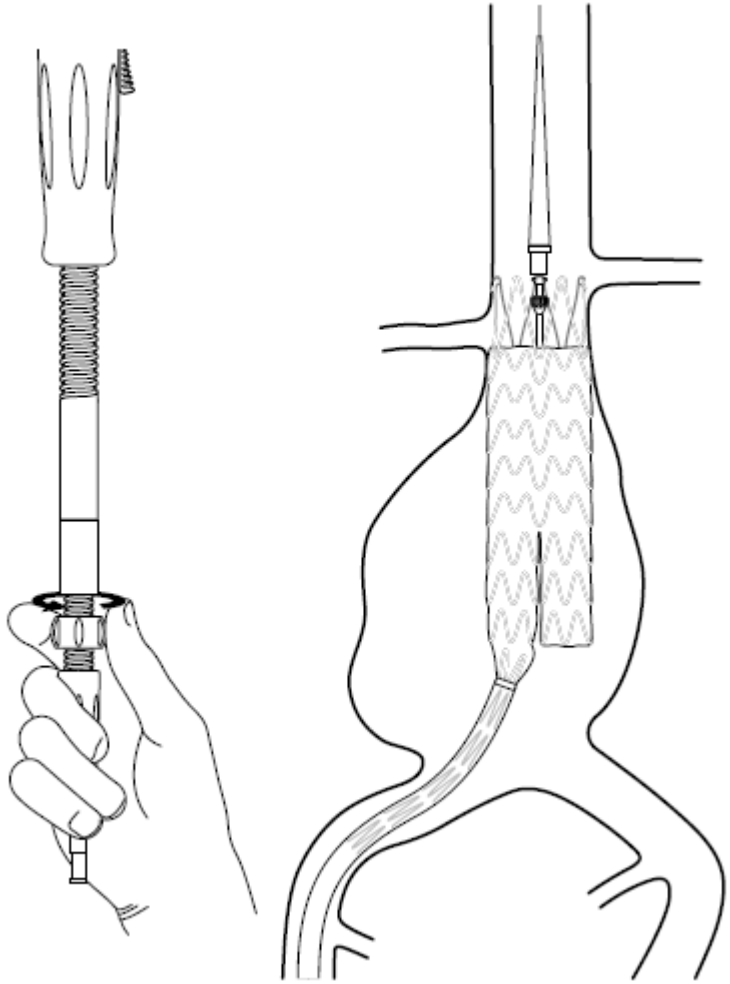
Hansen *J Biomech Eng* 2015

10 – Deploy Stent Top-Cap



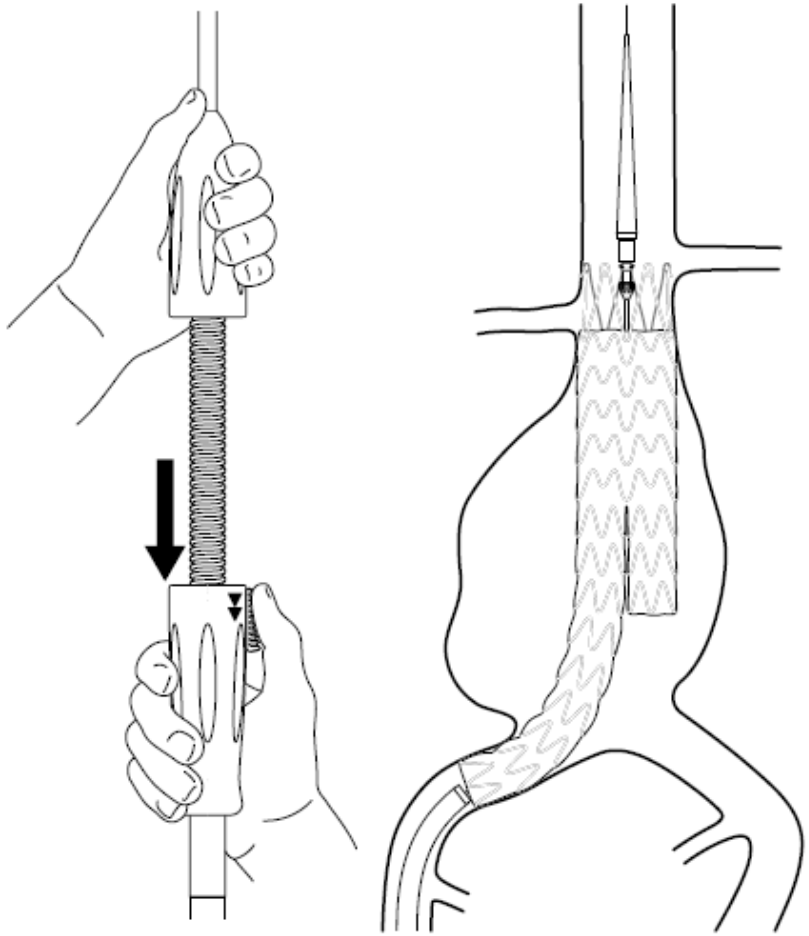
- Rotate dial clockwise at end of graft from one side to the other.
- This releases the sheath constraints on the top part of the graft.

10 – Deploy Stent Top-Cap



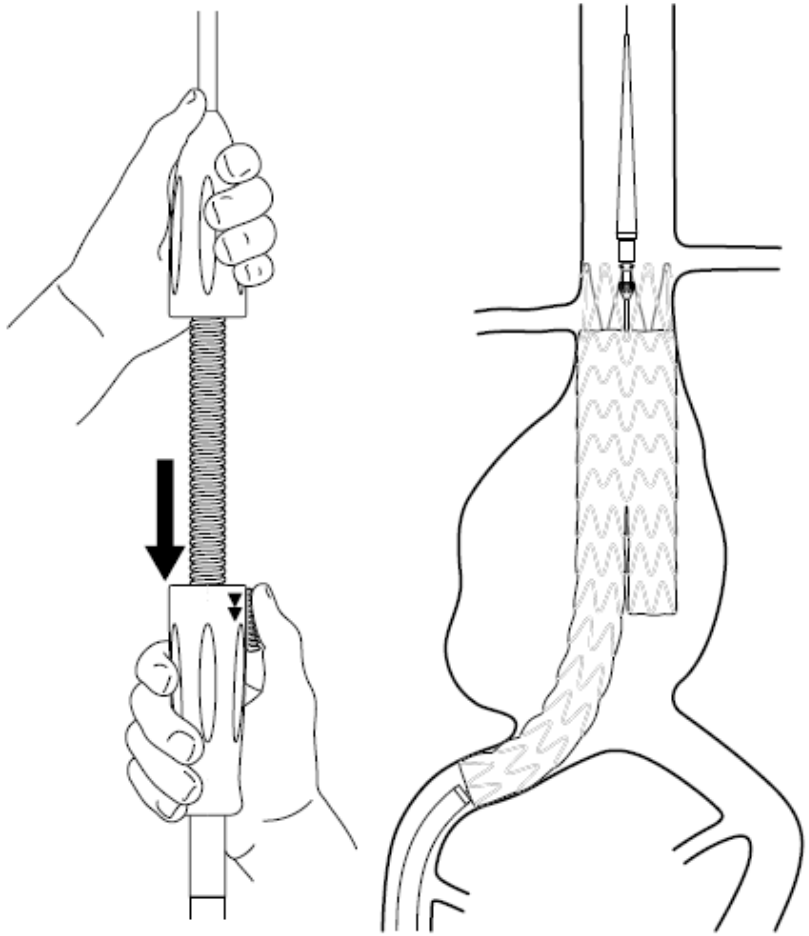
- Rotate dial clockwise at end of graft from one side to the other.
- This releases the sheath constraints on the top part of the graft.
- The graft can no longer be re-positioned.
- Keep the graft deployment sheath stable.

11 – Deploy rest of ipsilateral limb



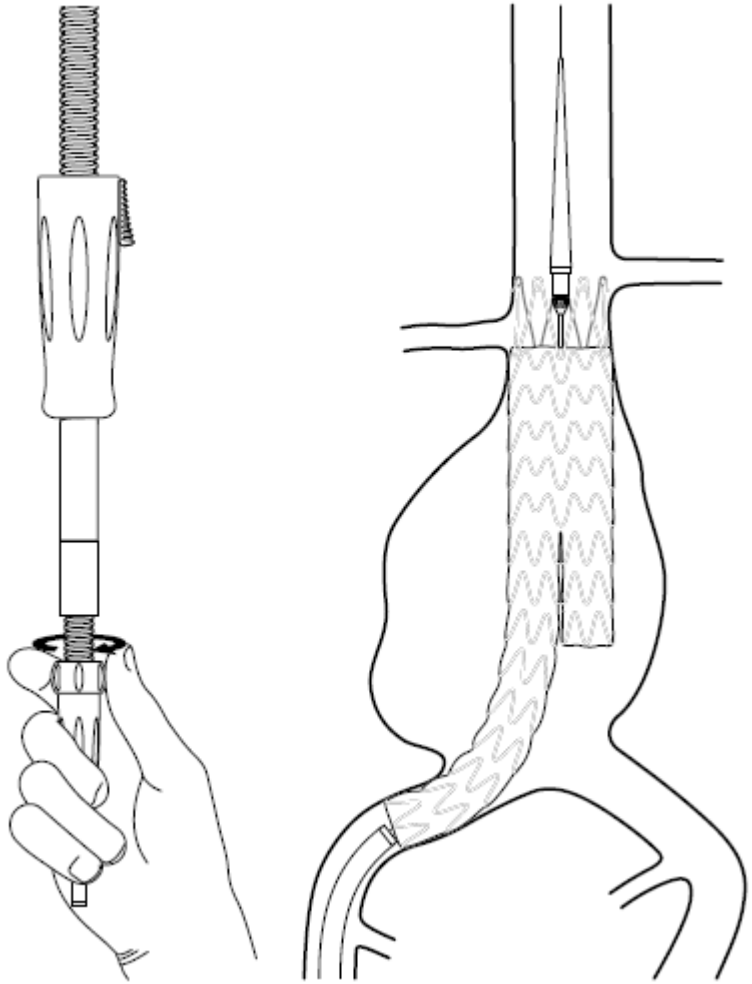
- Continue deployment of the remainder of the main body.
- May be performed with continued counter-clockwise movements as before.

11 – Deploy rest of ipsilateral limb



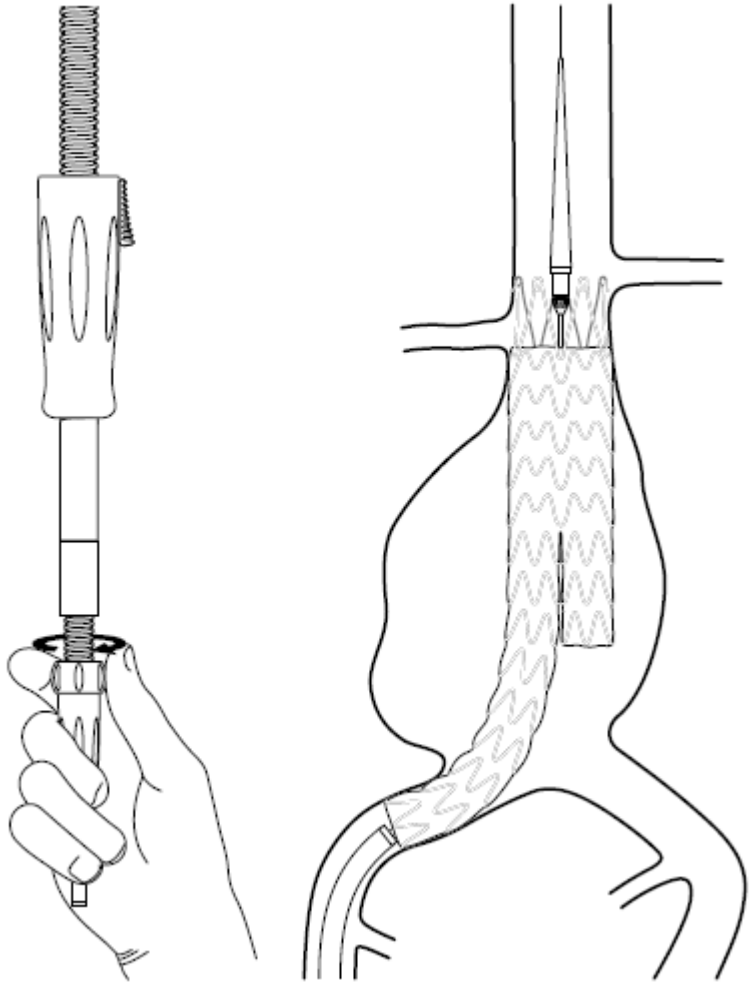
- Continue deployment of the remainder of the main body.
- May be performed with continued counter-clockwise movements as before.
- Continue until stent fully deployed as identified on fluroscopy and usually the deployment dial will have reached the end of the stent shaft.

12 – Re-capture top cap



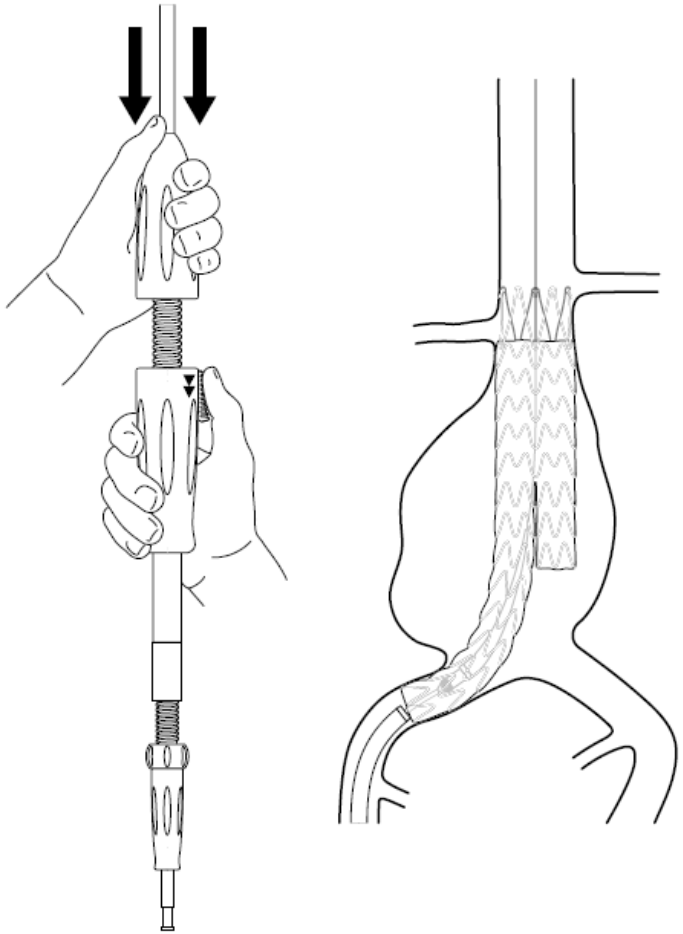
- Critical Portion.

12 – Re-capture top cap



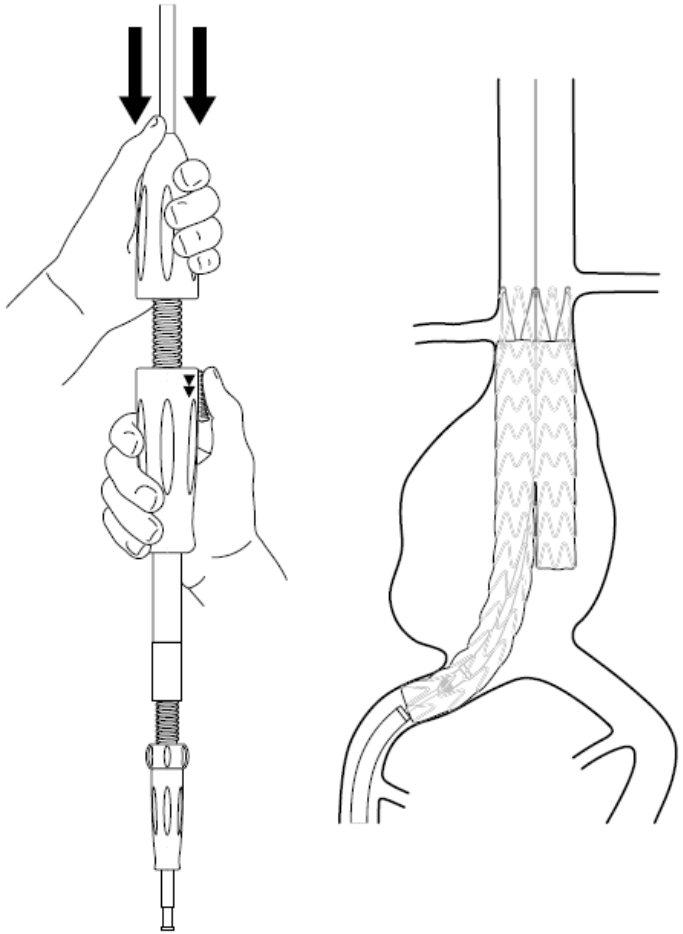
- With both hands on the stent delivery mechanism, insert the stent approximately 5cm under fluroscopy until the top-mechanism is above the uncovered portion of the stent.
- The distal dial is then rotated counter-clockwise until it is placed at the other end to recapture spindle within the sleeve of spindle tip.

13 – Withdraw aortic Endurant delivery system



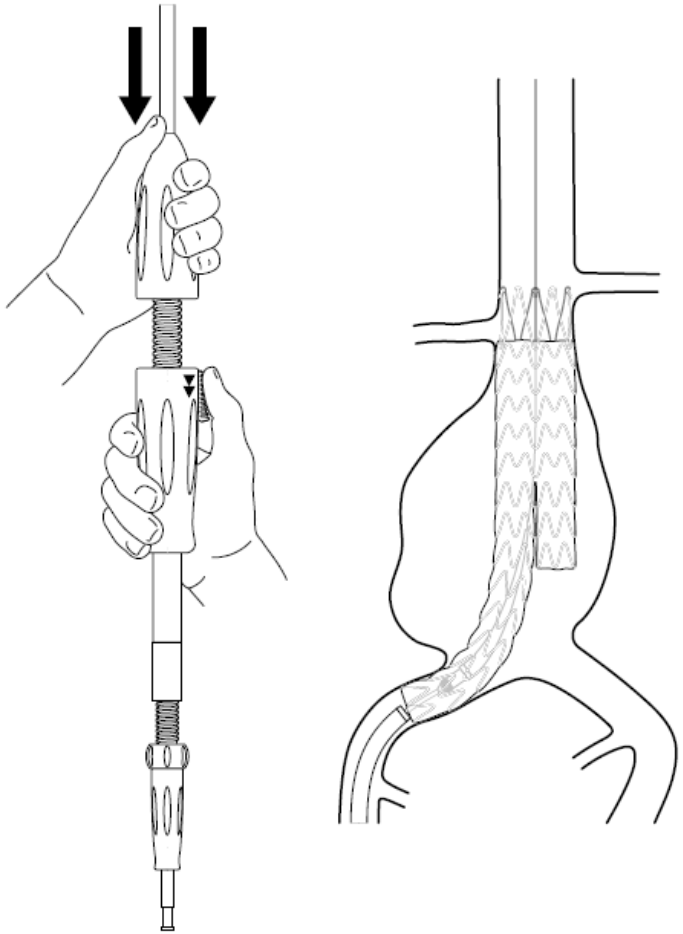
- Critical Portion.

13 – Withdraw aortic Endurant delivery system



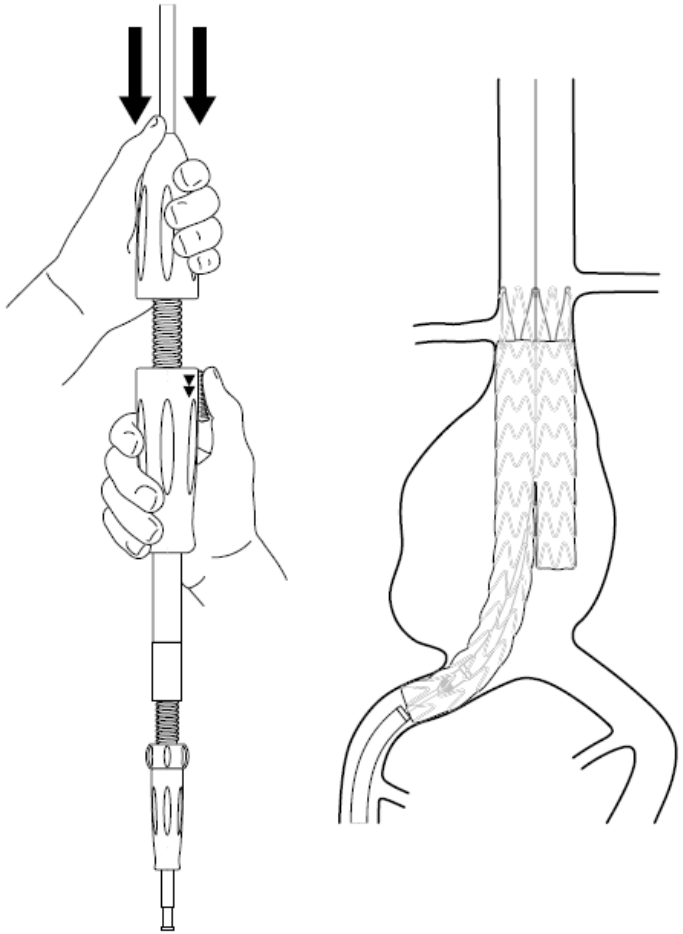
- Absolutely vital to complete slowly under fluoroscopic control.
- Place both hands on stent again.
- Using a gradual side to side rotating process, slowly withdraw the top of the stent past the uncovered metal barbs of the stent and look closely for any movement of the proximal portion of the previously deployed stent.

13 – Withdraw aortic Endurant delivery system



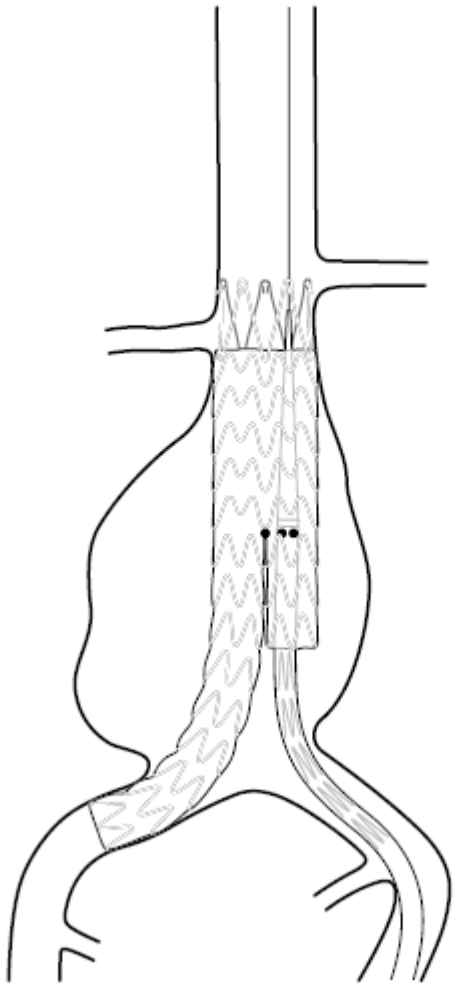
- Absolutely vital to complete slowly under fluoroscopic control.
- Then click on distal end-dial on blue slider to release mechanism.
- Keep right-hand fixed at this point.
- Then withdraw grey portion with left-hand to meet the right-hand.
- Rotate mechanism to lock in place.

13 – Withdraw aortic Endurant delivery system



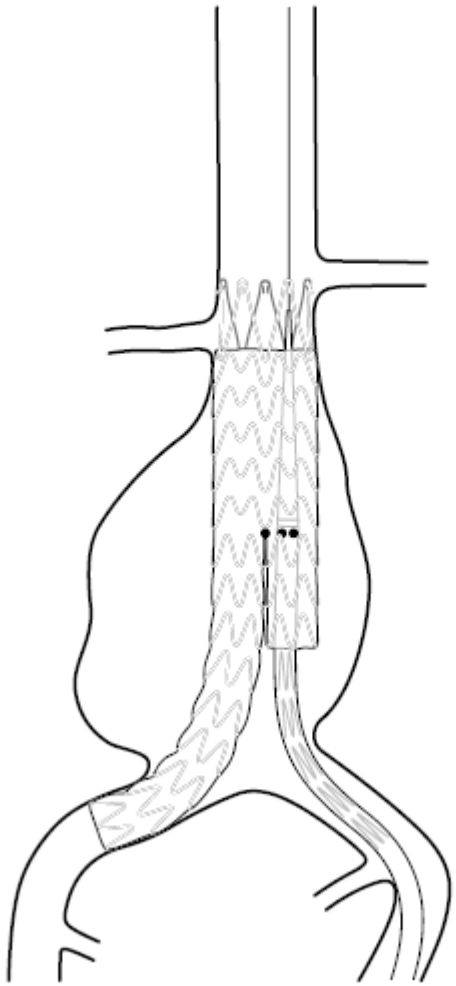
- Absolutely vital to complete slowly under fluoroscopic control.
- Then click on distal end-dial on blue slider to release mechanism.
- Keep right-hand fixed at this point.
- Then withdraw grey portion with left-hand to meet the right-hand.
- Rotate mechanism to lock in place.
- Exchange spent stent sheath for 16Fr Sheath.

14 – Plan contralateral insertion



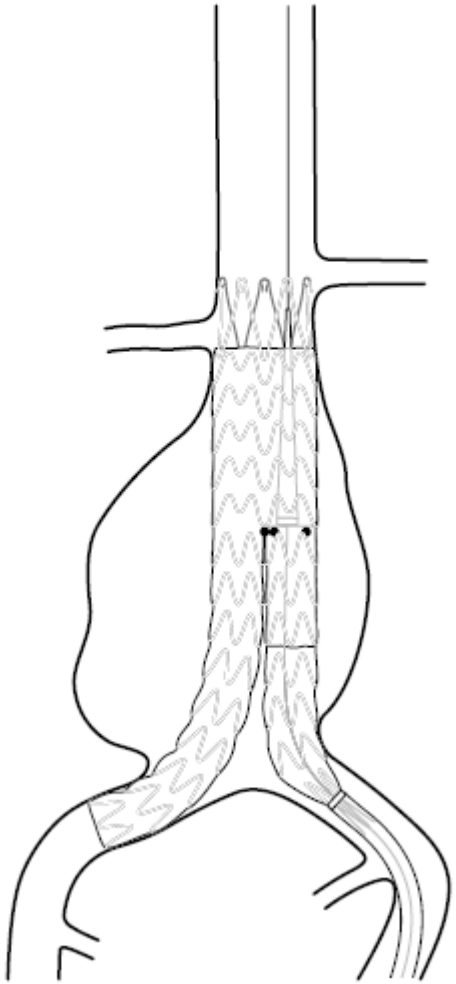
- Place measuring Pig-Tail at level of the proximal marker at the origin of the gate.
- Perform an angiogram via the 7Fr sheath and mark the iliac bifurcation.
- Confirm contralateral stent length and distal landing point.

15 – Insert the contralateral limb



- Exchange out the 7Fr sheath.
- Pinch the artery for haemostasis.
- Wipe the wire with wet swab.
- Activate the hydrophilic coating on stent sheath.
- Place the Endurant stent graft over the Lunderquist wire.
- Insert stent carefully under constant fluoroscopic imaging to match the proximal markers.

16 – Deploy the contralateral limb



- Pick whether you wish to focus on the proximal markers or the iliac bifurcation.
- Deploy the stent using the rotation or sliding mechanisms similar to before.
- Once stent fully deployed, re-capture deployment mechanism by holding blue slider stable with right hand and sliding grey proximal introducer outwards and lock in place.
- Exchange spent stent sheath for 14Fr sheath.

17 – Balloon Moulding (if required)

- Place Coda or Reliant Balloon over the maintained Lunderquist wire.
- Fill 20ml syringe with half and half.
- Inflate under fluoroscopy until balloon walls parallel.
- Balloon stent junctions and distal landing zone.
- Be careful not to inflate balloon too far distally and risk rupturing uncovered native vessel.

18 – Completion Angiogram

- Place Pig-Tail catheter at renal level.
- Remove Lunderquist wire.
- Completion angiogram performed with simultaneous aspiration of blood via distal sheaths to simulate flowing blood.

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- Remove Lunderquist wire.
- Completion angiogram performed with simultaneous aspiration of blood via distal sheaths to simulate flowing blood.
- Evaluate flow through renals, graft and run off vessels.
- Evaluate present of Type 1 – 3 endoleaks.

Vessel Closure

- Keep hold of sheaths !!!!

Vessel Closure

- Curved clamp to distal run-off vessels – SFA / PFA.

- Have angled clamp to the proximal CFA;
  - Primary surgeon grasps sloop gently with one hand and has clamp in other hand.
  - Assistant holding the sheath gradually withdraws sheath slowly.
  - Allow a short gush of blood and then apply clamp.

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- Once haemostasis secure, release distal clamp to ensure back-bleeding and re-apply.
- Close with 5/0 prolene.
- Routine wound closure thereafter.

Post-EVAR procedural care

- Ward transfer.
- Clinical and neurovascular observations.
- Restart medications.
- Restoration of normal diet.
- Mobilise.
- Home day 1-2.

EVAR Follow-Up Imaging Protocols

- Previous recommendations regarding post-endovascular repair (post-EVAR) surveillance included CT imaging at 1, 6, and 12 months postoperatively and yearly thereafter to evaluate for late graft complications (i.e., migration, occlusion, and endoleak).

EVAR Follow-Up Imaging Protocols

- However, more recent concerns regarding the frequent use of CT scanning, cost, and cumulative radiation exposure/potential lifetime cancer risk have resulted in a shift towards colour duplex ultrasound imaging for surveillance.

- Current recommendations include contrast-enhanced CT imaging at 1 and 12 months during the first year following EVAR.

- If neither endoleak nor AAA enlargement is documented during first year after EVAR, colour duplex ultrasonography is suggested as an alternative to CT imaging for annual postoperative surveillance.

EVAR Follow-Up Imaging

- Suggestion of addition non-contrast CT imaging every 5 years in absence of concern.

- Antibiotic prophylaxis of graft infection is required prior to bronchoscopy, gastrointestinal or genitourinary endoscopy, and any dental procedure that may lead to bleeding.

Questions ?