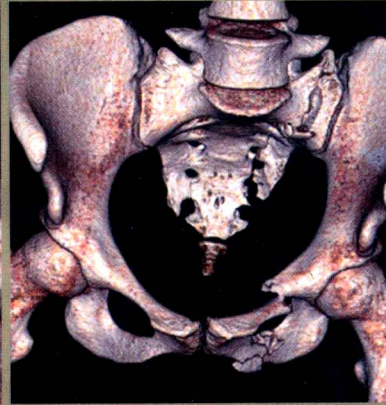
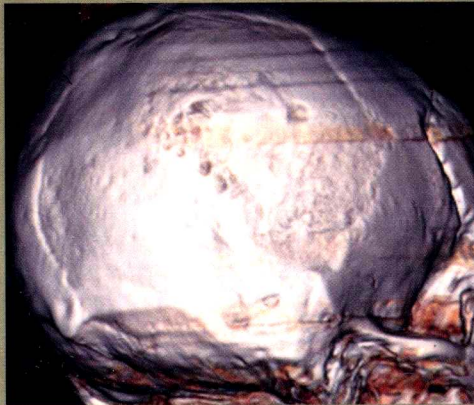
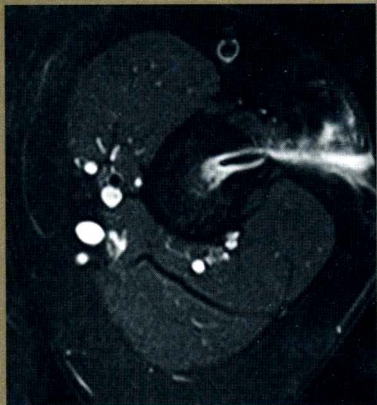


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Adam Greenspan  
Javier Beltran

# Orthopedic Imaging

A Practical Approach



SIXTH EDITION

*Foreword by* Lynne S. Steinbach



Wolters Kluwer





# ORTHOPEDIC IMAGING

## A PRACTICAL APPROACH

SIXTH EDITION

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# **ORTHOPEDIC IMAGING**

A PRACTICAL APPROACH

*To my wife, Barbara,  
my children, Michael, Samantha, and Luddy,  
and my grandchildren, Anna and Sydney,  
who light up my life;  
and to the memory of my mother Eugenia and my father Bernard,  
a brilliant physician, who taught me my ABCs of the medical profession  
and made me aware of the beauty of the medical practice.*

*A.G.*

*To my wife, Andrea, and my sons, Xavier and Luis,  
for their love and support.*

*J.G.*



# Foreword

How exciting that the sixth edition of Adam Greenspan's *Orthopedic Imaging: A Practical Approach* has been published. It is bigger, more comprehensive, and even better than the last edition, which is a true feat. In addition, Dr. Greenspan, who is known around the world as the creator and editor of this esteemed book, has been joined by Javier Beltran as coauthor. No one could ask for a better team. Unlike some other works, this book is both written and edited by these two experts. Highly regarded in the area of musculoskeletal imaging, both authors are armed with vast experience and a unique talent for presenting material in an organized, readable manner and enhancing it with magnificent schematics, line drawings, diagrams, tables, and images.

The original author, Adam Greenspan, is known internationally for this book and many others. Dr. Greenspan is a Fellow of the American College of Radiology and a member of the International Skeletal Society. He has drawn upon his extensive experience in the field, which began at the Hospital for Joint Diseases-Orthopedic Institute in New York City and led him to the University of California, Davis School of Medicine, where he has been Professor of Radiology for more than 25 years.

New coauthor Javier Beltran brings to the book a high level of expertise in musculoskeletal magnetic resonance imaging (MRI) and other areas of radiology. Dr. Beltran started his academic career at the forefront of MRI with his own set of books, similar in style to Dr. Greenspan's musculoskeletal publications. Many of us learned musculoskeletal MRI through these books. A Fellow of the American College of Radiology and recent President of the International Skeletal Society, Dr. Beltran practiced in Spain before coming to the United States, where he accepted professorships in radiology at Ohio State University Medical Center and then the Hospital for Joint Diseases-New York University, before assuming his current position as Chairman of Radiology at Maimonides Medical Center in Brooklyn, New York.

This comprehensive work on musculoskeletal imaging has been expanded, extensively revised, and updated since the last edition published 4 years ago. Among the many noteworthy features of this book, the following stand out. The coverage of musculoskeletal MRI has been significantly increased, although the work has remained a single volume. A modern perspective that includes algorithms and economics, along with safety and radiation concerns, has been incorporated. The wide-ranging view of musculoskeletal imaging encompasses fundamentals gleaned from radiographs, MRI, computed tomography (CT) (including three-dimensional CT, dual-energy CT, and positron emission tomography [PET]/CT), nuclear medicine imaging, and ultrasound, and imaging guidelines are

stressed throughout. Procedures commonly performed by musculoskeletal radiologists, such as arthrography, percutaneous image-guided biopsy, and radiofrequency ablation, are also reviewed. Appropriate mention is made of the therapeutic approaches, pathology, molecular genetics, and cytogenetics of musculoskeletal diseases, as well. Finally, as with the last edition, the text is fully searchable online.

All aspects of musculoskeletal imaging have been addressed and made current in this newest edition. Topics include trauma; sports medicine (which has been considerably expanded); arthritides; congenital and developmental anomalies, including dysplasias; metabolic and systemic diseases; infections; and neoplasms of the musculoskeletal system, including those of the spine. The writing is clear and concise, providing practical information and advice. A differential diagnosis for each disorder is enumerated. The "Suggested Readings" section in each chapter has been updated and includes classic source references as well as current citations. Each chapter ends with a set of "Practical Points to Remember," which summarize important concepts. This book offers a variety of unique and useful topics, including the role of the orthopedic radiologist, bone formation and growth, anatomic-radiologic considerations, and choice of imaging modality.

Tables and charts have been updated, and all figures are of the highest quality, making the organization and recall of information much easier. How opportune and fantastic that Dr. Beltran's brother, the world-renowned medical artist Salvador Beltran, has contributed a large number of new and original schematics to this edition. The many tables, figures, and diagrams will draw readers of all backgrounds and specialties. These visuals, in their unique way, provide greater clarity to the underlying concepts, allowing for ease in understanding, and retaining, information on classification. Full color is used throughout the book, enhancing its appeal to all.

This book is of value to a wide audience interested in musculoskeletal imaging. In addition to radiologists and orthopedic surgeons in training and practice, rheumatologists, radiology technologists, primary care physicians, medical students, physical therapists, and physiatrists will also covet the information herein. All will want to update their library with this newest edition of *Orthopedic Imaging: A Practical Approach*.

It is a great honor and privilege to review this book written by my respected friends, Adam and Javier. They are at the top of their field and a true dream team.

**Lynne S. Steinbach, MD, FACR**  
Professor of Radiology and Orthopedic Surgery  
University of California, San Francisco



# Preface to the First Edition

*Orthopedic Radiology: A Practical Approach* was written to facilitate the complex process of diagnostic investigation in a broad range of orthopedic disorders. Its underlying concept is threefold: to provide a basic understanding of the currently available imaging modalities used to diagnose many commonly encountered disorders of bones and joints, to help in the choice of the most effective radiologic technique with a view to minimizing the cost of examination as well as the exposure of patients to radiation, and to emphasize the need for providing the orthopedic surgeon with the information required to choose the right therapy. It does not attempt to compete in size and scope with other books on the same subject. Many uncommon entities have been excluded, as have the exact instructions for performing procedures. Likewise, the nature of the volume does not allow inclusion of every detail of a given disorder or full discussion of controversial aspects. These matters are left to the reader's further study of the literature and the many standard and specialized textbooks compiled in the "References and Further Reading" section at the end of the volume.

As its subtitle states, *Orthopedic Radiology* strives to provide its primary audience, medical students and residents in radiology and orthopedics, with a practical approach to its subject. To this end, crucial information

within the text of each chapter has been tabulated in a section entitled "Practical Points to Remember" at the end of the chapter. Numerous original schematic diagrams and tables have been developed, detailing, for example, classifications of fractures, the morphologic features of arthritic and neoplastic disorders, and the positioning of patients for the various standard and special radiographic projections, as well as the most effective radiologic techniques for demonstrating abnormalities. Radiographic reproductions, many of which are accompanied by explanatory, labeled line drawings, have been specially prepared to provide high-quality examples of the classic presentations of a wide spectrum of orthopedic disorders. Moreover, most figure captions are written in a case-study format, which, combined with a system of diagnostic notations (explained in Chapter 1) following each legend, is meant to impart an appreciation of the process of radiologic investigations. Although its aim is to teach, *Orthopedic Radiology* should also serve as a convenient reference for physicians interested in bone and joint disorders and those customarily employing radiologic studies in their everyday practice.

**Adam Greenspan, MD, FACR**



# Preface

Spectacular progress being made in the field of musculoskeletal imaging has prompted the publication of the new edition of this book. The introduction of new imaging modalities and the improvement of existing ones have expanded the armamentarium of the radiologist but, at the same time, created some confusion in the proper use of these techniques. Concerns about the increasing use of imaging techniques that involve ionizing radiation (radiography, fluoroscopy, arthrography, scintigraphy, and computed tomography [CT]) have grown during the past decade. These concerns have led to a shift toward the increased use of ultrasonography and magnetic resonance imaging (MRI). The task of the sixth edition of *Orthopedic Imaging: A Practical Approach* is not only to familiarize the reader with a variety of new imaging modalities but also to present the constructive and beneficial, as well as negative, aspects of these techniques. The goal is to help the radiologist choose the proper sequence of radiologic examinations with the purpose of decreasing the cost and time needed to arrive at the correct diagnosis and to carry out the proper evaluation of a given disorder.

This new edition has many changes, additions, and improvements. Most importantly, a coauthor has been added: Javier Beltran, MD, FACR, Professor and Chairman of Radiology at Maimonides Medical Center in Brooklyn, New York. Dr. Beltran, a pioneer of musculoskeletal MRI, is the author and coauthor of many books in this field, including the classic book *MRI: Musculoskeletal System*. Because advances in MRI have considerable impact on musculoskeletal imaging and because MRI has become a primary diagnostic tool in orthopedic imaging, the addition of such an expert as Dr. Beltran has strengthened the sections devoted to this subject and guaranteed inclusion of the most up-to-date information.

The overall design of this book, incorporating full color, has been retained; however, a new interior design has been created. The single-volume format, despite an increase in size, has been preserved. Practical

Points have again been provided at the end of each chapter as a quick review of pertinent information. New references have been added to each chapter. Technically suboptimal figures have been deleted and replaced with better quality images. Some outdated material has also been deleted, and discussion of a variety of conditions has been updated. In particular, new information on cytogenetic and molecular genetics of a variety of tumors and other diseases has been added. Almost every chapter contains new sections and new illustrations. Examples include new material on sports injuries, knee joint dislocations, injuries of the posterolateral corner of the knee, and imaging of the postoperative shoulder and knee; new views on so-called *spontaneous osteonecrosis of the knee* and *osteochondritis dissecans of the talus*; current views on cartilage imaging; classification of fractures of the sacrum; new trends in applying dual-energy CT to the diagnosis of tophaceous gout; imaging evaluation of compressive and entrapment neuropathies of the upper and lower extremities; imaging of parasitic infections; and many more. Advances in the latest therapeutic approaches to many conditions have also been included. Applications of three-dimensional CT, MRI, ultrasound (US), and 18F-fluorodeoxyglucose positron emission tomography (FDG PET)-CT have been expanded as well. Nevertheless, although the authors recognize the value of more advanced imaging techniques, as in the previous editions, they emphasize the mastery of conventional radiography as the basic tool of every radiologist.

This book has been written primarily for the radiologists and orthopedic surgeons, although it may also be of use for the physical therapists, rheumatologists, and other physicians interested in application of imaging techniques to the musculoskeletal system.

**Adam Greenspan, MD, FACR**  
**Javier Beltran, MD, FACR**





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As with the previous editions, this project could not have been successfully completed without the prudent and dutiful efforts of the many individuals acknowledged here.



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