TRAUMA IMAGING

IN THE THORAX AND ABDOMEN

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TRAUMA IMAGING IN THE THORAX AND ABDOMEN

We dedicate this book to injured people
and to the clinicians and radiologists who strive to help them.

Foreword

Despite the prevalence of trauma and its impact on those affected, the study of trauma has long been a stepchild in civilian medical and surgical research. Significant advances have invariably awaited the application of newer tenets of care in the management of wartime casualties. The importance of rapid evacuation was demonstrated conclusively in Korea, the Middle East and Vietnam, and this work by Doctors Rosenberger, Adler, and Troupin, based on experience with trauma victims emerging from combat in Lebanon, conclusively demonstrates the value of high technology diagnostic imaging.

The recent expansion of academic medical centers has had a significant influence on the care and treatment of trauma in the United States. Many such centers are now associated with municipal and county hospitals, historically responsible for the care of trauma victims. This association has greatly improved the quality of training afforded physicians and paramedical personnel, thereby elevating the quality of care of the traumatized patient. These developments have been coupled with the designation of specialized regional trauma centers, linked in close communication with ambulances staffed by paramedical personnel who are trained in resuscitation and preadmission evaluation. These changes mirror the evacuation chains established in wartime and have added immeasurably to the victim's chance of survival.

Fortunately, there is growing awareness of the potential gravity of trauma on the quality of life; a realization that many of those affected are young and in the midst of their productive lives. The impact of proper diagnosis and care on these lives is enormous and justifies the increasing public policy priorities being given to these trauma centers.

Diagnostic imaging has undergone a veritable explosion of its technologic armamentarium as well as a substantial expansion in the number of radiologists. These

two factors have led to subspecialization in radiology paralleling developments in other medical and surgical disciplines. The care and diagnosis of traumatized victims cuts across many emerging fields of subspecialization in radiology. The need for integration, for an overall concept of the care and management of the trauma victim, and for an overview of the role of diagnostic imaging is obvious. When properly applied, this imaging may be pivotal, but when poorly performed and improperly utilized, it may be perilous or even fatal.

Radiologists must participate actively in the care and diagnosis of trauma victims and understand what the trauma surgeon needs to know; what questions need to be answered and why; what is important and what is irrelevant. They should know the pathomechanics, pathophysiology, and effects of the various forms and forces of injury, i.e., blunt, blast, and penetrating. They must understand the interrelationships between clinical and radiographic procedures, i.e., peritoneal lavage and abdominal computed tomography. They should know the potential means and goals of treatment, be aware of the expected outcomes and complications and understand the rationale for clinical decisions. They must have a firm grasp of diagnostic alternatives and algorithms to lead the surgeon and his patient through the technological maze.

This text brings together all of these elements to allow those involved in the care and management of the traumatized patient to understand the clinical setting, the use and limitations of imaging technology, and the selection and performance of appropriate imaging procedures. The authors are to be commended for their insights and efforts. This timely, important and much needed work is an outstanding example of international medical cooperation at its best; would that other international efforts were so humane and fruitful. I applaud and congratulate Doctors Rosenberger, Adler, and Troupin for this outstanding contribution to the care and management of the victims of trauma. I was flattered by their request to write this foreword and I am pleased to associate myself with their work in this small way. The reader will be rewarded by being well informed and their patients by being better served.

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Preface

Only in recent years has more appropriate emphasis been focused on trauma, formerly a low priority health care issue in civilian life as compared to cancer, cardiovascular, and neurologic disease. However, trauma has been aptly called the "epidemic of the twentieth century," filling emergency rooms throughout the world with the victims of automobile accidents, falls, penetrating wounds, agricultural injuries, and house fires. These emergency rooms and radiology departments must also be prepared for mass casualties from a train wreck, a stadium collapse, or an industrial explosion. Such patients often have multiple injuries, and lifesaving clinical management may demand well-conceived, well-executed diagnostic imaging.

Clinicians and radiologists each need to understand the basic physics governing blunt and penetrating trauma, as well as the pathophysiology of the inflicted tissue injuries. Thoraco-abdominal trauma does not respect our artificially drawn subspecialty lines, and effective integration of a multispecialty team cannot be overemphasized. The clinician members determine the triage priorities for each patient and identify the significant questions, while the radiologist can best judge how these questions should be answered. There will always be legitimate controversies in the selection of imaging modalities, and published state-of-the-art recommendations must be tempered by local factors such as availability of equipment, radiologic skills with these modalities, and the clinician's confidence in these skills.

Trauma diagnosis of the abdomen and thorax is vastly different today from what it was just a few years ago, revolutionized by the use of computed tomography (CT), and in selected circumstances, radionuclide imaging and sonography. Combinations of these modalities now accurately evaluate specific organ injuries and localize the collections of blood, air, urine, or bile that spill from these torn structures. With an accurate

imaging assessment, exploratory surgery can sometimes be avoided in favor of vigilant, informed observation. Contrast studies of the gastrointestinal and lower urinary tracts retain their pivotally important roles in suspected perforations and lacerations. The choice of specific contrast agent requires thoughtful selection, and a preplanned imaging sequence in the multitraumatized patient must avoid contrast extravasation from the bladder, for instance, when pelvic arteriography for hemorrhage is pending.

Angiography provides the means to detect acute vascular thromboses and bleeding sites, as well as later pseudoaneurysms or arteriovenous fistulas. Interventional catheter techniques offer a nonoperative alternative to occlusion of bleeding vessels or to dilatation of structures that have become stenotic due to injury.

Persistent hematomas or infected collections can be precisely localized by CT or ultrasound for aspiration and percutaneous tube drainage. The potential role of magnetic resonance imaging (MRI) in thoracoabdominal trauma has yet to be explored. If current problems relating to scanning time and metallic life support systems can be solved, MRI may be able to offer extremely sensitive detection of bleeding sites and hematomas.

Much of the clinical experience illustrated in this book is drawn from the Rambam Medical Center in Haifa, Israel, a hospital serving a regional population of a million people, in an area thriving with industry, agriculture, and transportation systems. During the wars in the Middle East, the hospital also figured prominently as a major trauma center for northern Israel, handling large numbers of military and civilian casualties. In both peacetime and war, prompt, decisive diagnostic imaging was required in many of these patients, and a large data base of technical refinements and diagnostic criteria consequently evolved. At the time of this writing, Rambam case experience includes over 600 computed tomographic studies for thoraco-abdominal trauma. Supplementary illustrative material has been added from current files of the Hospital of the University of Pennsylvania and the Children's Hospital of Philadelphia.

An extensive English-language literature review and analysis has been carried out, some of which is offered in the bibliography at the end of each chapter. These references span and integrate the clinical and the radiologic literatures, and include both original reports and updated critical reviews.

The goal has been to create a book that provides realistic insights into the clinical management issues in traumatology, as well as a clear overview of the role of modern imaging.

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Acknowledgments

The need for this book became apparent to the Israeli authors as modern imaging technology advanced and made many of the methodologies formerly used in caring for trauma victims obsolete. At Rambam Hospital, computed tomography became the workhorse for trauma diagnosis during the 1982 Lebanese war, and those lessons were promptly adapted to the trauma victims of peacetime.

In subsequent sabbaticals at the University of Pennsylvania, these ideas were discussed and considered, and with the addition of the American author, the idea began to develop specific form. Comprehensive literature review and analysis were undertaken, on both sides of the ocean, and during scholarly leave in Israel, extensive case material was reviewed and selected.

The concept and execution of an international collaboration between a medical center on the firing line and one whose academic and support resources are greater does not just happen. We are enormously grateful to Dr. Stanley Baum, radiology chairman, University of Pennsylvania, for many things. His foresight and support in establishing ongoing exchange between the two medical centers were translated into innumerable details of academic space, time, research library access, photographic facilities, and secretarial support. The Rambam Medical Center was also most gracious and hospitable in providing a comfortable living and working environment for the American author on academic leave from Philadelphia.

Many of our radiology colleagues were tremendously generous with their advice, clinical coverage, case material, and friendship. They include Uriel Kleinhaus, Menucha Pery, Joseph Kaftori, and Achuva Engle in Haifa and Marc Banner, Howard Pollack, Gordon McLean, Victor Lewis, Michael Velchik, Saroosh Mahboubi, Sidney Heyman, John Bonavita, and Adele Friedman in Philadelphia. The time commitments and distractions of book authorship

affect families as well as colleagues; it is important that Vera, Kurt, and Bert know how much we appreciate them.

It was a privilege to work with excellent photographers; skilled, uncomplaining, and dedicated to high quality. Juanita James and Steve Strommer within the Hospital of the University of Pennsylvania radiology department shared the large demanding work load with Milne Hewish and with Pauline Wong in Philadelphia. Year Book Medical publishers provided the grant support that allowed half of the photography to be done privately when the volume exceeded the capacity of in-house facilities.

The book would not have been written without Gwen Reece. Her intelligence, dedication, secretarial skills, good humor, and resourcefulness overcame innumerable obstacles in producing the manuscript. She has our deepest admiration, gratitude, and affection.

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Authors' Note to the Reader About Illustrations

We have made three unconventional, but deliberate, decisions about the illustrative material that merit mention at the outset.

A few technically suboptimal images have been retained when they were, in our judgment, particularly instructive cases. It is the nature of urgency in a traumatology environment that a pragmatic, rather than aesthetic, end point is often acceptable.

Second, we have designed some of our multipart illustrations to include more than one patient, when it was important to group, compare, and contrast a spectrum of severities. In each instance the legend will be quite specific in warning the reader of this.

Finally, we believe that cross coordination of chapter illustrations is not only acceptable, but desirable. Many accident victims sustain multiorgan injuries and we have used a few of these cases to facilitate review and integration of material from previous chapters.

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