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TEXTBOOK OF DENTAL RADIOGRAPH

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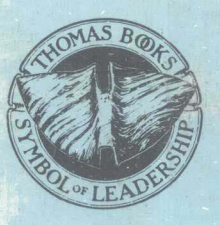

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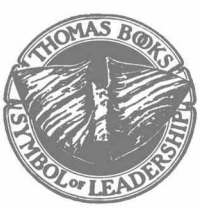

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THIS TEXTBOOK IS DEDICATED TO
OUR STUDENTS, IN PARTIAL PAYMENT OF
THE DEBT WE OWE OUR TEACHERS

PREFACE

THIS TEXTBOOK was written to serve four purposes:

First, to serve as a reinforcement of the learning acquired in lectures in dental radiography;

Second, to serve as a reference guide for the clinical application of the radiographic procedures learned in lectures in dental radiography;

Third, to serve as a reference after completion of courses in dental radiography;

Fourth, and to serve as a source of information for the dental assistant, dental hygienist, registered X-ray technologist and dentist.

Specifically, it is hoped that this textbook will aid the student in dental radiography to develop competence in the skills and understandings of dental radiography; provide an orderly progression of learning for the student of dental radiography; arouse the spirit of curiosity in the student of dental radiography; stimulate the student of dental radiography to become more responsive to the changing needs of dental radiography; and to promote the dentist's awareness of his responsibility to his patient to use dental radiographic procedures intelligently.

This textbook represents a compilation of information based for the most part on publications of our contemporaries and predecessors.

In order to present the material in an informal manner, continuous references to these sources have been deleted. However, the reader will find a list of suggested references at the end of each chapter. We realize that this textbook could not have been written without the ideas, data, observations and conclusions of others. Therefore, this textbook is dedicated to our contemporaries and predecessors who have made this textbook a reality.

INTRODUCTION

RADIOGRAPHIC EXAMINATION is as essential for diagnostic purposes in dentistry as it is in medicine. A clinical examination of the oral cavity without the aid of radiographs is restricted to the exposed surfaces of the teeth and associated soft tissues. Therefore, dental radiography offers the only preoperative means of inspecting the hidden structures of the oral cavity, namely, the roots and internal structures of the teeth, the approximal surfaces of the teeth and the surrounding alveolar bone. It is obvious, then, that a general radiographic examination of the oral structures is essential to the diagnosis of dental and oral conditions.

Kurt H. Thoma,* well known authority in medicine and dentistry, had this to say concerning dental radiographic examination.

> "Radiographic examination is useful to discover, to confirm, to classify, to define, and to localize a lesion. It is helpful in establishing an early diagnosis, in finding the origin of symptoms and cause of disease, and in discovering the extent of tissue involvement. It is of great value in establishing a differential diagnosis between inflammatory processes and benign and infiltrating tumors. Finally, radiographic examination is a valuable aid in checking the progress of treatment."

The purpose of dental radiography is to provide the dentist with a radiograph of the best diagnostic quality. The requisites of any good diagnostic radiograph, regardless of technic used, are (1) proper contrast and density of the tissues radiographed, (2) maximal definition and minimal distortion of the anatomical structures involved, (3) anatomical accuracy and (4) coverage of the boundaries of the anatomical region under consideration. Of course, to attain these requisites every step in the radiographic procedure must be thoroughly understood and carried out. The equipment must be adequate; the projection, exposure, and processing technics must be correct; and the operator must be completely competent.

Although radiography is defined as the art and practice of making radiographs, it is much more than a series of procedures—it is both a *science* and an *art*. It is a *science* in that it embodies the sciences of physics, mathematics, and chemistry; it is an *art* in that it requires practice, study, experience and judgement to attain the desired skill.

Those that desire to become competent in dental radiography must possess the following abilities:

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* Thoma, Kurt H.: *Oral and Dental Diagnosis,* 3rd edition. Philadelphia, W. B. Saunders Co., 1949.

1. Understand the scientific principles that govern radiographic technics;
2. Understand the means by which those principles are applied;
3. Be able to produce an acceptable diagnostic radiograph consistently;
4. Determine common radiographic errors that cause poor radiographs and to be able to correct these errors;
5. Appreciate and guard against the dangers of x-radiation;
6. Manage dental patients correctly under difficult situations.

It is important to remember that the slightest inaccuracy in a dental radiograph may nullify its possible assistance in oral diagnosis. Any misconception of the images on the radiograph by the dentist may cause an interpretative error that in turn may cause the dentist to arrive at an incorrect diagnosis. Thus, the ability to master dental radiography is as equally important as the ability to interpret the radiograph. These abilities go "hand-in-hand" because a poor radiograph could not be accurately read by the best dental diagnostician, and a quality radiograph is useless unless read properly.

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We are indebted to several of our colleagues and predecessors for their publications, which served as a valuable source of reference. Included in this group are Professor Albert Richards of the University of Michigan; Dr. J. Meschan of Bowman Gray School of Medicine; Mr. William Bloom of General Electric; Dr. William Updegrave of Temple University; Dr. Lincoln Manson-Hing of University of Alabama; Dr. Harrison Berry, Jr. of the University of Pennsylvania; Arthur Fuchs (deceased) of Rochester, New York; Dr. Michel Ter-Pogossian of Washington University (St. Louis); Mr. F. Jaundrell-Thompson of London, England; and Mr. Herman Seeman, Rochester, New York.

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F. H. S.

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Figure 2-2: Michel M. Ter-Pogossian: *The Physical Aspects of Diagnostic Radiology.* New York, Hoeber Medical Division, Harper and Row, 1967, p. 16.

Figure 2-3: William R. Hendee: *Medical Radiation Physics.* Chicago, Year Book Medical Publishers, 1970, p. 37.

Figure 2-6: Michel M. Ter-Pogossian: *The Physical Aspects of Diagnostic Radiology.* New York, Hoeber Medical Division, Harper and Row, 1967, p. 29.

Figure 2-7: F. Jaundrell-Thompson, and W. J. Ashworth: *X-Ray Physics and Equipment,* 2nd ed. Philadelphia, F. A. Davis, 1970, p. 725.

Figure 2-8: F. Jaundrell-Thompson, and W. J. Ashworth: *X-Ray Physics and Equipment,* 2nd ed. Philadelphia, F. A. Davis, 1970, p. 728.

Figure 2-9: Michel M. Ter-Pogossian: *The Physical Aspects of Diagnostic Radiology.* New York, Hoeber Medical Division, Harper and Row, 1967, p. 34.

Figure 2-10: *Dental X-Ray Generation and Radiographic Principles.* Milwaukee, General Electric Company, p. 1.

Figure 2-11: *X-Rays in Dentistry.* Rochester, New York, Eastman Kodak Company, 1964, p. 2.

Figure 2-12: *Dental X-Ray Generation and Radiographic Principles.* Milwaukee, General Electric Company, p. 6.

Figure 2-13: *X-Rays in Dentistry.* Rochester, New York, Eastman Kodak Company, p. 3.

Figure 2-14: *The Fundamentals of Radiography,* 10th ed., Rochester, New York, Eastman Kodak Company, 1960, p. 10.

Figure 2-15: *Dental X-Ray Generation and Radiographic Principles.* Milwaukee, General Electric Company, p. 5.

Figure 2-16: *Dental X-Ray Generation and Radiographic Principles.* Milwaukee, General Electric Company, p. 5.

Figure 2-17: *Dental X-Ray Generation and Radiographic Principles.* Milwaukee, General Electric Company, p. 5.

Figure 2-20: *The Fundamentals of Radiography,* 10th ed. Rochester, New York, Eastman Kodak Company, 1960, p. 8.

Figure 3-2: Herman E. Seeman: *Physical and Photographic Principles of Medical Radiography.* New York, John Wiley and Sons, 1968, p. 6.

Figure 3-3: *The Fundamentals of Radiography,* 10th ed. Rochester, New York, Eastman Kodak Company, 1960, p. 13.

Figure 3-4: *X-Rays in Dentistry.* Rochester, New York, Eastman Kodak Company, p. 5.

Figure 3-8: Arthur W. Fuchs: *Principles of Radiographic Exposure and Processing,* 2nd ed. Springfield, Illinois, Charles C Thomas, 1969, p. 7.

Figure 3-9: Arthur W. Fuchs: *Principles of Radiographic Exposure and Processing,* 2nd ed. Springfield, Illinois, Charles C Thomas, 1969, p. 7.

Figure 3-10: *The Fundamentals of Radiography,* 10th ed. Rochester, New York, Eastman Kodak Company, 1960, p. 43.

Figure 3-11: *The Fundamentals of Radiography,* 10th ed. Rochester, New York, Eastman Kodak Company, 1960, p. 23.

Figure 3-12: Arthur W. Fuchs: *Principles of Radiographic Exposure and Processing,* 2nd ed. Springfield, Illinois, Charles C Thomas, 1969, p. 161.

Figure 3-17: William L. Bloom, Jr.; John L. Hollenbach; and James A. Morgan: *Medical Radiographic Technic,* 3rd ed. Springfield, Illinois, Charles C Thomas, 1965, p. 135.

Figure 4-2: Arthur W. Fuchs: *Principles of Radiographic Exposure and Processing,* 2nd ed. Springfield, Illinois, Charles C Thomas, 1969, p. 32.

Figure 4-3: Arthur W. Fuchs: *Principles of Radiographic Exposure and Processing,* 2nd ed. Springfield, Illinois, Charles C Thomas, 1969, p. 33.

Figure 4-6: Arthur W. Fuchs: *Principles of Radiographic Exposure and Processing,* 2nd ed. Springfield, Illinois, Charles C Thomas, 1969, p. 145.

Figure 4-7: *The Fundamentals of Radiography,* 10th ed. Rochester, New York, Eastman Kodak Company, 1960, p. 19.

Figure 4-8: Arthur W. Fuchs: *Principles of Radiographic Exposure and Processing,* 2nd ed. Springfield, Illinois, Charles C Thomas, 1969, p. 148.

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Figure 5-2: Meschan, Isadore: *Synopsis of Roentgen Signs.* Philadelphia, W. B. Saunders, 1962, p 15.

Figure 5-3: Manson-Hing, Lincoln R.: The fundamental biologic effects of x-rays in dentistry. *Oral Surgery, Oral Medicine and Oral Pathology,* 12:568, May, 1959 (St. Louis, C. V. Mosby).

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Figure 6-3: Ennis, LeRoy M., and Berry, Harrison M.: *Dental Roentgenology,* 5th ed. Philadelphia, Lea and Febiger, 1959, p. 76.

Figure 6-20: Updegrave, William: *Simplification and Standardization of the Bisecting-Angle and Interproximal Technics.* Elgin, Illinois, Rinn Corporation, 1967, p. 8.

Figure 6-22: Updegrave, William: *Simplification and Standardization of the Bisecting-Angle and Interproximal Technics.* Elgin, Illinois, Rinn Corporation, 1967, p. 13.

Figure 6-24: Updegrave, William: *Simplification and Standardization of the Bisecting-Angle and Interproximal Technics.* Elgin, Illinois, Rinn Corporation, 1967, p. 10.

Figure 6-26: Updegrave, William: *Simplification and Standardization of the Bisecting Angle and Interproximal Technics.* Elgin, Illinois, Rinn Corporation, 1967, p. 15.

Figure 6-42: Updegrave, William: *New Horizons in Periapical Radiography.* Elgin, Illinois, Rinn Corporation, 1966, p. 14.

Figure 6-43: Updegrave, William: *New Horizons in Periapical Radiography.* Elgin, Illinois, Rinn Corporation, 1966, p. 20.

Figure 6-44A: Updegrave, William: *New Horizons in Periapical Radiography.* Elgin, Illinois, Rinn Corporation, 1966, p. 16.

Figure 6-44B: Updegrave, William: *New Horizons in Periapical Radiography.* Elgin, Illinois, Rinn Corporation, 1966, p. 16.

Figure 6-45: Updegrave, William: *New Horizons in Periapical Radiography.* Elgin, Illinois, Rinn Corporation, 1966, p. 7.

Figure 6-46: Updegrave, William: *New Horizons in Periapical Radiography.* Elgin, Illinois, Rinn Corporation, 1966, p. 20.

Figure 6-48: Updegrave, William: *New Horizons in Periapical Radiography.* Elgin, Illinois, Rinn Corporation, 1966, p. 27.
Figure 6-54: Ennis, LeRoy M., and Berry, Harrison M.: *Dental Roentgenology,* 5th ed. Philadelphia, Lea & Febiger, 1959, p. 106.
Figure 6-57: Richards, Albert: New concepts in dental x-ray machines. *J Am Dent Assoc,* 73:69, 1966.
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Figure 8-4: Porter, A., and Sweet, S.: Safelights reconsidered. *Dent Radiol Photo,* 35, No. 2, 1962, Figure 5.
Figure 8-5: Ibid., Figure 6.
Figure 8-6: Ibid., Figure 7.
Figure 8-7: Ibid., Figure 8.
Figure 8-8: Ibid., Figure 9.
Figure 8-9: Ibid., Figure 10.
Figure 8-11: *X-rays in Dentistry.* Eastman Kodak Company, 1969, p. 71.
Figure 8-21: Wainwright, William W., and Villanyi, Andrew A.: The simplest radiographic analyzer: The x-ray checker, *J So Calif State Dent Assoc,* 28:124, April, 1960.
Figure 9-15: *Radiodontic Pitfalls.* Eastman Kodak Company, Figure 18.
Figure 9-25: *Darkroom Procedures to Assure Diagnostic Quality Results,* Taped-slide Series, Rinn Corporation, Slide No. 70, reticulation.
Figure 11-1: Bloom, William L., Hollenback, John L., and Morgan, James A.: *Medical Radiographic Technic,* 3rd ed. Springfield, Illinois, Charles C Thomas, 1969, p. 195.
Figure 11-2: Updegrave, William J.: Panoramic Radiography, *Dental Rad & Photo,* Eastman Kodak Company, Vol. 36, No. 4, 1963.
Figure 11-5: Ibid.
Figure 11-12: Ibid.

CONTENTS

Textbook of Dental Radiography

CHAPTER 1

HISTORICAL BACKGROUND OF DENTAL RADIOLOGY

The Discovery of X-Rays

X-RAYS WERE DISCOVERED on November 8, 1895 by Wilhelm Conrad Roentgen, Professor of Physics and Director of the Physical Institute of the University of Wurzburg. X-rays rank with anesthesia as one of the two greatest discoveries that have revolutionized the medical and dental professions. Today, it is extremely difficult to imagine practicing either profession without the aid of these discoveries.

One must remember that the apparatus used by Roentgen in his discovery represented the labor of many ingenious investigators. Various European investigators twenty-five years before the discovery of x-rays began intensive experimentation with vacuum tubes and the production of fluorescence. The first vacuum tubes used were called Geissler tubes after Geissler, an ingenious mechanic of Bonn, Germany. Later on they were called by the names of investigators that modified the original Geissler tubes (for example—the Hittorf & Crookes Tubes). During these twenty-five years between 1870 and 1895, Hittorf, Hertz, Goldstein, and Plucker of Germany, Sir William Crookes of England, and Lenard of Hungary had revealed many new and interesting phenomena concerning the production of fluorescence in a vacuum tube. Their experiments suggested to Roentgen the probability that there were more problems in connection with these developments which were yet to be solved.

At the beginning of October, 1895, Roentgen decided to make some experiments with this fluorescence phenomena which seemed to be coming from the cathode electrode. This fluorescence had already been called "cathode rays" by Goldstein. During the course of determining whether the cathode fluorescence or cathode rays could pass through the thick glass of the vacuum tube, he covered a Hittorf-Crookes tube with black paper and darkened the room completely (See Figure 1-1). At this very instant an electric discharge was passed through the tube, he noticed a faint greenish glowing object coming from a table near the tube. Roentgen struck a match and discovered the mysterious light was a piece of barium platinocyanide screen, which is fluorescent.

After further investigation of this phenomenon, he concluded that the effect was caused by the generation of new invisible rays capable of penetrating opaque materials and producing visible fluorescence in certain chemicals. By interposing his hand between the source of the rays and a luminescent cardboard, Roentgen was the first to see the bones of a living hand projected in silhouette

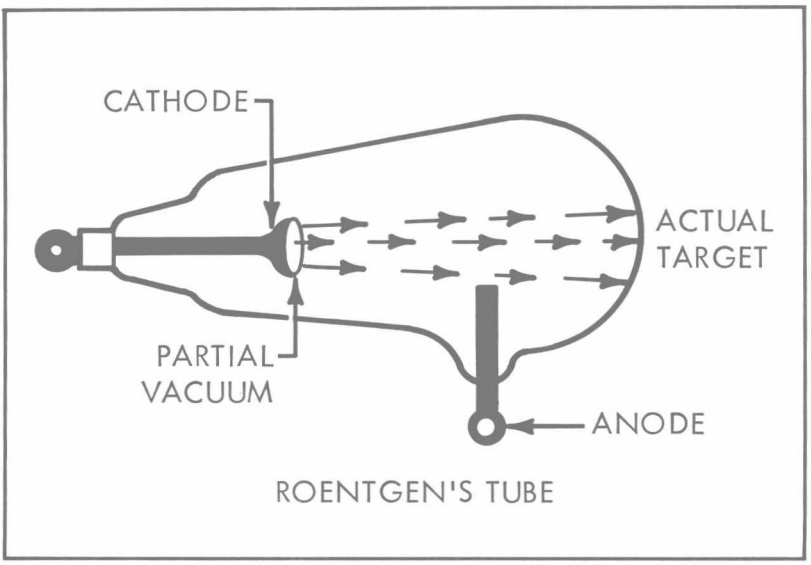

Figure 1-1. Hittorf-Crookes tube used by Roentgen.

upon the screen. The replacing of the fluorescent screen with a recording photographic plate was the next important discovery. This discovery enabled Roentgen to take the first radiograph ever taken of the human body—it was a radiograph of his wife Bertha's hand.

Roentgen's name and the news of his discovery became known throughout the whole world, and the modest discoverer spoke for the first time on his "New Kind of Ray" before the Physical Medical Society of the University of Wurzburg on January 23, 1896. At this meeting Roentgen demonstrated numerous successful experiments with the x-rays and exhibited various x-ray pictures and they, of course, excited the greatest interest. After the lecture and demonstration, the scientists rose as one and declared that henceforth these rays should be known as roentgen rays.

The Beginning of Dental Radiology

Two weeks after the announcement of Roentgen's discovery, Dr. Otto Walkhoff of Braunschweig, Germany, had completed the first radiograph of the jaws. The exposure time for Walkhoff's first radiograph of the jaws was twenty-five minutes. He used a regular photographic glass plate, placed on the outside of the jaws. The glass plate was quite insensitive to x-rays.

Dr. W. G. Morton, New York physician, has the distinction of taking the first dental radiograph in America in 1896. This was accomplished by use of dry human skulls. He read a paper on this subject before the New York Odontological Society on April 24, 1896, and it was published in the June, 1896 issue of *Dental Cosmos*. He also was the first to take a whole-body x-ray which was accomplished in 1897 by use of a 3 x 6

feet sheet of film. The exposure time was thirty minutes. The subject was a thirty-year-old female.

Dr. C. Edmund Kells of New Orleans was the first dentist in the United States to take an intraoral radiograph of a living patient. He also originated the technique of placing diagnostic wires in the roots of pulpless teeth (May, 1899). Dr. Kells presented the first clinic on the use of x-rays in dentistry at a meeting of the Southern Dental Association at Asheville, North Carolina in July, 1896. Exposures of five to fifteen minutes were used with a developing time of thirty to sixty minutes. As an indication of the intensive work on x-ray tubes and high-voltage sources can be revealed by the fact that Kells read a paper at the meeting of the National Dental Association in 1899 which records the fact that he had reduced exposure times to one to five minutes in three years.

Dr. Kells' contribution to the development of x-rays in dentistry finally cost him his life. Nothing was known about the hidden dangers lurking in the strange penetrating rays. The early x-ray machines were very crude. The variations in the quality of the x-rays was adjusted by a method called "setting the tube." One hand held the fluoroscope (hand type) and the other hand was placed between the tube and the fluoroscope. The rheostat of the x-ray machine was adjusted according to how sharp the bones in the hand would show up on the fluoroscope. The hand was exposed to a few seconds of x-radiation every time the tube was set. No harmful effects were noticed for at least five to ten years of this continued exposure to small amounts of radiation. Then the hands of the early pioneers started to show evidences of malignant growths. Dr. Kells first lost three fingers, later his whole hand was removed, and then his arm had to be amputated. But even this did not help. Preferring death to long and continuous suffering, Kells committed suicide—another unsung hero who gave his life for humanity.

Many of these early researchers in radiation, unaware of its effect on living tissue, gave their very lives to science. We today, who use and benefit from x-radiation in many ways, owe these men a debt of gratitude.

The Development of the Dental X-Ray Machine

At the turn of the century x-ray pictures were taken with very long exposure times (one to five minutes for a single exposure). *Why were such long exposure times necessary?*

For three reasons: (1) Direct Current was the only available source of power (A.C. power was not yet in universal use), (2) the poor efficiency of gas tubes, and (3) extreme lack of emulsion sensitivity of films used.

A transformer cannot transform low-voltage current into high-voltage current from a direct current source. To overcome this obstacle electrical interrupters were developed to change direct current into alternating current. The most common interrupter was a "vibrator" type that *made* and *broke* the primary circuit by vibrating a thin steel strip within the magnetic field of the metal core of the transformer. This strip had to be thin and lightweight if it was