History of Bone Tumor Pathology and Radiology

with Lent Johnson's Insights

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This book is dedicated to Dr. Lent Johnson and to all the other members of the Armed Forces Institute of Pathology (AFIP) who have helped to advance the art and science of bone pathology and skeletal radiology.

Preface

There is no doubt that bone pathology and skeletal radiology are specialized areas of medical practice. Both offer fellowship training at major academic medical centers after completion of residency programs. Both have specialized societies for continuing education, yet neither is recognized with official subspecialty status by their respective certifying boards in the United States. Subspecialization in any field of endeavor requires a body of knowledge to be learned, expert teachers, and willing students. This book attempts to describe how these two specialties developed from their earliest times, and on into the twenty-first century. Their beginnings are in general anatomic pathology and in general diagnostic radiology so some of that history is included. Pathology, currently, has subdivisions with anatomic and clinical experts. Of those subdivisions, only anatomic pathology and its specialty area of surgical pathology will be discussed. The book is ultimately focused on the subspecialties of bone pathology and skeletal radiology as they are related to the diagnosis of bone tumors and as they developed in the United States. That is not to say that there were not many contributions to their development from other places around the world. This book is not intended to be a complete history of either pathology or radiology as there are already excellent works on each. Therefore by its nature, many eminent pathologists and radiologists will not be mentioned. [Also, it does not deal with the history of orthopaedic surgery although many surgeons played key roles and are mentioned.] The framework of the book was written by Dr. Johnson near the end of his career at the Armed Forces Institute of Pathology (AFIP).

Lent C. Johnson was a fixture in the Army Medical Museum and Pathology Department at the AFIP for more than 50 years beginning in 1946. The Institute was located on the grounds of the Walter Reed Army Medical Center campus in northwest Washington DC. He had graduated from Rush Medical College in Chicago where he came under the tutelage of the renowned orthopaedic surgeon, Dallas Phemister. As a student, he became interested in pathology, and it has been said that at that time there was more pathology instruction there than at any other medical school. He served as the Chief of Bone and Joint Pathology at the AFIP from 1946 to 1980 and was involved in the Radiologic-Pathologic (Rad-Path) Course for radiology residents. I was one of those residents for the 6-week course in the fall of

1982. I also attended the AFIP orthopaedic pathology course in 1989. Here are some thoughts about Dr. Johnson by Gwilym Lodwick who was one of his students and others, "Lent Johnson was an extraordinary pathologist. Brilliant, controversial, intuitive, intellectually organized, and unrestrained by the conventional thinking of his peers, Lent was highly respected by his friends and students. Lent's opinions about structure and process were exciting fare. A workaholic, he had integrated tumor histology and location with age and the physiology of bone growth into an exciting hypothesis on the origin of bone tumors, published as *A General Theory of Bone Tumors*. Lent was as skilled as any in the radiologic interpretation of bone disease, even though the state of knowledge of how to interpret X-rays of bone neoplasms was far from perfect." The AFIPs "esteemed pathologists individually and through their collective efforts established a standard of excellence, which continues to be recognized around the world." His areas of interest in pathology were not limited to bone tumors, they also included paleopathology. Donald Ortner, a Smithsonian Institution anthropologist, referred to him as a "legendary American orthopaedic pathologist, (who) vigorously promoted a system that had seven basic categories of disease: anomaly, trauma and repair, inflammatory-immune, circulatory (vascular), metabolic, neuromechanical and neoplastic" (in the book, *A Companion to Paleopathology*). As Dr. Lodwick said, Lent was a workaholic. He was still making trips to his office at the AFIP when he passed away while working in his home office at the age of 88 on an updated version of his 1953 paper on *A General Theory of Bone Tumors* (personal communication from Dr. Bruce Ragsdale).

Lent Johnson was a founding member of the International Skeletal Society (ISS) in 1974, and I was lucky enough to be invited to be a member in 1997 and attended my first meeting in Dublin in 1998. I had the pleasure of working directly with him during my two tours of duty at the Walter Reed Army Medical Center during my career as a radiologist in the US Army. We would cross paths at tumor board discussions and during my own research into skeletal metastases, multiple myeloma, and primary lymphoma of bone. Late in his career, Lent wrote the core text of this book. He asked me to review an early draft of the material which I gladly did. I then moved on from active duty at Walter Reed Army Medical Center shortly after that to an academic practice at the University of Maryland in Baltimore in 1993 and Dr. Johnson died in 1998. For many years, I lectured at the Rad-Path course and continued to work with the incredible archive materials. I retired from my musculoskeletal radiology position at the University of Maryland Medical Center (UMMC) in 2022. Dr. Johnson's original manuscript lay untouched until I had time in retirement to consider finishing it for him. This finished product is an edited version of Dr. Johnson's original material supplemented by my additions. All credit is due to him for much of the contents of chapters 1 through 6. Those chapters focus on the early years of pathology and radiology and on the "big four," as Dr. Johnson calls them; Drs. Coley, Bloodgood, Codman, and Ewing. In those chapters, I have added details about the people, places, and works written. I have added material at the end of the book in chapters 7 and 8 to include information on the further development of the specialties of Bone Pathology and Skeletal Radiology after Dr. Johnson's story ends [that is since 1998]. Although Dr. Johnson himself once said, "complete citation of

the literature in every pertinent field is not possible" I accept responsibility for the omission of any major references. Because I was only able to initiate the completion of this work 24 years after Dr. Johnson passed, I was not able to verify all of his sources, but I have tried to confirm the information contained in his chapters. Otherwise, original sources were used for the information contained in this book's pages whenever possible. No artificial intelligence programs were used at any point. Some passages are quoted at length because the original writing is so elegant that I could not resist using it. I have included many other shorter quotations because I thought that the original writer's words would represent the historical facts better than my interpretation of them.

My own development as a musculoskeletal radiologist, like the careers of many Army medical officers, was largely a case of on-the-job training. It began with Dr. Barbara Stahl, one of my professors at St. Anselm College in Manchester, NH, who set me on my undergraduate path. She challenged all the pre-med students with her rigorous course in "Comparative Vertebrate Anatomy." It made me want to know more and she helped me to gain admission to Tufts University School of Medicine in Boston where I received my MD in 1980. As a graduate of the University of New Hampshire Reserve Officer Training Program (ROTC), I was deferred from active duty to attend medical school. While in medical school, a radiology elective rotation that included teaching from the great Alice Ettinger using the Lucy Squire book, *Fundamentals of Roentgenology*, confirmed my interest in that field. Subsequent radiology internship and residency programs at Tripler Army Medical Center in Honolulu, Hawaii, exposed me to such radiology legends as Drs. Maurice (Moe) Reeder, Deborah Forester, and Donald Resnick. Few mainland teachers could resist an invitation to the Hawaiian islands to lecture to radiology residents for 1 hour a day while having the rest of the day to enjoy Oahu, so the training programs at Tripler attracted many distinguished visiting professors. Like almost all military radiology residents, I attended the AFIP Rad-Path Course in Washington, DC. After finishing my residency, tours of duty found me at Eisenhower Army Medical Center in Augusta, GA, Walter Reed Army Medical Center in Washington, DC, (twice) at the Uniformed Services University of the Health Sciences in Bethesda, Maryland, where I did my clinical work for 1 year at the National Naval Medical Center alongside Anne Brower and back in Hawaii at Tripler. Many radiologists at those institutions selflessly helped me to learn the craft of musculoskeletal radiology. Among those who did the most were COL Raoul Hagen, Larry McNeish, Anne Brower, COL Mark Hansen, and Mark Kransdorf. Following 13 years of active duty, I joined the faculty of the University of Maryland School of Medicine in Baltimore in 1993 and worked in the musculoskeletal radiology section for the next 29 years. Shortly after my arrival, I was allowed to do a 1-week mini Magnetic Resonance Imaging fellowship at the University of Pennsylvania in Philadelphia under the direction of Drs. Murray Dalinka and Bruce Kneeland. Committing to a medical career requires a commitment to lifelong learning and I continued to learn from my colleagues, fellows, residents, and medical students. My closest colleagues and research partners included Chuck (Charles) Resnik, Andy (Andrew) Sonin, Mark Murphey, Stacy Smith, Derik Davis, Ghada Issa, and Larry Holder. The pathological findings of our

tumor cases were reviewed for many years across town from the University of Maryland at Johns Hopkins Hospital by Dr. Ed McCarthy who continues the legacy of his Hopkins pathology predecessors. He is a great teacher and he asked me to help him with an after-hours "Bone Club" (like those in many cities) where we showed interesting cases from our respective hospitals to the residents training in pathology, radiology, and orthopaedics. These mentors and colleagues also were instrumental in prodding me to apply and be accepted into the membership of the Society of Skeletal Radiology (SSR), the ISS, and the Musculoskeletal Tumor Society (MSTS) where I learned even more from other radiologists, pathologists, and orthopaedic surgeons like Andrea Baur-Melnyk (Germany), Gunnar Astrom (Sweden), Fiona Bonar (Australia), Mark Davies (UK), Joe Mirra, Leonard Kahn, Michael Klein, Hud Berry, Tom Temple, Alan Levine, Albert Aboulafia, and so many others. Heady stuff for a boy from small town Pittsfield, Massachusetts.

I don't pretend to be a historian although history is one of my favorite subjects to read and learn about. One well-respected American history writer is the late Stephen Ambrose. In one of his books, "To America" he revealed some of the writing tips he learned from his mentors and had used throughout the years. I have tried to follow his advice during the writing of this book. I have tried not to let my personal biases influence the historical facts. I must admit that it was difficult given that the book is partially about a military facility and the people who worked there that I had the privilege of knowing and working with.

A note about spelling and word choices. For people's names, I have used what seem to be the most commonly accepted spellings in their native language. For certain words or terms, different forms can be found. For example, X-ray, x-ray, xray, orthopaedics, orthopedics, etc. Again I have used the form that seemed to me to be most historically correct.

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My former secretary, Michelle Johnson, at the Department of Radiology, UMMC who took Dr. Johnson's handwritten and typewriter pages and transformed them into a computer Word document for me.

Finally, my wife, Angela, for allowing me time away from our retirement activities to do all of the necessary research and writing.

Introduction

Dead men can tell tales. Forensic science television shows and murder mysteries are full of the ways that the dead leave clues to the cause of their demise. The investigators are aided often by pathologists and other medical specialists. The discipline of pathology is defined, in the 23rd edition of Stedman's Medical Dictionary, as the "medical science, and specialty practice, that deals with all aspects of disease, but with special reference to the essential nature, the causes, and development of abnormal conditions, as well as the structural and functional changes that result from the disease processes." Radiology is defined as "the branch of medical science dealing with use of x-rays, radioactive substances, and other forms of radiant energy in diagnosis and treatment of disease." The major concern of this work will be the structure of bone and its neoplasms in the context of living patients. Three disciplines are involved, each with its own presuppositions, logic, language, and interpretations: (1) the anatomy of the surgeon separates those things, which are separable; (2) the histology of the pathologist distinguishes size, shape, and chemical staining reactions of cells; (3) the roentgenogram of the radiologist records the physical variations in density of cartilage and bone. Each of the disciplines is a specialty with its own language. Patient care requires cooperation of the disciplines and if possible, a common language, or at least a language correlation system.

First, some background on the development of the disciplines of bone pathology and skeletal radiology especially as they concern themselves with bone tumors. The discovery of bone cells and X rays in the 1800s depended on two centuries of preliminary work. Each discipline is dependent upon its specialized instruments, so some detail is provided regarding the history of microscopes and fluoroscopes. Why focus on bone tumors? Because bone tumors impose some of the greatest demands on the three disciplines.

Humans and other mammals have an internal hard skeleton, a scaffolding that maintains the outward shape. It is wrapped in protective skin with an outer dead inert layer. In between are muscles and organs—the parenchyma. The parenchyma is kept in place by a supporting stroma; a soft skeleton—of chords (artery-vein-nerve) and sheets (ligament-tendon-fascia). The hard skeleton consists of (bound-water) cartilage and (bound-mineral) bone. Both soft and hard skeletons are of

mesenchymal cell origin as are the flowing fluids (blood cells and endothelial channels), the vascular and neural tubes (smooth muscle-elastica-adventitia and neural wrappings), and the lightweight filler and baffle of fat. Mesenchymal tumors may be as complex as the normal structures that they caricature: single bone tumors may contain several components. Cartilage and bone are chemically complex intercellular precipitates produced by skeletal cells, and cells also produce the enzyme complexes that can dissolve them. The skeleton is an organ system with many different bone types (tubular, flat, etc.) with different behavioral adaptabilities that test the limits of gross anatomy. Each bone is a cortical-cancellous-articular organ, the product of unfolding development that tests the limits of histology. Their varied and changing mineral content tests the limits of radiology.

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Chapter 1
The Essence of Structure

Everywhere Form in Development Moveth

—From Faust by Johann Wolfgang von Goethe

Illnesses were the result of "causes," which may be seen, postulated, or imagined. During the early days of patient care, a physician directed an apothecary to add something to the patient—herbs, theriacs, drugs—that would relieve the misery. The surgeon's barber-knives subtracted something—pus, blood, foreign body, tumor—to comfort or cure the patient. Our approach now, however, is that of the biologist, concerned with the total organism. An organism is first and foremost a structure. Cyclic variations of structure characterize *function*. (a change of structure brings a change of function: a persistent change of function results in a change of structure.) Molecular chemical changes constitute *energetics*. How did the structural disciplines and their terminology develop? How do tumors differ? What is the natural history of bone tumors? Not only do tumors vary, but individual tumor behavior and structure change with duration. The structural changes can be observed and recorded. Knowledge of structure began with the *external* appearance of a person; short or tall, skinny or fat, crippled or distorted. Medieval *internal* anatomy, extrapolated from butchering, sacrificing, and memories of ancient dissections, was diagramed as crude separate charts of blood vessels, nerves, and viscera each within a body outline.

The Renaissance, driven by Islamic science and translations of ancient knowledge, by the influx of Byzantine concepts, and broadcast by the printing press, generated an awed respect for tradition and dogma. Expressed in Greek and Latin, it imposed a uniform pattern of thinking. Renaissance anatomy was taught by reading an ancient classic text, then looking in the cadaver for what was described (Fig. 1.1). "The old men dreamed dreams" (Acts 2:16-21). But the discovery of new lands, new plants, and new animals was the unexpected experience of exploration often by northern Europeans who published in the vernacular. This brought out different ways of thinking that characterized each discipline's language. "The young men saw visions" (Acts 2:16-21). The new discoveries required maps and illustrations.

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Fig. 1.1 Manuscript illustration by Johannes de Ketham in Fasciculo di Medcina 1493

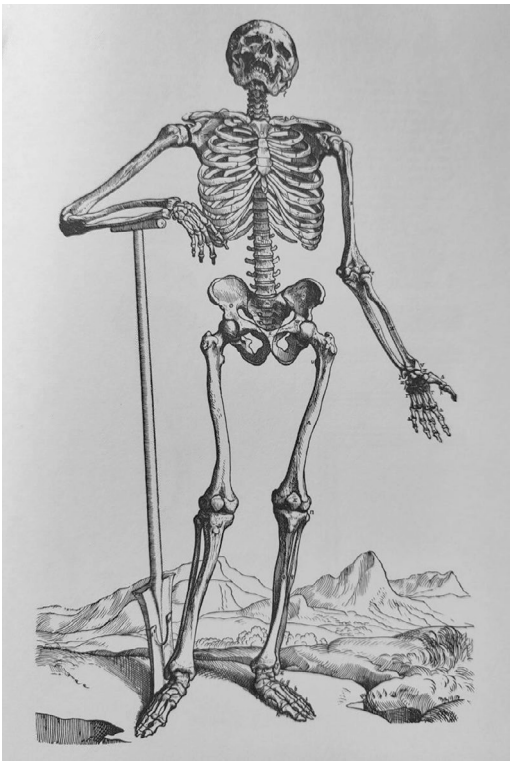

Fig. 1.2 Woodcut from Vesalius' De humani corporis fabrica libri septem 1543

Fortunately, in the early Renaissance period ways had been devised to make accurate drawings. With no guidelines but working by trial and error, proportion and perspective had developed (fourteenth century) aided by mathematics and geometry [1]. Later (fifteenth century), chiaroscuro, the shading for depth and background that adds realism, was perfected [2]. Good illustrations were possible (Fig. 1.2).

General Pathology Beginnings

Anatomic discoveries resulted from (a) dissections for art, (b) dissections for teaching, and (c) dissections to find the cause of death.

(a) Dissections for art—Realistic sculpture and painting of the active human body needed knowledge of the movement of bone and muscle beneath the skin. This could only be learned by dissection. Some of the earliest recorded systematic human dissections were in the third century BCE by Herophilos and those in his school in Alexandria, Egypt [3]. According to the Roman historian, Pliny, Herophilos was "the first man who searched into the causes of disease" by dissection of the human body [4, p. 10]. The artist had to dissect in order to draw.