ABDOMINAL X-RAYS FOR MEDICAL STUDENTS



CHRISTOPHER CLARKE & ANTHONY DUX



WILEY Blackwell



This book is dedicated to all teaching radiologists and their students.

This title is also available as an e-book. For more details, please see **www.wiley.com/buy/9781118600559** or scan this QR code:



Abdominal X-rays for Medical Students

Christopher G.D. Clarke, MBChB

Radiology Registrar and Honorary Lecturer in Human Anatomy Nottingham University Hospitals Nottingham, UK

Anthony E.W. Dux, MB BS, FRCR

Former Consultant Radiologist and Honorary Senior Lecturer University Hospitals of Leicester Leicester, UK

WILEY Blackwell

This edition first published 2015 © 2015 by John Wiley & Sons, Ltd.

Registered Office John Wiley & Sons, Ltd., The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

Editorial Offices 9600 Garsington Road, Oxford, OX4 2DQ, UK The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK 350 Main Street, Malden, MA 02148-5020, USA

For details of our global editorial offices, for customer services and for information about how to apply for permission to reuse the copyright material in this book please see our website at www.wiley.com/wiley-blackwell

The right of the authors to be identified as the authors of this work has been asserted in accordance with the UK Copyright, Designs and Patents Act 1988.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, except as permitted by the UK Copyright, Designs and Patents Act 1988, without the prior permission of the publisher.

Designations used by companies to distinguish their products are often claimed as trademarks. All brand names and product names used in this book are trade names, service marks, trademarks or registered trademarks of their respective owners. The publisher is not associated with any product or vendor mentioned in this book. It is sold on the understanding that the publisher is not engaged in rendering professional services. If professional advice or other expert assistance is required, the services of a competent professional should be sought.

The contents of this work are intended to further general scientific research, understanding, and discussion only and are not intended and should not be relied upon as recommending or promoting a specific method, diagnosis, or treatment by health science practitioners for any particular patient. The publisher and the author make no representations or warranties with respect to the accuracy or completeness of the contents of this work and specifically disclaim all warranties, including without limitation any implied warranties of fitness for a particular purpose. In view of ongoing research, equipment modifications, changes in governmental regulations, and the constant flow of information relating to the use of medicines, equipment, and devices, the reader is urged to review and evaluate the information provided in the package insert or instructions for each medicine, equipment, or device for, among other things, any changes in the instructions or indication of usage and for added warnings and precautions. Readers should consult with a specialist where appropriate. The fact that an organization or Website is referred to in this work as a citation and/or a potential source of further information does not mean that the author or the publisher endorses the information the organization or Website may provide or recommendations it may make. Further, readers should be aware that Internet Websites listed in this work may have changed or disappeared between when this work was written and when it is read. No warranty may be created or extended by any promotional statements for this work. Neither the publisher nor the author shall be liable for any damages arising herefrom.

Library of Congress Cataloging-in-Publication Data

Clarke, Christopher, 1986–, author.
Abdominal X-rays for medical students / Christopher G.D. Clarke, Anthony E.W. Dux.
p.; cm.
Includes bibliographical references and index.
ISBN 978-1-118-60055-9 (pbk.)
I. Dux, Anthony, author. II. Title.
[DNLM: 1. Radiography, Abdominal–methods–Atlases. 2. Abdomen–pathology–Atlases.

3. Digestive System Diseases-radiography-Atlases. WI 17]

RC944 617.5′507572–dc23

2014047517

A catalogue record for this book is available from the British Library.

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic books.

Cover images: Radiographs showing calcification in the wall of the abdominal aorta; fetus in situ; dilated small bowel; gas-filled distended stomach; toxic megacolon; various ingested foreign objects. Illustrations by Christopher Clarke.

Set in 10/13pt Frutiger by SPi Publisher Services, Pondicherry, India

Contents

Preface, vii Acknowledgements, viii Learning objectives checklist, ix

Part 1

About X-rays, 1

What are X-rays?, 1 How are X-rays produced?, 1 How do X-rays make an image?, 2 How are X-ray images (radiographs) stored?, 3 Radiation hazards, 3 The Ionising Radiation (Medical Exposure) Regulations, 3 In women of reproductive age, 3

Indications for an abdominal X-ray, 4

Abdominal X-ray views, 5

AP Supine abdominal X-ray, 5 Other views, 5

Radiograph quality, 6

Inclusion, 6 Exposure, 6

Normal anatomy on an abdominal X-ray, 8

Right and left (Figure 7), 8 Quadrants and regions (Figure 8), 8 Abdominal viscera 1 (Figure 9), 8 Abdominal viscera 2 (Figure 10), 9 Skeletal structures (Figure 11), 10 Pelvis (Figure 12), 10 Lung bases (may be visualised at the top of the abdomen) (Figure 13), 11 Bowel 1 (Figure 14), 11 Bowel 2 (Figure 15), 12

Presenting an abdominal radiograph, 14

Be systematic!, 14

Part 2

Overview of the ABCDE of abdominal radiographs, 15

A – Air in the wrong place, 16

Pneumoperitoneum (gas in the peritoneal cavity), 21 Pneumoretroperitoneum (gas in the retroperitoneal space), 26 Pneumobilia (gas in the biliary tree), 28 Portal venous gas (gas in the portal vein), 29

B – Bowel, 17

Dilated small bowel, 30 Dilated large bowel, 34 Volvulus, 37 Dilated stomach, 40 Hernia, 41 Bowel wall inflammation, 43 Faecal loading, 48 Faecal impaction, 49

C – Calcification, 18

Gallstones in the gallbladder (cholelithiasis), 50 Renal stones (urolithiasis), 53 Bladder stones, 56 Nephrocalcinosis, 57 Pancreatic calcification, 58 Adrenal calcification, 59 Abdominal aortic aneurysm (AAA) calcification, 60 Fetus, 62 Calcified structures of little clinical significance, 63 Calcified costal cartilage, 63 Phleboliths ('vein stones'), 63 Calcified mesenteric lymph nodes, 64 Calcified uterine fibroids, 65 Prostate calcification, 65 Abdominal aortic calcification (normal calibre), 66 Splenic artery calcification, 66

D – Disability (bones and solid organs), 19

Pelvic fractures – 3 Polo rings test, 67 Sclerotic and lucent bone lesions, 68 Spine pathology, 69 Solid organ enlargement, 71

E – Everything else, 20

Medical and surgical objects (iatrogenic), 73 Surgical clips/staples/sutures, 73 Urinary catheter, 75 Supra-pubic catheter, 75 Nasogastric (NG) and nasojejunal (NJ) tubes, 76 Flatus tube, 77 Surgical drain, 78 Nephrostomy catheter, 78 Peritoneal dialysis (PD) catheter, 79 Gastric band device, 79 Percutaneous endoscopic gastrostomy (PEG)/ radiologically inserted gastrostomy (RIG), 80 Stoma bag, 80 Stents, 81 Inferior vena cava (IVC) filter, 84 Intra-uterine device (IUD), 85 Pessary, 85 Foreign bodies, 86 Retained surgical swab, 86 Swallowed objects, 87 Objects inserted per-rectum (PR), 88 Clothing artefact, 90 Piercings, 90 Body packer, 91 Lung bases, 93

Self-assessment questions, 94 Self-assessment answers, 99 Glossary, 107 Index, 112

Preface

The abdominal radiograph is commonly encountered within the hospital setting, and often junior doctors are the first to review and act upon the radiograph findings. Medical students therefore need to learn how to interpret basic signs and pathology on an abdominal radiograph.

This book is a follow-up to *Chest X-rays for Medical Students*, which Anthony and I wrote a few years ago to help medical students with chest radiographs. Since publishing the chest X-ray book, I have entered clinical radiology training at Nottingham University Hospitals NHS Trust and passed fellowship exams. Anthony has retired, returning a few days a week to continue reporting and teaching. This book has taken approximately 12 months to write and much longer to collect all the radiographs featured within.

The most novel and exciting aspect of *Abdominal X-rays for Medical Students* is the way colour overlays are used to highlight the anatomy and pathology. This way of 'marking' the radiographs separates this book from others and makes it easy to appreciate the sign or pathology of interest. Generally, two radiographs are displayed side by side with the radiograph on the right marked out in colour and the radiograph on the left unmarked for comparison. This makes it easy to compare and identify the abnormality on the unmarked radiograph. Some signs and pathologies are difficult to appreciate, and I experimented with different enhancement techniques until I found one that worked. The result of this was that I have ended up using a range of different techniques to show or enhance pathology in this book.

This book is not intended to be used as an encyclopaedic reference but as a colourful and informative teaching aid to help medical students, junior doctors, radiographers and nurses learn the basics of abdominal X-ray interpretation in a simplified, logical and systematic way. We try to avoid confusing terms and fully explain any commonly used radiographic signs such as *thumbprinting* or *Rigler's sign*.

I hope that by the end of this book, you should have a system to use for analysing and presenting abdominal radiographs and know how to recognise the important common pathologies on an abdominal X-ray.

We are constantly improving and refining this teaching resource for future students, so would really appreciate any feedback or suggestions you may have. Please feel free to contact us with any ideas you have.

I hope that you enjoy using this book.

Christopher G.D. Clarke

Acknowledgements

First, we would like to thank the staff at Nottingham University Hospitals NHS Trust, University Hospitals of Leicester NHS Trust and Derby Hospitals NHS Foundation Trust, without whose dedication and work none of this would be possible. We would like to acknowledge our colleagues who have read this workbook and made numerous suggestions and contributions including many of the Nottingham and Leicester clinical radiology trainees. It would be impossible to name everyone, but we are very grateful.

We would like to thank Dr Tim Taylor and Benjamin Troth for providing many excellent radiograph examples. A special thanks goes to Dr Gill Turner for providing us with access to her fantastic collection of abdominal radiographs, many of which are used in this book. I just hope the colouring has done her collection justice!

Special thanks also go to the many medical students who attended focus groups, lectures and teaching sessions and gave fantastic feedback. I would like to thank Elizabeth Bridges, Sally Wege, Stephanie Ainley and Mark Evans for giving up their time to help in the very early stages of writing. Also I would like to thank Theodora Goodwin, Sian Dobbs, Charlotte Bee, Gemma Dracup and Jenna Harris for their feedback on the draft. Their suggestions and contributions shaped this book and were invaluable. We are grateful to Carole and David Clarke and Gill Turner for taking time to proof read the draft and provide numerous suggestions to improve the book. Thank you to William Clarke and George Booth for their help with the diagrams and photos.

The 'Polo' name and image is reproduced with the kind permission of Société des Produits Nestlé S.A.

Thanks to Martin Davies and Karen Moore from Wiley-Blackwell for their patience and for giving us the opportunity to see our work published again. To all our friends that have supported us and to all those people who remain unnamed in this acknowledgement, we are very grateful.

Finally, thank you to Stewart Petersen for his advice, encouragement and support in publishing *Chest X-rays for Medical Students*. Without his contribution and kindness, *Abdominal X-rays for Medical Students* would never have been developed.

Learning objectives checklist

 \square

 \square

 \square

 \square

(Keep track of your learning by ticking the \square when you have covered that topic)

By the end of this workbook, students should:

- Have a basic understanding of what X-rays are and how the image is produced.
- Have a system for analysing (ABCDE) and presenting an abdominal radiograph.
- Know how to recognise the following on a plain abdominal radiograph:
 - Pneumoperitoneum (gas in the peritoneal cavity)
 - Pneumoretroperitoneum (gas in the retroperitoneal space)
 - Pneumobilia (gas in the biliary tree)
 - Portal venous gas (gas in the portal vein)
 - Dilated small bowel
 - Dilated large bowel
 - Volvulus
 - Dilated stomach
 - Hernia
 - Bowel wall inflammation
 - Faecal loading
 - Faecal impaction
 - Gallstones in the gallbladder (cholelithiasis)
 - Renal stones (urolithiasis)
 - Bladder stones
 - Nephrocalcinosis
 - Pancreatic calcification
 - Adrenal calcification
 - Abdominal aortic aneurysm (AAA) calcification
 Fetus
 - Calcified costal cartilage
 - Phleboliths ('vein stones')

•	Calcified mesenteric lymph nodes	
•	Calcified uterine fibroids	
•	Prostate calcification	
•	Abdominal aortic calcification (normal calibre)	
•	Splenic artery calcification	
•	Pelvic fractures – 3 Polo rings test	
•	Sclerotic and lucent bone lesions	
•	Spine pathology	
•	Solid organ enlargement	
•	Surgical clips/staples/sutures	
•	Urinary catheter	
•	Supra-pubic catheter	
•	Nasogastric (NG) and nasojejunal (NJ) tubes	
•	Flatus tube	
•	Surgical drain	
•	Nephrostomy catheter	
•	Peritoneal dialysis (PD) catheter	
•	Gastric band device	
•	Percutaneous endoscopic gastrostomy (PEG)/radiologically inserted gastrostomy (RIG)	
•	Stoma bag	
•	Stents	
•	Inferior vena cava (IVC) filter	
•	Intra-uterine device (IUD)	
•	Pessary	
•	Retained surgical swab	
•	Swallowed objects	
•	Objects inserted per-rectum (PR)	
•	Clothing artefact	
•	Piercings	
•	Body packer	
•	Lung bases	

About X-rays

What are X-rays?

X-rays are a form of **ionising radiation**. They are part of the electromagnetic spectrum and have sufficient energy to cause ionisations. They contain more energy than ultraviolet (UV) waves but less energy than gamma rays.



Figure 1: The electromagnetic spectrum (Freq is short for frequency).

Radiation is the transfer of energy in the form of particles or waves.

Ionising radiation is the radiation with sufficient energy to cause ionisations, which is a process whereby radiation removes an outer shell electron from an atom. Thus ionising radiation is able to cause changes on a molecular level in biologically important molecules (e.g. DNA).

Uses of ionising radiation include conventional X-rays (plain radiographs), contrast studies, computed tomography (CT), nuclear medicine and positron emission tomography (PET).

How are X-rays produced?

X-rays are produced by focusing a high-energy beam of electrons onto a metal target (e.g. tungsten). The electrons hit the metal target and some will have enough energy to knock out another electron from the inner shell of one of the metal atoms. As a result, electrons from higher energy levels then fill up this vacancy and

Abdominal X-rays for Medical Students, First Edition. Christopher G.D. Clarke and Anthony E.W. Dux. © 2015 John Wiley & Sons, Ltd. Published 2015 by John Wiley & Sons, Ltd.