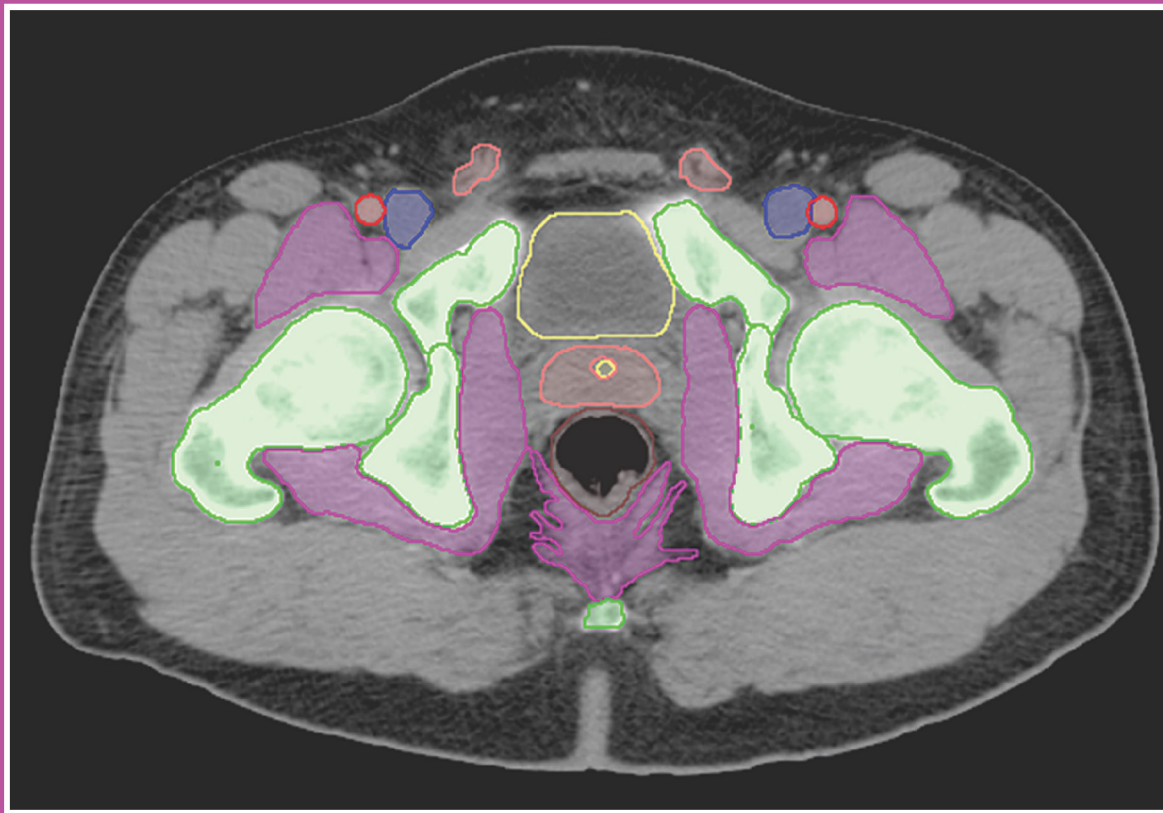


CT Anatomy for Radiotherapy



Second edition

Pete Bridge
David J. Tipper

CT Anatomy for Radiotherapy

*Full the full range of M&K Publishing books
please visit our website:*

www.mkupdate.co.uk

CT Anatomy for Radiotherapy

Pete Bridge
David J. Tipper

CT Anatomy for Radiotherapy

Pete Bridge
David J. Tipper

ISBN: 978-1-910451-09-0

First published 2011
Reprinted with corrections 2012
This revised 2nd edn. published 2017

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, without either the prior permission of the publishers or a licence permitting restricted copying in the United Kingdom issued by the Copyright Licensing Agency, 90 Tottenham Court Road, London, W1T 4LP. Permissions may be sought directly from M&K Publishing, phone: 01768 773030, fax: 01768 781099 or email: publishing@mkupdate.co.uk

Any person who does any unauthorised act in relation to this publication may be liable to criminal prosecution and civil claims for damages.
Original format and layout and all images © the authors.

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

Notice

Clinical practice and medical knowledge constantly evolve. Standard safety precautions must be followed, but, as knowledge is broadened by research, changes in practice, treatment and drug therapy may become necessary or appropriate. Readers must check the most current product information provided by the manufacturer of each drug to be administered and verify the dosages and correct administration, as well as contraindications. It is the responsibility of the practitioner, utilising the experience and knowledge of the patient, to determine dosages and the best treatment for each individual patient. Any brands mentioned in this book are as examples only and are not endorsed by the publisher. Neither the publisher nor the authors assume any liability for any injury and/or damage to persons or property arising from this publication.

To contact M&K Publishing write to:
M&K Update Ltd · The Old Bakery · St. John's Street
Keswick · Cumbria CA12 5AS
Tel: 01768 773030 · Fax: 01768 781099
publishing@mkupdate.co.uk
www.mkupdate.co.uk

Designed and typeset in 11pt Helvetica Neue by Mary Blood
Printed by Bell & Bain, Glasgow

Contents

About the authors	ix
Acknowledgements	x
Foreword by Dr David Bottomley	xi
Preface to the Second Edition	xiii

Chapter 1 Introduction

1.1 Purpose of the book	3
1.2 CT Principles and Equipment	4
1.3 CT Interpretation	6
1.4 Common CT Artefacts	14
1.5 CT Safety	17
1.6 MRI Principles and Equipment: A brief introduction	20

Chapter 2 Pelvis and Abdomen

2.1 Musculoskeletal System	25
2.2 Urinary System	30
2.3 Digestive System	33
2.4 Male Reproductive System	41
2.5 Female Reproductive System	45
2.6 Circulatory System	49
2.7 Structure Focus: Penile bulb	54
2.8 Lymphatic System	57
2.9 Full Male Pelvis and Abdomen CT Anatomy	60
2.10 Full Female Pelvis and Abdomen CT Anatomy	80
2.11 Tumour Pathology	96
2.12 Self-Test Questions	103

Chapter 3 Thorax

3.1 Musculoskeletal System	113
3.2 Digestive System	116
3.3 Respiratory System	118
3.4 Cardiovascular System	124
3.5 Structure Focus: Coronary arteries	131
3.6 Lymphatic System	134
3.7 Full Thorax CT Anatomy	141
3.8 Tumour Pathology	157
3.9 Self-Test Questions	161

Chapter 4 Head and Neck (Extracranial)

4.1 Musculoskeletal System	167
4.2 Digestive System	175
4.3 Respiratory System	180
4.4 Circulatory System	185
4.5 Structure Focus: Brachial plexus	190
4.6 Lymphatic System	193

- 4.7 Deep Spaces **200**
- 4.8 Full Head and Neck CT Anatomy **212**
- 4.9 Tumour Pathology **232**
- 4.10 Self-Test Questions **235**

Chapter 5 Intracranial

- 5.1 Cerebrospinal Fluid Spaces **241**
- 5.2 Circulatory System **246**
- 5.3 Central Nervous System **252**
- 5.4 Structure Focus: Supra-sellar Structures **259**
- 5.5 Full Intracranial CT and MR Anatomy **263**
- 5.6 Tumour Pathology **303**
- 5.7 Self-Test Questions **306**

Chapter 6 CT in Radiotherapy

- 6.1 Kilovoltage Cone Beam CT **313**
- 6.2 Megavoltage Cone Beam CT **315**

Self-Test Answers **318**

Structure Key: Chapter 2 **320**

Structure Key: Chapter 3 **321**

Structure Key: Chapter 4 **322**

Structure Key: Chapter 5 **323**

References and Further Reading **324**

Index **325**

About the authors

Pete Bridge BSc MSc SFHEA

Pete is a radiotherapy lecturer at the University of Liverpool, where he teaches research skills, radiotherapy planning, radiation physics, 3D simulation and CT anatomy. He has previously coordinated radiotherapy courses at undergraduate and postgraduate level in Brisbane and Sheffield respectively. Along with David, Pete pioneered CPD short courses on CT Anatomy, structure outlining and MR Anatomy for Radiotherapy. Pete has worked clinically as a therapy radiographer in Manchester, Auckland, Dundee and Derby. He is particularly interested in structure outlining for radiotherapy planning and has strong research interests in 3D volumetric segmentation and the expanding role of MR in radiotherapy.

David J. Tipper DCR(R) PgCert (MRI) PgCert (CT)

David is the Cross-Sectional Imaging Manager for Derby Teaching Hospitals NHS Foundation Trust. He has worked clinically as a diagnostic radiographer for 25 years and now has what he describes as his dream job. He chose to specialise in cross-sectional imaging early on in his career, and has worked clinically in CT and MRI for nearly 15 years in several regional centres. David has an almost obsessive interest in cross-sectional anatomy and also lectures regularly on the subject.

Acknowledgements

The grateful thanks of the authors are extended to:

David Bottomley, Consultant Clinical Oncologist, for the foreword; Greg Rattray, radiotherapy manager at the Royal Brisbane and Women's Hospital for the IGRT images; Jacqui Bridge, Mark Warren and Professor Angela Duxbury for support and advice.

All CT images in the book were acquired using a 64 slice GE™ VCT Lightspeed scanner. The MR images were acquired on a Siemens Avanto 1.5T MRI scanner. Structure outlining and 3D reconstruction was performed using Varian Medical Systems' ECLIPSE™ planning system contouring tools.

Foreword

Since its publication in 2010, *CT Anatomy for Radiotherapy* has been an invaluable aid to a wide variety of health professionals, both qualified and in training. Since then, the demand for CT interpretation skills has continued to increase in line with technological development and role extension to support the widespread adoption of IGRT.

This second edition has many welcome additions and updates; yet the book retains its original user-friendly format and strong focus on radiotherapy-specific structures and issues. The book continues to support the evolving role of radiotherapy staff as they play a more active part in structure outlining and increasingly routine cone-beam CT verification. The dedicated lymph node sections have been refreshed considerably with detailed delineation of common nodal regions. The text has been updated throughout to reflect changes in technology and practice while the reader is further supported with additional self-test questions and some more interesting pathology examples. I am sure that readers will find the new 'Structure Focus' sections particularly useful with valuable information about some of the more challenging anatomical regions relevant to radiotherapy.

The unique combination of the authors' knowledge of both current and emerging radiotherapy requirements and CT image interpretation has yet again produced an accessible and highly relevant text that provides a high enough level of detail to satisfy the most inquisitive of students and support radiotherapy practice for a range of professionals.

This second edition promises to be a most welcome update to what has already become one of the essential texts for those training or working in radiotherapy at any level. I look forward to seeing it replace the tattered first edition on my shelf and again have no hesitation in commending it to you.

David Bottomley MB BS MRCP FRCR

Consultant in Clinical Oncology, St. James's Institute of Oncology, Leeds, UK

2016

Preface to the Second Edition

Anatomy of the human form is a fascinating subject. As with the first edition, the aim of this book is to help you to understand each CT section along with the transferable skills to help you interpret images in your own clinical practice. We hope to provide you with a level of understanding enabling you to recognise all the different anatomical regions, structures and systems that are relevant to radiotherapy. The focus remains firmly on structures relevant to radiotherapy with images based on radiotherapy positioning, immobilisation methods and imaging techniques.

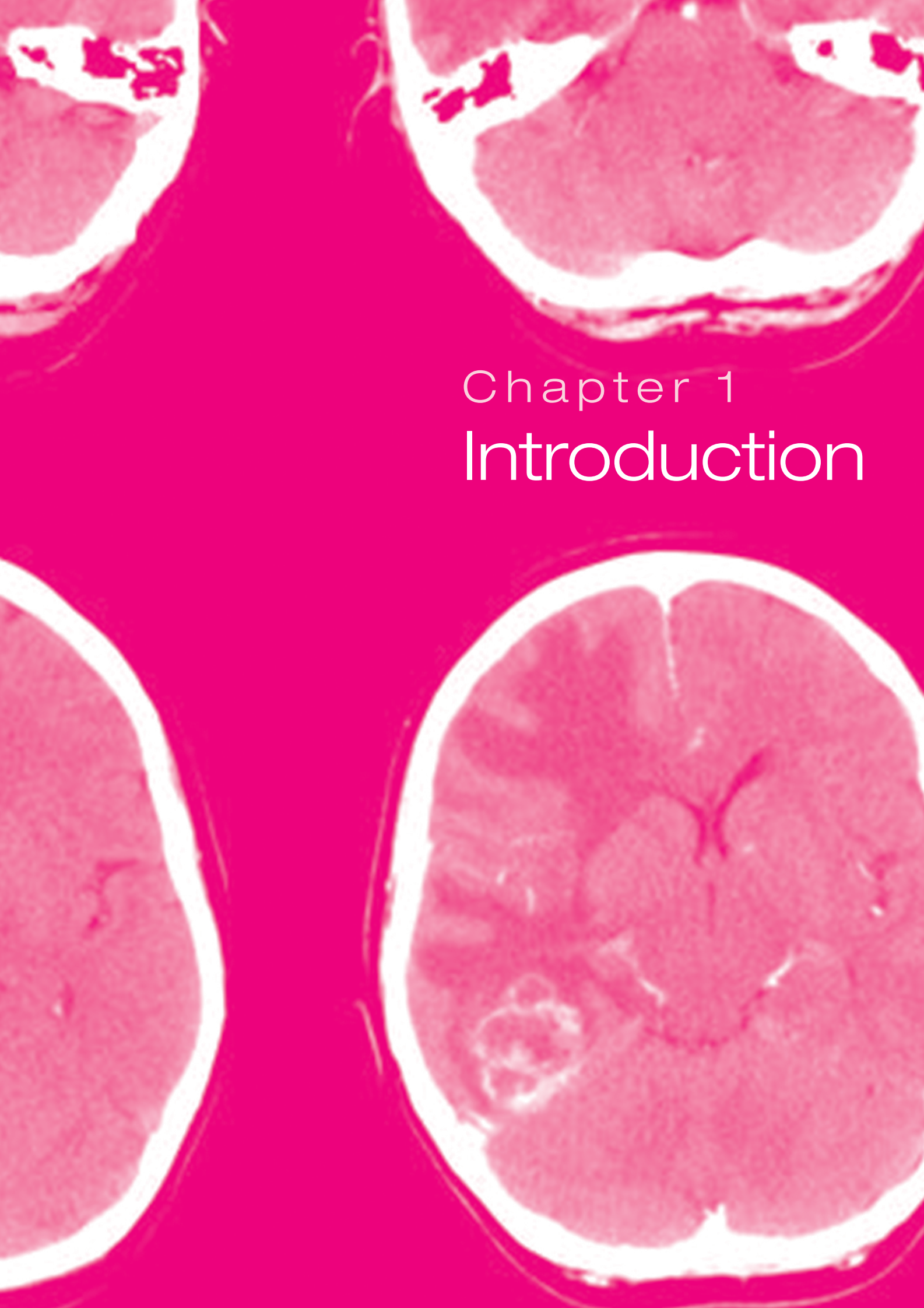
Since the publication of the first edition the world of radiotherapy has continued to evolve, with cone-beam CT IGRT now commonplace in most clinical centres. Despite the ever-increasing technological sophistication of treatment delivery systems, automated segmentation algorithms and image matching software, there is a higher need than ever for CT interpretation skills in radiotherapy practice. Although image fusion with MR and PET scans continues to inform target delineation prior to planning, it is still rare to find a patient on a linear accelerator who has not arrived there via a CT bore.

As with the first edition, this text aims to meet the constant demand for a radiographic anatomy text suitable for interpretation of radiotherapy CT images. As such, the text continues to stand apart from diagnostic books by drawing on different planes of images and focusing solely on anatomical sites relevant to radiotherapy. The second edition has responded to feedback from clinical radiotherapy colleagues by providing several key additional sections and updates. Chapter 1 has more information relating to safety in CT, use of contrast and minimising the impact of artefacts. The 'lymphatic' sections have been updated with anatomically accurate outlines to help with nodal CTV target delineation. New dedicated 'Structure Focus' sections concentrate on anatomical structures that are challenging yet clinically relevant for trial protocols or included in updated guidelines. These sections cover the penile bulb, coronary arteries, brachial plexus and complex supra-sellar regions. Additional self-test questions have been added to help consolidate learning and the IGRT information in Chapter 6 has been updated to reflect the dramatic technological developments, since the first edition.

The refreshed and extended second edition aims to support ongoing development of CT interpretation skills in the radiotherapy professions. It will be of interest to both qualified and student therapy radiographers working with IGRT equipment, CT scanners or radiotherapy planning software. It will also be of value to other radiotherapy professionals wishing to update their knowledge of CT anatomy or working towards specialisation in advanced planning, structure outlining or IGRT.

CT Anatomy for Radiotherapy's second edition is a product of ongoing collaboration between the diagnostic radiography and radiotherapy disciplines and it aims to provide enough detail of essential diagnostic CT interpretation skills while remaining relevant and focused on radiotherapy. We hope you find it to be a useful and enjoyable read that will not only help you in your clinical practice but also nurture a growing interest in the endlessly fascinating world of cross-sectional anatomy.

Pete Bridge and David J. Tipper, 2016



Chapter 1
Introduction

