ATLAS OF XERORADIOGRAPHIC ANATOMY OF NORMAL SKELETAL SYSTEMS

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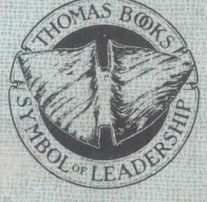

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CHARLES C THOMAS · PUBLISHER
Springfield · Illinois · U.S.A.

Published and Distributed Throughout the World by
CHARLES C THOMAS • PUBLISHER
BANNERSTONE HOUSE
301-327 East Lawrence Avenue, Springfield, Illinois, U.S.A.

ISBN 0-398-03715-9

Library of Congress Catalog Card Number: 77 12053

With THOMAS BOOKS *careful attention is given to all details of manufacturing and design. It is the Publisher's desire to present books that are satisfactory as to their physical qualities and artistic possibilities and appropriate for their particular use.* THOMAS BOOKS *will be true to those laws of quality that assure a good name and good will.*

Library of Congress Cataloging in Publication Data
Wolfe, John N
Atlas of xeroradiographic anatomy of normal skeletal systems

Bibliography: p.
1. Human skeleton—Radiography—Atlases. 2. Xeroradiography—Atlases.
I. Kapdi, Chandrakant C., joint author. II. Murphy, Hedwig S., joint author.
[DNLM: 1. Joints—Anatomy and histology—Atlases. 2. Joints—
Radiography—Atlases. 3. Xeroradiography—Atlases.
4. Bone and bones—Anatomy and histology. 5. Bone
and Bones—Radiography—Atlases. WE17 W854a]
QM101.W6 611'.71'0222 77-12053
ISBN 0-398-03715-9

Printed in the United States of America
P-4

FOREWORD

OVER THE PAST TEN YEARS xeroradiography has established a definite role in the field of diagnostic radiology. Due to its high resolution capability, the soft tissues and skeletal structures are seen in much better detail. Also, due to the inherent broad recording latitude, one is able to see the bones as well as the surrounding soft tissues on the same image clearer than the conventional radiographs where separate exposures have to be made for the bones and soft tissues.

The purpose of this monograph is threefold: (1) To provide radiologists and radiology residents; emergency room physicians in trauma cases; orthopedic, oral, and neurosurgeons; and others the ready reference for the most widely used views of the axial and appendicular skeletal system. (2) To enable them to identify the anatomic landmarks directly from the xeroradiographic image rather than trying to correlate it with accompanying line diagrams as in conventional radiographs where the anatomic detail is not equally sharp and is often obscured by overlapping structures. (3) To provide a technique chart as a guideline for x-ray technicians and students and to give them a better understanding of good quality xeroradiographs and also how to correct the image when it is "too blue" or "too white."

We wish to emphasize that this monograph is primarily an atlas of xeroradiographic anatomy with a brief description on each radiographic position. Readers are directed to refer to the standard textbooks on positioning in radiography for further detail. Every effort has been made to include all the standard views of the skeletal system used in routine practice. The technique chart is, of course, to be used only as a guideline since necessary adjustment will have to be made when patients are either too heavy or too small and also when the primary area of interest is of the bones or the soft tissues.

Much of the information regarding xeroradiography and the technique chart is drawn from our own experience. However, we did refer to several standard textbooks for radiographic positioning and various atlases for

radiographic anatomy. They are listed in the bibliography. Also included in the bibliography is the list of selected articles on xerography of the soft tissues and bones.

We sincerely hope that this atlas will serve the needs of medical students, physicians, and x-ray technologists.

ACKNOWLEDGMENTS

NO TEXTBOOK IN RADIOLOGY can be written without the cooperation and assistance of dedicated x-ray technologists. We express our thanks to Mr. George Sam, our chief x-ray technician, to Mr. Mitchell Sioma, R.T. and to Mr. William Rogers, R.T. for providing us with images of excellent quality.

We would like to extend our deepest gratitude to Miss Maggie McEntee, R.T., for her meticulous reading of the sections on radiographic positions from the technologist's point of view. Her constructive criticism, valuable suggestions, and necessary corrections have made our work much easier.

Finally, we would like to thank our secretaries, Mrs. Judy Brosch, Mrs. Joan Czubko, Miss Martine Salane, and Miss Constance Smith for typing this manuscript.

J.N.W.
C.C.K.
H.S.M.

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Part One

Chapter I

XERORADIOGRAPHY

HISTORICAL REVIEW

THE HISTORICAL REVIEW OF XERORADIOGRAPHY can be divided into two periods; the first was the period of the early experimentation and the second was a later period which led to the commercial production of xeroradiographic machines.

Xeroradiography is an outgrowth of the science of xerography which was discovered by Chester F. Carlson in 1937. Carlson thought at the time that that method of duplicating graphic material might also have radiographic uses. He reasoned that if the photoconductor selenium would respond to energy in the form of light it probably would also respond to various forms of ionizing radiation.

Experiments were carried out at Battelle Memorial Institute, Columbus, Ohio which confirmed the fact that indeed one could produce radiographic images utilizing the principles of xerography.

Shortly after that the Xerox™ Corporation produced a number of simple machines for use in the medical radiographic industry and also for industrial nondestructive testing. At that time, there was seen the possibility of emergency use of xeroradiography as an imaging technique in the event of an atomic disaster by which conventional photochemical means of recording radiographic images might be impaired.

The early xeroradiographic equipment was rather simple in design, with many manual operations required for the production of an image. It consisted of the following components: (1) plates, (2) cassettes, (3) charging unit, (4) developing unit, (5) viewing unit, (6) transfer unit, (7) cleaning unit, and (8) relaxation unit. Each of these components required considerable interface between the operator and the equipment.

The early investigations of xerography as applied to medical radiography began in 1952 and was more or less abandoned within the next ten years. In brief, the opinion of most investigators was that the technique had some promise but there were many drawbacks to it, paramount among which was its relatively slow speed when compared to modern radiographic imaging systems utilizing film and intensifying screens.

Investigation into medical usage began in 1952 with the work of

John F. Roach of Albany Medical College, New York, who studied a wide variety of medical radiographic applications. He was instrumental in pointing out the sensitivity issue concerning medical use of xeroradiography. The process was as sensitive as medical x-ray film used without intensifying screens, but the xeroradiographic plate was several times less sensitive than film combined with intensifying screens. Hence this meant in effect that for the applications where intensifying screens are employed, the dosage required for xeroradiographic exposures would be several times those for film.

About the time of this work, the New York State Civil Defense Commission under the direction of Herman Hilleboe, who was also Director of the Department of Health of New York State, consulted with Roach on the problem of supplying these hospitals with emergency radiographic equipment. It was decided that xeroradiographic equipment was particularly suitable because x-ray film would be exposed and rendered useless by nuclear radiation whereas xeroradiographic plates would be unharmed. A number of special self-contained xeroradiographic units were supplied by the Haloid Company for these standby installations and are presently stored throughout New York State for use in the event of atomic disaster.

Another early investigation of xeroradiography was done by a group at St. Vincent's Hospital and Medical Center of New York, beginning in 1956, under the direction of Francis F. Ruzicka, Jr. They first thought to use it in the operating room to obtain rapidly processed radiography for hip pinnings. The relatively primitive nature of the equipment available terminated this experiment. They shifted their experimentation and later found their best results were in mammography, where they were encouraged by the good delineation of the glandular tissue and other soft tissue structures of the breast, together with lower dosage. They did not, however, find correct interpretation significantly greater with xeroradiography in the results of a comparative study of 463 mammograms.

Other investigators into this subject during its early period include Hills, Stanford, and Moore; Henny; and Farmer, Fowler, and Haggith. The latter group discussed coupling xeroradiography to a megavoltage treatment simulator, thus obtaining a very quick readout of treatment location and port size within ten seconds after exposure. Their conclusion was that this was an effective procedure.

There followed several other studies concerned with the response of selenium to various energies of radiation, the most notable of which, insofar as medical xeroradiography is concerned, is that by Nagami, who studied the response of selenium to various energy levels of irradiation and concluded the most efficient was 13 kVp, which is the K edge of