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RADIOGRAPHIC EVALUATION OF ARTIFICIAL TEETH IN ENDODONTICS USING DIRECT AND INDIRECT DIGITAL SENSORS UNDER DIFFERENT EXPOSURE TIMES, KILOVOLTAGES (KV), AND MILLIAMPERAGES (MA)

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ABSTRACT

The introduction of digital radiography marked a significant advancement in dentistry starting in the 1980s, with the emergence of the first intraoral digital radiographic imaging systems. This technology revolutionized diagnostic imaging exams, presenting itself as a beneficial alternative to conventional radiology.(1, 2) In digital radiography, the image acquisition process is similar to the conventional technique, with the main difference being the image receptor: instead of traditional film, a digital sensor is used. There are three methods of acquiring digital radiographic images: indirect, semi-direct, and direct. The indirect method involves scanning a radiographic film, while the semi-direct and direct methods use digital receptors such as photostimulable phosphor plates (PSP) and solid-state sensors (CCD), respectively. (1, 2) The use of positioning devices and protective barriers is common to prevent cross-contamination. Digital radiography offers several advantages, including significant reduction in radiation exposure, rapid image acquisition, ease of manipulation and analysis, reduced environmental impact, lower retake rates due to technical errors, and unlimited storage without loss of quality. (3, 4) Image enlargement on monitors also facilitates communication with the patient and clinical decision-making. Therefore, this study aimed to evaluate radiographic images of artificial teeth under different exposure times, kilovoltages (kV), and milliamperages (mA), using direct and indirect digital sensors in the context of endodontics.(3, 4)

Keywords: digital radiography. artificial teeth. image quality. Endodontics. exposure parameters.

INTRODUCTION

For decades, endodontic education relied almost exclusively on extracted human teeth. Currently, due to the risks of cross-infection and the difficulty in obtaining natural teeth, artificial replicas have been increasingly used (5, 6).

Reader et al. highlighted several reasons why the use of natural teeth is not suitable for endodontic training. In 1980, Peterson proposed artificial teeth made of wax, which accurately modeled root canals, although reproducing enamel and dentin was more limited. In 2005, Nassri et al. presented artificial teeth made of opaque and translucent resins that resembled natural teeth (5-7).

The objective of this study is to compare the quality of radiographic images of artificial teeth obtained with direct and indirect digital sensors, varying the exposure parameters such as time, kV, and mA (5-7).

Application of Dental Radiology in Endodontics

The evaluation of the dental pulp, root canals, and periapical structures cannot be performed solely through clinical examination, making the use of complementary imaging exams essential. These exams are crucial during all phases of diagnosis, planning, execution, and follow-up of endodontic treatment (6, 8).

Dentists must be able to perform and interpret radiographs, as well as understand radiographic anatomy, normal variations, and pathological changes, ensuring accurate interpretation (9).

Intraoral radiographs, such as periapical and bitewing techniques, are widely used in clinical practice due to their accessibility, simplicity, low radiation dose, cost-effectiveness, and high diagnostic quality (10).

Before performing any radiographic exam, strict biosafety and radiation protection protocols must be followed to ensure the safety of both the patient and the professional (7).

METHODOLOGY

Periapical radiographs were taken of artificial teeth with previously prepared endodontic access. Images were acquired using direct (CCD) and indirect (PSP) digital sensors, with variations in exposure times, kilovoltage (60–70 kV), and milliamperage. (11)

The images were analyzed using ImageJ software, with a focus on sharpness, contrast, and radiographic density to identify the ideal parameters for optimal diagnostic image quality (11).

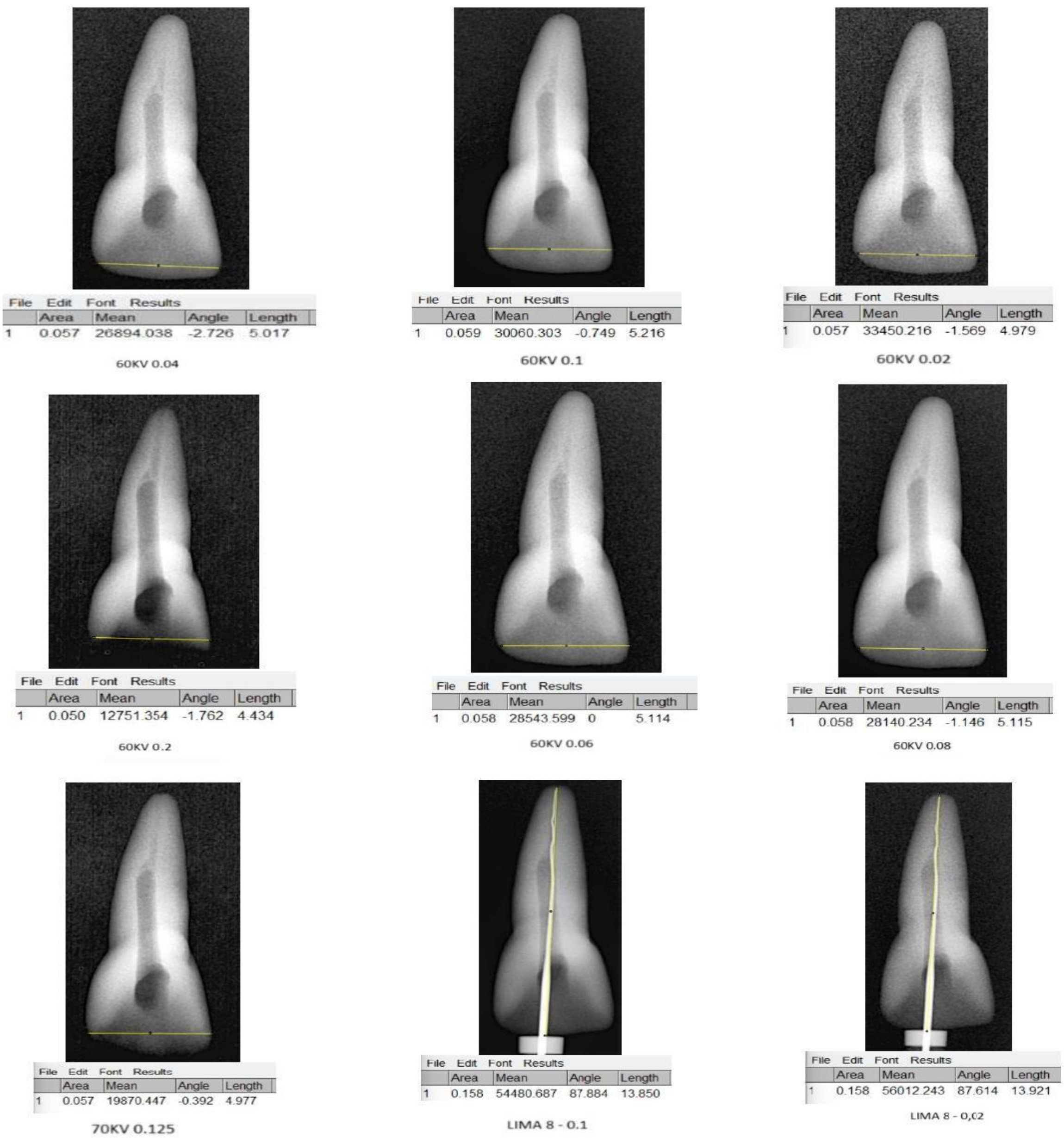
RESULTS

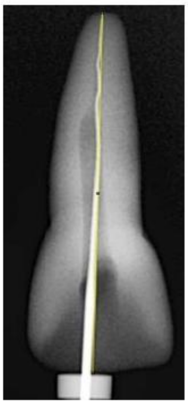
Image analysis showed significant variations in sharpness and clarity depending on exposure parameters. Overexposure resulted in high-density (very dark) images, while underexposure produced low-density (very light) images.

Factors such as exposure time, mA, kV, timer calibration, source-to-film distance, and processing time directly affect image quality (11).

The best images, in terms of sharpness and density, were obtained at 60 kV with exposure times between 0.02s and 0.04s. Radiographs taken with higher kV and longer exposure times presented greater radiolucency, compromising diagnostic quality. (6, 8)

Radiographs with Different Exposures and Measurements Using the ImageJ Application Source: Images produced by the authors.





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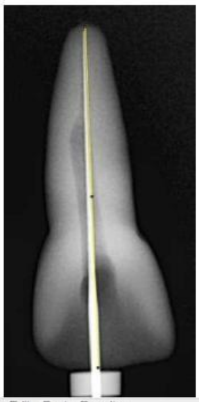
1	0.158	43357.396	88.593	13.879

LIMA 8 - 0.06



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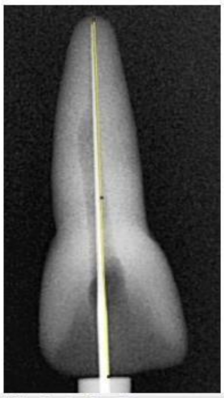
LIMA 10 - 0.1



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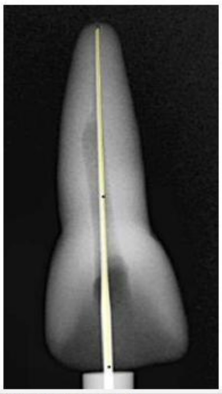
LIMA 10 - 0.02



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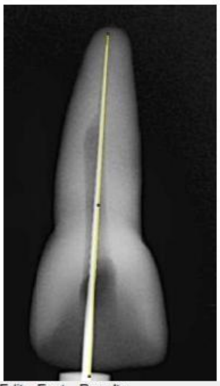
1	0.155	51705.359	91.718	13.642

LIMA 10 - 0.06



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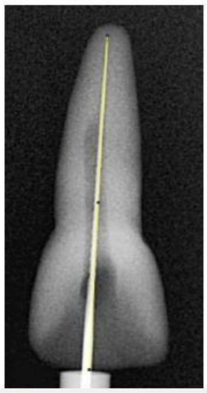
1	0.158	49185.290	87.054	13.928

LIMA 15 - 0.1



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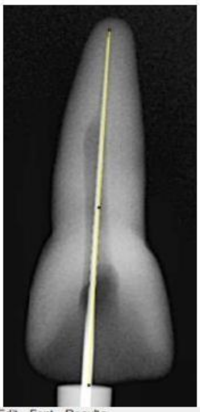
1	0.154	55184.587	87.109	13.517

LIMA 15 - 0,02



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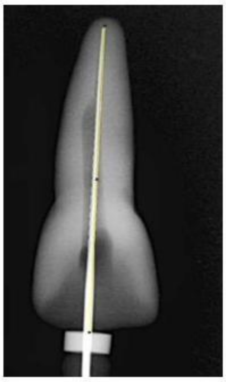
1	0.155	53210.733	86.836	13.589

LIMA 15 - 0.06



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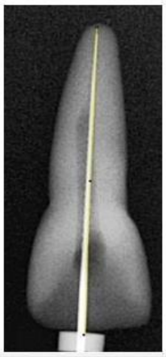
1	0.155	44728.951	87.280	13.052

LIMA 20 - 0.1



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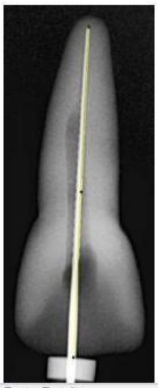
1	0.159	53016.085	87.765	13.988

LIMA 20 - 0,02



File Edit Font Results

	Area	Mean	Angle	Length
1	0.154	44689.500	87.267	13.584

LIMA 20 - 0,06

File Edit Font Results

	Area	Mean	Angle	Length
1	0.158	59296.183	81.830	13.914

LIMA 25 - 0,1

File Edit Font Results

	Area	Mean	Angle	Length
1	0.157	49078.275	82.489	13.823

LIMA 25 - 0,02

File Edit Font Results

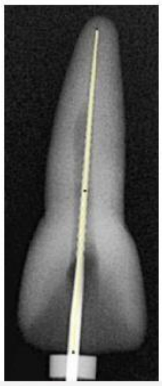
	Area	Mean	Angle	Length
1	0.156	39769.068	82.132	13.697

LIMA 25 - 0,06

File Edit Font Results

	Area	Mean	Angle	Length
1	0.155	45325.335	85.557	13.643

LIMA 30 - 0,1



File Edit Font Results

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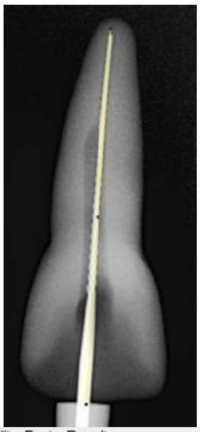
1	0.152	60130.961	85.769	13.400

LIMA 30 - 0,02



File Edit Font Results

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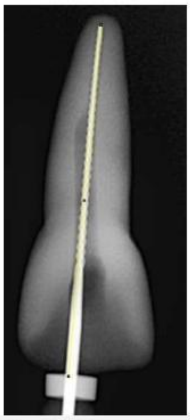
LIMA 30 - 0,06



File Edit Font Results

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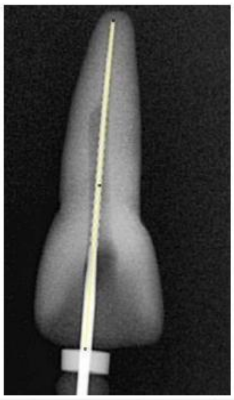
LIMA 35 - 0,1



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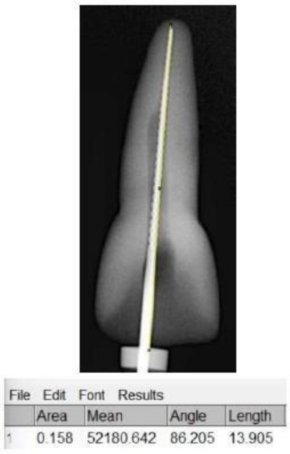
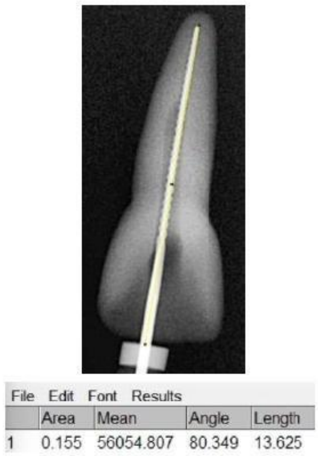
1	0.154	60518.808	85.093	13.550

LIMA 35 - 0,02

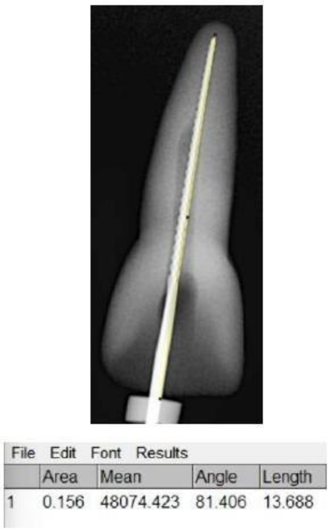


LIMA 35 - 0,06

LIMA 40 - 0,1



LIMA 40 - 0,02



LIMA 40 - 0,06

DISCUSSION

The findings confirm the importance of strict control of technical parameters in dental radiology. Accurate calibration of exposure factors is essential to avoid artifacts and ensure images of sufficient quality for reliable diagnosis (5, 6).

The results also corroborate previous studies on the impact of technical errors on the quality of images obtained in both clinical and educational settings (3-6).

CONCLUSION

The radiographic images obtained in this study demonstrate the relevance of quality control in dental radiodiagnosis. Proper selection of exposure parameters allows for high-quality imaging with minimal ionizing radiation exposure, benefiting both clinical practice and academic training (3-6).

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