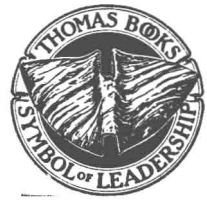
BONE AND JOINT DISEASES

Pathology Correlated With Roentgenological and Clinical Features

J. VERNON LUCK
M.S. (Ortho.), M.D., F.A.C.S., F.I.C.S.

Assistant Clinical Professor of Orthopedic Surgery, University of Southern California. Senior Attending Physician, Department of Orthopedic Surgery, and Consultant in Orthopedic Pathology, Los Angeles County Hospital. Member, Subcommittee in Orthopedic Surgery, National Research Council. Member, Board of Associate Editors, Journal of Bone and Joint Surgery.



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

CHARLES C THOMAS • PUBLISHER

BANNERSTONE HOUSE

301-327 EAST LAWRENCE AVENUE, SPRINGFIELD, ILLINOIS, U.S.A.

Published simultaneously in The British Commonwealth of Nations by
BLACKWELL SCIENTIFIC PUBLICATIONS, LTD., OXFORD, ENGLAND

Published simultaneously in Canada by
THE RYERSON PRESS, TORONTO

FIRST EDITION

Printed in the United States of America

BONE AND JOINT DISEASES

To

ARTHUR STEINDLER

WITH GRATITUDE, AFFECTION, AND
RESPECT

Preface

This book has been ten years in preparation. It began as a set of mimeographed lectures prepared at the requests of graduate students, interns, and resident physicians in Doctor Arthur Steindler's Department of Orthopedic Surgery at the State University of Iowa. Seminars, given throughout the year, emphasized the correlation of pathologic anatomy with the associated roentgenologic and clinical findings. Since no textbook of the pathology of bones and joints was in existence, it occurred to Doctor Steindler and Mr. Charles C Thomas that I should prepare such a book. Impressed by the great need for a book on this subject and having a large store of the needed materials from which to draw, I agreed to undertake this arduous task. The preparation of the manuscript took ten years in place of two as planned; and while it was laborious and protracted it was never monotonous or uninteresting. Four years in military service delayed completion of the manuscript but at the same time led me to the Army Institute of Pathology and an opportunity to study its magnificent collection of bone and joint specimens and histologic sections.

In the study of bone and joint diseases there is an urgent need for further correlation of the reflections of these diseases in pathologic anatomy, roentgenograms, and clinical symptoms. This book has been written with this need ever in mind. A constant effort has been made to help bridge the chasm that has existed between the laboratory and the clinical practice of medicine. Emphasis has been placed upon the "dynamic quality of pathologic events" and upon the fact that "disease is not a *thing* but a *process.*"

The study of surgical pathology is not limited to the examination of dead tissues. It is, of course, essential to study the characteristics of the various entities as portrayed by surgical and autopsy specimens, but our goal is to visualize and understand the abnormal physiological functions that terminated in the changes observed in the specimen. No one claims that this is an easy task. The explanation of so many living processes ever eludes us, but this does not excuse us when we lose sight of the fact that the structural organization of the body is a living process.

Many physicians have excused themselves from learning more about

bone and joint pathology by the erroneous belief that our knowledge of this subject is hopelessly cloaked in uncertainty and controversy. This view, and the complacency it breeds, needs to be uprooted. Even in the most controversial of subjects there is much that is understood. For example, the subject of bone tumors is little understood in the realm of the etiology. Yet the pathologic anatomy and much of the pathogenesis are well defined and a clear knowledge of them is of real practical value to the clinician.

An orthopedic surgeon lifts himself above the technician class by his knowledge of physiology and pathology. As Joseph Nash stated so well; "Operative technique is only the apex of the great pyramid of surgical knowledge; it is the broad and heavy base that is most needed and most difficult to construct." The roentgenologist rises above seeing mere shadows on his roentgenograms when his knowledge of physiology and pathology enable him to visualize the shadows unfolding before him as living tissue undergoing their kaleidoscope of changes.

It was formerly considered ideal for clinicians to acquire a knowledge of pathology but was not looked upon as either essential or entirely practicable. A knowledge of pathology is now deemed a practical necessity, and in becoming so, the practice of medicine has stepped upward on its ladder of achievement. Even in the field of fracture therapy, so often viewed as being entirely mechanical, Sir Reginald Watson-Jones stated: "The surgeon who attempts to treat fractures without a full knowledge of the pathology of bones and joints is faced with insuperable difficulties."

One cannot engage in a long and detailed study of the pathology of bones and joints without acquiring a profound admiration for the magnificent manner in which the skeleton frequently carries on its functions in the face of seemingly insurmountable obstacles. For example, to watch an entire diaphysis of a long bone succumb to the ravages of a pyogenic osteomyelitis and then be rebuilt without ever an interruption in continuity of the bone is so impressive. We do well, in our study of living pathology, when we attempt to determine what nature is seeking to achieve in her defensive responses to the onslaughts of disease processes. Arthrodecing operations for tuberculous arthritis were founded upon the observation that nature was striving to fuse the involved joint and was in need of help. Nature was attempting to fuse the joint for the good reason that bony fusion would bring the complete immobilization necessary for an arrest of the infection.

Obviously it is impossible to present a comprehensive dissertation

on so vast a subject in so few pages. It is not often that the earnest student will find all that he seeks within these covers. A textbook style of presentation has been necessary, and, although didactic, it is not intended to be dogmatic and certainly not judicial. I have felt no obligation to supply a theory to explain each of numerous unanswered questions in the field of bone and joint pathology. The old chinese proverb comes to mind: "To be uncertain is to be uncomfortable, but to be certain is to be ridiculous."

Acknowledgments

I hold a keen appreciation of the fact that it is the contributions of my contemporaries and the works of countless investigators who, through the centuries, have contributed to our knowledge of bone and joint diseases that gives this volume whatever value it possesses. The greater portion of the illustrative material herein presented is from the departments of orthopedic surgery, pathology, roentgenology, general surgery, and pediatrics of the State University of Iowa. When illustrations were used from sources other than the State University of Iowa and my private practice, the source is mentioned beneath the illustration. I shall feel apologetic if there is an instance in which proper credit has not been given.

This book is dedicated to Doctor Arthur Steindler as a token of my gratitude to him for the great privilege of having been his student and for the pleasure and inspiration that comes from having him for a friend.

I also owe a debt of gratitude to the late Ernst Freund. His knowledge and enthusiasm for the study of bone and joint pathology were great indeed. I am indebted to him for several of the gross specimens portrayed in the chapters on the malacic diseases. These valuable specimens, collected by him while he was associated with Erdheim, were bequeathed to the State University of Iowa when his untimely passing robbed the world of an outstanding physician and teacher.

In the actual preparation of the manuscript for a book such as this, an author needs a host of generous friends, a patient and enthusiastic publisher, well trained medical librarians, professional photographers, and, I might add, a tolerant family. I have had the advantages of all these.

I must, and do with pleasure acknowledge my indebtedness to the following contributors to this volume:

Physicians—V. L. Andrews, Colonel J. E. Ash, Ray A. Carter, Edward L. Compere, William Cooper, Colonel R. O. Dart, Hugh A. Edmondson, Jerome G. Finder, Carl L. Gillies, Earnest M. Hall, C. Howard Hatcher, Phillip C. Jeans, H. Dabney Kerr, Ralph E. Knutti, M. Pinson Neal, Dallas B. Phemister, Ignacio Ponseti, Alfred R. Shands, Jr., Albert R. Smith, Harry P. Smith, Sophie Spitz, A. Purdy Stout, Robert T. Tidrick, Emory D. Warner, John C. Wilson, and Angus Wright.

Librarians—Miss N. A. Frohwein, Mrs. B. P. Wallace (who also read the manuscript), Miss Frances Glaeser, Mrs. Mary Irish, and the late Hazel Granger.

Photographers—Messers Fred and Gordon Kent (photographers for the State University of Iowa), Daryl Davis, Julius Weber, Edward Hamilton, Lloyd Matlovsky, and Roy M. Reeves.

Histologic Technician—Mrs. Geraldine Sheridan.

Publisher—And last but by no means the least, I owe a debt of gratitude to Mr. Charles C Thomas and his son Mr. Payne Thomas for their continuous interest and help in the years of preparation of the manuscript, and for their expert handling of the physical qualities of the book.

This Book

BONE AND JOINT DISEASES

By

J. VERNON LUCK
M.S. (Ortho.), M.D., F.A.C.S., F.I.C.S.

was set and printed by The Ovid Bell Press, Inc., of Fulton, Missouri. The binding was done by the Becktold Company of St. Louis, Missouri. The engravings were made by G. R. Grubb & Company of Champaign, Illinois. The type face is Baskerville, set 11 point on 13 point. The type page is 29 x 48 picas. The text paper is 70-pound Oxford Mainefold Enamel. The binding cloth is Du Pont Fabrikoid, Quality 700, Color 5027, Grain 0-7 (Roller), Medium Pliability, Finish SB.

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.*

Contents

BONE AND JOINT DISEASES

CHAPTER I

The Normal Skeletal System

Contents

INTRODUCTION

The skeleton is far more than the articulated framework for the body. It is the "great storehouse" of calcium, the center for the production of red blood cells and granulocytes, and an armor for the brain and thoracic viscera. Bone and cartilage, the principal tissues through which these purposes are so well achieved, are low in metabolism but very much alive, and remarkably sensitive to internal and external influences.

Bone is a connective tissue modified for the special function of forming a rigid framework; hyaline articular cartilage is a connective tissue

modified to form articular surfaces. The rigidity of bone is attained through the deposition of calcium salts in a dense network of collagenous fibrils; the lime salts serving the dual purpose of conferring rigidity and offering a readily available store of calcium and phosphorus for bodily needs.

Its inert appearance and its hardness long led investigators into the error of believing bone to be a nonviable, inorganic structure. Even Virchow is said by McCrudden to have looked upon bone as "a finished product." Cohnheim, in his classical report in 1889, refuted the previous teachings and demonstrated anabolism and catabolism in bone. This pioneer work touched off innumerable investigations into the character of bone in health and disease, but it is only in recent years that the subject has received the widespread interest and attention it justly deserves.

EMBRYOLOGY OF THE SKELETON

At the fifth week of embryonic development, the first evidence of what is destined to become a skeletal system appears in the form of axis condensation of the mesenchyme in the extremity anlagen. The mesenchyme forming the anlagen is a part of the mesoderm growing between the ectoderm and endoderm. Mesenchymal cells, creating the skeleton, differentiate first into precartilage and then into hyaline cartilage. At the periphery of the cartilaginous core a connective tissue sheath forms and serves as a perichondrium. There are mother cells in the deep layers of the perichondrium, and through these more cartilage is deposited, layer upon layer, increasing the dimensions of the cartilaginous core by appositional growth. In the beginning the cartilaginous cells have an angular shape and large nuclei, and are closely packed; with increasing maturity the cells lose their angular shape, become rounded and develop capsules. During the sixth week of embryonic life, transverse segmentation appears in the cartilaginous cores, these zones of segmentation representing sites of future joints (Fig. 1).

Differentiation of the upper extremities proceeds ahead of the lower extremities, and the proximal aspect of the extremities precedes the differentiation in the distal aspect. This embryonic process, in which proximal aspects of the skeleton and of other parts of the body differentiate prior to the distal aspects, is known as the law of proximo-distal differentiation.

By the ninth week of embryonic life, the perichondrium in the middle one-third of the future diaphyses transforms to periosteum and forms

a thin sleeve of bone. This sleeve of periosteal bone advances proximally and distally toward the transverse zones of demarcation which are being transformed into joints. At this same time a nucleus of calcification appears in the center of the cartilaginous core. Blood vessels are attracted to the nucleus and erode their way to it from the periphery passing through the periosteum and the sleeve of periosteal bone. Having reached the nucleus, a process of enchondral ossification is established in which the calcified cartilage is absorbed and a primitive, spongy type of bone is laid down. A nucleus of ossification thus forms, gradually enlarges in all directions, fuses with the sleeve of periosteal bone at the periphery, and extends proximally and distally to ossify the diaphysis.

During the third and fourth months, joint cavities appear in the transverse zones of demarcation. Periosteum and perichondrium, crossing the joint sites, differentiate into joint capsules and peripheral ligaments. Such ligaments as the anterior and posterior cruciates of the knee move into the joint from the periphery after the joint has formed, explaining the presence of their synovial covering. While the major portion of the skeleton ossifies by enchondral ossification in the manner described, the bones of the cranial vault, the face, and the major portion of the clavicles ossify by intramembranous ossification. By this method the preosseous membrane structure, which forms the original skeleton, becomes ossified by direct ossification of the primitive fibrous tissues forming the membrane. Ossification of the membrane bones appears between the sixth and eighth weeks of embryonic life. The processes of enchondral and intramembranous ossification will be described in detail later in this chapter under *Histogenesis.*

Many congenital abnormalities develop during the first month of embryonic life. Such conditions as polydactylism, lobster-claw hand and complete loss of parts or entire extremities develop during this time. Such deformities as club feet usually appear considerably later, occurring in most instances during the second trimester of pregnancy.

HISTOLOGY OF BONES AND JOINTS

Bone

Bone, a dense calcified tissue, contains cells termed osteocytes which lie in microscopic cavities called lacunae. Fine processes project in all directions from the cells through minute canals, termed canaliculae. There is a free branching and anastomosis of the canaliculae as well as the processes that pass through them. Bone differs from other types