Course Syllabus

*Cardiac & Vascular Interventional Imaging (Angiography)*

*Vascular Interventional Stream*
Section A: Angiographic Equipment

**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
  o Cardiac vs. vascular interventional applications
• Understand the characteristics and use of the following liquid embolics
  o Onyx
  o Histoacryl
  o Lipiodol
• Understand particulate embolics
  o Principle use
  o Common angiographic applications
• Understand Gelfoam
  o Composition
  o Angiographic applications

**Thrombectomy**

• Understand chemical thrombectomy
  o Angiographic applications
  o Thrombolytic drugs used
  o Catheters employed
  o Relationship to mechanical thrombectomy
• Understand mechanical thrombectomy
  o Angiographic applications
  o Understand the currently available devices and how they operate
    ▪ Rotational atherectomy catheters
    ▪ Tretratola device
    ▪ Solitaire device
    ▪ Angiojet (rheolytic) system
Section B: Angiographic Anatomy, Pathophysiology & Pharmacology

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 processes 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)
o Right and left renal artery
o Inferior mesenteric artery (IMA)
o Aortic bifurcation
o Iliac venous confluence
• List structures passing through each diaphragmatic hiatus
  o Include vertebral level for each one
• Describe the arterial supply to the brain
• List all major intracranial arterial vessels
  o Cerebral branches
  o Cerebellar branches
• List the arteries of the aortic arch (the great vessels), from proximal to distal
  o Brachiocephalic/Subclavian artery and subsidiary branches
  o 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
  o 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
  o Drug class
  o Common dosing
  o Effect of combining with Epinephrine
• Fentanyl
  o Drug class
  o Primary Uses
  o Common dosing
• Midazolam
  o Drug class
  o Primary Uses
  o Common dosing
• Heparin
  o Drug class
Primary angiographic uses
- 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

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 it is
  - 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
o Source-to-object distance
o Object-to-image distance

• Know the common focal spot sizes in use in angiography, and understand
  o The effect on image resolution
  o 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
  o 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
  o Arch/Thoracic aorta
  o Abdominal aorta
  o Common femoral artery
  o Below knee imaging (tibial arteries)
• Compare and contrast Image/mask averaging and Maximum Opacification techniques
  o Indications for use
  o Effect on signal-to-noise ratio (SNR)
• Compare and contrast Image Overlay and Roadmap techniques
  o Discuss when they should and should not be used

**Contrast Injection Principles**

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

**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 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

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**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
o Retrieval methods
  ▪ Vascular approach
  ▪ Snare vs cone retrieval
  o Pre retrieval venography rationale

- Understand gonadal vein embolisation procedures
  o Indications
  o Venous anatomy
  o 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
  o Advantages and disadvantages
  o Describe the up-and-over technique
- For peripheral angiography understand clinical scenarios for utilisation of an antegrade approach
  o Advantages and disadvantages
- List common projections required to image the following
  o Common iliac bifurcation
  o Common femoral bifurcation
- Understand the application of CO2 in peripheral angiographic imaging
  o Indications and contraindications
  o Angiographic technique variations when imaging with CO2 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
  o Intracranial internal carotid artery (ICA)
    ▪ Posterior-Anterior (PA)
    ▪ Lateral
    ▪ Trans-orbital oblique
  o Intracranial vertebral artery
    ▪ Posterior-Anterior (PA)
    ▪ Lateral
- Understand the intracranial vascular anatomy best demonstrated for each standard neuroangiographic projection (as listed above)
  o Arterial
    ▪ Anterior, middle and posterior cerebral vessels
    ▪ Basilar artery
• Ophthalmic artery
  o Venous
    ▪ Intracranial sinuses
• Understand endovascular treatment options for wide necked vs. narrow necked aneurysms
  o Definition of wide vs. narrow necked aneurysms
  o Treatment options
    ▪ Coiling
    ▪ Balloon/Stent assisted coiling
    ▪ Flow diversion
• Understand the treatment options for embolic stroke
  o Intravenous therapy
  o Endovascular treatment
    ▪ Mechanical and suction thrombectomy systems
• Understand the endovascular treatment options for cerebral vasospasm
  o Equipment required
  o Drugs employed
  o Indications for angioplasty
• List indications for the following neuro-vascular procedures
  o (Inferior) petrosal sinus sampling
  o Balloon occlusion testing
  o Maxillary artery embolisation
Section E: Angiographic/Fluoroscopic Image Labelling

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
  o Subclavian artery and branches
    ▪ Vertebral artery
    ▪ Thyrocervical trunk
    ▪ Costocervical trunk
    ▪ Internal thoracic (mammary) artery
  o Axillary artery
  o Brachial artery
  o Radial, ulnar and interosseous arteries
  o Deep and superficial palmar arches
  o Proximal brachial artery

- Lower limb arteriography
  o Common femoral arterial bifurcation
  o Superficial and Deep (profunda) femoral
  o Popliteal
  o Genicular arteries
  o Anterior and Posterior tibial arteries
  o Peroneal artery
  o Median and lateral plantar arch
  o Dorsalis pedis