Journal of Orthodontics, Vol. 36, 2009, 253–259

SCIENTIFIC SECTION

Prediction of space available for unerupted permanent canine and premolars in a Nepalese population

Alok K Jaiswal, Keshab R Paudel, Situ L Shrestha and Sunita Jaiswal
College of Dental Surgery, UCMS, Bhairahawa, Nepal

Objectives: To test the use of Moyers prediction method and Tanaka and Johnston's equations for use in a Nepalese population and to construct new probability tables and prediction formulae based on the actual tooth sizes in a sample of the Nepalese population.

Design: Cross-sectional.

Source and setting: Dental, medical and nursing science students at the B.P. Koirala Institute of Health Sciences, Dharan, Nepal.

Subjects and methods: The sample consisted of 100 Nepalese males and 100 females aged between 17 and 23 years. Subjects without any previous orthodontic treatment, fully erupted permanent teeth and with no dental anomalies were recruited. Dental study models were taken and measurements of the mesio-distal widths of teeth were carried out using digital caliper. The measured values were compared with predicted values derived from Moyers method and Tanaka and Johnston equations. Independent *t* tests were used to examine differences between genders. Correlation coefficients and linear regression equations were used to compare the actual Nepalese tooth widths with predicted values

Results: Moyers method at 50% tends to underestimate the actual width of the canine and premolars in males by 0.3 mm and overestimate the width in females by 0.2 mm. The Tanaka and Johnston method tends to overestimate the actual width of the canine and premolars in both males (0.7 mm) and females 1.0 mm.

Conclusion: The newly developed regression equations are more accurate for prediction of width of unerupted permanent teeth in a Nepalese population. Further studies are required based on larger sample size, to confirm the applicability of the new regression equations proposed.

Key words: Dental, space prediction, Nepalese

Received 28th March 2008; accepted 11th July 2009

Introduction

An accurate space analysis is an important part of orthodontic treatment planning[1–3] and one aspect of a space analysis in the mixed dentition might be the prediction of future space requirements. The common methods used for space analysis and prediction are:

- direct measurement of teeth from study models;[4,5]
- measurement of tooth size using radiographs;[6–8]
- or a combination of the two techniques.[9–11]

Most authors suggest that a combination of methods is more accurate than one technique.[12,13] Ballard and Wylie[14] state that the reliability of the radiographic method depends on several factors such as technique sensitivity, accuracy of measurement and whether the teeth are rotated in their crypts. Due to concerns about radiation protection radiographic methods may be less frequently used. Also in some developing country, such as Nepal, there may be limited availability of dental radiographic machines.

At present most prediction methods depend upon data derived from white northern European and North American Caucasian populations.[4,5] The most widely used Moyer's probability tables[4] and the Tanaka and Johnston's method[5] for space analysis were developed from this population and according to Profit and Fields,[1] the reliability of Moyers table is good for Northern Europeans, but is not valid for other ethnic groups.

To-date, only one study has demonstrated tooth size variations in the Nepalese population compared to other racial groups.[15] According to this study, the mean tooth width in the Nepalese populations was smaller than in

Address for correspondence: Alok Kumar Jaiswal, College of Dental Surgery, UCMS, Bhairahawa, Nepal.
Email: dralokjaiswal@gmail.com

DOI 10.1179/14653120723283

the white northern European and North American Caucasian population, except for the maxillary lateral incisors in males.

Since there are variations in permanent tooth sizes among different ethnic groups the application of non-radiographic approaches has been questioned.[16–19] Other variations can occur due to environmental factors,[20] heredity[21] gender differences[4] and bilateral asymmetry.[22,23]

Several studies have been conducted to evaluate the accuracy of the Tanaka and Johnston and Moyer's probability tables in non-white populations. The populations studied include Black South African,[16] Asian-American,[10] Saudi Arabian,[18] Thai,[24] Jewish-Israeli,[25] Syrian,[26] Senegalese,[27] Peruvian,[28] Jordanian[29] and Chinese.[30] All the investigators concluded that neither direct nor radiographic measurements accurately predicted tooth size when applied to non-white groups. Thus it is necessary to develop a Nepalese prediction equation in order to carry out an accurate space analysis in this population.

The objectives of this study were to:

- test the correlation between the predicted and actual mesio-distal widths of the unerupted maxillary and mandibular permanent canine and premolars using the total mesio-distal width of mandibular four permanent incisors.
- construct new probability tables and prediction formula based on the tooth size of a Nepalese population.
- compare the reliability of the new prediction values against those of the most commonly used values (Moyers[4] and Tanaka and Johnston[5]).

Materials and methods

The study was approved by the ethics and research committee of the Health Research Council (Ref. BPKIHS-HRC/07/1191, Date: 25 November 2007). A convenience sample was obtained consisting of dental, medical and nursing sciences students attending the B.P. Koirala Institute of Health Sciences (BPKIHS), Dharan, Nepal. Informed consent was obtained from each subject to take part in the study. A total of 10 dentists were involved in the screening of the subjects and all were trained for 5 days at the out patient department of BPKIHS prior to the data collection.

The inclusion criteria were native Nepalese with Nepalese phenotypical characteristics such as brown skin colour, black hair and eye colour ranging from brown to black, age ranging from 17 to 23 years and all permanent teeth erupted (except third molar). The exclusion criteria were subjects with proximal or occlusal wear, interproximal caries or restorations, crowding, spacing or diastema, any cross bite, any over retained deciduous tooth, missing permanent tooth, deep carious tooth, any hypoplasia or dental anomalies and any past history of orthodontic treatment.[31,32]

Alginate impressions were taken at BPKIHS and immediately cast in dental plaster. Measurements were carried out directly from the study models using a Starrett digital calliper (0–150 mm, 799A-6/150, Starrett tools (Suzhou) Co. Ltd, China accuracy of ± 0.01 mm). The mesio-distal dimensions of the following teeth were measured: the mandibular permanent incisors, the mandibular and maxillary permanent canines and the mandibular and maxillary first and second premolars. All measurements were made by a single investigator. A maximum number of 10 pairs of casts were measured per day to avoid fatigue. All measurements were taken perpendicular to the long axis of the tooth with the calliper beak entering the interproximal area from the buccal or occlusal side.[31] The maximum mesio-distal width of each tooth was measured and recorded to 0.1 mm. Repeat measurements were performed after 2 weeks to minimize the possibility of error. Intra-examiner reliability was predetermined as 0.2 mm.[17,23] If the variation in the repeat measurements was greater than 0.2 mm a third measurement was taken. Repeat measurements that varied by 0.2 mm or less were averaged.

Statistical analysis

Descriptive statistical analyses were carried out which included calculation of the mean values, standard deviation and ranges. All prediction methods used in this study were based on an average of both sides of the arch. Before combining the data a paired t test was performed and no statistically significant differences were found between the right and left sides. An independent t test was performed to compare the tooth sizes between genders. The significance level was set at $P<0.05$. Correlation coefficients (r) and linear regression equations were formulated to express the relationships between the sum of the mesio-distal widths of the four mandibular incisors (x) and the sum of the mandibular and maxillary arch canines and premolars (y). The constants a and b in the linear regression equation ($y=a+bx$), coefficient of determination (r^2) and the standard error of estimate (SEE) were calculated for male, female and both sexes in combination. The data derived from the present study were used to frame prediction equations and to compare with Moyers

prediction method and Tanaka and Johnston equations. All statistical analyses were performed using Stata software (version 10.0) in the Department of Biostatistics at Nanjing Medical University.

Results

An initial screening was carried out on 1454 subjects and 632 subjects were found to fulfil the inclusion criteria. To make an equal sample size of male and females the first 100 subjects for each gender were selected to take part in the study.

Table 1 shows the sum of the mesio-distal widths of the teeth measured. The differences between males and females are shown in Table 1. A statistically significant difference was found between the widths of the male and female teeth. The correlation coefficients (r) between the mesio-distal widths of the mandibular incisors and canine to premolars for male, female and a combined group and the regression values of a and b, the SEE (standard error of the estimate) and the coefficient of determination (r^2) of the maxillary and mandibular regression equations are shown in Table 2.

The correlation coefficients (r) between the sum of the mesio-distal widths of the lower incisors and the sum of the mesio-distal widths of the canines and premolars were 0.41 for the maxillary canines and premolars and 0.38 for the mandibular canines and premolars for males. The equivalent figures for the females was 0.57 (maxillary canines and premolars) and 0.60 (mandibular canines and premolars) and for both sexes combined the correlations were 0.51 (maxillary canines and premolars) and 0.52 (mandibular canines and premolars). These values suggest that a reasonable correlation exists between the mesio-distal widths of the lower permanent incisors and the actual mesio-distal widths of the canines and premolars. For both male and female subjects, the Moyers and Tanaka and the Johnston methods either underestimate or overestimate the actual width of canine and premolars and these differences were statistically significant (Tables 3 and 4).

Table 2 Regression parameters for prediction of buccal segment widths.

				Constants		
Tooth group	Gender	r	r^2	a	b	SEE (mm)
Maxillary arch	M	0.41	0.16	15.52	0.26	0.82
	F	0.57	0.32	12.16	0.40	0.91
	M+F	0.51	0.26	13.35	0.35	0.88
Mandibular arch	M	0.38	0.15	14.44	0.28	0.97
	F	0.60	0.36	10.12	0.46	0.96
	M+F	0.52	0.27	11.60	0.40	0.99

SEE, standard error of estimate.

Discussion

In this study, we have measured tooth size in a sample of 100 Nepalese males and females in order to aid the determination of space requirements in the mixed dentition.

The coefficients of determination (r^2) values are indications of predictive accuracy. In the present study, Nepalese females possessed higher r^2 values (0.32 for maxillary teeth and 0.36 for mandibular teeth) compared to males (0.16 and 0.15 respectively). Some authors[19,27] obtained higher r^2 values for males whereas others[24] have reported higher r^2 values for females. These differences in r^2 values might be due to differences in sample sizes and ethnic diversity. The SEE denotes error involved in the use of prediction equations. The lower the SEE, the better the prediction equation. For the present study, the SEE ranged from 0.82 to 0.99 (Table 2). The SEE was lower for the maxillary teeth (0.82) compared to the mandibular teeth (0.97).

Applying the values of coefficients a and b, listed in Table 2, four equations for the prediction of

Table 1 Descriptive statistics for sum of mesio-distal widths of mandibular incisors; maxillary and mandibular canine and premolars (P is the result of the independent t test n=100 for each gender).

Tooth group	Gender	Mean (mm)	SD (mm)	Confidence interval	Range (mm)	Mean difference (SD)	P
Lower incisors	M	22.8	1.4	22.6–22.9	19.9–25.8	0.5 (0.2)	0.003
Lower incisors	F	22.3	1.6	22.1–22.5	17.7–26.2		
Maxillary canines and premolars	M	21.4	0.9	21.2–21.6	19.4–23.7	0.6 (0.2)	<0.001
Maxillary canines and premolars	F	21.0	1.1	20.8–21.2	17.4–24.6		
Mandibular canines and premolars	M	20.0	1.1	20.7–21.2	18.3–24.2	0.4 (0.1)	0.005
Mandibular canines and premolars	F	20.4	1.2	20.1–20.6	17.3–23.2		

Table 3 Comparison of predicted and actual values of Moyers, Tanaka and Johnston methods and present study for males (*P* value for an independent *t* test with equal variances).

	Predicted values of ΣCPM		Actual values of ΣCPM		Difference of predicted minus actual values		
Prediction methods	Mean	SD	Mean	SD	Mean	SD	*P*
Moyers 50% (1988)	20.8	0.4	21.2	1.0	−0.3	0.9	<0.001
Tanaka and Johnston (1974)	21.9	0.7	21.2	1.0	0.7	1.0	<0.001
Present study	21.0	0.6	21.2	1.0	−0.1	1.0	0.110

ΣCPM, sum of width of canines and premolars.

mesio-distal dimensions of the maxillary and mandibular canines and premolars were derived as follows:

1. for Nepalese males:

   Mandibular arch : $y = 14{\cdot}44 + 0{\cdot}28x$

   Maxillary arch : $y = 15{\cdot}52 + 0{\cdot}26x$

2. for Nepalese females:

   Mandibular arch : $y = 10{\cdot}12 + 0{\cdot}46x$

   Maxillary arch : $y = 12{\cdot}16 + 0{\cdot}40x$

   where x is mesio-distal dimension of the four permanent mandibular incisors in millimetres; y is mesio-distal dimension of the canines and premolars in millimetres.

Using these regression equations, we can predict the mesio-distal width of unerupted permanent canines and premolars for Nepalese subjects. Here 'x' is the sum of the widths of the lower permanent incisors and 'y' is the predicted value of the mesio-distal width of the unerupted permanent canines and premolars. Table 5 shows the prediction equations formulated from different populations found in the literature.

For Nepalese males, Moyers method at 50% tends to underestimate the actual width of the canine and premolars by 0.3 mm with a standard deviation of 0.9 mm. Whereas the Tanaka and Johnston method tends to overestimate the actual width of the canine and premolars by 0.7 mm with a standard deviation of 1.0 mm (Table 3). For Nepalese females, the Moyers method at 50% tends to overestimate the actual sum of canine and premolars by 0.2 mm (SD 1.0 mm) and the Tanaka and Johnston method tends to overestimate the actual sum of the canine and premolars by 1.0 mm (SD 1.0 mm) (Table 4).

The Moyers method uses percentiles to increase the accuracy of their prediction method. They suggested that the 75th percentile is the most accurate level for the prediction of crowding. In the present study, we found that when the Moyers method was applied to our Nepali sample at the 50th percentile it overestimated tooth size, therefore if it was applied at the 75th percentile the prediction error would be even greater. Tanaka and Johnston framed their equations for predicting the sum of the unerupted canine and premolar widths as regression formula without mentioning any percentage level.

Using the new regression equations, the mean difference between the predicted and actual width of the canine and premolars was calculated. The values are −0.10 (SD 0.96) for males, and 0.02 (SD 1.02) for females. These values were not statistically significant (Tables 3 and 4).

Many authors[16,17,23] have reported variations in the mesio-distal widths of permanent teeth in different racial

Table 4 Comparison of predicted and actual values of Moyers, Tanaka and Johnston methods and present study for females.

	Predicted values of ΣCPM		Actual values of ΣCPM		Difference of predicted minus actual values		
Prediction methods	Mean	SD	Mean	SD	Mean	SD	*P*
Moyers 50% (1988)	20.8	0.7	20.7	1.2	0.2	1.0	0.010
Tanaka and Johnston (1974)	21.6	0.8	20.7	1.2	1.0	1.0	<0.001
Present study	20.7	0.4	20.7	1.2	0.0	1.0	0.750

ΣCPM, sum of width of canines and premolars.

and ethnic groups. Table 5 shows comparisons between the regression equations of the present study with different ethnic groups from other studies. Nepalese males have the largest constant '*a*' (15.52) in the maxillary arch (Tables 2 and 5).

A previous study by Shrestha[15] in a Nepalese population found that the mesio-distal widths of permanent teeth in Nepalese subjects were between 0.5 and 1.2 mm smaller than those of white North Europeans. The data from our sample also suggested similar differences. Therefore, data derived from one ethnic group might not be applicable to another ethnic group for the purpose of the prediction of the size of unerupted permanent teeth.[3,18,19] The prediction equations obtained, from the data based on a Nepalese population, would be more accurate and reliable to Nepalese subjects despite the ethnic diversity of Nepal. Sexual dimorphism has also been noticed by different authors;[8,19,24] however, there are no raw data available to compare with the present study. Further

Table 5 Regression equations derived from various ethnic groups.

Study	Population group	Gender	Arch	Regression equation
Moyers[2]* (1988)	North American White	M	Mx	$y=9.73+0.51x$
		M	Mn	$y=10.79+0.45x$
		F	Mx	$y=14.17+0.28x$
		F	Mn	$y=8.85+0.52x$
Tanaka and Johnston[3] (1974)	North American White	M+F	Mx	$y=11.0+0.50x$
		M+F	Mn	$y=10.5+0.50x$
Zilberman *et al.*[26]	Israeli	M+F	Mx	$y=7.2+0.63x$
		M+F	Mn	$y=8.6+0.55x$
Jaroontham and Godfrey[25]	Northeastern Thailand	M+F	Mx	$y=11.87+0.47x$
		M+F	Mn	$y=10.30+0.50x$
		M	Mx	$y=13.36+0.41x$
		M	Mn	$y=11.92+0.43x$
		F	Mx	$y=11.16+0.49x$
		F	Mn	$y=9.49+0.53x$
Al Khadra[18]	Saudi Arab	M+F	Mx	$y=7.20+0.63x$
		M+F	Mn	$y=8.60+0.55x$
Yuen *et al.*[19]	Hong Kong Chinese	M	Mx	$y=7.97+0.66x$
		M	Mn	$y=8.82+0.58x$
		F	Mx	$y=8.30+0.61x$
		F	Mn	$y=6.66+0.64x$
Diagne *et al.*[28]	Black Senegalese	M+F	Mx	$y=9.87+0.53x$
		M+F	Mn	$y=5.67+0.70x$
		M	Mx	$y=9.60+0.55x$
		M	Mn	$y=5.45+0.72x$
		F	Mx	$y=13.77+0.35x$
		F	Mn	$y=8.74+0.56x$
Alhaija and Qudeimat[30]	Jordanian	M+F	Mx	$y=10.55+0.53x$
		M+F	Mn	$y=9.41+0.53x$
Peng *et al.*[31]	Mainland Chinese	M	Mx	$y=10.87+0.51x$
		M	Mn	$y=10.36+0.50x$
		F	Mx	$y=11.88+0.56x$
		F	Mn	$y=10.03+0.49x$
Present study	Nepalese	M+F	Mx	$y=13.35+0.35x$
		M+F	Mn	$y=11.60+0.40x$
		M	Mx	$y=15.52+0.26x$
		M	Mn	$y=14.44+0.28x$
		F	Mx	$y=12.16+0.40x$
		F	Mn	$y=10.12+0.46x$

*Moyers table (1988) at 50th percentile.
Mx, maxilla.
Mn, mandible.

investigations are required to test the accuracy of the newly developed prediction equations in different ethnic groups of Nepal.

There is a difference between statistical and clinical significance. Proffit[1] suggests that a mean error of <1.5 mm is not clinically significant for a Bolton's analysis. Our results found differences between predicted and actual tooth size of less than 1 mm per quadrant; however if multiplied for all four quadrants then the findings could be clinically significant. The other limitation is that the prediction correlations only account for a small percentage of the variation. This suggests that differences in tooth size between individuals may limit the accuracy of the prediction correlations and therefore they should only be used as a guide as to future space requirements.

Conclusions

- Both the Tanaka and Johnston and the Moyers prediction methods lead to inaccuracies when determining the actual widths of the canines and premolars in Nepalese subjects.
- The newly developed prediction equations will help inform treatment planning decisions in a Nepalese population.
- Statistically significant sexual dimorphism exists in tooth sizes between Nepalese males and females.
- Further studies based on larger sample sizes are required to confirm the applicability of the new regression equations proposed.

Contributors

Dr Alok Jaiswal was responsible for the study design; obtaining funding; logistic, administrative, and technical support and data interpretation; and final approval of the article. Dr Keshab Paudel, Dr Sunita Jaiswal and Dr Situ Shrestha were responsible for recruitment of participants and data collection; analysis and final revision of the article. Dr Alok Jaiswal is the guarantor.

Acknowledgements

I would like to thank Dr Hari, Dr Ujjwal, Dr Mannu, Dr Manoj and Dr Prakash who helped me with the sample collection and Miss Xiao Yan Liu for her advice and help in statistical analysis.

References

1. Proffit W. *Contemporary Orthodontics*, 4th Edn. St. Louis: Mosby, 2007, 195–201.
2. Lee-Chan S, Jacobson B, Chwa K, Jacobson R. Mixed dentition analysis for Asian-Americans. *Am J Orthod Dentofacial Orthop* 1998; **113**: 293–99.
3. Bishara SE, Jakobsen JR. Comparison of two non-radiographic methods of predicting permanent tooth size in the mixed dentition. *Am J Orthod Dentofac Orthop* 1998; **113**: 573–76.
4. Moyers RE. *Handbook of Orthodontics*, 4th Edn. Chicago: Yearbook Medical Publishers, 1988, 235–40.
5. Tanaka MM, Johnston LE. The prediction of the size of unerupted canine and premolars in contemporary populations. *J Am Dent Assoc* 1974; **88**: 798–801.
6. Nance HN. Limitation of orthodontic treatment. I. Mixed dentition diagnosis and treatment. *Am J Orthod* 1947; **33**: 177–223.
7. Huckaba GW. Arch size analysis and tooth size prediction. *Dent Clin North Am* 1964; **11**: 431–40.
8. Paula S, Almeida MA, Lee PC. Prediction of mesio-distal diameter of unerupted lower canines and premolars using 45° cephalometric radiography. *Am J Orthod Dentofacial Orthop* 1995; **107**: 309–14.
9. Hixon EH, Oldfather RE. Estimation of the sizes of unerupted canine and premolars teeth. *Angle Orthod* 1958; **28**: 236–40.
10. Staley RN, Kerber PE. A revision of the Hixon and Oldfather mixed-dentition prediction method. *Am J Orthod* 1980; **78**: 296–302.
11. Staley RN, O'Gorman TW, Hoag, JF, Shelly TH. Prediction of the size of the unerupted canine and premolars in a contemporary orthodontic population. *J Am Dent Assoc* 1984; **108**: 185–90.
12. Gardner RB. A comparison of four methods of predicting arch length. *Am J Orthod* 1979; **75**: 387–98.
13. Staley RN, Shelly TH, Martin JF. Prediction of lower canine and premolar widths in the mixed dentition. *Am J Orthod* 1979; **76**: 300–09.
14. Ballard ML, Wylie WL. Mixed dentition case analysis estimating size of unerupted permanent teeth. *Am J Orthod* 1947; **33**: 745–759.
15. Shrestha R. Measurement of mesio-distal tooth diameter of Nepalese permanent dentition. *J Nep Dent Assoc* 2005; **7**(1): 55–63.
16. Schirmer UR, Wiltshire WA. Orthodontic probability tables for black patients of African descent: Mixed dentition analysis. *Am J Orthod Dentofacial Orthop* 1997; **112**: 545–51.
17. Bishara SE, Jakobsen JR, Abdallah EM, Garcia AF. Comparison of mesio-distal and bucco-lingual crown dimensions of the permanent teeth in three populations from Egypt, Mexico and the United States. *Am J Ortho Dentofacial Orthop* 1989; **96**: 416–22.
18. Al-Khadra BH. Prediction of the size of unerupted canines and premolars in a Saudi Arab population. *Am J Ortho Dentofacial Orthop* 1993; **104**: 369–72.
19. Yuen KK, Tang EL, So LL. Mixed dentition analysis for Hong Kong Chinese. *Angle Orthod* 1998; **68**: 21–28.

20. Doris MD, Bernard BW, Kuftinec MM. A biometric study of tooth size and dental crowding. *Am J Orthod* 1981; **79**: 326–36.
21. Townsend GC, Brown T. Heritability of permanent tooth size. *Am J Phys Anthropol* 1978; **49**: 497–504.
22. Ballard ML. Asymmetry in tooth size, a factor in the etiology, diagnosis and treatment of malocclusion. *Angle Orthod* 1944; **14**: 67–71.
23. Bishara SE, Garcia A, Jakobsen SR, Fahl JA. Mesio-distal crown dimensions in Mexico and the United States. *Angle Orthod* 1986; **56**: 315–23.
24. Jaroontham J, Godfrey K. Mixed dentition space analysis in Thai population. *Eur J Orthod* 2000; **22**: 127–34.
25. Zilberman Y, Kaye E, Vardimon A. Estimation of mesio-distal width of permanent canines and premolars in early mixed dentition. *J Dent Res* 1977; **56**: 911–15.
26. Nourallah AW, Gesch D, Mohammad NK, Splieth C. New regression equations for predicting the size of unerupted canines and premolars in contemporary population. *Angle Orthod* 2002; **72**: 216–21.
27. Diagne F, Diop-Ba K, Ngom PI, Mbow K. Mixed dentition analysis in Senegalese population: Elaboration of prediction tables. *Am J Orthod Dentofacial Orthop* 2003; **124**: 178–83.
28. Flores Mir C, Bernabe E, Camus C, Carhuayo MA, Major P.W. Prediction of mesio-distal canine and premolars tooth width in a sample of Peruvian adolescents. *Orthod Craniofacial Res* 2003; **6**: 173–76.
29. ESJ Abu Alhaija, Qudeimat MA. Mixed dentition space analysis in Jordanian population: comparison of two methods. *Int J Paediatr Dent* 2006; **16**: 104–10.
30. Peng H, Wang X, Chen K. The prediction equation of the permanent canine and premolar crown. *Hua Xi Kou Qiang Yi Xue Za Zhi* 2000; **18**(1): 55–57.
31. Legovic M, Novosel A, Legovic A. Regression equations for determining mesio-distal crown diameters of canines and premolars. *Angle Orthod* 2003; **73**(3): 314–18.
32. Bernabé E, Flores MC. Are the lower incisors the best predictors for the unerupted canine and premolars sums? An analysis of a Peruvian sample. *Angle Orthod* 2005; **75**(2): 198–203.