

---

# MDCT Protocols

---

Andrea Laghi  
Editor

# **MDCT Protocols**

## **Whole Body and Emergencies**

*With contributions from*

A. Bozzao, R. Ferrari, F. Fraioli, M. Rengo, L. Romano

*Editor*

ANDREA LAGHI

Department of Radiological Sciences, Oncology and Pathology  
“Sapienza” University of Rome, Polo Pontino, Latina, Italy

*Co-authors*

ALESSANDRO BOZZAO

Neuroradiology,  
NESMOS Department  
Faculty of Medicine and Psychology  
“Sapienza” University of Rome  
Rome, Italy

F. FRAIOLI

Chest Imaging Team  
Department of Radiological Sciences  
Oncology and Pathology  
“Sapienza” University of Rome  
Rome, Italy

RICCARDO FERRARI

Department of Radiology  
San Giovanni Addolorata Hospital  
Rome, Italy

MARCO RENGÒ

Department of Radiological Sciences  
Oncology and Pathology  
“Sapienza” University of Rome  
Polo Pontino, Latina, Italy

LUIGIA ROMANO

Department of Diagnostic Imaging  
A. Cardarelli Hospital, Naples, Italy

ISBN 978-88-470-2402-1

ISBN 978-88-470-2403-8 (eBook)

DOI 10.1007/978-88-470-2403-8

Springer Milan Dordrecht Heidelberg London New York

Library of Congress Control Number: 2011939491

© Springer-Verlag Italia 2012

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilm or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the Italian Copyright Law in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the Italian Copyright Law.

The use of general descriptive names, registered names, trademarks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use. Product liability: The publishers cannot guarantee the accuracy of any information about dosage and application contained in this book. In every individual case the user must check such information by consulting the relevant literature.

9 8 7 6 5 4 3 2 1

Cover design: Ikona S.r.l., Milan, Italy

Typesetting: C & G di Cerri e Galassi, Cremona, Italy

Printing and binding: Arti Grafiche Nidasio, Assago (Mi), Italy

*Printed in Italy*

Springer-Verlag Italia S.r.l., Via Decembrio 28, I-20137 Milan

Springer is part of Springer Science+Business Media ([www.springer.com](http://www.springer.com))

## Preface

Multidetector-row computed tomography (MDCT) is currently the imaging modality of choice for the study of many anatomical districts in different clinical settings, as it provides a fast, reliable, and accurate simultaneous evaluation of different organs, including parenchyma, hollow viscera, vessels, and bony structures.

The technological catalyst behind the revolution in CT began a little more than 10 years ago, with the introduction in 1998 of 4-slice systems. Rapid progress quickly led to the 320-slice and dual-source scanners of today. These developments have had obvious consequences on CT study techniques, which have become increasingly refined and focused on the clinical query of the examination. In fact, the most frequent causes of diagnostic error are no longer due to limitations of the scanners but rather to inappropriate patient preparation and an incorrect choice of acquisition protocol.

Moreover, recent-generation MDCT scanners offer new diagnostic opportunities to the radiologist, who nowadays is frequently called on to confer with clinicians in fields from which he or she was previously completely excluded (e.g., the heart, the peripheral circulation, and the colon). This is a new and stimulating challenge for radiologists, which at the same time requires further cultural progress to facilitate such multi-specialty collaborations. Indeed, while on the one hand multi-slice scanners have opened up new fields of study, on the other they have also given rise to particular problems, which require specific training, of both a technical and a clinical nature.

The aim of this volume is to provide the general concepts for optimizing an MDCT study by taking into consideration the differences between the various anatomical regions and the diagnostic potential of MDCT for each one. This is achieved also through the presentation of numerous cases, whose intention is neither a complete description of the disease nor a comprehensive explanation of the imaging characteristics of the different lesions, but to demonstrate the optimal imaging

protocol in different clinical settings. Each case is, in fact, accompanied by a detailed presentation of the factors determining the overall quality of the examination (patient preparation, contrast material injection modality and parameters, scan delay), which the radiologist must bear in mind. A meticulous description of the acquisition techniques (collimation, effective slice thickness, reconstruction interval) does not accompany the cases, as these features have become nearly standardized on the most recently marketed MDCT systems and the most important general concepts are nonetheless given in the Introduction. In the choice of study protocol, which at all times is correlated with the clinical indications of the examination, consideration is always given to radiation dose, particularly in young patients, with acquisitions being suggested only in the enhancement phases, after the injection of contrast material, as they are necessary for diagnostic purposes.

We truly hope that this booklet is of help in clinical practice, especially for general radiologists and specialists in training but also for all practitioners facing the challenges posed by the new MDCT technology.

Rome, October 2011

Andrea Laghi

# Contents

## Technical Basis

<b>1</b>	<b>Introduction</b> .....	3
<b>2</b>	<b>The Technology</b> .....	5
2.1	Scanner Characteristics .....	5
2.2	Systems for Reducing Dose Exposure .....	7
2.3	Multi-Energy .....	9
<b>3</b>	<b>Contrast-Medium Administration</b> .....	11
3.1	Arterial Enhancement .....	11
3.2	Parenchymal Enhancement .....	15
3.3	Timing .....	16
3.4	Saline Flush .....	17
<b>4</b>	<b>Special Examinations</b> .....	19
4.1	Thorax .....	19
4.2	Heart .....	21
4.3	Urinary System .....	25
4.4	Small Bowel .....	25
4.5	Colon .....	28
4.6	Perfusion .....	30
<b>5</b>	<b>Essential References</b> .....	33

## Clinical Cases

<b>Neuro</b> .....	40
Aneurysm with Subarachnoid Hemorrhage .....	40
Arteriovenous Malformation in a Patient with Acute Cerebellar Hemorrhage .....	42

Acute Pre-occlusive Stenosis of the Right Middle Cerebral Artery .....	44
Acute Thrombosis of the Left Transverse Sinus .....	46
Acute Thrombosis of the Right Rolandic Vein .....	48
Posterior Communicating Artery Occasional Aneurysm .....	50
Occasional Aneurysm .....	52
Acute Occlusion of the Middle Cerebral Artery Frontal Branches ..	54
Acute Occlusion of the Middle Cerebral Artery .....	56
Arteriovenous Malformation (AVM) .....	58
Moya-Moya Disease .....	60
Multiple Aneurysms in Subarachnoid Hemorrhage .....	62
Dural Arteriovenous Fistula .....	64
Pre-occlusive Stenosis of the Basilar Artery .....	66
Pre-occlusive Stenosis of the Vertebral Arteries .....	68
Acute Thrombosis of the Superior Sagittal Sinus .....	70
Arteriovenous Malformation (AVM) in a Patient with Acute Intraventricular Hemorrhage .....	72
<b>Thorax</b> .....	74
Air Trapping .....	74
Mosaic Oligoemia .....	76
Pulmonary Embolism, Standard Protocol .....	78
Pulmonary Embolism, CT Perfusion .....	80
Pulmonary Hypertension .....	82
Arteriovenous Pulmonary Malformation .....	84
Pulmonary Nodules .....	86
Computer-assisted Detection (CAD) .....	88
Lung Cancer, CT Perfusion .....	90
Whole-Thorax Perfusion .....	92
COPD, Dual Energy .....	94
<b>Abdomen</b> .....	96
Liver. Hemangioma .....	96
Liver. Adenoma .....	98
Liver. Focal Nodular Hyperplasia (FNH) .....	100
Liver. Hepatocellular Carcinoma (HCC) .....	102
Liver. HCC, Perfusion Study .....	104
Liver. Peripheral Cholangiocarcinoma .....	106
Liver. Hypovascular Metastases from Lung Cancer .....	108
Liver. Hypervascular Metastases from Renal Cell Carcinoma .....	110

Biliary Tree. Intraductal Papillary Carcinoma of the Common Bile Duct .....	112
Pancreas. Ductal Adenocarcinoma .....	114
Pancreas. Serous Cystic Neoplasm .....	116
Pancreas. Intraductal Papillary Mucinous Neoplasm (IPMN) .....	118
Spleen. Post-traumatic Arteriovenous Intrasplenic Fistulas .....	120
Stomach. Adenocarcinoma .....	122
Small Bowel. Crohn's Disease of the Terminal Ileum .....	124
Small Bowel. Gastrointestinal Stromal Tumor (GIST) .....	126
Colon. Diverticulosis .....	128
Colon. Adenocarcinoma of the Sigmoid Colon .....	130
Colon. Pedunculated Polyp of the Ascending Colon .....	132
Colon. Angiodysplasia of the Sigmoid Colon .....	134
Rectum. Carcinoma .....	136
Rectum. CT Perfusion .....	138
Peritoneum. Carcinomatosis from Malignant Ovarian Cancer .....	140
Adrenal Glands. Adenoma .....	142
Adrenal Glands. Metastases from Lung Cancer .....	144
Kidney. Carcinoma and Angiomyolipoma .....	146
Urinary Tract. CT Urography .....	148
Urinary Tract. Low-dose CT for Urolithiasis .....	150
Bladder. Carcinoma .....	152
Prostate. CT Perfusion .....	154
<b>Heart</b> .....	156
Dilated Cardiomyopathy .....	156
Hypertrophic Cardiomyopathy .....	158
Non-compaction Cardiomyopathy .....	160
Atrial Myxoma .....	162
Transplant (Postoperative Study) .....	164
Transposition of the Great Vessels (Postoperative Study of the Great Vessels) .....	166
Bicuspid Aortic Valve .....	168
Iatrogenic Coronary Dissection .....	170
Coronary Artery Anomaly .....	172
Three-Vessel Disease .....	174
Chronic Total Occlusion of the Left Anterior Descending Artery with Associated Apical Infarction .....	176
Plaque with Positive Remodeling .....	178
Stenosis of the Left Anterior Descending Artery .....	180



Right Coronary Artery Stent .....	182
Aneurysm of an Aorto-coronary Venous Graft .....	184
Double Bypass .....	186
Triple Bypass .....	188
<b>Vascular</b> .....	190
Whole-Body Angiography .....	190
Carotid Arteries-Carotid Stenosis with Ulcerated Plaque .....	192
Evaluation of Carotid Stent .....	194
Lusory Artery .....	196
Post-traumatic Thoracic Aorta Aneurysm (with Cardiac Gating) ...	198
Perforating Ulcer of the Thoracic Aorta (without Cardiac Gating) .	200
Aortic Dissection Type A .....	202
Aortic Dissection Type B .....	204
Mesenteric Vessels Anomalies and Pathologic Presentations .....	206
Aneurysm of the Subrenal Abdominal Aorta .....	208
Aortic Endoprosthesis with Type I Endoleak .....	210
Aortic Endoprosthesis with Type II Endoleak .....	212
Aortic Endoprosthesis with Peri-prosthetic Inflammation .....	214
Celiac Trunk Stent .....	216
Aorto-Bifemoral Bypass .....	218
Bifurcation Endoprosthesis and Patent Femoro-femoral Bypass ..	220
Lower Limbs-Peripheral Arterial Disease .....	222
<b>Emergency</b> .....	224
Post-traumatic Arterio-porto-biliary Fistula of the Liver .....	224
Obstructive Jaundice by Cystic Lymphangioma of the Anterior Para-renal Space .....	226
Bleeding Colonic Diverticulum .....	228
Hemopneumoperitoneum Due to a Weapon-related Injury of the Pericardium and Diaphragm .....	230
Volvulus in a Left Paraduodenal Hernia .....	232
Fistula Between a Right Iliac Arterial Aneurysm in a Loop of Small Intestine .....	234
Mechanical Obstruction of the Small Intestine by Gallstone Ileus .	236
Bleeding Jejunal Gastrointestinal Stromal Tumor .....	238
Phytobezoar-induced Mechanical Intestinal Obstruction .....	240
Iatrogenic Injury of the Right Diaphragmatic Artery by Thermo-ablation of a Liver Nodule .....	242
Traumatic Injury to the Right Hemi-diaphragm .....	244

Abdominal Aortic Aneurysm with Aorto-caval Fistula .....	246
Ileal Volvulus Complicated by Intestinal Ischemia .....	248
Perforated Peptic Ulcer .....	250
Active Bleeding in a Hematoma of the Back .....	252

## Contributors

DAVIDE BELLINI

Department of Radiological  
Sciences, Oncology and Pathology  
“Sapienza” – University of Rome  
Polo Pontino, Latina, Italy

DAMIANO CARUSO

Department of Radiological  
Sciences, Oncology and Pathology  
“Sapienza” – University of Rome  
Polo Pontino, Latina, Italy

VALENTINA CIPRIANI

Neuroradiology  
NESMOS Department  
Faculty of Medicine and Psychology  
“Sapienza” University of Rome  
Rome, Italy

STEFANIA DANIELE

Department of Diagnostic Imaging  
A. Cardarelli Hospital  
Naples, Italy

CARLO NICOLA DE CECCO

Department of Radiological  
Sciences, Oncology and Pathology  
“Sapienza” – University of Rome  
Polo Pontino, Latina, Italy

LORENZO FIGÀ TALAMANCA

Neuroradiology  
NESMOS Department  
Faculty of Medicine and Psychology  
“Sapienza” University of Rome  
Rome, Italy

ANDREA FIORELLI

Chest Imaging Team  
Department of Radiological Sciences  
Oncology and Pathology  
“Sapienza” University of Rome  
Rome, Italy

NICOLA GAGLIARDI

Department of Diagnostic Imaging  
A. Cardarelli Hospital  
Naples, Italy

PAOLA LUCCHESI

Department of Radiological  
Sciences, Oncology and Pathology  
“Sapienza” – University of Rome  
Polo Pontino, Latina, Italy

MARCO MARIA MACERONI

Department of Radiological  
Sciences, Oncology and Pathology  
“Sapienza” – University of Rome  
Polo Pontino, Latina, Italy

STEFANELLA MEROLA

Department of Diagnostic Imaging  
A. Cardarelli Hospital  
Naples, Italy

SILVANA NICOTRA

Department of Diagnostic Imaging  
A. Cardarelli Hospital  
Naples, Italy

MARCELLO OSIMANI  
Department of Radiological  
Sciences, Oncology and Pathology  
“Sapienza” – University of Rome  
Polo Pontino, Latina, Italy

PASQUALE PAOLANTONIO  
Department of Radiology  
San Giovanni Addolorata Hospital  
Rome, Italy

ANTONIO PINTO  
Department of Diagnostic Imaging  
A. Cardarelli Hospital  
Naples, Italy

GIANLUCA PONTICIELLO  
Department of Diagnostic Imaging  
A. Cardarelli Hospital  
Naples, Italy

SILVIA PUGLIESE  
Neuroradiology  
NESMOS Department  
Faculty of Medicine and Psychology  
“Sapienza” University of Rome  
Rome, Italy

STEFANIA ROMANO  
Department of Diagnostic Imaging  
A. Cardarelli Hospital  
Naples, Italy

GIUSEPPE RUGGIERO  
Department of Diagnostic Imaging  
A. Cardarelli Hospital  
Naples, Italy

GIOVANNA RUSSO  
Department of Diagnostic Imaging  
A. Cardarelli Hospital  
Naples, Italy

MARIANO SCAGLIONE  
Department of Diagnostic Imaging  
Pineta Grande Hospital  
Castel Volturno, Caserta, Italy

GIACOMO SICA  
Department of Diagnostic Imaging  
Pineta Grande Hospital  
Castel Volturno, Caserta, Italy

AMELIA SPARANO  
Department of Diagnostic Imaging  
A. Cardarelli Hospital  
Naples, Italy

CIRO STAVOLO  
Department of Diagnostic Imaging  
A. Cardarelli Hospital  
Naples, Italy

MICHELA TANGA  
Department of Diagnostic Imaging  
Pineta Grande Hospital  
Castel Volturno, Caserta, Italy

FABRIZIO VECCHIETTI  
Department of Radiological  
Sciences, Oncology and Pathology  
“Sapienza” – University of Rome  
Polo Pontino, Latina, Italy

DANIELA VECCHIONE  
Department of Diagnostic Imaging  
A. Cardarelli Hospital  
Naples, Italy