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**RESEARCH ARTICLE**

# Differences in Maxillary and Mandibular Premolar Length Distortion at Various Angulation Angles of Periapical Radiographs

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***ABSTRACT***

***Background:*** *Periapical radiographic techniques are usually used in root canal treatment. Distortion on bisecting technique periapical radiographs is relatively more common, especially on premolars located at the curved jaw area.* ***Objective:*** *To determine the difference in the length distortion of the maxillary and mandibular premolars at various exposure angles of periapical radiographs.* ***Methods:*** *The research conducted using observational analytic research, and the research design is cross-sectional. The sample used in this study were 30 upper premolars X-rayed using the periapical bisecting technique with a reference angle from the first literature book +30 and a reference angle from the second literature book +40 and 30 lower premolars X-rayed at -10 and -15 angles.* ***Results:*** *On the independent sample T-test, p value<0.05 for both the upper and lower premolars, so it can be concluded that there is a significant difference in distortion with a reference angle of +30 and +40 on upper premolars and -10 and -15 reference angles on the lower premolars.* ***Discussion:*** *Distortion of periapical radiographs with bisecting technique occurs more easily. The placement of the periapical sensor must be as close as possible to the object so that the correct position of the periapical sensor also plays a role in the formation of distortion.* ***Conclusion:*** *There is a significant difference in the length distortion of the upper and lower premolars on the angle of exposure periapical bisecting radiographs from the two reference books.*

***Keywords:*** *Angulation angle, Bisecting, Periapical, Premolars*

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## INTRODUCTION

The periapical technique is widely used because it is more detailed, cheaper, and simpler than the panoramic technique.[1] Periapical radiographic techniques are usually used in root canal treatment because inaccurate working length measurements can lead to inadequate debridement and underfilling of the root canals.[2] Radiographic examination also has an important role in identifying the configuration of the root canal.[3]

The position of the premolars in the jaw is located between the anterior and posterior regions, which is located at the curve of the jaw arch, making it relatively difficult to place films in the mouth for intraoral radiography. Distortion in the bisecting technique is relatively more com in periapical radiographs, especially in premolars located at the angle of the jaw, so research is needed to determine the amount of vertical angle that can be tolerated to achieve minimal distortion.[4] The bisecting technique is often used in dental practice but has drawbacks distortion often occurs due to vertical and horizontal angle errors.[5]

Several studies have discussed that the position of the radiographic apparatus is closely related to the radiographic geometry.[6] Whaites and Drage, in their book, mention the angle in the bisecting technique for the lower premolars is −15°, and for the maxillary region of the premolars is +40°.[7] Meanwhile, White and Pharoah, in their book, mention the angle in the bisecting technique for the lower premolars is −10° and for the maxillary premolars is +30°.[8] Purpose of this studi is to determine the difference in the length distortion of the maxillary and mandibular premolars to the angle of radiograph taking based on references from White and Pharoah as well as Whaites and Drage in the jaw model of FKG UMY students.

## MATERIALS AND METHODS

This research is an analytic observational study with a cross sectional research design. This study used an analytic research design to determine the difference in distortion of tooth length to the angle of radiograph taking according to reference books. The samples used were 30 upper premolars and 30 lower premolars after extraction with intact conditions, the length of the teeth was measured using a sliding caliper and determined as the length of the natural teeth. The sample teeth were implanted in a jaw model made of jaw prints on Faculty of Dentistry, Universitas Muhammadiyah Yogyakarta students. The jaw model using original molds from students is intended to simulate the upper jaw according to the shape of the patient's palate and the lower jaw to simulate the depth of the base of the patient's mouth.

The jaw model that has been implanted with premolars is then positioned so that the occlusal plane of the jaw to be x-rayed is parallel to the horizontal plane. Place the size two periapical sensor from Vistascan Mini Easy Durr Dental in the arch as close as possible to the object. Position the Veraview iX Morita periapical X-ray tube cone with the tilt angle according to the reference and the LED alignment position guide point right on the cervical of the premolars.

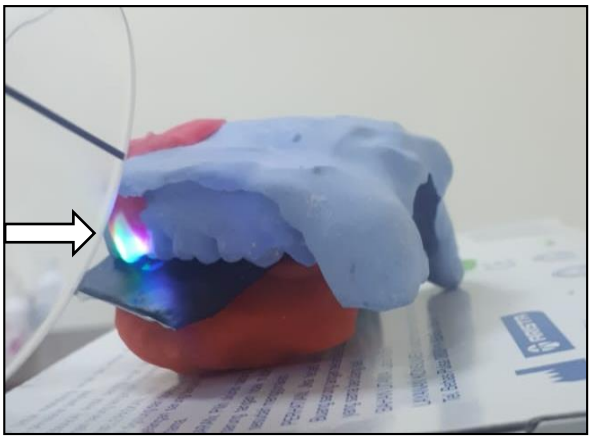

**Figure 1.** The LED Alignment position guide is positioned on the cervical premolars (arrows)


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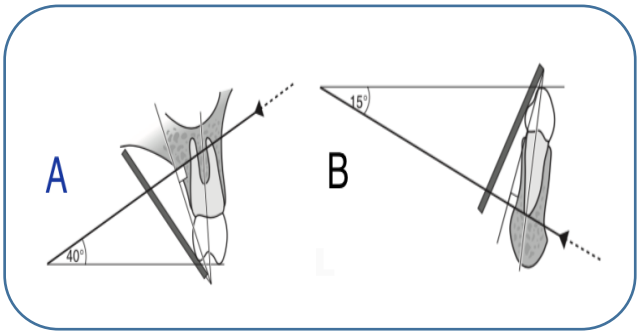
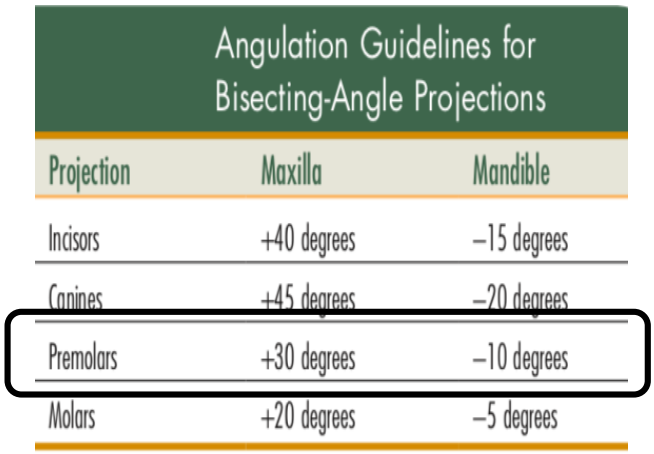



**Figure 2.** Reference angle for taking radiographs according to Whites and Drag. A. Upper premolars. B. Lower premolars.[7]



Angulation Guidelines for Bisecting-Angle Projections

| Projection | Maxilla | Mandible |
|---|---|---|
| Incisors | +40 degrees | –15 degrees |
| Canines | +45 degrees | –20 degrees |
| Premolars | +30 degrees | –10 degrees |
| Molars | +20 degrees | –5 degrees |

**Figure 3.** Reference angle for taking radiographs according to White and Pharoah.[8]

The length of the teeth on the radiograph was measured using the DBSWIN software. The magnitude of the distortion in this study is the difference between the tooth length measurements on the radiograph and the original tooth length.

## RESULT

This research was conducted at the Dental Hospital of the University of Muhammadiyah Yogyakarta using samples of the original upper and lower premolars implanted in a jaw model.

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**Table 1.** Mean distortion and standard deviation (SB) of premolar length

| $\bar{X}$ | Upper Premolar | | Lower Premolar | |
|---|---|---|---|---|
| | Angle (°) | Distortion (mm) ± SD | Angle (°) | Distortion (mm) ± SD |
| Reference by White | 30 | 2.1607 ± 0.44213 | -10 | 0.6043 ± 0.10016 |
| Reference by Whaites | 40 | 1.1073 ± 0.29367 | -15 | 0.4873 ± 0.06762 |

Table 1 shows that the reference angle from White and Pharoah produces a larger average distortion than the reference angle from Whites and Drage. The existing data is then tested to determine whether the data is normally distributed, as shown in Tables 2 and 3.

**Table 2.** Normality test on samples of upper premolars.

| *Tests of Normality* | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Angles | *Kolmogorov-Smirnov*[a] | | | *Shapiro-Wilk* | | |
| | | *Statistic* | *df* | *Sig.* | *Statistic* | *df* | *Sig.* |
| Upper Premolar | Reference by White | .106 | 30 | .200* | .941 | 30 | .094 |
| | Reference by Whaites | .150 | 30 | .082 | .955 | 30 | .231 |

**Table 3.** Normality test on samples of lower premolars.

| *Tests of Normality* | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Angles | *Kolmogorov-Smirnov*[a] | | | *Shapiro-Wilk* | | |
| | | *Stat* | *df* | *Sig.* | *Stat* | *df* | *Sig.* |
| Lower Premolar | Reference by White | .140 | 30 | .141 | .932 | 30 | .056 |
| | Refernece by Whaites | .151 | 30 | .079 | .938 | 30 | .080 |

Tables 2 and 3 show that the value of the degrees of freedom (df) for each group is 30, so the normality test uses the Shapiro-Wilk technique. Sig. value in each group, both upper and lower premolars > 0.05, the data is normally distributed so that an analysis can be carried out using the Independent-Samples T-Test to determine the significance of the difference in the mean in each group.



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**Table 4.** Independent-Samples Test on upper premolars

| *Independent Samples Test* | | | | | | |
|---|---|---|---|---|---|---|
| | | *Levene's Test for Equality of Variances* | | *t-test for Equality of Means* | | |
| | | *F* | *Sig.* | *t* | *df* | *Sig.(2-tailed)* |
| Upper Premolar | *Equal variances assumed* | 7.188 | .010 | 10.870 | 58 | .000 |
| | *Equal Variance Not assumed* | | | 10.870 | 50.420 | .000 |

**Table 5**. Independent-Samples Test on lower premolars

| *Independent Samples Test* | | | | | | |
|---|---|---|---|---|---|---|
| | | *Levene's Test for Equality of Variances* | | *t-test for Equality of Means* | | |
| | | *F* | *Sig.* | *t* | *df* | *Sig. (2-tailed)* |
| Lower Premolar | *Equal variances assumed* | 10.071 | .002 | 5.303 | 58 | .000 |
| | *Equal variances not assumed* | | | 5.303 | 50.886 | .000 |

Variances for the upper premolars was 0.010 and for the lower premolars was 0.002, both <0.05, this means that the variance of the data in each group of reference angles is not homogeneous, so the interpretation of the Independent samples Test output table is guided by the values contained in line Equal variance not assumed.[9] Sig. (2-tailed) of 0.000 <0.05, it can be concluded that there is a statistically significant difference in the distortion of the length of the upper and lower premolars to the reference angle according to White and Pharoah and Whaites and Drage.

## DISCUSSION

This study aimed to determine the difference in the magnitude of the tooth length distortion concerning several vertical angles according to references from 2 literature books. The average magnitude of distortion in maxillary premolars is greater than that of mandibular premolars. The difference in reference angle between the top and bottom is also greater in the upper premolars. Besides that, several other studies have also proven that the maxillary teeth experience more vertical angle errors than the mandible.[10,11]

The results of the T-test from the research data on both the upper and lower premolars show that there is a significant difference. These differences can happen because changes in the vertical angle have a very important role in the results of projected objects onto the film sensor. Other researchers also stated that the bisecting periapical radiograph distortion occurs more easily, so the angulation angle needs to be considered.[12] Placement of the periapical sensor must be as close as possible to the object so that the correct position of the periapical sensor also has a role in the formation of distortion. For the maxilla, the placement of the periapical sensor is influenced by the curvature of the palate, and for the mandible, it is influenced by the floor of the mouth.[8] In general, the position of the X-ray source, the object, and the film's location affects the distortion of the periapical radiograph.[13]

A vertical angle that is too large will result in a shortened image of the teeth on the radiograph and vice versa. If the vertical angle is too small, the teeth will elongate.[14] According to other researchers, the distortion in radiographs is caused by incorrect film placement, an incorrect irradiation angle setting, and increased object film distance.[2] Reference vertical angles are provided as approximations only. The difference in patients, in this case, is that the arch of the maxilla and the floor of the mouth in the mandible have different conditions that affect the tilt of the periapical sensor placement. The recommended vertical angulation is only a general guide.[7] The position of the teeth in the arch also affects the distortion. Teeth have different inclinations or slopes in the buccal-lingual direction, so the inclination in the buccal-lingual direction also affects the amount of


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distortion. The position of the individual teeth varies so that each patient's angle of periapical radiograph taking must be assessed independently.[7]

## CONCLUSION

Based on the results of this study, it can be concluded that there is a significant difference in the distortion of the length of the maxillary and mandibular premolars concerning the angle of periapical radiograph taken according to references from White and Pharoah and Whaites and Drage.

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