

FLUOROSCOPY in Diagnostic Roentgenology

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TO

MY WIFE, RITA

PREFACE

Three score years have passed since the discovery of the roentgen rays. With their utilization for medical purposes, a new branch of medicine came into being: Roentgenology. Throughout these sixty years two phenomena of this radiation have been employed toward diagnosis of disease: the excitation of luminosity in certain substances and the photographic effect on a photosensitive emulsion. The first of these phenomena led to the development of fluoroscopy, the second brought forth radiography.

An extensive literature on diagnostic roentgenology exists and is available to interested professionals. Most of it, however, is based upon utilization of the radiographic method. Literature dealing with fluoroscopy is very scarce, and this deficiency is felt not only by the radiologist but also by students and practitioners of medicine, who have often complained to me of how little information is available in this field.

Therefore, I feel justified in having written this book, especially since it is the first attempt to compile all the essential knowledge about fluoroscopy into a single, complete volume. This book is also the first critical approach to the potentials and limitations of the fluoroscopic method. Thus, it should be helpful not only to the student of medicine and the clinician, but also to the roentgenologist and to the specialist in fields other than roentgenology.

The text has been collected from the various sources dealing with fluoroscopy as well as from the scattered remarks about the subject in the many works on radiography. A great deal had to be gathered from the early roentgenologic literature where many discoveries were based only upon

fluoroscopic findings. On the other hand, because of new technical developments, a great deal of the very recent literature has been included. Many observations and critical remarks stem from my own experience.

Since classification of material in any text is an arbitrary matter, the following will deal with my method of classification and with my reasons for selecting it.

Part One is a general description of the fluoroscopic method starting with some brief historical remarks. This is followed by chapters dealing with the essential fluoroscopic equipment, and with the perception and the physical and clinical evaluation of the fluoroscopic image. Special chapters are dedicated to the principles of screen amplification, to the hazards of fluoroscopy and to foreign bodies.

In radiography the examiner is usually confronted with the finished product of a technical procedure. The problems of radiographic techniques may or may not concern the examiner, depending upon the efficiency of his technician. As soon as the physician is provided with a satisfactory radiograph, his interest turns to the clinical evaluation of the processed film. Technical questions arise only when they are connected with diagnostic considerations, e.g., artefacts simulating pathologic shadows or foreign bodies, faulty projections leading to distortions, or superimposition of important structures.

In fluoroscopy, a working knowledge of technical details is essential for the proper understanding of fluoroscopic diagnosis. The examiner must be his own technician, not only because he finds he can work without technical help, but because he can thus judge, correct and improve the quality of the fluor-

oscopic image. In order to perform fluoroscopy expertly, it is necessary to become familiar with the technical factors; for this reason, a great deal of consideration has been given to the technical chapters of Part One.

Part Two deals with fluoroscopy of specific organs and anatomic tracts. Stress has been placed upon the detailed description of the fluoroscopic technique of examination. The great potential as well as the limitations of clinical fluoroscopy are pointed out, and the correct registration of changes and interpretations based upon a thorough analysis of all observed signs are the final goals of this book. A purpose of the book has therefore been to present the principles and techniques of fluoroscopy—not only in relation to disease entities but also in relation to the recognized criteria for effective diagnosis.

It will often be possible to arrive at a gratifying differential diagnosis based upon fluoroscopic findings. However, this book strives to give advice also in cases where fluoroscopy has served its maximum usefulness and a definite diagnosis has not yet been made. In such cases, procedures for further clarification have been suggested.

It is impossible and quite unnecessary to cover all fluoroscopic procedures devised by various examiners and used for every special indication. There are also procedures which are not generally recognized and some which have been disputed for one reason or another. Some of them seemed to me to be of interest and are briefly discussed. In all other cases, only those fluoroscopic procedures which contribute definite information have been thoroughly considered.

Since this work has been written not only as a textbook, but also as a reference book, it contains a bibliography after each chapter. First consideration has been given to publications dealing exclusively or for the most part with fluoroscopy. In addition, papers or books describing important features of diagnostic roentgenology had to be listed. I am

fully aware that any such selection is open to the criticism of subjectivity, and many references originally included in this bibliography had, of necessity, to be omitted.

The photographs of this book are unretouched positive prints showing the shadows dark and the transparencies bright. This has been done deliberately (and contrary to the generally presented mode of reproducing roentgenograms as x-ray negatives) in order to show images as they actually appear on the fluorescent screen.

The roentgenograms were taken from patients examined in the x-ray departments of the Flower Fifth Avenue Hospital, New York, the Metropolitan Hospital on Welfare Island, New York, and in my private office. The overwhelming majority of radiographic interpretations has been confirmed by biopsy or necropsy. The remaining roentgenologic findings have been corroborated by pathognomonic clinical and laboratory diagnosis.

For the photographs illustrating fluoroscopic equipment, I am indebted to the Picker X-Ray Corporation and the X-Ray division of the Westinghouse Electric Corporation. The india ink drawings and the diagrams of this book were drawn by me and are simple in outline so that the reader should find no difficulty in following the explanations.

I desire to express my sincere thanks to Dr. Frank J. Borrelli and Dr. Tobias B. Weinberg for their support in letting me use the material of the above-mentioned hospitals.

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O. D.

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INTRODUCTION

Although diagnostic roentgenology has been the intensive subject of a great number of books and publications, inspection reveals that the bulk of this literature deals primarily with the roentgenographic method. These texts teach diagnosis as derived from the interpretation of roentgenograms, while the evaluation of fluoroscopic observation has been either ignored or presented sporadically. When fluoroscopy became the subject of a work, it fell victim to many shortcomings. Some books are rather incomplete, dealing with the *technique* of the examination with only a few essential features of interpretation. Others wrongly endeavor to treat fluoroscopy independently of other roentgenologic methods. The experienced diagnostician knows that fluoroscopy has a well-defined place as an independent method of clinical examination, but that its full scope is not realized if it is separated from other roentgenologic methods.

Thus, a *complete* and *accurate* presentation of the subject of fluoroscopy must not only consider its diagnostic possibilities attainable without additional methods of examination, but also discuss those sources of information which are utilized in conjunction with radiography. In addition, emphasis must be placed upon the importance of fluoroscopy in differential diagnosis where radiography alone cannot supply the answer to a particular problem. This, then, is why this book dealing with the entire scope of fluoroscopy, with all its great potential as well as its limitations, is necessary within the framework of diagnostic roentgenology.

Significantly, the physiologic aspect is the salient feature of this book, whereas most texts on x-ray diagnosis seem predominantly

concerned with the anatomic viewpoint. This presentation of fluoroscopy is not only the first attempt to compile a complete text devoted to this particular field, but also fills a much-needed gap in diagnostic roentgenology.

Of course, all complete diagnostic x-ray units have incorporated in them a fluoroscopic device. However, the fluoroscope by itself is so widely used today that it is becoming part of the regular equipment of the general practitioner as well as specialists in fields other than radiology. It goes without saying that those who use this instrument should be familiar with both the full range of its usefulness and its limitations.

Some physicians sometimes resort to fluoroscopy alone, without the subsequent use of radiography. They may do this for several different reasons:

- (1) Time does not allow the performance of complicated procedures associated with many radiographic techniques.

- (2) Expensive radiographic equipment can hardly be amortized unless used to the capacity usually expected in the radiologic practice of a specialist.

- (3) In order to interpret roentgenograms accurately, a great deal of time and effort must be devoted to a study of the entire field of diagnostic roentgenology.

Although competence in fluoroscopy requires training, experience and extensive clinical material, it takes less time and effort because of its limited application than does study of the entire field of radiology with its many complicated procedures. Indeed, there are sufficient opportunities, both in hospitals and private practice, to become acquainted

with the proper use of the fluoroscope, and the clinician should be encouraged to employ this valuable instrument to its fullest extent. For successful performance, however, proper guidance is essential. Unfortunately, this guidance is not always at hand and there are many physicians who still lack sufficient training in fluoroscopy. As a result, many patients are not fluoroscoped as part of an examination, simply because of the misconception that no essential information can be obtained by this method. On the other hand, in many cases where fluoroscopy is used both in hospitals and private practice, inadequate experience and knowledge preclude attainment of optimal diagnostic assistance.

The untrained examiner will often start his fluoroscopy without taking time for dark adaptation. Then, in an attempt to overcome the lack of adaptation, he may resort to a higher kilovoltage, resulting in overpenetration and loss of essential contrast. He may fail to turn the patient in various directions under the screen, thereby losing the potential value of physiologic tests, localization and three-dimensional orientation.

Another error sometimes observed is that of keeping the double slit diaphragm open while the x-rays are turned on, and the failure to adjust the field of vision only to the region to be observed. In some instances, the radiation is not kept within the boundaries of the protecting screen, but extends above, below or on either side. Handling the fluoroscope in this way is dangerous to the examiner as he may expose his face to direct radiation. Occasionally, too, a physician who is examining with a wide-open diaphragm may start a conversation with a colleague, forgetful that his patient is receiving a "therapeutic" dose.

Unless a physician has had the opportunity of observing a trained fluoroscopist it is difficult for him to acquire the necessary knowledge of technique because there has been a scarcity of literature devoted to this subject. General practitioners and specialists will therefore warmly welcome "Fluor-

oscopy in Diagnostic Roentgenology." The author has tried to deal with fluoroscopy on a broad level, so that the clinician may become familiar with the problems of the roentgenologist. The book will open broad vistas for fluoroscopic examination, while still indicating where other diagnostic methods may be used to greater advantage. And it will clearly define the limits of the fluoroscopic technique.

A clear exposition of the principles and techniques of fluoroscopy will have similar value to the roentgenologist, especially since some roentgenologists have displayed a tendency to restrict its use or even to discard it entirely. Fluoroscopy is too often replaced by radiographic procedures performed by a technician, without the presence of the physician. It must be remembered that a radiologist who restricts his practice to the interpretation of roentgenograms loses contact with practically all clinical factors and deprives himself of the advantages of questioning the patient. He has no knowledge of points of tenderness and cannot utilize the important factor of palpation. Discoloration of the skin, redness or jaundice can be noticed only on direct inspection and visible external deformities or swellings are clinical signs which may not be elicited from the roentgenograms, but which are obvious to the fluoroscopist.

Fluoroscopy, like auscultation or percussion, establishes a close personal relationship between the patient and the physician. Clinical signs discovered before the fluoroscopic examination may direct the physician to pay special attention to certain otherwise normal variations observed during the course of the examination. It may prompt him to take special care in observing phenomena which otherwise might be overlooked.

The significance of fluoroscopy in relation to radiography was well put by H. Roesler when he said, "Rotating the patient during fluoroscopy has the same relation to a film record as a ride through a country has to a picture postcard of the same scenery." The

pioneer Holzknecht, one of the great scientists in the field of radiology, often called the radiographic image "dead" while fluoroscopy meant to him the observation of the "live body."

This book treats fluoroscopy from every angle and shows to what degree interpretation is possible without the use of other radiologic methods. In addition, it discusses the use of fluoroscopy in conjunction with radiography and it evaluates its contribution to the roentgenologic diagnosis for certain pathologic conditions. Thus, "Fluoroscopy in Diagnostic Roentgenology" is not only a text, but also a reference book for those who use the fluoroscope in their practice of medicine.

Among the physicians in specialties other than radiology, the internist and particularly the cardiologist and gastroenterologist will find the greatest use for this book. However, the surgeon will also derive a great deal of benefit in the diagnosis of many emergency conditions and in the localization and removal of foreign bodies. The neurologist and neurosurgeon, as well as the gynecologist, will be interested in particular chapters of this book. A special chapter has been dedicated to urology, even though the urologist in this country does not now use fluoroscopy to any appreciable degree. However, he soon will be called on to employ this method more and more. For fluoroscopy, in conjunction with standard or spot radiography, will soon become the method of choice in urology as well as in orthopedic and traumatic surgery and other specialized fields of medicine.

These predictions are based upon the fact that electronic screen amplification has become a practical reality. It is now possible to observe the fluoroscopic image at a level of "daylight" brightness, eliminating the disadvantages and inconvenience of dark adaptation. In addition, the clarity of perception closely approaches that of a roentgenogram viewed on an illuminator. Furthermore, this new type of fluoroscopy permits a considerable reduction in x-ray radi-

ation, so that the time of examination may be prolonged if desirable or necessary, without damage to the patient or operator. Amplified fluoroscopy combined with spot photography of the intensified image appears to be the most logical trend in the future of diagnostic roentgenology.

In the field of bone diseases per se, radiography will remain the sole method of examination because fluoroscopy can offer no additional advantage. The structural details of the amplified screen image are still inferior to radiographic definition. However, in other fields, the superiority of amplified fluoroscopy over the conventional type reveals itself almost immediately.

There is no doubt, then, that electronic screen amplification will widen the range of application for fluoroscopic procedures. This new technical development considerably improves fluoroscopic perception and facilitates the detection and proper interpretation of pathology. On the other hand, it does not affect the fundamental physical and physiologic phenomena discovered by means of conventional fluoroscopy.

Because of the basic importance of *physics* in fluoroscopy, Dr. Deutschberger has presented this subject in a concise but comprehensive form. Written for the needs of the clinician, this section is not intended to be a treatise on mechanical and electrical engineering for the physicist; it aims instead to give the student as well as the practitioner of medicine an understanding of the technique of examination, methodical observation and analysis of interpretation.

With its emphasis on fundamental aspects of fluoroscopic diagnosis and with its inclusion of data on electronic amplification of the fluoroscopic image, this work will serve its purpose of summarizing current knowledge and anticipating future developments in its broad field. It will act as a teaching instrument for students of medicine, for practicing physicians and for specialists who are eager to command every resource in the best means toward accurate diagnosis.

FRANK D. BORRELLI, M.D.

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PART ONE

GENERAL CONSIDERATIONS
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