# Prediction of mesio distal width of unerupted permanent canines and premolars in panoramic radiographs

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**Abstract**

**Aim:** Prediction of mesiodistal width of unerupted permanent canines and premolars in mixed dentition period is necessary for space analysis. Use of panoramic radiographs instead of periapical radiographs in space analysis decreases the cost and X-ray exposure. The aim of this study was prediction of mesiodistal width of unerupted permanent canine and premolars by panoramic radiographs.

**Materials and Method:** Panoramic radiographs and dental casts of 60 orthodontic patients were selected. The largest mesiodistal width of dental crown of upper and lower canines and premolars on the panoramic and dental cast and also mesiodistal width of lower incisors on dental cast were measured. SPSS was used and data were analyzed by Pearson's coefficient correlation between panoramic, cast and linear regression analysis and paired sample T-test.

**Results:** R for predication of total unilateral mesiodistal width of permanent canine and premolars from cast and panoramic in upper jaw was 0.589 and in lower jaw was 0.691. R for prediction of mesiodistal width for unerupted canine and premolars by use of lower incisors width from dental cast and radiographic width of upper permanent canine for upper jaw and lower second premolar for lower jaw were respectively 0.664 and 0.999.

**Conclusion:** Based on introduced linear equation for prediction of mesiodistal width of canine and premolars, the best equation resulted from use of lower incisor width from dental cast and one radiographic agent which is canine in upper arch and second premolar in lower arch.

**Key words:** Mixed dentition, Linear regression analysis, Mesiodistal crown width, Panoramic radiography.

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A comprehensive evidence-based patient evaluation is needed for a comprehensive treatment and includes panoramic and cephalometric radiographs, dental cast analysis and clinical examination.[1-2] Tooth size-arch size discrepancy is a common malocclusion and it can be diagnosed in mixed dentition period and mixed dentition space analysis is a critical stage in malocclusion evaluation.[2-4]

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In space analysis, space available compared with space required for tooth alignment and sizes of unerupted permanent canines and premolars are needed for this analysis.[5-6]

First trials for mesiodistal width prediction of unerupted teeth were done by Black in 1897.[7] Moyer's, Tanaka- Jahnston and Staley- Kerber's tables and diagrams are conclusion of the studies, which were conducted after wards to predict mesiodistal width of unerupted teeth.

Now, mesiodistal width of unerupted teeth can be estimated with three methods:

Radiographic measurement

Prediction tables such as Moyer's and Tanaka-Johnston.

Compound methods of radiographs and tables.

Panoramic radiographs are common for orthodontic patients. If mesiodistal width of unerupted teeth could be estimated by panoramic radiographs, x-ray exposure and cost would be decreased. It should be kept in mind that in panoramic radiographs, the parts which are inside image layer are sharp but distortion or magnification is present outside this layer. Image layer is dependent on apparatus type and jaw size. Some problems like lower sharpness of images in relation to Intra-oral image, blurring of central parts because of thin image layer in this area and superimposition of cervical vertebrae in anterior region should be kept in mind. [8-11] Akesson et al. conducted a study on panoramic radiographs magnification in evaluation of marginal bone in comparison with intraoral radiographs and probing. They found that mean panoramic magnification in upper jaw was 27% and in lower jaw was 26%, but in bitewing and periapical radiographs in lower jaw it was 5%.[12]

Talaeipour et al. found that panoramic apparatus magnification in transverse dimension in dental sample was 30.55% and in anterior region was 24.8%.[13]

Irwin et al. found that the highest accuracy in mixed dentition space analysis methods is related to radiographic- dental cast method of Staley- Kerber.[14] Volchansky et al. showed that panoramic magnification in upper jaw was 27% and in lower jaw was 26%.[15]

Tootla and Fayle found that although Moyer's method had fewer variability and more reproducibility in comparison with simple observation of dental casts and radiographs but none of them was useful in final space analysis.[16] Khan et al. found that Tanaka-Johnston method was not useful in South African blacks.[17]

The aim of this study was to create formulae for mesiodistal width prediction of unerupted permanent canines and premolars in Yazd, by use of panoramic radiographs.

## Materials and Methods

In this cross-sectional study, 60 panoramic radiographs and dental casts of 11-25 years old patient with these inclusion criteria were selected:

enough radiographic sharpness absence of rotation in sample teeth existing of all canines and premolars absence of images in radiographs absence of wear or any impairment like stripping in enamel complete eruption of teeth anterior to permanent first molars.

The radiographs should be taken in one clinic by one technician. Radiograph apparatus used in this study was Planmeca (2002 EC proline, Finland) and radiographs were taken with 12 mA and 80 kvp x-ray in 18 second filtration of 2.5mm Al and prepared with automatic film processor (Velopex Extrax, England) in 4 minutes and 27°c temperature.

Radiographic film used in this study was 15× 30 cm panoramic film (Kodak, France).

The widest mesiodistal width of permanent canines and premolars of both jaws in each quadrant were measured on dental cast and panoramic radiographs fixed on a view box in an optimal light condition with digimatic gauge (CD-15 model, Mitutoyo, Japan) and 0.01mm accuracy. Also widest mesiodistal width of lower incisors in contact point area was measured on dental cast. After data registration, they were analyzed with SPSS software and Pearson's coefficient correlation, linear regression analysis and paired sample T-test were done.

## Results

Data analysis was done by Pearson's coefficient correlation test linear regression analysis and sample t-test. Mean magnifications of sample teeth were determined as shown in table 1, the highest amount of magnification was resulted in upper second premolar (33.52%) and the lowest amount in upper permanent canine (13.98%). As shown in table 1 in all samples except for the upper second premolar correlation coefficient was linear.

Regression correlation of A and B were statistically significant for linear regression formula (Y=A+BX) except for the upper second premolar. (P-value $< 0.05$) The highest value of correlation coefficient (R) was related to upper permanent canine (0.639) and the lowest R was related to upper second premolar (0.235).

Table 2 shows linear regression parameters for prediction of total mesiodistal width of

permanent canine and first and second premolars in these groups:
P1: total mesiodistal width of upper permanent canine, first and second premolars on panoramic radiographs.
P2: total mesiodistal width of lower permanent canine, first and second premolars on panoramic radiographs.
P3: total mesiodistal width of lower permanent canine, first and second premolars by use of total mesiodistal width of lower permanent Incisors (on the dental cast) and upper permanent canine (on the panoramic).
P4: total mesiodistal width of lower permanent canine, first and second premolars by use of total mesiodistal width of lower permanent Incisors (on the dental cast) and lower permanent second premolar (on the panoramic).
As seen, coefficients are statistically significant for use in linear regression formulae in Y=A+BX for P1,P2,P3 groups and in Y=BX for P4 group.
In evaluation of measurement accuracy by paired sample t-test, R between two measurements showed differences between two measurements were not statistically significant (P-value >0.05), and the data were correlated completely.(Table 3)

**Table 1: Linear regression parameter for prediction of mesiodistal width of permanent canine, first and second premolars in upper and lower jaw**

| Dental group | Correlation coefficient(R) | $R^2$ | P.value (R) | Standar d error | Regression coefficient | |
|---|---|---|---|---|---|---|
| | | | | | B | A |
| Upper canine | 0.639 | 0.409 | 0 | 0.018 | 0.473 | 3.531 |
| Lower canine | 0.510 | 0.260 | 0 | 0.017 | 0.301 | 4.420 |
| Upper first premolar | 0.449 | 0.202 | 0 | 0.015 | 0.252 | 4.724 |
| Lower first premolar | 0.598 | 0.357 | 0 | 0.014 | 0.367 | 3.912 |
| Upper second premolar | 0.235 | 0.055 | 0.70 | 0.018 | 0.168 | 5.258 |
| Lower second premolar | 0.615 | 0.378 | 0 | 0.017 | 0.422 | 3.251 |

**Table2: Linear regression parameters for prediction of mesiodistal width of permanent canine, first and second premolars in P1, P2, P3, P4 groups.**

| Dental group | Correlation coefficient | R2 | Standard error | P.value (R) | Regression coefficient | |
|---|---|---|---|---|---|---|
| | | | | | B | A |
| P1* | 0.589 | 0.347 | 0.038 | 0 | 0.353 | 11.963 |
| P2** | 0.691 | 0.477 | 0.038 | 0 | 0.462 | 9.068 |
| P3*** | 0.664 | 0.441 | 0.035 | 0 | 0.425 | 8.103 |
| P4**** | 0.999 | 0.998 | 0.034 | 0 | 0.659 | |

**Table3: Correlation coefficient (R), P-value (R), P-value (2-tailed) parameters er between two measurements**

| Dental group | Number | R2 | P.value (R) | P.value (2-tailed) |
|---|---|---|---|---|
| Upper canine | 5 | 0.958 | 0.042 | 0.388 |
| Upper first premolar | 5 | 0.962 | 0.038 | 0.265 |
| Upper second premolar | 5 | 0.995 | 0.005 | 0.740 |

## Discussion

Space analysis is a critical part in evaluation of malocclusion in mixed dentition period. Using panoramic radiographs instead of periapical radiographs decrease exposure and cost.

One goal of this study is to determine magnification of panoramic radiographs. According to the results, the highest value of horizontal magnification is related to upper second premolar (33.52%) and the lowest value to upper canine (13.98%). Decrease in magnification is probably because of rotation and thinning of focal trough anterior region for compensating mandibular arc and canine position.[10] Magnification values in this study are less than Talaeipaur et al., probably because of differences between apparatus, measurement tools and its accuracy.[13]

The main goal of this study is to predict mesiodistal width of permanent unerupted canines, and premolars by three methods:

Use of mesiodistal width of individual teeth on panoramic radiographs (Table 1).

Considering R and P-value, prediction linear regression formulae for permanent canine and premolars except upper second premolar are stated. The formula is not useful for upper second premolar because of high P-value (0.07) and low R (0.235).

The highest value of R is related to upper permanent canine (0.639) and the lowest to upper second premolar (0.235). So, mesiodistal width prediction is true in 40% of cases for upper permanent canine and in 5% for upper premolar. R for lower second premolar (0.615) permanent canine (0.510), upper first premolar (0.449) are between this range.

Use of total mesiodistal width of canine and premolar on panoramic radiographs (Table 2).

With considering linear regression formula, total mesiodistal width were predicted according to their size on panoramic radiographs by use of Y=A+BX equation.

Y is total width of teeth on cast and X is total width of teeth on panoramic radiographs.

Use of these equations shows total mesiodistal width of these teeth in upper jaw and lower jaw will be predicted by panoramic radiographs in 34% and 47% respectively.

Lower R in upper jaw is related to lower correlation coefficient of upper premolars.

Use of panoramic radiographs (upper canine for upper jaw and lower second premolar for lower jaw) and dental casts (lower permanent incisors) (Table 2).

In this part of study, mesiodistal width of premolars and canine are added to total width of lower incisors to improve prediction of mesiodistal width of canine and premolars and then linear regression formula is used. The equation in upper arch is Y=A+BX. Y is total mesiodistal width of upper permanent canine and premolars and X is total mesiodistal width of lower incisors on dental cast and mesiodistal width of upper permanent canine on panoramic. R2 in this study showed that prediction accuracy of total width of permanent canine and premolars was 44%. The equation in lower arch is Y=BX, X is total mesiodistal width of lower incisor on dental cast and lower second premolar

on panoramic radiographs and showed prediction accuracy of total width of permanent canine and premolars was 99%. Use of lower incisors in this part of prediction caused better and higher R2 especially in lower arch.

Like Staley- Kerber method, we also concluded in both jaws that the highest value of R is related to adding one radiographic agent to total lower incisor width. In Staley-Kerber method, periapial radiograph and in this study, panoramic radiograph was used.

R without considering radiographic agent in upper arch was 0.589 and in lower arch was 0.691 but with adding upper canine in upper arch and second premolar in lower arch, R increased to 0.664 in upper and to 0.999 in lower arch in Staley-Kerber method.

## Conclusion

Based on introduced linear equation, the best equation for unerupted permanent canine and premolars width prediction resulted by the use of total width of lower incisor on dental cast and a radiographic agent which was permanent canine in upper arch and second premolar in lower arch. In this study, the best for prediction of canine & premolars in upper jaw is $Y= 0.425x + 8.103$ and in lower jaw is $Y= 0.659$ X. X is total mesiodistal with of lower incisors on dental cast and a radiographic agent (canine width for upper jaw and second premolar width for lower jaw) in panoramic radiograph.

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## References

1.Proffit WR, Field HW. Contemporary orthodontics. 3rd ed. St.Louis: Mosby 2000.pp. 165-70.

2. Abu Alhaija ES, Qudelmat MA. Mixed dentition space analysis in a Jordanian population: comparison of two methods. Int J paediat Dent 2006;16: 104-10.

3. Ling JY, Wong RW. Tanaka-Johnston mixed dentition analysis for southern Chinese in Hong kong. The Angle Orthod 2006; 76(4): 632-6.

4. Bernabe E, Biostat C, Flors-Mir C, Orth C. Are the lower incisors the best predictors for unerupted canines and premolars sums? An Analysis of Peruvian sample. Angle orthod 2004; 15(2): 202-7.

5. AL-khadra BH. Prediction of the size of unerupted canines and premolars in a Saudi Arab population. Am J orthod Dentofac Orthop 1993;104: 293-9.

6. Lee-Chan S, Jacobson BN, Chwa KH, Jacobson RS. Mixed dentition analysis for Asian-Americans. Am J Orthod Dentofac orthop 1998;113: 293-9.

7. Flors-Mir C, Bernabe E, Camus C, Carhuayo MA, Major PW .Prediction of mesiodistal canine and premolar tooth width in a sample of Peruvian adolescents. Orthod Cranio Research 2003; 6: 173-6.

8. Hashim HA, AL-Shalan TA. Prediction of the size of unerupted permanent cuspids and bicuspids in a Saudi sample: A pilot study. J Contemp Dent Prac 2003; 9: 40-53.

9. White SC, Pharoah MJ. Oral radiology: principles and interpretation, 5th ed. St Louis: Mosby 2004.PP. 191-209.

10. Tavakoli MA, Basiri N. Dental panoramic radiography. Tehran: Shayan nemoudar; 2004.PP. 10-69

11. American Dental Association Council on Scientific Affairs. The use of dental radiographs: Update and recommendations. JADA 2006; 137: 1304-12.

12. Akesson L, Hakansson J, Ronlin M. Comparison of panoramic and intraoral radiography and pocket probing for the measurement of the marginal bone level. J Clin Periodont 1992; 19: 326-32.

13. Talaeipour AR, Vatanvar M, Shirazian Sh. Evaluation of magnification of Trophy panoramic machine (Odontotorama PC model) in different area of jaws. JIDA 2003: 15: 104-10.

14. Irwin RD, Herold JS, Richardson A. Mixed dentition analysis: A review of methods and their accuracy. Int J Paediat Dent 1995; 5: 137-42.

15. Voichansky A, Cleaton-Jones P, Drummond S, Bonecker M. Technique for linear measurement on panoramic and periapical radiographs: a pilot study. Quintessence Int 2006; 37(3): 191-7.
16. Tootla R, Fayle SA. Comparison of two methods of space prediction in the mixed dentition. Peadiatr Dent 2003; 25: 350-6.
17. Khan MI, Seedat AK, Hlongwa P. Tooth width predictions in a sample of Black South Africans. SADJ 2007; 62: 244, 246-9.
18. Legoic M, Novosel A, Legovic A. Regression equations for determining mesiodistal crown diameters of canines and premolars. The Angle Orthod 2003; 73(3): 314-8.