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Alternative tools as a guide for measuring the vertical dimension of teeth on periapical radiographs

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ABSTRACT

Objectives: This research is aimed to find out the advantages of alternative tools as a guide for measuring the vertical dimensions of teeth on periapical radiographs and comparing the lengths of vertical dimensions of teeth on periapical radiographs with the actual lengths.

Materials and Methods: This research is using analytical observational study with a cross-sectional study design. The research data were primary data from 30 periapical radiographs of two maxillary central incisors, which were photographed using a periapical projection with bisecting technique and a periapical film that had been attached with wire on the outer layer of the film wrap. The data were analyzed by a paired T-Test using SPSS software.

Results: The p-value of ALT (Actual Length of the Tooth) for tooth 11 was 0.53 and for tooth 21 was 0.140. These results show a p-value > 0.05.

Conclusion: There is no statistically significant difference between the calculation of tooth length on periapical radiographs using alternative tools and the calculation of actual tooth length so that alternative tools can be used as a guide for measuring the vertical dimensions of teeth on periapical radiographs.

Keywords: *Intraoral radiography, periapical radiography, tooth length measurement, vertical dimension, wire*
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INTRODUCTION

Radiography has become one of the main diagnostic tools in dentistry. Its use is to get a real image of the image produced when X-rays pass through various levels of the thickness of an object. Radiographic examination has an important role in helping determine the diagnosis, prognosis, treatment plan, and knowing the results of the treatment that has been completed.[6,17] There are two dental radiography techniques based on where the film is placed; extraoral and intraoral techniques. In the intraoral radiography technique, a film is placed in the patient's oral cavity to obtain a more detailed view of the teeth and surrounding tissues. Intraoral radiographs include periapical, occlusal, and bitewing radiographs.[2]

Examination of the radiographic results also has limitations. One of the limitations is distortions. Distortion on radiographs generally occurs in a vertical or horizontal direction in the form of elongation, shortening, and changes in size, so that the size of the teeth on the film will be different from the actual size. Size lengthening in the image can occur if the vertical angulation angle is too small, while size shortening in the image can occur if the vertical angle is too large.[8,10]

Periapical radiographs are radiographs that show the roots and crowns of one tooth or several teeth, including the periapical tissues. Periapical radiographs are most often used in endodontic treatment and help to detect periapical pathology.[7,16] Periapical projection with parallel technique and bisecting technique are the radiographic examination techniques of choice that are often used in case management. A research study by Ibrahim et al showed that the proportion of radiographic retrieval due to errors was higher in the bisecting technique (24.16%), compared to the parallel technique (10.83%). This shows that the parallel technique produces less distortion than the bisecting technique.[11] However, the technique of bisecting is required on patients with specific sensitivities.

Periapical radiographs are often used in endodontic treatments that include dental pulp treatment.[9] Periapical radiographs also play a role in planning implant treatment and evaluating the edentulous ridge. They can assist dentists in estimating the vertical dimension for implant length.[18] The vertical dimension on a periapical radiograph is the object viewed from the vertical plane. The teeth used are the maxillary central incisors because they have a single root so that it can make it easier to measure the vertical dimensions. The periapical radiographic technique

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used is the bisecting technique, which is a technique that is often used in dental practice because it has better flexibility in patients.[3] Film positioning is relatively simple and fast, can be adjusted to the dental arch, and if all angulation angles are correct, the tooth length is almost the same as the natural tooth.[16] In addition, the bisecting technique is more at risk of distortion, so that the results of this study can be used as a benchmark for other techniques.

Diagnostic radiographs are often used in conservative dentistry to perform endodontic treatments by measuring the working length of root canal treatment (RCT) to estimate the working length of the tooth by measuring from the occlusal to the root apex.[4] Measurement of working length in RCT can be done using Grossman's method.[5,14]

This study aims to examine and discuss further the benefits of alternative tools as a guide for measuring the vertical dimensions of teeth on periapical radiographs. At the time of sampling in this study, two maxillary central incisors that implanted in the phantom were photographed using a periapical projection with the bisecting technique at Dental Hospital, Universitas Airlangga. The maxillary central incisors were usually photographed using the bisecting technique without using a film holder.

MATERIALS AND METHODS

This type of research is analytic observational with a cross-sectional study design. The study population consisted of 30 periapical radiographs of two maxillary central incisors which were extracted teeth and were placed on a dental x-ray phantom. A sampling of two maxillary central incisors was photographed using a periapical projection with bisecting technique and exposed 30 times to produce 30 periapical radiographs. The criteria that were selected were the results of periapical radiographs that met the quality evaluation, which showed that the maxillary central incisors were included in the periapical radiograph, there was no overlapping, minimal distortion, a clear picture, and good contrast, detail, and sharpness according to the purpose of manufacture radiograph. The research times will be July 24, 2021 and August 3, 2021, at the Dental Radiology Polyclinic, Dental Hospital, Universitas Airlangga Surabaya. Data analysis was carried out using the paired T-test. The tools and materials for this research include: 1) dental X-ray unit, 2) dental X-ray phantom, 3) caliper, 4) stationery, 5) two maxillary central incisors with normal crowns and no dental caries, no fillings or restorations, straight root anatomy with normal root canals and no anomalies, 6) Hanshin dental film brand periapical film, 7) Alternative tools, specifically wire with a diameter of 0.8 mm and a length of 10 mm, 8) Developer and fixer solution (monobath).

The way this research works is as follows: the researcher selected two maxillary central incisors (11 and 21) according to the sample criteria; the length of the incisors was measured using a caliper and the measurement results were recorded; the incisors were placed on a dental x-ray phantom. For an X-ray phantom, the wire is cut to a length of 10 mm and then affixed to the outer layer of the periapical film wrap in a vertical position at the top right of the film near the radiographic identifier (film dot or film number). Radiographic photos are performed using a periapical bisecting radiography technique by exposure to the film. Following exposure, the film is developed and fixed with developer and fixer solutions (monobath washing process or self-processing). Film processing does not require a dark room because it uses Hanshin dental film. Vertical dimension measurements are

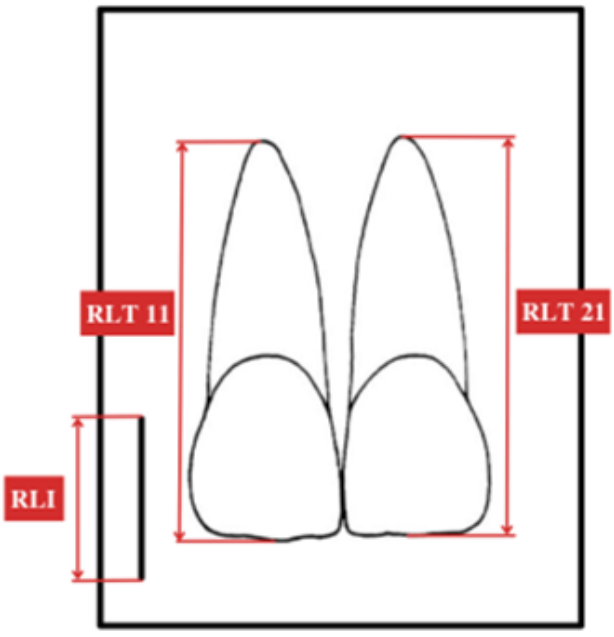

Figure 1. An illustration of measuring the vertical dimension of a tooth on a periapical radiograph

taken using caliper from the teeth and alternative tools on radiographs of the length of the tooth measured from the tooth axis at the incisal crown to the apex and the length of the wire (Fig. 1). The results of measuring the vertical dimensions of the teeth and wires on the radiograph are compared with the results of measuring the actual length of the teeth and wires using the Grossman's method calculation with the formula below and then the results of measurements and calculations obtained are entered into the table.

RESULTS

The results of the research that has been carried out, obtained the results of measuring the vertical dimensions of the teeth on periapical radiographs with an average ALI value of 10.18 mm, the ALT of tooth 11, at 24.09 mm, and the ALT of tooth 21, at 24.30 mm. Then, after the results of measuring the vertical dimensions of the teeth on the periapical radiograph were entered into the Grossman's method calculation, the average tooth length on

Grossman's Formula:

$$ALT = \frac{ALI \; x \; RLT}{RLI}$$

ALT = Actual Length of the Tooth
RLT = Radiographic Length of Tooth
ALI = Actual Length of Instrument
RLI = Radiographic Length of Instrument

Table 1. Data Characteristics

TOOTH	NUMBER OF SAMPLE (N)	PERIAPICAL RADIOGRAPHS SHOW AN AVERAGE TOOTH LENGTH	STANDARD DEVIATION	ACTUAL TOOTH LENGTH	THE DIFFERENCE BETWEEN THE TOOTH LENGTH ON THE PERIAPICAL RADIOGRAPH AND THE ACTUAL TOOTH LENGTH	MINIMUM VALUE	MAXIMUM VALUE
11	30	23.64 mm	0.28	23.7 mm	0.06 mm	22.76	24.35
21	30	23.85 mm	0.32	23.9 mm	0.05 mm	23.14	24.60

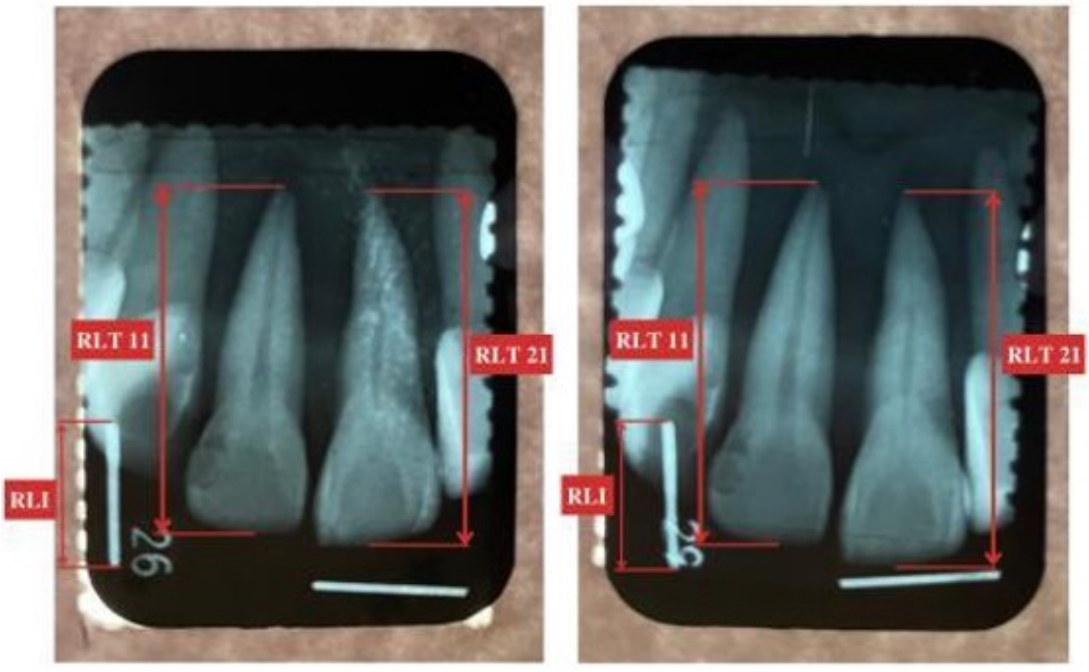

Figure 2. Measuring the vertical dimension of a tooth on a periapical radiograph

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Table 2. Paired T-test results of the measurement of the vertical dimensions of the tooth length on the periapical radiograph with the calculation of the actual tooth length.

	Tooth 11	Tooth 21
p-value	0.53	0.140

the periapical radiograph of tooth 11 was 23.64 mm, with a minimum value of 22.76 mm and a maximum value of 24.35 mm. The average tooth length on the periapical radiograph of tooth 21 was 23.85 mm, with a minimum value of 23.14 mm and a maximum value of 24.60 mm. Meanwhile, the result of measuring the actual length of the teeth with the caliper on tooth 11 is 23.7 mm, and on tooth 21 is 23.9 mm. Thus, the difference in tooth length on periapical radiographs with the actual tooth length on tooth 11 was 0.06 mm and on tooth 21 it was 0.05 mm.

The data from the calculation of tooth length on periapical radiographs was tested for normality and homogeneity. After the data had been normally distributed and homogeneous, a paired T-test was used to test the relationship between the actual tooth length data using a caliper and Grossman's method calculation. with the help of alternative tools. Based on the paired T-test, the p-value of the 11 was 0.53 and the 21 was 0.140. These results indicate a p-value > 0.05 (Table 2) and indicate that there is no significant difference between the actual tooth length data using the calculation of tooth length on periapical radiographs and the actual tooth length calculation using a caliper.

DISCUSSION

The difference between the length of the tooth on the periapical radiograph and the actual length of the tooth as measured using a caliper in this study could be caused by several factors, one of which is distortion, which causes the determination of the measuring point to be different. The most common distortion in periapical radiograph are elongation and foreshortening of the image. Distortion that found in the sample of this study is the elongation or lengthening of size in the image.[8] When there is elongation or foreshortening, it is possible that the measuring point will be longer or shorter so that the measurement can be slightly shifted to the right or to the left. In addition, sometimes in the periapical radiograph there is a shadow that makes the measuring point at the incisal and apical teeth more difficult to determine. The difference can still be tolerated, as seen from the results of statistical analysis that shows there is no significant difference. The difference in the length of the teeth on the periapical radiograph with the actual tooth length with a caliper between tooth 11 and tooth 21 of 0.01 can also be caused by differences in the determination of measuring points on tooth 11 and tooth 21 even though they are on the same periapical radiograph. Radiographic results cannot be exact or consistent each time the periapical radiograph is taken. There is no significant difference, which indicates this alternative tool can be used. The determination of measuring points that can vary between observers is also due to the fact that the radiographic results have superimposition, the effect of sharpness and image resolution on periapical radiographs, as well as vertical distortion due to the film position and X-ray direction, which can change so that the vertical angulation angle is different.

Distortion involves foreshortening and elongation, which is something that is difficult to avoid, but in this research, there was a small difference between the length of the tooth on the periapical radiograph and the actual tooth length because it used Grossman's method. Grossman's method is used to obtain tooth length on periapical radiographs using the mathematical comparison principle that known and unknown lengths can be compared with the same ratio of angulation.[5,14]

The use of periapical radiographs before, during, and after treatment is essential so that anatomical details, canal length, obturation quality, and dental and bone pathology can be identified and monitored. The application of digital periapical radiographs in endodontics is advantageous because it provides real-time image display, minimal radiation exposure, and is easy to store.[1] This research uses periapical radiographs, which are often used in endodontic treatment, especially in root canal treatment. Root canal treatment is a dental procedure that requires measuring the vertical dimension of the actual tooth length and the vertical dimension of the tooth length on the radiograph.[9] Accurate determination of working length is one of the most important steps during endodontic treatment to make sure that the instrument or k-file does not pass through the apical foramen and induce injury to the periapical tissues. Inaccuracy in determining the vertical dimension of tooth length can lead to various complications such as ledge formation, apical perforation, and overextension of irrigation through apical narrowing which causes periradicular inflammation, pain, and ultimately lowers overall treatment outcome.[15] In endodontic treatment, to measure the vertical dimension between the length of the tooth and the required k-file, the k-file is inserted into the root canal before the radiograph is

taken so that intervention with the tooth has occurred.[12] An alternative tool in the form of wire can be used in calculating the vertical dimension of tooth length on the periapical radiographs because, in this study, the results of statistical analysis showed that there was no significant difference between the vertical dimensions of the calculated tooth length on periapical radiographs and the actual tooth length. These results indicate that an alternative tool can be used to determine the length of an object from the vertical direction in periapical radiographs. An alternative tool in the form of a wire can be used to help measure the vertical dimension of the length of the tooth without invasion. This can be done by making a periapical radiograph before the intervention of the k-file with the tooth so that the vertical dimensions of the length of the tooth and the length of the k-file to be used can be predicted first. Before inserting the k-file into the root canal and can anticipate the occurrence of perforation in the root canal. In addition, making a radiograph at the beginning can also be used to determine root anatomy and see if there is a foreign body or a broken k-file in the root canal. It can predict the distance of the foreign body from the orifice in a vertical direction.

Periapical radiographs also play a role in planning implant treatment and evaluating the edentulous ridge, so they can assist dentists in estimating the vertical dimension for the choice of implant length used.[17] Radiographic analysis is the best non-invasive method for bone level determination, and among various radiographic techniques, the periapical technique has evident to be the most appropriate method for linear measurement of the vertical dimension of alveolar bone height.[13] Alternative tools in periapical radiography can be used to facilitate measurements that require vertical dimension length. For example, in measuring the vertical dimension of the alveolar bone height in implant treatment, the length of the implant can be predicted in advance without invasion.

Based on the results of this research, an alternative tool from wire that is used as a guide for measuring the vertical dimensions of teeth on periapical radiographs can be applied in several areas of health care. One such area is dental conservation, which can estimate the working length of root canals in advance and can help in the study of periodontics, prosthodontics, and oral surgery in determining the length of dental implants to be installed.

CONCLUSION

Based on research results, an alternative tool with a wire can be used as a guide for measuring the vertical dimensions of the teeth on periapical radiographs. Alternative tools can help the dental radiology in measuring the vertical dimension of teeth on periapical radiographs, can help the endodontic to estimate the working length of the root canal in advance, and can help the prosthodontics and oral surgery in planning implant treatment to estimate the length of the implant.

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FOOTNOTES

All authors have no potential conflict of interest to declare for this article. This research was registered and approved by the Research Ethics Committee with the registration number of 392/ HRECC.FODM/VII/2021. All procedures conducted were in accordance with the ethical standards.

REFERENCES

1. Ahmed HMA. Guidelines to enhance the interpretation of two-dimensional periapical radiographic images in endodontics. European Journal of General Dentistry. 2015;4(3):106 – 12.
2. Anggara A, Iswani R, Darmawangsa. Perubahan Sudut Penyinaran Vertikal Pada Bisecting Technique Radiography Terhadap Keakuratan Dimensi Panjang Gigi Premolar Satu Atas. Jurnal B-Dent. 2018;5(1):1–8.
3. Antolis M, Priaminiarti M, Kiswanjaya B. 2014. Vertical Angulation Alteration Tolerance in the Periapical Radiograph of Maxillary Incisor (An in vitro Study). Journal of Dentistry Indonesia. 2014;21(2):39-43.
4. Basrani B. Endodontic Radiology. 2nd ed. Statue Avenue: Wiley -Blackwell; 2012. p.5,8.
5. Bhatt A, Gupta V, Rajkumar B, Arora R. Working Length Determination – The Soul of Root Canal Therapy : A review. International Journal of Dental and Health Sciences. 2015;02 (01):107.
6. Butt A, Mahoney M, Savage NW. The impact of computer display performance on the quality of digital radiographs: A review. Australian Dental Journal. 2012;57:16–23.
7. Gupta A, Devi P, Srivastava R, Jyoti B. Intra oral periapical radiography - basics yet intrigue: A review. Bangladesh Journal of Dental Research of Dental Research & Education. 2014;4 (2):83-7.
8. Heryanto OE, Nehemia B, Iskandar HHB. Toleransi Perubahan Sudut Vertikal dengan Proyeksi Periapikal pada Premolar Satu Rahang Bawah. Skripsi. Jakarta: Universitas Indonesia; 2013.
9. Hutami OS, Muryani A. Perawatan saluran akar (PSA) satu kali kunjungan pada gigi molar pertama bawah kanan dengan restorasi endocrown resin komposit. Jurnal Kedokteran Gigi Universitas Padjadjaran. 2020;32(2):54-63.
10. Ianucci JM, Howerton LJ. Dental Radiography: Principles and Techniques. 5th ed. St. Louis, Missouri: Elsevier/ Saunders; 2017. p.179.
11. Ibrahim MF, Aziz MS, Maxood A, Khan WU. Comparison of Paralleling And Bisecting Angle Techniques In Endodontic Working Length Radiography. Pakistan Oral & Dental Journal. 2014;33(1):160–4.
12. Joseph M. 2019. Clinical Success of Two Working Length Determination Techniques - A Randomized Controlled Trial. Master Thesis. Chennai: The Tamilnadu Dr.M.G.R. Medical University; 2019. p.5–19.
13. Messias A, Tondela JP, Rocha S, Reis R, Nicolau P, Guerra F. Acrylic Customized X-Ray Positioning Stent for Prospective Bone Level Analysis in Long-Term Clinical Implant Studies. Open Journal of Radiology. 2013;3:136-42.
14. Puspitasari NMI. Perbandingan Panjang Insisif Sentral Sebenarnya Dengan Panjang Gigi Insisif Sentral Pada Perhitungan Diagnostic Wire Foto (DWF) Menggunakan Teknik Rontgen Foto Periapikal. Tesis. Denpasar: Fakultas Kedokteran Gigi Universitas Mahasaraswati; 2014.
15. Sridhara A, Konde S, Noojadi SR, Kumar NC, Belludi AC. Comparative Evaluation of Intraoral and Extraoral Periapical Radiographic Techniques in Determination of Working Length: An In Vivo Study. International Journal of Clinical Pediatric Dentistry. 2020;13(3): 211-6.

16. Whaites E, Drage N. Essentials of Dental Radiography and Radiology. 5th Edition. New York: Churchill Livingstone Elsevier; 2013. p.85.
17. White S, Pharoah MJ. Oral Radiology: principles and interpretation, 6th Edition. St Louis, Missouri: Mosby Elsevier; 2014.
18. Yunus B. Correction parameters in conventional dental radiography for dental implant. Dental Journal (Majalah Kedokteran Gigi). 2009;42(4):175-8.