The Unofficial Guide to Radiology

"The Unofficial Guide to Radiology" follows on from the "The Unofficial Guide to Passing OSCEs". This book teaches systematic analysis of the three main types of X-rays: chest, abdominal and orthopaedic, with additional chapters looking at all the other main radiology tests such as CT and MRI. The layout is designed to make the book as relevant to clinical practice as possible; the X-rays are presented in the context of a real life scenario. The reader is asked to interpret the X-ray before turning over the page to reveal a model report accompanied by a fully annotated version of the X-ray. To further enhance the clinical relevance, each case has 5 clinical and radiology-related multiple-choice questions with detailed answers. These test core knowledge for exams and working life, and illustrate how the X-ray findings will influence patient management.

This book is suitable for:

- Medical Students
- Radiographers
- Nursing Students
- Junior Doctors
- Physicians Associates
- Nurses
- Advanced Nurse Practitioners

"Radiology is a constant challenge for students and doctors in busy clinical units; having a good command of the essentials is a real advantage. This book is well-presented and very accessible. The annotated examples provide realistic challenges with immediate feedback. It didn’t take long before I felt better prepared for my next ward round!"

Simon Maxwell, Professor of Student Learning, University of Edinburgh

"Perhaps one of the biggest strengths of this book is the cases section, allowing you to practice not only interpreting high quality images but also to link them to a case history. The questions that follow not only test your radiology, but also your understanding of signs, symptoms, underlying pathophysiology and management of the condition. As well as detailed answers in each section, the book also shows you the best way to present each case, whether in an OSCE situation or on a ward round. The ease of use, detailed pictures and emphasis on key points of this one should cement it as the number one undergraduate book for radiology.”

James Brookes, Medical Student

"Which radiographs from each system are most likely to be presented in exams? This excellent book presents the classics, and at one level this makes it a high-yield textbook that will be extremely valuable to medical students and junior doctors. What is especially striking is the definition and clarity of the illustrations, with on-image labelling enabling one to be absolutely certain of which is the endotracheal tube, the nasogastric tube and the central line, for example.”

Bob Clarke, Associate Dean, Professional Development, London. Director, Ask Doctor Clarke Ltd.

ISBN: 978 0 9571499 4 6

RRP £39.99

Join Our Medical Book Writing Project (details inside)
THE UNOFFICIAL GUIDE TO RADIOLOGY

FIRST EDITION

MARK RODRIGUES BSc (Hons) MBChB (Hons)
Radiology Registrar, Royal Infirmary of Edinburgh;
Honorary Clinical Tutor, University of Edinburgh, UK

ZESHAN QURESHI BM BSc (Hons)
Academic Clinical Fellow (International Child Health) Great Ormond Street
and Institute for Global Health, London;
Honorary Clinical Tutor, University of Edinburgh, UK
INTRODUCTION

‘The Unofficial Guide to Radiology’ is the fifth book in the Unofficial Guide to Medicine series. Almost every patient has some form of medical imaging performed during his or her investigations and management. The commonest form of imaging, and the modality which all doctors should be able to interpret, remains the X-ray. This important aspect of radiology is therefore the main focus of the book. Other imaging modalities are specialised investigations interpreted by radiologists. However, medical students, doctors, nurses, physician’s associates, and surgeons need to understand what these tests involve, when they are indicated and contraindicated, and how to best request them. Therefore, these aspects are also covered in the book.

Despite its universal importance, X-ray interpretation is often an overlooked subject in the medical school curriculum, which many medical students and junior doctors find difficult and daunting. I was no different when I started work as a junior doctor. However, since starting radiology training, I have realised X-ray interpretation should not be that way.

The keys to interpreting X-rays are having a systematic method for assessing the X-ray and getting lots of practice at looking at and presenting X-rays. Occasionally, there may be a complex X-ray you find difficult, or a subtle finding you overlook, but that’s what keeps people like me in a job, so do not worry about it.

The “4 Ds” are a useful framework for X-ray interpretation which underpins the approach used in this book. First, you need to Detect and Describe the abnormalities on the X-ray. You then need to form a Differential diagnosis based on clinical and X-ray findings before Deciding what further imaging and management is required.

There are lots of radiology textbooks available, but I do not think there is one which is ideally suited for teaching medical students and junior doctors. Many have small, often poor quality images. Radiology is a visual subject and therefore such images are difficult to use to demonstrate key clinical findings. This is confounded by the fact that the findings are usually only described in a figure below the image, and it is often difficult to know exactly what part of the image corresponds to which finding! Another fundamental problem with many radiology textbooks is that they deal with X-rays in isolation. In reality, X-rays are part of the clinical assessment and management of patients, and thus they should be taught in a clinical context.

The content, layout and approach used in this book are designed to make it as useful and clinically relevant as possible:

• Over 200 large, high quality radiological images are used throughout the book and important findings are annotated on the images to highlight the key points and findings to the reader.
• The chest, abdominal and orthopaedic X-ray chapters contain step-by-step approaches to interpreting and presenting X-rays.
• Each of these chapters also covers 20 common and important X-ray cases/diagnoses. They are labelled as ‘Case X’ to not give away the diagnosis, but at the end of the book there is a list of all the diagnoses.
• The X-rays are presented in the context of a clinical scenario. The reader is asked to “present their findings” before turning over the page to reveal a model X-ray report accompanied by a fully annotated version of the X-ray. This encourages the reader to look at the X-ray thoroughly, as if working on a ward, and come to their own conclusions about the X-ray findings and any further management required before seeing the answers.
• To further enhance the clinical relevance, each case has 5 clinical and radiology-related multiple-choice questions with detailed answers. These are aimed to test core knowledge needed for exams and working life, and illustrate how the X-ray findings will influence patient management.
• The bonus X-ray chapter provides over 50 further X-ray cases to help consolidate the reader’s knowledge and provide an opportunity to practice the skills they have learnt.

• Five chapters are devoted to other important imaging investigations: computed tomography (CT), magnetic resonance imaging (MRI), ultrasound (USS), nuclear medicine, and fluoroscopy. These cover the details of what the examinations entail, their common indications, contraindications and key imaging findings.

• The content is in line with the Royal College of Radiologists’ Undergraduate Radiology Curriculum 2012, making it up to date and relevant to today’s students and junior doctors.

With this textbook, we hope you will become more confident and competent in these radiology competencies, both in exams and in clinical practice, and we also hope that this is just the beginning. We want you to get involved, this textbook has been a collaboration with junior doctors and students just like you. You have the power to contribute something valuable to medicine; we welcome your suggestions and would love for you to get in touch. A good starting point is our Facebook page, which is growing into a forum for medical education: Search for “The Unofficial Guide to Medicine” or enter the hyperlink below into your web browser.

Please get in touch and be part of the medical education project.

Mark Rodrigues, mark.a.rodrigues@gmail.com

Zeshan Qureshi, zeshanqureshi@doctors.org.uk, @DrZeshanQureshi

Facebook: http://www.facebook.com/TheUnofficialGuideToMedicine
Radiology is encountered every day by medical students. From the wards to OSCEs, from theatre to outpatient clinics, radiology is everywhere at the undergraduate level and beyond. The importance of understanding the principles of imaging, radiation doses and the clinical interpretation of results is paramount. Radiology is a key diagnostic and monitoring tool in modern medicine, so the ability to assess an X-ray in a systematic order is a vital skill. The vast range of techniques, and the complexity of the human body, means this is not a subject that can be learnt overnight, and this book aims to provide you with a grounding in this mammoth specialty.

The authors have ensured they have included the basic scientific principles underlying radiology. The book covers many imaging modalities and presents them in a systematic order to give you a clear approach to interpreting what you see. Detailed pictures along the way point out normal anatomical features as well as deformities and anomalies. Perhaps one of the biggest strengths of this book is the cases section, which allows you to practice not only interpreting high quality images but also to link them to a case history. The questions that follow not only test your radiology knowledge, but also your understanding of signs, symptoms, underlying pathophysiology and management of the condition. As well as providing detailed answers in each section, the book also shows you the best way to present each case, whether in an OSCE situation or on a ward round.

"The Unofficial Guide to OSCEs has quickly become established as one of the most useful undergraduate books. The ease of use, detailed pictures and emphasis on key points of this title should cement it as the number one undergraduate book for radiology. I hope you find it invaluable throughout your studies and it brings you success in all of your exams!"

James Brookes

Which radiographs from each system are most likely to be presented in exams? This excellent book presents the classics, and at one level this makes it a high-yield textbook that will be extremely valuable to medical students and junior doctors.

But it is much more than that. Not only does it teach pattern recognition, it also clearly and simply explains the underlying concepts which make such images easier to interpret and answers all those tricky questions that return to haunt clinicians on a regular basis. For example, when should I use CT and when would magnetic resonance imaging be more appropriate?

This book also teaches a systematic approach to reporting, with the bonus cases particularly useful in enabling readers to check that they have learnt from the core cases that have gone before. This interactivity is essential to its success and the skills acquired will transfer to life beyond the exams.

What is especially striking is the definition and clarity of the illustrations, with on-image labelling enabling one to be absolutely certain of which is the endotracheal tube, the nasogastric tube and the central line, for example.

"Mark Rodrigues and Zeshan Qureshi are to be congratulated on producing this excellent volume. As with the other books in this series, the multi-author collaborative approach works exceptionally well and the democratisation of the reviewing process ensures that this will meet the needs of medical students and junior doctors, both in their exams and in their day to day work. In summary, this is another classic in the “Unofficial Guide” series."

Bob Clarke
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A&amp;E</td>
<td>accident and emergency</td>
</tr>
<tr>
<td>AAA</td>
<td>abdominal aortic aneurysm</td>
</tr>
<tr>
<td>ACE</td>
<td>angiotensin converting enzyme</td>
</tr>
<tr>
<td>ACJ</td>
<td>acromio-clavicular joint</td>
</tr>
<tr>
<td>ADEM</td>
<td>acute disseminated encephalomyelitis</td>
</tr>
<tr>
<td>ADH</td>
<td>anti-diuretic hormone</td>
</tr>
<tr>
<td>AIN</td>
<td>anterior interosseous nerve</td>
</tr>
<tr>
<td>AMT</td>
<td>abbreviated mental test</td>
</tr>
<tr>
<td>ANCA</td>
<td>anti-neutrophil cytoplasmic antibodies</td>
</tr>
<tr>
<td>AP</td>
<td>anterior to posterior</td>
</tr>
<tr>
<td>ATLS</td>
<td>Advanced Trauma Life Support</td>
</tr>
<tr>
<td>AV</td>
<td>arteriovenous</td>
</tr>
<tr>
<td>AVN</td>
<td>avascular necrosis</td>
</tr>
<tr>
<td>AXR</td>
<td>abdominal X-ray</td>
</tr>
<tr>
<td>BTS</td>
<td>British Thoracic Society</td>
</tr>
<tr>
<td>CABG</td>
<td>coronary artery bypass graft</td>
</tr>
<tr>
<td>CBD</td>
<td>common bile duct</td>
</tr>
<tr>
<td>CCAM</td>
<td>congenital cystic adenoid malformation</td>
</tr>
<tr>
<td>cm</td>
<td>centimetre</td>
</tr>
<tr>
<td>COPD</td>
<td>chronic obstructive pulmonary disease</td>
</tr>
<tr>
<td>CPAP</td>
<td>continuous positive airway pressure ventilation</td>
</tr>
<tr>
<td>CRP</td>
<td>C-reactive protein</td>
</tr>
<tr>
<td>CSF</td>
<td>cerebrospinal fluid</td>
</tr>
<tr>
<td>CT</td>
<td>computer tomography</td>
</tr>
<tr>
<td>CTPA</td>
<td>computer tomography pulmonary angiogram</td>
</tr>
<tr>
<td>DDH</td>
<td>developmental dysplasia of the hip</td>
</tr>
<tr>
<td>DEXA</td>
<td>dual energy X-ray absorptiometry</td>
</tr>
<tr>
<td>DHS</td>
<td>dynamic hip screw</td>
</tr>
<tr>
<td>DIPJ</td>
<td>distal interphalangeal joint</td>
</tr>
<tr>
<td>DMSA</td>
<td>dimercaptosuccinic acid</td>
</tr>
<tr>
<td>DTPA</td>
<td>diethylenetriaminepentaacetic acid</td>
</tr>
<tr>
<td>DVT</td>
<td>deep venous thrombosis</td>
</tr>
<tr>
<td>DWI</td>
<td>diffusion weighted image</td>
</tr>
<tr>
<td>ECG</td>
<td>electrocardiogram</td>
</tr>
<tr>
<td>ECG</td>
<td>ear, nose and throat</td>
</tr>
<tr>
<td>ERCP</td>
<td>endoscopic retrograde cholangiopancreatogram</td>
</tr>
<tr>
<td>ESR</td>
<td>erythrocyte sedimentation rate</td>
</tr>
<tr>
<td>ESWL</td>
<td>extracorporeal shock wave lithotripsy</td>
</tr>
<tr>
<td>ET</td>
<td>endo-tracheal</td>
</tr>
<tr>
<td>EVAR</td>
<td>endovascular aneurysm repair</td>
</tr>
<tr>
<td>FAST</td>
<td>focused assessment with sonography in trauma</td>
</tr>
<tr>
<td>FDL</td>
<td>flexor pollicis longus</td>
</tr>
<tr>
<td>FDP</td>
<td>flexor digitorum profundus</td>
</tr>
<tr>
<td>FDS</td>
<td>flexor digitorum superficialis</td>
</tr>
<tr>
<td>FLAIR</td>
<td>fluid attenuation inversion recovery</td>
</tr>
<tr>
<td>FOOSH</td>
<td>falls onto an outstretched hand</td>
</tr>
<tr>
<td>G</td>
<td>gauge</td>
</tr>
<tr>
<td>g/L</td>
<td>grams per litre</td>
</tr>
<tr>
<td>G&amp;S</td>
<td>group and save</td>
</tr>
<tr>
<td>GCS</td>
<td>Glasgow coma scale</td>
</tr>
<tr>
<td>GI</td>
<td>gastrointestinal</td>
</tr>
<tr>
<td>GTN</td>
<td>glycercy trinitrate</td>
</tr>
<tr>
<td>HAS</td>
<td>human serum albumin</td>
</tr>
<tr>
<td>HIDA</td>
<td>hepatobiliary iminodiacetic acid</td>
</tr>
<tr>
<td>HIP</td>
<td>heparin-induced thrombocytopenia</td>
</tr>
<tr>
<td>HLA</td>
<td>human leukocyte antigen</td>
</tr>
<tr>
<td>HPOA</td>
<td>hypertrophic pulmonary osteoarthropathy</td>
</tr>
<tr>
<td>HRCT</td>
<td>high resolution CT</td>
</tr>
<tr>
<td>HRT</td>
<td>hormone replacement therapy</td>
</tr>
<tr>
<td>HU</td>
<td>Hounsfield unit</td>
</tr>
<tr>
<td>IRMER</td>
<td>ionising radiation [medical exposure] regulations</td>
</tr>
<tr>
<td>ITP</td>
<td>idiopathic thrombocytopenic purpura</td>
</tr>
<tr>
<td>ITU</td>
<td>intensive treatment unit</td>
</tr>
<tr>
<td>IU</td>
<td>international unit</td>
</tr>
<tr>
<td>IUCD</td>
<td>intrauterine contraceptive device</td>
</tr>
<tr>
<td>IV</td>
<td>intra-venous</td>
</tr>
<tr>
<td>IVC</td>
<td>inferior vena cava</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>IVU</td>
<td>intravenous urogram</td>
</tr>
<tr>
<td>JVP</td>
<td>jugular venous pressure</td>
</tr>
<tr>
<td>kg</td>
<td>kilogram</td>
</tr>
<tr>
<td>KUB</td>
<td>kidneys, urethra, bladder</td>
</tr>
<tr>
<td>LDH</td>
<td>lactate dehydrogenase</td>
</tr>
<tr>
<td>LIF</td>
<td>left iliac fossa</td>
</tr>
<tr>
<td>LLL</td>
<td>left lower lobe</td>
</tr>
<tr>
<td>LUL</td>
<td>left upper lobe</td>
</tr>
<tr>
<td>m</td>
<td>metre</td>
</tr>
<tr>
<td>MAG3</td>
<td>methyl-acetyl-gly-gly-gly</td>
</tr>
<tr>
<td>MCPJ</td>
<td>metacarpophalangeal joint</td>
</tr>
<tr>
<td>MDP</td>
<td>methylene disphosphonate</td>
</tr>
<tr>
<td>MDT</td>
<td>multi-disciplinary team</td>
</tr>
<tr>
<td>MIRP</td>
<td>minimally invasive retroperitoneal pancreatic necrosectomy</td>
</tr>
<tr>
<td>mm</td>
<td>millimetre</td>
</tr>
<tr>
<td>mmHg</td>
<td>millimetres of mercury</td>
</tr>
<tr>
<td>mmol/L</td>
<td>millimoles per litre</td>
</tr>
<tr>
<td>MRA</td>
<td>magnetic resonance angiography</td>
</tr>
<tr>
<td>MRCP</td>
<td>magnetic resonance cholangiopancreatogram</td>
</tr>
<tr>
<td>MRI</td>
<td>magnetic resonance imaging</td>
</tr>
<tr>
<td>MRSA</td>
<td>methicillin resistant Staphylococcus aureus</td>
</tr>
<tr>
<td>mSv</td>
<td>milliSieverts</td>
</tr>
<tr>
<td>MTPJ</td>
<td>metatarsophalangeal joint</td>
</tr>
<tr>
<td>NAI</td>
<td>non-accidental injury</td>
</tr>
<tr>
<td>NG</td>
<td>naso-gastric</td>
</tr>
<tr>
<td>NSAID</td>
<td>non-steroidal anti-inflammatory drug</td>
</tr>
<tr>
<td>OA</td>
<td>osteoarthritis</td>
</tr>
<tr>
<td>PA</td>
<td>posterior to anterior</td>
</tr>
<tr>
<td>PaCO₂</td>
<td>partial pressure of carbon dioxide</td>
</tr>
<tr>
<td>PaO₂</td>
<td>partial pressure of oxygen</td>
</tr>
<tr>
<td>PE</td>
<td>pulmonary embolus</td>
</tr>
<tr>
<td>PEA</td>
<td>pulseless electrical activity</td>
</tr>
<tr>
<td>PEG</td>
<td>percutaneous endoscopic gastrostomy</td>
</tr>
<tr>
<td>PET</td>
<td>positron emission tomography</td>
</tr>
<tr>
<td>PFO</td>
<td>patent foramen ovale</td>
</tr>
<tr>
<td>PICC</td>
<td>peripherally inserted central catheter</td>
</tr>
<tr>
<td>PIN</td>
<td>posterior interosseous nerve</td>
</tr>
<tr>
<td>PIPJ</td>
<td>proximal interphalangeal joint</td>
</tr>
<tr>
<td>PR</td>
<td>per rectum</td>
</tr>
<tr>
<td>RLL</td>
<td>right lower lobe</td>
</tr>
<tr>
<td>RML</td>
<td>right middle lobe</td>
</tr>
<tr>
<td>RUL</td>
<td>right upper lobe</td>
</tr>
<tr>
<td>RUQ</td>
<td>right upper quadrant</td>
</tr>
<tr>
<td>SCIWORA</td>
<td>spinal cord injury without radiological abnormality</td>
</tr>
<tr>
<td>SHO</td>
<td>senior house officer</td>
</tr>
<tr>
<td>SI</td>
<td>sacroiliac</td>
</tr>
<tr>
<td>SiADH</td>
<td>syndrome of inappropriate anti-diuretic hormone</td>
</tr>
<tr>
<td>SLE</td>
<td>systemic lupus erythematosus</td>
</tr>
<tr>
<td>SMA</td>
<td>superior mesenteric artery</td>
</tr>
<tr>
<td>SMV</td>
<td>superior mesenteric vein</td>
</tr>
<tr>
<td>SP</td>
<td>spinous process</td>
</tr>
<tr>
<td>STIR</td>
<td>short tau inversion recovery</td>
</tr>
<tr>
<td>SUFE</td>
<td>slipped upper femoral epiphysis</td>
</tr>
<tr>
<td>TB</td>
<td>tuberculosis</td>
</tr>
<tr>
<td>THR</td>
<td>total hip replacement</td>
</tr>
<tr>
<td>TNF</td>
<td>tumour necrosis factor</td>
</tr>
<tr>
<td>TNM</td>
<td>tumour, nodes, metastases</td>
</tr>
<tr>
<td>U&amp;Es</td>
<td>urea and electrolytes</td>
</tr>
<tr>
<td>USS</td>
<td>ultrasound scan</td>
</tr>
<tr>
<td>VQ</td>
<td>ventilation/perfusion</td>
</tr>
<tr>
<td>VTE</td>
<td>venous thromboembolism</td>
</tr>
<tr>
<td>β-HCG</td>
<td>beta human chorionic gonadotrophin</td>
</tr>
</tbody>
</table>
CONTRIBUTORS

Editors
Mark Rodrigues
Radiology Registrar, Edinburgh Royal Infirmary, Edinburgh, UK

Zeshan Qureshi
Academic Clinical Fellow, Great Ormond Street and Institute of Global Health, London, UK

Authors
Jonathan Rodrigues
Radiology Registrar
(Bristol Royal Infirmary, Bristol)

Chest X-rays
Abdominal X-rays

Mark Rodrigues
Radiology Registrar
(Edinburgh Royal Infirmary, Edinburgh)

Introduction
Chest X-rays
Abdominal X-rays
CT
MRI
Ultrasound
Nuclear Medicine Scans
Fluroscopy

Bijan Hedayati
Radiology Consultant
(Lewisham Hospital, London)

Chest X-rays

Chris Gee
Orthopaedic Registrar, Trauma and Orthopaedics
(Western Sussex Hospitals, Sussex)

Orthopaedic X-rays

Amanda Cheng
Radiology Registrar (Western General Hospital and Edinburgh Royal Infirmary, Edinburgh)

Bonus X-rays

Kabir Varghese
Radiology Registrar
(Chelsea and Westminster, London)

Bonus X-rays

Reviewers
Brendan Kelly
University College Dublin

Chloe Thomson
University of Leicester

Marianna Christodoulou
University of Manchester

Madelaine Gimzewska
University of Edinburgh

Katherine Lattey
Brighton and Sussex Medical School

Jessica Spiteri Paris
University of Malta
# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>11</td>
</tr>
<tr>
<td>What are X-rays?</td>
<td>11</td>
</tr>
<tr>
<td>How are X-rays used to produce images?</td>
<td>12</td>
</tr>
<tr>
<td>The main densities on X-ray</td>
<td>12</td>
</tr>
<tr>
<td>Magnification</td>
<td>12</td>
</tr>
<tr>
<td>The hazards of using X-rays</td>
<td>13</td>
</tr>
<tr>
<td>Relevant legislation</td>
<td>13</td>
</tr>
<tr>
<td>Pregnancy and X-rays</td>
<td>14</td>
</tr>
<tr>
<td>How to request radiology examinations</td>
<td>14</td>
</tr>
<tr>
<td>When and how to discuss a patient with radiology</td>
<td>15</td>
</tr>
<tr>
<td>Chest X-Rays*</td>
<td>17</td>
</tr>
<tr>
<td>Introduction</td>
<td>17</td>
</tr>
<tr>
<td>20 Clinical Cases</td>
<td>29</td>
</tr>
<tr>
<td>Abdominal X-Rays*</td>
<td>181</td>
</tr>
<tr>
<td>Introduction</td>
<td>181</td>
</tr>
<tr>
<td>20 Clinical Cases</td>
<td>189</td>
</tr>
<tr>
<td>Orthopaedic X-Rays*</td>
<td>335</td>
</tr>
<tr>
<td>Introduction</td>
<td>335</td>
</tr>
<tr>
<td>Spine X-Ray Cases</td>
<td>367</td>
</tr>
<tr>
<td>Shoulder X-Ray Cases</td>
<td>391</td>
</tr>
<tr>
<td>Elbow X-Ray Cases</td>
<td>399</td>
</tr>
<tr>
<td>Wrist X-Ray Cases</td>
<td>407</td>
</tr>
<tr>
<td>Hip X-Ray Cases</td>
<td>429</td>
</tr>
<tr>
<td>Knee X-Ray Cases</td>
<td>473</td>
</tr>
<tr>
<td>Tibia/Fibular X-Ray Cases</td>
<td>497</td>
</tr>
<tr>
<td>Ankle X-Ray Cases</td>
<td>513</td>
</tr>
<tr>
<td>CT Scans</td>
<td>521</td>
</tr>
<tr>
<td>CT Head</td>
<td>525</td>
</tr>
<tr>
<td>CT Cervical Spine</td>
<td>530</td>
</tr>
<tr>
<td>CT in Orthopaedics</td>
<td>530</td>
</tr>
<tr>
<td>CT Chest</td>
<td>531</td>
</tr>
<tr>
<td>CT Abdomen and Pelvis</td>
<td>535</td>
</tr>
<tr>
<td>MRI Scans</td>
<td>543</td>
</tr>
<tr>
<td>MRI Head</td>
<td>544</td>
</tr>
<tr>
<td>MRI Spine</td>
<td>549</td>
</tr>
<tr>
<td>MRCP</td>
<td>553</td>
</tr>
<tr>
<td>MRI Small Bowel</td>
<td>554</td>
</tr>
<tr>
<td>MRI Knee &amp; Other Joints</td>
<td>555</td>
</tr>
<tr>
<td>Ultrasound Scan</td>
<td>557</td>
</tr>
<tr>
<td>Neck USS</td>
<td>558</td>
</tr>
<tr>
<td>Chest USS</td>
<td>558</td>
</tr>
<tr>
<td>Abdominal USS</td>
<td>560</td>
</tr>
<tr>
<td>Pelvic USS</td>
<td>562</td>
</tr>
<tr>
<td>FAST Scanning</td>
<td>563</td>
</tr>
<tr>
<td>Vascular USS</td>
<td>563</td>
</tr>
<tr>
<td>Musculoskeletal USS</td>
<td>564</td>
</tr>
<tr>
<td>Ultrasound Guided Procedures</td>
<td>564</td>
</tr>
<tr>
<td>Nuclear Medicine Scans</td>
<td>565</td>
</tr>
<tr>
<td>VQ scan</td>
<td>566</td>
</tr>
<tr>
<td>Myocardial perfusion scan</td>
<td>567</td>
</tr>
<tr>
<td>Genitourinary scan</td>
<td>567</td>
</tr>
<tr>
<td>Bone imaging</td>
<td>568</td>
</tr>
<tr>
<td>PET/CT</td>
<td>569</td>
</tr>
<tr>
<td>Fluoroscopy</td>
<td>571</td>
</tr>
<tr>
<td>Contrast Swallow</td>
<td>572</td>
</tr>
<tr>
<td>Barium Follow Through</td>
<td>576</td>
</tr>
<tr>
<td>Contrast Enema</td>
<td>576</td>
</tr>
<tr>
<td>Tubogram</td>
<td>576</td>
</tr>
<tr>
<td>Bonus Cases*</td>
<td>579</td>
</tr>
<tr>
<td>Bonus Chest X-Rays</td>
<td>579</td>
</tr>
<tr>
<td>Advanced Chest X-Rays</td>
<td>579</td>
</tr>
<tr>
<td>Bonus Abdominal X-Rays</td>
<td>603</td>
</tr>
<tr>
<td>Advanced Abdominal X-Rays</td>
<td>613</td>
</tr>
<tr>
<td>Bonus Orthopaedic X-Rays</td>
<td>625</td>
</tr>
<tr>
<td>Advanced Orthopaedic X-Rays</td>
<td>637</td>
</tr>
<tr>
<td>* For Chest X-Rays, Abdominal X-Rays, Orthopaedic X-Rays and the Bonus Cases, all cases have been labelled ‘Case X’ to mimic real life clinical situations/assessment. For reference, the X-rays are also all listed by diagnosis and clinical signs on p695.</td>
<td></td>
</tr>
</tbody>
</table>
CHEST X-RAYS

This introduction to the chapter is aimed at providing a systematic framework for approaching chest X-rays. Further details and examples of the specific X-ray findings discussed below are covered more extensively in the example cases later in the chapter and in the bonus X-ray chapter.

In this book we look only at frontal chest X-rays (PA and AP X-rays), as these account for almost all chest X-rays performed. The lateral chest X-ray is not commonly performed and has been largely replaced by CT.

1. Projection (AP/ PA)

The projection of a chest X-ray can affect its appearance and interpretation. Therefore it is important to determine which projection has been used.

- The two possible projections for a frontal chest X-ray are the anteroposterior (AP) and the posteroanterior (PA). Somewhere on the X-ray you should see something that indicates whether it is AP or PA.
- The PA X-ray provides the best assessment of the thorax but requires the patient to be able to stand (or sit on a stool). This is the standard projection, so if there is no annotation stating otherwise, you can assume the X-ray is PA.

**Figure 1:** These are two chest X-rays from the same patient. **Image A** is a well inspired PA chest X-ray. **Image B** is a less well (but still adequately) inspired AP X-ray. Notice the dramatic effect of the projection and degree of inspiration on the apparent heart size. Also note the amount of the scapulae which is projected over the lungs in each projection.
• AP X-rays provide a less comprehensive assessment than PA X-rays due to the effects of magnification and the position of the scapulae (figure 1). They are usually only performed for haemodynamically compromised patients.

• If you cannot remember which one is the standard view, remember, “AP is ‘crAP’, so PA is standard”.

• If you are asked to justify why an X-ray is PA, remember that in PA X-rays, the patient’s arms are positioned in such a way that the scapulae are pulled almost fully out of the lung fields. In AP X-rays, this positioning is not possible, and the scapulae are projected further over the lungs.

2. Patient Details

• It is important to ensure you are looking at the correct X-ray from the correct patient.

• The patient’s details will be on the X-ray (unless anonymised for the exam).

• Say the name, age/date of birth, and when the X-ray was taken.

KEY POINT

There is a saying in radiology that the most important X-ray is the previous one. It is always helpful to compare the current X-ray with previous X-rays and imaging to see if there has been any change in the findings.

3. Technical Quality

• Check that the X-ray includes all of the thorax (both lung apices, the lateral sides of the ribcage, and both costophrenic angles). Important pathology can be missed if the entire thorax is not imaged.

• It is unlikely that you will be given an X-ray in the exam that does not show the entire lungs, but some parts are occasionally missed in practice.

• It is important to assess RIP – Rotation, Inspiration, Penetration.

Rotation

• The heads of the clavicles (medial ends) should be equidistant from the spinous processes of the vertebral bodies. If they are not, the patient is rotated.

• Patient rotation can erroneously give the impression of mediastinal shift or lung pathology (figure 2).

Inspiration

• PA and AP X-rays are taken in held deep inspiration. Count the ribs to assess inspiratory effort.

• You should count down to the lowest rib crossing through the diaphragm. Six anterior ribs or 10 posterior ribs indicate adequate inspiratory effort.

**Figure 2:** These are two X-rays from the same patient. **Image A:** The patient is well centred. **Image B:** The patient is so rotated that the trachea is no longer projected over the spine. The position of the heads of the clavicles shows this patient is markedly rotated. The left lower zone appears abnormal, but this is probably due to the marked patient rotation & the resultant abnormal position of the heart.

*This appearance is, however, probably caused by the abnormally positioned cardiac shadow, and a repeat X-ray with the patient well-centred should be obtained.*
Fewer ribs indicate an underinspired X-ray. This may be due to the timing of the X-ray, or more frequently, because the patient is unable to take and hold a deep breath (due to pain, breathing problems, or confusion). Underinspired X-rays can cause crowding of the lung markings at the bases, incorrectly giving the impression of consolidation or other pathology. Additionally, the heart may appear falsely enlarged (figure 1).

**Penetration**
- The X-ray is adequately penetrated if you can just see the vertebral bodies behind the heart.
- “Underpenetrated” means that you cannot see behind the heart and “overpenetrated” means that you will be able to see the vertebral bodies very clearly.
- Over and under penetration can obscure or obliterate significant findings, particularly in the lungs.
- This is less of a problem with the advent of digital viewers which allow the X-ray “windows” to be manipulated. However, this function can only manipulate the image so far, so adequate penetration is still important.

**KEY POINT**
Rotated, under-inspired or under/overpenetrated X-rays can hinder accurate assessment. These technical factors must be taken into account when assessing the X-ray.

**4. Obvious Abnormalities**

If you can see obvious abnormalities, say so and describe them:

**Which lung is involved?**

**Which part of the lung?**
- If possible, say which lobe is/lobes are involved. Remember it is not always possible to determine this on an X-ray – in which case use upper, middle, or lower zone to describe the abnormality’s location. CT can locate abnormalities more accurately.

**Size**

**Shape**
- Is it focal or diffuse, rounded or spiculated, well or poorly demarcated?

**Density**

Describe the density of an abnormality in relation to the normal surrounding tissue, e.g. if the abnormality is in the lung, compare it to the normal lung; if in the bone, compare it with the other bones.

If the abnormality is denser (i.e. whiter) than the normal tissue, you can say that there is increased opacification or density; if less-dense (i.e. blacker), say there is increased lucency or reduced density.

**Texture**

You should assess whether the abnormality has a uniform or heterogenous appearance.

**Other features**
- If there is anything else in the abnormality, such as air bronchograms or fluid levels, then mention these as well.
- Are there other abnormalities, such as volume change, bony abnormalities, or surgical clips?

**5. Systematic Review of the X-ray (Figure 3)**

Initially assess from a distance to see differences in lung shadowing/obvious masses. Previously, when using hard-copy X-rays, you would be taught to look at the X-ray initially from four feet; however, now most X-rays are viewed on computer so make sure you zoom out as much as possible for your initial inspection.

- After that, reassess from close-up to look for subtle abnormalities.
- It does not matter what system you use for assessing the X-ray, as long as you do not miss any areas.
- A useful system is ABCDD (Airway, Breathing, Circulation, Diaphragm/ Delicates).
- Also comment on manmade abnormalities, e.g. lines, pacemakers, a nasogastric (NG) tube.

**A – Airway**
- Is the trachea central?
- If not, is it deviated due to patient rotation or pathology?
• If the cause is pathological, is the trachea being pulled to one side (volume loss, such as lobar or lung collapse) or pushed away (increased volume such as a large pleural effusion or mediastinal mass)?

**B – Breathing**

- Start in the apices and work down to the costophrenic angles, comparing both lungs to look for differences.
- Ensure that you inspect the entire lung, including the apices, hila, and costophrenic angles.
- The left hilum should never be lower than the right. If this is the case, you must look for volume loss either pulling the right hilum up or pushing the left hilum down.
- Both hila should be the same density and have no lumps or convex margins.
- Look around the edge of the lungs, assessing for pneumothoraces. These can be particularly subtle at the lung apex.

**C – Cardiac and mediastinum**

- Assess the heart size. Cardiomegaly is defined by the maximal transverse cardiac diameter being greater than 50% of the maximal transverse internal thoracic diameter (cardiothoracic ratio). This can only be accurately assessed on a well-inspired PA X-ray due the effects of magnification on AP and underinspired X-rays (see figure 1). However, it is still important to assess cardiac size on an AP X-ray – if it’s normal on the AP, then it will be normal on the PA; conversely, if it is grossly enlarged on the PA, it is likely to be enlarged on the PA X-ray.
- The cardiac and mediastinal borders should be clearly visible. If this is not the case, you must consider whether there is pathology in the adjacent lung.
- The mediastinum and heart should be positioned over the thoracic vertebra. If this is not the case, you must first check that the patient is not rotated. Then you must assess for volume change in the lungs (either volume loss pulling structures towards the abnormal side or increased volume pushing them away), accounting for the position of the mediastinum and heart. Marginal mediastinal shift can be observed if the margins of the thoracic vertebral bodies can be clearly seen beyond the cardiac and mediastinal contours on a well-centred X-ray.
- Widening of the mediastinum may be due to technical factors (e.g. AP projection), vascular structures (e.g. unfolding of the thoracic aorta or aortic dissection), masses (mediastinal tumours or lymph node enlargement) or haemorrhage (e.g. ruptured aorta). The clinical findings in such cases are important, as the cause can be difficult to determine on X-ray. CT can be used if required for further assessment.
- The right paratracheal stripe can be useful to assess, if visible. It is composed of the soft tissue between the medial wall of the right lung and the right wall of the trachea. It is visible in 50-60% of X-rays and should measure <5mm in diameter. If it is thickened, it is commonly due to lymph node enlargement.
- The aortopulmonary window is another area to assess for lymph node enlargement. The aortopulmonary window is located between the aortic arch and the left pulmonary artery. Normally there should be no soft tissue visible in this region, thus giving the impression of a window. If this is not the case, you must consider lymph node enlargement.
- You should assess the mediastinum for the presence of gas within it (pneumomediastinum). This appears as linear lucencies projected over the mediastinum. These often extend into the neck and may be associated with surgical emphysema (figure 4).
- It is important to remember that the lung continues behind the heart (a large portion of the left lower lobe is behind the heart). The cardiac shadow should be of uniform density. If this is not the case, you must consider whether retrocardiac pathology, such as consolidation, lobar collapse, or a mass, is present. This can be difficult to assess due to the overlying cardiac shadow. Inverting the image often makes any abnormality more obvious (figure 5).

**D – Diaphragm**

- Both hemidiaphragms should be visible and upwardly convex. Flattening of a hemidiaphragm suggests raised intrathoracic pressure either from lung hyperexpansion, as seen in air trapping with COPD, or tension pneumothoraces.
- The right hemidiaphragm is normally slightly higher than the left due to the mass effect of the adjacent liver. If this is not the case, you must consider whether one of the hemidiaphragms is being abnormally pulled up or pushed down.
• Remember that the lungs extend behind the diaphragms, so you need to look for lung pathology through the hemidiaphragms. Again, inverting the image can make such pathology more obvious.

• Look for free air under the diaphragm. This can be difficult, as the gastric bubble and bowel loops can have a similar appearance (figure 6).

• The costophrenic angles should be sharp. If not, there is likely to be pleural fluid present.

D – Delicates

• Assess the bones. Look at the ribs for fractures or bone destruction. Assess the rib spaces, which should be roughly equal. Narrowing can be seen with volume loss in the underlying lung. Review the rest of the imaged skeleton for fractures or destructive bone lesions.

• Look at the soft tissues for evidence of surgical emphysema (gas [black areas] in the soft tissues) and previous surgery (surgical clips, mastectomy).

Figure 3: A normal PA chest X-ray demonstrating the normal anatomy.

Figure 4: PA chest X-ray showing linear lucencies projected over the upper mediastinum. Their location and appearances are consistent with a pneumomediastinum. There may also be evidence of gas within the soft tissues (surgical emphysema) or pericardium (pneumopericardium).

Figure 5: Image A: This X-ray looks normal on initial viewing; however, closer inspection of the review areas reveals a very subtle retrocardiac mass, which will be located in the medial aspect of the lower lobe. This abnormality is much easier to see if the X-ray is inverted (Image B).
Chest X-Rays

Introduction

Lines (see Figure 7)

- An endotraheal (ET) tube should have its tip proximal to the carina. Problems can arise if it is inserted too far and the tip enters one of the bronchi. This will result in collapse of the non-ventilated lobes.
- The tip of a nasogastric (NG) tube should lie well below the left hemidiaphragm in the stomach.

Problems to look out for include misplacement into the lungs, and the tip being within the distal oesophagus.

Central lines are most commonly inserted into the internal jugular veins. Their tips should be in mid or lower superior vena cava. Complications include misplacement and a pneumothorax.

Figure 6: These three X-rays show how difficult it can be to diagnose free subdiaphragmatic gas.

Image A: Is a normal chest X-ray with gas in the stomach. We know the gas is within the stomach, as it is under the left hemidiaphragm, and the soft tissue rim overlying the gas is a few millimetres thick, as it consists of the stomach wall and adjacent diaphragm.

Image B: Contrast that appearance to the centre X-ray, which shows a large pneumoperitoneum. In this case, the soft tissue rim between the lung and abdomen is very thin, as it solely represents the diaphragm.

Image C: Is a mimic of free subdiaphragmatic gas. In this case, inspection of the area below the right hemidiaphragm reveals bowel markings. These appearances are due to interposition of a loop of bowel between the liver and right hemidiaphragm, and is known as Chilaiditi’s sign.

Figure 7: An AP chest X-ray demonstrating satisfactorily positioned endotracheal tube, right and left internal jugular central lines, and nasogastric tube. Note that the right internal jugular line descends straight down the right side of the mediastinum (as it travels through the right brachiocephalic vein), whereas the left sided central line passes diagonally across the mediastinum (as it travels through the left brachiocephalic vein). The tips of both of the lines should be projected over the mid or lower superior vena cava.
6. Review Areas

Double-check the following areas, since pathology is easily overlooked at these sites on initial viewing (see figure 8):

- Apices
- Hila
- Behind the heart
- Costophrenic angles
- Under the diaphragm

7. Summary

- Summarise your findings and give a differential list. Think about the history and clinical examination as well as the X-ray findings when making your differential diagnosis.
- Say whether you would like to review previous imaging if you think this would help.
- Suggest further investigations, including imaging, which may be useful.
- Suggest a management plan for the patient.

KEY POINT

Remember you are looking at a chest X-ray, not a lung X-ray. Ensure you assess all of the X-ray, including the soft tissues, bones such as the clavicles, scapulae and visible humeri, and the upper abdomen.

SPECIFIC FINDINGS ON CHEST X-RAY

Pneumonia

- Dense or patchy consolidation, usually unilateral.
- May contain air bronchograms (air containing bronchioles running through consolidated lung).
- In the lower zones, pneumonia may be difficult to distinguish from effusions, so both should be on your differential list (remember there is often a parapneumonic effusion).
The silhouette sign is useful for locating in which lobe of the lung the pathology is located (figure 9). Normally, there is a sharp border between the aerated lung and the soft tissues of the heart and diaphragm. This is due to the large differences in the number of X-rays attenuated by the soft tissues (a relatively high proportion of X-rays) and the lung (relatively few X-rays).

If there is consolidation, the normally aerated lung is replaced by fluid or pus. This attenuates X-rays to a similar extent to the heart and diaphragms. The usually sharp border between the lung and these structures is thus lost if there is consolidation in the lobe abutting these soft tissues.

It is necessary to know which lobes contact the heart and diaphragmatic borders in order to be able to use the silhouette sign:

- **Diaphragms**: left and right lower lobes
- **Right heart border**: right middle lobe
- **Left heart border**: lingula (part of the left upper lobe)

---

**Figure 9**: X-rays demonstrating consolidation and the silhouette sign.

**Image A**: Shows loss of the medial aspect of the right hemidiaphragm but a clear right heart border, indicating right lower lobe consolidation.

**Image B**: Shows an indistinct right heart border with preservation of the right hemidiaphragm, in keeping with right middle lobe consolidation.

**Image C**: Shows a clear left heart border but loss of the left hemidiaphragm, consistent with left lower lobe consolidation.

**Image D**: The bottom right X-ray shows loss of the left heart border but a clear left hemidiaphragm, indicating consolidation within the lingula.
You can use the checklist below to assess the chest X-rays shown in this chapter.

<table>
<thead>
<tr>
<th>Technical Aspects</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Check patient details (name, date of birth, hospital number)</td>
<td>✔</td>
</tr>
<tr>
<td>Check the date of the X-ray</td>
<td>✔</td>
</tr>
<tr>
<td>Identify the projection of the X-ray</td>
<td>✔</td>
</tr>
<tr>
<td>Assess technical quality of X-ray (rotation, inspiration, penetration)</td>
<td>✔</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Obvious Abnormalities</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Describe any obvious abnormality</td>
<td>✔</td>
</tr>
<tr>
<td>Site (lung and zone/lobe)</td>
<td>✔</td>
</tr>
<tr>
<td>Size (if relevant)</td>
<td>✔</td>
</tr>
<tr>
<td>Shape (if relevant)</td>
<td>✔</td>
</tr>
<tr>
<td>Density</td>
<td>✔</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Systematic Review of the X-ray</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Position of trachea</td>
<td>✔</td>
</tr>
<tr>
<td>Assessment of lungs</td>
<td>✔</td>
</tr>
<tr>
<td>Size and appearance of hila</td>
<td>✔</td>
</tr>
<tr>
<td>Assess for cardiomegaly</td>
<td>✔</td>
</tr>
<tr>
<td>Assess cardiac and mediastinal borders and cardiophrenic angles</td>
<td>✔</td>
</tr>
<tr>
<td>Position and appearance of hemidiaphragms</td>
<td>✔</td>
</tr>
<tr>
<td>Evidence of pneumoperitoneum (free air under the diaphragm)</td>
<td>✔</td>
</tr>
<tr>
<td>Assess the imaged skeleton</td>
<td>✔</td>
</tr>
<tr>
<td>Assess the imaged soft tissues (e.g. surgical emphysema, mastectomy)</td>
<td>✔</td>
</tr>
<tr>
<td>Comment on iatrogenic abnormalities</td>
<td>✔</td>
</tr>
<tr>
<td>Look at review areas (apices, hila, behind the heart, costophrenic angles, under the diaphragm)</td>
<td>✔</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Summary</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Present findings</td>
<td>✔</td>
</tr>
<tr>
<td>Review relevant previous imaging if appropriate</td>
<td>✔</td>
</tr>
<tr>
<td>Provide a differential diagnosis where appropriate</td>
<td>✔</td>
</tr>
<tr>
<td>Suggest appropriate further imaging/investigations if relevant</td>
<td>✔</td>
</tr>
</tbody>
</table>
An 18 year old presents with sudden onset right sided chest pain and shortness of breath. As part of his work up he undergoes a chest X-ray.
**IN SUMMARY** – This chest X-ray shows a large right pneumothorax. There is no evidence of associated tension. There is no underlying cause discernible on this X-ray, suggesting that this is a primary spontaneous pneumothorax.
QUESTIONS

1. Which of the following are risk factors for a primary spontaneous pneumothorax?
   A) Male gender
   B) Smoking
   C) COPD
   D) Trauma
   E) Marfan’s syndrome

2. Which of the following clinical findings would be supportive of a large simple right sided pneumothorax?
   A) Central trachea. Dull percussion and reduced air entry on the right side of the chest
   B) Central trachea. Dull percussion with bronchial breathing and crackles on the right side of the chest
   C) Central trachea. Hyperresonant percussion and reduced air entry on the right side of the chest
   D) Central trachea. Hyperresonant percussion and reduced air entry on the left side of the chest
   E) Trachea deviated to the left. Hyperresonant percussion and reduced air entry on the right side of the chest. Hypotensive, tachycardic

3. Which of the following are appropriate differential diagnoses for a patient who presents with sudden breathlessness?
   A) Pulmonary embolus
   B) Pneumothorax
   C) Pneumonia
   D) Heart failure
   E) Anaphylaxis

4. Which of the following is the most appropriate initial imaging investigation in a patient suspected of having a simple pneumothorax?
   A) Erect PA chest X-ray
   B) PA and lateral chest X-rays
   C) Expiratory chest X-ray
   D) Supine chest X-ray
   E) CT

5. Which of the following is the most appropriate management option for a previously healthy patient with a small, asymptomatic primary pneumothorax?
   A) Conservative management and discharge the patient
   B) Conservative management with outpatient follow up
   C) Admit for conservative management, high flow oxygen, and monitoring
   D) Aspirate as much of the pneumothorax as possible
   E) Chest drain insertion
ANSWERS TO QUESTIONS

1. Which of the following are risk factors for a primary spontaneous pneumothorax?

The correct answers are A) Male gender and B) Smoking.

A pneumothorax is the presence of air or gas within the pleural space. The gas separates the visceral and parietal pleura, and can lead to the compression of the adjacent lung. Pneumothoraces can be considered as:

- Primary spontaneous (no cause is identified)
- Secondary spontaneous (occur in the setting of lung disease)
- Traumatic (either blunt or penetrating)
- Iatrogenic (such as after lung biopsy or central line or pacemaker insertion)

A) Male gender – Correct. As mentioned above, primary spontaneous pneumothoraces occur in patients without underlying lung disease or trauma. The precise cause of these pneumothoraces is uncertain. There is some evidence that they are due to the rupture of small sub-pleural blebs (small, air-filled cysts just under the visceral pleura). Patients are typically tall, slim young men. Other risk factors for primary spontaneous pneumothoraces include smoking and family history.

B) Smoking – Correct. Smoking is a recognised risk factor for primary spontaneous pneumothoraces.

C) COPD – Incorrect. COPD is a risk factor for a pneumothorax. However, it results in secondary not primary spontaneous pneumothoraces. Patients who have extensive emphysema and large bullae are most at risk, as these are thin-walled, air-containing structures which are prone to rupture. Most pneumothoraces (>70%) are secondary. In addition to COPD, there are many other lung pathologies which can increase the risk of a secondary pneumothorax, including airway disorders (such as asthma/interstitial lung disease), infections (such as tuberculosis (TB)/necrotising pneumonia/pneumocystis jiroveci), systemic connective tissue disorders (such as Marfan’s syndrome/Ehlers-Danlos syndrome/rheumatoid arthritis), and lung cancer.

D) Trauma – Incorrect. Trauma is a well established cause of a pneumothorax. However, it does not cause a spontaneous pneumothorax. Blunt trauma can result in rib fractures which tear the lung surface, whereas penetrating trauma can injure the lung surface directly. In addition to air, there may be blood in the pleural space, resulting in a haemopneumothorax. A horizontal air fluid level is a useful clue to the presence of both air and fluid in the pleural space (remember that a pleural effusion will usually have a curving meniscus rather than a completely horizontal upper margin).

E) Marfan’s syndrome – Incorrect. Marfan’s syndrome is a systemic connective tissue disorder which is known to increase the risk of pneumothoraces. It is considered a risk factor for secondary, not primary spontaneous pneumothoraces.

KEY POINT

Most pneumothoraces are secondary, and a variety of lung and systemic disorders can be implicated. Spontaneous primary pneumothoraces typically occur in young, slim, tall male smokers.
2. Which of the following clinical findings would be supportive of a large simple right sided pneumothorax?

The correct answer is C) Central trachea. Hyperresonant percussion and reduced air entry on the right side of the chest.

Accurate clinical assessment of the patient is a key part of clinical practice, and is commonly assessed in examinations. It is important to know the different combinations of clinical findings associated with a pneumothorax, a pleural effusion, lobar collapse, and pneumonia. Briefly, the chest examination should follow the pattern of inspection, palpation, percussion, and auscultation. Look for symmetrical shape and chest expansion. Assess the position of the mediastinum (trachea and apex beat) and assess for chest expansion. Percuss and auscultate both lungs. Assessing routine observations, such as oxygen saturations and blood pressure, is also important.

A) Central trachea. Dull percussion and reduced air entry on the right side of the chest – Incorrect. This combination of findings is suggestive of a right sided pleural effusion. With a pleural effusion you would expect to find reduced chest expansion, a very dull/stony dull percussion note, absent or reduced breath sounds, reduced vocal resonance, and no added sounds on the side of the effusion. With large effusions there may be a shift of the mediastinum to the contralateral side.

B) Central trachea. Dull percussion and bronchial breathing and crackles on the right side of the chest – Incorrect. This combination of clinical findings is in keeping with a right sided pneumonia. Typically, there is reduced chest expansion, dull percussion, bronchial breathing with added crackles, and increased vocal resonance in pneumonia.

C) Central trachea. Hyperresonant percussion and reduced air entry on the right side of the chest – Correct. These findings are consistent with a simple right pneumothorax. You would expect to find reduced chest expansion, hyperresonant percussion, and absent breath sounds, with no added sounds on the side of the pneumothorax. There should be no mediastinal shift.

D) Central trachea. Hyperresonant percussion and reduced air entry on the left side of the chest – Incorrect. These findings would be in keeping with a simple left sided pneumothorax.

E) Trachea deviated to the left. Hyperresonant percussion and reduced air entry on the right side of the chest. Hypotensive, tachycardic – Incorrect. This combination of clinical findings is worrying and should raise your suspicions of a tension pneumothorax. In addition to the usual findings associated with a simple pneumothorax, there is mediastinal shift to the contralateral side and evidence of significantly impaired ventilation and circulation (hypoxia, cyanosis, hypotension, tachycardia, reduced consciousness level). Tension pneumothoraces are a medical emergency and need urgent treatment (there is a case covering tension pneumothorax in more detail later in the chapter).

KEY POINTS

1. Patients with a small pneumothorax may have few if any findings on clinical examination. Chest X-ray is a more sensitive test for identifying a pneumothorax, particularly a small pneumothorax.

2. Not all patients have classic findings on history and examination. It is important to use your clinical findings to request appropriate investigations, such as blood tests and a chest X-ray, to help narrow your differential diagnosis.
3. Which of the following are appropriate differential diagnoses for a patient who presents with sudden breathlessness?

The correct answers are A) Pulmonary embolus, B) Pneumothorax, and E) Anaphylaxis.

There is a wide range of pathologies which can cause breathlessness. These include respiratory conditions, cardiac diseases, and systemic problems. It is important to be able to formulate an appropriate differential diagnosis from the history and examination to guide suitable investigations and initial management. Establishing the time frame of the onset of breathlessness is very helpful in formulating your differential diagnosis. Sudden onset refers to breathlessness that develops over seconds and includes pulmonary embolus, pneumothorax, anaphylaxis, and inhaled foreign bodies. Dyspnoea associated with pneumonia, heart failure, metabolic acidosis, and exacerbations of asthma or COPD tend to develop more slowly, over minutes to hours. Other conditions, such as interstitial lung disease and anaemia, have a much more chronic onset.

A) Pulmonary embolus – Correct. Pulmonary embolus can cause very sudden breathlessness. Other symptoms include pleuritic chest pain and dizziness. Clinical examination of the chest often reveals no abnormal signs. There may be a swollen limb, suggesting an underlying deep venous thrombosis. The patient may have had recent surgery or have other risk factors present, such as being post-partum, or having an underlying malignancy or a genetic prothrombotic tendency.

B) Pneumothorax – Correct. A pneumothorax often results in a sudden onset of breathlessness and pleuritic chest pain. There may be a history of an underlying lung condition (see question 1 for examples of conditions which predispose to secondary pneumothoraces) or trauma. The constellation of clinical findings associated with a pneumothorax is discussed in question 2.

C) Pneumonia – Incorrect. Pneumonia and other infections are common causes of breathlessness; however, the onset of breathlessness is usually more subacute, occurring over hours rather than seconds. Other features include a productive cough with green sputum, a raised temperature, and appropriate clinical findings.

D) Heart failure – Incorrect. Heart failure is a common cause of breathlessness, but usually its onset is more insidious. Patients may also complain of orthopnoea and paroxysmal nocturnal dyspnoea. There may be a previous history of cardiac disease. Clinical examination may demonstrate an elevated jugular venous pulse and evidence of pleural effusions.

E) Anaphylaxis – Correct. Anaphylaxis is a systemic and life threatening allergic reaction. It usually occurs shortly after contact with the allergen (previous sensitisation to the allergen is required). Symptoms develop rapidly over minutes and include facial swelling, wheezing, breathlessness, urticaria, and, potentially, shock. Urgent management using the ABCDE approach and administration of intramuscular adrenaline is required.

KEY POINT

Use the history and examination findings to help formulate a differential diagnosis to guide appropriate investigations and management. But remember that some patients, such as those presenting with anaphylaxis, may need urgent treatment before you will be able to complete a full history and examination. In these patients, use the ABCDE approach to assessment and management.

4. Which of the following is the most appropriate initial imaging investigation in a patient suspected of having a simple pneumothorax?

The correct answer is A) Erect PA chest X-ray.

The chest X-ray is the first line imaging modality for suspected simple pneumothoraces. Imaging has a key role in confirming the diagnosis of a pneumothorax, assessing its size, and excluding other differential diagnoses. There are various different types of chest X-ray, which are discussed below.
Which of the following is the most appropriate management option for a previously healthy patient with a small, asymptomatic primary pneumothorax?

The correct answer is B) Conservative management with outpatient follow up.

The management of pneumothoraces depends on whether the patient is symptomatic, the size of the pneumothorax, and the presence of underlying lung disease. As is the case with all potentially unwell patients, it is useful initially to approach the assessment and management of the patient using the ABCDE approach.

A) Conservative management and discharge the patient – Incorrect. Whilst asymptomatic (not breathless) patients with a small (<2cm) spontaneous primary pneumothorax can be safely managed conservatively with analgesia, it is important to arrange for the patient to be reviewed in the outpatient clinic in 2-4 weeks. This is to ensure that the patient has not deteriorated and the pneumothorax has not increased in size. Patients should be followed up with the respiratory team until complete resolution of their pneumothorax has occurred. Patients should also be instructed to return to hospital if they develop symptoms.

B) PA and lateral chest X-rays – Incorrect. The lateral chest X-ray can provide helpful information if a pneumothorax is not visible on the PA X-ray. However, it is not part of routine practice.

C) Expiratory chest X-ray – Incorrect. Expiratory X-rays may make a subtle pneumothorax more readily visible. However, there are not performed in the first instance. Additionally, they can limit the assessment of the lungs and cardiac shadow.

D) Supine chest X-ray – Incorrect. Pneumothoraces can be very subtle and difficult to identify on supine chest X-rays, as the air collects anteriorly, and there may not be a clearly discernible lung edge as seen in an erect X-ray. Supine chest X-rays are thus not performed routinely. Instead they are reserved for trauma patients who cannot be safely moved. Features suggestive of a pneumothorax on a supine chest X-ray include a sharply outlined dome of the hemidiaphragm, a deep lateral costophrenic sulcus, and a hyperlucent upper quadrant of the abdomen (due to the lucent gas within the pleural space overlying the upper abdomen).

E) CT – Incorrect. Whilst CT is the most sensitive and specific test for a pneumothorax, its high radiation dose (approximately equivalent to 400 chest X-rays) and the satisfactory accuracy of standard PA chest X-rays mean CT is not the first line imaging modality for suspected pneumothoraces; instead, it is reserved for patients in whom there is continued suspicion of a pneumothorax but no evidence on a chest X-ray, or for assessing trauma patients. CT also provides the most reliable assessment of pneumothorax size.

KEY POINTS

1. Remember that your environment can affect how easy or difficult it is to interpret X-rays. For example, a brightly lit room, with glare and a low resolution ward monitor, may make it difficult or impossible to identify a small pneumothorax. Always try to optimise your chance of picking up pathology by using diagnostic quality workstations in a dark room if you are making diagnostic decisions.

2. Pneumothoraces can be difficult to see on chest X-rays. Inverting the image can make the lung edge more obvious. Also, your eyes tend to see horizontal lines better than vertical ones; it is thus sometimes useful to rotate the chest X-ray by 90 degrees so that the lateral chest wall (and therefore the lung edge) is horizontal.

3. Always check the apices on an erect chest X-ray and around the lung bases on a supine chest X-ray for evidence of a pneumothorax.
B) Conservative management with outpatient follow up: Correct. See above. The patient should be instructed to return immediately if they experience symptoms, to identify those patients with enlarging pneumothoraces. All patients with a pneumothorax should avoid air travel until complete resolution. Diving should be permanently avoided in most patients who have had a pneumothorax.

C) Admit for conservative management, high flow oxygen, and monitoring – Incorrect. If the patient is not breathless and has a small primary spontaneous pneumothorax, he or she can usually be managed safely as an outpatient, admission to hospital and high flow oxygen is not required. In contrast, symptomatic patients with a small (<2cm) secondary pneumothorax should be admitted, treated with high flow oxygen (if necessary), and monitored for 24 hours. Supplementary oxygen not only improves hypoxaemia, but also increases the speed at which a pneumothorax resolves.

D) Aspirate as much of the pneumothorax as possible – Incorrect. Patients with a large and/or symptomatic primary or secondary pneumothorax need active management. Needle aspiration, using a 14-16G needle, is as effective as chest drain insertion, but reduces length of hospital stay and morbidity. These procedures should be performed in the safe triangle in the mid-axillary region. If, following needle aspiration, the patient’s symptoms have improved and the pneumothorax is <2cm in size, then no further intervention is required at that stage. If, however, this is not the case, the patient may require a chest drain (repeat needle aspiration should not be performed).

E) Chest drain insertion – Incorrect. Small bore (<14F) chest drains are indicated in patients who do not improve following needle aspiration and those with bilateral or tension pneumothoraces.

**KEY POINTS**

1. The size of the pneumothorax is one of the parameters used in deciding appropriate treatment. A large pneumothorax is defined by a rim of >2cm between the lung margin and chest wall, measured at the level of the hilum. If this rim is <2cm the patient has asmall pneumothorax.

2. Patients admitted with a pneumothorax should be reviewed by a respiratory physician within 24 hours.

3. Pleurodesis is a procedure in which the pleural space is obliterated (either chemically or surgically) and can be used in patients who suffer recurrent pneumothoraces.

**IMPORTANT LEARNING POINTS:**

- A pneumothorax is a collection of air in the pleural space.
- It can be primary, secondary to underlying lung disease, related to trauma, or related to medical procedures.
- Typical clinical features of a simple pneumothorax include: reduced chest expansion, hyperresonant percussion, and reduced air entry ipsilaterally, without evidence of mediastinal shift or cardiovascular compromise.
- The erect PA chest X-ray is the first line investigation for suspected pneumothorax; however, CT is the gold standard.
- Treatment depends on whether the patient is symptomatic, the size of the pneumothorax, and the presence of underlying lung disease.
This introduction to the chapter is aimed at providing a systematic framework for approaching abdominal X-rays. Further details and examples of the specific X-rays findings discussed below are covered more extensively in the example cases later in the chapter and in the bonus X-ray chapter.

### KEY POINT

**Systematic approach to abdominal X-rays**

1. **Projection**
2. **Patient details**
3. **Technical adequacy**
4. **Obvious abnormalities**
5. **Systematic review of the X-ray**
6. **Summary**

### 1. Projection

- The standard abdominal X-ray (AXR) is an AP X-ray with the patient in the supine position. You can assume this is the case unless told otherwise.
- Sometimes, a lateral decubitus (the patient is rolled onto their left side and the X-ray taken in an AP direction) or a lateral shoot through (the patient is supine but a lateral X-ray is taken) abdominal X-ray is performed. Such X-rays should be clearly labelled. They are most frequently undertaken in neonates to confirm or exclude a pneumoperitoneum.

### 2. Patient Details

- It is important to check you are looking at the correct X-ray from the correct patient.
- The patient details should be listed on the film.
- State the name, age (or date of birth), and the date on which the film was taken.

### 3. Technical Adequacy

- The entire abdomen should be included in the X-ray.
- Check the X-ray includes the hemidiaphragms down to the symphysis pubis and hernial orifices.
- If the entire abdomen has not been included, you need to decide whether a repeat/additional X-ray is required.

### 4. Obvious Abnormalities

- If there is an obvious abnormality, such as small bowel dilatation, comment on this before conducting your systematic review of the film.

### 5. Systematic Review of the Film

**Assess the Bowel (see figure 1)**

When looking at the bowel try to identify:

- Large and small bowel.
- Diameter of the bowel.
- Bowel wall thickness.
A 38 year old man presents to A&E with acute left sided loin pain, urinary frequency and haematuria. As part of his work up, an abdominal X-ray is performed.
IN SUMMARY – This abdominal X-ray shows multiple small left sided renal calculi.
PRESENT
YOUR
FINDINGS...

- This is a supine AP X-ray of the abdomen.
- It has been anonymised and the timing of the examination is not available. I would like to check the name and date of birth, as well as the time and date of the examination.
- The hernial orifices and right hemidiaphragm have not been included on the image; therefore, this is a technically inadequate X-ray.
- The most pertinent abnormality is the rounded areas of calcification projected over the left upper quadrant at the level of T12/L1. Given their position (overlying the left renal outline) and appearance, they are most in keeping with small renal calculi.
- There is no evidence of urinary calculi in the expected distribution of the left ureter, nor are there any visible right sided urinary tract calculi.
- The bowel gas pattern is normal. No plain film evidence of bowel obstruction, perforation or mucosal oedema.
- Fixation screws are projected over the left sacro-iliac joint. There is an abnormal area of bone on the left side of the L5 vertebral body which is in keeping with partial sacralisation of the L5 vertebra (a congenital anomaly, which is usually of no clinical significance, where the transverse process of the L5 vertebral body fuses onto the sacrum). Otherwise, there is no significant abnormality of the imaged skeleton.

QUESTIONs

1. Which of the following is/are risk factors for developing renal calculi?
   - (A) Hypercalcaemia
   - (B) Renal tubular acidosis
   - (C) Over hydration
   - (D) Inflammatory bowel disease
   - (E) Recurrent urinary tract infections

2. Which of the following are symptoms associated with renal calculi?
   - (A) Pain
   - (B) Nausea and vomiting
   - (C) Dysuria
   - (D) Haematuria
   - (E) All of the above

3. Which type of renal stone is least likely to be visible on an X-ray?
   - (A) Uric acid
   - (B) Calcium oxalate
   - (C) Calcium phosphate
   - (D) Struvite
   - (E) Cysteine

4. What is the diagnostic modality of choice for identifying renal calculi?
   - (A) Abdominal X-ray/KUB (Kidney, Ureter, Bladder)
   - (B) Intravenous urogram
   - (C) Ultrasound
   - (D) Non-contrast CT KUB
   - (E) Contrast enhanced CT of the abdomen and pelvis

5. What is the most appropriate initial management of a well patient with renal colic and a small (<5 mm) left sided calculus at the left vesicoureteric junction identified on CT KUB?
   - (A) Urgent ureteroscopy and stone retrieval
   - (B) Urgent extracorporeal shock wave lithotripsy (ESWL)
   - (C) Urgent percutaneous nephrostomy
   - (D) Conservative approach (supportive treatment with analgesia and anti-emetics and follow up with X-ray KUBs [if the stone is visible on X-ray] until the stone has passed)
   - (E) Percutaneous nephrolithotomy
ANSWERS TO QUESTIONS

1. Which of the following is/are risk factors for developing renal calculi?

The correct answers are A) Hypercalcaemia, B) Renal tubular acidosis, D) Inflammatory bowel disease and E) Recurrent urinary tract infections.

Renal calculi are common, occurring in 5-10% of the population. They typically occur in middle age (30-60 years) and affect men more commonly than women. There are several risk factors for developing renal calculi.

A) Hypercalcaemia – Correct. Calcium is a component of most renal calculi, in the form of calcium oxalate or calcium phosphate. There is increased risk of developing calcium containing renal calculi with conditions that cause hypercalcaemia, such as primary hyperparathyroidism, malignancy, sarcoidosis, Addison’s disease and medications (thiazides, vitamin D analogues, lithium).

B) Renal tubular acidosis – Correct. There is an increased risk of developing calcium renal stones in type 1 renal tubular acidosis. This is due to alkaline urine, hypercalciuria and low citrate which are associated with this condition.

C) Over hydration – Incorrect. Renal calculi are more common in hot climates due to dehydration. Dehydration results in concentrated urine, which can become supersaturated with substances that result in stone formation.

D) Inflammatory bowel disease – Correct. Calcium oxalate stones are more common in patients with Crohn’s disease or those who have had a previous small bowel resection.

E) Recurrent urinary tract infections – Correct. Struvite stones (magnesium ammonium phosphate) form in alkaline urine which contains ammonia. These conditions can occur in the presence of urease producing bacteria, such as Proteus, Klebsiella and Enterobacter (urease metabolises urea into ammonia and carbon dioxide). Struvite stones typically occur in patients who have had multiple urinary tract infections such as those with vesicoureteric reflux, neurogenic bladder and obstructive uropathies.

2. Which of the following are symptoms associated with renal calculi?

The correct answer is E) All of the above.

Many patients with renal calculi are asymptomatic; however, renal calculi can cause a variety of symptoms.

A) Pain – Incorrect. Renal colic is the classic symptom associated with urinary tract calculi. It is caused by a calculus becoming lodged in a ureter, with resultant hypertonia of the ureter in an attempt to overcome the blockage. The 3 anatomical sites at which calculi typically become obstructed are a) the pelvi-ureteric junction, b) where the ureter crosses over the iliac vessels, and c) at the vesico-ureteric junction. Additionally, any pathological narrowing, such as a stricture, can cause stone impaction. The pain usually starts acutely, spreads from the loin to groin and comes in waves. In contrast to peritonitis, patients with renal colic usually writhes around the bed in agony.

B) Nausea and vomiting – Incorrect. Nausea and vomiting is common. It is mediated via an autonomic response to the pain. The ganglion which receives pain signals from the kidneys also supplies the stomach.

C) Dysuria – Incorrect. Dysuria can occur with urinary tract calculi. It is also commonly seen in cystitis (bladder inflammation, which is often secondary to infection).

D) Haematuria – Incorrect. Haematuria is another classic clinical finding in patients with renal calculi. It is often microscopic and is related to inflammation and trauma caused by the calculus. However, the absence of haematuria on urinalysis does not exclude renal calculi.

E) All of the above – Correct. As the previous answers suggest, renal calculi can cause a variety of symptoms. They can also cause fever and rigors if there is super-added infection, acute kidney injury secondary to ureteral obstruction, as well as being asymptomatic.

KEY POINT

Dissecting or leaking abdominal aortic aneurysms can cause loin pain similar in nature to renal colic. In addition, if the aneurysm is adjacent to a ureter, there may be haematuria. Therefore, it is important to consider this serious differential diagnosis particularly in patients aged over 65 years presenting with renal colic for the first time.
3. Which type of renal stone is least likely to be visible on an X-ray?

The correct answer is A) Uric acid.

Different types of renal calculi have varying X-ray density. Overall, approximately 75-90% of renal calculi are radio-opaque (i.e. visible) on plain X-rays, and almost all stones are radio-opaque on CT. The exception is calculi that form in HIV patients being treated with the protease inhibitor indinavir; these stones are classically radiolucent even on CT.

A) Uric acid – Correct. Uric acid stones are the least radio-opaque stones out of the listed options. They are typically radiolucent on X-ray but usually visible on CT. They form in patients with increased levels of uric acid, such as those with gout or who are being treated for myeloproliferative disorders. They account for approximately 10% of renal calculi. Xanthine stones are also typically radiolucent but are a rare cause of renal calculi.

B) Calcium oxalate – Incorrect. Calcium containing renal calculi are the most common type of stone, accounting for approximately 75%. They are the most radio-opaque renal calculi.

C) Calcium phosphate – Incorrect. See 'B'.

D) Struvite – Incorrect. Struvite calculi form in the presence of urease producing bacteria (see Question 1) and account for approximately 15% of renal stones. They are generally radio-opaque, and are the second densest type of renal calculi. Most staghorn calculi are composed of struvite.

E) Cysteine – Incorrect. Cysteine stones are rare. They occur in patients with cystinuria, an uncommon autosomal recessive condition. Cysteine stones are usually radio-opaque on plain X-ray but less dense than calcium containing or struvite stones.

KEY POINT

Not all renal calculi are radio-opaque on X-ray. Therefore, a normal abdominal/KUB X-ray does not exclude renal calculi. CT is much more sensitive for identifying renal calculi.

4. What is the diagnostic modality of choice for identifying renal calculi?

The correct answer is D) Non-contrast CT KUB.

Imaging is used to confirm the diagnosis of renal/urinary tract calculi, exclude differential diagnoses, such as appendicitis and diverticulitis, and identify any complications, such as hydronephrosis. All the options listed can help diagnose urinary tract calculi.

A) Abdominal X-ray/KUB – Incorrect. Whilst 75-90% of renal calculi are radio-opaque, they can be difficult to identify on abdominal X-ray if they are small. Additionally, it can be difficult to differentiate urinary tract calculi from other causes of renal, abdominal or pelvic calcification such as nephrocalcinosis and calcified phleboliths. An abdominal/KUB X-ray should be performed if a calculus is identified on CT; X-rays can be used to monitor its response to treatment if the calculus is radio-opaque and visible on the X-ray. Additionally, if a patient is known to have radio-opaque calculus, plain X-rays can be used if they re-present with acute pain to assess any change in position of the known calculus.

B) Intravenous urogram – Incorrect. In the past, IVUs were the diagnostic test of choice for urinary tract calculi. However, they have now been superseded by CT. IVUs involve intravenous administration of contrast followed by plain X-rays of the kidneys, ureters and bladder (KUB) once the contrast is within the urinary collecting system. Urinary calculi, including radiolucent calculi, will show as filling defects within the urinary tract. Additionally, urinary tract obstruction (hydronephrosis) secondary to the urinary tract calculus can be diagnosed.

C) Ultrasound – Incorrect. Ultrasound can occasionally identify renal calculi. However, this modality is not as sensitive as CT. Additionally, it is usually impossible to image the entire ureter due to overlying bowel gas. Therefore, ultrasound has a low sensitivity for detecting urinary tract calculi. Ultrasound is good at identifying urinary tract obstruction which may be caused by calculus. Furthermore, it can identify other causes of loin pain and haematuria such as renal tumours, as well as gynaecological pathology, such as ovarian cysts, which can present in a similar manner.

D) Non-contrast CT KUB – Correct. Non contrast CT KUB is the imaging modality of choice. It is a low dose non-contrast CT which has a sensitivity of 95-100% and a higher specificity than IVU. It is readily available and quick to perform. As it is a non-contrast examination, it can be safely performed in patients with renal impairment (which may be secondary to urinary tract calculi). As well as identifying calculi, CT KUB can
assess for complications (e.g., urinary tract obstruction causing hydronephrosis). Additionally, it permits an assessment of the other abdominal and pelvic organs, helping to identify or exclude other differential diagnoses, such as appendicitis and diverticulitis (although the accuracy for this is limited by the low dose nature of the examination and the lack of intravenous contrast). As discussed in Question 3, a small proportion of urinary tract calculi are not visible on CT; however, there may still be secondary signs of urinary tract calculi, such as perinephric and peri-ureteral stranding.

5. What is the most appropriate initial management of a well patient with renal colic and a small (<5 mm) left sided calculus at the left vesicoureteric junction identified on CT KUB?

The correct answer is D) Conservative approach (supportive treatment with analgesia and anti-emetics and follow up with X-ray KUBs [if the stone is visible on X-ray] until the stone has passed).

The management of urinary tract calculi depends on the size and site of the stone and whether there is evidence of associated infection.

A) Urgent ureteroscopy and stone retrieval – Incorrect. Ureteroscopy is an invasive procedure reserved for patients with larger stones, persistent pain or those who fail to respond to conservative therapy. A ureteroscope is inserted via the urethra, through the bladder and into the appropriate ureter. Most ureteric calculi are accessible. However, results are best for those calculi located in the distal ureters.

B) Urgent extracorporeal shock wave lithotripsy (ESWL) – Incorrect. ESWL is another treatment modality reserved for patients who fail conservative management or have large stones. An external energy source causes shock waves which are targeted towards the stone. The aim is to fragment stones to allow them to pass through the ureters. The fragments can cause renal colic and ESWL may fail in large and hard stones.

C) Urgent percutaneous nephrostomy – Incorrect. Urgent percutaneous nephrostomy is needed in patients with an obstructed kidney and super-added infection. It is usually performed under sedation with antibiotic coverage to reduce the risk of sepsicaemia. Once the collecting system has been suitably drained and the infection treated, the access gained via the nephrostomy can be used for nephrolithotomy (procedure to remove the stone) if required. An alternative approach to draining an infected, obstructed collecting system is from below (in a retrograde fashion) with an endoscopically placed ureteric stent extending from the bladder, up the ureter and into the renal pelvis.

D) Conservative approach (supportive treatment with analgesia and anti-emetics and follow up with X-ray KUBs [if the stone is visible on X-ray] until the stone has passed) - Correct. Most small (<5 mm) stones in the ureter pass spontaneously, particularly if they are located distally. Patients can therefore be treated conservatively if there is no evidence of an infected, obstructed collecting system (see above). The mainstay of treatment is analgesia (NSAIDs such as diclofenac are used as 1st line), anti-emetics and IV fluids if dehydrated. Medications such as tamsulosin (an alpha blocker) or nifedipine (a calcium channel blocker) can be used to facilitate the passage of the stone. If visible on X-rays, the progress of such stones can be monitored by serial X-ray KUBs. If the stone fails to pass after 4–6 weeks, the pain becomes intolerable, or if the patient develops an infected, obstructed collecting system, an alternative treatment option is required (see above).

E) Percutaneous nephrolithotomy – Incorrect. Percutaneous nephrolithotomy is used to fragment large renal calculi. It is usually reserved for large or complex stones or patients in which ESWL and ureteroscopy have failed.
This introduction to the chapter is aimed at providing a systematic framework for approaching orthopaedic X-rays. Further details and examples of the specific X-rays findings discussed below are covered more extensively in the example cases later in the chapter and the bonus X-ray chapter.

**KEY POINT**

**Systematic approach to orthopaedic X-rays**

1. **Projection**
2. **Patient details**
3. **Technical adequacy**
4. **Obvious abnormalities**
5. **Systematic review of the X-ray**
6. **Summary**

**1. Projection**

- Assessment of any bone or joint in general requires at least two views—‘one view is one too few’! These normally consist of AP and lateral X-rays (figure 1).
- For some sites, such as the scaphoid, where fractures are difficult to detect, it is routine to obtain more than two views.

**Figure 1.**

*Image A:* AP view of this finger shows apparently normal alignment of the interphalangeal joints

*Image B:* The lateral view shows posterior dislocations at both of these joints!

These X-rays dramatically show why one view is one too few!

**KEY POINT**

Remember: children develop and mature at different rates and therefore the age of a patient does not tell you whether they are skeletally mature or not.
Figure 20. Lateral (Image A) and AP (Image B) elbow X-rays demonstrating the various ossification centres (Capitellar, Radial head, Medial/Internal epicondyle, Trochlear, Olecranon, External/Lateral epicondyle = CRITOE).

The Gartland classification system is useful for categorising the severity of supracondylar fractures, and the X-ray features are summarised in Table 1. It relates to ‘extension type’ supracondylar injury, where the distal fragment is displaced posteriorly. Flexion type injuries comprise 5% of supracondylar fractures, and are classified separately.

<table>
<thead>
<tr>
<th>Gartland 1</th>
<th>Gartland 2</th>
<th>Gartland 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Anterior humeral line" /></td>
<td><img src="image" alt="Posterior cortex intact" /></td>
<td><img src="image" alt="Complete displacement" /></td>
</tr>
<tr>
<td>An undisplaced supracondylar fracture. A line drawn along the anterior edge of the humerus (anterior humeral line) transects the capitellum.</td>
<td>This is a displaced supracondylar fracture but the posterior cortex of the distal humerus is intact. However, the anterior humeral line now does not transect the capitellum.</td>
<td>This is a completely displaced supracondylar fracture, and the posterior cortex of the distal humerus is not intact. These are the injuries most often associated with neurovascular compromise and compartment syndrome.</td>
</tr>
</tbody>
</table>

Table 1: The Gartland Classification for supracondylar fractures.
HIP CASE 5

A 75 year old man has fallen over at home. He was unable to get up and has been brought to A&E by ambulance where it was noted his left leg was shortened and externally rotated. This is his X-ray.
IN SUMMARY – This X-ray shows a displaced left intracapsular fracture of the neck of femur. I would want to see a later X-ray of the hip to complete my radiological assessment of the fracture. Degenerative changes of the hips and spine are evident and there is marked vascular calcification.
PRESENT YOUR FINDINGS...

- This is an AP X-ray of the pelvis of a skeletally mature patient.
- It has been anonymised and the timing of the examination is not available. I would like to confirm the patient’s details and timing of the examination before I make any further assessment.
- The X-ray is adequately penetrated, with no important areas cut off.
- There is a displaced fracture of the left hip. It is an intracapsular subcapital fracture of the femoral neck.
- There is shortening and external rotation of the femur.
- No other fracture is visible.
- There are no areas of lucency or cystic changes to suggest a pathological fracture.
- There is a loss of joint space in both hips with osteophytes, subchondral sclerosis and subchondral cysts consistent with osteoarthritis.
- Degenerative changes are also visible in the lumbar spine and the lumbosacral junction.
- There is calcification of the femoral vessels bilaterally, in keeping with diabetes or renal failure.
- There are a few surgical clips projected over the left thigh suggesting previous surgery.

QUESTIONS

1. The initial management of this fracture involves which of the following?
   A) Stabilise the patient
   B) Identify any medical issues
   C) Take a full history including a history of the mechanism of injury
   D) Take a full social history
   E) Request a CT of the hip to allow accurate preoperative planning

2. What grade is this fracture using the Garden Classification?
   A) 1
   B) 2
   C) 3
   D) 4
   E) A

3. What is the best surgical management for this 75 year old patient if they are independent and medically fit prior to the injury?
   A) Hemiarthroplasty
   B) Total hip replacement
   C) Surgical fixation
   D) Traction and bed rest
   E) Early mobilisation

4. If this fracture occurred in a fit and well 20 year old, which would be the best surgical option?
   A) Hemiarthroplasty
   B) Total hip replacement
   C) Surgical fixation
   D) Traction and bed rest
   E) Early mobilisation

5. Which of these is absolutely necessary prior to the patient having surgery?
   A) Consent from the patient
   B) Nil by mouth for 6 hours
   C) Blood cross-matched
   D) Results of a full set of bloods including urea and electrolytes
   E) None of the above
ANSWERS TO QUESTIONS

1. The initial management of this fracture involves which of the following?

The correct answers are A) Stabilise the patient, B) Identify any medical issues, C) Take a full history including a history of the mechanism of injury and D) Take a full social history.

A) Stabilise the patient – Correct. Stabilising all trauma patients is important however there are other important points to consider. Patients should be assessed using the ATLS ABCDE algorithm if there is any concern about major trauma. Stabilisation includes fluid resuscitation and early pain relief. Analgesia should be prescribed using the WHO pain ladder as a guide, starting at the most appropriate step. A nerve block is a very effective method of pain relief but should only be performed by a trained member of staff.

B) Identify any medical issues – Correct. Patients with femoral neck fractures are typically elderly and often have other medical co-morbidities which must be considered. These include chronic co-morbid conditions such as renal failure, COPD, ischaemic heart disease and dementia as well as acute problems which may have contributed to the fall (e.g. infection) or resulted from the fall (e.g. intracranial haemorrhage). These must be identified and treated early to optimise the patient for surgery. Patients may also be on warfarin. This will need to be reversed prior to surgery. However, the indication for warfarin must be considered before reversing it, as the risks of stopping it may be high. In these cases, or if you are in doubt, you should discuss the case with a haematologist for advice.

D) Take a full social history – Correct. It is important to take a full social history from all patients who sustained fractures to the femoral neck. This includes where the patient lives, the requirement of assistance with their activities of daily living, the use of walking aids both in the house and outside and an abbreviated mental test (AMT). The degree of independence will impact on surgical decision-making.

C) Take a full history including a history of the mechanism of injury – Correct. A full history of the mechanism of injury is very important. Did they trip or did they collapse?

E) Request a CT of the hip to allow accurate preoperative planning – Incorrect. This is not required. The main questions which needs to be answered for preoperative planning are whether the fracture is intra or extracapsular and the degree of displacement. AP and lateral X-rays can almost always answer these questions. CT of the hip can be used if there is high clinical suspicion of a hip fracture but no evidence on the X-rays. MRI is an alternate imaging strategy in such cases.

KEY POINT

Blood tests should also be performed to assess for:

A) Pre-operative anaemia – patients may need a pre-operative transfusion
B) Pre-operative renal failure or electrolyte derangement which may affect anaesthesia and fluid management
C) Blood group and save – surgery can be associated with significant blood loss and should be prepared for
D) Inflammatory markers – patients may have sepsis
E) Clotting – drugs or liver dysfunction may affect clotting and may need to be corrected pre-operatively
2. What grade is this fracture using the Garden Classification?

The correct answer is C) 3.

Intracapsular fractures often need surgery to have the femoral head replaced, but in certain cases this is not necessary, and in some cases conservative management might be considered. The Garden Classification is used to categorise the degree of displacement of an intracapsular femoral neck fracture, and as such, also defines how likely it is that the blood supply to the femoral head has been disrupted.

The classification system goes from 1 to 4, where 1 and 2 are undisplaced and 3 and 4 are displaced. The subtle differences between 1/2 (undisplaced) and 3/4 (displaced) are best appreciated by looking at the trabeculation (lines seen within bone) in the different fractures. In Garden 1 fractures, the trabeculation lines in the head point vertically in comparison to the normal. In Garden 2 fractures, they are all in line. In Garden 3 fractures, the trabeculation lines in the head are more horizontal than normal. In Garden 4 fractures, the head has displaced but returned to its normal alignment and so the trabeculations are all in line.

A) 1 – Incorrect. In Garden 1 fractures, there is an incomplete fracture with impaction at the fracture site with the femoral head tilted into a valgus (more upright) position. Therefore, the capsule is likely to remain intact and the risk of AVN (avascular necrosis) is reduced. Surgical fixation using screws prevents displacement of the fracture and is the best option for most patients. Keeping the patient’s own femoral head reduces the risk of dislocation or need for revision surgery. If the patient has little pain, this fracture could potentially be treated without surgery and with full weight bearing but follow-up X-rays are needed to ensure the fracture does not displace.

B) 2 – Incorrect. In Garden 2 fractures, the fracture is complete and undisplaced and again surgical fixation is possible as the risk of AVN is low. This fracture is often grouped with Garden 1 fractures as undisplaced and treatment is essentially the same although as the fracture is complete there is a higher risk of displacement if the fracture is treated non-operatively.

C) 3 – Correct. This is a Garden 3 fracture. In Garden 3 fractures, there is displacement and there is a high chance of AVN. In the majority of patients, a hemiarthroplasty or THR is necessary.

D) 4 – Incorrect. In Garden 4, the fracture is fully displaced. For the vast majority of patients, THR or hemiarthroplasty is required.

E) A – Incorrect. The classification is from 1 to 4 not A to D.

KEY POINTS

1. Undisplaced fractures have a lower risk of AVN in comparison to displaced fractures. Use the Garden Classification to consider the degree of displacement and then this will help guide your surgical decision making.

2. “1, 2 give it a screw, 3, 4, Austin Moore” is an aid memoire for the treatment of intracapsular fractures. Cannulated screws can be used in undisplaced fractures (Garden 1 or 2), whereas an arthroplasty is usually required for displaced fracture (Garden 3 and 4). Austin Moore is an outdated type of arthroplasty.
3. What is the best surgical management for this 75 year old patient if they are independent and medically fit prior to the injury?

The correct answer is B) Total hip replacement.

The aim of surgery in fractures of the neck of femur should be to allow early mobilisation with limited chance of further surgery. In the elderly, most surgeons will opt for either a THR or a hemiarthroplasty for intracapsular fractures.

A) Hemiarthroplasty – Incorrect. A hemiarthroplasty is a half hip replacement. The ball of the ball and socket joint is replaced but the socket is left alone. This option has some advantages such as a low risk of dislocation. However, the implant differs from normal anatomy and patients will often not be able to return to full function. It is therefore usually reserved for patients with limited premorbid mobility. In addition, if a patient had arthritis in the joint prior to the fracture, there is the chance of ongoing pain because the arthritis is still present in the acetabulum.

B) Total hip replacement – Correct. In a THR, the ball and socket are replaced, allowing for a better correction of the prior anatomy and a better return to function. NICE guidelines state that THR should be considered for independent patients with a displaced intracapsular fracture of the neck of the femur who need no more than one stick to mobilise. This operation takes slightly longer and is therefore associated with slightly more blood loss compared with a hemiarthroplasty. There is also a higher chance of dislocation. However, by replacing both the ball and socket, it is possible to get a more anatomical implant which allows better return to function. In addition, there are further benefits for patients with a fracture and pre-existing hip joint arthritis, as replacing both the femoral head and lining the acetabulum will help alleviate the symptoms of arthritis.

C) Surgical fixation – Incorrect. In this age group, it is not advisable to attempt fixation for a displaced intracapsular fracture as the risks of further surgery are too high if AVN develops. However, if the fracture is undisplaced or minimally displaced, then this may be a good option. The risk of AVN in displaced fractures is above 30%, but may be much lower in undisplaced fractures.

D) Traction and bed rest – Incorrect. Intracapsular fractures do not respond well to traction and bed rest. Although some extracapsular fractures will heal with time, as this fracture is displaced and intracapsular, the likelihood is the fracture will not heal (non-union) and the patient will be left immobile with all the associated/related complications. This treatment option may be considered in very frail patients who are expected to die from an underlying or acute medical problem (in these patients, surgery is not appropriate).

E) Early mobilisation – Incorrect. Very occasionally, patients will present with an undisplaced intracapsular fracture where the fracture is old and healed or the patient is able to mobilise. In such circumstances, it is possible to avoid an operation. However, should further pain develop, X-rays are repeated to ensure there has been no displacement that would warrant surgical intervention.

4. If this fracture occurred in a fit and well 20 year old, which would be the best surgical option?

The correct answer is C) Surgical fixation.

There is a significant difference between femoral neck fractures in the elderly (> 65 years) and the young. Young patients are usually fit and the fracture is often associated with high-energy trauma. They are expected to live longer and be more active. Therefore, preservation of the native femoral hip is crucial in young patients with an intracapsular fracture.
5. Which of these is absolutely necessary prior to the patient having surgery?

The correct answer is **E) None of the above.**

None of these are absolutely necessary for a patient to have an operation. In an emergency situation, you may not be able to wait for the patient to be adequately fasted or to consent the patient if they are unconscious. Similarly, blood results may not be available in time. Although these are not absolutely necessary in such patients, they are desirable and should be considered in a “standard” patient with a femoral neck fracture.

A) Consent from the patient – Incorrect. Informed consent should be obtained from the patient or guardian. Ideally, the person consenting should either be the operating surgeon or someone who can perform the operation. If not, then the person consenting should have a full understanding of all the risks and benefits of a surgery together with the technical steps of the operation. The patient should be allowed sufficient time to come to a decision. In some circumstances, such as an unconscious patient requiring emergency surgery, it is not possible to obtain consent, in which case it is acceptable to perform the surgery if it is judged to be in the patient’s best interests.

B) Nil by mouth for 6 hours – Incorrect. It is generally important to make sure the patient is fasted for 6 hours prior to the operation. This reduces the risk of aspiration of gastric contents on the anaesthetic induction. Although this applies for all surgical patients, this is especially relevant in trauma, which itself delays gastric emptying. Again, in some circumstances, this may not be possible, and emergency surgery should not be delayed if the patient is not fasted. Instead, the anaesthetic team can perform a rapid sequence induction, which minimises the risk of aspiration.

C) Surgical fixation – Correct. Ideally, the patient needs to go straight to theatre. The fracture can be accurately reduced and fixed with either 3 screws or a short dynamic hip screw and a second screw. There is still a significant risk of AVN of the femoral head, which would require a further operation. However, as this patient is young and fit, the risks of further surgery are relatively low. It is therefore desirable to keep the patient’s femoral head and accept the possibility of further surgery, rather than replacing it in the first instance.

D) Traction and bed rest – Incorrect. This is not appropriate for patients in this age group with this fracture.

E) Early mobilisation – Incorrect. Young patients with an intracapsular fracture are best treated by surgical fixation even if the fracture is undisplaced. It is also very unlikely for a young person to present with a healing intracapsular fracture, as this is a high-energy injury which will be picked up on initial presentation.

**KEY POINT**

Patients under 65 should be considered for surgical fixation of their intracapsular neck of femur fracture within 6 hours of injury. Doing so may reduce the risk of AVN and preserve the femoral head, improving the long-term functional outcome.
C) Blood cross-matched – Incorrect. Patients undergoing surgery for femoral neck fractures are at risk of significant intra-operative blood loss and should have a valid group and save (G&S). If there is concern that the patient is at high risk of bleeding, then they should have blood cross-matched prior to surgery. In an emergency, waiting for cross-matched blood is not necessary as O negative or type specific blood is readily available.

D) Results of a full set of bloods including urea and electrolytes - Incorrect. Elderly patients with neck of femur fractures often have multiple medical conditions and most take several medications. These can adversely affect their renal function and electrolyte balance, which needs to be recognised and addressed prior to surgery. It is therefore important to discuss such patients with the anaesthetist. If you are unsure about the patient’s other co-morbid conditions or past medical history, you should seek advice from the medical registrar. In emergency situations, the full blood result may not be available at the time of surgery. In such cases, the anaesthetic team may have to correct any electrolyte abnormality during the operation.

E) None of the above – Correct. Although not absolutely necessary, these should all be done for the standard patient with a neck of femur fracture.
What are CT scans and how are they performed?

A CT scanner essentially consists of an X-ray tube which spins around the CT table (figure 1). The X-ray tube is housed in the gantry, which is the donut shaped part of the scanner. The patient lies on the table (usually on his/her back). The couch travels through the centre of the gantry as the X-ray tube spins around the patient, taking hundreds of X-rays from different angles. The data are processed by a computer to produce images.

**Figure 1. Diagram of a CT scanner**

The hole in the gantry is relatively large and the scan very quick (lasting seconds), making CT suitable for, and well tolerated by, most patients, including those who are unwell. Patients need to be able to lie flat on their back and remain still, albeit for a short period of time. Depending on the scan, they may be required to hold their breath momentarily. Contrast agents (IV, oral or rectal) may be required to improve diagnostic accuracy of the scan (this will be decided by the radiologist). Indications for contrast will be considered within the text. IV contrast can cause a hot flushing sensation when administered – the radiographers will warn the patient about this.

CT produces images with much greater contrast between structures than is usually seen with X-rays, although MRI is even better than CT.

The CT image

Looking through a CT scan allows you to view axial, coronal and sagittal planes of the body (figure 2). The standard CT image is the axial (transverse) image and on this the left side of the image corresponds to the right side of the body (for example in, figure 16, the heart, which is a left sided structure, is on the right side of the image). At first glance, this may appear counterintuitive. However, considering how we look at a frontal chest X-ray helps us understand why the CT images are displayed in this way.

When we look at a frontal chest X-ray, it is as if the patient is standing directly opposite and looking towards us (i.e. we are face to face). Therefore, their left hand side is in the right side of our field of view, and so the cardiac shadow and other left sided structures appear on the right side of the X-ray, and vice versa. A coronal CT image is exactly the same – it’s as if the patient is standing opposite and looking directly at us.

Now imagine the patient lies back onto a bed (or the CT table) so their feet are nearest us and their head is furthest away. As we look at them, their left side still remains in the right side of our field of view and vice versa. So, if we take an image in the axial (transverse) plane with the patient lying on their back and view it from their feet end, then we will see that their left sided structures, such as the heart, will be on the right side of the image. When we look at axial CT images on a monitor, it is as if we are standing at the feet end of the patient and looking up towards their head.

The same principles apply to MRI images.

---

**Figure 2. Axial, coronal and sagittal planes**
What is it and how is it performed?

The physics behind MRI is very complicated. It is not necessary to fully understand how MR images are produced (in the same way you can drive a car without knowing exactly how the engine works!); however, a basic understanding is helpful.

In simple terms, MRI uses a magnetic field and radio waves to produce images. The patient lies inside the magnet, which causes hydrogen ions (protons) within the body to align (either with or against the magnetic field). A radiofrequency pulse of a specific magnitude and duration is then sent through the patient. This transfers energy to the protons (excitation) and changes their direction of alignment. Over time, the energy from these excited protons is lost (decays) and the protons realign with the magnetic field (relaxation). This process emits radio frequencies which are detected by the MRI scanner and result in the image. The speed of the relaxation process depends on the size and duration of the initial radiofrequency pulse, the structure of the substance in which the hydrogen ions/protons are in and the influence of surrounding hydrogen ions/protons. Thus, the different tissues and substances result in different signals which are detected by the MRI scanner and influence the image produced.

In contrast to CT, the hole in the MRI scanner where the patient lies is relatively small, the scans take a long time to be acquired and the scanner is noisy. Patients who are claustrophobic or unable to lie still for prolonged periods may not be able to tolerate a MRI.

Various different types of sequences can be acquired which provide different types of information. The science behind the different types of sequence is complex and does not need to be understood by non-specialists. T1 weighted images are useful for demonstrating anatomy and lymph nodes, whereas T2 weighted sequences are useful for showing fluid and therefore areas of oedema.

Images can be acquired in various planes. However, unlike CT, the images usually cannot be reformatted into different planes once they have been acquired.

Use of ionising radiation

One of the benefits of MRI over CT is that no ionising radiation used. Instead, as described above, MRI uses a magnetic field and radio waves to produce the images. However, MRI scanning has other hazards associated with it.

Magnetic fields

- The strong magnetic field of the MRI scanner can turn ferromagnetic objects, such as scissors and non-MRI compatible oxygen cylinders, into projectiles, with the potential to cause serious injury or death to patients or staff. The MRI magnet is essentially always on; therefore, only MRI compatible metallic objects should be taken into the MRI scanner room.

- The magnetic fields can interfere with some electronic devices, such as certain pacemakers and cochlear implants. Such devices must be checked to see whether they are MR safe before a patient or staff member with one of them can enter the MRI room.

Radiofrequency fields

- These can result in heating of tissues and structures. Usually, the body can dissipate the heat with vasodilation. However, the potential for burns exists if non-MRI compatible monitoring leads and electrodes are used.
What is it and how is it performed?

Ultrasound uses very high frequency sound waves (which are inaudible to humans) to produce images. The ultrasound waves are produced by the ultrasound transducer and travel as a beam through the body. When they come across a boundary between two different tissues, the waves can either be reflected or refracted. The ultrasound waves which are reflected back are detected by the transducer and are used to make the images. The amplitude of the reflected waves, combined with the time they take to return to the transducer, are used to generate the image.

Ultrasound waves travel well through solid and liquid media. In contrast, the ultrasound waves are scattered by gases. Therefore, gel is used as an interface between the transducer and the patient to improve the transmission of ultrasound waves between the transducer and the body.

There are three main types of ultrasound imaging:

- **B-mode** (brightness mode) produces real-time 2 dimensional images (figure 6A). The amplitude of the echo for each pixel is represented using a grey-scale. This is the standard ultrasound image. Pathology may be demonstrated by a change in the size or shape of a structure, or an alteration in its brightness (echogenicity).

- **Colour flow imaging** is used to show the direction of flow and provides an estimation of velocity (figure 6B). The flow assessed is usually blood flow but can be any flowing or moving substance such as a jet of urine entering the bladder from the ureter. The colour flow information is superimposed on the B-mode image. In general, red indicates flow towards the ultrasound transducer, blue away, and yellow/green turbulent flow. Alterations in velocity and/or the direction of flow can indicate pathology.

- **Doppler imaging** can be used to accurately calculate the velocity of flow (figure 2). The change in frequency of the transmitted ultrasound waves compared with those received by the transducer allows the velocity to be calculated (the angle between the ultrasound beam and the direction of flow also needs to be measured). The velocity of flow can be used to determine the degree of a stenosis. Doppler also provides a tracing of the flow in terms of amplitude and direction (waveform) and the appearance of the waveform can be a useful indicator of pathology.

Ultrasound is usually a quick and well-tolerated examination. Ideally, it is performed in the radiology department using the departmental ultrasound machines. The patient can be scanned on the ultrasound couch or in a trolley/bed depending on their clinical condition. Portable ultrasounds can be used on patients who are unable to travel to the ultrasound department. However, the portable ultrasound machines produce inferior images compared with the departmental machines, meaning the examination is usually less comprehensive.

The patient may have to move into different positions during the examination; therefore, patient mobility and cooperation are important. The more tissue ultrasound waves have to travel through, the fewer that are returned and detected. Therefore, it is easier to image superficial rather than deep structures. Additionally, the image quality in overweight and obese patients is often reduced and occasionally a diagnostic scan is not possible if the patient is too large.

**Use of ionising radiation**

Ultrasound uses no ionising radiation, it has no significant adverse effects and is safe to use in all patients.

**Main indications**

As mentioned above, ultrasound travels well through solid and liquid. It is therefore most useful for imaging solid organs, such as the liver, kidneys and spleen, and fluid filled structures, such as the bladder. The main common indications are discussed below but further details can be found in the Royal College of Radiologist’s guidelines (Making the best use of clinical radiology services/refer).
NUCLEAR MEDICINE

What is it and how is it performed?

Nuclear medicine (nuclear imaging/gamma imaging) uses radiopharmaceuticals to produce images. Radiopharmaceuticals are composed of two components; a radionuclide and a pharmaceutical. Radionuclides are unstable isotopes which undergo radioactive decay. The radiation emitted from certain radionuclides can be detected and measured, for example by a gamma camera. The pharmaceutical is used to localise the radionuclide to tissues of diagnostic interest. For example, Technetium 99m methylene diphosphonate (99mTc MDP) is a commonly used radiopharmaceutical in bone scanning. The methylene diphosphonate (pharmaceutical) is a bisphosphonate analogue and therefore localises to areas of osteoblastic activity. As 99mTc (a radionuclide) decays, it emits gamma rays which can be detected.

The exact combination of pharmaceutical and radionuclide depends on the indications for the scan. The main radiopharmaceuticals will be briefly mentioned below.

The methods of acquiring the images vary depending on the type of scan. In general, the radiopharmaceutical is delivered to the patient (IV, oral, inhaled) and after an appropriate amount of time, the patient lies in the gamma camera, which detects the location and amount of radiopharmaceutical in the body.

X-rays, CT, MRI, ultrasound and fluoroscopy provide anatomical imaging (i.e. they acquire images of anatomical structures and pathology is identified as changes in the normal anatomy). By contrast, nuclear medicine provides functional imaging: the pharmaceutical components take part in metabolic reactions and other processes in the body (e.g. bisphosphonate analogues used in bone imaging localise to areas of osteoblastic activity, fluorodeoxyglucose used in PET scanning is metabolised like glucose and some radiopharmaceuticals used in renal imaging are filtered by kidneys).

The use of a pharmaceutical in the imaging process therefore means nuclear medicine can assess metabolic reactions and other functional processes in the body, and hence provides functional rather than anatomical imaging. This has many advantages; it is particularly helpful as there may be significant functional changes before there is a resultant anatomical change (e.g. the function of a kidney may significantly decrease before any obvious anatomical change occurs). Conversely, an anatomical abnormality may persist long after appropriate treatment even though it is no longer functionally active (e.g. fibrotic scarring at the site of a previous tumour deposit). Such changes may not be detectable by other imaging techniques, such as CT or MRI, but the functional changes may be picked up with nuclear medicine techniques.

The main limitation of nuclear imaging is the lack of spatial resolution and poor anatomical detail. Therefore, functional and anatomical imaging are complementary and the two are increasingly used concomitantly.

PET is a specific type of nuclear medicine. Fluorine-18 (18F) combined with deoxyglucose (FDG) is the most commonly used radiopharmaceutical. Deoxyglucose is a glucose analogue and therefore localises to sites of increased metabolic activity. The physics behind PET is different from other forms of nuclear imaging. As 18F decays, it releases a positron (a positively charged electron), which travels only a few millimetres in the body before being annihilated by an electron. This reaction results in two high energy photons being released simultaneously in opposite directions. A specific PET camera is used to detect the two annihilation photons and from this determine where the annihilation reaction occurred. PET is almost always combined with CT (PET-CT) to improve the quality of the data (the CT is used to permit attenuation corrections and it allows the data from PET to be fused onto a CT, which provides detailed anatomical information).

Use of ionising radiation

Nuclear imaging relies on radioactive decay of radionuclides and therefore is a source of ionising radiation. When the radionuclide is administered to the patient, it usually travels throughout the body and therefore results in a radiation dose to the entire body (in contrast, X-rays and CT only give a significant radiation dose to the areas being imaged).
What is it and how is it performed?

Fluoroscopy (screening) uses X-rays and contrast material to produce images. The patient lies or stands on the screening table. The patient and X-ray camera are positioned and series of low-dose X-rays are taken, often before, during and after the administration of contrast material.

Two types of image can be taken when screening (figure 1). Fluoroscopic imaging allows multiple images to be taken in quick succession. They are of lower quality than formal X-ray exposures but use less radiation. The greyscale used is the opposite to standard X-rays, with high attenuating material and structures, such as bone, appearing as dark areas, and low attenuating substances, such as gas, appearing as light areas. Formal X-ray exposures can also be acquired. These are like a normal X-ray in appearance (using the standard grey scale) and provide a more detailed image, but use a higher radiation dose and cannot be performed in quick succession. Usually a combination of these types of imaging are used during fluoroscopic studies.

The type of contrast used depends on the examination being performed. Most contrast material, such as barium, is positive contrast – it attenuates/blocks the X-rays significantly more than tissues and organs, and therefore appears dark on fluoroscopic imaging and bright on formal X-rays. Positive contrast materials can be water-soluble (e.g. gastrograffin) or non-water soluble (e.g. barium). Barium produces the best images but is only safe for use inside the gastrointestinal tract. Water-soluble contrast, on the other hand, is safe for use almost everywhere in the body, including the peritoneal cavity. Water-soluble contrast is therefore used for examinations where there may be leakage from the gastrointestinal tract (e.g. if the patient has a suspected perforated oesophagus) and for “tubograms” (when contrast is injected into an iatrogenic tube, such as a surgical drain, urinary catheter or nasogastric tube).

Air or gas can be used as a negative contrast material (it attenuates the X-rays much less than tissues and organs). A double contrast examination uses both a positive contrast material and air.

**Figure 1. Examples of a fluoroscopic and formal X-ray exposure from a cholecystostomy tubogram.**

**Image A:** This image demonstrates that high attenuation material, such as the contrast within the gallbladder and common bile duct, are dark on fluoroscopic images and the edges of structures, such as the gallbladder are not particularly sharp.

**Image B:** This formal X-ray exposure performed in the same patient shows the usual greyscale we expect in X-rays, with high contrast structures and material appearing white. Notice how the edges of the gallbladder and common bile duct are better defined compared with the fluoroscopic image.
Orthopaedic X-Rays
Lumbar degenerative changes (case about cauda equina syndrome) .................................................... 367
Anterior wedge compression fracture ................................................................. 375
Cervical spine fracture ........................................................................ 383
Anterior shoulder dislocation ................................................................. 391
Supracondylar fracture ........................................................................ 399
Salter Harris fracture .............................................................................. 407
Scaphoid fracture ................................................................................ 415
Colles’ fracture .................................................................................... 423
Hip joint osteoarthritis ......................................................................... 429
Perthes’ disease ..................................................................................... 435
Pelvic fracture .......................................................................................... 443
Slipped upper femoral epiphysis ............................................................. 451
Intracapsular fracture of the neck of femur ........................................... 457
Extracapsular fracture of the neck of femur ........................................... 465
Paediatric aggressive bone lesion ............................................................. 473
Lipoaemorrhrosis/Tibial plateau fracture/Fibular fracture .................... 481
Knee joint osteoarthritis ........................................................................ 489
Tibial and fibular shaft fractures ............................................................. 497
Osteomyelitis/Periosteal reaction ............................................................. 505
Bimalleolar fracture/Dislocation of the ankle joint ............................. 513

Bonus Orthopaedic X-Rays
5th metacarpal fracture ........................................................................ 637
Normal foot X-ray ................................................................................ 639
Healed fractures (rib/clavicle/coracoid)/Pneumothorax ......................... 641
Normal elbow X-ray ............................................................................. 643
Slipped upper femoral epiphysis ............................................................. 645
Lisfranc injury ....................................................................................... 647
Distal radial (with dorsal angulation) fracture ........................................ 649
Weber C ankle fracture .......................................................................... 651
5th metatarsal fracture .......................................................................... 653
Lipoaemorrhrosis ................................................................................ 655
Anterior shoulder dislocation ............................................................... 657
Comminuted mid shaft femoral fracture .............................................. 659
Comminuted humeral surgical neck fracture ........................................ 661
Monteggia fracture ................................................................................ 663
Posterior shoulder dislocation ............................................................... 665
Rheumatoid arthritis .............................................................................. 667
Distal radial (minimally displaced) fracture ........................................... 669
Pathological shaft of femur fracture ....................................................... 671
Acromio-clavicular joint disruption .................................................... 673
5th metatarsal fracture .......................................................................... 675
Enchondroma (lytic bone lesion) ............................................................ 677
Distal radial (buckle) fracture ............................................................... 679
Intracapsular fracture of the femoral neck .......................................... 681
Triquetal fracture .................................................................................. 683
Weber A ankle fracture ........................................................................ 685
Radial head fracture ............................................................................. 687
Trapezial fracture ................................................................................ 689
Extracapsular (subtrochanteric) fracture of the femoral neck ............. 691
Supracondylar fracture ........................................................................ 693

Chest X-Rays
Primary spontaneous pneumothorax ................................................... 29
Tension pneumothorax ....................................................................... 37
Normal CXR .......................................................................................... 45
Collapsed right upper lobe .................................................................. 53
Pleural effusion .................................................................................... 61
Hilar mass ............................................................................................... 69
Apical lung mass with rib destruction ............................................... 77
Multiple pulmonary metastases ........................................................... 85
Sarcoïdosis ............................................................................................ 91
Ingested foreign body .......................................................................... 97
Left lower lobe consolidation .............................................................. 105
Possible pulmonary embolism ............................................................ 113
Congestive cardiac failure .................................................................. 121
Free subdiaphragmatic gas ................................................................. 129
Mediastinal mass ................................................................................ 137
Lung abscess and pneumonia ............................................................... 145
Left lower lobe collapse and humeral fracture ...................................... 153
 Incorrectly placed NG tube ................................................................. 161
Pericardial effusion .............................................................................. 169
Calciﬁed pleural plaques ...................................................................... 175

Bonus Chest X-Rays
Apical pneumothorax ........................................................................ 579
Normal CXR .......................................................................................... 581
Free subdiaphragmatic gas ................................................................. 583
Pleural effusion .................................................................................... 585
Misplaced NG tube ............................................................................... 587
Left lower lobe collapse ..................................................................... 589
Pericardial effusion .............................................................................. 591
Misplaced NG tube and dilated small bowel loops under the diaphragm 593
Left lower lobe consolidation .............................................................. 595
Right middle lobe consolidation ......................................................... 597
Right upper lobe collapse ................................................................. 599
Right upper lobe consolidation/Basal atelectasis ............................... 601
Right lower lobe consolidation ............................................................ 603
Free subdiaphragmatic gas ................................................................. 605
Lungula consolidation ........................................................................ 607
Left upper lobe collapse .................................................................... 609
Pneumomediastinum .......................................................................... 611

Abdominal X-Rays
Normal AXR ...................................................................................... 189
Small bowel obstruction ..................................................................... 195
Large bowel obstruction .................................................................... 203
Sigmoid volvulus ................................................................................ 211
Pneumoperitoneum ........................................................................... 217
Thumbprinting .................................................................................... 225
Pneumatosis intestinalis and pneumoperitoneum ............................ 233
Constipation ......................................................................................... 241
Splenomegaly ...................................................................................... 247
Gallstones ............................................................................................. 255
Renal calculi ........................................................................................ 263
Chronic pancreatitis ........................................................................... 269
Uterine fibroid ...................................................................................... 277
Splenic artery aneurysm ..................................................................... 285
Abdominal aortic aneurysm ................................................................. 293
Sclerotic bone metastases ................................................................. 299
ankylosing spondylitis ......................................................................... 305
Ingested foreign bodies ........................................................................ 313
Duodenal atresia/Double-bubble sign ............................................. 321
Pneumatosis intestinalis ................................................................. 327

Bonus Abdominal X-Rays
Gallstones ............................................................................................. 613
Migrated IUCD .................................................................................... 615
Large bowel obstruction ..................................................................... 617
Normal AXR ........................................................................................ 619
Small bowel obstruction/ Pneumoperitoneum ..................................... 621
Thumbprinting/Toxic dilatation of the transverse colon ..................... 623
Bilateral nephrostomy ......................................................................... 625
Thumbprinting .................................................................................... 627
Necrotising enterocolitis ...................................................................... 629
Paget’s disease ...................................................................................... 631
Splenomegaly ...................................................................................... 633
Intra-abdominal surgical swab/ Small bowel obstruction ................ 635
large bowel obstruction, 203f, 204f, 205–210, 617f, 618f
necrotising enterocolitis, 327f, 328f, 331–332, 629f, 630f
nephrostomy complications, 625f, 626f
Paget’s disease, 631f, 632f
pancreatitis, 269f, 270f, 271–276
pneumoperitoneum, 217f, 218f, 219–224, 234f, 621f, 622f
renal calculi, 263f, 264f, 265–268
sigmoid colon volvulus, 211f, 212f, 213–216
small bowel obstruction, 195f, 196f, 197–202, 635f, 636f
splenic artery aneurysm, 285f, 286f, 287–292
spleenomegaly, 247f, 248f, 249–254, 633f, 634f
uterine fibroid, 277f, 278f, 279–284
checklist, 186
dose, 192–193, 523
indications, 192
normal findings, 189f, 190f, 191–194, 619f, 620f
projection, 181
small/large bowel differences, 193
systematic review, 181–185
Abcess, see Lung abscess; Pancreatic abscess
Achilles tendon, rupture, 517
Acute pancreatitis
causes, 273
complications, 276
management, 275
pleural effusion induction, 66
ultrasound for gallstones, 274
Adhesions, small bowel obstruction, 200
Advance Trauma Life Support (ATLS), 446–447, 478
AILN, see Anterior interosseous nerve
Alcoholism
acute pancreatitis, 273
chronic pancreatitis, 272
lung abscess risk factor, 149
Allergy, contrast agents, 523
AMPLE assessment, 447
Anal fissure, constipation, 245
Anaphylaxis, breathlessness, 34
Anatomical snuff box, pain and scaphoid fracture, 418
Ankle
medial clear space, 518
orthopaedic X-ray assessment, 362f, 363f
fracture with talar shift, 651f, 652f
malleolar fracture case examples, 513f, 514f, 515–520, 685f, 686f, 689f, 690f
Ottawa Ankle Rules, 516
Weber classification of lateral malleolar fractures, 363, 517
talar shift, 518–519
triplane fracture, 414
Ankle jerk, spinal injury assessment, 380
Ankylosing spondylitis
abdominal X-ray, 305f, 306f, 309
clinical presentation, 308
extra-spinal joint involvement, 310
hepatic fibrosis, 311
treatment, 311–312
Anterior interosseous nerve (AIN) injury following supracondylar fracture, 404
testing, 427
Aortic dissection, chest computed tomography, 534f
Appendicitis, foreign body ingestion, 430
Asbestos exposure, case example with chest X-ray of pleural plaques, 175f, 176f, 177–180
Ascites, portal hypertension, 290
Aspirin, pericardial effusion management, 174
Atherosclerosis, abdominal aortic aneurysm, 296
ATLS, see Advance Trauma Life Support
Avascular necrosis
hip, see Perthes’ disease
scaphoid, 419
Axillary nerve, injury in shoulder dislocation, 396
Babinski sign, 304
Back pain
management, 374
red flags, 308
Bamboo spine, ankylosing spondylitis, 309
Barium follow-through, 576
Barium swallow
constipation induction, 246
principles, 572
small bowel obstruction diagnosis, 202
views, 573f, 574f, 575f
Bat’s wing consolidation, 122f
Bell classification, necrotising enterocolitis, 332
Bennett’s fracture, 364
Biliary colic, gallstone presentation, 259
Blood culture, necrotising enterocolitis, 331
Blood gas, venous central line, 167–168
Bone metastasis
abdominal X-ray, 299f, 300f
causes, 302
clinical findings, 302
spinal cord compression management, 304
### INDEX

**Bone scan**
- principles, 565, 568f, 569
- prostate cancer staging, 302–303
- radiation dose, 566

**Bony Bankart lesion**, 397

**Bowel ischaemia**
- abdominal X-ray, 233f, 234f, 235–240
- acute versus chronic, 240
- case examples with abdominal X-ray, 233f, 234f, 235–240, 627f, 628f
- computed tomography, 237, 239
- management of acute disease, 237
- pneumatisis intestinalis, 236, 238

**Bowel obstruction**
- abdominal X-ray assessment, 182, 183
- case examples with abdominal X-rays
  - large bowel obstruction, 203f, 204f, 205–210, 617f, 618f
  - small bowel obstruction, 195f, 196f, 197–202, 621f, 622f, 635f, 636f
- central loops in small bowel obstruction, 198
- foreign body ingestion, 320
- pseudo-obstruction versus mechanical large bowel obstruction, 206
- small/large bowel differences on X-ray, 193
- stenting of large bowel

**Breast cancer**
- lobar lung collapse, 156
- sclerotic bone metastasis, 302

**Breathlessness**, differential diagnosis, 34

**Bronchiectasis**, pneumonia complication, 111–112

**Bronchoscopy**, foreign body retrieval, 104

**Burst fracture**, 364

**Caecum, volvulus**, 213–214, 216

**CAP**, see Community acquired pneumonia

**Cardiothoracic ratio**
- congestive cardiac failure, 125
- measurement, 50–51

**Carotid artery, Doppler ultrasound**, 558, 559f

**Carpal tunnel, anatomy**, 422

**Cauda equina syndrome**
- clinical features, 370
- decompression surgery, 373
- lumbar spine X-ray, 367f, 368f
- magnetic resonance imaging, 372, 550f
- physical examination, 371

**Cavitating tumour, lung**, 148

**Central cord syndrome**, 382

**Central line**
- chest X-ray, 22f
- insertion, 166–167

**Chamber dissection, 534f**
- indications, 531
- lobar lung collapse, 532
- lung parenchyma assessment, 532f
- pulmonary nodule, 531f
- trauma, 533f

**Chest drain**
- Seldinger technique, 68

**Chest ultrasound**, 558, 559f

**Chest X-ray**
- abnormality assessment, 19
- calcification causes, 180
- case examples
  - asbestos exposure and pleural plaques, 175f, 176f, 177–180
  - foreign body ingestion, 97f, 98f, 99–104
  - lobar collapse
    - right upper lobe collapse, 53, 54f, 55–60, 599f, 600f
    - left lower lobe collapse, 153f, 154f, 155–160, 589f, 590f
  - lung abscess, 145f, 146f, 147–152
  - lung cancer
    - hilar mass, 69f, 70f, 71–76
    - metastasis sites, 74–75
    - Pancoast tumour, 77f, 78f, 79–84
    - pulmonary metastases, 85f, 86f, 87–90
    - mediastinal mass, 137f, 138f, 139–141
    - normal findings, 46f, 47–52
    - pericardial effusion, 169f, 170f, 591f, 592f
    - pleural effusion, 61f, 62f, 63–68, 585f, 586f
    - pneumomediastinum, 611f, 612f
    - pneumonia, 105f, 106f, 107–112, 595f, 596f, 597f, 598f, 601f, 602f, 603f, 604f, 607f, 608f
    - pneumoperitoneum, 129f, 130f, 131–136, 583f, 584f
    - pneumothorax
      - primary spontaneous, 29f, 30f, 31–36
      - small left apical pneumothorax, 579f, 580f
      - tension pneumothorax, 37f, 38f, 39–44
      - pulmonary embolism, 113f, 114f, 115–120, 581f, 582f
- pulmonary oedema, 121f, 122f, 123–128
- sarcoidosis of lung, 91f, 92f, 93–96
- tube and line displacement, 161f, 162f, 163–168, 587f, 588f, 593f, 594f
- checklist, 28
- consolidation causes, 108, 117, 122f, 162f
- dose, 48–49
- inspirations, 48
- inspiration during, 18–19
- lines and tubes, 22f
- lung collapse, see Lobar lung collapse
- lymphadenopathy, 94
- patient details, 18
- penetration assessment, 19
- pleural effusion, 25f
- pneumonia, 23, 24f, 25
- pneumothorax, 25f
- projection, 17f, 18
- pulmonary oedema, 25f
- review
  - ABCDD mnemonic
  - airway, 19–20
  - breathing, 20
  - cardiac and mediastinum, 20, 21f
  - cardiac delicates, 21
  - diaphragm, 20–21, 22f
  - summarisation, 23
- rotation, 18f
- Cholecystitis, gallstone presentation, 259
- Chronic myeloid leukaemia, splenomegaly, 252
- Chronic obstructive pulmonary disease (COPD), 20, 603f, 604f
- Chronic pancreatitis, abdominal X-ray, 269f, 270f
- Clavicle, see Shoulder
- Clips, see Sterilisation clips
- Cocksackie virus, pericardial effusion
- induction, 172
- Coffee bean sign, sigmoid colon volvulus, 215
- Colchicine, pericardial effusion
- management, 174
- Colitis
  - case example with abdominal X-ray, 225f, 226f, 227–232
  - causes, 228
- ulcerative colitis, see Inflammatory bowel disease
- Colles’ fracture, 364, 423f, 424f, 425–428
- Colon cancer
  - colonoscopy, 209
  - large bowel obstruction, 207
  - lobar lung collapse, 156
- Colon, see Large bowel
INDEX

Colonoscopy, 209, 539f
Community acquired pneumonia (CAP)
  case examples, 595f, 596f, 601f, 602f
  pathogens, 110
  scoring, 111
Compartment syndrome, 402, 486, 503
Computed tomography (CT)
  abdominal aortic aneurysm rupture imaging, 298
  abdominal CT, 535f, 536f, 537f, 538f, 539f, 540f, 541f
  angiography, 542f
  bone tumour, 479
  bowel ischaemia, 237, 239
  cancer staging, 159
  cervical spine, 344f, 388–389, 530f
  chest CT, 531f, 532f, 533f, 534f
  contraindications, 524
  contrast agents
    allergy, 523
    metformin patient precautions, 524
    nephropathy induction, 523–524
    types, 523
    dose, 523
  foreign body ingestion, 101
  head CT, 525, 526f, 527f, 528f, 529f
  indications, 524
  lung abscess, 150–151
  lung cancer, 75
  orthopaedic CT, 530f, 531
  pancreatic abscess, 276
  pelvis fracture, 446
  PET/CT, see Positron emission tomography
  pleural calcification, 179
  pneumoperitoneum, 132–133, 223–224
  principles, 521f
  pulmonary metastases, 90
  scanner, 521f
  sigmoid colon volvulus, 216
  tibial plateau fracture, 488
  windowing, 522f, 523
Computed tomography pulmonary angiography (CTPA)
  pleural effusion, 67
  pulmonary embolism, 531f
Congestive cardiac failure
  assessment, 117
  chest X-ray findings, 114–115
  clinical features, 114
Constipation
  ankylosing spondylitis, 306f
  bone metastasis, 302
  causes, 244–245
  complications, 246
  imaging, 241f, 242f, 245–246
  management, 245
tenesmus, 244
Continuous positive airway pressure (CPAP), pulmonary oedema management, 128
Contrast agents
  computed tomography
    allergy, 523
    metformin patient precautions, 524
    nephropathy induction, 523–524
    types, 523
    gadolinium for magnetic resonance imaging, 544
  Contrast enema, 576f
  Contrast swallow, see Barium swallow
  COPD, see Chronic obstructive pulmonary disease
  Costophrenic angle, blunting, 30f, 62f
  CPAP, see Continuous positive airway pressure
  Cremasteric reflex, spinal injury assessment, 380
CRITOE acronym, ossification centres, 351, 353f
Crohn's disease, see Inflammatory bowel disease
CTPA, see Computed tomography pulmonary angiography
Cubitus varus, supracondylar fracture, 406
CURB 65, pneumonia scoring, 111
Danazol, uterine fibroid management, 283
Deep vein thrombosis (DVT)
  complications, 119–120
  pneumonia complication, 111–112
  prophylaxis in ulcerative colitis flare management, 232
  ultrasound, 118
Demyelination, magnetic resonance imaging, 547f
Dermatome, spinal injury assessment, 380, 389–390
Diarrhoea, bloody diarrhoea assessment, 229
Dislocation, 339, 340f
Disseminated intravascular coagulation, necrotising enterocolitis, 334
Diverticulitis, stricture formation, 208
Docusate sodium, constipation management, 245
Double bubble sign, 322f
Down's syndrome, duodenal atresia, 325
Duodenal atresia
  abdominal X-ray, 321f, 322f, 325
  associated conditions, 325
  case example with abdominal X-ray, 321f, 322f, 323–326
  double bubble sign, 322f
  management, 326
  signs and symptoms, 324
  stenosis similarity, 324
Duodenum, volvulus, 213
DVT, see Deep vein thrombosis
Dysmenorrhoea, uterine fibroids, 281
ECG, see Electrocardiogram
Elbow
  anatomy, 405
  anterior interosseous nerve injury, 404
  effusion X-ray, 337f, 687f, 688f, 693f, 694f
  orthopaedic X-ray assessment, 350, 351f, 352f, 353f, 403
  normal findings, 643f, 644f
  radial head fracture, 687f, 688f
  supracondylar fracture
    case examples, 399f, 400f, 401–406, 693f, 694f
    deformities following, 405–406
    Gartland classification, 353, 403
  ossification centres, 351, 353f
Electrocardiogram (ECG), congestive cardiac failure, 127
Emergency surgery, prerequisites, 463–464
Emphysema, lung abscess risk factor, 149
Empyema
  pleural calcification, 178
  pneumonia complication, 111–112
  Enchondroma, location and age, 480
Endoscopic retrograde cholangiopancreatography (ERCP), acute pancreatitis, 273
Endoscopy
  battery stuck in mid-oesophagus, 319
  complications, 320
Endotracheal tube (ET)
  chest X-ray, 22f
  positioning, 166
Enema, sigmoid colon volvulus management, 216
Enterocolic fistulae, necrotising enterocolitis, 334
Epilepsy, magnetic resonance imaging, 548
ERCP, see Endoscopic retrograde cholangiopancreatography
ET, see Endotracheal tube
Ewing's sarcoma
  differential diagnosis, 477
  location and age, 480
Faecal loading, see Constipation
FAST, see Focused assessment with sonography in trauma
Femoral vein, ultrasound, 563f
Femur
  neck fracture, see Hip
  shaft fracture X-rays, 339f, 659f, 660f, 671f, 672f
<table>
<thead>
<tr>
<th>Page</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>700</td>
<td><strong>INDEX</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Holstein Lewis fracture</th>
<th>365</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hormone replacement therapy (HRT), pulmonary embolism risks</td>
<td>116</td>
</tr>
<tr>
<td>Horner’s syndrome, lung cancer</td>
<td>80–81</td>
</tr>
<tr>
<td>Hounsfield unit (HU)</td>
<td>522</td>
</tr>
<tr>
<td>HPOA, see Hypertrophic pulmonary osteoarthropathy</td>
<td></td>
</tr>
<tr>
<td>HRT, see Hormone replacement therapy</td>
<td></td>
</tr>
<tr>
<td>HU, see Hounsfield unit</td>
<td></td>
</tr>
<tr>
<td>Hydronephrosis, abdominal aortic aneurysm</td>
<td>296</td>
</tr>
<tr>
<td>Hypercalcaemia, constipation</td>
<td>244</td>
</tr>
<tr>
<td>Hypertension, splenic artery aneurysm risks</td>
<td>290</td>
</tr>
<tr>
<td>Hypertrophic pulmonary osteoarthopathy (HPOA), lung cancer</td>
<td>74</td>
</tr>
<tr>
<td>Hypotension, pericardial effusion</td>
<td>173</td>
</tr>
<tr>
<td>Hypoxia, tension pneumothorax</td>
<td>41</td>
</tr>
<tr>
<td>Hysterectomy, uterine fibroid management</td>
<td>284</td>
</tr>
<tr>
<td>Idiopathic thrombocytopaenic purpura, Splenectomy</td>
<td>253</td>
</tr>
<tr>
<td>Inflammatory bowel disease</td>
<td>256</td>
</tr>
<tr>
<td>abdominal X-ray findings, 623f, 624f</td>
<td></td>
</tr>
<tr>
<td>Crohn’s disease versus ulcerative colitis, 230</td>
<td></td>
</tr>
<tr>
<td>flares</td>
<td>254</td>
</tr>
<tr>
<td>toxic megacolon assessment, 231</td>
<td></td>
</tr>
<tr>
<td>ulcerative colitis management, 232</td>
<td></td>
</tr>
<tr>
<td>gallstone risks with Crohn’s disease, 258</td>
<td></td>
</tr>
<tr>
<td>pneumoperitoneum induction, 135</td>
<td></td>
</tr>
<tr>
<td>renal calculi, 266</td>
<td></td>
</tr>
<tr>
<td>stricture formation, 208</td>
<td></td>
</tr>
<tr>
<td>Infliximab, ankylosing spondylitis management</td>
<td>312</td>
</tr>
<tr>
<td>Interosseus nerve, testing</td>
<td>427</td>
</tr>
<tr>
<td>Interventional radiology, bowel ischaemia</td>
<td>237</td>
</tr>
<tr>
<td>Intra-aortic balloon pump, pulmonary oedema management</td>
<td>128</td>
</tr>
<tr>
<td>Intrauterine contraceptive device (IUCD), X-ray of migration, 615f, 616f</td>
<td></td>
</tr>
<tr>
<td>IUCD, see Intrauterine contraceptive device</td>
<td></td>
</tr>
<tr>
<td>Jaundice, gallstone presentation</td>
<td>259</td>
</tr>
<tr>
<td>Jeffrey fracture</td>
<td>365, 388</td>
</tr>
<tr>
<td>Jones fracture, 365</td>
<td></td>
</tr>
<tr>
<td>Kerley B lines</td>
<td>25f</td>
</tr>
<tr>
<td>Kidney</td>
<td>27f</td>
</tr>
<tr>
<td>abdominal X-ray assessment, 185</td>
<td></td>
</tr>
<tr>
<td>failure, see Renal failure stones, see Renal calculus ultrasound, 560, 561f</td>
<td></td>
</tr>
<tr>
<td>Klein’s line, 366</td>
<td></td>
</tr>
<tr>
<td>Knee</td>
<td></td>
</tr>
<tr>
<td>aspiration, 487</td>
<td></td>
</tr>
<tr>
<td>bone tumour case study, 473f, 474f, 475–480</td>
<td></td>
</tr>
<tr>
<td>magnetic resonance imaging, 555f</td>
<td></td>
</tr>
<tr>
<td>orthopaedic X-ray assessment, 360, 361f</td>
<td></td>
</tr>
<tr>
<td>osteoarthritis case example, 489f, 490f, 491–496</td>
<td></td>
</tr>
<tr>
<td>tibial plateau fracture case studies, 481f, 482f, 483–488, 655f, 656f</td>
<td></td>
</tr>
<tr>
<td>X-ray features, 494–495</td>
<td></td>
</tr>
<tr>
<td>Knee replacement, 496</td>
<td></td>
</tr>
<tr>
<td>Kocher’s method, shoulder dislocation reduction, 395</td>
<td></td>
</tr>
<tr>
<td>Lactulose, constipation management, 245</td>
<td></td>
</tr>
<tr>
<td>Large bowel</td>
<td></td>
</tr>
<tr>
<td>abdominal X-ray assessment, 182f</td>
<td></td>
</tr>
<tr>
<td>abscess, 334</td>
<td></td>
</tr>
<tr>
<td>constipation and perforation, 246</td>
<td></td>
</tr>
<tr>
<td>obstruction, 182, 183f, 617f, 618f</td>
<td></td>
</tr>
<tr>
<td>obstruction, see Bowel obstruction sigmoid colon volvulus, 211f, 212f, 213–216</td>
<td></td>
</tr>
<tr>
<td>small bowel differences on X-ray, 193</td>
<td></td>
</tr>
<tr>
<td>thumbprinting, 185f, 185</td>
<td></td>
</tr>
<tr>
<td>Laryngeal cancer, asbestos exposure, 179</td>
<td></td>
</tr>
<tr>
<td>Left lower lobe collapse, 26f, 153f, 154f, 155–160</td>
<td></td>
</tr>
<tr>
<td>Left upper lobe collapse, 26, 58, 609f, 610f</td>
<td></td>
</tr>
<tr>
<td>Levonorgestrel intrauterine device, uterine fibroid management, 283</td>
<td></td>
</tr>
<tr>
<td>Lipohamaerthrombosis</td>
<td></td>
</tr>
<tr>
<td>fracture association, 484</td>
<td></td>
</tr>
<tr>
<td>tibial plateau fracture case studies, 481f, 482f, 483–488, 655f, 656f</td>
<td></td>
</tr>
<tr>
<td>Lisfranc injury, 365</td>
<td></td>
</tr>
<tr>
<td>Liver</td>
<td></td>
</tr>
<tr>
<td>abdominal X-ray assessment, 185</td>
<td></td>
</tr>
<tr>
<td>ultrasound, 560f, 561f</td>
<td></td>
</tr>
<tr>
<td>Liver transplantation, splenic artery aneurysm risks, 290</td>
<td></td>
</tr>
<tr>
<td>Lobar lung collapse</td>
<td></td>
</tr>
<tr>
<td>cancer association, 156</td>
<td></td>
</tr>
<tr>
<td>causes, 57</td>
<td></td>
</tr>
<tr>
<td>chest physiotherapy, 60</td>
<td></td>
</tr>
<tr>
<td>chest X-ray</td>
<td></td>
</tr>
<tr>
<td>left lower lobe, 26f, 153f, 154f, 155–160, 589f, 590f</td>
<td></td>
</tr>
<tr>
<td>left upper lobe, 26, 58, 609f, 610f</td>
<td></td>
</tr>
<tr>
<td>right lower lobe, 27f</td>
<td></td>
</tr>
<tr>
<td>right middle lobe, 27f</td>
<td></td>
</tr>
<tr>
<td>right upper lobe, 26, 53, 54f, 55–60, 599f, 600f</td>
<td></td>
</tr>
<tr>
<td>clinical presentation, 56</td>
<td></td>
</tr>
<tr>
<td>computed tomography, 532</td>
<td></td>
</tr>
<tr>
<td>foreign body induction, 102</td>
<td></td>
</tr>
<tr>
<td>Low-molecular-weight heparin, pulmonary embolism management, 119</td>
<td></td>
</tr>
<tr>
<td>Luftsichel sign, 26f</td>
<td></td>
</tr>
<tr>
<td>Lumbar spine, see Cauda equina syndrome; Spine</td>
<td></td>
</tr>
<tr>
<td>Lung</td>
<td></td>
</tr>
<tr>
<td>parenchyma assessment with chest computed tomography, 532f</td>
<td></td>
</tr>
<tr>
<td>X-ray, see Chest X-ray</td>
<td></td>
</tr>
<tr>
<td>Lung abscess</td>
<td></td>
</tr>
<tr>
<td>aetiology, 150–151</td>
<td></td>
</tr>
<tr>
<td>chest X-ray findings, 145f, 146f</td>
<td></td>
</tr>
<tr>
<td>differential diagnosis, 148</td>
<td></td>
</tr>
<tr>
<td>risk factors, 149</td>
<td></td>
</tr>
<tr>
<td>treatment, 151–152</td>
<td></td>
</tr>
<tr>
<td>Lung cancer</td>
<td></td>
</tr>
<tr>
<td>case examples with chest X-rays</td>
<td></td>
</tr>
<tr>
<td>hilar mass, 69f, 70f, 71–76</td>
<td></td>
</tr>
<tr>
<td>metastasis sites, 74–75</td>
<td></td>
</tr>
<tr>
<td>Pancoast tumour, 77f, 78f, 79–84</td>
<td></td>
</tr>
<tr>
<td>pulmonary metastases, 85f, 86f, 87–90</td>
<td></td>
</tr>
<tr>
<td>consolidation on chest X-ray, 108</td>
<td></td>
</tr>
<tr>
<td>lobar lung collapse, 156</td>
<td></td>
</tr>
<tr>
<td>Lung collapse, see Lobar lung collapse</td>
<td></td>
</tr>
<tr>
<td>Lung ventilation/perfusion scan principles, 565</td>
<td></td>
</tr>
<tr>
<td>pulmonary embolism, 566, 567f</td>
<td></td>
</tr>
<tr>
<td>radiation dose, 566</td>
<td></td>
</tr>
<tr>
<td>Lymphadenopathy</td>
<td></td>
</tr>
<tr>
<td>chest X-ray findings, 94</td>
<td></td>
</tr>
<tr>
<td>sarcoidosis of lung, 91f, 92f, 94</td>
<td></td>
</tr>
<tr>
<td>Lymph node, calcification in upper left quadrant of abdominal X-ray, 288</td>
<td></td>
</tr>
<tr>
<td>Lymphoma</td>
<td></td>
</tr>
<tr>
<td>hilar mass, 73</td>
<td></td>
</tr>
<tr>
<td>mediastinal mass differential diagnosis, 142–143</td>
<td></td>
</tr>
<tr>
<td>splenomegaly, 252–253</td>
<td></td>
</tr>
<tr>
<td>Magnetic resonance cholangiopancreatography (MRCP), 261, 553f</td>
<td></td>
</tr>
<tr>
<td>Magnetic resonance imaging (MRI)</td>
<td></td>
</tr>
<tr>
<td>bone tumour of knee, 479</td>
<td></td>
</tr>
<tr>
<td>cauda equina syndrome, 372</td>
<td></td>
</tr>
<tr>
<td>cervical spine, 388–389</td>
<td></td>
</tr>
<tr>
<td>contraindications, 544</td>
<td></td>
</tr>
<tr>
<td>gadolinium contrast agent, 544</td>
<td></td>
</tr>
<tr>
<td>head MRI</td>
<td></td>
</tr>
<tr>
<td>congenital abnormalities, 549</td>
<td></td>
</tr>
<tr>
<td>demyelination, 547f</td>
<td></td>
</tr>
</tbody>
</table>
epilepsy, 548
indications, 544
pituitary, 548
space occupying lesions, 548f
stroke, 546f
vascular abnormalities, 549
weighted images, 545f
indications, 544
knee, 555f
osteomyelitis, 510
Pancoast tumour, 83
principles, 543
safety, 543
scanner, 543f
small bowel, 554f
spinal cord compression, 303
spine MRI
cauda equina syndrome, 550f
indications, 549
normal findings, 549f
spinal canal stenosis, 552f
spinal cord compression, 550, 551f
spinal cord trauma, 553f
uterine fibroids, 282
weighted sequences, 544
Maiossevenue injury, 365
Malaria, splenomegaly, 252
Malleolus, fracture, 637f
Malignant melanoma, 174
Malignancy, staging, 83
Malrotation, duodenal atresia, 325
Medial clear space, 518
Medial nerve, injury in Colles’ fracture, 426–427
Mediastinum
chest X-ray assessment, 20, 21f, 140
gas, see Pneumomediastinum
mass, case example with chest X-ray, 137f, 138f, 139–141
mediastinitis and oesophageal foreign body induction, 100
Menorrhagia, uterine fibroids, 281
Mesothelioma, asbestos exposure, 179
Metacarpal, fracture, 637f, 638f
Metal detector, ingested coin detection, 100
Metastasis, lung cancer, 74–75
Metatarsal, fracture, 639f, 640f, 647f, 648f, 653f, 654f, 675f, 676f
Mitral regurgitation
calcification on X-ray, 180
pulmonary oedema, 126
Metformin, contrast agent precautions, 524
Monteggia fracture, 365
MRCP, see Magnetic resonance cholangiopancreatography
MRI, see Magnetic resonance imaging
Mucus plug, lobar lung collapse, 157
Multiple myeloma, 158, 480
Myasthenia, lung cancer, 74
Myelofibrosis, splenomegaly, 252
Myocardial infarction, pericardial effusion induction, 172
Myocardial perfusion scan
principles, 565, 567
radiation dose, 566
Myomectomy, uterine fibroid management, 284
Myotome, spinal injury assessment, 380
Myotome, spinal injury assessment, 380, 390
Nasendoscopy, foreign body retrieval, 104
Nasogastric (NG) tube
acute pancreatitis, 275
cHEST X-rays, 22f, 161f, 162f, 165, 587f, 588f, 593f, 594f
placement, 164
small bowel obstruction management, 201
Necrotising enterocolitis
abdominal X-ray, 327f, 328f, 331–332, 629f, 630f
Bell classification system, 332
complications, 333–334
management, 332–333
risk factors, 330
stricture formation, 208
Needle decompression, tension pneumothorax, 38, 42, 44
Nephrostomy, complications, 625f, 626f
NG tube, see Nasogastric tube
Nuclear medicine, see Bone scan;
Genitourinary scan; Lung ventilation/perfusion scan; Myocardial perfusion scan; Positron emission tomography
Obesity, gallstone risks, 258
Oesophageal varices, portal hypertension as cause, 291
Oesophagus
battery stuck in mid-oesophagus, 319
fistula from foreign body ingestion, 320
perforation from foreign body ingestion, 320
Open fracture
Gustilo classification, 504
management, 501–502
Opioids, constipation, 244
Orthopaedic computed tomography, 530–531
Orthopaedic X-rays, see also specific bones and joints
ankle assessment, 362f, 363f
checklist, 366
either elbow assessment, 350, 351f, 352f, 353f
Gartland classification of supracondylar fracture, 353
fracture
appearance, 336f
descriptors, 338–339
names, 364–366
hip assessment, 357f, 358f, 359f, 360
knee assessment, 360, 361f
pelvis assessment, 357f, 358f, 359f, 360
projection, 335f
shoulder assessment, 348, 349f, 350f
spine
cervical spine assessment, 340–341, 342f, 343f, 344f, 345f
thoracolumbar spine assessment, 345, 346f, 347f
subluxation versus dislocation, 339, 340f
systematic review, 336f, 337f, 338f
technical adequacy, 336
wrist assessment, 354f, 355f, 356f
Ossification centres, elbow, 351, 353f
Osteoarthritis
hip case example, 336f, 429f, 430f, 431–434
knee case example, 489f, 490f, 491–496
severity assessment, 433
X-ray features, 432
Osteomyelitis
clinical findings, 508
differential diagnosis, 477
magnetic resonance imaging, 510
management, 511
pathogens, 509
arthrosis, 507–512
Osteophyte, knee arthritis, 494–496
Osteosarcoma
location and age, 480
pathological fracture, 158
Ottawa Ankle Rules, 516
Ovarian cyst, ultrasound, 562f
Paget’s disease, X-ray findings, 631f, 632f
Pancoast tumour, see Lung cancer
Pancreas
abdominal X-ray assessment, 185
annular pancreas, 324–325
ultrasound, 560
Pancreatic abscess, acute pancreatitis association, 276
Pancreatitis, see Acute pancreatitis;
Chronic pancreatitis
Patella reflex, spinal injury assessment, 380
Pelvic ultrasound, 562f
Pelvis
fracture
bladder and urethral injuries, 449
case example, 443f, 444f, 445–450
computed tomography, 446
INDEX

management, 450
mortality, 449
types, 448–449
orthopaedic X-ray assessment, 357f,
358f, 359f, 360
lung abscess differential diagnosis, 148
Pleurial effusion, case examples with chest X-ray, 169f, 170f, 591f, 592f
Periosteal reaction
aggressive bone lesion, 476
osteomyelitis, 505f, 506f
Pleuritis, pneumoperitoneum induction, 136
Perthes’ disease
differential diagnosis, 440
severity assessment, 441
treatment, 441–442
X-ray case example, 435f, 436f,
437–442
PET, see Positron emission tomography
Phlebolith, 278f
Physi, see Growth plate
Pituitary, magnetic resonance imaging, 548
Pleur al calcification
causes, 178
imaging, 177f, 179
Pleur al effusion
case examples with chest X-ray, 61f,
62f, 63–68, 585f, 586f
chest X-ray findings, 25f
clinical signs and symptoms, 64
congestive cardiac failure, 125
draining, 68
exudate analysis, 64–65
exudative effusion aetiology, 65–66
pneumonia complication, 111–112
transudate versus exudate effusions, 66
ultrasound, 559f
Pneumatisos intestinalis, differential diagnosis, 236, 238
Pneumomediastinum, case example, 611f, 612f
Pneumonia
case examples with chest X-rays, 105f,
106f, 107–112, 595f, 596f, 597, 598f,
601f, 602f, 603f, 604f, 607f, 608f
chest X-ray findings, 23, 24f, 25
community acquired pneumonia
    case examples, 595f, 596f, 601f, 602f
    pathogens, 110
    scoring, 111
    complications, 111–112
    consolidation on chest X-ray, 108–109
pleural effusion induction, 65
Pneumoperitoneum
    abdominal X-ray assessment, 184f, 185f
    case examples with abdominal X-ray,
        217f, 218f, 219–224, 234f, 583f, 584f,
        621f, 622f
    causes, 134–135, 220
    chest X-ray findings, 129f, 130f,
        131–136
    post-operative, 136
Pneumothorax
    breathlessness, 34
    case examples with chest X-rays
        primary spontaneous, 29f, 30f,
        31–36
    small left apical pneumothorax,
        579f, 580f
    tension pneumothorax, 37f, 38f,
        39–44
    chest X-ray findings, 25f
    evolution from simple pneumothorax, 40
    pneumonia complication, 111–112
    shoulder X-ray, 641f, 642f
    tension pneumothorax, 20
Portal hypertension, 290–291, 560
Positron emission tomography (PET)
    indications, 420
    PET/CT
        principles, 565
        radiation dose, 566
        tumours, 569f
    Posterior interosseus nerve, testing, 427
Pregnancy
    pulmonary embolism evaluation, 118
    splenic artery aneurysm risks, 290
    X-ray safety, 14
    Premature infants, necrotising enterocolitis, 330
    Prostate cancer
        bone metastasis, 299f, 300f, 301–304
        staging, 302–303
    Pulmonary artery hypertension
        hilar mass, 73
        pulmonary embolism complication,
            119–120
    Pulmonary embolism
        breathlessness, 34
        case examples with chest X-ray, 113f,
            114f, 115–120, 581f, 582f
        complications, 119–120
        lung ventilation/perfusion scan, 566,
            567f
        pregnant patient evaluation, 118
        risk factors, 116
        treatment, 119
    Pulmonary fibrosis, 96, 179
    Pulmonary oedema
        case example with chest X-ray, 121f,
            122f, 123–128
        causes, 126
    chest X-ray findings, 25f, 108
    treatment, 128
    Pulmonary infarction
        haemoptysis, 72
        lung abscess differential diagnosis, 148
        pleural effusion induction, 66
Radial inclination, 355
Radial nerve, testing, 427
Radius, see Elbow; Wrist
Renal artery stenosis, 427
Renal calculi
    abdominal X-ray, 263f, 264f
    calcification in upper left quadrant of
        abdominal X-ray, 288
    computed tomography, 267–268, 540f
    management, 268
    risk factors, 266
    symptoms, 266
    uric acid stones, 267
Renal failure
    contrast agent nephropathy
        induction, 523–524
    pericardial effusion induction, 172
    pulmonary oedema, 126
    Renal tubular acidosis, renal calculi, 266
    Retroperitoneal fibrosis, abdominal
        aortic aneurysm, 296
    Rheumatoid arthritis, hand X-ray, 667f, 668f
    Right lower lobe collapse, 27f
    Right middle lobe collapse, 27f
    Right upper lobe collapse, 26, 53, 54f,
        55–60, 599f, 600f
    Rigler’s sign, 234f
    Rolando’s fracture, 365
    Round atelectasis, asbestos exposure, 179
Sacralic joint, abdominal X-ray, 194
Saddle anaesthesia, cauda equina
    syndrome, 371
Sail sign, 26, 27f, 154f
Salter Harris classification, growth plate
    fractures, 364, 408f, 411–412
Sarcoidosis
    clinical presentation, 95–96
    differential diagnosis in lung, 78
    hilar mass, 73
    lung, 91f, 92f, 93–96
    risk factors, 94–95
Scaphoid, see Wrist
SCIWORA, see Spinal cord injury without
    radiological abnormality
Second fracture, 365
Seldinger technique, 68
Senna, constipation management, 245
Septic arthritis, distinguishing from
    irritable hip, 512

702 • Index
INDEX

Shenton’s line, 366
Short bowel syndrome, necrotising enterocolitis, 334
Shoulder
ankylosing spondylitis, 310
dislocation
axillary nerve injury, 396
bony abnormalities with anterior dislocations, 397
instability following injury, 397–398
reduction, 395
types, 394
orthopaedic X-ray
acromio-clavicular joint disruption, 673f, 674f
assessment, 348, 349f, 350f
glenohumeral joint dislocation, 391f, 392f, 393–398, 657f, 658f
humeral neck fracture, 661f, 662f
posterior dislocation, 665f, 666f
SiADH, see Syndrome of inappropriate antidiuretic hormone secretion
Sickle cell anaemia, calcification in upper left quadrant of abdominal X-ray, 288
Sigmoid colon volvulus
abdominal X-ray, 211f, 212f, 213–216
contrast enema, 576f
Sigmoidoscopy, sigmoid colon volvulus management, 216
Silhouette sign
mediastinal mass, 142
pneumonia chest X-ray, 24f, 109
Silicosis, calcification on X-ray, 180
Slipped upper femoral epiphysis (SUFE) case examples, 451f, 452f, 453–456, 645f, 646f
clinical presentation, 454
coronal slippage incidence, 455
management, 456
pathology, 454
Trehovian’s sign, 455
Small bowel
abdominal X-ray assessment, 182f
barium follow-through, 576
dilation in necrotising enterocolitis, 331–332
large bowel differences on X-ray, 193
magnetic resonance imaging, 554f
obstruction, see Bowel obstruction ultrasound, 561f
Smith’s fracture, 365, 427–428
Spinal canal stenosis, magnetic resonance imaging, 552f
Spinal cord compression
bone metastasis, 302–304
cauda equina syndrome decompression surgery, 373
magnetic resonance imaging, 550, 551f
Spinal cord injury without radiological abnormality (SCIWORA), 384
Spinal cord trauma, magnetic resonance imaging, 553f
Spinal shock, 381
Spine, see also Cauda equina syndrome
back pain management, 374
cauda equina syndrome decompression surgery, 373
cervical spine computed tomography, 530f
computed tomography of cervical spine, 388–389
magnetic resonance imaging of cervical spine, 388–389
orthopaedic X-ray
central cord syndrome, 382
cervical spine
assessment, 340–341, 342f, 343f, 344f, 345f
case example of fracture without trauma, 382f, 383f, 384–390
lines for lateral X-ray assessment, 387
Chance fracture-associated injuries, 379
Jefferson fracture, 388
L1 fracture, 375f, 376f
level of sensation and fracture location, 380, 389–390
stable fracture, 376
thoracolumbar spine assessment, 345, 346f, 347f
Spine magnetic resonance imaging
cauda equina syndrome, 550f
indications, 549
normal findings, 549f
spinal canal stenosis, 552f
spinal cord compression, 550, 551f
spinal cord trauma, 553f
Spleen
abdominal X-ray assessment, 185f
genital aplasia, 251
erythrocyes, 251
lymphocyte production, 251
size, 251
Splenectomy
indications, 253
management in post-operative period, 254
splenic artery aneurysm, 292
Splenic artery aneurysm
abdominal X-ray of calcification, 285f, 286f, 288
pseudaneurysm differentiation, 289
risk factors, 290
treatment, 292
Splenomegaly
case examples with abdominal X-ray, 247f, 248f, 249–254, 633f, 634f
causes, 252
physical examination, 250
portal hypertension, 290
splenic artery aneurysm, 286f
ultrasound, 560
Staphylococcus aureus, osteomyelitis association, 509
Sterilisation clips
abdominal X-ray assessment, 186
placement, 248f
Stomach, volvulus, 213
Streptococcus pneumoniae, community acquired pneumonia, 110
Stroke
computed tomography of haemorrhage, 525, 526f, 527
magnetic resonance imaging, 546f
Subluxation, 339, 340f
SUFE, see Slipped upper femoral epiphysis
Superior vena cava, stenting in Pancoast tumour, 84
Supracondylar fracture, see Elbow Syndrome of inappropriate antidiuretic hormone secretion (SiADH), lung cancer, 74
Tachycardia, tension pneumothorax, 41
Talus, shi1, 518–519
TB, see Tuberculosis
Tenemus, constipation, 244
Teratoma, mediastinal mass differential diagnosis, 142–143
Thrombolysis, pulmonary embolism management, 119
Thumbprinting, colitis, 218
Thurstand Holland fragment, 365
Thymoma, mediastinal mass differential diagnosis, 142–143
Thyroid cancer, lobular lung collapse, 156
Tibia, see also Knee
osteomyelitis case example, 505f, 506f, 507–512
shaft fracture case example, 497f, 498f, 499–504
Toxic megacolon, 231
Tranexamic acid, uterine fibroid management, 283
Trauma, initial series X-rays, 447
Trendelenburg sign, 432–433
Trehovian’s sign, 366, 455
Triplane fracture, 414
Triquetral bone, see Wrist
Tuberculosis (TB)
differential diagnosis, 89

Index • 703
INDEX

hilar mass, 73
pleural effusion induction, 66
Tubogram, 576, 577f

Ulcerative colitis, see Inflammatory bowel disease
Ulna
distal fracture, see Wrist shaft fracture, 663f, 664f
Ulna variance, 355

Ultrasound scans
abdominal aortic aneurysm, 297
abdominal ultrasound, 559f, 560f
B-mode, 557
chest ultrasound, 558, 559f
colour flow imaging, 557, 563f
congestive cardiac failure echocardiogram, 127
contraindications, 558
deep vein thrombosis, 118
Doppler imaging, 557–558, 559f
focused assessment with sonography in trauma, 448, 563
gallstones, 260, 274
guided procedures, 564
indications, 557
musculoskeletal ultrasound, 564
neck, 558f, 559f
pelvic ultrasound, 562f
pleural effusion, 67–68
principles, 557
reflection of waves, 558
safety, 557
vascular ultrasound, 563f

Ultrasound therapy, uterine fibroid management, 284
Urinary incontinence, cauda equina syndrome, 370
Urinary tract infection, renal calculi, 266

Uterine fibroid
abdominal X-ray of calcification, 277f, 278f
case example with abdominal X-ray, 277f, 278f, 279–284
magnetic resonance imaging, 282
management, 283–284
sites, 281
symptoms, 280

VACTERL, duodenal atresia, 325
Varicella pneumonia, calcification on X-ray, 180
Veil sign, 26f
Ventilation/perfusion scan, see Lung ventilation/perfusion scan
Vertebral body osteitis, ankylosing spondylitis, 309
Volar angulation, 355
Volar Barton’s fracture, 365
Volvulus
sigmoid colon volvulus, 211f, 212f,
213–216
sites, 213
Wackenheim’s line, 366
Wall test, 308
Warfarin
initial prothrombotic effects, 119
pulmonary embolism management, 119
Water skiing, pneumoperitoneum induction, 135
Weber classification, malleolus fractures, 363, 517, 686f
Wegener’s granulomatosis, 148
Westermark’s sign, 114f
Wilm’s tumour, 89
Wrist
carpal tunnel anatomy, 422
orthopaedic X-ray assessment, 354f, 355f, 356f
case examples
Colles’ fracture, 423f, 424f,
425–428
distal radius fracture, 407f, 408f,
409–414, 649f, 650f, 669f, 670f,
679f, 680f
scaphoid fracture, 415f, 416f
triquetral fracture, 356f, 683f,
684f
distal radius radiological measurements, 428
radial inclination, 355
radius fracture, 356f
Smith’s fracture, 365, 427–428
ulna variance, 355
volar angulation, 355

X-ray, see also specific areas and structures
densities, 12f
dose, 192–193, 523
generation, 11f
hazards, 13
image production, 12
magnification of anteroposterior view,
12, 13f
pregnancy, 14
regulatory legislation, 13–14
requesting
form, 14–15
radiology team interactions, 15–16
The Unofficial Guide to Radiology

The Unofficial Guide to Radiology follows on from the 'The Unofficial Guide to Passing OSCEs'. This book teaches systematic analysis of the three main types of X-rays: chest, abdominal and orthopaedic, with additional chapters looking at all the other main radiology tests such as CT and MRI. The layout is designed to make the book as relevant to clinical practice as possible; the X-rays are presented in the context of a real life scenario. The reader is asked to interpret the X-ray before turning over the page to reveal a model report accompanied by a fully annotated version of the X-ray. To further enhance the clinical relevance, each case has 5 clinical and radiology-related multiple-choice questions with detailed answers. These test core knowledge for exams and working life, and illustrate how the X-ray findings will influence patient management.

This book is suitable for:
- Medical Students
- Radiographers
- Nursing Students
- Junior Doctors
- Physicians Associates
- Nurses
- Advanced Nurse Practitioners

"Radiology is a constant challenge for students and doctors in busy clinical units: having a good command of the essentials is a real advantage. This book is well-presented and very accessible. The annotated examples provide realistic challenges with immediate feedback. It didn’t take long before I felt better prepared for my next ward round."
Simon Maxwell, Professor of Student Learning, University of Edinburgh

"Perhaps one of the biggest strengths of this book is the cases section, allowing you to practice not only interpreting high quality images but also to link them to a case history. The questions that follow not only test your radiology, but also your understanding of signs, symptoms, underlying pathophysiology and management of the condition. As well as detailed answers in each section, the book also shows you the best way to present each case, whether in an OSCE situation or on a ward round. The ease of use, detailed pictures and emphasis on key points of this one should cement it as the number one undergraduate book for radiology."
James Brookes, Medical Student

"Which radiographs from each system are most likely to be presented in exams? This excellent book presents the classics, and at one level this makes it a high-yield textbook that will be extremely valuable to medical students and junior doctors. What is especially striking is the definition and clarity of the illustrations, with on-image labelling, enabling one to be absolutely certain of which is the endotracheal tube, the nasogastric tube and the central line, for example."
Bob Clarke, Associate Dean, Professional Development, London. Director, Ask Doctor Clarke Ltd.

ISBN: 978 0 9571499 4 6

RRP £39.99

The Unofficial Guide to Radiology: Chest, Abdominal and Orthopaedic X-Rays, plus CTs, MRIs and Other Important Modalities

Core Radiology Curriculum Covered: 100 Annotated X-Rays (including how to present them), 300 Multiple Choice Questions (with detailed explanations)

Mark Rodrigues and Zeshan Qureshi