The X-ray in dentistry, and the legacy of C. Edmund Kells


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Many pioneers in dentistry and science forged the future of modern health care. We shall always be indebted to dentists such as Horace Wells and William Morton, who are credited with the discovery of anesthesia; Greene Vardiman (G.V.) Black for his many contributions to dentistry; Willoughby Miller, who proposed that oral bacteria produce acids that dissolve tooth structure; Robert Ledley, who developed the first whole-body computed tomographic (CT) scanner; and biochemist William Gies, who championed a scientific basis for dentistry and dental education. These, and many others, helped shape dentistry and medicine into what they are today.
This commentary focuses on C. Edmund Kells, who was among the pioneers of modern health care. He not only introduced radiography to dentistry, but he also held dozens of patents on medical, dental and household devices. Dr. Kells was a true dental pioneer and scientific genius.

In 1895, Wilhelm Conrad Roentgen discovered the X-ray, and the following year Dr. Kells introduced this new and revolutionary technology to dentistry. This 1920 landmark article, highlighted here in the centennial year of The Journal of the American Dental Association (JADA), was published in the Journal of the National Dental Association, a precursor to JADA. It is the publication of a paper read by Dr. Kells at the 1919 Association meeting in New Orleans. In this article, he modestly refers to his introduction of the X-ray to dentistry in 1896 at a meeting of the Southern Dental Association held in Asheville, N.C., just a few months after Dr. Roentgen’s discovery.

When Dr. Kells read this paper before the National Dental Association (NDA) in 1919, he had been using “the rays” for 23 years. He initially used a Ruhmkorff induction coil and Hittof-Crookes tubes to generate X-rays and recorded the images on glass photographic plates. By 1919, General Electric had invented a self-contained shockproof dental X-ray unit, and Eastman Kodak had introduced “Regular” film, a machine-manufactured dental film packet.

Notwithstanding these technical improvements and others yet to come, Dr. Kells and his contemporaries lived in a two-dimensional X-ray world. Radiographs, or skiagraphs as they were known at the time, are two-dimensional representations of three-dimensional patients; the third dimension is represented as varying shades of gray caused by the differential attenuation of anatomic structures in the X-ray beam. Therefore, either two radiographs taken at right angles to one another or stereoscopic views are needed to fully appreciate the three-dimensional relationships among teeth and their supporting structures. In the words of Dr. Kells, “…for a thoro [sic] diagnosis in some cases, some teeth need to be rayed from two or three angles…”

Despite improvements in dental X-ray units and image receptors, including the introduction of dental digital imaging in the late 1980s, two-dimensional geometric projection of intraoral radiographs was a limitation that had to be contended with for the first half of the 20th century.

Much of the Dr. Kells’ article deals with the “crime,” as he put it, of focal infection. The article provides a window into a segment of medical and dental thinking and practice of the time, and gives us Dr. Kells’ view of how to make meaningful change. The article focuses on how the X-ray was being used to support a flawed concept of disease origin—the theory of focal infection. Focal infection theories were very much in vogue during a time when the origins of disease were not as well understood as they are today. Interested readers are referred to an excellent historical review of focal infection by Pal-lasch and Wahl.

Briefly stated, focal infection theory is the concept that a local infection in a small area of the body can lead to subsequent infections in other parts of the body, due either to the spread of the infectious agent itself or to toxins produced by the infection. The focal infection theory, popular in the late 19th and early 20th centuries, had oral health in its cross-hairs. Dr. William Hunter, a British physician, claimed that poor dental health or “oral sepsis” from periodontal disease or “pyorrhea alveolaris,” as it was called at the time, could cause systemic diseases such as gastritis, “nervous disorders,” meningitis, ulcerative endocarditis, osteomyelitis and “other septic conditions.”

In 1915, Dr. Frank Billings introduced American physicians to focal infection theory in
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lectures at Stanford University and advocated tonsillectomies and dental extractions as remedies for focal infection.10 Many physicians and dentists were convinced. Even such prominent physicians as Dr. Charles Mayo promoted the theory. In 1916, Dr. Mayo stated that chronic diseases and diseases such as neuritis, sciatica, acute paralysis, appendicitis, gall bladder diseases and stomach ulceration were caused by local infections and “while there are several sources in the body for the entrance of bacteria and their culture in a local focus, the mouth is far the most common situation.”11 Dr. Mayo also stated that “the bulk of the dentist’s work should be referred work of physicians versed in the rudiments of dentistry.”11 Physicians with little else to go on, and often after X-raying the teeth, would make a diagnosis that necessitated removal of the teeth. Patients were referred to dentists for extraction and untold millions of teeth were needlessly removed.

Dr. Kells was an early critic of the theory of focal infection, and in his presentation to the NDA he condemned the mass extraction of teeth. He was adamant that dentists must refuse to extract teeth based merely on requests from physicians. It must be remembered that Dr. Kells was not a lightweight in medical/dental circles; he had attained considerable prominence through his many contributions and accomplishments. When he spoke, people listened. We remember him mainly for his efforts to bring the X-ray to dental practice. However, among his many other accomplishments were patents for the first electric air compressor, the first electric dental unit, the first electric mouth lamp and the first “electrified” dental office.

Some have claimed that perhaps his most significant contribution was his invention of an electric suction apparatus for the irrigation and aspiration of fluid during surgery. Dr. Rudolph Matas, one of the world’s most renowned surgeons, paid tribute to Dr. Kells: “The suction apparatus is sufficient to immortalize the name of C. Edmund Kells. He has won the eternal gratitude of every working surgeon in the world.”12 Every dentist owes him the same gratitude, and it is little wonder that he was held in high esteem by both professions.

This article6 makes it quite clear that Dr. Kells’ innovation, namely the application of the X-ray in dentistry, was state-of-the-art in 1919. He stated, “The Roentgen Ray is an absolute necessity to a high class dental practice” and “the general practitioner of dentistry is not fully capable of rendering his patients THE VERY BEST SERVICES unless his equipment includes an X-ray machine.” Furthermore, he wanted it understood that the X-ray was to be used to enhance the practice of dentistry and not to encourage the “mania for extracting devitalized teeth, whether good, bad or indifferent” in the name of focal infection. He wanted to “check the evil” of focal infection by speaking out. The article often repeats his commitment to the preservation of oral health and the dentition. He was very concerned that incompetent and inexperienced persons were misinterpreting what they saw on dental radiographs and thereby causing untold harm. He advocated the restoration of teeth even though, on X-ray, they may appear “infected.” He also stated that devitalized teeth should be saved and not necessarily labeled infected and, therefore, extracted.

Dr. Kells placed the blame for dental mutilation squarely on physicians who ordered mass extractions and dentists who complied without question. A recommendation to help curtail the “crime” was to educate physicians in oral health by including lectures by dentists in medical school curricula. His recommendation to the dental profession was that no dentist “will extract a tooth upon orders of a physician.”6 Gradually over time, the focal infection theory fell out of favor. Clinicians came to realize that the removal of teeth, or tonsils for that matter, did not usually relieve the symptoms their patients presented. No doubt, Dr. Kells’ early admonitions played a significant role in the demise of the theory of focal infection.

By the 1950s, the theory of focal infection was all but dead as more and more clinicians spoke out against it and as advances in medical science provided explanations for the etiology of many diseases. An entire issue of JADA in 1951
was devoted to a review of focal infection that also could be considered a “landmark” JADA article. After evaluating the evidence for focal infection it was concluded that "over the years, close observation of the benefits derived from the promiscuous removal of teeth led members of both the dental and medical professions to question the soundness of the theory. Many authorities who formerly felt that focal infection was an important etiologic factor in systemic disease have become skeptical and now recommend less radical procedures in the treatment of such disorders." However, to a minor extent, the theory of focal infection lingered on for many years. When one of the authors of this Commentary (PHJ) started his oral surgery practice in the late 1960s, he occasionally had physicians refer patients to him for removal of teeth to treat various nonoral diseases.

Dr. Kells died in 1928, but his spirit of innovation lived on as the mid-20th century witnessed the development of panoramic radiography, based on principles first described by Dr. Hisatsugu Numata in the 1930s and Dr. Yrjö V. Paatero in the 1940s. A patent for an “Apparatus for producing radiographs of selected structures within a subject” was issued in 1957 to Drs. Donald C. Hudson and John W. Kumpula on behalf of the U.S. Secretary of the Army. The military’s interest in developing panoramic radiography was in the rapid assessment of large numbers of recruits for military preparedness and to have records for post-mortem identification when necessary. The S.S. White Co. produced the first commercially available panoramic machine in the 1960s and opened a new window onto the oral and maxillofacial region. The curved surface tomogram follows the shape of the dental arches and displays the teeth, jaws and surrounding structures that lie within the U-shaped focal trough as a flat image. As with two-dimensional projection radiography, panoramic radiography has enjoyed significant technological refinements over the last 50 years, including the replacement of film with digital sensors that allow images to be stored, manipulated and transmitted with relative ease.

The latest development in oral and maxillofacial radiology involves acquiring three-dimensional or volumetric images with cone-beam computed tomography (CBCT). Although many CBCT machines look like panoramic machines, the images produced are akin to the cross-sectional images produced by a medical CT machine. Unlike plain radiography and panoramic radiography that started out using film and migrated to a digital environment, CBCT is inherently a digital technology. With a single sweep around the patient’s head, CBCT acquires a three-dimensional volumetric map of the head that can be manipulated and displayed in any plane of space, including a U-shaped panoramic-like curved surface. CBCT has been especially useful in presurgical implant site assessment, evaluation of the temporomandibular joints, investigation of pathology and trauma in the maxillofacial region, and evaluation of developmental disturbances of the facial region.

In addition to these quintessential dental radiographic techniques—intraoral, panoramic and CBCT imaging—oral and maxillofacial radiology and other dental specialties have adopted medical imaging technologies for their own purposes. Orthodontists adopted conventional head and neck radiographs and generate cephalometric radiographs for morphometric measurements to evaluate growth and development and to assess orthodontic treatment outcomes. Contrast agents—mentioned by Dr.
Kells: “the ingenious Roentgenologist gives his patient a free lunch of bismuth and then takes moving pictures of it as it travels down the alimentary canal” —have been used in sialography and temporomandibular arthrography. Imaging modalities such as CT, magnetic resonance imaging (MRI), nuclear medicine, ultrasound, positron emission tomography (PET), and single photon emission computed tomography (SPECT) all have applications in the oral and maxillofacial region.

When the 200th anniversary of JADA is celebrated in 2113, there will be as yet unimagined advancements in diagnostic imaging that will be championed by as yet unborn pioneers—pioneers in the tradition of C. Edmund Kells, who lived for the betterment of the profession and the alleviation of suffering.

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