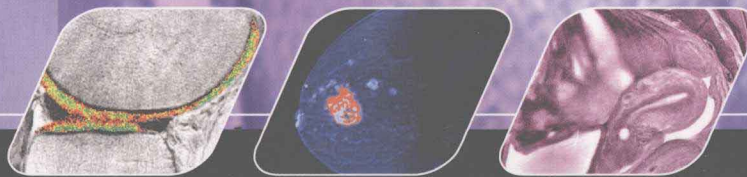
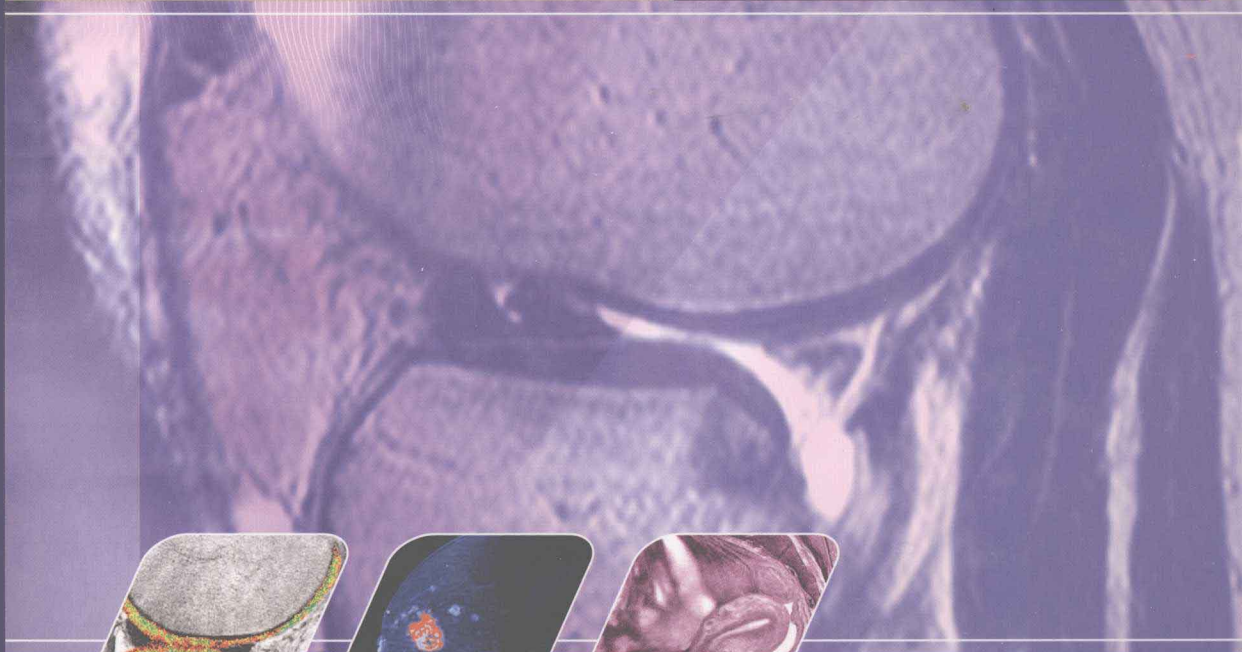


volume three

V3

THIRD EDITION



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# Clinical Magnetic Resonance Imaging

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volume three — **V3** — **THIRD EDITION**

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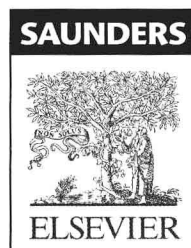
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# Clinical Magnetic Resonance Imaging

## DEDICATION

*To my wife, Melissa, and children Daniel, Laura, Amanda, and Alexis, for their love and bemused tolerance of my many foibles, and to Dr Sven Paulin, for his guidance and unwavering support during the formative stages of my career.*

**RRE**

*To my wife, Kay, my son, André, and his wife, Sara.*

**JRH**

*To my wife, Marilyn, and my children, Nancy, Robert, Alyssa, and Chad. Thank you for your support, patience, and understanding while I toiled on this book.*

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*To my wife, Maribeth, without whose support and patience my involvement in this book would have been impossible.*

**JVC**

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# P R E F A C E

## TO THE THIRD EDITION OF *CLINICAL MAGNETIC RESONANCE IMAGING*

This is the third edition of *Clinical Magnetic Resonance Imaging*. It has been almost a decade and a half since the publication of the first edition, which came into existence at a time when the field of MRI was still very much in its infancy. Back in the era defined by the first edition, MRI was a fledgling modality. Although well accepted as a helpful tool in the field of brain imaging, MRI had little clinical utility in other areas. Scans often took 15 minutes or longer and the MR images were routinely plagued with artifacts. MRI of the knee was just coming into its own, and other musculoskeletal applications were in their infancy. The only contrast agents available were nonspecific and used much like iodine-based agents for computed tomography (CT).

The second edition was published at a time when MRI was on firmer footing as a diagnostic tool in the fields of brain, spine, and joint imaging. Abdominal and pelvic applications appeared promising, whereas cardiovascular applications suffered from severe technological limitations and were seldom successful or useful. Fast imaging techniques were entirely hardware based and available only to a handful of academic investigators.

Nine long years have passed since the second edition. Over that period, we have all experienced the physical passage of time, perhaps hair a bit grayer, joint aches a bit more frequent, maybe even a tad less spry in our step. Yet over the same period, MRI has grown and prospered to a degree that would have been difficult to imagine in years past. There has been exponential growth in the number of MRI systems across the globe. New whole-body scanner installations include systems at field strengths of 3 T to 9.4 T, which at the time of the first edition would have been considered impossible by many top investigators in the field. Nowadays, echo planar imaging is routinely used for diagnosis of stroke and other disorders of the brain. MRI can easily depict brain function based on changes in blood oxygenation or flow, and is considered superior in many ways to positron emission tomography. Contrast-enhanced angiograms that rival digital subtraction angiography in quality are the routine, with new contrast agents and imaging techniques in development that might allow MR angiography to surpass even that long-recognized gold standard.

Advances in molecular imaging permit imaging of stem cells in vivo, tracking of cell migration, and identification of specific receptors in cancer. Novel therapies such as MR-guided focused ultrasound are used to non-invasively annihilate uterine fibroids, breast tumors, and even brain tumors without the morbidity expected from an invasive surgical procedure. Advances in the technology for cardiac imaging have made this a routine test that is beginning to compete with established nuclear and echocardiographic tests for the diagnosis of heart disease. Abdominal images can be acquired within a comfortable breath-hold with quality that rivals multi-detector CT. High-field imaging has reinforced the diagnostic value of musculoskeletal imaging, which is now one of the most common applications of MRI, whereas open-architecture low-field systems offer greater patient convenience and eliminate problems with claustrophobia.

The progress seems unstoppable. New developments in other areas such as hyperpolarized contrast agents, parallel imaging, spectroscopy, and scanner hardware promise to propel the field to ever-greater clinical utility, while offering the scientist endless possibilities for clinical investigation.

The third edition of *Clinical Magnetic Resonance Imaging* is greatly expanded in size and scope compared with the previous editions. We have endeavored to explore all significant aspects of the field, including the basic principles, techniques, and clinical applications. The chapters are written by internationally recognized experts in their respective fields. Moreover, we have endeavored to maintain some of the more appreciated qualities of the previous editions: clarity in writing, practicality, and utility for day-to-day practice. New features include extensive use of color illustrations and an accompanying website (<http://www.clinicalmri.com>) that will keep the reader up to date with the latest developments and interesting cases, and provide continuing medical education credits.

The preparation of this textbook was a huge task, but it was also an endeavor of love that provided the editors with great satisfaction. We hope that it provides you with a useful guide to one of the most exciting fields in medicine today.