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Endodontic Radiography

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In no other branch of dentistry does radiology play such an important role as in Endodontics.

The discovery of X-rays by Wilhelm Conrad Roentgen (Fig. 5.1) on the night of November 8, 1895 had such a profound impact on the entire medical world that it has come to be considered one of the most revolutionary achievements in the history of medical science.

In the field of Dentistry, Endodontics is surely the branch that has benefited most from this discovery, not only because of continual technical and technological improvements,[46] but mainly because the use of X-rays has brought dentists "out of the dark", allowing them to visualize areas not accessible by other diagnostic means.

Prior to this important date, dentists could only "attempt", with greater or lesser success, to reach a diagnosis and implement a therapeutic approach to endodontic problems.

The advent of the first oral radiography equipment (Fig. 5.2) permitted visualization for the first time of the changes that occur in the bone surrounding the apices of non-vital teeth, as well as the results of endodontic therapy.

In this way, Endodontics ceased to be simply an empirical pursuit; from that moment on, it became a scientific discipline.[28]

Today, the X-ray machine must be included among the dental equipment, especially in an endodontic

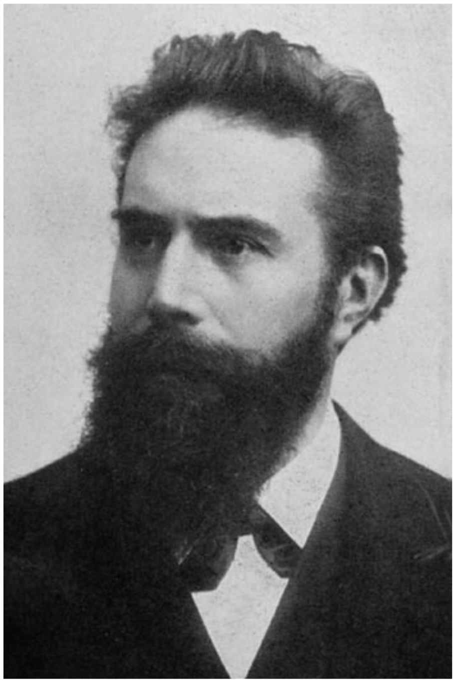

Fig. 5.1. Wilhelm Conrad Roentgen

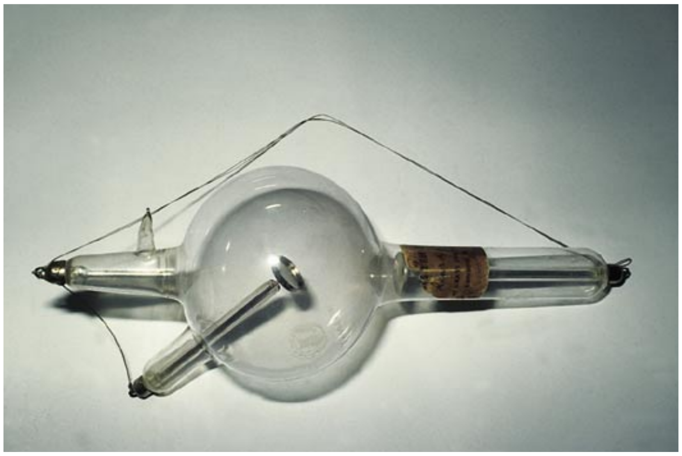

Fig. 5.2. One of the first tubes used at the turn of the century to produce X-rays.

practice. Having to work on the root canals of a patient without the help of this essential diagnostic apparatus is inconceivable.

In this chapter, we will discuss several fundamental principles of oral radiology. We will analyze the correct techniques of obtaining, developing and interpretating radiographs in Endodontics. We will not discuss the physical principles of ionizing radiation in detail, nor will we describe the biological effects of radiation itself; for a discussion of these topics, the reader is referred to the numerous radiology textbooks.

BASIC PRINCIPLES OF RADIOLOGY

X-rays are electromagnetic radiations. They have the same nature as visible light rays; like them, X-rays travel in a straight line until they are either absorbed or deflected. In contrast to visible light, however, they are not perceptible to the eye because of their short wavelength (10^{-10} to 10^{-6} cm).[8] Differences among the various types of electromagnetic radiation depend upon their wavelength. Starting with the longest wavelengths, electromagnetic radiation includes:

- Electric waves
- Radio, television, and radar waves
- Infrared rays
- Visible light rays
- Ultraviolet rays
- X-rays
- Gamma rays

Depending on its wavelength, which is measured in Ångström units (Å), electromagnetic radiation has variable capacity to pass through solid bodies. Rays with longer wavelengths have poor penetrating power. In contrast, those with shorter wavelengths, beginning with ultraviolet light, have increasing penetrating power. The wavelength of the X-rays used in oral radiography vary from 0.8 to 0.1 Å; thus, their penetrating power is greater than that of ultraviolet rays.[1]

Apart from the radiation's wavelength, the penetrating power depends on the atomic mass (density) of the object penetrated. Low-density objects are almost completely penetrated, while higher-density objects are penetrated to a lesser extent. Lead does not allow X-rays to pass at all; therefore, it is an optimal protective material against the harmful effects of X-rays.

If one examines X-rays passing through an object, one finds that a portion of them have been absorbed by the object, which therefore projects a "shadow", like an opaque body struck by a beam of light.

Just as bodies of varying opacity hit by light rays throw different shadows depending on their capacity to be traversed by luminous radiation, bodies of variable density struck by X-rays throw different shadows depending on their capacity to be penetrated by these electromagnetic radiations.

Because less dense bodies (e.g., soft tissues) are traversed to a greater degree, they throw lighter shadows, while denser bodies (e.g., bone) are traversed less and draw more radiation, for which reason they throw darker shadows. One must keep in mind, however, that because the radiographic image is a *negative*, the shadows appear to be reversed: soft tissues appear dark, while bone appears light.

In conclusion, the images produced by radiography represent the shadows that bodies of different densities project onto a film when placed in the X-ray's path.

Furthermore, a radiograph is a *two-dimensional* representation of *three-dimensional* structures. In other words, it is a fictitious image and never a real image [40] with all the consequences this implies. This is an extremely important concept that must never be forgotten.

In radiology, shadows corresponding to different anatomical structures situated on different planes are superimposed, with the consequent phenomena of summation and cancellation (e.g., one radiopaque body superimposed on a radiolucent one can hide the latter). Furthermore, like all shadows, radiographic images also are deformed to a certain degree with respect to the true dimensions of the body under examination. This deformation will be exaggerated more or less, according to the radiologic technique employed. The dentist must keep these factors in consideration during the clinical practice.

PRINCIPLES OF X-RAY FORMATION

X-rays are produced when electrons, accelerated by a high potential of tens of thousands of volts (or tens of kilovolts), strike a target at high speed (Fig. 5.3). To produce X-rays, the following are also required:

a) source of electrons,
b) high voltage to accelerate the electrons,
c) target that once hit by these electrons becomes the source of this radiation.

a) *Source of electrons*. The source is a tungsten filament (the cathode or negative electrode), which is enclosed within a glass-walled vacuum tube together with