

A TEXTBOOK *of* ROENTGENOLOGY

THE ROENTGEN RAY IN DIAGNOSIS AND TREATMENT

By

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PREFACE

The contents of this book bring the roentgenologist more into the class of consultant than any other book on roentgenology written up to the present. It is a development of the times showing that the roentgenologist must be a pathologist to take his place as a consultant. The author has taken pathology and shown what roentgenology can do in the way of treatment of the pathology or in the way of showing up the pathology without resorting to surgery. Other books have emphasized the X-ray film and worked backwards to the pathology. To many roentgenologists this book supplies the knowledge of pathology which is essential to them. It is a book which should appeal to the clinician as much as to the roentgenologist; it brings them closer together than any other book on the subject of roentgenology.

A. HOWARD PRIE.

INTRODUCTION

Of all the links in the clinical chain which leads eventually to the proper understanding of the pathological condition from which a patient is suffering there is none which gives so much or so accurate information regarding the gross morphological changes in the organs, as roentgenological examination. With the development of new apparatus and with improvement in technique this form of investigation is steadily increasing in value. This is true not only in diagnosis but also in therapeutics. To the specialist in any branch of medicine the limitations and the extent of the assistance which can be obtained from roentgenology is well known with regard to his own field of work, but the general practitioner as a rule is not usually quite so well informed regarding the positive and negative aspects of this method of investigation and treatment. The situation of the student is somewhat similar to that of the general practitioner and the lack of time for sufficient routine instruction in roentgenology as part of the medical curriculum prevents him from acquiring a satisfactory knowledge of the value which roentgenological diagnosis and roentgenotherapy can have for him in general practice.

Many of the requests received for roentgenological investigation and treatment make it obvious that the physician has not had the opportunity of obtaining a sufficiently clear idea of the nature of the information which roentgenological examination can elicit, nor any idea of the fact that roentgen examination of the same part of the body may be carried out in many different ways, each intended to throw a special light on a different clinico-pathological problem.

So far it does not appear to have been accepted as a basic fact in medical practice that consultation between the roentgenologist and the clinician should take place before any roentgenological examination other than the very simplest is undertaken. It must be remembered that the examination and interpretation of roentgenograms are directly correlated with the technique of their production, and that it may be very difficult to analyze a roentgenogram satisfactorily unless one is capable of analyzing the technique which was employed in producing it. Hitherto overmuch stress has been laid on the promiscuous viewing of roentgenograms in wards and operating theatres, etc., and insufficient stress has been laid on the proper consultation prior and subsequent to the roentgenological investigation. There is a tendency to view the roentgenogram as a photograph and to imagine that its full value is its face value, whereas, it should rather

be viewed as a work of art, and the physical accuracy of its detail looked upon only as a scaffolding erected to support and display the pathological evidence contained in it.

While the roentgenogram is a picture, it is true, it should not be looked upon as a picture puzzle, but rather as a picture in the production of which the roentgenologist is intimately concerned. The clinician supplies the theme, the roentgenologist supplies the technique required to produce the picture and both together examine the completed work of art and decide on its proper value. The adaptation of the technique to the particular problem for the purpose of demonstrating special alterations in structure or function is of the utmost importance, and the information contained in the roentgenograms cannot be as complete as it should unless all the information possible is obtained. It is a *sine qua non* that the utmost information can be obtained from roentgenograms only when the utmost information regarding the suspected pathological condition of the patient is considered in designing the technique for their production. The actual analysis of the film should always be made from the point of view of the alterations in the structure and the functions of the parts portrayed, instead of, as unfortunately it often is, from the point of view of clinical disease.

Every roentgenological examination is an attempt to solve a definite clinico-pathological problem, and every roentgenological treatment is an attempt to cure or alleviate a definite pathological condition. Neither roentgenological examination nor roentgenotherapy partake of the nature of a foraging expedition, and the student or the interne who hopes to receive help from either of these sources must have a very clear conception of the pathological changes which are to be sought for in attempting to elucidate the problem in which he is seeking aid, or a clear conception of the pathological changes which he wishes to have treated. A clinical problem is a question as to what morbid anatomy is present to cause the clinical condition which the patient presents, while the question of the advisability of employing roentgenotherapy is essentially the question as to what results may be expected by treating a certain morbid histological change with irradiation. Roentgenological investigation is a clinical procedure. Roentgenotherapy is clinical treatment. They both mean direct contact with the patient and full control of and responsibility for that patient while the examination or treatment is being carried out. They differ essentially from laboratory tests which are concerned primarily with the examination or treatment of something which is no longer an integral part of the patient. Roentgenology deals with living pathology, the roentgenogram being an image of a condition of the patient's tissues at a particular moment, and roentgenotherapy being the direct application

of a therapeutic agency to a patient with a particular pathological condition. It should be recognized that for the purposes of examination and treatment the patient must be under the full control of the roentgenologist. Roentgenology differs from clinical chemical and pathological examinations which deal almost entirely with tissues, secretions, and excretions after they have left the patient, in that there is not the same absolute necessity for the patient to be under the complete control of the biochemist or pathologist for the period of the examination.

That the interest of the patient is paramount does not appear to have been always kept in mind in the past, but it is obvious that in any roentgenological examination which is to be carried out the coöperation between the clinician and the roentgenologist must be sufficiently close to ensure that the patient receives the utmost benefit from the investigation. If the information supplied by the clinician is vague and incomplete the analysis of the roentgenological findings made by the roentgenologist must also be vague and incomplete and to enable the patient to obtain the best possible advice indefiniteness must be replaced by accuracy.

The rapid increase in the scope of roentgenological investigation, its extension to wider and wider fields of morbid anatomy, the numerous new methods of investigation, the variety of technical procedures, the special methods of positioning, the new pieces of apparatus, the development of special methods for special diseases, the continued improvement in roentgen generators, tubes, etc., and the steady improvement in all the accessories, are so bewildering to the general practitioner and to the student, bewildering at times even to the roentgenologist himself, that it is becoming increasingly difficult for anyone not practicing roentgenology as a specialty to keep in touch with all the roentgenological developments that apply to his own sphere of medical practice, even assuming that he has the natural aptitude and the subsequent training to enable him to make full use of them. The utmost that the average specialist can hope to do is to keep well informed regarding any additional aid which he can hope for from the advances in roentgenological knowledge so as to be able to coöperate with the roentgenologist sufficiently to ensure the patient obtaining the utmost value from the roentgenological investigation. It is the duty of the clinician to keep himself acquainted with the increasing value of roentgenological investigation in detecting the pathological changes underlying any clinical condition, and it is the roentgenologist's duty to be acquainted with the particular methods of examination, the particular preparation for examination, the special technical factors, the most suitable apparatus and the use of all special positions and other procedures which are necessary to elicit all the information possible, and above all to be able to interpret that information correctly.

This book is intended primarily to enable the practitioner to understand the basis on which roentgenology rests so that he may be better able to appreciate the help which roentgenology can be to him in his work. No details of mechanical or electrical technique have been included and instead of attempting to teach the science of roentgenological interpretation the attempt has been made to inculcate the idea that different shadows will appear upon the roentgenogram according to the technique employed in its production. Just as an artist, in painting two pictures of a landscape, can depict two totally different themes despite the identity of the physical features, so too the roentgenologist by taking two roentgenograms of the same part of the body can demonstrate different structures by varying his technique. The roentgenological examination of the thorax can demonstrate either the structure of bone or the structure of the lung, the size of the heart or the action of the heart. It can demonstrate the structure of the lung even when this appears in a roentgenogram taken with one technique to be entirely obscured by fluid or it may be made to show the fluid without demonstrating the structure of the lung. So, too, in the examination of a bone the technique adapted to demonstrate the finest detail of the calcified trabeculae may not demonstrate any pathological change in the early stage of a bone infection, whereas it may be possible by means of the so-called soft tissue technique to demonstrate changes in the surrounding soft tissue and even minor alterations in the density of the bone before lime absorption has become sufficiently marked to show definite changes in the osseous architecture. It is the task of the roentgenologist to determine the form of examination which is suitable for eliciting the information required, just as the clinician determines the particular forms of clinical examination which he must make in order to arrive at his diagnosis. It is not necessary to carry out every known test on the blood to determine the nature of a disease of the blood. The particular form of examination necessary is determined as the clinical examination proceeds. In a like manner all the different roentgenological methods of examining any part of the body or any organ are not and need not be carried out as a roentgenological routine. The detailed findings of the clinical examination are usually sufficient to enable the roentgenologist to determine the most satisfactory technical procedures for him to adopt. Technique, which of a necessity cannot be and can never become absolutely standardized, is an all important one from the roentgenologist's standpoint. Without it, and without the proper knowledge and experience necessary to produce the best technical results the roentgenologist suffers a severe handicap and his pathological, clinical, and interpretative ability, no matter how excellent, can produce an opinion of no higher quality than the roentgenogram itself, though, it is true, that sound medical judgment

and poor technical knowledge are much better than bad medical judgment and good technical knowledge.

The technical side of roentgenology can never be left to the technician, for the roentgenologist himself must modify the physical factors at his disposal so as to suit the particular investigation which he wishes to make, and sound medical judgment is quite as necessary in determining the most efficient technique in a roentgenological examination as it is in determining the most efficient and suitable surgical technique.

The attitude of the clinician towards a problem requiring roentgenological elucidation differs entirely from that of the roentgenologist. The clinician must have some definite problem in his mind and also a definite idea as to the help that roentgenology can afford him, as well as the relative value of this assistance. The roentgenologist, on the other hand, views the problem from a totally different angle. He considers the patient as suffering from certain clinical conditions which may be due to one or more of a number of different pathological causes, one or more of which is possibly accompanied by morbid anatomical changes capable of being demonstrated roentgenologically. Knowing what these changes are likely to be he must then decide what preparation of the patient is necessary, and what technical procedures must be adopted for the purpose of demonstrating them. From a consideration of the images seen on the roentgenoscope and the roentgenogram he concludes that certain pathological changes are probably present. He does this from the alterations in the size, the shape, the position, the density, or the function of the organ or organs under investigation. Finally, in considering this pathological change in relation to the clinical facts of which he is aware, he must attempt to aid the clinician in deciding on the pathological diagnosis. During his examination he may observe changes in the structure or function of organs and tissues other than those under investigation. These changes may or not give additional diagnostic information, and some, or all, or none of them may throw light on the particular clinical problem which he is attempting to elucidate.

While in a few cases it is true that the roentgenologist feels that his findings definitely settle the diagnosis, his opinion in most cases is no more than a summation of probabilities, a very accurate summation maybe, but nevertheless one which is not absolutely certain. The accuracy of his opinions will increase *pari passu* with his knowledge of general medicine, and of the value of the clinical facts presented to him by the referring clinician, but most of all his accuracy will depend upon his knowledge of morbid anatomy or macroscopic pathology.

No definite attempt is made here to meet the needs of the roentgenologist. He has at his disposal a library of special works on each of the

by Maurice de Broglie, translated by J. R. Clarke (1925), *The Structure of Matter* by J. A. Cranston (1924), *The Physics of X-Ray Therapy* by W. N. Mayneord (1929), and *X-Rays* by G. W. C. Kaye (1918). For the pathological discussions *A Textbook of Pathology* by William Boyd (1932), *Pathology for Students and Practitioners* by Dr. Edward Kaufmann, translated by Stanley P. Reimann (1929) and *Neoplastic Diseases* by James Ewing (1928) have been used, while for the general roentgenological findings the work of Alban Köhler on *The Borderlands of the Normal and Early Pathological in the Skiagram*, translated by Arthur Turnbull (1928), *Röntgendiagnostik in der Chirurgie und Ihren Grenzgebieten* by Dr. Herman Meyer (1927) and *Roentgen Interpretation* by George W. Holmes and Howard E. Ruggles (1926), for special chapters the works of Russell D. Carman, *The Roentgen Diagnosis of the Diseases of the Alimentary Tract* (1920), of W. A. Newman Dorland and Maximilian John Hubeny, *The X-Ray in Embryology and Obstetrics* (1926), of H. Wessler and Leopold Jaches, *Clinical Roentgenology of Diseases of the Chest* (1923), of F. Barjon, *Radio-Diagnosis of Pleuro-Pulmonary Affections*, translated by James A. Honeij (1918), and the *Annals of Roentgenology*, especially the works of Hugh H. Young and Charles A. Waters, *Urological Roentgenology*, and L. R. Sante, *Roentgenology of the Chest*, and the work of H. Vaquez and E. Bordet, *Radiologie du Cœur et des Vaisseaux de la Base* (1928), and of Frederick H. Baetjer and Charles A. Waters, *Injuries and Diseases of the Bones and Joints* (1921); and for treatment the works of Ira I. Kaplan, *Practical Radiation Therapy* (1931), and George Miller MacKee, *X-Rays and Radium in the Treatment of Diseases of the Skin* (1921) and the *Lehrbuch der Strahlentherapie* by Professor Dr. Hans Meyer (1925) have been freely consulted.

It is frequently impossible to decide whether an idea is one's own or has been culled, and in the latter case it is sometimes impossible to remember its source of origin. To those authors who have been mentioned my very special thanks are due. I would like to acknowledge my indebtedness to those whose names I have unwittingly omitted.

No claim for originality is made, though it is felt that the method of presentation represents a new departure.

To my medical confrères on the staff of the Vancouver General Hospital I owe much in the way of encouragement and help, most of all perhaps to Dr. H. H. Pitts, the Director of the Pathological Laboratory.

To my own staff in the Roentgenological Department of the Vancouver General Hospital I am indebted for the technical work involved in the preparation of the illustrations, and especially to Mr. F. Monk for his photographic assistance.

The *via media* is not always easily found, and in a field as extensive as roentgenology, in which the side-tracks are so numerous, it is frequently a matter of very fine judgment to decide which shall be avoided. It has been felt necessary to traverse the whole of the field, even if most parts have been covered very rapidly, with the object of enabling the student to find an answer, incomplete though it must necessarily be, to any of the questions which will present themselves to his mind in the course of his clinical work.

The knowledge of the basic sciences acquired in the early years of medical training is often extremely hazy during the last years of pre-graduate study and consequently the introductory chapter has been made entirely physical. This has appeared to be necessary for the sake of completeness but it is hoped the chapter has been kept within justifiable limits while still remaining sufficiently detailed to satisfy the likely enquiries of the student.

Furthermore, it has been thought advisable to briefly outline some of the problems of roentgenological technique, especially insofar as they refer to distortion, in the hope that an appreciation of these facts by the clinician will lead to closer coöperation with the roentgenologist, and thereby secure the utmost freedom for the roentgenologist to vary his technique to suit the investigation.

The teaching of roentgenology is best carried out in conjunction with the clinical examination of which it forms a special part. In the past the student, in many cases, was informed merely of the result of the roentgenological examination without being informed of the mental background which led to the request for the examination. It is advisable that compulsory clinical roentgenology should form a part of every medical curriculum. This could be best secured, it would seem, by having the roentgenologist present at the bedside clinic in the rôle of consultant.

Outlines of the most recent innovations in technical procedure have been given where it has been felt that the innovations are likely to have a permanent value. Advances are being made so rapidly at the present time that what is an innovation today may become an absolute necessity in a few months' time and consequently the omission of a general résumé of the present trend of investigation would seem inadvisable.

Roentgenological anatomy is essentially the anatomy of bodily density and the anatomical descriptions included in each chapter have been kept within the limits which were felt necessary to enable the reader to understand the manner in which differences in the densities of the tissues as evidenced on the roentgenogram can be interpreted as normal or pathological.

The physical part of the work has been mainly drawn from *X-Rays*

chapters into which this book is divided. Nevertheless, it is felt that the point of view which has been stressed throughout the work may be of value to those who intend practicing as roentgenologists if it acts as a stimulus to them to pursue the study of pathology as closely as they do that of roentgenology.

There is as far as the author is aware no book in English which bridges the gap between morbid anatomy and roentgenology and the continued association with students and internes has taught him that a real need for such a presentation exists.

The economical aspect of the practice of medicine cannot be overlooked, and it is felt that this work will enable the clinician to avoid the unnecessary expense to which the patient is put when requests are made for roentgenological examinations which are of relatively little value, and in addition will help him to decide on those roentgenological examinations which are well worth while to him and his patient. It is hoped that gradually the so-called routine X-ray examination will be eliminated. There will always remain a certain percentage of cases, the requirements of which will be met by this investigation, cases in which the clinical evidence is insufficient to reduce the possible diagnoses to a small number. This will include cases of "silent" pulmonary tuberculosis, but even in these it must be remembered that the roentgenological examination is being carried out for a very special purpose, since, for the detection of a hidden tuberculous focus in the lung, it is necessary that the technique must be specially designed to show the intimate details of the structure of the lung.

With the advent of shock-proof equipment and standardized exposure tables it is probable that more and more clinicians will undertake their own roentgenological investigations. It is sincerely to be wished that such examinations will be strictly limited in their scope and that the investigations will be carried out only for the purposes of determining clear-cut issues, since, as a rule, the examination can be done most satisfactorily for the patient by those who are able to devote themselves entirely to this specialty.

Throughout the book some stress has been laid on the histological changes present in different diseases with the object of inculcating the basic idea that roentgenotherapy depends absolutely on a thorough understanding of morbid histology, in the same way as roentgen diagnosis depends upon a knowledge of the gross pathological changes which are in themselves expressions of the histological changes.

The unity of radium and X-ray from the point of view of radiation therapy has necessitated the introduction of the subject of radium therapy, but it is hoped that the space allotted to it will not be found out of keeping with its importance among the objects at which this work is aimed.

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