Multidetector-Row Computed Tomography
Scanning and Contrast Protocols

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The discovery of X-rays by Konrad Roentgen is one of the major milestones in the history of modern medicine, allowing for the first time a noninvasive look inside the patient. Two-dimensional X-ray images remained the basis of clinical radiology until the early 1970s when computerized cross-sectional imaging with computed tomography (CT) and ultrasound became routinely available.

Cross-sectional imaging did indeed dramatically change our knowledge of the incidence and the evolution of many diseases. It rapidly became the basic clinical tool for diagnosis and follow-up and had a fundamental impact on medicine.

A second revolution started in the early 1980s with the clinical introduction of magnetic resonance imaging (MRI). At that time the excitement among radiologists was such that many believed MRI would rapidly replace CT and even ultrasound for most of the diagnostic work. MRI with its fantastic soft-tissue contrast, its multiplanar imaging capability, the potential of tissue- or organ-specific contrast agents, and last but not least the absence of ionizing radiation seemed a technique difficult to beat. On top of this, the evolution of MR technology was so fast, that most limitations which characterized the early MR systems were rapidly overcome, and this evolution is still ongoing. CT seemed completely outperformed and outdated even though volumetric acquisition with spiral technology was already widely available at that time.

Even the introduction of the first dual-slice spiral scanner did not receive too much attention. On the contrary, most radiology departments invested massively in the acquisition of MR magnets and many changed their name from “radiology” to “imaging” departments.

However, things started to change with the introduction of the first four-slice spiral CT scanners in 1998. Multidetector-row technology caused a worldwide revival of CT. The reason for this revival resides in the amazing technical advancements in the hardware and software offered by these new devices.

Today, the latest multidetector-row CT (MDCT) scanners offer the possibility to perform volumetric submillimetric isotropic imaging of large body areas in only a few seconds. These data can be reviewed and even directly reconstructed in any arbitrary plane.

If needed, the acquisitions can be gated to freeze the cardiac motion, and if multiphase images are reconstructed, functional information can be extracted from the time sequences. As a result many of the features which were considered typical advantages of MRI are today also available on a standard MDCT scanner.

However, CT remains X-ray based and therefore unfortunately still has a number of weak points compared to MRI, including the lower soft-tissue contrast and the use of ionizing radiation. On the other hand, CT has the advantage of being less complicated to perform and to interpret.

Still, to take full advantage of modern MDCT technology, radiologists have to reconsider their acquisition protocols, particularly regarding timing and the administration of contrast media.

It is obvious that once the total acquisition time of an examination is reduced to only a few seconds, one has to take into account the normal and/or abnormal vascular physiology of the patient.

Acquisition parameters, injection regimes, timing, and contrast concentrations have to be individually optimized. Without a very careful approach many of the benefits of a fast CT scan are often lost and the images become suboptimal or even unreadable.
The workflow of CT also has to be reengineered. Currently, patient preparation and data acquisition represent only a minor part of the total workflow. Efficient data transfer, archiving, three-dimensional processing, and image interpretation become increasingly demanding on hard- and software because of the massive amounts of data produced.

The goal of the present volume is to provide practical answers to the questions most often raised. The authors sought to come up with state-of-the-art protocols and solutions for the different generations of MDCT scanners currently available on the market and in doing so, they hope that this book will help the readers to get the most out of their equipment.

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SECTION I

Principles and Challenges of MDCT
Multidetector row computed tomography (MDCT) has modified the imaging approach for the assessment of many diseases. The technique enables the acquisition of a volume of data, rather than slices. The most recent clinical developments involving this technique include the screening of colorectal polyps, the detection of lung nodules, the screening for cardiac and coronary artery diseases, and the easy three-dimensional rendering of various vessels in any part of the body.

Advantages of the technique include the rapid acquisition and three-dimensional rendering of images even of the pulsating heart or vessels. The spatial resolution is improving and so is the diagnostic confidence. Due to the faster acquisition time, we are moving towards automated procedures of acquisition and image reading.

However, there are several challenges that radiology departments face in the use of this rapidly evolving technique. These challenges include (among others):

• Management of the workload of a CT suite; today it takes more time to position patients than to acquire the images. The organization of the day-to-day work must be optimized.
• The number of images to be read by the radiologist has dramatically increased. The time necessary for their interpretation is also increasing. In the very near future, automatic three-dimensional rendering of the raw data will simplify this.
• The rapid translation of the table may increase the number of motion artifacts. Various methods have already been developed to reduce motion artifacts.
• The rate of injection and volume of contrast needed for the examinations have to be adapted. High-concentration contrast media are now preferable.

Of utmost importance is the control of the radiation delivered during a MDCT examination, both in children and in adults. The manufacturers are progressively introducing methods that will allow the radiation dose to be reduced. For instance, attenuation-based online modulation of the tube current in order to reduce the milliampere settings has now become commercially available and this permits a dose reduction without loss of image quality.

Important questions that need to be answered soon concern the evaluation of the clinical impact of systematic screenings that all radiologists tend to perform (i.e., for pulmonary nodules). Are we doing better? Are we improving the medical care and outcome?

Finally, other techniques are also able to provide the same or similar clinical information; comparisons are necessary in order to choose the best technique and to reduce cost and optimize patient management.

**Suggested Reading**


