METHODS IN MOLECULAR BIOLOGY

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Preclinical MRI

Methods and Protocols

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Preface

Magnetic resonance imaging (MRI), the most versatile of all *in vivo* imaging modalities, was born in 1973, when the Nobel Prize awardees, Paul C. Lauterbur and Peter Mansfield, at the State University of New York and the University of Nottingham, published their pioneering works on the use of magnetic field gradients to spatially localize the NMR signal. Lauterbur obtained images of two water filled tubes using magnetic field gradients and backprojection. He named this new imaging technique "zeugmatography," derived from the Greek word *zeugma*, meaning "that which is used for joining," in reference to the joint action of magnetic field gradients and radiofrequency to generate the image. In the same year, Mansfield published his work demonstrating how a linear field gradient, along with the Fourier transform, could be used to localize the NMR signal from different layers within a solid sample, which is the basis of the slice selection used nowadays. Later, in 1977, Mansfield and Maudsley obtained the first image of a part of the human body, a finger.

Since then, MRI has experienced a tremendous evolution thanks to the joint effort of scientists from many different fields. Today, MRI is undoubtedly the leading technique in diagnostic imaging. It has attracted a great deal of interest because of its unique combination of qualities. MRI uses non-ionizing radiation, which is harmless to human tissue; offers very high image quality, providing excellent anatomical detail; and additionally is also capable of providing functional and metabolic information. On the negative side, it was conventionally argued that MRI suffered from low sensitivity compared to other imaging modalities. However, a new generation of contrast agents based on nanotechnology is making it possible to overcome this limitation and bring MRI into the molecular imaging category.

Consequently, interest in MRI continues to grow and gain new adepts from different fields who see MRI as a very powerful tool capable of answering many of their scientific questions. Thus, in addition to the unquestionable growth of MRI use in clinical diagnosis, its applications in basic and translational research have also increased enormously in recent years, resulting in the creation of a multitude of preclinical imaging units worldwide.

This book was conceived with the idea of providing an update on a wide variety of preclinical MRI methods and protocols to help technicians and researchers interested in this technology to perform studies that have already been implemented by recognized experts in the field.

The book is organized in seven parts:

Part I covers the basics of MRI physics, relaxation, image contrast, and main acquisition sequences.

Part II describes updated methodology and protocols for diffusion, perfusion, and functional imaging.

Part III is dedicated to *in vivo* spectroscopy, covering both proton and heteronuclear spectroscopy, as well as spectroscopic imaging.

Part IV is intended to include some less common advanced techniques that we thought might be of high interest to the readers of this book.

Parts V and VI illustrate some applications of the methods described above.

Part VII includes theoretical chapters aimed at providing relevant information on anesthesia and contrast agents.

Finally, we would like to thank the collaboration of all the excellent experts who have generously contributed with their chapters to the elaboration of this book.

Málaga, Spain — *María Luisa García-Martín*
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