



**Australian Society of Medical Imaging and Radiation Therapy**

The national professional organisation representing medical radiation practitioners

ABN 26 924 779 836



# MIAP1

Nov 2018

MEDICAL IMAGING ADVISORY PANEL 1

## Course Syllabus

*Cardiac & Vascular Interventional Imaging (Angiography)*

**Vascular Interventional Stream**

# Section A: Angiographic Equipment

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## TOPICS:

### **General**

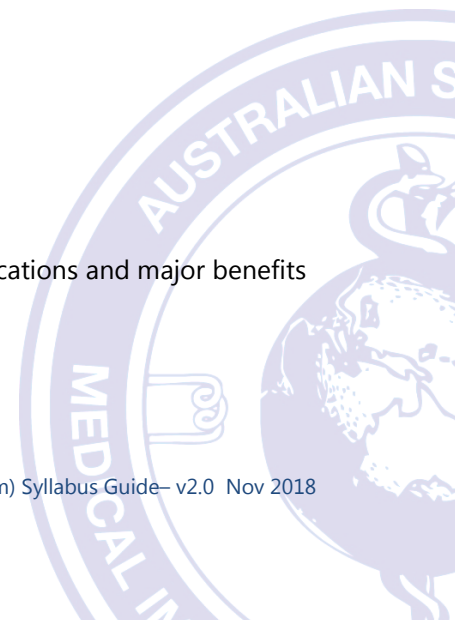
- Understand the French sizing system

### **Sheaths**

- Understand vascular sheaths
  - General design and purpose
  - Use of long Sheaths
  - Purpose of Break-Away (peel apart) sheaths

### **Catheters**

- Understand the terms
  - Pushability
  - Crossability
  - Torque
  - Steerability
- Compare and contrast the shape, characteristics and use of the following flush catheters
  - Pigtail
  - Contra/VCF/ Omni Flush
- Understand the general shape of the following catheters
  - Hinck
  - Cobra
  - Rim
  - Simmonds 1&2
- Understand the common uses of the following catheters (principle anatomical engagements)
  - Cobra
  - Rim
  - Simmonds 1&2
  - Headhunter
- Understand the design and primary uses of Glide Catheters
- Understand the following characteristics of Guide Catheters
  - Sizing
  - Indications for use
  - How they differ from a standard diagnostic catheter
- Understand the general definition of a micro-catheter and describe its applications and major benefits



## **Guide Wires**

- J-Wires vs. straight wires
  - Indications for use
  - Advantages and disadvantages
- Understand the design and general use of Glide Wires
- Compare and contrast the following wire-based delivery systems
  - 0.035 vs 0.018 vs 0.014
  - Understand the primary uses (and limits) of each system
- Know the primary uses, general length, and disadvantages associated with the use of Exchange Wires
  - Standard exchange
  - Stiff exchange
    - Amplatz
    - Lunderquist

## **Balloons**

- Understand the term balloon compliance
  - Compare the uses of Compliant and Non-Compliant Balloons
- Understand the following angiography balloon terms
  - Rated Burst Pressure
  - Nominal Pressure
  - Difference between circumferential and longitudinal balloon rupture
- Understand the type and use of Occlusion Balloons
  - In the following regions: Neuro, Gastric and Aortic
  - Understand the principle uses of the CODA balloon
- Specialist balloons
  - Cutting balloons - Describe the design and indications of cutting balloon use
  - Drug Eluting Balloons – describe their uses and the drugs routinely applied

## **Stents**

- Compare and contrast Self Expanding and Balloon Expandable Stents
  - Delivery mechanisms
  - Advantages vs. disadvantages (including radial strength characteristics)
- Understand the design and general uses of Covered Stents
- Understand Flow Diverters
  - Indications
  - Design characteristics and how they work

## **Embolics**

- Understand the design, use and function of embolising coils
  - Coil sizing
  - 3D (framing) vs. tornado vs. spiral
  - Fibred
- Detachable vs. pushable coils



- List indications for both
- Understand the characteristics and use of Amplatzer devices
  - Cardiac vs. vascular interventional applications
- Understand the characteristics and use of the following liquid embolics
  - Onyx
  - Histoacryl
  - Lipiodol
- Understand particulate embolics
  - Principle use
  - Common angiographic applications
- Understand Gelfoam
  - Composition
  - Angiographic applications

### ***Thrombectomy***

- Understand chemical thrombectomy
  - Angiographic applications
  - Thrombolytic drugs used
  - Catheters employed
  - Relationship to mechanical thrombectomy
- Understand mechanical thrombectomy
  - Angiographic applications
  - Understand the currently available devices and how they operate
    - Rotational atherectomy catheters
    - Trerotola device
    - Solitaire device
    - Angiojet (rheolytic) system



# Section B: Angiographic Anatomy, Pathophysiology & Pharmacology

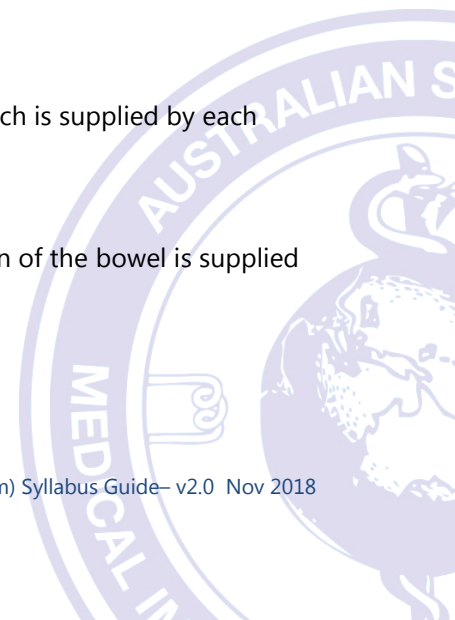
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## TOPICS:

- Identify the macroscopic and microscopic structure of arteries and veins
- Understand the principles of Virchow's triad
- List pathological processes that may result in arterial narrowing
  - Intrinsic vs. extrinsic
    - Acute
    - Chronic
- List pathological processes that may result in venous narrowing
  - Intrinsic vs. extrinsic
    - Acute
    - Chronic
- List pathological process that result in vascular occlusion
  - Acute
  - Chronic
- Understand the pathological process behind aneurysm development
  - Fusiform vs. saccular vs. mycotic
  - True vs. false (pseudo) aneurysm
- Understand and compare the following terms
  - Arterio-venous malformation
    - Nidus
  - Arterio-venous fistula
    - Pathological
    - Surgically created
  - Angiogenesis
- Define hepatic-portal venous pressure gradient and its clinical significance in portal hypertension
  - Understand clinically relevant pressure gradient values

## **Arterial Anatomy - Principles**

- Describe the composition of the femoral triangle
- List the arterial supply to the stomach indicating which portion of the stomach is supplied by each vessel
- List arterial supply to duodenum and pancreas
  - Pancreatic head supply vs. pancreatic tail supply
- List arterial supply to the lower gastrointestinal tract indicating which portion of the bowel is supplied by each vessel
- List the vertebral levels of the following
  - Coeliac trunk
  - Superior mesenteric artery (SMA)



- Right and left renal artery
- Inferior mesenteric artery (IMA)
- Aortic bifurcation
- Iliac venous confluence
- List structures passing through each diaphragmatic hiatus
  - Include vertebral level for each one
- Describe the arterial supply to the brain
- List all major intracranial arterial vessels
  - Cerebral branches
  - Cerebellar branches
- List the arteries of the aortic arch (the great vessels), from proximal to distal
  - Brachiocephalic/Subclavian artery and subsidiary branches
  - Carotid arteries and its subsidiaries

## **Bloodwork**

### **Clotting Factors**

- Understand the clinical relevance of a low haemoglobin level, and its primary causes
- Understand an International Normalised Ratio (INR) test and when it should be performed
- Discuss the functions of platelets during vessel haemostasis
  - Understand the implications of a low platelet count
- Understand an Activated Clotting time (ACT) test and when it should be performed

### **Renal Function**

- Understand the clinical importance of Glomerular Filtration Rate (GFR) tests in angiography, and know the levels for safe operation
- Understand Creatinine: What it is, how it is produced, and how to manage high levels prior to angiography
- Understand Urea: What it is, how it is excreted, and the clinical relevance of low levels

## **Drugs**

- Lignocaine
  - Drug class
  - Common dosing
  - Effect of combining with Epinephrine
- Fentanyl
  - Drug class
  - Primary Uses
  - Common dosing
- Midazolam
  - Drug class
  - Primary Uses
  - Common dosing
- Heparin
  - Drug class



- Primary angiographic uses
  - Common dosing
- GTN
  - Discuss the primary angiographic use
  - Mechanism of action
- Papaverine
  - Drug class
  - Primary functions
  - Angiographic applications
- Verapamil and Nimodopine
  - Drug class
  - Mechanism of action
  - Angiographic applications
- Urokinase
  - Drug class
  - Angiographic applications



## Section C: Angiographic Physics

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### **Radiation Biology & Safety**

- Understand what contributes to patient dose in fluoroscopic procedures
  - Types of photons (transmitted, scattered and absorbed)
  - Common methods for reducing these doses
- Understand what contributes to operator dose in fluoroscopic procedures
  - Areas of highest scatter dose
  - Types of photons (transmitted, scattered and absorbed)
  - Common methods for reducing these doses
- Discuss the importance and uses of Diagnostic Reference Levels (DRL's) in angiography
  - Understand how DRL values are arrived at
- Compare and contrast acute and chronic radiation injury
  - Define each type
  - Common forms these injuries may take
  - Trigger levels

### **Radiation Dose Metrics**

- Describe the location and purpose of the Interventional Reference Point (IRP)
  - Understand the implications of changing table height on the resultant radiation dose measurements
- Understand Dose Area Product (DAP)
  - What it is
  - Where it is measured
  - Clinical relevance
- Discuss Air Kerma (AK)
  - What is it
  - Clinical relevance, and how it differs from the Surface Entrance Dose
  - Understand how to determine the maximum skin dose (single region) where multiple projections have been used

### **Radiation Protection**

- Know the Australian Standards for
  - Heavy lead gowns
  - Annual absorbed dose limits

### **Imaging Physics**

- Understand the effects of a changing field of view (FOV) on patient dose
  - Collimation vs. magnification
- List image magnification changes with changes to the following
  - Source-to-image distance





- Source-to-object distance
  - Object-to-image distance
- Know the common focal spot sizes in use in angiography, and understand
  - The effect on image resolution
  - The effect on heat loading
- Understand the effects of changing matrix size on image resolution
- Understand what the Detective Quantum Efficiency (DQE) says about an angiography system. What is its relevance?
- Vessel calibration methods
  - Understand the limitations to each method (foreshortening, magnification, errors induced when calibrating from small distances)
    - Measuring catheters
    - Catheter/sheath width calibration
    - Automatic (magnification factor) calibration
    - Ruler calibration (top of table, or on top of patient)

### ***Bi-Plane Angiography***

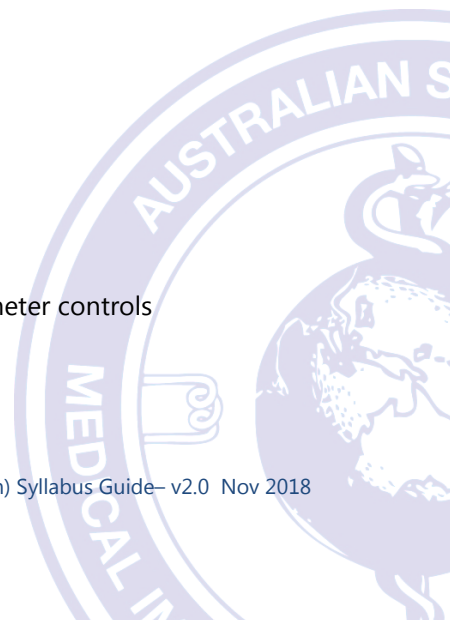
- List advantages of bi-planar angiographic systems
- List disadvantages of bi-planar angiographic systems
- List angiographic procedures from which bi-planar imaging provides significant benefits

### ***Digital Subtraction Techniques***

- List indications for x-ray (acquisition) delays vs. Injection delays
- List approximate acquisition rates for the following common protocols
  - Arch/Thoracic aorta
  - Abdominal aorta
  - Common femoral artery
  - Below knee imaging (tibial arteries)
- Compare and contrast Image/mask averaging and Maximum Opacification techniques
  - Indications for use
  - Effect on signal-to-noise ratio (SNR)
- Compare and contrast Image Overlay and Roadmap techniques
  - Discuss when they should and should not be used

### ***Contrast Injection Principles***

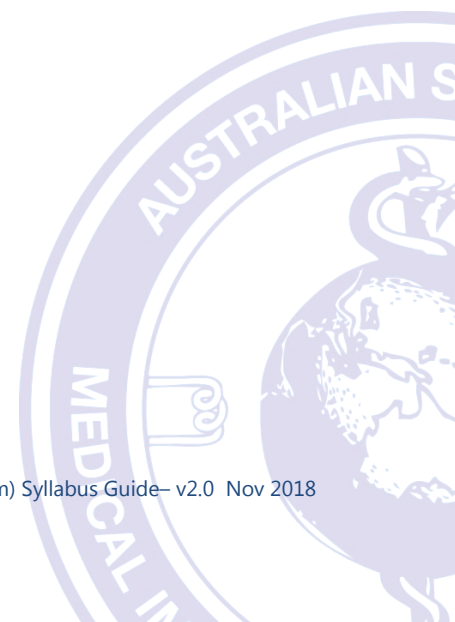
- Understand Poiseuille's law
  - Factors affecting the pressure of injection
  - Maximising injection flow rates
- Understand the use of angiographic powered injectors and what each parameter controls
  - Injection rate
  - Injection volume
  - Injection delay



- X-ray delay
- Rate rise
- Pressure limit

### ***Rotational Angiography***

- List the advantages and disadvantages of rotational angiography
- Understand the technique differences between 3D rotational angiography (3DRA) and 3D digital subtraction angiography (3DDSA)
  - Acquisition parameters
  - Injection dilution
  - Injection volume
- Describe the difference between the following (3DRA/3D DSA) standard image reconstruction modes
  - Volume rendered (VR)
  - Maximum intensity projections (MIP)



# Section D: Fundamental vascular angiographic and interventional procedures

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## **General Principles**

- Understand why patients must remain still during procedures and the methods used to achieve this
- Understand why monitoring a patient's blood pressure, oxygen saturation, heart rate and respiratory rate during a procedure is important
- Understand the risks of pressure injury and for the patient and ways to prevent this

## **Sterile Technique**

- Understand basic principles of sterile technique *as they relate to the procedure, staff, and patient*
  - The use of sterile gowns/gloves/drapes
  - How to dispense sterile equipment/fluids into the sterile field
  - Cleaning preparation of the access site
  - Use of personal protective equipment in the procedure room
- Understand basic principles of sterile technique *as they relate to the x-ray equipment*
  - Avoiding contamination of the sterile field

## **Vascular Access**

- List all steps (in order) of the modified Seldinger technique
  - Indicate equipment required at each stage
- Compare and contrast brachial artery vs. common femoral arterial access
  - Indications
  - Contraindications
- List standard and alternative endovascular approaches to venography

## **Procedure Risks & Complications**

- List potential complications related to arterial access
- List contraindications to performing angiographic procedures
- List major and minor complications related to the injection of iodinated contrast media
- List potential procedural complications

## **Fluoroscopic Intervention**

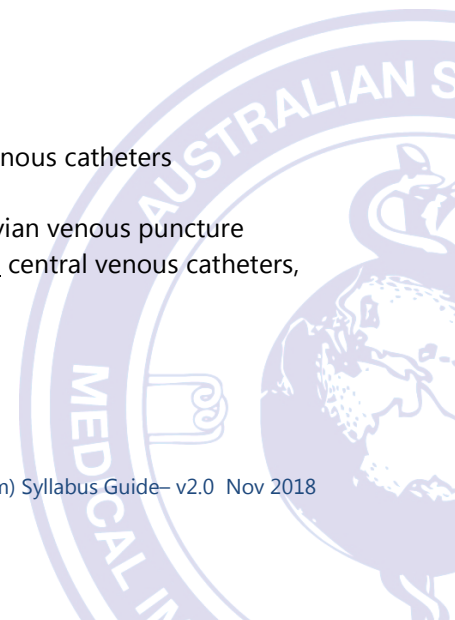
- Understand nephrostomy tube insertion
  - Indications
  - Procedure requirements
    - Patient positioning



- Equipment required
- Understand ureteric stent insertion (performed in radiology)
  - Indications
  - Procedure requirements
    - Patient positioning
    - Equipment required
- Understand percutaneous trans-hepatic cholangiography (PTC/PTHC)
  - Indications
    - Internal/external biliary drainage
    - Biliary stenting
    - Rendezvous procedure
  - Procedure requirements
    - Patient positioning
    - Equipment required
- Understand endoscopic retrograde cholangio-pancreatography (ERCP)
  - Indications
  - Procedure requirements
    - Patient positioning
    - Equipment required
    - Imaging requirements
- ERCP – Intervention
  - Describe biliary sphincterotomy
  - Indications for plastic vs. metal stents
  - Methods for stone extraction
- Understand radiologically inserted gastrostomy tubes (RIG)
  - Indications
  - Procedure requirements
    - Imaging requirements
    - Equipment required

### ***Venous Interventional Procedures***

- Understand peripherally inserted central catheters (PICC)
  - Indications
  - Procedure
    - Equipment required
    - Imaging requirements
    - Ideal catheter tip placement
- Understand the differences between tunnelled and non-tunnelled central venous catheters
  - Clinical situations in which they are employed
  - List the advantages and disadvantages of internal jugular vs. subclavian venous puncture
- Understand the indications and differences between the following tunnelled central venous catheters, defining ideal tip position
  - Permcath, Hickmans, Portacath



## ***Thoracic Angiography***

- For arch arteriography list
  - Indications
  - Standard projection
  - Catheter used
- List indications for performing the following selective thoracic angiographic procedures
  - Bronchial arteriography
  - Spinal arteriography
  - Intercostal arteriography
- List indications for performing pulmonary angiography
  - Acute vs. Chronic conditions

## ***Abdominal Angiography***

- Understand infra-renal endovascular aortic repair (EVAR) procedures
  - Indications
  - Equipment
    - Describe the composition of stents used in EVAR procedures
    - Wires used
    - Catheters used
- Understand the categorisation of endoleaks
  - List all 5 types of endoleak
  - List treatment options for type 2 endoleak
- In the treatment of hepatic tumours
  - Differentiate between Trans-arterial chemo-embolisation (TACE) and selective internal radiation therapy (SIRT) procedures
    - List indications
  - TACE infusion/embolisation rationale
- Understand the application of endovascular techniques in the embolisation of visceral bleeding, listing the choice of embolic in each case
  - Renal
  - Hepatic
  - Splenic
    - Rationale of distal vs. proximal splenic embolisation
  - Lower gastrointestinal
- Understand uterine artery embolization (UAE) procedures
  - Indications
  - Embolics employed
- Understand procedures for infra-renal inferior vena cava (IVC) filter insertion
  - Indications
  - Vascular approach
  - Target zone for IVC filter placement
  - Maximum IVC widths for insertion
- Understand procedures for infra-renal inferior vena cava (IVC) retrieval
  - Indications



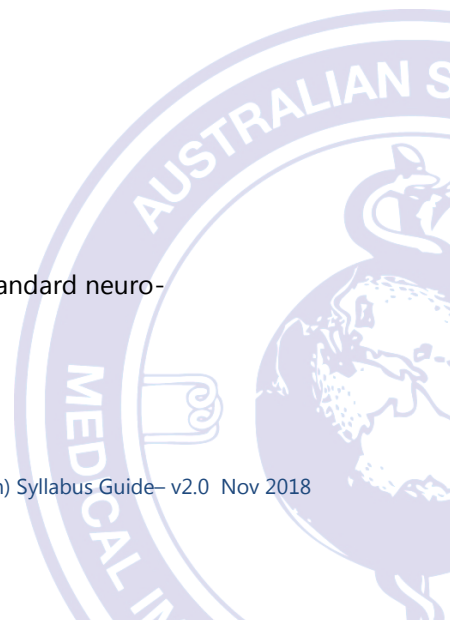
- Retrieval methods
  - Vascular approach
  - Snare vs cone retrieval
- Pre retrieval venography rationale
- Understand gonadal vein embolisation procedures
  - Indications
  - Venous anatomy
  - Embolics employed

### **Peripheral Angiography**

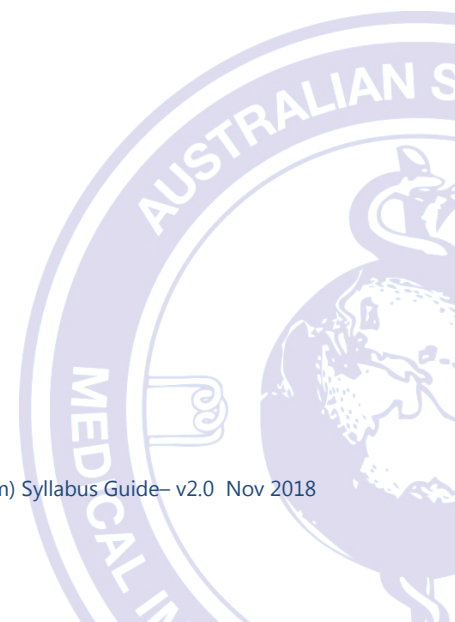
- List indications for performing diagnostic lower limb angiography
- Define ankle-brachial index (ABI)
- For peripheral angiography understand clinical scenarios for utilisation of a retrograde approach
  - Advantages and disadvantages
  - Describe the up-and-over technique
- For peripheral angiography understand clinical scenarios for utilisation of an antegrade approach
  - Advantages and disadvantages
- List common projections required to image the following
  - Common iliac bifurcation
  - Common femoral bifurcation
- Understand the application of CO<sub>2</sub> in peripheral angiographic imaging
  - Indications and contraindications
  - Angiographic technique variations when imaging with CO<sub>2</sub> vs. iodinated contrast
    - Table tilt
    - Post processing techniques

### **Cerebral Angiography**

- List indications for performing diagnostic cerebral angiography
- For intracranial imaging list advantages/disadvantages of catheter angiography compared to computed tomographic angiography (CTA)
- Understand baseline neurovascular projections, indicating the alignment of bony landmarks and area of interest
  - Intracranial internal carotid artery (ICA)
    - Posterior-Anterior (PA)
    - Lateral
    - Trans-orbital oblique
  - Intracranial vertebral artery
    - Posterior-Anterior (PA)
    - Lateral
- Understand the intracranial vascular anatomy best demonstrated for each standard neuro-angiographic projection (as listed above)
  - Arterial
    - Anterior, middle and posterior cerebral vessels
    - Basilar artery



- Ophthalmic artery
  - Venous
    - Intracranial sinuses
- Understand endovascular treatment options for wide necked vs. narrow necked aneurysms
  - Definition of wide vs. narrow necked aneurysms
  - Treatment options
    - Coiling
    - Balloon/Stent assisted coiling
    - Flow diversion
- Understand the treatment options for embolic stroke
  - Intravenous therapy
  - Endovascular treatment
    - Mechanical and suction thrombectomy systems
- Understand the endovascular treatment options for cerebral vasospasm
  - Equipment required
  - Drugs employed
  - Indications for angioplasty
- List indications for the following neuro-vascular procedures
  - (Inferior) petrosal sinus sampling
  - Balloon occlusion testing
  - Maxillary artery embolisation



## Section E: Angiographic/Fluoroscopic Image Labelling

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### **List and/or Label the Following Anatomical Structures:**

#### **Head & Neck**

- Extracranial arterial supply
  - Common carotid bifurcation
  - Internal carotid
  - External carotid
  - Vertebral
- Intracranial arterial supply
  - Anterior cerebral artery
  - Middle cerebral artery
  - Posterior cerebral artery
  - Superior cerebellar artery
  - Anterior-inferior cerebellar artery
  - Posterior-inferior cerebellar artery
- Intracranial venous drainage
  - Superior sagittal sinus
  - Inferior sagittal sinus
  - Transverse sinus
  - Sigmoid sinus
  - Internal cerebral veins
  - Great vein of Galen
  - Cavernous sinus
  - Inferior petrosal sinuses

#### **Thoracic**

- Aortic arch and great vessels
- Thoracic aortic branches
  - Bronchial
  - Intercostal
- Central venous
  - Superior vena cava
  - Inferior vena cava
  - Right atrium
  - Main pulmonary trunk

#### **Abdominal**

- Coeliac arterial branches
  - Common hepatic artery
    - Hepatic proper
    - Gastroduodenal artery
    - Superior pancreato-duodenal artery





- Right gastroepiploic artery
    - Right gastric artery
  - Splenic artery
    - Dorsal pancreatic/Pancreata magna
  - Left Gastric
- Superior and Inferior mesenteric arteriography
  - Right colic
  - Middle colic
  - Left colic
  - Sigmoid
  - Superior Rectal
- Abdominal wall arterial supply
  - Parietal arteries
    - Inferior phrenic
    - Lumbar
    - Median sacral
- Pelvic Arteriography
  - Common iliac
  - Internal iliac branches
    - Anterior trunk
      - Ilio-lumbar
      - Gluteal branches
    - Posterior trunk
      - Obturator
      - Vesicle
      - Uterine
      - Internal pudendal
  - External Iliac
    - Deep iliac circumflex
    - Inferior epigastric
- Central venous
  - Inferior vena cava
  - Renal vein
  - Hepatic vein
- Portal venous
  - Superior mesenteric vein
  - Splenic vein
  - Inferior mesenteric vein
- Cholangiography
  - Hepatic ducts
  - Cystic duct
  - Common bile duct
  - Pancreatic duct



## Peripheral

- Upper arm arteriography
  - Subclavian artery and branches
    - Vertebral artery
    - Thyrocervical trunk
    - Costocervical trunk
    - Internal thoracic (mammary) artery
  - Axillary artery
  - Brachial artery
  - Radial, ulnar and interosseous arteries
  - Deep and superficial palmar arches
  - Proximal brachial artery
  
- Lower limb arteriography
  - Common femoral arterial bifurcation
  - Superficial and Deep (profunda) femoral
  - Popliteal
  - Genicular arteries
  - Anterior and Posterior tibial arteries
  - Peroneal artery
  - Median and lateral plantar arch
  - Dorsalis pedis

