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SUMMARY

This document analyzes the radiological safety related to the use of portable intraoral X-ray equipment in dentistry. The radiation emitted by a fixed unit and a portable unit will be compared, showing that the portable unit generates a greater angular aperture of the radiation beam, which can expose tissues outside the diagnostic area. Additionally, it is explained that the operator of the portable equipment is exposed to higher levels of radiation due to proximity to the X-ray source.

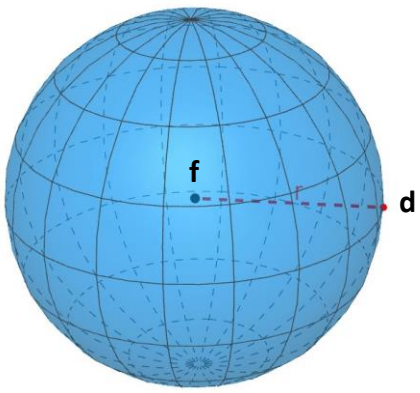
CONSIDERATIONS ON RADIOLOGICAL SAFETY WITH PORTABLE INTRAORAL X-RAY EQUIPMENT.

Electromagnetic radiation encompasses a broad spectrum that covers wavelength ranges from meters (m.) for radiofrequency to micrometers (micromm.) for gamma rays.

The range of wavelengths visible to the human eye covers only the spectrum from 400 to 700 nanometers. (nmm.).

X-rays, used among other applications for radiodiagnosis, with a wavelength in the range of 100 nm, due to their high energy potential, are ionizing radiation, with sufficient energy to penetrate matter, interact with body cells, potentially causing biological damage to tissues, of Deterministic, Stochastic, and Cumulative types, depending on the energy level of the radiation source and the duration of exposure.

Basic concepts about the physics of electromagnetic radiation:



The basic model for the study of the physics of electromagnetic radiation considers that the radiation source f is isotropic, that is: point-like, and that the radiation expands in any direction and with the same intensity at a distance d from the generating source. (fig.1).

The power of the generating source is expressed in Watts (W), and the distance d is expressed in meters. The power density D intercepted at distance d is:

D=W/4πd^2, expressed in Watts/m^2

That is to say: the intensity of the radiation is inversely proportional to the square of the distance.

In the applications of X-rays for radiodiagnosis, various factors must be considered, such as:

-The X-ray Tube, due to its characteristics, is not an isotropic radiator, that is: the radiation is not point-like and neither omnidirectional.

-The radiation is collimated to illuminate only the area covered by the image receptor device.

-The energy level of the X-ray source and the duration of radiation exposure are referred to as: Technical Factors of the equipment.

$$D = \frac{KV^n \; x \; mA}{d^2} \; x \; t$$

Where:

D = Radiation dose

KV = Energy level of the radiation source, expressed in Kilovolts, raised to the power of n based on the efficiency of the source and its filtration. The product: KV x mA expresses the power of the generator in Watts, similarly to what was seen earlier in the physics of electromagnetic radiation.

mA: Anode current of the X-ray tube, expressed in milliamperes.

d = Distance, squared, between the radiation source and the image receptor.

t = Duration of the exposure.

Therefore, the radiation dose is inversely proportional to the square of the distance between the generating source and the image receptor, similarly to what was previously seen in the basic concepts of radiation physics. (1).

The purpose of this introduction to Technical Factors in radiodiagnosis is to make a comparative analysis between a FIXED type X-ray Equipment for intraoral dental radiodiagnosis, that is, installed on a Fixed Support to be operated remotely, and a PORTABLE Equipment, to be operated with the operator holding the equipment with their hands.

The comparative analysis was conducted using 2 Intraoral X-ray Units available on the market as samples:

FIXED EQUIPMENT: Brand CORIX 70 PLUS-USV, mod. 70 Plus-USV, Generator Block series No. A37499.
PORTABLE EQUIPMENT: Brand Gulin Refine Medical Instruments Co., Ltd., mod. RTG-RXS, series No. 120RCC328A407.

Comparison of technical specifications provided by the manufacturer:

TECHNICAL SPECIFICATIONS		
	CORIX 70 PLUS – USV (FIJO)	**Gulin Refine Medical Instruments Co., Ltd., mod. RTG-RXS**
Voltage of the RX Tube	70KVp	60KVp
Anode current	8 mA	2mA
Exposure Time Range	0.03 – 3.00 s	0.01 – 2.00 s
Focal Length	200 mm.	200 mm.*
Total Filtration	> 2.0 mm. Al_	1.8 mm Al_
Remote Trigger	> 2.0 m_	WITHOUT REMOTE TRIGGER
LEak Radiation	< 50 mR/h	NOT ESPECIFIED
Note: The specified focal length is NOT correct. Measured: 108 mm.		

For comparative purposes, a test exposure was conducted with both devices, with an exposure time of 0.5 s. and 1.0 s., using a Radiation Dose Meter, brand Radcal, mod. Start Rapidose, s/n 01B-12-10415, with valid calibration, for the reading of: Kilovolts, Dose in mR, Exposure Time, and Inherent Filtration.

Radiation dose measured with FIXED EQUIPMENT: 0.5 s. = 381 mR, 1.0 s. = 760.8 mR.

Radiation dose measured with the PORTABLE EQUIPMENT: 0.5 s. = 453.3 mR, 1.0 s. = 976.3 mR.

The highest dose recorded with the PORTABLE EQUIPMENT is justified by the shorter Focal Distance (X-ray Tube Focus – Image Receptor), limited by the manufacturer to 108 mm, compared to a Focal Distance of 200 mm for the FIXED EQUIPMENT. (2).

A comparative analysis of the specified Focal Distance for both products indicates that the PORTABLE EQUIPMENT generates a radiation beam with a larger angular aperture, 32.6 degrees, compared to 17.0 degrees for the FIXED EQUIPMENT, with the former potentially radiating tissues outside the predetermined diagnostic area (Fig.2), in accordance with the standards of various international organizations. (3).

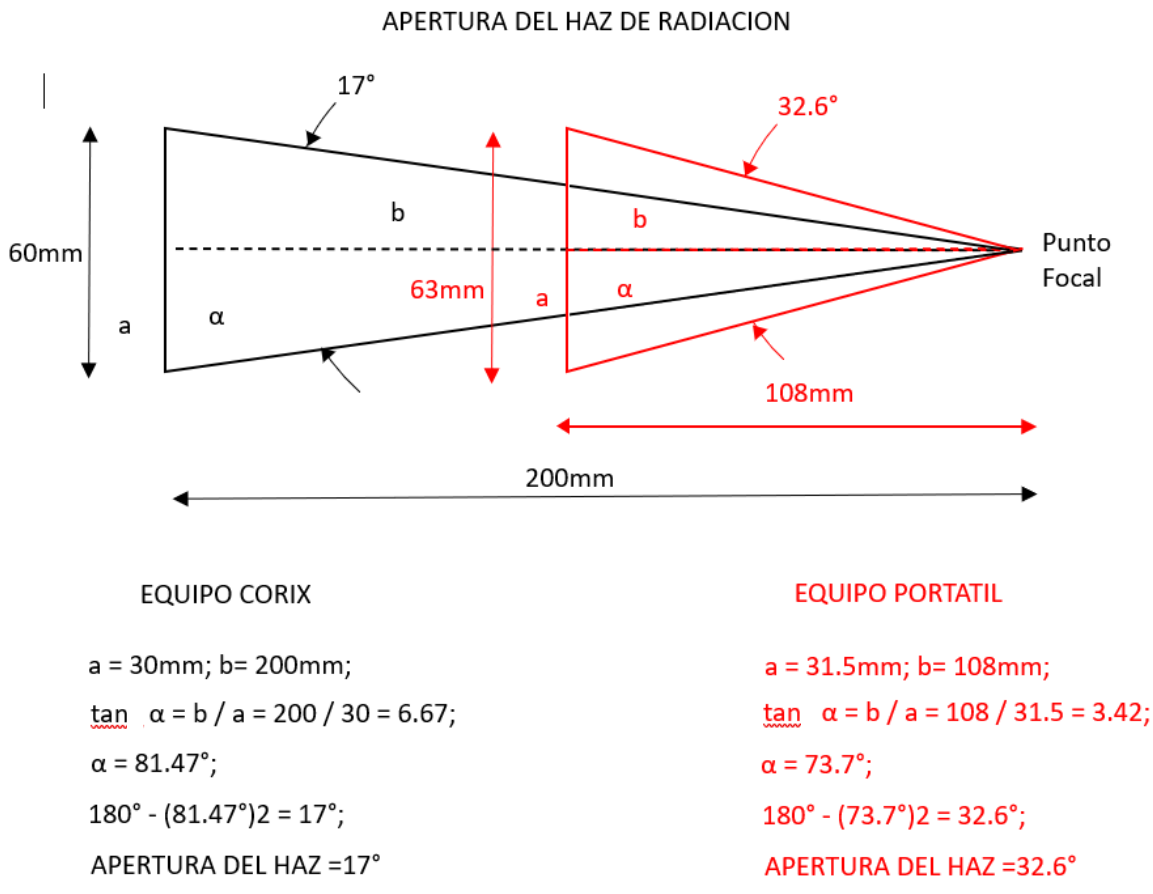


Figure 2

Ionizing Radiation:

The radiations emitted by X-ray generators are:

-Primary Radiation: It is the useful radiation emitted by the equipment to produce a radiographic image.

-Secondary Radiation: It is scatter radiation, created by the interaction of the primary radiation beam with materials such as the patient's face and oral structure.

-Leakage Radiation: It is the radiation emitted by the shielded casing of the X-ray Tube during exposure. The manufacturer is responsible for limiting the Leakage Radiation to values below those specified by the U.S. CFR 820.30 Standard. (k).

The equipment operator must take the necessary measures to minimize their occupational exposure to ionizing radiation. Various international organizations: ICRP, IAEA, Euratom, UNSCEAR, CSN, IPN, and ALARA standards indicate that the Operator must maintain a distance of 2 meters or more from the radiation source, using a remote trigger. (3).

With a PORTABLE EQUIPMENT, the Operator must hold the equipment with their hands. Considering an average distance of 60 cm between the Operator and the Patient, the Operator will be exposed to a level of Secondary Radiation of:

(200 cm^2) /(60 cm^2)= 11 times greater than that produced by a FIXED EQUIPMENT with a remote trigger, in the best case, as their hands will be exposed to a higher dose due to their proximity to the Patient and the residual Leakage Radiation generated by the equipment. Therefore, the U.S. CDRH recommends that the Operator of PORTABLE EQUIPMENT use lead gloves and aprons. (4).

The conclusions of this study confirm what was reported by the European Academy of Dentomaxillofacial Radiology, which states: PORTABLE (X-ray) EQUIPMENT should NOT be used for routine work in the dental office. Its use should be limited solely to scenarios such as: fieldwork, care for disabled patients, or forensic work, where the use of FIXED EQUIPMENT is not feasible, and when the PORTABLE EQUIPMENT is equipped with an appropriate device to shield the Operator from scattered radiation. (5).

Most dentists are unaware of the risks associated with the use of ionizing radiation sources, which increase with the frequency and dose applied, making the equipment operator the one exposed to the highest risk.

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