ORIGINAL ARTICLE

Comparing Different Methods to Estimate the Combined Mesiodistal Widths of Maxillary and Mandibular Incisors

Mohammed Nahidh

Department of Orthodontics, University of Baghdad School of Dentistry, Iraq

ORCID ID of the author: M.N. 0000-0003-0155-418X.

ABSTRACT

Objective: This study aimed to develop regression equations to predict the combined mesiodistal widths of maxillary and mandibular incisors from each other and compare them with other methods.

Methods: One hundred pairs of study models from 100 Iraqi subjects with normal occlusion were used in this study. The individualized mesiodistal widths of maxillary and mandibular incisors were measured using electronic digital calipers. The combined mesiodistal widths of maxillary and mandibular incisors were calculated according to Tonn's and Abhi's formulas and from regression equations to be compared with the actual one.

Results: Both sums of the maxillary and mandibular incisors were significantly correlated. There were significantly high differences between the actual and calculated sum widths, and also between the calculated and predicted ones. On the other hand, a non-significant difference was obtained between the actual and predicted sum widths of maxillary and mandibular incisors.

Conclusion: Tonn's and Abhi's methods are not reliable methods to calculate the sum widths of maxillary and mandibular incisors. New regression equations are developed to predict the sum widths of maxillary and mandibular incisors from each other.

Keywords: Abhi's formula, Tonn's formula, regression

INTRODUCTION

The main purposes of orthodontic treatment are to establish the esthetic harmony, functional efficiency, and structural balance (1, 2), in addition to obtaining straight teeth and stable results. These purposes can be attained by having a good inter-digitation between the maxillary and mandibular teeth with coordinated tooth size materials in the same arch and both arches (3).

The maxillary and mandibular incisors are subjected to many anomalies, such as the difference in size, shape, or number. The most affected tooth is the lateral incisor in both arches. It may be congenitally missed, small in size, and being peg shaped (maxillary) or may be missed (mandibular) (4).

In 1909, Pont established an index to predict the maxillary inter-premolar and inter-molar distances using the combined mesiodistal widths of maxillary incisors (5). This index gave inaccurate prediction in some cases with congenitally missing and abnormally shaped maxillary incisors, especially the laterals (6). To resolve this problem,

Tonn (7) applied a formula to calculate the mesiodistal widths of the four maxillary incisors using the sum of mandibular incisors widths as follows: Sum of maxillary incisors=(Sum of mandibular incisors*4/3)+0.5.

In 2014, Bansal et al. (3) modified the Tonn's formula to estimate the sum of mandibular incisors widths from the sum of maxillary incisors widths and called it Abhi's formula: Sum of mandibular incisors= (Sum of maxillary incisors-0.5)*0.75. This formula was used to predict the mesiodistal width of impacted or missed lower incisor teeth.

To the best of author knowledge, until now, no study has been published to determine the reliability of the two mentioned methods, so the aim of the present study was to compare the sum mesiodistal widths of the maxillary and mandibular incisors using Tonn's and Abhi's methods with the actual mesiodistal widths and, at the same time, to formulate regression equations to predict the sum mesiodistal widths of the maxillary and mandibular incisors and compare them with the actual and previous methods.

METHODS

Sample
One hundred pairs of study models belonging to 50 male and 50 female subjects were used in this study. All subjects were of Iraqi Arab origin, aged between 17 and 22 years, with full permanent dentition regardless of the third molars. The teeth were in normal occlusion with no caries, fillings, or signs of attrition or abnormal anatomy.

Methods
After signing the consent form, the subjects were examined to fulfill the inclusion criteria. Then, alginate impressions were taken for the maxillary and mandibular teeth using the Hydrogum alginate impression material (Zhermack, Italy) and poured with Type IV dental stone (Navy blue, Zhermack, Italy) according to the manufacturer instructions. The individual mesiodistal width of maxillary and mandibular incisors was measured from the anatomical contact points using electronic digital calipers (Mitutoyo, Japan) with 0.01 mm sensitivity, held parallel to the occlusal plane (1), and the sum of mesiodistal widths of maxillary and

mandibular incisors was obtained to be considered as the actual sum of widths, while the calculated widths were obtained using Tonn's and Abhi's methods. The predicted sum widths were obtained using the regression equations.

Statistical analysis
The data were collected and analyzed using the Statistical Package for Social Sciences program version 21 (IBM Corp.; Armonk, NY, USA). The statistical analyses included:

1. Descriptive statistics comprising the Shapiro-Wilk test and the mean and standard deviations
2. Inferential statistics
a. Intraclass correlation test to test the reliability of the measurements
b. Independent samples t-test to verify the gender difference for the measurements
c. Pearson's correlation coefficient (r) to detect the relation between the sum of mesiodistal widths of maxillary and mandibular incisors
d. Simple regression analysis to establish the regression equations that can be used to predict the sum of mesiodistal widths of maxillary and mandibular incisors from each other
e. A paired sample t-test to compare the sum of mesiodistal widths of maxillary and mandibular incisors of both genders obtained with different methods

In the statistical evaluation, the following levels of significance were used:

Non-significant	NS	$p>0.05$
Significant	S	$0.05 \geq p > 0.01$
Highly significant	HS	$p \leq 0.01$

RESULTS

First, testing the normality of data distribution was performed using the Shapiro–Wilk test, and the results indicated normally distributed data. Intraclass correlation indicated good reliability when repeating measurements after 1 week (more than 0.7).

Table 1. Descriptive statistics and gender difference of the mesiodistal width of individualized and combined maxillary and mandibular four incisors

Teeth		Males		Females		Gender Difference		
		Mean	SD	Mean	SD	Mean Difference	t-Test	p
Maxillary	RL	6.779	0.530	6.636	0.464	0.143	1.431	0.156 (NS)
	RC	8.899	0.535	8.489	0.438	0.409	4.187	0.000 (HS)
	LC	8.898	0.523	8.533	0.459	0.365	3.705	0.000 (HS)
	LL	6.770	0.561	6.645	0.461	0.125	1.218	0.226 (NS)
	Sum	31.345	1.739	30.304	1.548	1.042	3.164	0.002 (HS)
Mandibular	RL	6.014	0.448	5.678	0.319	0.336	4.318	0.000 (HS)
	RC	5.369	0.329	5.167	0.304	0.203	3.196	0.002 (HS)
	LC	5.332	0.373	5.197	0.319	0.136	1.956	0.053 (NS)
	LL	5.987	0.360	5.720	0.318	0.267	3.938	0.000 (HS)
	Sum	22.703	1.332	21.761	1.079	0.942	3.886	0.000 (HS)

RL: Right lateral; RC: Right central; LC: Left central; LL: Left lateral

Table 1 revealed the descriptive statistics and gender difference of the mesiodistal width of individualized and combined maxillary and mandibular four incisors. Generally, the mean values of the measured parameters were significantly higher in males than females except for the maxillary right and left laterals and mandibular left central incisor where there was non-significant gender difference.

The relation between the combined widths of maxillary and mandibular incisors was presented in Table 2 for both genders.

Table 2. The relation between the sum width of maxillary and mandibular incisors

Gender	r	p
Males	0.867	0.000 (HS)
Females	0.731	0.000 (HS)

Table 3. Regression equations for both genders

Gender	Maxilla	Mandible
Males	$Y=5.631+1.133 X_1$	$Y_2=1.877+0.664 X_2$
Females	$Y_1=7.486+1.049 X_1$	$Y_2=6.325+0.509 X_2$

Y_1: Sum of maxillary incisors widths; X_1: Sum of mandibular incisors widths; Y_2: Sum of mandibular incisors widths; X_2: Sum of maxillary incisors widths

There was a strong direct significantly high correlation between them.

Regression equations to predict the sum of mesiodistal widths of the maxillary and mandibular incisors from each other are presented in Table 3, also for both genders.

In Tables 4 and 5, the actual sum of widths of maxillary and mandibular incisors was compared with that obtained from Tonn and Abhi and with that predicted by regression equations in both genders. There were significantly high method differences between both the actual and the predicted methods with that of Tonn's and Abhi's methods, while a non-significant method difference was detected between the actual and predicted one.

DISCUSSION

One of the most reliable methods of estimating the width of unerupted teeth is the developing of regression equation utilizing other teeth. Many studies had been conducted in Iraq to estimate the width of unerupted canine and premolars using this method and other methods (8-17).

Pont (5) tried to predict the maxillary inter-premolar and inter-molar distances using the combined mesiodistal widths of

Table 4. Descriptive statistics and methods' comparison in the male group

Teeth		Descriptive Statistics			Comparison		
	Methods	N	Mean	SD	Mean Difference	t-Test	p
Maxillary	Actual	50	31.345	1.739	0.574	4.490	0.000 (HS)
	Tonn	50	30.771	1.776			
Mandibular	Actual	50	22.703	1.332	-0.432	-4.500	0.000 (HS)
	Abhi	50	23.135	1.304			
Maxillary	Actual	50	31.345	1.739	-0.009	-0.069	0.946 (NS)
	Regression	50	31.354	1.510			
Mandibular	Actual	50	22.703	1.332	0.013	0.137	0.892 (NS)
	Regression	50	22.690	1.155			
Maxillary	Tonn	50	30.771	1.776	-0.583	-15.515	0.000 (HS)
	Regression	50	31.354	1.510			
Mandibular	Abhi	50	23.135	1.304	0.445	21.062	0.000 (HS)
	Regression	50	22.690	1.155			

Table 5. Descriptive statistics and methods' comparison in the female group

Teeth		Descriptive Statistics			Comparison		
	Methods	N	Mean	SD	Mean Difference	t-Test	p
Maxillary	Actual	50	30.304	1.548	0.789	5.071	0.000 (HS)
	Tonn	50	29.515	1.438			
Mandibular	Actual	50	21.761	1.079	-0.593	-5.082	0.000 (HS)
	Abhi	50	22.354	1.161			
Maxillary	Actual	50	30.304	1.548	-0.009	-0.064	0.949 (NS)
	Regression	50	30.313	1.130			
Mandibular	Actual	50	21.761	1.079	0.012	0.113	0.910 (NS)
	Regression	50	21.749	0.788			
Maxillary	Tonn	50	29.515	1.438	-0.798	-18.357	0.000 (HS)
	Regression	50	30.313	1.130			
Mandibular	Abhi	50	22.354	1.161	0.605	11.451	0.000 (HS)
	Regression	50	21.749	0.788			

maxillary incisors, but the problems associated with the presence and absence of lateral incisors made his index inaccurate. To solve this problem, Tonn (7) developed a formula to calculate the mesiodistal width of the four maxillary incisors using the sum of mandibular incisors width. Bansal et al. (3) benefited from this idea and calculated the mesiodistal widths of the four mandibular incisors using the sum of maxillary incisors width. Till now, there was no evidence about the accuracy of these methods, and to the best of the authors' knowledge, no study had been performed to ensure their accuracy. Hence this study was conducted.

The sample included Iraqi Arab subjects with full permanent dentition and class I occlusal relation. The individualized mesiodistal width of maxillary and mandibular anterior teeth was measured and collected for both genders. Reviewing Table 1 revealed that there was a significantly high difference between the genders for most of the measurements except the width of maxillary laterals and mandibular left central incisor. This difference is in the agreement with previous findings indicating significantly wider teeth in males (18, 19). The common finding that the tooth crown sizes in males exceeded, on average, those in females results from a greater thickness of dentin in male teeth. The difference is elucidated by the indorsing effect of the Y chromosome on dentin growth, probably through cell proliferation (20, 21).

The second step was finding the relationship between the sum of maxillary and mandibular anterior teeth widths using Pearson's correlation coefficient test. The results in Table 2 indicated that there was a direct strong significantly high correlation between the parameters in both genders. Vardimon and Lambertz (22) reported that if the value of the correlation coefficient test is greater than 0.70, the prediction procedures will be more reliable. These results paved the road for the next step, which was developing regression equations to estimate the combined widths of maxillary and mandibular incisors from each other for both genders, as described in Table 3.

The equation was calculated as Y=a+b X, where Y is the combined mesiodistal crowns widths of mandibular or maxillary permanent anterior teeth, X is the combined mesiodistal crowns widths of maxillary or mandibular anterior teeth based on which to predict, a is constant, and b is the regression coefficient. Now the actual sum widths (measured from study casts), calculated sum widths (calculated from Tonn's and Abhi's methods) in addition to the estimated sum widths (gained from applying the regression equations) were compared in both genders (Tables 4 and 5). The results revealed that there was a significantly high difference between the actual width and the calculated width. On the other hand, there was a non-significant difference between the actual and the predicted widths, while a significantly high difference was observed between the calculated and predicted widths. These results confirmed that the sum mesiodistal widths calculated from Tonn's and Abhi's methods were not reliable, and hence one cannot rely on these methods to calculate the sum widths of maxillary and mandibular anterior teeth.

Further studies are needed to develop regression equations in different countries as the mesiodistal widths of teeth are not the same in all people.

CONCLUSION

The present study is the first to determine the accuracy of the previous methods since no research has been performed to examine these methods statistically. Tonn's and Abhi's methods were not reliable in calculating sum mesiodistal widths of maxillary and mandibular incisors.

New regression equations to predict the sum widths of maxillary and mandibular anterior teeth were developed for both genders, and they proved statistically that their results were not different from the actual sum widths.

REFERENCES

1. Proffit WR, Fields HW Jr, Sarver DM. Contemporary orthodontics. 5th ed. St. Louis: Elsevier Mosby; 2013.
2. Graber LW, Vig KWL, Vanarsdall RL Jr, Huang GJ. Orthodontics current principles and techniques. 6th ed. St. Louis: Elsevier Inc; 2017.
3. Bansal A, John T, Chinde V, Sami L, Ahmed A, Jain A, et al. Think mathematic, gain orthodontic. Innovative modification of Tonn formula to calculate mesiodistal width of missing lower incisors. IOSR J Dent Med Sci 2014; 13: 61-2. [CrossRef]
4. Singh G. Textbook of Orthodontics. 3rd ed. New Delhi: Jaypee Brothers medical publishers (P) Ltd.; 2015.
5. Pont A. der Zahnindex in der Orthodontie. Z. zahnarztl. Orthop 1909; 3: 306.
6. Rakosi T, Jonas I, Graber TM. Color atlas of dental medicine. Orthodontic-diagnosis. 1st ed. New York: Thieme medical publishers Inc.; 1993
7. Tonn P. Uber die mesio-distalen Zahnbreiten-Relationen der Zähne des Oberkiefers zu den entsprechenden des Unterkiefers bei normale und anormaler Occlusion. Diss., Berlin, 1937.
8. Al-Khashan JA. Dimensional features of permanent teeth in Iraqis. Iraqi Dent J 1989; Special issue, Abstract book: 69-70.
9. Sofia SH. Mesio-distal crown diameter of permanent teeth and prediction chart for mixed dentition analysis. A master thesis. Department of Pedodontics, Orthodontics and Preventive Dentistry, College of Dentistry, University of Mousl, 1996.
10. Jargees HT. Prediction of the mesio-distal crown diameter of the un-erupted lower premolars. A master thesis. Department of Pedodontics, Orthodontics and Preventive Dentistry, College of Dentistry, University of Mousl, 2003.

11. Awni KhM. Comparison between Tanaka/ Johnston and Boston University prediction approaches in a group of Iraqi pupils. Al-Rafidain Dent J 2005; 5: 154-60.

12. Abdulrasool HM. First permanent molar as a guide for space analysis in the canine and premolar region. Iraqi Orthod J 2005; 1: 66-7.

13. Al-Bustani SHJ. Prediction of the canines and premolars size (comparative study). A master thesis. Department of Orthodontics, College of Dentistry, University of Baghdad, 2006.

14. Al-Dabagh DJ. Prediction of mesio-distal width of maxillary canines depending on mesio-distal width of mandibular canines by using regression equation. J Bagh Coll Dentistry 2011; 23: 114-8.

15. Jarjees HT. Estimation of the crown widths of un-erupted canine and premolars by using vistibulo-oral crown dimensions of permanent teeth. Al-Rafidain Dent J 2012; 12: 350-5.

16. Nahidh M. Prediction the widths of maxillary and mandibular canines and premolars from the widths of maxillary incisors and first molars (Iraqi study). J Bagh Coll Dentistry 2013; 25: 153-7. [CrossRef]

17. Nahidh M. Predicting the combined widths of unerupted maxillary and mandibular canines and premolars utilizing the widths of maxillary and mandibular central incisors and first molars. IOSR J Dent Med Sci 2016; 15: 80-4. [CrossRef]

18. Ghose LJ, Baghdadi VS. Analysis of the Iraqi dentition: Mesiodistal crown diameters of permanent teeth. J Dent Res 1979; 85: 1047-54. [CrossRef]

19. Saunders SR, Chan AH, Kahlon B, Kluge HF, FitzGerald CM. Sexual dimorphism of the dental tissues in human permanent mandibular canines and third premolars. Am J Phys Anthropol 2007; 133: 735-40. [CrossRef]

20. Moss ML, Moss-Salentijn L. Analysis of developmental processes possibly related to human dental sexual dimorphism in permanent and deciduous canines. Am J Phys Anthropol 1977; 46: 407-13. [CrossRef]

21. Alvesalo L, Tammisalo E, Therman E. 47 XXX females, sex chromosomes and tooth crown structure. Hum Genet 1987; 77: 345-8. [CrossRef]

22. Vardimon AD, Lambertz W. Statistical evaluation of torque angles in reference to straight-wire appliance (SWA) theories. Am J Orthod 1986; 89: 56-66. [CrossRef]