Early Pioneers of Oral and Maxillofacial Radiology

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Wilhelm Conrad Roentgen (1845-1923). On Friday, November 8, 1895, Professor Wilhelm Conrad Roentgen, a professor of physics at the University of Wurzburg in Germany, serendipitously discovered a "new kind of ray." Roentgen presented a paper dealing with his discovery and later published it under the title "A Preliminary Communication of the New Kind of Ray." Roentgen's discovery appeared in the New York Herald on January 7, 1896. A translation of Roentgen's original paper appeared in *Nature* (London) on January 23 and was reproduced in *Science* (New York) on February 14th, 1896. On January 23, 1896, Roentgen gave the first public demonstration of x-ray images before the Wurzburg Physical Medical Society. In 1901, Roentgen was awarded the first Nobel Prize in physics for his work with x rays. He donated his prize money to the University of Wurzburg, the place of his discovery.

Friedrich Otto Walkhoff (1860-1934). Within 14 days of the announcement of Roentgen's rays, the first dental images were made by Friedrich Otto Walkhoff and Wilhelm Konig using an ordinary photographic glass plate wrapped in a rubber dam as an image receptor. Afterwards Fritz Giesel, Walkhoffs' close friend and professor, made a radiographic image of Walkhoff's molars with an exposure time of 25 minutes. Otto Walkhoff and Fritz Giesel established the first dental roentgenologic laboratory in the world. In April 1898, Walkhoff succeeded in making extra-oral radiographic images with an exposure time of 30 minutes. Loss of hair was noticed on the side of the head of some of the patients after irradiation. In 1927, Fritz Giesel died of metastatic carcinoma caused by heavy radiation exposure of the hands.

Wilhelm Konig. On February 2, 1896, physicist Wilhelm Konig of Frankfurt, Germany, made 14 dental images of his own mouth. Each image required an exposure time of 9 minutes. Konig's images clearly showed the fillings in the teeth and were of good quality because he used a "focus tube" which resulted in the production of more penetrating, focused x rays. This concentration of rays required a markedly shorter exposure time.

Thomas Alva Edison (1847-1931). Within two days of the announcement in the United States, Thomas A. Edison began experiments to duplicate Roentgen's discovery. Edison realized early on that the invention of a good fluoroscope was absolutely essential. The fluorescing salt that Roentgen used was barium platinocyanide. In March 1896, he demonstrated that calcium tungstate was a more suitable crystal for fluoroscopic purposes than barium platinocyanide.

In the Americas the first dental radiograph was made in 1896. It may never be known who made the first dental radiograph in the Americas. It was either William James Morton, MD, of New York, C. Edmund Kells, DDS, of New Orleans, or William Herbert Rollins, DDS, MD, of Boston.

William James Morton, (1845-1920). Morton, a New York physician, made a dental radiograph in April 1896. Later in April, at the meeting of the New York Odontological Society, he described his radiographic apparatus and displayed the radiographs which showed restorations. He commented on the radiation burns and injuries caused by radiography, "so great was the impetus to investigate Roentgen's discovery, that a group of inefficient apparatus was placed in inefficient hands. The burns, necrosis of the derma and depilation (epilation) recorded were invariably due to long exposures, or nearness of the patient to the tube because of inefficient x-ray apparatus".

Charles Edmund Kells, (1865-1928). Most dentists claim that the first dental radiograph on a patient was made by C. Edmund Kells of New Orleans in April 1896. To keep the film in place in the oral cavity, Kells invented the first film holder made of aluminum and gutta percha. He demonstrated his equipment at the 27th Annual Meeting of the Southern Dental Association at Battery Park Hotel in Asheville, North Carolina in July 1896. Kells stated that it was essential that

the film or glass plate be placed as close as possible to the object and at the same time parallel to their plane surfaces to prevent distortion. Thus he was the first advocate of the right-angle or paralleling technique in making intra-oral radiographs. On May 10, 1899, using lead wire with zinc oxychloride or chloropercha to fill a large root canal, C. Edmund Kells became the first dentist to use radiography in root canal therapy. Kells had more than thirty inventions and patents. One of his inventions that has won him the eternal gratitude of surgeons worldwide is the suction apparatus for the aspiration of fluids and the irrigation of cavities in the human body during surgical procedures.
In 1906, Kells noticed keratosis on his hands. During the next 14 years ulcers (ulcerative dermatitis) appeared on his hands. Later several epidermoid carcinomas began to grow on his skin. In 1926, surgeons at Johns Hopkins Hospital amputated his left arm. The carcinoma as a result of x-radiation metastasized to his heart and lungs. On May 7, 1928, after years of insufferable pain, he took his own life by gunshot.

See also:

- *C. Edmund Kells* by Langland and Fortier at http://www.aaomr.org/?page=AAOMRHistory
- *Dentist, Inventor, Scientist* by Jeffries at http://www.aaomr.org/?page=AAOMRHistory
- Kells museum in New Orleans at http://www.aaomr.org/?page=AAOMRHistory

William Herbert Rollins, (1852-1929). Rollins, although a practicing dentist, also had a medical degree. Soon after the discovery of x rays, William Herbert Rollins began to investigate the properties of the x-ray beam. In July 1896, he designed and used an intraoral camera (cassette) and an oral fluoroscope. In addition, he invented an x-ray arm and bracket for the dental office (undoubtedly the first dental x-ray apparatus described in the literature) although it was never commercially manufactured. In January 1898, while exposing his hand to a high voltage evacuated gas tube, Rollins suffered a severe burn. This piqued his interest in radiation protection and became a leading advocate in radiation protection. He urged radiologists to use the smallest exposure that would accomplish the task of diagnosis. His experiments revealed adverse physiological effects associated with x-ray exposures. He recommended three precautionary measures: 1) wear radiopaque (leaded) glasses, 2) enclose the x-ray tube in leaded (or other non-radiable) housing, and 3) only irradiate the area of interest of the patient and mask all adjacent areas with radiopaque materials. In 1903, Rollins suggested the use of selective filtration of the x-ray beam. He also developed the concept of rectangular collimation.

See also:

- Wm. Rollins History Part 1 at http://www.aaomr.org/?page=AAOMRHistory
- Wm. Rollins History Part 2 at http://www.aaomr.org/?page=AAOMRHistory

Weston A. Price, (1870-1948). In August 1900, Weston A. Price of Cleveland, Ohio, first introduced the subject of interpretation at the International Dental Congress in Paris. An outstanding statement made by Price was “No part of the x-ray work requires truer skill than the interpretation of the negative or the positive it produces. A most intimate acquaintance is absolutely necessary, not simply the anatomy of the parts, but with the relative densities.”
In 1904, Price proposed an x-ray projection technique based on the age-old “rule of isometry,” later called the “bisection of the angle” technique. In 1904 Price stated “the effects of x rays are accumulative, and the operator is in danger by a hundredfold more than the patient when making *skiagraphs* (radiographs).” In 1901, Price became a charter member of the Roentgen Ray Society (Medical Group) formed in Buffalo, New York, in 1901.

William D. Coolidge, (1874-1975). Coolidge's research at General Electric research laboratory in Schenectady, New York, resulted in the production of ductile tungsten filaments for electric lamps. In 1913, Coolidge developed an x-ray tube with a tungsten target (anode) and a cathode consisting of a spiral-shaped tungsten wire that could be heated to incandescence when the tube was evacuated. In May 1913, Coolidge applied for a patent on his "hot cathode" tube. As for the old gas tubes (developed earlier by Thomas Edison), any change in the electrical current would alter both the quantity and hardness of the x-ray beam. With the Coolidge tube the quantity and hardness of the x-ray beam could be independently controlled. In addition, by vacuum-casting copper around the ductile tungsten disk of the anode target, Coolidge increased 1) the heat conductivity of the anode to absorb more heat energy (copper) and 2) the capability of the target (tungsten) to produce more x-rays. Coolidge also developed the self-rectifying tube which made obsolete the "interrupterless coil," or mechanical rectifier, which was bulky and noisy. The high-vacuum tube could now operate directly from a transformer.
In 1919, Samuel H. Bartlett of New York City developed a workable oil-immersed shockproof unit with a Coolidge tube. This invention led Coolidge in 1920 to design a small, flexible, and safe unit for dental radiography. It had a small self-rectifying tube and a 60,000 volt supply transformer enclosed in an oil-filled metal case.

The Victor X-ray Company of Chicago (which later became a subsidiary of General Electric Corporation) in 1923 was the first to introduce a dental x-ray machine with the Coolidge shockproof tube head principle of putting the transformer and a Coolidge hot-cathode tube in a metal container. The Victor CDX model was a breakthrough because it put radiography within the reach of all general dental practitioners. By this time one out of three dentists had x-ray equipment. Coolidge's name became inseparably linked with the hot-cathode tube that he invented. The Coolidge tube revolutionized the generation of x-ray beams and remains to this day the model on which all x-ray tubes for medical and dental x-ray machines are patterned.

Howard Riley Raper, (1887-1978). In 1909, Raper (a dentist at the Indiana Dental College, now known as Indiana University School of Dentistry) established the first course in dental radiography for dental undergraduate students. In 1913 Raper published one of the first textbooks on dental radiology entitled, *Elementary and Dental Radiography* and published another textbook entitled, *Electro-radiographic Diagnosis* in 1921. In 1915, Raper was the first to practice dental radiology as a specialist. Raper's invention, the "anglemeter" was used to determine the angulation of the x-ray beam in the bisecting-angle technique. Raper was searching for a technique to disclose interproximal carious lesions; in 1925 he suggested to the Eastman Kodak Company the idea of producing a bite-wing film which then began manufacturing it for the dental profession.
Raper and Kells were close friends but they disagreed in two areas: 1) Kells believed dental radiology belonged in the hands of specialists whose practice was primarily the taking and interpreting of dental radiographs. Raper, on the other hand, was convinced that dental radiology should be taught to undergraduate dental students and to general practitioners, 2) Kells and Raper became intellectual antagonists in dental publications on the use of bite-wing radiographs to detect interproximal carious lesions. Kells argued that the x-ray technique was used too often and that dentists should not rely solely on radiographs for diagnosing dental caries. In contrast, Raper firmly believed that early diagnosis of dental caries through the use of the bite-wing x-ray technique would help eliminate the problem of a toothache.

Franklin W. McCormack. McCormack, a medical x-ray technician from San Francisco, California was the first to put the paralleling principles to practical use in intraoral dental radiography. In 1911 he opened one of the first dental x-ray laboratories in San Francisco. He hand-wrapped his dental films in black paper, adding a flat metal plate to give the film rigidity, and then wrapped both in waxed paper for use in the patient's mouth. The metal plate backing prevented back-scatter radiation on the film. In 1935, McCormack began using a hemostat and wooden bite-blocks with a 36 inch focal-spot-to-face distance. He gave three reasons for long distance exposures: 1) many more exposures can be made with less danger of burning the patient, because the soft, long rays are the dangerous ones and are lost in the air prior to striking the flesh; 2) only the short penetrating rays will travel long distances and still have ample penetration

value, thus producing beautiful negatives with fine details of the teeth and bone; 3) the long-distance method prevents the occurrence of a shadow of the malar bone over the apexes of the upper molars, when exposures of this region are made. He referred to this technique as the "McCormack Long Distance Technique" and presented it at the Missouri State Dental Association on April 12, 1920. It was published in the *Journal of Dental Research* in September 1920, giving him the distinct honor of becoming the first layman to have his research published in a dental research journal.

Gordon M. Fitzgerald, (1907-1981). In 1930, Fitzgerald met Franklin W. McCormack at a Commonwealth Club meeting and was given a job to work as an x-ray technician in McCormack's dental x-ray laboratory. Fitzgerald found McCormack's laboratory to be a safe place during x-ray exposures because he could stand 8 feet away from the patient and behind a leaded shield. In 1932 McCormack enrolled Fitzgerald at the University of California Dental School at San Francisco. At that time the school did not offer a course in dental roentgenology; however, a year after his graduation he accepted a teaching position to start a new course in dental roentgenology at the school. Fitzgerald converted McCormack's tabletop long-distance (36 inch FFD) technique to the dental chair, so dentists could use it in their dental offices. He was an advocate of attaining anatomic accuracy and long-scale contrast in the radiographic image by means of the long cone paralleling technique and high kilovoltage (80 to 100 kVp). He believed that long-scale contrast produced by high kilovoltage was by far the best contrast for dental radiographic interpretation.

Medical Radiology: An interesting history of the early days of medical radiology entitled:

- "In the Name of Science: Suffering, Sacrifice, and the Formation of American Roentgenology" by R. Herzig at http://www.aaomr.org/?page=AAOMRHistory

The dental profession owes a debt of gratitude to these early pioneers for their curiosity, ingenuity, and sacrifices.

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