Francisco Antônio de Almeida Filho

Radiology and Ultrasonography in the Imaging Diagnosis of Domestic Animals



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In parallel with his academic career, he is a journalist and coordinating editor of the magazines Encontro X and ASSTROSPAR. As a writer, he has a strong presence in technical literature in the fields of Radiology and Veterinary Medicine, with 18 published books. He is a member of the Independent Academy of Letters (AIL) of Pernambuco, occupying chair 59, and a corresponding Academician of FEBACLA, occupying chair 37. Internationally recognized, he is a Peace Ambassador and Commander of the Justice of the Peace by the World Organization for Human Rights, an entity signatory to the UN.

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Introduction

1. Contextualization of Digital Competence

Operational competence in veterinary radiology is a fundamental aspect to ensure diagnostic accuracy and clinical efficacy in the care of domestic animals. The ability to handle radiological equipment safely and effectively, combined with the capacity to interpret images, constitutes the foundation of modern veterinary practice. Image analysis requires not only technical knowledge but also a detailed understanding of the anatomical and pathological particularities of animals, making operational competence a cornerstone in the training of veterinarians specialized in imaging diagnosis.

2. Objective of the Book

The primary objective of this book is to provide a solid foundation for the understanding and application of imaging diagnosis techniques in the context of Veterinary Medicine. The work aims to empower professionals and students to develop practical and analytical skills, enabling them to integrate theoretical knowledge with the demands of daily clinical practice. Furthermore, the book aims to familiarize the reader with the technological innovations influencing the field, fostering continuous and updated education in veterinary radiology.

3. Work Structure and Methodology

The methodology adopted in this book combines theoretical explanations with practical examples and case studies, providing an

applied approach to imaging diagnosis. The work is organized to permit a didactic progression, beginning with the fundamentals of veterinary radiology and advancing to more complex image analysis techniques. Each chapter is structured to address a specific area of radiology, including topics such as radiographic positioning, pathology evaluation and technological innovations, offering the reader a comprehensive and in-depth understanding.

Chapter 1: Introduction to Veterinary Radiology

1.1. Brief History of Radiology and Veterinary Radiology

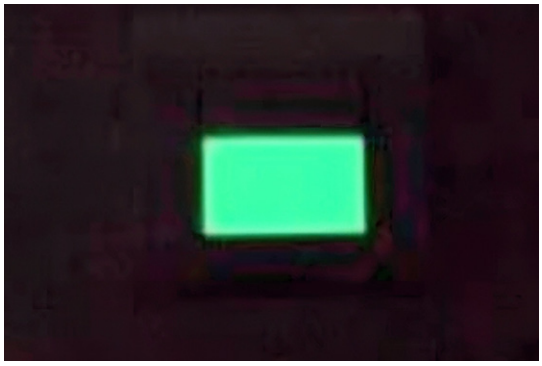
History of Radiology

The discovery of X-rays was a historic milestone that revolutionized science and medicine. In 1895, the German physicist Wilhelm Conrad Röntgen (1845–1923) (Figure 1.1) accidentally discovered this type of radiation while studying cathode rays in a Crookes tube, a vacuum glass tube containing an anode and a cathode (Figure 1.2).

Figure 1.1: Wilhelm Conrad Röntgen.	Figure 1.2: Crookes tube.
 Source: Francisco *et al.*, 2005.	 Source: Quimicafacil.net, 2024.

Upon energizing the tube, Röntgen observed that a specific substance barium platinocyanide emitted fluorescent light when exposed to the radiation emanating from the tube, shown in Figure 1.3. This reaction was astonishing, as it produced a latent image, something hitherto invisible and unknown in the field of physics. This accidental observation initiated a series of experiments that culminated in the development of radiography.

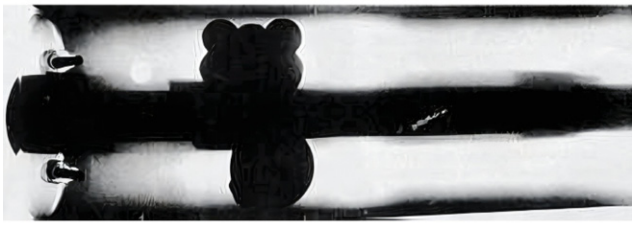
Figure 1.3: representation of fluorescence.



Source: author's collection, 2024.

Following this initial discovery, Röntgen proceeded to deepen his experiments to explore the potential of X-rays. To better understand this invisible radiation and its characteristics, he placed objects of various materials between the tube and a screen coated with barium platinocyanide, observing that some materials permitted the passage of radiation, while others partially blocked it, thereby creating a shadow or image on the screen. He even observed a fissure inside the barrel of his rifle (Figure 1.4).

Figure 1.4: fissure inside the barrel of a rifle.



Source: Seara da Ciência, UFC, n.d.

This experience inspired him to utilize X-rays to obtain internal images of material and biological structures. However, Röntgen's most renowned experiment involved his wife, Bertha, who became the subject of the first human radiograph in history (Figure 1.5).

Figure 1.5: the first human radiograph in history.



Source: Seara da Ciência, UFC, n.d.

In the experiment involving his wife, Röntgen employed the same Crookes tube and a glass plate coated with a barium platinocyanide film. He requested that Bertha position her hand between the X-ray tube and the plate, subjecting it to a prolonged exposure of approximately fifteen minutes. At the conclusion of the process, the obtained image clearly revealed the bones of Bertha's hand, as well as the shadow of her wedding ring. This was the first radiographic image in history, demonstrating the potential of X-rays to reveal internal structures without the need for invasive procedures.

The discovery of X-rays rapidly attracted the attention of the scientific and medical communities due to its potential impact on diagnostic medicine. Before X-rays, physicians primarily relied on external signs and symptoms reported by patients to formulate diagnoses, and invasive procedures were often the only means to confirm or rule out suspicions. With radiography, it became possible to noninvasively examine the interior of the human body, facilitating the diagnosis of bone fractures, dental problems, tumors, and pulmonary diseases, among others. Since 1896, the use of X-rays had already disseminated in hospitals and clinics, radically transforming medical practice.

However, at the outset, the effects of X-rays on the human body were still poorly understood, and safety precautions were virtually nonexistent. Röntgen, for example, was unaware of the dangers posed by prolonged exposure to ionizing radiation. For years, scientists and radiology technicians handled X-rays without protection, resulting in numerous cases of injuries, burns, and even cancer among professionals. The discovery of risks associated with radiation spurred the development of safety standards and equipment, such as lead aprons and protective devices, which remain indispensable in radiological practice to this day (Figure 1.6).

Figure 1.6: first radiological protection equipment.



Source: CRTR5, n.d.

Beyond medicine, X-rays also opened new perspectives in various fields of knowledge. In the field of physics, Röntgen's discovery stimulated research on the nature of electromagnetic radiation, influenced quantum theory, and helped reveal the internal structure of atoms.

Röntgen was widely recognized for his discovery. In 1901, he received the first Nobel Prize in Physics, a well-deserved recognition of the scientific and practical impact of his work. Although he initially refused to patent his discovery, preferring it to be freely exploited by the scientific community, his legacy endures to this day. He chose to name his discovery "X-rays" due to the lack

of knowledge regarding its nature at the time, with the "X" representing the mathematical unknown, a symbol of the mystery embodied by this radiation.

The discovery of X-rays is considered one of the greatest scientific achievements of the nineteenth century, and Wilhelm Conrad Röntgen's journey exemplifies how scientific curiosity and dedication to knowledge can transform our understanding of the world and significantly enhance human quality of life.

History of Radiology in Brazil

The first radiology equipment acquired by Brazil was installed in 1897 (Figure 1.7), in the city of Formiga, Minas Gerais. This historic milestone occurred during a period when Brazil was still adapting to technological and scientific innovations. The equipment that operated on batteries was a genuine innovation for its time, considering that the city lacked electricity. The acquisition of this device represented not only the introduction of radiology in the country but also a significant step towards the modernization of Brazilian medicine.

Figure 1.7: the first X-ray equipment in Brazil.



Source: Fenelon; Almeida, 2000.

Dr. José Carlos Ferreira Pires was a key figure in the history of Brazilian radiology, responsible for performing the first radiograph in the country (Figure 1.8). This notable event occurred in 1898 and

involved a case of a foreign body in the hand of then-Minister Lauro Muller. The selection of the minister as patient underscores the significance of the event, not only in the medical realm but also within the social and political context of the time. The performance of this radiography demonstrated the effectiveness of the new equipment and consolidated confidence in radiology as an essential diagnostic tool.

Figure 1.8: first radiography performed in Brazil.



Source: Fenelon; Almeida, 2000.

The history of radiology in Brazil, from the acquisition of the first equipment to the execution of the first radiography, stands as a testament to the evolution of medicine and science in the country.

History of Veterinary Radiology

In 1910, Brazil took a significant step towards the advancement of Veterinary Medicine with the promulgation of Decree No. 8,219, signed by Nilo Peçanha, president at the time, which mandated the establishment of Veterinary Medicine Schools throughout the country. This decision reflected the growing need for qualified professionals to care for animal and public health, as they were

intrinsically linked to human wellbeing and the development of agriculture and livestock.

The first two Veterinary Medicine Schools were established in the state of Rio de Janeiro: the Army Veterinary School and the Superior School of Agriculture and Veterinary Medicine. These institutions were fundamental in training professionals, providing a solid educational foundation and preparing students to meet the challenges of veterinary medicine. The establishment of these schools marked a paradigm shift, whereby veterinary medicine came to be recognized as an essential profession, not only for animal health but also for public health and the rural economy.

The official recognition of the profession was formalized with the first legal diploma of Veterinary Physician, conferred by Decree No. 23,133, dated September 9th, 1933. This data is now celebrated as Veterinary Physician Day, symbolizing the importance of the profession and the contribution of veterinary physicians to society. With the formalization of the profession, veterinary physicians assumed a more prominent role in animal health policies and disease prevention, which, in turn, positively impacted farm animal welfare and food safety.

In 1968, the veterinary field celebrated another achievement with the approval of Law No. 5,517, which created the Federal and Regional Veterinary Councils (CRMV). The creation of these councils marked an important milestone, as it established a regulatory framework for the profession, ensuring the ethics, responsibility, and quality of services provided by veterinary physicians. With the guidance provided, it became possible to supervise and direct the professional practice, ensuring that veterinarians acted in compliance with applicable regulations, thereby increasing public confidence in veterinary services.

In that same year, at the School of Medical and Biological Sciences of Botucatu, affiliated with the Júlio de Mesquita Filho State University (UNESP), the discipline which is affiliated as the first Veterinary Radiologist in Brazil, and his contribution was fundamental to the introduction of imaging diagnosis techniques in Veterinary Medicine. Veterinary radiology became an indispensable tool for diagnosing diseases and lesions in animals, enabling more accurate diagnoses and more effective treatments.

The inclusion of Veterinary Radiology in the academic curriculum marked a significant advancement, as the discipline not only enriched students' education but also broadened the possibilities for diagnosis and intervention in animal health. Moreover, this field is critically important in emergency medicine and veterinary surgery, where rapid and accurate diagnosis can be the difference between life and death for the animal. Mastery of these techniques has become essential to modern Veterinary Medicine, and the creation of specialization programs at universities reflects the increasing demand for professionals in this field.

Therefore, as we celebrate the history of Veterinary Medicine in Brazil, it is essential to acknowledge and honor the dedicated and committed professionals who work to ensure the health and well-being of animals, thereby contributing to public health and the sustainable development of Brazilian livestock farming. The legacy left by the pioneers of the profession, such as Professor Benedicto Wlademir de Martin, continues to inspire new generations of veterinarians to pursue excellence in their practices and to be advocates for animal and human health.

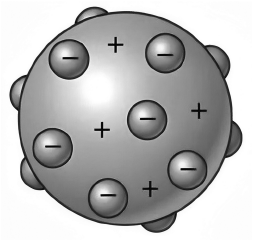
1.2. Physical Basis of X-ray

Atomic Models

Atomic models are theoretical representations that aim to describe the structure and behavior of atoms. Throughout history, various proposals have been developed to explain the nature of matter, each contributing to the current understanding of chemistry and physics. The atomic models are:

- **Dalton's Model (1803):** John Dalton proposed that matter is composed of indivisible and indestructible atoms. According to his theory, atoms of the same element are identical in mass and properties, while atoms of different elements have different masses. Dalton also developed the concept that atoms combine in fixed proportions to form compounds.
- **Thomson Model (1897):** J. J. Thomson, upon discovering the electron, proposed that the atom is a positively charged sphere in which electrons are embedded, akin to a 'plum pudding' (Figure 1.9). This model was among the first to introduce the idea that the atom is not an indivisible particle.

Figure 1.9: Thomson atomic model.



Source: Fogaça, n.d.

- **Rutherford Model (1911):** Ernest Rutherford proposed that the atom consists of a dense, positively charged nucleus surrounded by electrons orbiting it (Figure 1.10), thereby