

Cardiovascular and Interventional Radiological Society of Europe

# A European Interventional Radiology Syllabus

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**A European IR Syllabus 2008**

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## Foreword

Interventional radiologists have spent the last decade developing the specialty. Understandably there has been little time to think about training in anything other than the simplest terms. However the specialty has grown up and is now such an integral part of medical practice that patient groups have a right to expect well trained interventionists. In addition European regulations place training at the forefront of good medical practice. Such thinking has been the trigger to produce this IR training document. As pioneers of all these new treatment modalities we also have an obligation to set standards about how the next generation of interventionalists is going to be trained.

New medical subspecialty curriculum thinking, which stipulates 3 years common trunk + 2 years subspecialisation, provides the opportunity to specialize in interventional radiology. CIRSE has played an important role in setting standards for the general and subspecialisation curriculum. In the coming years this will be implemented in most European countries.

This European Interventional Syllabus is a comprehensive overview about what training in IR should be. It provides a framework for the 2 years of subspecialty training but goes further to provide a curriculum for dedicated fellowship IR training. Thus most of the advanced training, as described in this syllabus, is for those who want to dedicate a substantial part of their working life to IR. This syllabus is a guideline and support to develop local IR fellowships.

For all those wishing to train in minimally invasive image guided procedures, not trained in radiology, this syllabus should also set a standard for the quality of their training. Image interpretation and radiation protection are the foundation on which good practice in IR is built.

This syllabus can be used for training in organ specific interventions as part of a larger non IR curriculum.

It is the intention of CIRSE to drive European IR training and to establish a European training certificate in IR, based on this document.

This document is complementary to the Clinical Practice in Interventional Radiology Manual released in 2007.

Finally this document could not have been produced without the great effort of a couple of enthusiastic individuals. I especially want to thank Tony Nicholson who produced the core of this document, Nacio Bilbao and David Kessel without whom this document would not have been realized.

Jim Reekers  
*CIRSE President*

## Introduction: Training in Interventional Radiology

This syllabus draws on the ethos of the CanMEDS[1] project and the Union Européenne des Médecins Spécialistes (UEMS) principles of Good Medical Practice[2-5]. Emphasis is placed on identifying and developing the key skills required by a trained interventional radiologist. It is intended to incorporate the features of a "curriculum" as defined by the UEMS and the Post Graduate Medical Education Training Board (PMETB) in the UK [6,7].

Entry into specialist training in interventional radiology will be from a recognised clinical radiology training scheme but may be from another specialty with transfer of credits for relevant competence. It is recommended that training will be provided in centres throughout Europe who are recognized as specialty training centres in Interventional Radiology by national medical and/or clinical governance bodies. The major role that specialist societies both national and international have to play in training is recognised by this document and their further educational provision encouraged. Core material for the syllabus should be available electronically and from training institution libraries and should be supplemented by tutorials and lectures where appropriate. Technique and experience should be provided by significant catheter laboratory and theatre exposure as well as through patient contact in clinical settings. Training techniques will be subject to national guidelines but modular training is encouraged, some modules being mandatory and others optional depending on the trainee's particular interest. The duration of Basic Specialty Training will be no more than 5 years using initially the 3+2 model with an option for further specialist training in the 6th year. In years 1-3 it is expected that trainees will have developed competence provided from a core curriculum which forms the basis of specialized IR training (See Page 18).

Trainees should acquire experience and competence in a staged manner reflecting the individual trainees' requirements.

Competence and performance will be assessed and will be based on a trainees knowledge, understanding and practical skills as the trainee progresses through the program. Regular appraisal and assessment should identify individual needs and provide timely feedback. Appropriate tools will be used for each element in a similar fashion to that described in the CanMEDS project [1], by UEMS [5] and by PMETB in the UK [6-8]. This will be based on formal examination and work based assessment. This will be familiar to most trainees who have come through national training programmes in Europe and will utilise tools such as case based discussion (CBD), direct observation of practice and procedures (DOPS), Objective Structured Clinical Examination (OSCE) and Peer Assessment Tools (PAT, 360 degree appraisal). Experience and Performance will be evaluated from the trainees' logbook and trainers' evaluations. If successful, the end of training will be marked by award of European Diploma in Interventional Radiology though some might wish to demonstrate a higher degree of knowledge in certain specialist areas and also obtain a European Diploma in Vascular and Endovascular Radiology. This diploma would be supervised and awarded by the Radiology Division of UEMS. It is not anticipated initially that such a diploma would preclude any nationally trained practitioner from practicing interventional radiology.

### References

1. Frank JR, Jabbour M, Tugwell P, et al. Skills for the new millennium: report of the societal needs working group, CanMEDS 2000 Project. *Annals Royal College of Physicians and Surgeons of Canada* 1996;29:206-216.
2. Union Européenne des Médecins Spécialistes. Charter on Quality Assurance in Medical Specialist Practice in the European Union, March 1996
3. Union Européenne des Médecins Spécialistes. Promoting Good Medical Care, 1996
4. Union Européenne des Médecins Spécialistes. Budapest Declaration on Ensuring The Quality of Medical Care, 1996
5. Union Européenne des Médecins Spécialistes. UEMS Policy Statement on Assessments during Specialist Postgraduate Medical Training, 2006
6. PMETB What is Curriculum?
7. PMETB Standards for Curricula
8. PMETB Principles for an assessment system for postgraduate medical training

# 1 The Interventional Radiology Educational Programme

## Purpose

The education programme defines the specific knowledge, skills, and attitudes required for trainees in interventional radiology. This programme is intended to combine with modular training in diagnostic radiology but also accepts the skills and abilities of practitioners from other specialties, allowing crossover into interventional radiology as it is in the best interests of patients to ensure that all practitioners are adequately trained. Following the programme will optimise the abilities of the interventional radiologists at completion of training.

The programme provides the educational experiences necessary to fulfil the Essential Roles and Key Competence of Specialist Physicians as defined in CanMEDS 2000 [1]:

### MEDICAL EXPERT

- Demonstrate diagnostic and therapeutic skills for ethical and effective patient care
- Access and apply relevant information to clinical practice
- Demonstrate effective consultation services with respect to patient care, education and legal opinions

### COMMUNICATOR

- Establish therapeutic relationship with patients/families
- Obtain and synthesize relevant history from patients/families/communities and listen effectively
- Discuss appropriate information with patients/families and the health care team

### COLLABORATOR

- Consult effectively with other physicians and health care professionals
- Contribute effectively to other interdisciplinary team activities

### MANAGER

- Utilize resources effectively to balance patient care, learning needs, and outside activities
- Allocate finite health care resources wisely
- Work effectively and efficiently in a health care organization
- Utilize information technology to optimize patient care, life-long learning and other activities

### HEALTH ADVOCATE

- Identify the important determinants of health affecting patients
- Contribute effectively to improved health of patients and communities
- Recognize and respond to those issues where advocacy is appropriate

## SCHOLAR

- Develop, implement and monitor a personal continuing education strategy
- Critically appraise sources of medical information
- Facilitate learning of patients, house staff/students and other health professionals
- Contribute to development of new knowledge

## PROFESSIONAL

- Deliver highest quality care with integrity, honesty and compassion
- Exhibit appropriate personal and interpersonal professional behaviours
- Practise medicine ethically consistent with obligations of a physician

*\*Frank JR, Jabbour M, Tugwell P, et al. Skills for the new millenium: report of the societal needs working group, CanMEDS 2000 Project. Annals Royal College of Physicians and Surgeons of Canada 1996; 29:206-216.*

## The Content of the Syllabus and the Educational Programme

The content of the Syllabus and the Educational Programme emphasises the need for trainees to acquire knowledge, awareness and skills in 5 key areas.

### PATIENT CARE

Ability to provide care that is patient centred, compassionate, appropriate, and effective for the treatment of health problems and the promotion of health.

### CLINICAL KNOWLEDGE AND SKILLS

- The trainee will gain an understanding of the various disease processes they will encounter in terms of:
  - Epidemiology
  - Patho-physiology
  - Presentation and clinical manifestations
  - Investigations
  - Management strategies: Treatment alternatives and expected outcomes / prognosis

### TECHNICAL SKILLS

- The trainee will develop the necessary practical skills to perform key interventional procedures independently. Additional skills will be acquired to a variable degree. This will lead to certification to perform a range of procedures

### CLINICAL GOVERNANCE

- Practice-based Learning and Improvement that involves investigation and evaluation of their own patient care, appraisal and assimilation of scientific evidence, and improvements in patient care
- Professionalism, as manifested through a commitment to carrying out clinical governance appraisal and revalidation, professional responsibilities, adherence to ethical principles, and sensitivity to a diverse patient population

### SYSTEMS-BASED PRACTICE

- As manifested by actions that demonstrate an awareness of and responsiveness to the larger context and system of health care and the ability to work in multidisciplinary teams and to effectively utilise system resources to provide care that is of optimal value to individual patients
- This includes **interpersonal and communication skills** that result in appropriate clinical linkages, effective information exchange within the interventional radiology team and with patients, their families, and other health professionals

## 1.3 Acquisition of Experience and Clinical Competence

Trainees are expected to obtain competence in interventional radiology to the level expected of a consultant interventional radiologist. Throughout the programme trainees will be required to record their procedural activity in a logbook which will serve as a record of their "experience". The logbook will incorporate trainers' comments regarding the trainee's "competence". The logbook will allow scope for reflection regarding each case i.e. what the trainee has learned relating to any aspect of that particular procedure. This could include patient selection, consent, techniques, and complications. The trainee cannot receive accreditation if they fail either to complete the logbook or to achieve appropriate levels of experience / competence.

Experience is expected to be gained in a progressive manner. For instance a trainee hoping to pursue a career in Vascular Interventional Radiology might progress through their radiology training based on 3+2 years combination of general radiology and specialist training. This could easily be adapted in time to 2+3 if felt necessary. It is recognised that trainees will progress at different rates and training will be flexible to accommodate this. The training would be adjusted appropriately for other subspecialties. A sub specialist interventional radiologist would substitute their chosen specialism e.g. interventional urology, orthopaedic, neuro-intervention, GI interventional radiology etc, in year 3 / 4. A more general interventionalist would continue with general intervention for a greater proportion of years 4 and 5. The aim in either case is to produce a highly competent and skilled clinician within their chosen specialty.

## 1.4 General Competence in Interventional Radiology

The curriculum, including the training and assessment / evaluation of competence and knowledge, should be geared towards producing well rounded clinicians whose practice will reflect:

- Understanding of the disease processes relevant to their specialty interest
- Understanding of the respective disease prognoses, with and without treatment
- Understanding of the respective treatment alternatives
- Understanding of the limitations and expected outcomes of interventional procedures
- Ability to responsibly perform interventional radiological procedures
- Ability to recognize and manage complications of interventional procedures
- Ability to consent patients by explaining the above in a clear manner
- Ability to select the appropriate patients for treatment
- Ability to appropriately manage patients under their care
- Ability to work within multidisciplinary teams
- Ability to recognize their limitations and refer cases accordingly

## Assessment of the Trainee and the Programme

1.5

The programme must demonstrate an effective plan for assessing performance and monitoring progress during and after completion of training and for utilising assessment results to improve performance of both the trainee and the training scheme. This plan should include appraisal, assessment and examination.

## Trainee Evaluation

1.6

### USE OF MEASURES TO ASSESS

- Procedural Experience - via detailed log book records
- Procedural Competence - via
  - log book commentary by supervisors
  - direct observation of procedures (DOPS)
  - objective assessment measures
- Knowledge - via reflective log books and examination (MCQs, multiple option matching, case based discussion, objective structured clinical exams (OSCE))
- Practice-based learning and improvement - appraisal and assessment
- Interpersonal and communication skills, professionalism - 360° appraisal and assessment
- Evidence based practice - appraisal and assessment
- Objective assessment measures: these require development and validation for interventional radiology

### MECHANISM FOR PROVIDING REGULAR AND TIMELY PERFORMANCE ASSESSMENT AND FEEDBACK

- Mentoring / tutoring: regular assessment and appraisal

### MONITORING OF PROGRESSION THROUGH EXPECTED CAREER MILESTONES

- Use of results of assessment and appraisal to achieve progressive improvements in experience, competence and performance

## Programme Evaluation

1.7

The programme should monitor its effectiveness by reviewing performance and outcome assessment results. The training scheme should have a process for using performance assessment together with evaluation results to improve the programme.

## 2 General Topics in Interventional Radiology

The appropriate training of interventional radiologists will be defined by a curriculum which will include the following **five elements** which are central to safe and effective interventional radiology practice.

- **Patient care**
- **Recognizing and reducing hazards to patients and staff**
- **The interventional radiology team and its clinical links**
- **Interventional radiology clinical practice**
- **Drugs used in interventional radiology**

At the conclusion of training, the trainee will be familiar with the following aspects:

- **Relevant anatomy.** Understand the complementary roles of the various imaging modalities in the assessment and management of the system
- **Epidemiology,** including expected outcomes
- **Pathophysiology** including
  - Aetiology
  - Risk factors
- **Clinical presentation** - be able to elicit appropriate clinical history, perform physical examination and assess and classify patients
- **Investigation** - select appropriate laboratory and imaging investigations
- **Therapeutic options** - understand the range of treatment strategies including medical, endovascular / interventional and surgical alternatives to a level sufficient to be able to discuss management with patients and formulate appropriate treatment plans

### 2.1 Patient Care

#### OBJECTIVES

Appropriate care is central to patient safety and satisfaction with a procedure. Trainees must learn to assess and manage patients before, during and after the procedure. At the conclusion of training, the trainee will be able to:

#### Select patients for invasive procedures

- Determine which patients will benefit from an invasive diagnostic or therapeutic procedure and advise on the most appropriate course of management through a review of:
  - Available and / or elicited clinical history and examination
  - Pre-procedural non-invasive imaging studies
  - Results of laboratory investigations
  - Proposed and expected outcomes of the procedure
- The trainee is expected to recognize when there is insufficient information to allow adequate evaluation of the patient
- The trainee will demonstrate proper communication with the patient and referring physician(s) regarding procedure appropriateness
- If a procedure is deemed inappropriate, the trainee should establish the correct management pathway in conjunction with the patient and the referring team

**Properly evaluate a patient before an interventional procedure**

- Elicit a relevant history
- Perform a focused physical examination
- Demonstrate understanding of history / physical findings or treatment scenarios that require discussion with / referral to other specialty disciplines

**Identify factors that increase procedural risk and risk for conscious sedation and assign an ASA score from**

- Patient history and physical examination
- The results of appropriate laboratory tests
- A request for any appropriate further support from other clinical teams (e.g. anaesthetics)

**Obtain informed consent after a review of the procedure with the patient to explain:**

- The purpose of the intervention
- The likely outcome of the intervention regarding:
  - Technical success
  - Clinical success
  - Rate of recurrence
- The risks of the intervention
- The benefits of the intervention
- Any follow up studies / procedures required
- The alternative therapeutic options to the intervention

**The trainee will demonstrate:**

- Proper communication with the patient and relevant clinicians regarding potential risks and their implications for management
- Ability to assign the proper medication regimens / precautions before, during or after a procedure for
  - Blood sugar abnormalities
  - High or low blood pressure
  - Infection / antibiotic therapy
  - Renal dysfunction
  - Coagulopathy / anticoagulation
  - Drug / contrast reactions and interactions
  - Conscious sedation
  - Anaesthesia / analgesia
- Ability to recognise and treat any complications or problems occurring before, during and after the procedure including
  - Contrast reaction
  - Excessive sedation
  - Pain and anxiety
  - Nausea / vomiting
  - Arrhythmia
  - Decreased oxygen saturation
  - Sepsis
  - Hypertension / hypotension
  - Abnormal blood sugar
  - Haemorrhage / haematoma

### Ensure appropriate peri-procedural care for the patient including

- Adequate staffing levels: nurse, radiographic, operating department assistant (ODA) etc
- Adequate monitoring: pulse, BP, oxygen saturation etc
- Prompt recognition (by operator or other trained staff) of monitoring abnormalities
- Prompt recognition (by operator or other trained staff) of physical signs and symptoms that need immediate attention
- Implementation of appropriate treatment of any problem

### Ensure appropriate aftercare for the patient

- Record plan of aftercare in the patient record
- Communicate the plan effectively to radiology and ward staff
- Ensure unusual elements of care are expressly relayed to ward teams

### Provide appropriate patient follow-up in the inpatient and outpatient settings

- Review the patient post procedure and ensure appropriate care.
- Manage and advise on issues related to the procedure such as
  - Drain tubes
  - Pain control
  - Post embolization syndrome
  - Haematoma and false aneurysm
- Communicate with the appropriate clinicians, the patient & their relatives
- Arrange appropriate outpatient review and follow up investigation

## 2.2 Recognising and Reducing Occupational Hazards

### OBJECTIVES

At the conclusion of training, the trainee will be able to minimise:

- **Complications of interventional radiology**
- **The risks of ionizing radiation for the patient and IR staff**
- Understand the types of radiation used in interventional radiology
- Understand how radiation exposure is monitored
- Understand methods to decrease and monitor radiation dose to the patient and IR staff
- Understand the rationale for lead protective clothing, lead glasses, shields and gloves
- Recognize the need for maintenance and maintenance schedules for radiation protection devices
- Identify the organs especially sensitive to the effects of ionizing radiation and the maximum yearly organ and whole body dose
- Identify procedures at high risk for radiation skin injuries and how to avoid them

### The risks from pathogens, hazardous drugs and materials

- Identify patients at high risk for blood and body fluid borne pathogens
- Knowledge of the incidence and methods of transmission of common pathogens e.g. viral hepatitis, HIV and MRSA in the IR patient population
- Understand the methods of reducing transmission to attending staff and other patients including
  - protective clothing
  - proper use and disposal of contaminated clothing and sharp instruments
  - Immunological protection
- Understand how to prevent and manage needlestick injury

### Risks of injury during patient transfers

- Describe how to limit/reduce work related musculoskeletal injuries

## The Interventional Radiology Team

2.3

### OBJECTIVES

At the conclusion of training, the trainee will be able to:

#### Recognize and promote a team environment in the practice of interventional radiology including

- Radiographers
- Nurses
- Radiology helpers

#### Help to provide a safe, stimulating working environment in which all IR team members are encouraged to participate

- Support the continuing medical education of IR team members
- Involve team members in research and audit
- Integrate the various members of the IR team in quality assurance programmes

#### Encourage skills development of members of the IR team

- Understand the potential responsibilities and limitations in IR practice of
  - Radiographers
  - Nurses
- Encourage team members to acquire new skills which will improve job satisfaction and career advancement e.g. vascular ultrasound, insertion of central lines

## Interventional Radiology Clinical Practice

2.4

### OBJECTIVES

At the conclusion of training, the trainee will be able to:

#### Understand the importance of the relationship with all sources of referral to the IR service

- To ensure appropriate prioritization and management of all referrals
- To ensure that patients are assessed and advised by an appropriate clinician
- To ensure awareness of the entire skills repertoire of the interventional radiologist

#### Understand the necessity of developing and maintaining an interventional radiology clinic in order to

- Evaluate patients pre-and-post procedure
- Provide information and obtain informed consent in advance of procedures
- Facilitate formal documentation in the patient's case records
- Promote interventional radiology as a clinical practice

**Understand healthcare coding systems**

- To allow proper interaction with the financial aspects of the IR service
- To ensure appropriate contracts for service provision

**Provide care for patients as necessary utilizing the IR clinic**

- To ensure optimal patient care
- To properly assess outcome measures
- To facilitate research and audit

**Recognize the value of becoming a hub for patient referrals**

- To promote effective team working within the hospital
- To ensure prompt referral to the appropriate clinical teams
- To facilitate obtaining relevant clinical advice for patient management

**Communicate effectively with referring physicians**

- To ensure they are informed regarding management of their patients
- To ensure appropriate management and follow up by other clinical teams

**Integrate patient care coordinators to staff a functional IR clinic**

- Nurses & nurse practitioners
- Junior medical staff
- Consultants from other relevant disciplines
- Clerical staff

**Keep adequate medical records for interventional radiology patients and integrate with the hospital information systems**

- To ensure that information is readily available to other clinical care teams
- To facilitate research and audit

**Adhere to institutional and national information privacy and ethical standards with regard to**

- All medical records
- Correspondence
- Use of patient information for research purposes

**Understand the mechanisms and requirement for continually monitoring quality assurance including**

- Regular documentation and classification of complications from IR procedures
- Effective audit
- Contribution to national audits of practice and outcomes in IR

## Pharmacology of Interventional Radiology

2.5

### OBJECTIVES

At the end of training the trainee will understand the indications, contraindications, interactions and side effects of the principal pharmacological agents in common usage in interventional radiology, including but not restricted to:

- Aetiology, prevention and treatment of contrast reactions
- Local anaesthetics
- Analgesics
- Sedatives
- Vasoactive drugs
- Drugs affecting coagulation
- Drugs used in diabetes
- Antibiotics
- Antiemetics
- Management of circulatory collapse
- Management / pharmacology of cardiorespiratory arrest

## Core Syllabus

2.7

For those radiologists who do not intend to specialize in interventional radiology but practice diagnostic radiology with an interest in basic IR skills it is expected that access to parts of the modular training programme will be available. Such trainees should have a thorough knowledge of the performance and interpretation of diagnostic vascular techniques and a basic understanding of common interventional procedures. All trainees should have this core set of skills before embarking on specialist IR training and will have obtained many of the diagnostic skills during their initial 3 years. This core curriculum forms part of the specialized IR curriculum for practitioners who wish IR to be the major aspect of their professional practice.

### NON-INVASIVE VASCULAR IMAGING

#### Doppler Ultrasound

The trainee should demonstrate a thorough understanding and be able to interpret the following:

- Duplex ultrasound, including both arterial and venous examinations
- Normal and abnormal Doppler waveforms
- Common Doppler examinations, such as carotid, hepatic and renal Doppler studies and lower extremity venous duplex examinations

#### CT Angiography

The trainee should have a thorough understanding of:

- The basic physics of single slice helical CT and multi-detector CT
- CTA protocols including contrast materials used and reconstruction techniques
- Radiation doses for CTA and methods to reduce these
- Advantages and disadvantages of CTA versus other techniques

### MR Angiography (MRA)

The trainee should be familiar with:

- MR physics and MRA techniques
- Advantages and disadvantages of different contrast materials used for MRA
- Differences between time of flight, phase contrast, and contrast-enhanced techniques pertaining to MRA
- Advantages and disadvantages of MRA compared to other techniques

## DIAGNOSTIC ANGIOGRAPHY / VENOGRAPHY

### General Principles

The trainee should be familiar with:

- The basic chemistry of the different iodinated contrast materials used, and the advantages / disadvantages of each for angiography
- Mechanisms to minimise nephrotoxicity in high risk patients, such as patients with diabetes or renal impairment
- Treatment of both minor and major allergic reactions to iodinated contrast materials

### Arterial Puncture Technique

The trainee should have a thorough knowledge of:

- Standard groin anatomy, including the position of the inguinal ligament and the femoral nerve, artery and vein
- The Seldinger technique of arterial and venous puncture
- Mechanisms for guidewire, sheath and catheter insertions into the groin
- Mechanisms of puncture site haemostasis including manual compression and common closure devices
- Alternative sites of arterial puncture, such as brachial, axillary and radial

### Diagnostic Angiography

The trainee should be familiar with:

- Guidewires, sheaths and catheters used for common diagnostic angiographic procedures
- Digital subtraction angiographic techniques, bolus chase techniques, road mapping, and pixel shift techniques
- Standard arterial and venous anatomy and variations in anatomy throughout the body
- Peripheral vascular angiography
- Mesenteric and renal angiography
- Abdominal aortography
- Thoracic aortography
- Carotid, vertebral and subclavian angiography
- Diagnosis of atherosclerotic disease, vasculitis, aneurysmal disease, thrombosis, embolism and other vascular pathology
- The complication rates for common diagnostic procedures
- Post-procedural care regimens for standard diagnostic vascular procedures

## VASCULAR INTERVENTION

The trainee should be familiar with common vascular interventional procedures, such as:

### Angioplasty

- Angioplasty balloon dynamics, mechanism of action of angioplasty
- Indications for angioplasty
- Complications and results in different anatomic areas
- Drugs used during angioplasty
- Intra-arterial pressure studies
- Common angioplasty procedures, such as renal, iliac and femoral angioplasties
- Groin closure techniques and post-procedural care

### Arterial / Venous Stenting

- Basic mechanisms for stent deployment and materials used for stent construction
- Indications for stent placement versus angioplasty
- Complications and results
- Post-procedural care

## VENOUS INTERVENTION

### Venous Access

The trainee should be familiar with the various forms of venous access including:

- PICC lines, Hickman catheters, dialysis catheters and ports
- Indications for use of the above venous access catheters
- The technique of venous access in jugular and subclavian veins
- Results and complications

### Venoplasty and Stenting

The trainee should be familiar with:

- Success rates and complications
- Post-procedural care

### Caval Interruption

The trainee should be familiar with:

- Indications for caval filter placement
- Different filter types available, including retrievable filters
- Success rates and complications
- Post-procedural care

## NON-VASCULAR INTERVENTION

Trainees should have performed and have a thorough understanding of basic non-vascular interventional techniques, such as biopsy, abscess drainage, transhepatic cholangiography and nephrostomy techniques.

### Biopsy

The trainee should be familiar with:

- Consent procedures
- Pre-procedure coagulation tests and correction of abnormalities
- Differences in image modalities used for guiding biopsy, including CT and ultrasound
- Needles used for biopsy procedures including fine gauge needles, large gauge needles and trucut biopsy
- Planning a safe access route to the lesion to be biopsied
- Complication rates associated with individual organ biopsy
- Indications for fine needle biopsy versus large gauge or core biopsy
- Post-procedural care for chest and abdominal biopsy
- Algorithms for treatment of common complications, such as pneumothorax and hemorrhage

### Fluid Aspiration and Abscess Drainage

The trainee should be familiar with:

- Commonly used chest tubes and abscess drainage catheters
- Indications for chest drainage, fluid aspiration, and abscess drainage
- Imaging modalities used for guidance
- Interpretation of gram stain results
- Methods of chest tube placement
- Underwater seal drainage systems
- Fibrinolytic agents used in patients with loculated or complex empyemas
- Planning a safe access route for abscess drainage
- Antibiotic regimens used before abscess drainage
- Trocar and Seldinger techniques for catheter placement
- Situations where more than one catheter or larger catheters are required
- Various approaches to pelvic abscess drainage
- Post-procedural care including catheter care, ward rounds and when to remove catheters

### Hepatobiliary Intervention

The trainees should have knowledge of, and be able to perform basic hepatobiliary intervention, such as, transhepatic cholangiography and basic percutaneous biliary drainage (PBD).

The trainee should be familiar with:

- Pre-procedure workup, including antibiotic regimens, coagulation screening and intravenous fluid replacement
- Performance of transhepatic cholangiography
- One-stick needle systems for biliary drainage
- Catheters and stents used for biliary decompression
- Complications of biliary procedures
- Aftercare, including knowledge of complications, catheter care, and ward rounds

### Genitourinary Intervention:

The trainee should be familiar with:

- Indications for percutaneous nephrostomy
- Integration of ultrasound, CT and urographic studies to plan an appropriate nephrostomy
- Pre-procedural work-up including coagulation screens and antibiotic regimens
- Ultrasound / fluoroscopic guidance mechanism for percutaneous nephrostomy
- Catheters used for percutaneous nephrostomy
- Placement of percutaneous nephrostomy tubes
- Complications of percutaneous nephrostomy
- Aftercare, including catheter care and removal

### TECHNICAL, COMMUNICATION AND DECISION MAKING SKILLS

The goals of basic training in interventional radiology are as follows:

- The trainee should be able to interpret non-invasive imaging studies to determine that the requested procedure is appropriate and demonstrate ability to perform basic diagnostic and interventional procedures
- To determine the appropriateness of patient selection for a requested interventional procedure through a review of available history, imaging, laboratory values, and proposed or expected outcomes of the procedure
- To demonstrate an understanding of the history or physical findings that would require pre-procedure assistance from other specialty disciplines, such as Cardiology, Anaesthesia, Surgery or Internal Medicine
- To obtain informed consent after discussion of the procedure with the patient, including a discussion of risks, benefits, and alternative therapeutic options
- To be familiar with monitoring equipment used during interventional procedures and be able to recognise abnormalities and physical signs or symptoms that need immediate attention during the procedure
- To demonstrate an understanding of and be able to identify risk factors from the patient's history, physical or laboratory examinations that indicate potential risk for bleeding, nephrotoxicity, cardiovascular problems, breathing abnormalities, or adverse drug interactions during or after the procedure
- Knowledge of agents used for conscious sedation and analgesia during interventional procedures, with ability to identify risk factors that may indicate potential risks for conscious sedation
- Knowledge of radiation safety in the interventional radiology suite
- Knowledge of methods used to reduce accidental exposure to blood and body fluids in the interventional radiology suite

## 3 Specific Topics in Interventional Radiology

### 3.1 Vascular Diagnosis & Intervention

Vascular interventional radiologists encounter a wide range of conditions affecting almost every organ system and affecting both arteries and veins.

Trainees must appreciate and be familiar with

- **The role of the different imaging modalities in the assessment of vascular disease**
- **The scope of vascular interventional radiology and other medical and surgical strategies for the management and treatment of arterial and venous disease**

At the conclusion of the training, the trainee will be able to

- Demonstrate learning of topic specific educational objectives described below
- Understand the principles of patient selection and the therapeutic options for the conditions described below
- Understand pre-procedure evaluation peri-procedure and post-procedure management and follow-up for these patients
- Obtain complete and appropriate informed consent for all procedures
- Demonstrate technical competence in the performance of the following index vascular interventional procedures
  - Elective and Acute embolization therapy with various embolic agents
  - Elective and Acute Mechanical and Pharmacological Thrombolysis and thrombectomy
- Obtaining vascular access at common sites including use of ultrasound guidance
  - Elective and Acute diagnostic peripheral angiography
  - Elective and Acute diagnostic visceral angiography
  - Elective and Acute iliac and femoral arterial angioplasty
  - Recanalization and stenting of iliac artery occlusion
  - Aortic stent grafting

#### 3.1.1 Arterial Disease

- Peripheral arterial disease: in the lower and upper limbs
- Visceral arterial pathology: including mesenteric, hepatic, splenic, pancreatic, renal, bronchial
- Supra-aortic arterial pathology: including carotid and vertebral
- Aneurysmal disease: including thoracic and abdominal aorta
- Arterial Trauma including: Solid organs, bony trauma, peripheral circulation
- Arterial problems in obstetrics and gynaecology: including Obstetric haemorrhage and Uterine fibroid embolization
- Arterial pathology in Cancer patients: including Vascular invasion, Tumour circulation, Tumour embolization
- Abnormal arteriovenous communications including: Arteriovenous malformations, Arteriovenous fistula
- Syndromes with a major vascular component

## Peripheral Arterial Disease

### 3.1.1.1

#### OBJECTIVES

##### Vascular diagnosis of peripheral arterial disease (PAD)

At the conclusion of training, the trainee will be familiar with the following aspects of PAD affecting the upper and lower limbs:

- **Anatomy** relevant to PAD. Understand the complementary roles of the various imaging modalities in the assessment of PAD
- **Epidemiology** of PAD including expected outcomes in patients with PAD compared to age matched controls
- **Pathophysiology** of PAD including
  - Causes of peripheral ischaemia e.g. atherosclerosis, embolus, arteritis, fibromuscular disease, trauma, entrapment syndromes
  - Rheological factors, eg: viscosity, clotting mechanism, prothrombotic states
  - Recognition of the risk factors for development and progression of PAD
- **Clinical presentation** - be able to elicit appropriate clinical history, perform physical examination and assess and classify patients with acute and chronic peripheral ischaemia
- **Investigation** - select appropriate laboratory and imaging investigations
- **Therapeutic options** - understand the range of treatment strategies including medical, endovascular / interventional and surgical alternatives to a level sufficient to be able to discuss management with patients and formulate appropriate treatment plans

#### ANATOMY AND IMAGING OF PAD

The trainee will have a thorough understanding of arterial anatomy and how best to image it in different clinical scenarios.

##### Anatomy

Describe and recognise the anatomy and important relations of the aorta and its branches, e.g: Lower limb

- Name the major branches of the internal iliac artery
- Outline the normal arterial anatomy below the inguinal ligament
- Understand the anatomy relevant to thoracic outlet syndrome (TOS)
- Understand the anatomy relevant to popliteal entrapment syndrome
- Understand the pelvic anatomy of the internal pudendal artery and its role in angiography for vasculogenic impotence

##### Upper limb

- Understand the arterial anatomy of the aortic arch, neck and shoulder region
- Understand the anatomy of the upper extremity including the brachial, ulnar, radial and interosseous arteries
- Describe the anatomy of the hand including the deep and superficial palmar arches and the common and proper digital vessels
- Describe provocative measures for eliciting subclavian steal on non-invasive studies
- Describe measures for accentuating thoracic compression syndromes
- Describe anatomy relevant to thoracic compression syndromes
- Recognize the value of CT, US and MR as means of evaluating the causative factors in thoracic compression syndromes

**Recognise common or significant normal vascular anatomical variants, eg:**

- Persistent sciatic artery
- Duplication of the SFA
- High bifurcation of the popliteal artery
- Alterations in tibial vessel territories of distribution
- Recognize an aberrant proximal origin of the radial or ulnar artery

**Describe and recognise collateral pathways for patients with arterial occlusive disease:**

- Describe the important branches of the common femoral and profunda femoris artery and their role in collateral pathways of the pelvis, abdomen, and lower extremity
- Similarly describe the collaterals / anastomoses around the shoulder which supply the upper extremity in a case of proximal occlusion, thoracic compression syndromes

**Understand the bony and soft tissue anatomy of arterial puncture sites and recognize their importance in avoiding the complications of arterial puncture for angiography or interventions when accessing**

- The femoral artery
- The brachial artery
- The radial or ulnar artery
- The popliteal artery
- The infra popliteal artery
- The axillary artery
- The aorta

**Evaluate patients after vascular reconstructions or bypass**

- List causes of bypass graft failure
- Understand the role and limitations of ankle-brachial indices in evaluating the patient with a bypass graft
- Describe an imaging strategy for bypass graft surveillance
- List the sonographic features of a failing bypass graft
- Recognize the angiographic findings in anastomotic pseudoaneurysms
- Recognize the angiographic findings in thrombosis of bypass grafts
- Describe angiographic findings associated with graft failure
- Recognize the angiographic features of a clamp injury to an artery or a bypass graft

**Imaging****Understand the mechanisms, complementary roles and limitations of ultrasound, magnetic resonance angiography, computed tomography angiography, catheter angiography and rotational angiography in the investigation of PAD.****Describe strategies for imaging patients with PAD including algorithms for patients with:**

- Acute and chronic ischaemia
- Critical ischaemia and claudication
- Absent femoral pulses
- Contraindications to iodinated intravascular contrast
- Arterial bypass grafts
- Endografts
- Vascular trauma
- Entrapment syndromes including the use of stress and postural manoeuvres

### Understand the risks associated with the different imaging modalities including

- Contrast related
- Exposure to ionizing radiation
- Magnetic resonance imaging - including the effects of and on implanted materials e.g. pacemakers, vascular stents and implants, prosthetic joints
- Physical injury during / as a result of arterial catheterization

### Specific imaging modalities

- Ultrasound
  - Understand the specific role and limitations of colour flow Doppler imaging in the evaluation of lower extremity ischaemia
  - Be familiar with the indications and limitations of ultrasound imaging in selecting management strategies for patients with PAD
  - Be familiar with the indications for ultrasound imaging in surveillance of vascular grafts and the assessment of post angioplasty patients
  - Describe the sonographic findings of the complications of femoral artery puncture; e.g. haematoma, arterial occlusion or dissection, iatrogenic pseudoaneurysm and arteriovenous fistula
  - Understand the role of ultrasound in the image guidance of vascular needle puncture procedures
- MRA
  - Recognize the role of MRA in assessing arterial disease (eg in the lower extremities, including pedal vessels)
  - Understand the compromise that must be made between resolution, acquisition time and scan volume
  - Recognise artifacts associated with MRI / MRA e.g. susceptibility, wrap, & venous contamination and be able to suggest strategies to minimize them
  - Understand the potential for MRA to both overestimate and underestimate stenosis and the reasons for this
  - Understand how to set up for a peripheral arterial scan including positioning of volumes of interest, contrast dose and injection rates and timing
  - Understand the role of open MRA in procedural imaging guidance
- CTA
  - Recognize the value of CTA in assessing arterial obstruction, eg in the lower extremities
  - Understand the methods used to time imaging in relation to contrast bolus injection. Understand how to set up for a peripheral arterial scan including contrast dose and injection rates and timing of image acquisition
  - Understand the method of acquisition of volume data using CT systems, eg multi-detector arrays
  - Recognise artifacts associated with CT e.g. metallic densities, physiological movement and be able to suggest strategies to minimize them
- Catheter angiography
  - List advantages and disadvantages of various forms of angiography of the lower extremity including bolus chase DSA, incremental stations for DSA
  - Describe strategies for optimizing lower extremity angiography when only limited amounts of iodinated contrast may be used, or if CO<sub>2</sub> angiography is to be utilized
  - List strategies for optimizing tibial and foot vessel visualization during angiography including selective angiography and pharmacological vasodilatation
  - Understand the contraindications for catheter angiography including abnormal coagulation, renal dysfunction, contrast reaction, absent pulses
  - Understand how to image those patients in whom catheter angiography is contraindicated
  - Describe the angiographic features of vasospasm in the lower extremities
  - Describe a "standing wave" seen on angiography and discuss its clinical significance
  - Describe the complications of catheter angiography and their management

## Epidemiology & Pathophysiology of PAD

### Epidemiology of PAD

- Understand the incidence, prevalence and gender distribution of PAD
- Recognize the association with coronary artery disease and cerebrovascular disease
- Recognize the prognostic implication of PAD in terms of life expectancy compared to age matched controls and related to aetiology of the disease
- Recognize differences in incidence and prognosis for upper and lower limb vascular disease

### Pathophysiology

#### Atherosclerosis

Understand the pathophysiology, clinical manifestations and management strategies of atherosclerosis involving the aorta and iliac vessels:

- Risk factors for peripheral vascular atherosclerosis
- Natural history of peripheral vascular disease
- Major histological and biochemical features and associations of atheroma
- Gross pathological features including Occlusive disease and Ectatic atherosclerosis (arteriomegaly)
- Describe and categorize intermittent claudication (including Leriche syndrome) according to SVS/ISVS and Fontaine systems
- Categorize chronic critical limb ischaemia according to SVS/ISVS systems
- Describe and categorize acute critical limb ischaemia according to SVS/ISVS systems
- Recognize and understand the clinical management of thrombangitis obliterans (Buerger Disease)

#### Embolus

Understand the sources of emboli the clinical manifestations and management strategies for peripheral arterial emboli.

- Understand the nature, cause and treatment of blue digit syndrome
- Understand how to investigate other sources of embolism including cardiac
- Describe management strategies for peripheral arterial emboli
- Understand factors that influence the management strategy
- Recognise the appearance and causes of livedo reticularis

#### Aortic Dissection

- List causative factors for aortic dissection
- Recognize the angiographic, CT, MR and ultrasound (Transoesophageal) findings of aortic dissection
- Recognize the limitations of contrast angiography in diagnosis of aortic aneurysm or dissection
- Major histological and biochemical features and associations

#### Fibromuscular Dysplasia

- Describe histological and angiographic findings common to the forms of fibromuscular disease that may affect the aorta and its branches
- Associations with other disease entities (eg Von Recklinghausen's disease)
- The nature and rationale of the available therapeutic interventions

### Vasculitis

- Describe the pathophysiological basis and typical findings of vasculitis including Takayasu's arteritis, polyarteritis nodosa and Radiation damage:
- Recognize the angiographic findings in patients with post radiation changes to the pelvic vasculature
- Define Raynaud disease and Raynaud phenomenon
- List disease processes that demonstrate Raynaud phenomenon
- Recognize the angiographic signs and distribution of lesions in collagen vascular diseases including scleroderma, polyarteritis nodosa, rheumatoid arthritis and systemic lupus erythematosus
- Recognize the arteriographic signs of thromboangitis obliterans and its association with smokers

### Trauma

- Recognize the manifestations of blunt or penetrating trauma to the pelvis
- Understand the role of arteriography in the diagnosis and subsequent emergent treatment of these patients with embolization therapy
- List occupations or activities that may contribute to hypothenar hammer syndrome  
Recognize the associated angiographic findings

### Entrapment Syndromes

- Popliteal entrapment syndrome: Recognize the angiographic findings in popliteal entrapment syndrome. Describe the anatomical relationships between the popliteal artery and the gastrocnemius or popliteus muscles in the four types of popliteal entrapment
- Thoracic outlet syndrome (TOS): Recognize the angiographic findings in TOS. Describe the anatomic relationships responsible for TOS
- Describe the natural history and pathophysiological sequelae with / without treatment in these conditions

### Neoplastic Disease

- List imaging and angiographic findings present with malignancies relating to major / significant vascular structures

### Developmental Abnormalities and Vascular Malformations

#### Clinical presentation - history / signs

- Demonstrate skills in history taking and physical examination in relation to arterial vascular disease
- Describe the signs and symptoms of venous and intermittent claudication including the relevance of the distribution of symptoms. Recognise the difference between arterial and spinal "claudication"
- Describe the signs and symptoms of acute and chronic critical limb ischaemia
- Discuss the clinical findings in blue toe syndrome
- Differentiate between venous and arterial ischaemia
- Recognize compartment syndromes
- Recognise the non viable limb which requires primary amputation rather than revascularization
- Describe the presentations of thoracic outlet syndrome
- Describe the presentations of popliteal entrapment syndrome

## Therapeutic options in patients with peripheral vascular disease and extremity ischaemia

### General

- Recognise the complementary roles of Medical, Interventional radiological and Surgical treatment strategies
- Describe strategies for modifying / managing risk factors for cardiovascular disease including
  - Smoking cessation
  - Diabetes
  - Hypertension
  - Hyperlipidaemia
  - Thrombophilia
  - Antiplatelet agents
  - Weight reduction
  - Exercise
- Understand the strategies for management of chronic and acute limb ischaemia
- Understand the endovascular treatment options in chronic ischaemia
- Understand the role of angioplasty and stenting in ulcer and wound healing
- Understand the surgical treatment options in chronic ischaemia including endarterectomy, bypass grafting (anatomic and extra anatomic), amputation
- Understand the endovascular treatment options in acute ischaemia
- Understand the role of endovascular interventions in treatment of Blue Toe Syndrome
- Understand the surgical treatment options in acute ischaemia including thrombectomy, endarterectomy, bypass grafting (anatomic and extra anatomic), fasciotomy and amputation
- Understand the role of combined surgery with interventional radiology
- Understand the treatment options for thoracic outlet syndrome
- Understand the treatment options for popliteal entrapment syndrome
- Define primary patency, assisted primary patency and secondary patency
- Understand the use of life table analysis of outcomes

### Specific to endovascular therapy

- Plan optimal vascular access
- Demonstrate knowledge of proper puncture site management
- Categorize arterial lesions according to the expected outcome of endovascular management e.g.
  - Technical outcome
  - Complications
  - Clinical outcome
  - Restenosis
- List the indications and results for primary and secondary intervention in patients with extremity peripheral vascular disease
- List criteria for technical success of endovascular procedures
- List the complications of endovascular procedures including balloon angioplasty, stenting, stent grafting and thrombolysis according to the clinical setting
- Demonstrate technical competence in the performance of peripheral vascular interventions including
  - Recanalization techniques
  - Balloon angioplasty and stent placement
  - Thrombolysis
- Demonstrate correct selection and use of the equipment needed to perform interventional procedures including:
  - Guidewires
  - Catheters
  - Sheaths
  - Balloons
  - Stents and endografts

- Understand the role of intravascular pressure gradients including the use of vasodilators to assess the outcome of vascular interventions
- Understand pre-procedure, intra-procedure and post-procedure pharmacological management for patients undergoing peripheral vascular interventions including
  - Anticoagulation
  - Thrombolytic agents
  - Antiplatelet agents
  - Vasodilators
- Differentiate between embolic occlusion and in situ thrombosis in cases of acute limb ischemia and tailor therapy accordingly
- Understand the complementary roles of surgical and endovascular thrombolysis / thrombectomy techniques
- List the absolute and relative contraindications to pharmacologic thrombolysis
- Understand the indications, contraindications and limitations of puncture site closure devices
- Recognize the role of emerging treatments for restenosis including
  - Pharmacology
  - Brachytherapy

## Thoracic Aorta and Upper Extremity Arterial Disease

### 3.1.1.2

#### OBJECTIVES

At the conclusion of training, the trainee will be able to:

- Correctly utilize digital subtraction angiography to diagnose the spectrum of disease processes related to the thoracic aorta and upper extremities
- Recommend the proper use of ultrasound and CT or MR angiography for the identification of thoracic and upper extremity vascular pathologic disease processes
- Identify the normal anatomy of the ascending, transverse arch, and descending thoracic aorta including the great vessels to the head and neck and the intercostals or bronchial arterial anatomy
- Understand the basic embryology of the thoracic aorta
- List common anatomical normal variants of the thoracic aorta
- List congenital variants of the thoracic aorta and great vessels and understand how they may present with clinical abnormalities. Recognize chest radiograph findings in these variant anatomies. In particular, recognize the significance of the following:
  - Left aortic arch with aberrant right subclavian artery
  - Right aortic arch with mirror image branching
  - Right aortic arch with aberrant left subclavian artery
  - Cervical aortic arch
  - Coarctation of the aorta
- Describe and demonstrate the ability to utilize alternative means of catheterizing the great vessels in cases where variant anatomy is present
- Provide the definition of a thoracic aortic aneurysm
- Describe the imaging and pathology findings in atherosclerotic, syphilitic, mycotic, post-traumatic and congenital aneurysms
- Understand the clinical presentation of aortic dissection
- Categorize aortic dissection using the Stanford and DeBakey classifications and understand the anatomy of them
- Recognize predisposing factors to aortic dissection such as atherosclerosis, hypertension, collagen vascular disease, and pregnancy
- Understand the limitations of catheterization in the diagnosis of aortic dissection.
- Identify the typical signs of the true and false lumen of a dissection on arteriography, CT and MRI
- Understand how intravascular ultrasound can be an adjunct to identifying the true and false lumen and may impact catheter interventions for the treatment of dissection

- List chest radiography and CT findings in the setting of traumatic disruption of the aorta
- Understand how to perform emergency aortography for suspected traumatic disruption of the thoracic aorta
- Recognize the difference between an aortic pseudoaneurysm and a ductus diverticulum
- List two theoretical mechanisms for traumatic pseudoaneurysm formation of the thoracic aorta in the setting of a motor vehicle accident
- Describe the indications for upper extremity, neck, or thoracic aortic angiography in penetrating or blunt trauma resulting in a "proximity" lesion or wound
- Recognize the findings of arterial trauma with a penetrating or blast injury
- List diseases or agents that may cause aortitis
- Recognize the angiographic findings associated with different forms of aortitis
- Describe angiographic findings and typical distribution of abnormalities in Takayasu's aortitis
- Understand the potential causes of "dysphagia aortica" and "dysphagia lusoria"
- Recognize the angiographic and non-invasive findings in the vascular components of connective tissue disorders (e.g., Marfan syndrome and Ehlers-Danlos syndrome)
- Describe the normal anatomy of the bronchial and intercostal arteries and the common normal variants of these vessels
- Recognize the angiographic appearance of the artery of Adamkiewicz and understand its clinical significance
- Describe the advantages and disadvantages of axillary, brachial or radial artery puncture as alternatives to common femoral artery puncture for arteriographic procedures
- Recognize the clinical signs of angiographically induced complications of the above vessels. Describe imaging findings of puncture site complications with ultrasound and understand how to manage these complications
- Recognize the angiographic findings in various forms of trauma, including blunt trauma, penetrating trauma, and iatrogenic trauma

### 3.1.1.3 Aneurysmal Disease

#### INCLUDING THORACIC AND ABDOMINAL AORTA

At the conclusion of training, in addition to the generic objectives outlined in the PAD section, the trainee will be familiar with specific aspects of disease and of trauma affecting the thoracic and abdominal aorta.

#### OBJECTIVES

##### Anatomy & Imaging

- Describe and recognise the normal anatomy of the ascending aorta, transverse arch, descending thoracic and abdominal aorta
  - Understand the basic embryology of the aorta
  - Outline the normal anatomy of the origins of the great vessels at the aortic arch
  - Outline the normal anatomical origins of the intercostal and the bronchial arteries
  - Describe the normal anatomical origins of the anterior visceral, the lateral visceral and the somatic branches of the abdominal aorta
  - Know the levels of arterial connection between the aorta and the spinal cord
  - Recognize the angiographic appearance of the artery of Adamkiewicz and understand its clinical significance

- Recognise common or significant normal anatomical variation and describe the clinical significance of the following anatomical variants of the aorta and its main branch vessels
  - Left aortic arch with aberrant right subclavian artery
  - Right aortic arch with mirror image branching
  - Right aortic arch with aberrant left subclavian artery
  - Cervical aortic arch
  - Coarctation of the aorta
  - Horse-shoe kidney
- Recognise the chest radiographic findings in congenital variant anatomies of the thoracic aorta

### Epidemiology & Pathophysiology

- Understand the natural history of thoracic and abdominal aortic aneurysms and the implications for treatment
- Recognise the pathological differences between atherosclerotic, syphilitic, mycotic, posttraumatic and congenital aneurysms
- Describe the pathological spectrum encompassing aortic intramural haematoma, aortic ulceration and aortic dissection
- Understand the common factors predisposing to aortic dissection:
  - Atherosclerosis
  - Hypertension
  - Collagen vascular disease
  - Cystic medial necrosis
  - Trauma
  - Pregnancy
- Understand the natural history of aortic dissection including acute and chronic phases, the potential for late aneurysm formation and the implications for treatment
- Describe the mechanisms for traumatic pseudo-aneurysm formation in the thoracic aorta as a result of deceleration injury
- Recognize the difference between an aortic pseudo-aneurysm and a ductus diverticulum

### Clinical Presentation

- Perform a directed history and physical examination in patients with thoracic or abdominal aortic aneurysm. Recognise the symptoms and physical signs associated with:
  - Compression of adjacent structures by large arch or descending aortic aneurysms
  - Distal embolisation of aneurysm thrombus
  - Aorto-caval fistula
  - Aorto-enteric fistula
  - Intra-thoracic rupture of aortic aneurysm
  - Intra-abdominal rupture of aortic aneurysm
- Recognise the symptoms and physical signs associated with aortic dissection, including the following complications:
  - Dissection of the aortic root, aortic valve ring and coronary artery ostia
  - Dissection into the proximal great vessels in the arch
  - Mesenteric and renal arterial dissection
  - Occlusion of the aorto-iliac segments
  - Chronic dissection and aneurysm formation

### Investigations

- Integrate appropriate pre-procedural imaging work-up for aortic aneurysms and dissection, including:
  - Trans-thoracic and trans-abdominal ultrasound
  - Trans-oesophageal echo
  - CT angiography
  - MR angiography
  - Calibrated aortography
  - Intravascular ultrasound
- Define the imaging criteria for the presence of aortic aneurysm and describe the common configurations, including:
  - Ascending aortic, arch and descending aortic aneurysms
  - Thoraco-abdominal aneurysms (types I - IV)
  - Peri-renal and infra-renal aneurysms
  - Aorto-iliac aneurysms
  - Isolated iliac aneurysms
- Define the imaging criteria for the presence of aortic dissection:
  - Distinction from intramural haematoma and penetrating ulcer
  - Identify the typical signs of the true and false lumen of a dissection on catheter aortography, CTA and MRA
  - Identify the typical signs of branch vessel compromise
  - Understand the use of intravascular ultrasound for identifying true and false lumen
  - Understand the limitations of catheter aortography in the diagnosis of aortic dissection
- Categorize aortic dissection using both the Stanford and the DeBakey classifications
- Describe the chest radiographic and CT findings of traumatic thoracic aortic disruption and understand the technique of emergency aortography

### Therapeutic Options

Recognise the full range of treatment options currently available for aortic aneurysms and dissections including conventional open surgical repair, laparoscopically assisted open repair and endovascular repair.

- Classify thoracic and abdominal aortic aneurysms with respect to suitability for endovascular repair and define the anatomical information required in case selection and planning, including:
  - Condition and dimensions of the proximal sealing zone
  - Presence of significant angulation of the proximal neck
  - Centre line distance between the limits of the proximal and distal fixation zones
  - Condition and dimensions of distal sealing zone
  - Condition and dimensions of the access vessels
  - For thoracic lesions: the need for adjunctive carotid-subclavian bypass, carotid-carotid bypass or elephant trunk procedure
  - For peri-renal aneurysms: suitability for fenestrated or branched stent-grafts
  - For aneurysms involving the iliac segments: the need for embolization of the internal iliac ostium or suitability for a branched stent-graft
  - Assessment of the need for occlusion of large branch vessels involved in an aneurysm sac
- Recognize the limitations of endovascular treatment for thoracic and abdominal aortic aneurysms and identify those patients best suited for open surgical repair
- Describe the implications of the classification of aortic dissection for the medical, surgical or endovascular management of such cases:
  - Define the indications for medical treatment as opposed to surgical intervention
  - Define the indications for the use of aortic stent-grafts in acute or chronic aortic dissection

- Define the indications for the use of alternative endovascular interventions such as fenestration and/or bare stent placement in order to restore patency in compromised branch vessels
- Recognize the role of endovascular repair in the treatment of aortic dissection and define the anatomical information required in case selection and planning, including:
  - The site and extent of the primary intimal tear
  - The level of the distal re-entry site
  - Extent of involvement and compromise of significant branch vessels
  - Extent and diameter of any associated aortic aneurysm
  - Condition and dimensions of the proximal and distal sealing zones
- Demonstrate competence in the techniques concerned with the endovascular repair of aortic aneurysms or dissections, including:
  - Pre-procedural or peri-procedural transcatheter occlusion of significant branch vessels
  - Preparation, insertion and deployment of the current aortic stent-graft devices
  - Post-deployment manoeuvres required to safely remove the device introducer and close the access site
- Recognize patients with anatomy unsuitable for conventional access for endovascular repair and suggest alternative methods of endovascular graft placement
- Recognise the significant complications that may arise during endovascular repair and describe the appropriate management:
  - Dissection, occlusion or rupture of the access vessels, the aorta or the aneurysm sac
  - Covering important branch vessels, in particular: the carotid, subclavian, spinal, renal or internal iliac arteries
  - Distal embolisation of the arch vessels or the mesenteric, renal or lower limb vessels
  - Contrast reactions and contrast induced nephropathy (CIN)
  - Cardio-respiratory complications related to prolonged general anaesthesia in patients with poor cardiovascular reserve
- Define the concept of 'endoleak', the imaging criteria by which the 5 sub-types may be classified and the indications for re-intervention
- Describe the potential techniques for the management of endoleaks including:
  - Insertion of a giant Palmaz stent to achieve a proximal seal
  - Insertion of additional proximal or distal cuffs
  - Transcatheter embolisation of branch vessels
  - Percutaneous trans-sac injection of embolic materials
- Understand the requirements for medium and long term surveillance of aortic stentgrafts, including the detection of:
  - Structural failure
  - Device migration
  - Component dislocation within modular devices
  - Graft occlusion
  - Endoleaks
  - Sac expansion with or without endoleak
- Describe the methods available for medium and long term surveillance of aortic stentgrafts including:
  - Plain radiographs
  - Contrast enhanced ultrasound
  - CTA (all stent-grafts)
  - MRA (nitinol stent-grafts)
  - Intra-sac pressure monitoring devices
- Outline the advantages and limitations of endovascular stent grafts for aortic dissections or aneurysms with specific attention to:
  - Morbidity and mortality in comparison to open repair
  - Quality of life issues
  - Financial implications
  - Durability of current devices

### 3.1.1.4 Supra-Aortic Arterial Pathology

#### INCLUDING CAROTID AND VERTEBRAL

At the conclusion of training, the trainee will be able to:

- Identify patients with symptomatic carotid stenosis
- Perform directed history and physical examination in patients with carotid vascular disease
- Understand the indications for percutaneous intervention in patients with carotid vascular disease and the integration of appropriate medical and surgical therapeutic options in this patient population
- Integrate and evaluate pre-intervention noninvasive imaging work-up in patients with carotid vascular disease
- Categorize carotid bifurcation lesions as to their appropriateness for percutaneous therapy
- Understand the role of cerebral protection devices in percutaneous carotid interventions
- Understand the preprocedural, intraprocedural and postprocedural pharmacologic management in patients undergoing percutaneous therapy for carotid vascular disease
- Have familiarity with a wide variety of available angioplasty balloons, stents, guiding catheters, wires and cerebral protection devices for use in carotid interventions
- Demonstrate technical competence performing carotid interventions including but not limited to balloon angioplasty, stent placement and use of cerebral protection devices
- List the types and rates of expected complications of percutaneous carotid interventions
- Manage acute embolic complications during percutaneous carotid interventions with catheter-directed thrombolysis and other techniques
- Understand the role of percutaneous intervention in the great vessels including the subclavian and common carotid arteries
- Recognize the potential role for endovascular treatment of traumatic carotid injuries such as dissection and pseudoaneurysm

Discuss alternatives to contrast angiography for the evaluation of the upper extremity. Understand the role of MRA, CTA, and ultrasound in vascular diagnosis of the upper extremity.

### 3.1.1.5 Abnormal Arteriovenous Communications

#### INCLUDING ARTERIOVENOUS MALFORMATIONS, ARTERIOVENOUS FISTULA, VENOUS MALFORMATIONS

- Classify endothelial malformations according to their clinical presentation and natural history. Understand the difference between endothelial proliferative disorders (haemangioma) and developmental lesions - AVM, VM. Lymphatic malformation
- Understand various classification schemes for vascular malformations
- Evaluate patients with vascular malformations and categorize lesions as either high-flow or low-flow based on history, physical examination and imaging findings
- Order appropriate imaging studies to evaluate the extent and nature of patients presenting with vascular malformations. Understand that invasive vascular studies are rarely required in assessment
- Understand the typical MR appearances of low-flow and high flow malformations
- Understand the need for multidisciplinary management of patients with vascular malformations
- Understand the indications for treating, or not treating vascular malformations
- Recognize the clinical presentation of congenital haemangioma and understand the limited role of intervention in this condition

- Recognize the clinical presentation of lymphatic malformation and understand treatment options
- Recognize the clinical presentation of patients with low-flow vascular malformations and the indications for treatment of these lesions
- Understand the basic principles of treating patients with low-flow vascular malformations and the potential complications of treating these lesions
- Understand the agents that might be used in the treatment of low-flow vascular malformations
- Understand the clinical presentation of patients with high-flow vascular malformations and the indications for treatment of these lesions
- Understand the basic principles and agents used in treatment of high-flow vascular malformations
- List the potential risks and complications of treatment of high-flow vascular malformations
- Understand when patients with vascular malformations should be referred to large centres with concentrated experience in treating these patients
- Knowledge of syndromes in which a malformation is part of the clinical features e.g. Klippel-Trenaunay syndrome, haemorrhagic telangiectasia, Kasabach- Merritt syndrome. Understand the likely imaging findings

## Arterial and Venous Trauma

### 3.1.1.6

#### INCLUDING SOLID ORGANS, BONY TRAUMA, PERIPHERAL CIRCULATION

- Demonstrate a fundamental knowledge of the appropriate triage of patients suffering from blunt or penetrating trauma, with consideration of mechanism of injury and the patient's hemodynamic status
- Integrate laboratory data and hemodynamic parameters with knowledge of the location of injury, type of injury, and anatomic considerations in formulating an appropriate treatment algorithm for patients suffering from potential traumatic vascular injuries
- Identify traumatic vascular injuries on diagnostic arteriography, including active extravasation or hemorrhage, pseudoaneurysm, arterial-venous fistula, arterial transection, traumatic occlusion, intimal flap, and intramural hematoma
- Demonstrate competence in selective catheterization skills, including the use of microcatheters and guidewires
- Demonstrate competence in transcatheter embolization techniques, including the delivery of various embolic materials such as coils, Gelfoam, particulate material (micro-particles), and other agents
- Be familiar with the various angiographic equipment used in diagnostic arteriography, super-selective arteriography, and vascular embolization, with specific understanding of the characteristics of the different embolic materials with regards to their speed and reliability of delivery, duration of occlusive effect, preservation of normal tissue, and level of blockade of the arterial tree
- Recognize the potential role for vascular stents and covered stents in treating traumatic vascular injuries
- With regards to blunt and penetrating injuries to the liver:
  - Understand the roles of exploratory laparotomy and non-operative management in patients with traumatic hepatic injuries. List the indications and contraindications for hepatic artery embolization
  - Demonstrate knowledge of the hepatic vascular anatomy, including the anatomic variants of the celiac, superior mesenteric and hepatic arterial anatomy
  - Identify hepatic injuries on CT and angiography that may potentially be treated by transcatheter intervention, including active extravasation, hepatic artery pseudoaneurysm, arterio-venous fistula, or arterio-biliary fistula
  - Be familiar with the success and complication rates for hepatic artery embolization in patients with penetrating or blunt injuries to the liver. With regards to blunt and penetrating injuries to the spleen

- Understand the roles of exploratory laparotomy, splenectomy, and non-operative management in patients with splenic trauma
- Be familiar with the complications of splenectomy, including the frequency of overwhelming sepsis post-splenectomy
- Identify and stage splenic injuries on CT
- List the indications and contraindications for splenic artery embolization. Demonstrate knowledge of the different strategies for splenic artery embolization
- Identify splenic injuries on CT and angiography that may potentially be treated by transcatheter intervention
- Be familiar with the success and complication rates for splenic artery embolization in patients with splenic injury
- With regards to blunt and penetrating renal injuries:
  - Understand the roles of operative and non-operative management of traumatic renal injuries
  - Identify traumatic renal injuries on CT and angiography, including urinoma, arterial extravasation, renal artery pseudoaneurysm, arterial-venous fistula, and traumatic arterial dissection
  - List the indications and contraindications for renal artery embolization in patients with renal trauma
  - Be familiar with the success and complication rates for renal artery embolization in patients with renal trauma
- With regards to blunt and penetrating injuries to the pelvis:
  - Understand the limitations of surgical exploration in patients with pelvic hemorrhage
  - Understand the role of diagnostic arteriography and arterial embolization in hemodynamically stable and unstable patients
  - Be familiar with appropriate timing of pelvic arteriography with other interventions such as exploratory laparotomy or external fixation of pelvic fractures in patients with multiple traumatic injuries
  - Demonstrate knowledge of pelvic arterial anatomy, including an understanding of commonly injured vessels that are associated with specific patterns of pelvic fracture
  - Be familiar with different embolization strategies for pelvic hemorrhage, including both selective and non-selective (empiric) iliac artery embolization
  - Recognize the incidence of potential complications of pelvic embolization, such as ischemia, infarction, infection, non-targeted embolization, impotence, and claudication
- With regard to blunt and penetrating injuries to the extremities:
  - Demonstrate competence in identifying various clinical findings of extremity arterial injury, such as pulse deficit, limb ischemia, bruit, or expanding hematoma
  - Understand the role of Doppler evaluation in patients with suspected arterial injury of the extremities
  - Identify traumatic arterial injury on angiography, with a specific understanding of which vessels are expendable and potential candidates for transcatheter embolization
  - Demonstrate knowledge of potential collateral pathways, and identify the role of embolization proximal and distal to the level of arterial injury
- With regard to blunt and penetrating injuries to the face and neck:
  - Demonstrate knowledge of the zonal classification of penetrating injuries to the neck, including which proximity injuries warrant angiographic evaluation
  - List the indications and contraindications for transcatheter embolization of vascular injuries involving the face and neck. Identify the potential collateral pathways between the intracranial and extracranial circulation that may determine a patient's candidacy for embolization

## Visceral Arterial Pathology

### 3.1.1.7

#### OBJECTIVES

##### Vascular Diagnosis of Visceral Arterial Pathology

At the conclusion of training, the trainee will be familiar with the following aspects of visceral arterial pathology affecting mesenteric, hepatic, splenic, pancreatic, renal, bronchial arterial supplies:

- **Anatomy** relevant to visceral arterial pathology. Understand the complementary roles of the various imaging modalities in the assessment of visceral arterial disease
- **Epidemiology** of visceral arterial pathology
- **Pathophysiology** of visceral arterial pathology including.
  - Causes e.g. atherosclerosis, arteritis, fibromuscular disease, trauma, entrapment syndromes
- **Clinical presentation** - be able to elicit appropriate clinical history and physical examination
- **Therapeutic options** - understand the range of treatment strategies including medical, endovascular / interventional and surgical alternatives to a level sufficient to be able to discuss management with patients and formulate appropriate treatment plans

##### Gastrointestinal Tract Vascular Anatomy

- Name the three major ventral branches of the abdominal aorta that supply the gastrointestinal tract. Identify their approximate origins in relationship to the vertebral column in order to aid in catheterization
- Describe the most common branching patterns of the celiac axis and list common normal variants
- Identify the major branches of the splenic artery including the dorsal pancreatic artery, pancreatic magna artery, caudal pancreatic arteries, short gastric arteries and left gastroepiploic artery
- Identify on angiography the common hepatic artery, gastroduodenal artery, superior pancreaticoduodenal arteries, right gastroepiploic artery, proper hepatic artery, right and left hepatic arteries, supraduodenal artery, cystic artery, left gastric artery, and right gastric artery. Recognize common normal variants of these vascular territories
- Describe angiographic techniques and catheters that may help in selective catheterization of the above territories
- Identify the superior mesenteric artery, inferior pancreaticoduodenal branches, jejunal branches, ileal branches, middle colic artery, right colic artery and the ileocolic artery. Recognize common normal variants
- Identify on angiography the inferior mesenteric artery, left colic artery, sigmoid arteries, and superior hemorrhoidal artery
- Discuss and be able to identify on angiography the following anastomotic arteries: marginal artery of Drummond, arc of Riolan, arc of Buehler, arc of Barkow, meandering central anastomotic artery
- Recognize major branches of the mesenteric and portal venous systems
- Describe major portosystemic collateral venous systems and their significance in patients with portal hypertension
- List angiographic strategies for imaging the portal and mesenteric venous systems
- List the major blood supplies to the esophagus, stomach, duodenum, jejunum, ileum

### Gastrointestinal Bleeding

- Understand the clinical presentations and relevant physical signs in acute and chronic gastrointestinal blood loss
- Understand and evaluate the potential medical, surgical and endovascular treatment options in acute and chronic gastrointestinal blood loss
- Demonstrate knowledge of the potential aetiologies of acute and chronic gastrointestinal blood loss and the most frequently involved populations
- Integrate and direct the non-invasive imaging evaluation of patients with acute and chronic gastrointestinal blood loss including computed tomography, nuclear medicine and recognise the utility of endoscopic studies
- Describe the angiographic imaging findings in a patient with acute and chronic gastrointestinal blood loss including arterial extravasation within bowel, angiodysplasia, pseudoaneurysms and tumour circulation
- Recognise the importance of collateral pathways in the evaluation and treatment of acute and chronic gastrointestinal blood loss
- Recognise the angiographic findings in the visceral trauma on non-invasive imaging and angiographic imaging and be aware of potential management strategies
- Understand the role of anticoagulants, vasodilators and thrombolytic agents in the complete evaluation of occult acute and chronic gastrointestinal blood loss
- Demonstrate familiarity with the techniques and equipment used in embolization for acute and chronic gastrointestinal blood loss including the use of co-axial systems, micro-catheters and coils
- Demonstrate a knowledge of the potential complications and their preventative strategies and management including but not limited to Vasospasm, Arterial dissection, Catheterization failure (alternative access/catheters/guidecatheters), Coil migration and malposition, Thrombus
- Recognise the role of hepatic sources of haemobilia as a source of gastrointestinal blood loss
- Discuss the imaging strategies for the evaluation of a suspected aorto-enteric fistula including CT and angiography. List common scenarios for suspicion of aorto-enteric fistulae

### Visceral Artery Aneurysms

- Understand the clinical presentations and relevant physical signs in visceral artery aneurysms
- Demonstrate knowledge of the potential aetiologies of visceral artery aneurysms and the most frequently involved populations
- Understand and evaluate for an individual patient the potential medical, surgical and endovascular treatment options for visceral artery aneurysms
- Integrate and direct the non-invasive imaging evaluation of patients with suspected visceral artery aneurysms
- Describe the angiographic findings in a patient with a visceral artery aneurysm including an assessment of the suitability for endovascular treatment with reference to:
  - Access vessels
  - Site of origin
  - Aneurysm neck size
  - Aneurysm size
  - Potential sacrificed territory for successful exclusion
- Recognise the importance of collateral pathways in the treatment of visceral artery aneurysms
- Demonstrate familiarity with the techniques and equipment used in the embolization and exclusion of visceral artery aneurysms by coils, stent graft or other means
- Demonstrate a knowledge of potential complications and their preventative strategies in the treatment of visceral artery aneurysms including:
  - Aneurysm rupture
  - Coil migration and displacement
  - Catheterization failure

### Mesenteric ischaemia

- Understand the clinical presentations and relevant physical signs in acute and chronic mesenteric ischaemia
- Demonstrate knowledge of the potential aetiologies of acute and chronic mesenteric ischaemia and the most frequently involved populations
- Understand and evaluate for an individual patient the potential medical, surgical and endovascular treatment options for acute and chronic mesenteric ischaemia
- Integrate and evaluate the non-invasive imaging evaluation of a patient with acute and chronic mesenteric ischaemia including Doppler ultrasound / MRA /CT
- Demonstrate knowledge of the potential presentations of the celiac artery compression syndrome

Discuss the significance of the median arcuate ligament and the celiac neural plexus and understand the potential treatment options.

- Describe the angiographic findings and techniques for the assessment of acute and chronic mesenteric ischaemia including:
  - The value of non-selective lateral aortography
  - Evaluation of collateral pathways
- Understand and evaluate suitability for endovascular treatment including:
  - Site of lesion
  - Length of lesion
  - Side branch involvement
  - Appropriate access routes
- Understand the pre-procedural, intraprocedural and post-procedural pharmacological management of acute and chronic mesenteric ischaemia
- Demonstrate familiarity with the techniques and equipment used in the endovascular management of acute and chronic mesenteric ischaemia. In particular
  - Plan appropriate access (route, guidecatheters etc)
  - Use of suitable stents/ angioplasty equipment
- Understand the endovascular management option for the treatment of non-occlusive mesenteric ischaemia
- Demonstrate knowledge of the potential complications and their preventative strategies and management including but not limited to
  - Catheterization failure
  - In-situ thrombosis
  - Stent migration
  - Angioplasty failure
  - Cholesterol embolization
- List the expected immediate and long-term results for percutaneous interventions in mesenteric vascular disease

### Vasculitis

- Understand the clinical presentations and relevant physical signs in the common forms of vasculitis including Polyarteritis Nodosa, Giant cell arteritis, Takayasu's arteritis, Beurger's disease and Bechet's disease
- Demonstrate knowledge of the potential aetiologies of vasculitis and the most frequently involved populations
- Integrate and direct the non-invasive imaging evaluation of patients with vasculitis in particular discuss the limitations of non-invasive imaging for the assessment of small vessel vasculitis
- Describe the angiographic imaging findings in a patient with vasculitis
- Demonstrate knowledge of the potential complications of vasculitis and their endovascular management
- Describe the angiographic imaging findings in a patient with vasculitis

### Visceral and Gastrointestinal Tumours

- Describe the angiographic findings in benign and malignant hepatic tumours including hepatocellular carcinoma, hyper and hypovascular metastases and benign adenoma, focal nodular hyperplasia and haemangioma
- Demonstrate familiarity with the assessment and treatment options for patients with hepatocellular carcinoma including treatment by hepatic chemoembolization
- Understand the clinical presentations and relevant physical signs in the common gastrointestinal tumours including the neuroendocrine tumours such as carcinoid tumours

### Renovascular Disease

- Understand the clinical presentations and physical signs of patients with renovascular hypertension
- Perform a directed history and physical examination in patients with renovascular disease
- Understand and evaluate for an individual patient the potential medical, surgical and endovascular treatment options for a patient with renovascular disease
- Integrate and evaluate pre-intervention non-invasive imaging in the work-up of patients with suspected renovascular disease including the advantages and limitations of MRA/CTA and nuclear medicine studies
- Recognize the role of renal protective agents in the pre-and-post procedure management of patients with renovascular disease to minimize contrast nephropathy
- Utilize alternative contrast agents in the evaluation and treatment of renovascular disease
- Demonstrate familiarity with the equipment and techniques used in the treatment of renal artery stenosis
- Integrate the use of intra procedural intra-arterial pressure measurements in assessing the results of renovascular interventions
- Understand pre procedural, intra procedural and post procedural pharmacologic management in patients undergoing percutaneous therapy for renovascular disease
- List the types and rates of complications of renovascular interventions and their management including
  - Arterial dissection
  - In-situ thrombosis
  - Stent migration
  - Cholesterol embolization
- Understand the expected outcomes of percutaneous treatment of renovascular hypertension and ischemic nephropathy including long-term patency rates
- Understand the potential role for current and future treatment for restenosis in renovascular interventions
- Recognize the angiographic findings and indications for intervention in patients with fibromuscular dysplasia involving the renal arteries as well as the appropriate treatment and expected results in this specific patient population
- Demonstrate familiarity with the techniques and equipment used in the treatment of renal haemorrhage secondary to either iatrogenic trauma or direct trauma

### Bronchial Arteries

- Describe the normal anatomy of the bronchial and intercostals arteries and the common normal variants of these vessels
- Understand the role of bronchial embolization for patients with recurrent haemoptysis
- Describe angiographic techniques and strategies for catheterizing the bronchial arteries
- Recognize normal appearance of the bronchial arteries and recognize the angiographic appearance of abnormal vessels that can be seen in patients presenting with hemoptysis
- Recognize the angiographic appearance of the artery of Adamkiewicz and understand its clinical significance
- Describe important potential collateral pathways from non-bronchial systemic arteries and pulmonary arteries
- Demonstrate familiarity with the technique and equipment used in embolization of bronchial and nonbronchial systemic supplies in patients with recurrent haemoptysis
- Demonstrate knowledge of potential complications and their preventative strategies associated with bronchial embolization including paraplegia, chest pain, oesophageal necrosis, and bronchial necrosis

## Arterial Problems in Obstetrics and Gynaecology

### 3.1.1.8

#### UTERINE ARTERY EMBOLIZATION

- Identify proper indications and patient selection parameters for uterine artery embolization for the following patient groups:
  - Uterine fibroids
  - Post partum hemorrhage
  - Malignancy
  - Other indications, e.g., trophoblastic disease, uterine arteriovenous malformation
- Utilize proper imaging modalities for patient selection, and specific issues regarding appropriate selection (for UFE, fibroid location/pedunculation, presence of adenomyosis, endocavitary lesions)
- Understand the classic arterial anatomy and variations of uterine blood flow
- Understand the presence of collateral blood flow between the uterus and the ovaries, and physiologic ramifications of embolization in these territories
- In-depth familiarity with informed consent issues, including specific reproductive/fertility/menopausal effects, symptom resolution, and comparison to standard OB/G techniques, as well as the standard angiographic and embolization risks
- Apply the principles and practice of standard angiographic procedures to pelvic angiography and uterine artery catheterization
- Be familiar with a wide variety of catheters and embolic agents used in UFE
- Understand the principles of post procedure care for UFE with special attention to pain control issues and post-embolization syndrome
- Direct post procedure imaging studies, and appropriate laboratory evaluation
- List potential complications of UFE and their management

### 3.1.1.9 Arterial Pathology in Cancer Patients

#### INCLUDING VASCULAR INVASION, TUMOUR CIRCULATION, TUMOUR EMBOLIZATION

##### Anatomy

- Be familiar with the normal course and relationships of the major extra cranial arterial tree so as to recognise displacement or potential for invasion by tumour
- Have knowledge of the blood supply to major organs and muscle groups with knowledge of potential collateral supply
- Understand the concept of "end" arteries

##### Pathology

- Have a basic knowledge of tumour angiogenesis
- Have a basic knowledge of the process of tumour invasion of blood vessels
- Recognise the natural history and patterns of response of tumours suitable for arterial embolisation

##### Imaging

- Have knowledge of the clinical presentation of common tumours where either assessment of vascular invasion or treatment by embolisation plays an important part
- Have knowledge of characteristic patterns of vascularity in tumours particularly those which are hypervascular
- Have knowledge of radiographic features of vascular invasion
- Have knowledge of signs of vascular invasion with respect to assessing resectability
- Have knowledge of the use of ultrasound CT and MR both with and without contrast in the assessment of tumour vascularity and the role of these modalities in helping differentiate between benign and malignant lesions

##### Therapy

- Have a good understanding of the potential objectives of arterial embolisation (eg., palliation, cure, control of haemorrhage etc.)
- Have a good understanding of alternative therapeutic options to embolisation
- Have knowledge of embolisation materials and technique
- Have knowledge of the advantages and disadvantages of materials used in embolisation
- Have knowledge of common chemotherapeutic agents used in arterial chemotherapy
- Have knowledge of the indications for intra-arterial embolisation and chemoembolisation in cancers
- Be able to describe the signs and symptoms of post-embolisation syndrome
- Understand the role of the Radiologist in the management of complications of embolisation

## Management of Hepatic Malignancy (Vascular)

### 3.1.1.10

- Understand the proper role of various imaging studies (CT, MRI, PET and ultrasound) in diagnosis and staging of patients with hepatic malignancy
- Evaluate hepatic reserve using clinical and laboratory criteria and understand the impact on therapeutic options
- Have a basic understanding of tumour markers and their role in evaluating tumour response to therapy
- Perform a directed history and physical examination in patients with hepatic malignancy
- Understand available surgical and medical treatment options in patients with primary and metastatic hepatic malignancy
- Categorize patients with cirrhosis according to their CHILD-PUGH status and Okuda classification and understand the implications for survival
- List the causes of cirrhosis and implications for therapy in patients with co-existing hepatic malignancy
- Consult with patients and their families regarding treatment options, risks and benefits of various interventional oncologic therapies for hepatic malignancy
- Work within a multidisciplinary team to optimize patient care in this population
- Identify tumour types that respond well to chemoembolization
- List the absolute and relative contraindications to chemoembolization
- Categorize potential chemoembolization complications and their management
- Understand pre-and-post procedure care for chemoembolization patients
- Demonstrate technical competence in performing lobar, segmental and targeted chemoembolization therapy
- Identify patients at high risk for infectious complications following chemoembolization and strategies to prevent them
- Recognize arterial anatomic variants which affect feasibility and safety of chemoembolization

## Syndromes with a Major Vascular Component

### 3.1.1.11

#### OBJECTIVE

To gain a practical and working knowledge of an assortment of uncommon syndromes and generalised diseases all of which have a major vascular component. They are generally uncommon and may to present to a variety of clinicians as opposed to a vascular service.

There will be some overlap with those sections dealing with specific areas of vascular disease. Some uncommon vascular problems that are not syndromes that would not otherwise be covered will be included in this section.

Much of the management of vascular disease is compartmentalised into specific areas of clinical activity e.g. peripheral vascular disease, renovascular disease. The conditions that are outlined here can manifest themselves in a great variety of ways and the trainee should have an appreciation and a working knowledge of them.

#### Behcet's Syndrome

- To be aware of the clinical presentation and particularly the common non-vascular manifestations of this disease
- To be aware of the racial preponderance of this condition
- To understand how the venous system may be affected
- To be aware of the variety of ways in which it can affect the arterial system

### Marfan's Syndrome

- To be aware of the main clinical features and the ways in which it may present
- To have a knowledge of inheritance of this condition
- To understand how it most commonly presents with aortic disease and the clinical manifestations
- To be aware of the problems in the treatment of this condition and particularly regarding the endovascular treatment

### Takayasu's Disease and other Vasculitides

- To be aware of the racial predisposition of this condition and its preponderance in women
- To be aware of the criteria necessary to make this clinical diagnosis and the ways in which this condition may present. To have an understanding of the pathological process involved
- To be aware of the range of angiographic findings as well as the CT/MRI findings in active and early disease
- To be aware of the differences between active and non-active disease and the ways in which this may affect clinical management
- To have some understanding on the effectiveness of endovascular treatment particularly as it affects the renal arteries

### Middle Aortic Syndrome and William's Syndrome

- To be aware of this condition and what is usually necessary to make the clinical diagnosis
- To know of the usual angiographic appearances
- To have knowledge of the limitations of angioplasty/stenting in this condition

### Neurofibromatosis

- To be aware of the inheritance of this condition
- To have knowledge of the non-vascular manifestations of this disease
- To have knowledge of the vascular manifestations including arterial stenoses, aneurysms and arteriovenous fistulas and the risk of spontaneous rupture. To be aware in particular of neurovascular manifestations and the fact that the condition can mimic Polyarteritis nodosa
- To have knowledge of the problems and effectiveness of renal angioplasty

### Polyarteritis Nodosa

- To have an appreciation of the clinical manifestations of this condition and on what the clinical diagnosis is usually based
- To have an understanding of the role of arteriography in establishing the diagnosis
- To understand the angiographic manifestations of PAN and the sites where the abnormality is most likely to be noted
- To appreciate the possible interventional options in the treatment of complications

### Systemic Lupus Erythematosus

- To have a general knowledge of this condition and what is necessary for the diagnosis. To appreciate the treatment options
- To be aware of the possible vascular manifestations of this condition and the role of vascular interventional procedures

### Ehlers Danlos Syndrome

- To have a basic understanding of the clinical features of this condition and of its inheritance
- To understand the vascular features of this condition and its complications
- To be aware of the difficulties that this condition can presents to both the vascular surgeon and the radiologist

### Rubella

- To be aware of vascular conditions that can result following infections occurring during pregnancy

### Cholesterol Embolization

- To be aware of this condition, its pathology and the most common clinical manifestations
- To be aware that it can occur spontaneously but that it can follow a variety of interventions

## Venous Disease

## 3.1.2

### CONTENTS

- Peripheral venous disease including deep venous thrombosis, varicose veins
- Pulmonary Thromboembolic Disease
- Superior and inferior vena cava Disease
- Hepatic venous disease
- Portal venous disease including portal hypertension
- Gynaecologic venous Interventions

## Venous Diagnosis and Intervention

## 3.1.2.1

Trainees must appreciate the role of vascular interventional radiology and be aware of treatment strategies for venous disease in the following circumstances.

### Central Venous Access (*see section on page 49*)

- Ultrasound guided venous access
- Placement of tunnelled and conventional central lines for
  - Chemotherapy and parenteral nutrition
  - Haemodialysis
  - IV Antibiotics
- Use of secondary approaches when conventional access is impossible
- Maintenance / salvage of central venous catheters

### Peripheral Deep Venous Thrombosis

- Diagnosis
- Thrombolysis and thrombectomy
- Venous angioplasty and stenting

### **Pulmonary Thromboembolic Disease**

- Diagnosis
- VC filter insertion
- Pulmonary angiography
- Pulmonary thrombolysis and thrombectomy

### **Haemodialysis Access**

- Clinical assessment
- Diagnostic evaluation
- Interventions including balloon dilatation of failing grafts and fistulas

### **SVCO and IVCO (in benign and malignant Disease)**

- Clinical assessment
- Diagnostic evaluation
- Interventions

### **Portal Hypertension**

- Assessment of the portal vein
  - Ultrasound
  - CT
  - MRI
  - Angiography
  - Wedged hepatic venography
- Management of acute variceal haemorrhage
- Management of portal gastropathy
- Management of refractory ascites
- TIPS
  - Procedure
  - Evaluation
  - Follow up / maintenance

## **3.1.2.2 Peripheral Venous Disease**

### **INCLUDING PERIPHERAL DEEP VEIN THROMBOSIS**

#### **ANATOMY & PATHOPHYSIOLOGY**

- To review normal venous anatomy and major venous anatomic variants of clinical importance
- To describe the epidemiology, haemodynamics and clinical presentation associated with chronic venous insufficiency
- To outline the major risk factors for venous thrombosis including acquired and hereditary hypercoagulable conditions
- To discuss consequences of venous thrombosis on normal venous patency and valve function
- To discuss the relationship between acute deep vein thrombosis and the eventual development of chronic venous insufficiency

- To define:
  - Chronic venous insufficiency
- Varicose veins
  - Perforating veins
  - Lipodermatosclerosis
  - Phlegmasia cerulea dolens
- To describe the intermediate and long term sequelae of chronic venous insufficiency
- To differentiate congenital from acquired forms of venous insufficiency

#### DIAGNOSTIC EVALUATION

- To describe the "CEAP" classification system of chronic venous insufficiency: clinical condition, aetiology, anatomic distribution and pathophysiology
- To differentiate the clinical features of superficial venous insufficiency from deep vein (or combined) insufficiency

#### CHRONIC VENOUS

- To describe the characteristics of venous stasis ulcers and differentiate from other types of ulcers (eg arterial)

#### TREATMENT

- To describe the types of available therapy for superficial venous insufficiency (varicose veins) including elastic stockings, elevation, sclerotherapy, laser treatment, stab avulsion, stripping
- To recognise the relative risks and benefits associated with treatment of varicose veins including DVT, infection, skin slough, etc
- To describe the principles of non operative management of lower extremity chronic venous insufficiency: ambulation, elevation, exercise therapy and elastic support

### Pulmonary Thromboembolic Disease

#### 3.1.2.3

- Perform a directed history and physical exam in patients with thromboembolic disease
- Integrate non-invasive testing, vascular imaging, and physical findings to plan optimal access for IVC filter placement
- Identify the indications for IVC filter placement and pulmonary angiography in patients with venous thromboembolic disease and understand medical and surgical treatment options in these patients
- List the complications of pulmonary angiography, inferior vena cavography, vascular access, and IVC filter placement and their incidence as documented in the literature
- Be familiar with a wide range of interventional equipment including but not limited to guidewires, catheters, and IVC filters
- Understand the potential advantages and limitations of various types of filters including the maximal caval diameter in which each type of device may be placed
- Demonstrate technical competence in the performance of pulmonary angiography, inferior vena cavography and IVC filter placement
- Understand anatomic variants and pathology identified at inferior vena cavography that will affect the location of the IVC filter deployment

- Appropriately classify patients with acute and chronic thromboembolic disease based on history and physical as well as physiologic and imaging findings
- Integrate the use of intraprocedural pressure monitoring in performing pulmonary angiography
- Understand preprocedural, intraprocedural and postprocedural pharmacological management for patients undergoing IVC filter placement including anticoagulation

### 3.1.2.4 Superior and Inferior Vena Cava Disease

#### SVCO (SUPERIOR VENA CAVA OBSTRUCTION)

- Demonstrate an understanding of the causes and clinical manifestations of SVCO
- Perform a directed history and physical exam in patients with SVCO
- Understand the potential advantages and limitations of various medical and surgical treatment options available for managing SVCO and its complications. This includes medical /surgical management, radiotherapy and radiological intervention
- Demonstrate knowledge of the clinical success rates and complication rates reported for SVC stenting in the current medical literature, comparing it to other treatment options
- Demonstrate technical competence in the performance of the SVCO treatment , including venous access, thrombolysis, balloon dilatation and stent placement
- Be familiar with the various interventional equipment used in the SVCO procedure including but not limited to guidewires, sheaths, catheters, balloons and stents
- Recognize and manage intra- and post-procedural complications of SVCO stenting

#### IVCO (INFERIOR VENA CAVA OBSTRUCTION)

- Demonstrate an understanding of the causes and clinical manifestations of IVCO
- Perform a directed history and physical exam in patients with IVCO
- Understand the potential advantages and limitations of various medical and surgical treatment options available for managing IVCO and its complications. This includes medical /surgical management, radiotherapy and radiological intervention
- Demonstrate knowledge of the clinical success rates and complication rates reports for IVC stenting in the current medical literature, comparing it to other treatment options
- Demonstrate technical competence in the performance of the IVCO treatment , including venous access, thrombolysis, balloon dilatation and stent placement
- Be familiar with the various interventional equipment used in the IVCO procedure including guidewires, sheaths, catheters, balloons and stents
- Recognize and manage intra- and post-procedural complications of IVCO stenting

## Hepatic Venous Disease

### 3.1.2.5

- Demonstrate a fundamental knowledge of liver disease, including the causes and clinical manifestations of hepatic disease
- Demonstrate a fundamental knowledge of Budd Chiari, including its causes, clinical manifestations, and potential complications including ascites, hepatic failure and the sequelae of portal hypertension including hydrothorax, gastroesophageal varices, portal gastropathy, hepatorenal syndrome, and hepatic encephalopathy
- Understand the clinical utility and performance of hepatic vein recanalisation/dilatation and/or stent insertion (transjugular and percutaneous trans hepatic)
- Evaluate laboratory data in patients with chronic liver disease, with a specific understanding of liver function studies and other parameters useful in classifying liver disease
- Perform a directed history and physical examination in patients with Budd Chiari Syndrome
- Understand hepatic segmental anatomy, hepatic and portal venous anatomy, and common portosystemic collateral pathways
- List the indications and contraindications (relative and absolute) for transjugular intrahepatic portosystemic shunts
- Understand the potential advantages and limitations of various medical and surgical treatment options available for managing Budd Chiari and its complications. This includes medical management, endoscopic interventions, and surgical by-pass procedures for patients with gastroesophageal bleeding
- Demonstrate knowledge of the clinical success rates, patency rates, and complication rates reported for TIPS in current medical literature, including data comparing TIPS to endoscopic and surgical treatment options
- Understand the role of TIPS in patients being considered for liver transplantation
- Demonstrate technical competence in the performance of the TIPS procedure, including venous access, hepatic vein cannulation, transhepatic cannulation of the portal venous system, intra-procedural portal and systemic pressure monitoring, wedge portal venography, and transhepatic tract formation with balloon dilatation and stent placement
- Understand the role of variceal embolization in patients undergoing TIPS for variceal bleeding
- Demonstrate competence in the performance of variceal embolization
- Be familiar with the various interventional equipment used in the TIPS procedure including but not limited to guidewires, sheaths, catheters, balloons, stents, embolic materials, and transhepatic cannulation kits
- Demonstrate an understanding of the normal ranges for portal venous pressures, central venous pressures, and portosystemic pressure gradients, including target ranges for post-TIPS portosystemic pressure gradients
- Recognize and manage intra- and post-procedural complications of TIPS, including but not limited to haemoperitoneum, haemobilia, biliary-shunt fistula formation, progressive liver failure, shunt thrombosis or occlusion, right heart failure, and hepatic encephalopathy
- Establish post-procedural shunt surveillance algorithms with an understanding of the appropriate clinical parameters to monitor, including duplex sonography and shunt velocity measurements
- Demonstrate competence in the performance of TIPS revision procedures, including but not limited to the management of shunt stenosis or occlusion

### 3.1.2.6 Portal Venous Disease

#### INCLUDING PORTAL HYPERTENSION

- Demonstrate a fundamental knowledge of chronic liver disease, including its causes and clinical manifestations
- Demonstrate a fundamental knowledge of portal hypertension, including its causes, clinical manifestations, and potential complications including ascites, hepatic hydrothorax, gastroesophageal varices, portal gastropathy, hepatorenal syndrome, and hepatic encephalopathy
- Evaluate laboratory data in patients with chronic liver disease, with a specific understanding of liver function studies and other parameters useful in classifying liver disease
- Perform history and physical examination in patients with liver disease and portal hypertension
- Understand hepatic segmental anatomy, hepatic and portal venous anatomy, and common portosystemic collateral pathways
- Integrate patient clinical information into a classification scheme such as the Childs-Pugh score
- List the medical indications and contraindications for transjugular intrahepatic portosystemic shunts
- Understand the potential advantages and limitations of various medical and surgical treatment options available for managing portal hypertension and its complications. This includes medical management, endoscopic interventions, and surgical by-pass procedures for patients with gastroesophageal bleeding
- Demonstrate knowledge of the clinical success rates, patency rates, and complication rates reports for TIPS in current medical literature, including data comparing TIPS to endoscopic and surgical treatment options
- Demonstrate the role of TIPS in patients being considered for liver transplantation
- Demonstrate technical competence in the performance of the TIPS procedure, including venous access, hepatic vein cannulation, transhepatic cannulation of the portal venous system, intra-procedural portal and systemic pressure monitoring, wedge portal venography, and transhepatic tract formation with balloon dilatation and stent placement
- Understand the role of variceal embolization in patients undergoing TIPS for variceal bleeding. Demonstrate competence in the performance of variceal embolization
- Be familiar with the various interventional equipment used in the TIPS procedure including but not limited to guidewires, sheaths, catheters, balloons, stents, embolic materials, and transhepatic cannulation kits
- Demonstrate an understanding of the normal ranges for portal venous pressures, central venous pressures, and portosystemic pressure gradients, including target ranges for post-TIPS portosystemic pressure gradients
- Recognize and manage intra- and post-procedural complications of TIPS, including but not limited to haemoperitoneum, haemobilia, biliary-shunt fistula formation, progressive liver failure, shunt thrombosis or occlusion, right heart failure, and hepatic encephalopathy
- Establish post-procedural shunt surveillance algorithms with an understanding of the appropriate clinical parameters to monitor, including duplex sonography and shunt velocity measurements
- Demonstrate competence in the performance of TIPS revision procedures, including but not limited to the management of shunt stenosis or occlusion

## PORTAL VENOUS SYSTEM

- Describe techniques for imaging the portal venous system including indirect arteriography, hepatic vein catheterization with wedge portography using contrast/CO<sub>2</sub> and direct portal vein puncture. Understand the advantages and potential complications of each technique
- Recognize normal portal and hepatic venous pressures and expected portosystemic gradients in normal patients and in cases of portal hypertension
- Discuss prehepatic, intrahepatic, and posthepatic portal hypertension including etiologies and significance
- Demonstrate knowledge of the potential etiologies for Budd Chiari syndrome and the potential treatment options
- Recognize the patterns of portal vein occlusion including cavernous transformation of the portal vein and the important collateral pathways
- Demonstrate familiarity with the equipment and techniques used in the creation of a transjugular portal systemic shunt
- Demonstrate knowledge of potential complications and their preventative strategies in the treatment of visceral artery aneurysms including:
  - Venous laceration and bleeding
  - Shunt stenosis
  - Hepatic encephalopathy
- Outline a strategy for TIPS surveillance using colour Doppler ultrasound and list expected shunt velocities in a patent shunt. Describe abnormal findings that would lead to shunt catheterization for further evaluation
- List frequent surgical locations for the creation of port systemic shunts and be able to recognize them angiographically

## Gynaecological Venous Interventions

### 3.1.2.7

#### INCLUDING TESTICULAR VEIN EMBOLIZATION

- Be able to identify proper indications and patient selection parameters for gonadal vein embolization:
  - In males, varicoceles
  - In females, pelvic congestion syndrome
- Utilize proper imaging modalities and clinical history for patient selection, regarding appropriate selection
- Understand the classic venous anatomy and variations of gonadal veins
- Understand informed consent issues, including specific reproductive / fertility / menopausal effects, symptom resolution, and comparison to standard genitourinary or obstetrics and gynaecology techniques, as well as the standard angiographic and embolization risks
- Understand the principles of post procedure care, post gonadal vein embolization
- Be familiar with embolic agents and approaches used in embolization of gonadal veins and provide quality post procedure care in these patients

### 3.1.2.8 Haemodialysis access

#### CLINICAL ASPECTS

- Have knowledge of the anatomical locations and their preferred order of creation, of fistulas and synthetic grafts together with their expected outcomes
- Be aware of the need to avoid certain sites for venepuncture in patients with renal impairment
- Have familiarity with the recommendations of the American National Kidney Foundation Dialysis Outcomes Quality Initiative for vascular access (DOQI)
- Understand the indications and contra-indications, preferred access sites and preferred duration of temporary haemodialysis catheters
- Understand the preferred venous access sites for the placement of haemodialysis catheters and the evaluation of patients with physical examination and ultrasound prior to their placement
- Have knowledge of the evaluation of patients with malfunctioning haemodialysis catheters
- Understand the basic causes of catheter malfunction and the expected outcomes of intervention in malfunctioning catheters
- Have knowledge of the treatment of patients with infected haemodialysis catheters
- List alternative access possibilities when conventional venous access is not available
- Understand the indications and contraindications for peritoneal dialysis
- Understand the clinical aspects of the pre-operative work-up of patients for permanent haemodialysis
- Understand the clinical methods for surveillance and evaluation of dialysis access fistulae using physical examination and volume flow methods, as well as imaging (see below)
- Be familiar with the clinical presentation and signs of complicated, failing or failed haemodialysis access including failure of maturation of a native fistula, prolonged post dialysis bleeding, decreased Kt/V, decreased creatinine clearance, arm oedema and steal syndrome
- Have knowledge of the rationale, indications and contra-indications for the various techniques for intervention, in failing dialysis access
- Demonstrate knowledge of incidence of central vein stenosis in dialysis patients, including a knowledge of risk factors and preventive strategy
- List the surveillance methods for assessing vascular access including their advantages and disadvantages

#### IMAGING

- Have knowledge of the imaging techniques appropriate for the pre-operative assessment of patients undergoing fistula formation, including conventional angiography, CT, MR and ultrasound
- Have knowledge of the imaging techniques for the surveillance of, and detection of complications related to, fistula formation and venous access

#### PATHOLOGY

Demonstrate a basic understanding of the patho-physiology of arteriovenous access failure including failure of maturation of fistula, central venous stenosis, aneurysms and steal phenomena.

## THERAPY

- Have knowledge of the techniques, indications and contraindication for the insertion of temporary dialysis catheters including preferred sites and the DOQI guidelines for maximum recommended duration of temporary catheters
- Have knowledge of, and competence in, the techniques of placement of a number of different tunnelled haemodialysis catheters, and describe their advantages and disadvantages
- Describe the advantages and disadvantages of different line tip positions
- Understand the differences between primary, primary-assisted and secondary patency and the published literature relating to these different outcome points
- Describe / show competence in the treatment of venous, arterial and anastomotic stenosis and occlusions related to fistulas including angioplasty, cutting balloon angioplasty, stenting, stentgrafting, thrombolysis, thrombosuction, mechanical thrombectomy and mechanical revision
- Describe techniques for haemostasis post fistula or graft salvage
- Have knowledge of the expected outcomes and complications of these interventions
- Describe techniques for haemostasis post-fistula intervention
- Understand the advantages and disadvantages of the various techniques of thrombolysis used in thrombosed access fistulae
- Describe the different techniques available for treating steal syndrome including angioplasty, fistula restriction, surgical bypass and ligation
- Understand percutaneous radiological placement of peritoneal dialysis catheters, their complications and their management

## Central Venous Access

### 3.1.2.9

### ANATOMY

Understand the venous anatomy and other relevant anatomy of the neck, upper and lower limbs, chest and abdomen.

### NECK

- Outline the position of the external and internal jugular veins
- Outline the relationship of the carotid artery, vertebral artery, subclavian artery, sternocleidomastoid muscle, apical pleura and vagus nerves to the jugular veins
- Describe ways to augment jugular venous size to facilitate venous access
- Recognise the differences between veins and lymphadenopathy and thyroid cysts
- Describe the position and relevance of valves in the internal jugular and subclavian veins

### UPPER LIMB

- Outline the anatomy of the cephalic, basilic, brachial, axillary and subclavian veins
- Outline the normal arterial and variant arterial anatomy of the upper limb and why this is relevant to upper limb venous access
- Describe the relationship of the upper limb veins to their accompanying nerves and arteries
- Outline the relationship of the axillary and subclavian veins to the brachial plexus, lung pleura and adjacent arteries
- Describe preferred sites for placement of upper limb ports
- Describe how the tip position of central lines placed from the arm may vary depending on the position of the arm
- Understand the effect that the phases of respiration have on venous size and central venous pressure

### LOWER LIMB

- Describe the anatomy of the common femoral vein and the saphenofemoral junction
- Describe the anatomy of the femoral triangle

### CHEST

- Describe preferred sites for the exit points of subcutaneous tunnels on the anterior chest wall and how these may vary depending on the body habitus of the patient
- Describe preferred sites for placing subcutaneous ports on the chest wall
- Outline the anatomy of the SVC, brachiocephalic, azygos, hemiazygos and intercostals veins
- Describe the anatomy of the SVC in relation to the pericardial reflection
- Describe the branches of the brachiocephalic veins
- Describe the anatomical variants of central venous anatomy

### ABDOMEN

- Describe the anatomy of the iliac veins and IVC
- Describe the branches of the iliac veins and IVC
- Describe the anatomy of the translumbar route to the IVC and transhepatic approach to the hepatic veins
- Describe the anatomy of the hepatic venous system
- Describe the anatomical variants in iliac venous and IVC anatomy

### IMAGING/INVESTIGATION

- To recognise the anatomical features above shown by various imaging modalities including ultrasound, plain radiography, fluoroscopy and angiography, CT and MR
- Describe strategies for imaging the venous circulation in patients with suspected or documented venous occlusive disease
- Describe strategies for the imaging of patients with suspected complications of central venous access, including: venous thrombosis, atrial thrombus, endocarditis, pulmonary embolus, catheter fracture, fibrin sheaths, pseudoaneurysm, arteriovenous fistula and lines suspected to be inadvertently in the arterial tree
- To be proficient in the use of greyscale ultrasound for demonstrating venous anatomy
- To understand the use of Doppler ultrasound in the assessment of venous anatomy
- To confidently distinguish between the ultrasound appearances of veins and arteries
- To recognise that a central catheter is a normal position on post-procedural imaging
- To recognise that a central catheter is abnormally sited on post-procedural radiographs and know the range of possible locations for line tips that are in branch veins or outside the venous system

## **PATHOPHYSIOLOGY**

- To understand the causes of venous stenosis and venous occlusion
- To describe the interaction between venous catheters and the venous circulation and heart
- To understand approaches to prevention of line infection and how the risk of infection varies according to the anatomical site of access
- To understand the complications of line infection
- To understand the Pathophysiology and treatment of air embolus
- To understand the cause of "pinch off" syndrome leading to fragmentation of infra-clavicular central catheters via the axillary/subclavian route
- To understand the rationale for the use of central venous access and the interaction of drugs and other solutions with venous endothelium
- To understand the physiology of venous endothelium and how this can be impaired with intravenous catheters
- To understand how fibrin sheaths develop and how these compromise catheter function

## **PRACTICAL SKILLS TO ACQUIRE/ PROCEDURES TO UNDERSTAND, DESCRIBE AND HAVE PERFORMED**

- Ultrasound guided puncture of the internal jugular, external jugular, axillary-subclavian, upper limb and femoral veins
- Insertion of temporary and tunnelled lines via the jugular, subclavian and femoral approaches
- Placement of arm and chest wall ports
- Alternative strategies where standard routes of access are unavailable, including tunnelled femoral lines, translumbar IVC lines, transhepatic lines, Ultrasound guided puncture of the innominate veins and recanalisation of occluded central veins to facilitate access
- Insertion of chest drains for pneumothorax
- Management of massive air embolus
- Snare retrieval of intra-vascular catheter fragments
- Options and techniques for repositioning of mal-positioned lines
- Fibrin sheath stripping

## **EQUIPMENT**

- To understand the range of central venous catheters, ports, PICCs, dialysis and apheresis lines
- To understand the materials used in central venous catheters and their failure mechanisms
- To understand maximum flow rates achievable with different catheters
- To understand the maximum pressures to which lines may be subjected

## 3.2 Non Vascular Intervention

### GOALS

At the conclusion of training, the trainee will be able to:

- Demonstrate learning of the topic specific educational objectives
- Understand proper patient selection and therapeutic options for the interventional procedures described below
- Understand pre-procedure evaluation and post procedure management and follow-up for these procedures and patients
- Obtain complete and appropriate informed consent for all procedures
- Demonstrate technical competency in the performance of these procedures

### 3.2.1 Image-Directed Biopsy

- Describe advantages and disadvantages of various imaging modalities for biopsy of the chest, cervical region, abdomen and musculoskeletal lesions
- List the indications and contraindications for transthoracic needle biopsy
- Identify alternatives to transthoracic biopsy for patients with central subArinal masses, such as bronchoscopic biopsy
- Be familiar with a variety of biopsy needles and techniques including the use of CT fluoroscopy and various targeting technologies for difficult lesions
- Appropriately manage pre-procedure work-up including appropriate laboratory values
- Recognize which lesions are best approached with fine needle aspiration versus core biopsy as well as when to send the material for microbiologic evaluation if infection is suspected
- Appropriately treat patients with post biopsy pneumothorax including placement of a chest tube if necessary
- Identify safe approaches to percutaneous biopsy of lesions in the abdomen including retroperitoneal lymph nodes, pancreatic lesions, hepatic lesions and others
- Be familiar with treatment algorithm of patients experiencing significant haemorrhage following intra-abdominal biopsy

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## Image-Guided Aspiration and Drainage of Collections and Abscesses

### 3.2.2

#### PREPROCEDURAL OBJECTIVES

Demonstrate an understanding of the basic medical and clinical knowledge required to select patients for whom percutaneous interventions would be appropriate.

At the conclusion of training, the trainee will be familiar with the following aspects of patient selection for percutaneous drainage:

- **Anatomy** of the relevant organs, pleural and peritoneal spaces, significant anatomical variants and adjacent structures pertinent to understanding disease processes, planning interventional strategies, minimising, recognising and managing complications

#### Epidemiology / Pathophysiology

- Of those diseases associated with fluid collections and abscesses sufficient to aid diagnosis, understand disease progress and inform outcomes of interventions
- Including intestinal perforations, focal infections (primary and secondary), acute pancreatitis, acute cholecystitis, and post operative surgical complications

#### Clinical presentation

- Understand and recognise the common patterns and variety of presentations of loculated sepsis
- Be able to elicit an appropriate clinical history, perform a physical examination and assess the patients overall clinical status with regards to the risks and benefits of intervention

#### Investigation

- Assess appropriate laboratory investigations confirming clinical picture and procedural risks (coagulopathy etc)
- Demonstrate an understanding of the mechanisms, complementary roles and limitations of radiography, ultrasound, MRI, CT scanning, and Nuclide Imaging investigations relevant to the detection of focal sepsis
- Understand the disease process so that these investigations can be interpreted and acted upon if relevant to any proposed intervention

#### Therapeutic options

- Understand the range of treatment strategies including conservative, percutaneous interventional and surgical alternatives to a level sufficient to be able to discuss management with patients and formulate appropriate treatment plans
- Understand the clinical indications, relative and absolute contraindications and risk factors according to site, general patient factors and significant co-morbidities e.g. describe the indications and contraindications of diagnostic aspiration of pleural fluid collections and percutaneous chest tube drainage of complicated pleural effusion/empyema
- Understand the evolution of pancreatic collections and the timing and indication for drainage of pancreatic fluid collections

## PROCEDURAL OBJECTIVES

Demonstrate understanding of percutaneous aspiration and drainage techniques, procedural patient care and avoidance / management of complications:

At the conclusion of training, the trainee will be able to :

- Select the imaging modality most suitable to the nature and site of the target lesion and
  - Show an understanding of the advantages of CT scanning for deep seated / retroperitoneal disease and
  - The practical advantages of ultrasound scanning whenever suitable
  - Integrate a variety of imaging modalities (CT, Ultrasound and fluoroscopy) to optimise percutaneous drainage of intra-abdominal abscesses
  - Understand the advantages of CT fluoroscopy in accessing difficult fluid collections and placing drainage catheters
- Identify the safest and most expeditious route of drainage for abscess collections in various anatomic locations throughout the abdomen and pelvis
- Identification of potentially difficult cases such as multiloculated abscess cavities that may require placement of multiple catheters for adequate drainage or instillation of fibrinolytic agents to aid in drainage
  - Be familiar with a wide variety of drainage catheters and guidewires for the purposes of percutaneous abscess drainage
  - Understand the alternatives to tube thoracostomy including surgical drainage and pleurodesis
  - Familiarity with the range of co-axial needles, guidewires and drainage catheters used for percutaneous abscess drainage
  - Demonstrate basic knowledge of chemical sclerotherapy techniques for pleurodesis
  - Prescribe and supervise monitoring of adequate sedo-analgesic regimens, adequate hydration and sepsis risk for safe comfortable interventional procedures
  - Recognise and appropriately manage procedural complications
  - Understand the evolution of pancreatic fluid collections and the timing and indication for drainage of pancreatic fluid collections
  - Provide optimal follow-up care for patients status-post percutaneous abscess drainage with sinograms and repositioning or replacement of abscess drainage catheters as necessary
  - Post procedural Objectives: demonstrate the understanding and skills necessary to contribute to the ongoing care of patients after drainage procedures

#### AT THE CONCLUSION OF TRAINING, THE TRAINEE WILL BE ABLE TO

- Attend and review the clinical progress of the patient
- Assess complications including drain displacement, worsening sepsis, haemorrhagic complications, multiple organ dysfunction (poor renal output)
- Arrange and interpret appropriate post procedural imaging including sinograms
- Demonstrate a fundamental knowledge of chest tube drainage systems including water seal drainage systems and evaluation for persistent air leaks in patients with pneumothorax
- Demonstrate a skill at image guided puncture and drainage of a range of target lesions in common sites and conditions
  - E.g. demonstrate technical competence in imaging-guided placement of tube thoracostomy and be familiar with the various catheters available for this purpose
- Demonstrate understanding of dilatation of established drainage tracks for placement of larger bore catheters
- Properly manage patients following tube thoracostomy with catheter exchange and repositioning as necessary
- Understand when percutaneous abscess drainage catheters can be removed and demonstrate experience in their removal

## Gastrointestinal Interventions

### 3.2.3

#### NONVASCULAR SUMMARY

- Identify patients who are candidates for percutaneous gastrostomy percutaneous gastrojejunostomy, oesophageal gastroduodenal or rectal stenting
- List the contraindications to the above procedures
- Consider ethical factors prior to placement of enteral feeding access in this patient population
- Demonstrate technical competence in carrying out the procedures
- Be familiar with a wide variety of stents and percutaneous gastrostomy and gastrojejunostomy tubes as well as retention systems
- Recognize and treat complications including gastric bleeding and tracheal compression
- Identify patients who may benefit from a direct percutaneous jejunostomy and understand the basic principles of this procedure
- List indications for percutaneous cecostomy tube placement
- Understand the basic principles of local tumour ablation with percutaneous ethanol injection, radiofrequency ablation and other techniques
- Select patients with hepatic malignancies who will benefit from local tumour ablation strategies
- Integrate local, regional and systemic therapies in combination when appropriate in patients with hepatic malignancies
- Orchestrate proper follow-up imaging, laboratory and clinical evaluation after interventional radiological therapies for hepatic malignancy
- Be familiar with emerging interventional oncologic therapies such as targeted gene therapy, intraarterial brachytherapy and others

### 3.2.3.1 Cancer Interventions

### 3.2.3.2 Image-Guided Ablation (IGA)

- Hepatic Disease
- Renal Disease
- Lung Disease
- Skeletal Disease
- Other Disease Locations

#### HEPATIC DISEASE

##### Objective

Diagnosis and Non-Vascular Interventional Treatment of Hepatic Malignancy.

- **Anatomy** relevant to hepatic disease. Understand segmental and variant hepatic vascular anatomy relevant to liver disease both from the standpoint of minimally invasive therapy and surgical resection
- **Epidemiology** - To have a knowledge of the natural history of treated and untreated disease for metastatic colorectal disease, carcinoid / neuroendocrine tumours, primary hepatocellular carcinoma and the other metastatic diseases of the liver
- **Pathophysiology** - of the metastatic process in terms of vascular recruitment and tumour angiogenesis relevant to vascular and non-vascular intervention.
- **Clinical Presentation** - Be able to elicit an appropriate clinical history, perform a physical examination and assess the patients overall clinical status with regards to the risks and benefits of intervention. To understand the clinical staging of hepatic disease and decompensation in terms of Child-Pugh class and Okuda classification
- **Investigation** - Select appropriate laboratory and imaging investigations. Understand the disease process so that these investigations can be interpreted and acted upon relevant to any proposed results acted upon
- **Therapeutic Options** - Understand the range of treatment strategies including medical / oncological, interventional and surgical alternatives. To be able to balance and assess the relevant benefits and morbidity / mortality of any such intervention in the setting of primary and secondary malignant hepatic disease. Thereby to select patients who would benefit from local tumour ablation

##### Anatomy and Imaging of Hepatic Disease

The trainee will have a thorough understanding of arterial and variant arterial hepatic anatomy (from visceral vascular intervention) and segmental liver anatomy relevant to intervention.

##### Anatomy

###### Liver

- Name the major branches of the coeliac axis, common hepatic, gastroduodenal, pancreaticoduodenal and superior mesenteric arteries
- To understand variant hepatic anatomy in terms of right /left lobar dominance. Alterations caused by portal vein insufficiency, thrombosis (both bland and tumoural) and variant anatomy
- To understand the alterations of hepatic anatomy caused by Budd Chiari syndrome, cirrhotic disease and large volume, indolent intrahepatic malignant disease
- To understand biliary anatomy and it's bearing on targeted interventions

**Disease Process**

- To understand how the malignant process within the liver can alter hepatic blood supply and the bearing this will have on vascular and non-vascular interventions

**Related to the Liver**

- To understand the relations of the liver - extrahepatic biliary, gallbladder, gut, diaphragm and body wall - and their bearing on any proposed intervention
- To develop knowledge of how previous liver and visceral surgery will bear upon proposed interventions in terms of altered anatomy, hypertrophic change, vascular insufficiency etc

**Imaging Anatomy**

**To understand the mechanisms, complementary roles and limitations of ultrasound, magnetic resonance, magnetic resonance angiography, computed tomography +/- angiography, and contrast-enhanced cross-sectional imaging investigations relevant to the detection of liver malignancy.**

**Be able to describe strategies for imaging of patients with hepatic malignancy including algorithms for:**

- Metastatic colorectal disease
- Metastatic neuroendocrine tumours (include gut carcinoid)
- Hepatocellular carcinoma
- Other metastatic hepatic malignancy including breast, kidney etc

**Imaging Modalities**

As described earlier in the syllabus (under Peripheral Arterial Disease) to understand the risks and limitations of imaging modalities. In particular to have a firm grounding in the evolving roles of PET/CT and evolving contrast agents used in imaging hepatic malignancy.

- Understanding of FDG-PET/CT imaging, tracer avidity in different disease processes etc
- Knowledge of SPIO (super paramagnetic iron oxide) agents and Gadolinium, Gd-EOB, Gad-BOPTA etc and their utility in imaging hepatic disease

**Epidemiology of Hepatic Malignancy**

- To understand the incidence and prevalence of metastatic colorectal and neuroendocrine disease with respect to the primary disease
- Understand the place of hepatocellular carcinoma within the disease spectrum of cirrhotic liver disease
- Recognise the incidence and progression of metastatic liver disease with respect to breast and renal cancer and malignant melanoma. Thereby to understand the place for cytoreductive therapy in the overall management of the disease process

**Pathophysiology of Hepatic Malignancy**

- To understand the process of development of metastatic malignancy in the liver with particular reference to tumour vascularisation and its bearing on appropriate therapies
- To understand the evolution of malignant hepatocellular carcinoma as part of the cirrhotic liver disease process

### Clinical Presentation - History / Signs

- To demonstrate skills in history taking and physical examination with reference to metastatic and primary malignant liver disease
- To describe the signs and symptoms of these disease processes
- To determine patient fitness with regards to undertaking interventions and thereby to determine the appropriateness of any such intervention
- To be able to determine and recognise the complications of image-guided ablation and investigate appropriate investigation and management of complications such as haemorrhage, infection and gut perforation

### Therapeutic Options in Patients with Malignant Hepatic Disease

- Having appraised the patient, be able to balance the relative merits of various oncologic interventions in the setting of metastatic colorectal disease, neuroendocrine disease and primary hepatic malignancy besides other metastatic disease processes
- To have knowledge of current chemotherapeutic and radiotherapeutic regimes for different hepatic malignancies (as above)
- To understand the place of currently-advocated surgical management of liver disease by traditional resection or in combination with ablative therapies
- To have an in-depth knowledge of current technologies available in IGA - including radiofrequency ablation and alcohol ablation. To have an understanding of evolving technologies in this area including microwave and cryotherapy
- To have an understanding of the relative merits of adjunctive manoeuvres such as pre-IGA embolisation and chemoembolisation prior to ablation. To understand the limitations of current ablation technologies or how through technique - overlapping ablations, perfused devices, adjunctive techniques - larger volume disease may be undertaken. Thereby to formulate optimal overall treatment strategies

## RENAL DISEASE

Many of the underlying patient management processes regarding IGA apply generically to malignant hepatic, renal, lung, bony disease etc and are therefore not reduplicated under each heading. Only organ-specific issues are now cited under Anatomy, Epidemiology, Pathophysiology, Clinical Presentation, Investigation and Therapeutic options.

### Anatomy of Renal Disease

In-depth knowledge of normal and variant vascular and parenchymal anatomy with reference to the kidney. In particular issues pertaining to tumour vascularisation and the potential for energy-based IGA techniques to cause vascular, pelvicalyceal, urethral or collateral organ injury. The trainee should have knowledge of the embolization techniques used to modify tumour perfusion prior to kidney resection or in case of haemorrhage caused by renal intervention."

### Epidemiology

- Understand the overall incidence, prevalence and gender distribution of renal cancer. Additionally to have some knowledge of syndromal diseases such as Von Hippel Lindau syndrome where ongoing renal cancer management is an issue
- Recognise the prognostic implications of renal cancer both metastatic and small volume, indolent disease

## Pathophysiology

Understand the aetiology and clinical manifestations of renal cancer

### Clinical Presentation / Investigation:

- Demonstrate skills in history taking and physical examination relevant to renal cancer and assessment of patient fitness for proposed intervention. An understanding of assessment for anaesthetic risk and patient performance status
- Be able to assess imaging and staging investigations performed for renal cancer. To understand the radiological features relevant to renal cancer and its differential diagnosis and to recognise the features which would influence proposed resection, ablation and other interventions

### Therapeutic Options

- To understand the complementary roles of medical, interventional radiological and surgical treatment strategies
- To understand the strategies for medical management, palliative embolization and image guided ablation and partial or radical nephrectomy and the morbidity and mortality of these interventions

### Specific to Image-Guided Ablation

- Plan optimal procedural access, patient positioning and relevant / optional image-guidance methods
- Be able to utilise adjunctive procedures such as "hydro dissection" etc. in order to optimize procedural outcome
- Be able to recognise adverse events as soon as clinically or radiologically feasible and be able to advise on appropriate medical, interventional radiological or surgical intervention

## LUNG DISEASE

Many issues related to image-guided ablation and appropriate patient selection are generic to this form of cancer management and are dealt with under Hepatic malignancy. Only organ-specific issues are detailed below.

### Anatomy

Relevant to lung intervention:

- Understand lobar and fissural anatomy besides anatomical variants
- Understand pulmonary venous and arterial anatomy and bronchial arterial anatomy
- Understand segmental and lobar airway anatomy relevant to intervention
- Understand the relations of the lungs relevant to thermal ablation

### Epidemiology

- Understand the incidence and prevalence of the various types of primary lung carcinoma - squamous cell, non-small cell, and adenocarcinoma
- Understand the prevalence, incidence and prognostic significance of common lung metastases such as breast, kidney, thyroid, testis, colorectal and lung and the relevance of any proposed image-guided ablation in these cases

### Pathophysiology

- Causes and evolution of lung carcinoma - squamous, small cell, non-small cell adenocarcinoma
- Recognition of the risk factors for the above
- Recognition of the progressive features of lung malignancy both primary and metastatic

### Clinical Presentation

- Be able to elicit an appropriate clinical history and perform relevant clinical examinations prior to intervention
- Recognise features of progressive and metastatic disease which would guide appropriate therapy
- Determine cardiorespiratory reserve and performance status with regards to the proposed intervention

### Investigation of Lung Disease

- Select appropriate laboratory and imaging investigations relevant to patients with lung malignancy prior to intervention
- Determine clinical staging of patient by means of clinical examination and appropriate radiological staging by CXR, CT and MR where necessary
- Determine and understand patient fitness for intervention and in light of the staging of the disease be able to explain the appropriateness of intervention to the patient
- To understand the UICC TNM staging classification of lung carcinoma and its relevance to therapy

### Therapeutic Options

- To understand the range of treatment strategies for primary lung carcinoma including chemoradiotherapy, the relevance of surgical resection according to TNM staging and the potential of image-guided ablation
- To assess the patient during and following image-guided ablation and other cancer interventions. Be able to determine patient fitness for discharge and elicit complications following intervention

## SKELETAL DISEASE

Image-guided ablation is increasingly used to treat primary bone lesions such as osteoid osteoma and palliatively in cases of painful metastatic disease.

- To understand the clinical case for image-guided ablation of osteoid osteoma and its feasibility in different locations and clinical settings
- To be able to place oncologic and palliative interventions for metastatic bony disease in their appropriate clinical place alongside medical and surgical interventions
- To recognise new and evolving technologies for the treatment of primary and secondary bony disease
- To understand adjunctive manoeuvres that can be carried out - such as embolization and "hydro dissection" - in order to improve the outcome of image-guided ablation
- To be able to recognise and explain risk and therapeutic options to patients in these disease settings
- Be able to recognise complications of thermal image-guided ablation and advise on management

## Gastrointestinal Stenting

### 3.2.3.3

- Understand the indications, complications and contraindications for insertion of self-expanding stents for the oesophagus, stomach, duodenum and colon
- Understand the role of stent insertion for palliation of malignant dysphagia and malignant enteric obstruction and alternative treatment options
- Understand the 'bridge-to-therapy' concept and the limited role of temporary stenting for benign lesions (e.g. strictures resistant to conventional therapy, bleeding varices)
- Be able to advise on the appropriate combination of pre-stent imaging procedures, including endoscopy
- Identify patients requiring endoscopic assistance for duodenal and colonic strictures
- Understand the different properties of different stent constructions, stent materials, the role of stent covered vs uncovered stents and the options offered by removable and anti-reflux stents
- Be aware of the wide variety of stents and delivery systems
- Demonstrate technical competence in stent insertion and an understanding of removal procedures
- Recognise and appropriately treat complications of stent insertion and secondary stent failures such as migration and re-occlusion
- Appreciate the importance of a multi-disciplinary work-up and continued follow-up of stent patients

## Colonic Disease

### 3.2.3.4

#### ANATOMY

Describe the anatomy of the colon and its relationships to surrounding visceral structures

- Relationships of the sigmoid colon to pelvic viscera in the male
- Relationships of the sigmoid colon to the pelvic viscera in the female
- Relationships of the descending colon
- Relationships of the flexures
- Relationships of the ascending colon and caecum

Describe the colonic blood supply

Understand the variations of normal anatomy in particular malrotation

#### EPIDEMIOLOGY

- Understand the types of colonic disease that have the possibility of intervention
- Understand the prevalence of inflammatory disease
- Understand the prevalence of malignant disease
- Understand the relationships between the two types

#### PATHOPHYSIOLOGY

Understand the current concepts of CRC development

- The polyp to carcinoma pathway
- The relationships of inflammatory bowel disease to carcinoma
- Recognise when strictures may be benign and simple

### CLINICAL PRESENTATION

Understand the varied forms of presentation of colonic cancer

- Be able to examine the abdomen and perform a simple rectal examination
- Be capable of suggesting the most expedient imaging modality to expedite diagnosis

### INVESTIGATIONS

Understand and be able to discuss the imaging of the colon

- Be able to perform and interpret a barium/water soluble enema
- Be able to perform and interpret enteroclysis
- Be able to understand and interpret CT colonography
- Be able to understand and interpret a small bowel study
- Be able to perform an ultrasound scan to look for metastatic disease
- Be able to interpret a CT abdomen for staging
- Be able to understand the potential risks of colonoscopy

### THERAPEUTIC OPTIONS

- Understand the current surgical methods of treatment of colorectal carcinoma in
  - The acute presentation
  - A more chronic presentation
- Understand the best palliative surgical options available and the problems associated with colostomy
  - Understand the potential morbidity of colostomy
- Understand the current concepts of chemo-radiotherapy for rectal disease and the associated mesorectal surgery
- Understand the varied methods of endoscopic palliation
  - Laser treatment
  - Alcohol injection
  - Endoscopic stenting
- Understand the current concepts of colorectal stenting and its limitations
  - Have a knowledge of the current range of stents and delivery systems
  - Be able to manipulate catheters and wires within the colon
  - Be able to recognise the best catheter/ wire combinations
  - Be able to advise and manipulate through colonoscope in combined procedures
  - Be able to restent if required through existing stents
  - Be able to discuss stent retrieval as required
  - Be able to discuss when stenting is inappropriate

## Hepato-Pancreatico-Biliary (HPB) Intervention

### 3.2.4

#### OBJECTIVES

Demonstrate a basic medical and clinical understanding of HPB diseases

At the conclusion of training, the trainee will be familiar with the following aspects of HPB disease:

- **Anatomy** of the Liver, Pancreas and Biliary tree, significant anatomical variants and adjacent structures pertinent to understanding disease processes, planning interventional strategies, minimising, recognising and managing complications
- **Epidemiology** of HPB diseases, sufficient to aid diagnosis, understand disease progress and inform outcomes of interventions
- **Pathophysiology** demonstrate an understanding of:
  - The variety of causes of Jaundice e.g. obstructive ( stone, benign and malignant strictures, extrinsic causes) and non-obstructive (drugs, infections, autoimmune, toxic etc)
  - How disease processes alter anatomy and the implications for interventional strategies (e.g. level of obstruction and endoscopic vs percutaneous approaches
  - Disorders of Haemostasis/ multiple organ dysfunction in Jaundiced patients and the impact of additional sepsis. Implications for patient selection, optimising medical condition pre, intra and post procedurally
  - Vascular complications of HPB disease (ascites, portal hypertension/ thrombosis)
- **Clinical presentation** - Understand and recognise the common patterns and variety of presentations of HPB disease. Be able to elicit an appropriate clinical history, perform a physical examination and assess the patients overall clinical status with regards to the risks and benefits of intervention
  - Understand the various clinical presentations in patients with benign and malignant biliary strictures including obstructive jaundice, cholangitis and biliary colic
- **Investigation** - Select appropriate laboratory and imaging investigations. Understand the disease process so that these investigations can be interpreted and acted upon relevant to any proposed intervention
  - Integrate proper pre-procedure imaging work-up in patients with benign and malignant biliary obstruction
- **Therapeutic options**
  - Understand the range of treatment strategies including medical, endoscopic / percutaneous interventional and surgical alternatives to a level sufficient to be able to discuss management with patients and formulate appropriate treatment plans
  - Understand those clinical / interventional strategies which may best be decided in a multidisciplinary forum

**OBJECTIVE****The Effective Use of Diagnostic Imaging in HPB Disease**

At the conclusion of training, the trainee will be able:

- To demonstrate an understanding of the mechanisms, complementary roles and limitations of ultrasound, MRI, MRCP, ERCP. CT scanning, and Nuclide Imaging investigations relevant to the detection of HPB diseases
- Describe imaging strategies for patients with suspected HPB diseases including algorithms for:
  - Jaundice
  - Sepsis? Cholangitis
  - Biliary colic
  - Non-specific presentations of suspected HPB malignancy

**OBJECTIVE****Technical Knowledge and Skills in HPB Interventions**

At the conclusion of training, the trainee will be able to:

- Interpret pre-procedural imaging to produce an effective interventional strategy for relief of obstructive jaundice. Demonstrating an understanding of:
  - The advantage of the endoscopic approach to subhilar obstructions and generally stone disease at any level
  - The selection of endoscopic, percutaneous transhepatic or roux loop approaches
  - The selection of a drainage route(s) most appropriate to segmental anatomy and disease distribution
  - The assessment of potential complications related to individual patient anatomy
- Demonstrate familiarity with a wide array of percutaneous biliary access systems, and all equipment available for HPB interventional procedures including access and drainage systems, balloons, baskets, stents and stent grafts
- Prescribe and supervise monitoring of adequate sedo-analgesic regimens, adequate hydration and sepsis risk for safe comfortable interventional procedures. Describe and manage related complications
- Demonstrate a skill with percutaneous transhepatic cholangiography and biliary drainage under a combination of fluoroscopic and ultrasound guidance
- Organise appropriate post procedure management following drainage procedures to assess response to the intervention and recognise and manage complications including haemorrhage, infection, drain displacement
- Arrange further post drainage procedures including, as appropriate, check cholangiography, conversion to internal drainage, biliary stenting by percutaneous or combined radiological - endoscopic methods
- Identify patients who will benefit from an expanding metal stent
- Describe various methods for obtaining biopsies and/or cytology of biliary strictures
- Integrate biliary manometry in the management of patients with benign biliary strictures
- Demonstrate awareness of the various techniques of percutaneous management of biliary calculi including assisting endoscopic access, percutaneous sphincterotomy, stone crushing and retrieval
- List the major complications associated with percutaneous transhepatic cholangiography and biliary drainage and management of these complications
  - Recognize patients at high risk for sepsis following biliary interventions and understand how to treat post procedural sepsis should it occur
  - Manage patients with arterial biliary fistulae or bleeding following percutaneous biliary drainage

## Intervention of the Genito-Urinary Tract and Renal Transplants 3.3

### OBJECTIVES

At the conclusion of training the trainee should have a thorough understanding of the common disorders of the genito-urinary tract (including renal transplants), and should be competent to discuss, plan and safely carry out all the common interventional procedures applicable to the genitor-urinary tract and renal transplant. In particular the trainee should be familiar with:

### ANATOMY OF THE GU TRACT AND RENAL TRANSPLANTS

Describe the

- Normal and variant calyceal and vascular radiological anatomy of the upper renal tract
- Normal and variant ureteric and bladder anatomy (including post-cystectomy or post bladder augmentation)
- Radiological anatomy of the various retroperitoneal spaces
- Radiological and glandular anatomy of the prostate gland
- Surgical and radiological anatomy of renal transplants

### EPIDEMIOLOGY OF THE COMMON GU AND RENAL TRANSPLANT DISORDERS

Be familiar with the risk factors and epidemiology of the common GU disorders:

- **Renal stone disease**
- **The urinary tract cancers**
- **Male and female infertility**
- **Renal failure, replacement therapy and transplantation**

### PATHOPHYSIOLOGY OF THE COMMON GU AND RENAL TRANSPLANT DISORDERS

The trainee should have an understanding of

- The causes and the pathophysiology of the common GU disorders; in particular the causes, risk factors and pathology of renal stone disease and the common urinary tract cancers
- The causes of acute and chronic renal obstruction
- The renal physiological changes pre- and post ureteric obstruction
- Upper and lower tract urodynamics
- Male factor infertility

### CLINICAL PRESENTATION OF THE COMMON GU AND RENAL TRANSPLANT DISORDERS

The trainee should be able to carry out a problem orientated clinical, radiological and biochemical evaluation of the genito-urinary tract.

### INVESTIGATION OF THE COMMON GU AND RENAL TRANSPLANT DISORDERS

Be able to plan the appropriate biochemical, radiological and physiological investigations appropriate for planning of interventional procedures.

- Planning of the radiological investigation of suspected ureteric obstruction or ureteric leaks
- The use and limitations of the various radiological modalities for the diagnosis and planning of renal stone management
- The place of CT and MRI for the investigation of the common urinary tract cancers and their complications. The role of imaging in the diagnosis and evaluation of the renal mass and its place in the planning of imaging guided therapy
- The modern role of angiography, Doppler Ultrasound, CTA and MRA for the evaluation of renovascular disorders and transplant dysfunction
- Understand contrast agents, renal toxicity and how this may be limited

### THERAPEUTIC OPTIONS FOR THE MANAGEMENT OF THE COMMON GU AND RENAL TRANSPLANT DISORDERS

The trainee should be able to understand the role of interventional radiology in the overall management of the common disorders of the genito-urinary tract and renal transplants. The trainee should be able to discuss the likely outcome and complications of the proposed intervention procedure and the alternative surgical or medical options.

The trainee should be able to plan and carry out the interventional procedure; and recognise and manage any complications that may occur.

## 3.3.1 Pelvicalyceal & Ureteric Obstruction

### ANATOMY

- Understand the normal anatomy of the pelvicalyceal system & ureter with particular detail of the calyceal anatomy
- List the common normal variants & congenital anomalies of the pelvicalyceal system, ureter & bladder
- Understand the vascular anatomy, arterial & venous of the kidney
- List the common normal vascular variants of the arterial & venous supply to the kidney
- Understand the anatomical relations of adjacent organs & structures, the common anatomical variations, changes with respiratory phases & patient positioning

### PATHOPHYSIOLOGY

Understand the causes of pelvicalyceal & ureteric obstruction & how they impact on planning interventions.

### PRESENTATION AND CLINICAL MANIFESTATIONS

Understand the range of modes of presentation of, and the clinical and physical signs associated with, upper urinary tract obstruction.

## INVESTIGATION

- Describe the various modalities for the diagnosis of pelvicalyceal & ureteric obstruction
- Describe the pre-procedural evaluation including laboratory & imaging investigations & pharmacological management of patients requiring urological intervention
- Demonstrate knowledge & understanding of patient selection

## MANAGEMENT STRATEGIES

- Demonstrate knowledge of alternative therapeutic options, including retrograde, rendezvous procedures & endourological interventions
- Demonstrate knowledge & competence with the use of sedation & analgesia for optimum patient comfort & tolerance
- Discuss the use of prophylactic antibiotics in urological intervention
- Demonstrate understanding of correct patient positioning for percutaneous interventions
- Demonstrate knowledge and correct selection of equipment needed to perform percutaneous ureteric interventions
  - Needles (18-22G, sheathed & non-sheathed, standard & diamond-tip)
  - Guidewires
  - Dilators & sheaths (including peelaway sheaths)
  - Manipulation catheters
  - Drainage catheters and various locking mechanisms available
- Demonstrate understanding of the alternative endourological procedures available, with reference to the advantages & disadvantages, complications & outcomes
- Understand the clinical follow-up of patients following interventional procedure

### Percutaneous Nephrostomy Insertion

- List the indications for nephrostomy insertion
- Understand the technical aspects for diagnostic evaluation of pelvicalyceal & ureteric obstruction
- Describe the indications for antegrade puncture of the pelvicalyceal system
- Describe the interventional technique used for a Whitaker test
- Interpret the results, including equivocal findings, for the Whitaker test
- List the relative and absolute contraindications for nephrostomy insertion
- Describe the various imaging techniques for accessing the upper tracts safely and successfully:
  - Ultrasound (freehand and guided techniques)
  - Fluoroscopy
  - Computer tomography
  - Blind puncture
    - Demonstrate knowledge & understanding of planning access intervention
    - List the relative risks related to a different choice of calyceal access
    - Describe the various puncture techniques to access the upper tracts safely & successfully
  - Single puncture
  - Double puncture
- Describe the use of contrast, air & CO<sub>2</sub> to identify appropriate calyx for puncture
- Describe and demonstrate knowledge of parallax fluoroscopy to access the upper tracts
- Understand the correct technique for placement of external drainage nephrostomy catheter

- Understand the various catheter fixation techniques available
- List the types & rates of complications of nephrostomy insertion & their management
- Demonstrate technical confidence in performing percutaneous nephrostomy insertions
- Understand the various techniques used to opacify the collecting system in native kidneys, transplant kidneys & ileal conduits
- Demonstrate awareness and understanding of the specific problems relating to calyx access & the interventional techniques employed for percutaneous nephrostomy in the following special situations:
  - Malrotated & horseshoe kidneys
  - Pregnancy
  - Intensive care
  - Non-dilated obstructed uropathy
  - Transplant nephrostomy
  - Ileal conduits
  - Delivery of chemotherapy
  - Access for antegrade & retrograde endourological interventions (laser, resection, ablation etc.)
- Understand the expected outcomes for percutaneous nephrostomy insertion
- Describe the maintenance of long term nephrostomy drainage, catheter exchange & replacement of dislodged catheters

#### Ureteric Stent Insertion

- Understand the clinical considerations for ureteric stent insertion
- Demonstrate knowledge of the types of ureteric stent available
- Demonstrate knowledge of the different stent delivery systems
- Understand the physiology behind ureteric stent drainage with reference to ureteric stent size & patient morbidity
- Describe the available techniques for ureteric stent insertion & potential benefits of each
  - Antegrade ureteric stenting (AUS)
  - Retrograde ureteric stenting (RUS)
  - Combined ureteric stenting

#### Antegrade Ureteric Stent Insertion

- List the indications for antegrade ureteric stent insertion
- List the contraindications to antegrade ureteric stent insertion
- Demonstrate knowledge of correct calyx access for secondary ureteric intervention
- Demonstrate understanding of catheter exchange
- Understand the differences between primary & secondary ureteric stent placement
- Demonstrate understanding of catheter & guidewire manipulation within a tortuous ureter, ureteric kink & ureteric occlusions
- Be familiar with various techniques used to cross an obstructed ureter, including use of balloon dilatation, micro guidewires & catheters
- Understand the correct technique for insertion of an antegrade ureteric stent, use of guidewire, peelaway sheath & covering nephrostomy drainage catheter types
- List the types and rates of complications of antegrade ureteric stent insertion and their management
- Understand the expected outcomes for antegrade ureteric stent insertion
- Demonstrate knowledge of follow up of patients with a ureteric stent
- Demonstrate knowledge of the different techniques available to remove a ureteric stent

### **Retrograde Ureteric Stent Insertion**

- List the indications for retrograde ureteric stent insertion
- List the contraindications for retrograde ureteric stent insertion
- Demonstrate knowledge for the appropriate lesions to be approached by this technique
- Understand the role in rendezvous procedures
- Understand the role of retrograde urological interventions in ileal conduits and retrograde stent insertion
- Demonstrate knowledge of the different surgical techniques used to form ureteroileal anastomosis in ileal conduits
- List the types & rates of complications of retrograde ureteric stent insertion & their management
- Understand the expected outcomes for a retrograde ureteric stent insertion

### **Ureteric Interventions**

#### **Ureteric Balloon Dilatation**

- List the indications for ureteric balloon dilatation
- Demonstrate knowledge of the types of balloons available
- Demonstrate an understanding of the technique for balloon dilatation
- Understand the expected outcomes for balloon dilatation
- List the complications of balloon dilatation and their management

#### **Ureteric Occlusions**

- List the indications for occluding the ureter
- List the various techniques available for achieving ureteric occlusion
- Understand the expected outcomes from ureteric occlusion
- Understand the role of renal ablation

#### **Removal of Foreign Bodies**

- Demonstrate knowledge of the techniques to remove foreign bodies for the urinary tract
- Understand the limitations of the techniques
- Demonstrate knowledge of the equipment available for foreign body removal
- Understand the expected outcomes & complications

#### **Renal Transplants (see section 5 below)**

## **Renal Stone Disease**

### **3.3.2**

#### **EPIDEMIOLOGY & AETIOLOGY**

- Understand the aetiological and epidemiological factors influencing stone formation
  - Geographical
  - Dietary
  - Inhibitors and promoters of crystallisation
  - Nidus
  - Stasis
  - Dehydration
  - Infection
  - Metabolic factors
  - Understand stone structure and composition

### **CLINICAL PRESENTATION**

- Understand and describe the different clinical presentation of stone disease
- Understand the differential diagnosis of presenting symptoms and signs (e.g. haematuria, flank pain, etc...)
- Understand the associated morbidity and urgency of management in the presence of obstruction and infection

### **IMAGING**

- Understand and list the different imaging modalities used in demonstrating stones
- Understand the technical aspect of each modality
- Understand the indication for each modality (diagnosis, planning, follow up)
- Understand the limitation of each imaging modality

### **MANAGEMENT**

- Understand and list the different management options
- Understand and list the factors affecting the choice of management options (presentation, size, site, anatomical ...)

### **CONSERVATIVE**

- Understand the indications for conservative management and importance of follow up

### **EXTRACORPOREAL SHOCK WAVE LITHOTRIPSY (ESWL)**

- Understand the concept of lithotripsy
- Have an adequate understanding of different modes of generating the shock wave
- Have an adequate understanding of the different designs of lithotriptors and different methods of stone localisation (ultrasound and fluoroscopy)
- Understand the indications and contra-indications of ESWL
- Have an adequate understanding of treatment strategies
- Understands the complications of ESWL

### **URETEROSCOPY**

- Understand the indications for ureteroscopy
- Have an adequate understanding of the technical aspects of rigid and flexible ureteroscopy
- Have an adequate understanding of the different methods of stone fragmentation (ultrasound, mechanical devices, laser...)
- Have an adequate understanding of retrograde stent placement and its indications
- Understand the complications of ureteroscopy and management of complications

### **PERCUTANEOUS NEPHROLITHOTOMY (PCNL)**

- Understands the indications of PCNL
- Clear understanding of the renal anatomy and methods of renal access (see section on Pelvicalyceal obstruction and Nephrostomy insertion)
- Have good knowledge and familiarity with all instruments used to establish a percutaneous track
- Acquire the necessary skill and competence in handling needles, guide wires and dilatation kits
- Have an adequate understanding of scopes and methods of stone fragmentation and retrieval
- Acquire the necessary skills for nephrostomy placement, antegrade ureteric dilatation and stent insertion
- Understand and list the complications of PCNL and their early recognition
- Acquire the necessary skills for the interventional management of complications

### **LAPAROSCOPIC AND OPEN SURGERY**

- Have an adequate knowledge of the indications for laparoscopic and open surgery for stone disease
- Understand the complications of surgery
- Acquire the skills to manage some of the complications using interventional techniques

### **FOLLOW UP**

- Understand the rationale for follow up and its routines
- Understand the use of different imaging modalities for follow up

## **Renal Masses & Perirenal Collections**

### **3.3.3**

#### **ANATOMY**

- Understand the normal anatomy of the kidney, adjacent relations, perirenal spaces & routes of spread for disease

#### **PATHOPHYSIOLOGY / EPIDEMIOLOGY**

- Understand the incidence and classification of solid & cystic renal mass lesions
- List the common perirenal collections & underlying aetiologies

#### **PRESENTATION AND CLINICAL MANIFESTATIONS**

- Understand the clinical presentation of, and physical findings in, patients with renal masses & perirenal collections
- Understand the clinical indications & contraindications for renal biopsy
- Understand the clinical indications for retroperitoneal lymph node biopsy

#### **INVESTIGATION**

- Understand the pre-procedure work-up of patients undergoing drainage & biopsy procedures, including laboratory examinations

### MANAGEMENT STRATEGIES

- Understand the indications for percutaneous intervention in patients with a solid renal mass, cystic renal mass & perirenal collections
- Integrate imaging modalities to facilitate successful drainage
- Demonstrate detailed understanding of patient preparation, local anaesthetic administration & sedation
- Understand the role of diagnostic aspiration
- Be familiar with a range of needles, guidewires, drainage catheters & drainage kits.
- Demonstrate technical competence in image guided aspiration & drainage
- Understand the role of sclerotherapy in the management of cystic renal lesions
- List common sclerosant agents available
- Be familiar with a range of needles & devices available for percutaneous biopsy
- Understand the techniques available to access difficult lesions with CT & ultrasound
- Understand the management of significant complications following percutaneous biopsy
- Understand the correct transport medium required for correct pathological examination
- Provide optimal follow-up care for patients following percutaneous biopsy & drainage. Including catheter care, further imaging & intervention & catheter removal

### 3.3.4 Renal Tumours

#### INCLUDING BENIGN & MALIGNANT

#### PATHOPHYSIOLOGY / EPIDEMIOLOGY

- List the incidence, and types of common, uncommon & rare renal tumours
- Understand the biology of renal tumours with reference to their routes of spread (direct & metastatic) & growth

#### INVESTIGATION

- Understand the imaging modalities for the diagnosis & classification of renal tumours
- Be familiar with management strategies
- Demonstrate knowledge of the various surgical (including nephron sparing & laparoscopic techniques) & medical options available for the management of renal tumours
- Demonstrate knowledge of the advantages & disadvantages of surgical, medical & interventional radiological techniques, including morbidity, mortality & outcomes

#### Trans-Catheter Embolization Techniques

- Understand the role of embolization in the management of patients with renal tumours (benign & malignant)
- Demonstrate knowledge of the clinical indications for renal tumour embolization
- Describe the pre-procedural evaluation including laboratory investigations, imaging & pharmacological management of patients undergoing embolization
- Understand the different types of embolic agents available & the advantages & disadvantages for their use in renal tumour embolization
- Demonstrate technical competence in the selection of the correct embolic agent
- Demonstrate knowledge & technical competence of the use of different types of catheters, including microcatheters, for renal tumour embolization

- Understand the indications for primary embolization
- Understand the indications and timing for pre-operative embolization
- Understand the indications for post operative embolization
- Understand the role for the embolization of renal tumour metastasis
- Demonstrate technical competence in performing renal tumour embolization
- List the risks & complications related to trans-catheter embolization
- Understanding of the management of complications relating to tumour embolization
- Understanding of the management & follow-up of patients following renal tumour embolization
- Understand the outcomes of renal tumour embolization
- Demonstrate knowledge of new & novel techniques for the use in renal tumour embolization

### Renal Ablative Techniques

- List ablative techniques available
- Understand the role of these techniques in the management of patients with renal tumours (benign & malignant)
- Identify patients who will benefit from minimally invasive ablative techniques
- Demonstrate technical competence in the targeting of renal tumours for ablation and the imaging modalities available
- Understand the risks and complications of the renal tumour ablation
- Demonstrate knowledge of the management of complications from renal tumour ablative techniques
- Understand the equipment & technical considerations for each ablative technique
- Demonstrate knowledge of additional interventional techniques that may be utilised to facilitate complete tumour ablation, including complex ablations, role of pre-ablation embolization
- Demonstrate knowledge of additional technique utilised to prevent adverse injury to adjacent structures, including hydro-dissection, pelvic/lyceal cooling & ureteric stent placement
- Demonstrate knowledge of the outcomes expected from ablative techniques
- Understand the follow-up of patients following ablative techniques, including secondary interventions

## Genito-Urinary Interventions in Infertility and Priapism

### 3.3.5

#### VARICOCOELE

- Understand the postulated role of varicocoele in male infertility
- The frequency of varicocoele in symptomatic and asymptomatic groups
- The clinical and radiological diagnosis of varicocoele
- The evidence base for the role of the treatment of varicocoele
- The surgical and radiological treatments for the treatment of varicocoele
- Demonstrate technical competence in varicocoele embolization, by being able to choose
  - The most appropriate venous site of entry
  - Choose correct equipment and why
  - The correct embolic agent and discuss the advantages and limitations of the various agents available
  - Understand the normal and variant retroperitoneal venous anatomy
  - Describe the hazards and how to minimise and deal with complications
  - Describe the expected clinical outcome and the short term and long term morbidity

### FALLOPIAN TUBE OBSTRUCTION

- Understand the postulated role of fallopian tube obstruction in infertility
- The clinical and radiological diagnosis of fallopian tube obstruction
- The evidence base for the role of the treatment of fallopian tube obstruction
- The surgical and radiological treatments for the treatment fallopian tube obstruction
- Demonstrate technical competence in fallopian tube re-canalization, by being able to choose
  - Choose and discuss the choice of equipment
  - Describe the hazards and how to minimise and deal with complications
  - Describe the expected clinical outcome and the short term and long term morbidity

### PRIAPISM

- Understand the postulated mechanism of both high and low flow priapism
- The clinical and radiological evaluation of priapism
- The evidence base for the role of embolotherapy for the treatment of high flow priapism
- The surgical and radiological treatments for high flow priapism
- Demonstrate technical competence in internal pudendal and cavernosal artery cannulation and embolization by being able to
  - Choose and discuss the correct equipment
  - Be familiar with the normal and variant pelvic vascular anatomy
  - Describe the hazards and how to minimise and deal with complications
  - Describe the expected clinical outcome and the short term and long term morbidity

## 3.3.6 Interventional Radiology and Renal Transplant Dysfunction

- Understand the various late and early causes of transplant dysfunction
- Understand the surgical aspects of ureteric and vascular anastomosis; and the surgical orientation of the renal transplant and how this impinges on interventional approaches to the transplanted kidney. The differences between a live donor and cadaver kidney should be understood, and how this influences surgical anastomosis
- The radiological evaluation of transplant dysfunction.
  - Be able to discuss the role and limitations of Grey scale and Doppler ultrasound, scintigraphy, CTA, MRA, catheter angiography and intra-arterial pressure measurement in the evaluation of renovascular dysfunction
  - The role of intravenous urography, antegrade pyelography and upper tract urodynamics in the assessment of dilatation of the transplant kidney
  - Understand the role of grey scale ultrasound, diagnostic aspiration and biochemical analysis in the evaluation of the origin and relevance of peri-nephric collections
- Be able to discuss
  - The clinical evaluation of transplant renal artery stenosis (TRAS)
  - The relevance of TRAS in the context of post-transplant hypertension, dysfunction and unstable pulmonary oedema
  - The role of catheter angiography and intra-arterial pressure measurement in defining the grade of stenosis
  - The reasons for, the risks of and advantages of renal angioplasty and stenting with the patient
  - The long-term outcome of either procedure should also be discussed
  - The advantages of ipsilateral and contralateral arterial approach, as tailored to the surgical anastomosis

- Be able to discuss the investigation and management of transplant renal dilatation:
  - Understand the transplant renal anatomy
  - Understand the pathological conditions that affect the transplant ureter
  - Understand the differences between native & transplant pelvicalyceal dilatation and differentiate between simple renal dilation and true ureteric obstruction
  - Understand the indications & complications of surgical intervention
  - List the indications and role for percutaneous nephrostomy, ureteric dilatation and stenting in the short and long term management of ureteric obstruction, stenosis and leak
  - The trainee should have a knowledge of the risk, contraindications, advantages and success rate of each procedure
  - List the complications of renal transplant ureteric intervention & their management
  - The trainee should be able to discuss the safest percutaneous approach to the calyceal system of the transplant kidney, using either ultrasound or fluoroscopic guidance or both
  - Demonstrate knowledge of the differences between native & transplant calyx access & nephrostomy insertion technique
  - Discuss differences in the types & size of ureteric stent used in a transplant ureter
  - The role of perinephric collections in the causation of ureteric obstruction, their evaluation and percutaneous management, including sclerotherapy

## Prostate and Seminal Vesicles

### 3.3.7

#### PROSTATE CANCER

##### Anatomy, Pathology, Epidemiology and Diagnosis of Prostate Cancer

- Have a good understanding of the zonal anatomy and physiology of the prostate and seminal vesicles
- Understand the pathological processes affecting the prostate
- Understand the incidence and patho-physiology of prostate cancer
- Understand the clinical presentation of prostate cancer and importance of PSA, DRE and prostate biopsies
- Understand and being able to perform and interpret the imaging modalities used in prostate disease for diagnosis, staging and follow up ( TRUS, CT, MRI, PET)

##### Prostate Biopsy (TRUS guided)

- Acquire the necessary competence to perform and interpret transrectal ultrasound (TRUS)
- Be familiar with the different probes and needles/biopsy devices used for biopsies (TRUS guided)
- Understand the triaging of patients presenting with high PSA
- Acquire the necessary competence to carry out TRUS guided prostate biopsies according to local protocols
- Understand and list the complications of the procedure and how to avoid them
- Have adequate knowledge of the handling of biopsies specimen

### Management of Prostate Cancer

Have a good understanding of the management of prostate cancer and different treatment modalities and when possible be involved in the appropriate MDT meetings

- In specialised centres be familiar with the setup and the role of interventional radiologist in brachytherapy
  - Understand the indications and limitations of brachytherapy
  - Understand and list the complications of brachytherapy
  - Have a good knowledge of follow up protocols
- In specialised centres be familiar with the setup and role in radiology in High Intensity Focused Ultrasound (HIFU)
  - Understand the indications and limitations of HIFU
  - Understand and lists the complications of HIFU
  - Have a good knowledge of the follow up protocols
- Be familiar and understand other minimally invasive treatment modalities (cryotherapy, laser)
- Have a good understanding of the Surgical procedures and indications for post-operative imaging
- Have a good understanding of hormonal treatment as well as the management of advanced disease
- Have a good understanding of the indications and methods of external beam radiotherapy

### PROSTATITIS (ABSCESS)

- Understand the clinical presentations and pathology of prostatitis and imaging modalities
- Be familiar with methods of diagnosis of prostate abscess
- Understand and be familiar with methods of draining prostate abscess using image guidances (CT or TRUS) as well as different approach (Trans-rectal, trans-perineal)
- Understand and list the complications of prostate abscesses and drainage procedures

### 3.3.8 Male Infertility (Obstruction)

- Understand the anatomy of the male reproductive system
- Understand the congenital and acquired conditions associate with male infertility
- Understand and acquire the ability to interpret the imaging modalities used (TRUS, MRI)
- Be familiar with and acquire the skills to carry out contrast studies to demonstrate patency of the reproductive system
  - Seminal vesiculography
  - Vasography

## Orthopaedic Interventional Radiology 3.4

### Image directed Biopsy of Soft Tissue (ST) and Bones 3.4.1

#### CLINICAL CONSIDERATIONS

- List the indications and contra-indications for bone/ST biopsy
- Be aware of the consequences of inappropriate biopsy of primary bone/ST sarcomas
- Be familiar with the variety of biopsy needles and techniques including the use of CT fluoroscopy and various targeting technologies for accessing difficult lesions
- Identify alternatives to transthoracic biopsy for patients with central subcarinal masses at bronchoscopic biopsy. Appropriately manage pre-procedural work-up including appropriate laboratory values
- Be familiar with the treatment algorithm of patients experiencing significant haemorrhage following biopsy

#### IMAGING ASPECTS

- Describe the advantages and disadvantages of various imaging modalities for biopsy of soft tissue lesions in the chest, cervical region, abdomen and musculoskeletal lesions
- Describe the advantages and disadvantages of various imaging modalities for the biopsy of ribs, long bones and spinal lesions
- Identify safe approaches to percutaneous biopsy of lesions in the abdomen including retroperitoneal lymph nodes, pancreatic lesions, hepatic lesion and others
- Identify safe approaches to percutaneous biopsy of bone lesions demonstrating knowledge of overlying neurovascular and compartmental anatomy

#### PATHOLOGY

- Recognise which lesions are best approached with fine needle aspiration versus core biopsy
- Have knowledge of when to send material for appropriate microbiological evaluation if infection is suspected
- Be aware of the requirements for correct preservation, preparation and packaging and specimens for histological, cytological, microbiological investigations
- Be aware of the requirement for correct labelling of specimens and completion of request forms for histological, cytological or microbiological investigation
- Ensure correct and prompt transfer of specimens to appropriate laboratory

#### THERAPY

- Be able to treat patients with post-biopsy Pneumothorax including appropriate drainage
- Appreciate the suitability of different needle types for dense cortical bone, trabecular bone, lytic bone lesions and marrow aspirates

## 3.4.2 Spinal Intervention

### VERTEBRAL BODY COMPRESSION FRACTURES (VBCF)

#### Clinical Aspects

- Appropriately identify patients with Symptomatic VBCF
- Be able to identify patients with symptomatic VBCF
- Identify the indication for percutaneous vertebroplasty (PV) in patients with VBCF and understand the medical and surgical options in these patients
- Categorize VBCF as to their appropriateness and expected response for treatment with percutaneous techniques
- Identify patients who may benefit from kyphoplasty and the differences between kyphoplasty and vertebroplasty

#### Anatomy

- Demonstrate knowledge of proper vertebral body access techniques (transpedicular, parapedicular)

#### Imaging

- Integrate non-invasive testing (CT, MRI, Nuclear Medicine Scintigraphy), physical findings and past surgical history to identify symptomatic levels

#### Pathology

- Understand the pathophysiology of osteoporosis and neoplastic disease as it relates to the spine
- List the absolute and relative contra-indications to PV

#### Therapy

- List the complications of PV and their incidence as documented in the literature for VBCF secondary to osteoporosis and neoplastic spinal involvement
- Be familiar with interventional equipment used in PV including, but not limited to, cement delivery systems, needles and x-ray screening facilities
- Have an awareness of CE marking and licensing for cements and additional agents used in vertebroplasty
- Understand pre-procedural, intra-procedural and post-procedural pharmacological management for patients undergoing PV including constant sedation, narcotic and nonnarcotic allergies
- Understand the role of an anaesthetist/sedationist during PV
- List the absolute and relative contra-indications to PV

## SPINAL INJECTION PROCEDURES

*(Selective Nerve Root Blocks, Epidural Steroid Injections, Facet Joint Blocks, Discography, Radiofrequency Ablation of the Intervertebral Discs)*

### Clinical Aspects

- Understand the pathophysiology of and aetiology of various spinal pain syndromes including, but not limited to, discogenic pain, facet joint syndrome, spinal stenosis and nerve root impingement
- Appropriately identify patient with spinal pain syndrome
- Perform a directed history and physical exam in patient with back pain and/or radicular pain
- Identify the indications for spinal injection procedures on patients with back pain and/or radicular pain
- Understand the medical and surgical treatment options in these patients

### Anatomy

- Demonstrate appropriate knowledge of spinal anatomy and spinal fluoroscopic anatomy
- Be able to direct and interpret imaging
- Integrate non-invasive testing (CT, MRI, Nuclear Medicine Scintigraphy), physical findings and past surgical history to plan appropriate treatment strategies

### Therapy

- List the complications of spinal injection procedures and their incidence as documented in the literature
- Be familiar with interventional equipment as used in spinal injection procedures
- Understand pre-procedural, intra-procedural and post-procedural pharmacological management for patients undergoing spinal injection procedures including conscious sedation, narcotic and non-narcotic analgesics
- Demonstrate appropriate knowledge of steroids and anaesthetics used in spinal injection procedures
- List the absolute and relative contra-indications for spinal injections procedures and radiofrequency ablation

## RADIOFREQUENCY ABLATION OF OSTEIOD OSTEOMA

### Clinical Consideration

- Select patients with osteoid osteoma who will benefit from local tumour ablation
- Appreciate the intense pain produced by biopsy of osteoid osteoma and the consequent anaesthetic requirements
- Be aware of the principles for imaged-guided bone biopsy as applicable to ablation

### Therapy

- Understand the basic principles of local tumour ablation with radio-frequency ablation
- Orchestrate proper follow-up imaging, laboratory and clinical evaluation after interventional therapy

## Acronyms

|                 |   |
|-----------------|---|
| <b>AUS</b>      | Antegrade Ureteric Stenting   |
| <b>AVM</b>      | Arteriovenous Malformation  |
| <b>BP</b>       | Blood Pressure  |
| <b>canMEDS</b>  | Canadian Medical Education Directives for Specialists                       |
| <b>CBD</b>      | Common Bile Duct  |
| <b>CE</b>       | European Economic Area Certification  |
| <b>CIN</b>      | Contrast induced Nephropathy  |
| <b>CRC</b>      | Colorectal Carcinoma  |
| <b>CT</b>       | Computed Tomography   |
| <b>CTA</b>      | Computed Tomographic Angiography  |
| <b>CXR</b>      | Chest X-Ray   |
| <b>DAS</b>      | Digital Subtraction Angiography   |
| <b>DOPS</b>     | Direct Observation of Practice and Procedures                               |
| <b>DOQI</b>     | Dialysis Outcomes Quality Initiative (US National Kidney Foundation)        |
| <b>DRE</b>      | Digital Rectal Examination  |
| <b>ERCP</b>     | Endoscopic Resonance Cholangio-Pancreatography                              |
| <b>ESWL</b>     | Extracorporeal Shock Wave Lithotripsy                                       |
| <b>Gd-BOPTA</b> | Gadobenate dimeglumine (Contrast agent)                                     |
| <b>Gd-EOB</b>   | Gadolinium Ethoxybenzyl (Contrast agent)                                    |
| <b>GU</b>       | Genito-Urinary  |
| <b>HIFU</b>     | High Intensity Focused Ultrasound   |
| <b>HPB</b>      | Hepato-Pancreatico-Biliary  |
| <b>IGA</b>      | Image Guided Ablation   |
| <b>IVC</b>      | Intravenous Catheter  |
| <b>IVCO</b>     | Inferior Vena Cava Occlusion  |
| <b>MCQs</b>     | Multiple Choice Questions   |
| <b>MDT</b>      | Multi-Disciplinary Team   |
| <b>MRA</b>      | Magnetic Resonance Angiography  |
| <b>MRCP</b>     | Magnetic Resonance Cholangio-Pancreatography                                |
| <b>MRI</b>      | Magnet Resonance Imaging  |
| <b>NICE</b>     | National Institute for Health and Clinical Excellence (UK)                  |
| <b>ODA</b>      | Operating Department Assistant  |
| <b>OSCE</b>     | Objective Structured Clinical Examination                                   |
| <b>PAD</b>      | Peripheral Arterial Disease   |
| <b>PAN</b>      | Polyarteritis Nodosa  |
| <b>PAT</b>      | Peer Assessment Tools   |
| <b>PCNL</b>     | Percutaneous Nephrolithotomy  |
| <b>PET</b>      | Positron Emission Tomography  |
| <b>PICC</b>     | Peripherally Inserted Central Catheter                                      |
| <b>PMETB</b>    | Post Graduate Medical Education Training Board (UK)                         |
| <b>PSA</b>      | Prostate Specific Antigen   |
| <b>PV</b>       | Percutaneous Vertebroplasty   |
| <b>RUS</b>      | Retrograde Ureteric Stenting  |
| <b>SFA</b>      | Superficial Femoral Artery  |
| <b>SPIO</b>     | Super Paramagnetic Iron Oxide (Contrast agent)                              |
| <b>ST</b>       | Soft tissue   |
| <b>SVC</b>      | Superior Vena Cava  |
| <b>SVCO</b>     | Superior Vena Cava Obstruction  |
| <b>SVS/ISCS</b> | Society of Vascular Surgery/International Society of Cardiovascular Surgery |
| <b>TIPS</b>     | Transjugular Intrahepatic Portosystemic Shunt                               |
| <b>TOS</b>      | Thoracic Outlet Syndrome  |
| <b>TRAS</b>     | Transplant Renal Artery Stenosis  |
| <b>TRUS</b>     | Transrectal Ultrasound  |
| <b>UEMS</b>     | Union Européenne des Médecins Spécialisés                                   |
| <b>UFE</b>      | Uterine Fibroid Embolization  |
| <b>UICC-TNM</b> | International Union Against Cancer Classification of Malignant Tumours      |
| <b>VBCF</b>     | Vertebral Body Compression Fractures  |
| <b>VC</b>       | Vena Cava   |
| <b>VM</b>       | Venous Malformation   |



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