Musculoskeletal Cancer Surgery

Treatment of Sarcomas and Allied Diseases

The Washington Hospital Center (WHC), National Rehabilitation Hospital and National Children′s Hospital are located due north of the U.S. Capitol Building in Washington, D.C. These combined institutions are uniquely qualified to treat and rehabilitate patients with musculoskeletal cancer.

Musculoskeletal Cancer Surgery

Treatment of Sarcomas and Allied Diseases

Authors

Martin Malawer, M.D.
Washington Cancer Institute,
Washington Hospital Center,
Washington, D.C., USA

Paul H. Sugarbaker, M.D.
Washington Cancer Institute,
Washington Hospital Center,
Washington, D.C., USA

KLUWER ACADEMIC PUBLISHERS
NEW YORK, BOSTON, DORDRECHT, LONDON, MOSCOW

eBook ISBN: 0-306-48407-2
Print ISBN: 0-7923-6394-9

Created in the United States of America

Visit Kluwer Online at: http://kluweronline.com
and Kluwer's eBookstore at: http://ebooks.kluweronline.com

Contents

Foreword

Steven A. Rosenberg, MD

In the past two decades significant progress has occurred, in the management of patients with musculoskeletal cancers, that has improved both the survival and the quality of life of afflicted patients. Changes in the management of these patients have mirrored trends in the entire field of oncology.

The most significant change has been improvement in the surgical techniques for the resection of musculoskeletal cancers based on a detailed understanding of the anatomic features of each particular tumor site, as well as an appreciation of the natural biology that affects the local spread of these tumors. The current volume of *Musculoskeletal Cancer Surgery: Treatment of Sarcomas and Allied Diseases* provides a detailed description of important changes in the surgical approach to these patients. Amputation, once the mainstay of treatment for patients with bony and soft-tissue extremity sarcomas, has now largely been replaced by limb-sparing surgery using innovative approaches to cancer resection and the advent of new reconstruction techniques that can restore function in ways not possible even a decade ago. Although debilitating amputations are still required for some patients with locally extensive cancers, most patients with these tumors can look forward to surgical procedures that will maximize their functional outcome. The sophistication of many of these limb-sparing surgical approaches has resulted in a shift in the expertise required to perform these procedures and, increasingly, specialists in the management of musculoskeletal tumors have arisen to provide these patients with the benefits of these advances.

A second change in the management of these patients has been the introduction of combined-modality treatment utilizing the concerted application of surgery, radiation therapy and chemotherapy in a carefully integrated fashion to maximize survival and quality of life. The use of local radiation therapy has had a profound impact on the ability to achieve local control. Cooperation between surgeons and radiation therapists often results in the tailoring of surgical procedures to maximize the combined application of these two effective treatment modalities. Although impact on overall survival has not been demonstrated due to the addition of radiation therapy, important advances in improving the quality of life of patients receiving this combined-modality treatment have been evident.

A third change impacting on the survival of patients with musculoskeletal cancers has been the aggressive resection of metastatic deposits. Surgery remains the most effective treatment for adult patients with limited metastatic cancer, and durable disease-free and overall survival can be achieved by the vigorous resection of metastases arising from these cancers. Although the use of adjuvant chemotherapy has had dramatic impact on the treatment of many musculoskeletal cancers in children, the impact of chemotherapy on adults remains a controversial issue. Although transient responses can be seen in adults with many types of soft-tissue sarcomas, they are very rarely curative and the development of more effective systemic treatments for patients with soft-tissue sarcomas remains a major challenge in the future treatment of patients with this disease.

The state-of-the-art surgical techniques described in this text, applied in the context of integrated cancer therapy, can provide great benefit to patients with musculoskeletal cancers.

Chief, Surgery Branch,
National Cancer Institute,
National Institutes of Health,
Bethesda, Maryland

Acknowledgements

Martin Malawer, MD

Halstead once stated that ″the operating room was the laboratory for the surgeon″. This is as true today as it was a century ago. The surgical techniques described in this textbook were developed over a course of 20 years in the treatment of over 4000 patients. We would like to acknowledge our patients for their belief in us as surgeons and in our ability to restore the function to their extremities in lieu of an amputation. For those patients who did require an amputation, we acknowledge the tremendous will that they have had.

Surgery and surgical training is a three-way communication between patients, fellows and senior surgeons. This spoken and unspoken dialogue has been the foundation of many of these concepts, ideas and motivations presented in this textbook. We would like to acknowledge all of the residents and fellows that we have trained.

This textbook would not exist without the outstanding artistic skills of Joyce Hurwitz. Mrs Hurwitz has spent 20 years in close cooperation with the senior authors, illustrating multiple publications, presentations, posters and textbooks. Her utmost knowledge of surgical anatomy, combined with her interest and motivation in participating within the scientific community, sets her apart as a truly gifted individual.

Finally, the authors would like to acknowledge the hard work and dedication of all of the contributors. We are especially appreciative of the long hours and days that our Senior Research Assistant, Kristen Kellar, has spent, without which this book never would have been completed.

Dedication: To Ralph C. Marcove, MD and Kenneth C. Francis, MD

Martin Malawer, MD

Prior to the early 1970s almost all bone sarcomas were treated by amputation. Two surgeons in the United States, both in New York City, began the specialty of limb-sparing surgery as we know it today. Dr Kenneth C. Francis (photo not available) was the Clinical Professor of Orthopedic Surgery at the New York University School of Medicine. He was also the first orthopedic surgeon to be the chief of the Bone Tumor Service at Memorial Sloan Kettering Cancer Center. His first and only fellow was Dr Ralph Marcove, who ultimately became chief of the Bone Tumor Service at Memorial Sloan Kettering Cancer Center. Although separated by only one mile in New York City, the two men independently performed and developed the original techniques of distal femoral resections, total femoral prosthetic replacements, shoulder girdle resections, scapular resections and pelvic resections. The early 1970s yielded the introduction of Adriamycin© and methotrexate. Both surgeons understood the significance of adjuvant chemotherapy and the impact that it would have on patient survival and the choice of surgical procedure. The subsequent studies at Memorial Sloan Kettering Cancer Center, T1–T10, were undertaken by a team of oncologists with Dr Marcove as the surgeon. In 1973 Dr Francis performed the first distal femoral resection and reconstructed the defect at that time with a long-stemmed Walldius prosthesis. This, to the author's knowledge, was the first distal femoral replacement performed in the United States, if not the world. He attended a meeting at what was then a small company in New Jersey, Howmedica, Inc., and sat down with their engineers and outlined on a napkin a distal femoral prosthesis with a long femoral and tibial stem with a Walldius hinge. This book is dedicated to the knowledge, insightfulness and teaching and surgical skills of these two men. Dr Kenneth Francis died prematurely in May 1976, at the age of 53. Dr Ralph Marcove retired from Columbia Presbyterian Hospital in 1999 and died in February 2000.

Dr Ralph Marcove

Preface

Martin Malawer, MD

Musculoskeletal cancer surgery has undergone dramatic changes within the past two decades. Limb-sparing surgery is the hallmark of the surgical advances developed by this specialty. The role of the orthopedic oncology surgeon in the 1970s was to perform high-level amputations. This is what distinguished the orthopedic cancer surgeon from the general orthopedic surgeon. The development of limb-sparing surgery, in conjunction with the dynamic advances in imaging and chemotherapy, created the specialty of musculoskeletal oncology. The operative procedures performed today barely existed two decades ago. Today, approximately 90–95% of all bone and soft-tissue sarcomas can be treated by limb-sparing surgery. The aim of this book is to present in a concise, organized and well-illustrated format, the surgical techniques involved with limb-sparing procedures of the entire musculoskeletal system, including the upper and lower extremities as well as the pelvic and shoulder girdle. These techniques are a combination of surgical procedures that used to be considered of interest only to the general surgeon, vascular surgeon, plastic surgeon and orthopedic surgeon. The development of these multiple-treatment strategies and techniques has created the field of musculoskeletal cancer surgery as we know it today.

The surgical experience of the two authors, Martin Malawer, MD, and Paul H. Sugarbaker, MD, spans more than two decades each. The combined experience of Dr Malawer, Professor of Orthopedic Surgery at George Washington University, Children's National Medical Center, and the Washington Cancer Institute Division of Orthopedic Oncology, and Dr Sugarbaker, who developed several of the techniques described in this book while at the National Cancer Institute, Bethesda, Maryland, forms the foundation for this book. The techniques described in these pages have been developed by both authors over the past two decades.

The aim of this textbook is to illustrate well a step-by-step approach to limb-sparing procedures of the musculoskeletal system. These techniques, although not unique, are described specifically from the authors' experience, which began in the early 1970s and continues today. Dr Malawer has extensively reported different techniques for limb-sparing resections and endoprosthetic reconstructions. The technique of allograft replacement was developed in the early 1970s and utilized widely until the 1980s. Such techniques are not utilized by the authors but are well described elsewhere.

Surgery is a visual field, and the surgeon works in three dimensions. Therefore, the majority of the contents of this book are accompanied by photographs and illustrations of the surgical procedure as well as preoperative studies that the authors feel are uniquely important. The surgical descriptions, anatomic depictions, and the significance of each imaging study to each operative procedure are emphasized.

Since the mid-1970s the two authors have provided surgical care for approximately 4000 patients with benign, malignant and metastatic lesions, in children and adults. Detailed files, including operative photographs, pathology slides, Kodachrome slides and slides of the significant imaging studies for all of the major cases have been kept on each operative procedure. This collection is housed at the Center for Orthopedic Oncology and Musculoskeletal Research at the Washington Cancer Institute and is available to American and international surgeons and oncologists for study and research purposes.

Despite the complexity of limb-sparing surgical procedures and the multiple imaging studies, it was the purpose of the authors to present these data in a simple visual format. The bibliography is limited in most chapters, because the techniques described were developed by the authors themselves. The general chapters are well-referenced with the most up-to-date citations.

This book contains 36 chapters, divided into four sections. It addresses the basic pathology, surgical technique and management of all extremity and pelvic and shoulder girdle tumors as well as abdominal and truncal sarcoma surgery.

Chapter 1 includes a discussion of bone and soft-tissue sarcomas, including their epidemiology, radiographic characteristics and pathology. Biopsy techniques are discussed in Chapter 2. In Chapter 3, chemotherapy is discussed, outlining the chemotherapeutic agents that are effective in the treatment of bone and soft-tissue

sarcomas. Dr Dennis Priebat details the chemotherapy strategy that has evolved over the past 20 years. The experience of isolated-limb perfusion, a new technique used to treat sarcomas, is described in Chapter 4. Dr Brian Fuller, Chief of the Radiation Oncology Branch at the National Cancer Institute, in Chapter 5, describes the most current and comprehensive strategy for radiation therapy for extremity sarcomas. Chapter 6 discusses the use of cryosurgery in the treatment of certain bone tumors. This technique was developed by Dr Ralph Marcove at Memorial Sloan Kettering Cancer Center and has been continued by the authors. Chapters 7 and 8 summarize the management of abdominal and pelvic sarcomas. The author, Dr Paul Sugarbaker, has uniquely developed many techniques over the past 25 years. Chapters 9, 10 and 11 provide overviews of the treatment of tumors of the shoulder girdle, pelvic girdle and metastatic bone tumors, respectively. These chapters lay the foundation for the specific limb-sparing procedures in the remaining portion of the textbook.

Section Two describes in detail the techniques for muscle group resections of the lower extremity including gluteus maximus, adductor muscle group, quadriceps muscle group, posterior thigh and popliteal space.

Section Three discusses the surgical amputations utilized in orthopedic oncology surgery. These tend to be high-level amputations with which orthopedic and general surgeons tend not to be familiar. Forequarter amputation and the various types of hemipelvectomy are described. Dr Sugarbaker developed the technique of an anterior myocutaneous flap for patients with massively contaminated pelvic and buttock structures that cannot be resected by the standard posterior flap hemipelvectomy. These operative procedures were often deemed difficult and radical, but are still used today to cure certain patients who cannot be treated by limb-sparing surgeries. Phantom pain, a complication following an amputation for cancer patients, is discussed in Chapter 24. Due to the neuropathic effects of the chemotherapeutic agents, as well as the young age of these patients, this problem occurs frequently. Dr Lee Ann Rhodes describes treatment considerations for phantom limb pain.

Section Four describes in detail the limb-sparing procedures around the pelvis, proximal and distal femur, proximal tibia, fibula, proximal humerus and scapula. Although these procedures are performed at many centers throughout the world today, the techniques, morbidity and complications vary tremendously. The techniques as described by Dr Malawer, which he has perfected over the past 20 years, are presented in detail. The required staging studies and unique anatomic considerations, from a surgeon's viewpoint, are outlined for each anatomic site, with special considerations for the evaluation of the imaging studies.

The Appendix includes two chapters of interest to the musculoskeletal surgeon. Appendix A is a description of an abdominoinguinal incision developed by Dr Constantine Karakousis for resection of pelvic tumors. This is a combined intra- and extraperitoneal approach. Canine osteosarcomas are discussed by Dr Charles Kuntz. Osteosarcomas in dogs are extremely common, and the techniques and basis of limb-sparing surgical techniques in dogs offer an excellent orthopedic animal model and are of interest to musculoskeletal cancer surgeons.

Contributors

Jacob Bickels, MD
Attending Surgeon
The National Unit of Orthopedic Oncology
Tel-Aviv Sourasky Medical Center, Tel-Aviv, Israel

Brian G. Fuller, MD
Senior Investigator
Radiation Oncology Branch
Radiation Oncology Sciences Program
National Cancer Institute

Mordechai Gutman, MD
Director, Surgical Unit of Regional Chemotherapy
Tel-Aviv Sourasky Medical Center, Tel-Aviv, Israel
Associate Professor of Surgery
Sackler School of Medicine, Tel-Aviv University
Tel-Aviv, Israel

Robert M. Henshaw, MD
Department of Orthopedic Oncology
Washington Cancer Institute at
The Washington Hospital Center, Washington, DC
Assistant Clinical Professor of Orthopedic Surgery
George Washington University School of Medicine
Washington, DC
Consultant, Surgery Branch of the National Cancer Institute
National Institutes of Health
Bethesda, Maryland

Moshe Inbar, MD
Director, Department of Medical Oncology
Tel-Aviv Sourasky Medical Center, Tel-Aviv, Israel
Associate Professor of Oncology
Sackler School of Medicine, Tel-Aviv University
Tel-Aviv, Israel

James Jelinek, MD
Chairman, Department of Radiology
Washington Hospital Center, Washington, DC
Visiting Scientist
Department of Radiologic Pathology, Armed Forces Institute of Pathology, Washington, DC

Constantine P. Karakousis, MD, PhD
Associate Chief
Department of Surgical Oncology
Roswell Park Memorial Institute
Buffalo, New York

Orit Katzir, BOT
The National Unit of Orthopedic Oncology
Tel-Aviv Sourasky Medical Center, Tel-Aviv, Israel

Kristen L. Kellar, BS
Department of Orthopedic Oncology
Washington Cancer Institute at
The Washington Hospital Center, Washington, DC

Joseph M. Klausner, MD
Chairman of Surgery
Director, Departments of Surgery B and C
Tel-Aviv Sourasky Medical Center, Tel-Aviv, Israel
Professor of Surgery
Sackler School of Medicine, Tel-Aviv University
Tel-Aviv, Israel

Yehuda Kollender, MD
Attending Surgeon
The National Unit of Orthopedic Oncology
Tel-Aviv Sourasky Medical Center, Tel-Aviv, Israel

Charles Kuntz, DVM, MS
Diplomate of the American College of Veterinary Surgeons
Chief of Surgery
Regional Veterinary Referral Center
Springfield, VA

Eric Lang, MD
Attending Anesthesiologist
Department of Anesthesiology
Tel-Aviv Sourasky Medical Center
Tel-Aviv, Israel

Dina Lev-Chelouche, MD
Attending Surgeon
Department of Surgery B
Tel-Aviv Sourasky Medical Center, Tel-Aviv, Israel

Martin Malawer, MD
Director, Department of Orthopedic Oncology
Washington Cancer Institute at
The Washington Hospital Center, Washington, DC
Professor of Orthopedic Surgery
The George Washington University School of Medicine
Washington, DC
Consultant, Surgery Branch at the National Cancer Institute
The National Institutes of Health
Bethesda, Maryland
Clinical Professor of Orthopedic Surgery
Georgetown University School of Medicine
Washington, DC

Nissim Marouani, MD
Attending Anesthesiologist
Acute Postoperative Pain Service
Department of Anesthesiology
Tel-Aviv Sourasky Medical Center, Tel-Aviv, Israel

Isaac Meller, MD
Director, The National Unit of Orthopedic Oncology
Tel-Aviv Sourasky Medical Center, Tel-Aviv, Israel
Senior Lecturer
Sackler School of Medicine, Tel-Aviv University
Tel-Aviv, Israel

David Niv, MD
Director, Pain Service
Department of Anesthesiology
Tel-Aviv Sourasky Medical Center, Tel-Aviv, Israel
Associate Professor of Anesthesiology
Sackler School of Medicine, Tel-Aviv University
Tel-Aviv, Israel

Riki Oren, BPT
The National Unit of Orthopedic Oncology
Tel-Aviv Sourasky Medical Center, Tel-Aviv, Israel

Dennis Priebat, MD
Director of Medical Oncology
Washington Cancer Institute at
The Washington Hospital Center, Washington, DC

Lee Ann Rhodes, MD
Medical Director of Pain Management
Washington Cancer Institute at
The Washington Hospital Center, Washington, DC

Cynthia K. Rubert, MD
Department of Orthopedic Oncology
Washington Cancer Institute at
The Washington Hospital Center
Washington, DC

Valery Rudick, MD
Director, Department of Anesthesiology
Tel-Aviv Sourasky Medical Center, Tel-Aviv, Israel
Senior Lecturer
Associate Professor of Anesthesiology
Sackler School of Medicine, Tel-Aviv University
Tel-Aviv, Israel

Barry Shmookler, MD
Director of Surgical Pathology
The Washington Hospital Center
Washington, DC

Paul Sugarbaker, MD
Director, Surgical Oncology
Washington Cancer Institute at
The Washington Hospital Center
Washington, DC

Avi Weinbroum, MD
Director, Post-Anesthesia Care Unit
Department of Anesthesiology
Tel-Aviv Sourasky Medical Center, Tel-Aviv, Israel
Lecturer
Sackler School of Medicine, Tel-Aviv University
Tel-Aviv, Israel

James C. Wittig, MD
Assistant Professor of Orthopedic Surgery
Department of Orthopedic Surgery
New York University Medical Center
Hospital for Joint Diseases
Bellevue Hospital Center
New York, New York

Alice Zagury, BPT, MSc
Children's Hospital and the National Unit of Orthopedic Oncology
Tel-Aviv Sourasky Medical Center, Tel-Aviv, Israel