The effect of tooth shape ratio on mandibular incisors arrangement in Iraqi adult subjects

Sami K. Al-Joubori, B.D.S., M.Sc. [1]
Mohammed Nahidh, B.D.S., M.Sc. [2]

ABSTRACT

Background: This study aimed to assess the effect of tooth shape ratio on mandibular incisor arrangement.
Materials and methods: The sample included dental casts of some dental students and orthodontic patients having Class I dental and skeletal patterns with normal occlusion and severe crowding. The sample was divided into two groups according to the severity of crowding into: group I had Class I normal occlusion with mild or no crowded mandibular dentition and group II had Class I malocclusion with severe crowded mandibular dentition. Each group comprising of 40 subjects (20 males and 20 females). The mesio-distal and facio-lingual crown diameters were measured manually for each cast using modified vernier caliper gauge. Descriptive statistics were obtained for the measurements for both genders; independent samples t-test was performed to evaluate the gender difference in each group and to evaluate the groups' difference in total sample.
Results and Conclusions: The results showed that there is non-significant genders difference in both groups. Generally, the mesio-distal and facio-lingual dimensions were higher in severely crowded mandibular incisor group. Neither facio-lingual dimension nor the tooth shape ratio has significant influence of the mandibular incisor arrangement and the mesio-distal dimension is the most important factor.
Keywords: Tooth shape (Peck and Peck) ratio, normal occlusion, severe crowding. (J Bagh Coll Dentistry 2013; 25(Special Issue 1):132-136).

INTRODUCTION

The four mandibular incisors are the teeth most prone to positional irregularity. Studies have shown this, and no clinical orthodontist will deny it [1,2]. There are many potential factors in the etiology of mandibular anterior crowding. Tooth size variation is one of them [3]. Although a relationship between crown dimensions and the presence or absence of tooth irregularity is generally recognized, the exact nature of this association has, as yet, eluded investigators [4,5].

Peck and Peck [6] conducted a study to answer the question, "Do naturally well-aligned mandibular incisors possess distinctive dimensional characteristics?" Two samples of American white female young adults of European ancestry were utilized. The first group consisted of forty-five subjects carefully selected for their "perfect" mandibular incisor alignment. The second sample was a control population group of seventy subjects. Mesio-distal (MD) and facio-lingual (FL) crown diameters of the mandibular incisors were recorded for each subject in both groups by direct intraoral measurement. The results of this study indicated that mandibular incisors in perfect alignment are significantly smaller mesio-distally and significantly larger facio-lingually. From these findings it becomes apparent that tooth shape (MD and FL dimensions) is a determining factor in the presence and absence of mandibular incisor crowding.

(1)Assistant professor. Department of Orthodontics, College of Dentistry, University of Baghdad
(2)Lecturer. Department of Orthodontics, College of Dentistry, University of Baghdad

In 1972, Peck and Peck [7] conducted, on the same sample of the past study, a study to present the scientific basis and the clinical application of a new method for detecting and evaluating tooth shape deviations of the mandibular incisors. They proposed an index for clinical orthodontics utilizes an MD/FL ratio. It is constructed by dividing the mesio-distal on facio-lingual crowns diameters multiplying by 100. They concluded that a substantial relationship existed between mandibular incisor shape and the presence and absence of mandibular incisor crowding and the well-aligned mandibular incisors had MD/FL indices significantly lower than those-of crowded incisors.

Bau [8] carried out a study to investigate whether naturally perfectly aligned mandibular incisors differ significantly in their mesio-distal and facio-lingual dimensions and their mesio-distal-facio-lingual indices from naturally crowded mandibular incisors and whether associated with more ideal anterior intermaxillary tooth size indices than naturally crowded mandibular incisors. His results indicated that the mesio-distal dimension appears to demonstrate the most important distinctive difference between naturally aligned and naturally crowded mandibular incisor teeth.

Smith *et al.* [9] performed a study to answer the question of whether or not Peck and Peck ratios are more useful than simple measurements of incisor mesio-distal length. The results showed that the mesio-distal incisor lengths have slightly higher correlations with crowding than the shape ratios.

Imai *et al.* [10] investigated the relationship between tooth shape ratio and incisor arrangement and found that there is no clear relationship between tooth shape ratio of the mandibular incisors and arrangement of the permanent incisors in Japanese children.

This study aimed to assess the effect of tooth shape ratio on mandibular incisor arrangement.

MATERIALS AND METHODS

Sample

The sample included dental casts of some dental students and orthodontic patients having Class I skeletal pattern according to Foster [11] and Class I normal occlusion and Class I malocclusion (with severe crowding).

The inclusion criteria

1. Complete mandibular dentition (regardless the third molars).
2. Approximal contact present among the mandibular incisors.
3. Healthy gingival tissue with no gingivitis or periodontitis or any gum recession.
4. No history of abnormal habit.
5. No history of previous orthodontic treatment or maxillofacial surgery and facial trauma
6. No massive carious lesion or bulky restorations.

The sample was divided into two groups according to the degree of the mandibular dental arch crowding [12]:

1. The group 1: it includes (20 males and 20 females) with mild or no crowding.
2. The group 2: it includes (20 males and 20 females) with severe crowded mandibular dentition that is tooth size-arch size discrepancy of > 4mm.

Method

History and clinical examination

Each subject is asked to seat comfortably on the dental chair and asked information about the name, age, origin, medical history, the history of facial trauma and orthodontic treatment. Then they were asked to look forward horizontally (Frankfort plane parallel to the floor) for clinical examination, extra-orally and intra-orally to check their fulfillment of the required sample selection.

Dental Cast Production

Impressions were taken for every subject with Alginate impression material then poured with a prepared amount of stone. After setting of the dental stone, a base of Plaster of Paris was prepared and then the poured cast was inverted over it. After the final setting of the gypsum, the base was trimmed uniformly by trimmer and made ready for the measuring procedure.

Measuring Procedure

1. **Assessment of the mandibular dental arch crowding**

The assessment of the mandibular dental arch crowding was obtained by measuring the discrepancy in millimeters between the dental arch space available and the dental arch space required which was as followed:

Calculation of Dental Arch Space Available

To obtain the space available, a brass wire was extended from mesio-buccal cusp tip of first permanent molar on one side to that on the other side passing through the line of occlusion over the buccal cusps of the premolars, over the normal cuspal position of the canine and the incisal edge of mandibular incisors. Then the wire was carefully straightened and measured with modified vernier caliper gauge to the nearest 0.1mm [13].

Calculation of Dental Arch Space Required

The procedure of measuring the mesio-distal crown width was done as described by Hunter and Priest [14] as the greatest mesio-distal crown width of the teeth which was measured from the anatomic mesial contact point to the distal one. The measurements were made to the nearest 0.1 mm by using the modified sliding caliper gauge with pointed beak inserted in a plane parallel to the long axis of the tooth. The measurements started from the mandibular first permanent molar to the right central incisor on one side through to the corresponding tooth on the opposite side. After the mesio-distal crown width of each tooth was measured, the summation of these measurements in both right and left sides were calculated to determine the amount of the total mesio-distal crown width in the dental arch to calculate the space required. These measurements were used to quantify the dental arch length discrepancy by employing the basic equation:

Dental Arch Space Available - Dental Arch Space Required = Arch Length Discrepancy.

2. **Measuring the diameters of the mandibular incisors**

The maximum mesio-distal diameter was usually found at or near the incisal edge while the maximum facio-lingual diameter was measured by placing the vernier tips gingivally. The index proposed for clinical orthodontics utilizes an

MD/FL ratio. It is constructed in the following manner [7]:

Index= Mesio-distal diameter in mm. × 100
Facio-lingual diameter in mm.

Statistical Analyses

All the data of the sample were subjected to computerized statistical analysis using SPSS version 19 computer program. The statistical analyses included:

1. **Descriptive Statistics:** Means, standard deviations (SD) and statistical tables.
2. **Inferential Statistics:** Independent- samples t-test for the comparison between both genders in each group and between the groups in total sample.

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

Non-significant	NS	$P > 0.05$
Significant	*	$0.05 \geq P > 0.01$
Highly significant	**	$0.01 \geq P > 0.001$
Very highly significant	***	$P \leq 0.001$

RESULTS AND DISCUSSION

The results indicated in normal occlusion group (Table 1), the mesio-distal and facio-lingual dimensions were higher in males, while the MD/FL ratio was higher in females with a non-significant gender difference.

On the other hand, in severe crowding group (Table 2), the results showed that the mesio-distal and facio-lingual dimensions and MD/FL ratio were higher insignificantly in males except mesio-distal dimension and MD/FL ratio of mandibular right lateral incisor where were higher insignificantly in females.

As there was no genders difference in both groups, the total sample was compared between the two groups (Table 3) and the results showed that the mesio-distal and facio-lingual dimensions and MD/FL ratio were higher in severe crowding group with varying degrees of significance regarding the MD dimension only.

The findings of this study are in contrary to that of Peck and Peck [6] who found that the mandibular incisors in perfect alignment are significantly smaller mesio-distally and significantly larger facio-lingually, while agree with Bau [8], Imai *et al.* [10] and Agenter *et al.* [15] who found the same findings of the present study. This variability in the results may be attributed to the sample size and to the ethnic difference of other studies; in addition to that Peck and Peck [6] did their research on females only.

Reviewing the mean values of the variables measured in other studies, table 4 revealed that the MD and FL dimensions are slightly larger in the Iraqi sample while the tooth shape ratio is variable as it is affected by the MD and FL dimensions.

The conclusion that drawn from this study is that neither facio-lingual dimension nor the tooth shape ratio has significant influence of the mandibular incisor arrangement and the mesio-distal dimension is the major contributing factor for that.

REFERENCES

1. Massler M, Frankel JM. Prevalence of malocclusion in children aged 14 to 18 years. Am J Orthod 1951; 37(10): 751-68.
2. Berger H. The lower incisors in theory and practice. Angle Orthod 1959; 29(3): 133-48. **(IVSL).**
3. Ballard ML. Asymmetry in tooth size: a factor in the etiology, diagnosis and treatment of malocclusion. Angle Orthod 1944; 14(3): 67-70. **(IVSL).**
4. Moorrees CFA, Reed RB. Biometrics of crowding and spacing of the teeth in the mandible. Am J Phys Anthropol 1954; 12(1): 77-88.
5. Mills LF. Arch width, arch length, and tooth size in young adult males. Angle Orthod 1964; 34(2): 124-9. **(IVSL).**
6. Peck S, Peck H. Crown dimensions and mandibular incisor alignment. Angle Orthod 1972; 42(2): 148-53. **(IVSL).**
7. Peck H, Peck S. An index for assessing tooth shape deviations as applied to the mandibular incisors. Am J Orthod 1972; 61(4): 384-401.
8. Bau DJ. Mandibular incisor dimensions anterior intermaxillary ratio, in relation to mandibular incisor alignment. A master thesis. Department of Preventive Dentistry, Faculty of Dentistry, University of Sydeny, 1973.
9. Smith RJ, Davidson WM, Gipe DP. Incisor shape and incisor crowding: A re-evaluation of the Peck and Peck ratio. Am J Orthod 1982; 82(3): 231-5.
10. Imai H, Kuwana R, Yonezu T, Yakushiji M. The relation between tooth shape ratio and incisor arrangement in Japanese children. Bull Tokyo Dent Coll 2006; 47(2): 45–50
11. Foster TD. A textbook of Orthodontics. 2nd ed. Oxford: Blackwell Scientific Publications; 1985.
12. Ngan P, Alkire RG, Fields H Jr. Management of space problems in the primary and mixed dentitions. J Am Dent Assoc 1999; 130(9):1330-9.
13. Nance HN. The limitations of orthodontic treatment: I. Mixed dentition diagnosis and treatment. Am J Orthod Oral Surg 1947; 33(4): 177-223.
14. Hunter WS, Priest WR. Errors and discrepancies in measurement of tooth size. J Dent Res 1960; 39(2): 405-14.
15. Agenter MK, Harris EF, Blair RN. Influence of tooth crown size on malocclusion. Am J Orthod Dentofac Orthop 2009; 136(6):795-804. **(IVSL).**

Table 1: Descriptive statistics and gender difference in normal occlusion group

Teeth			Descriptive statistics						Genders difference	
			Male (N=20)		Female (N=20)		Total (N=40)			
			Mean	S.D	Mean	S.D	Mean	S.D	t-test	p-value
Lateral incisor	Left	MD	6.25	0.48	6.25	0.48	6.25	0.47	0	1 (NS)
		FL	6.73	0.43	6.69	0.43	6.71	0.42	0.3	0.77 (NS)
		ratio	93.05	7.33	93.72	8.64	93.39	7.91	-0.26	0.80 (NS)
	Right	MD	6.07	0.45	6.26	0.37	6.16	0.41	-1.51	0.14 (NS)
		FL	6.67	0.35	6.54	0.43	6.6	0.4	1	0.32 (NS)
		ratio	91.19	7.67	96.06	7.68	93.63	7.97	-2	0.052 (NS)
	Both	MD	6.16	0.57	6.25	0.42	6.2	0.44	-0.98	0.33 (NS)
		FL	6.69	0.39	6.61	0.43	6.65	0.41	0.9	0.37 (NS)
		ratio	92.12	7.46	94.89	8.16	93.51	7.89	-1.58	0.12 (NS)
Central incisor	Left	MD	5.63	0.38	5.59	0.48	5.61	0.43	0.29	0.77 (NS)
		FL	6.47	0.56	6.41	0.54	6.44	0.54	0.35	0.73 (NS)
		ratio	87.35	6.21	87.51	7.57	87.43	6.84	-0.07	0.94 (NS)
	Right	MD	5.69	0.4	5.6	0.44	5.64	0.42	0.72	0.48 (NS)
		FL	6.49	0.44	6.3	0.52	6.4	0.48	1.25	0.22 (NS)
		ratio	87.82	5.5	89.24	8.73	88.53	7.24	-0.62	0.54 (NS)
	Both	MD	5.66	0.39	5.59	0.45	5.63	0.42	0.71	0.48 (NS)
		FL	6.48	0.49	6.36	0.53	6.42	0.51	1.1	0.28 (NS)
		ratio	87.59	5.79	88.38	8.11	87.98	7.02	-0.5	0.62 (NS)

Table 2: Descriptive statistics and gender difference in severe mandibular anterior teeth crowding group

Teeth			Descriptive statistics						Genders difference	
			Male (N=20)		Female (N=20)		Total (N=40)			
			Mean	S.D	Mean	S.D	Mean	S.D	t-test	p-value
Lateral incisor	Left	MD	6.42	0.3	6.33	0.26	6.37	0.28	1	0.32 (NS)
		FL	6.84	0.46	6.75	0.32	6.8	0.39	0.72	0.48 (NS)
		ratio	94.08	6.22	93.82	4.24	93.95	5.26	0.16	0.88 (NS)
	Right	MD	6.35	0.24	6.47	0.38	6.41	0.32	-1.24	0.22 (NS)
		FL	6.82	0.41	6.61	0.4	6.71	0.42	1.67	0.10 (NS)
		ratio	93.29	5.56	98.21	7.21	95.75	6.83	-2.42	0.2 (NS)
	Both	MD	6.38	0.27	6.4	0.33	6.39	0.3	-0.26	0.80 (NS)
		FL	6.83	0.43	6.68	0.36	6.75	0.4	1.71	0.09 (NS)
		ratio	93.69	5.84	96.01	6.25	94.85	6.12	-1.72	0.09 (NS)
Central incisor	Left	MD	5.84	0.24	5.84	0.28	5.84	0.26	0	1 (NS)
		FL	6.73	0.55	6.58	0.37	6.65	0.47	1.04	0.30 (NS)
		ratio	87.25	7.18	89.02	5.56	88.14	6.4	-0.87	0.39 (NS)
	Right	MD	5.89	0.27	5.75	0.35	5.82	0.32	1.37	0.18 (NS)
		FL	6.67	0.45	6.6	0.38	6.63	0.41	0.57	0.57 (NS)
		ratio	88.46	5.04	87.34	5.67	88.9	5.33	0.66	0.51 (NS)
	Both	MD	5.86	0.25	5.8	0.31	5.83	0.29	1.05	0.29 (NS)
		FL	6.7	0.5	6.59	0.37	6.64	0.44	1.17	0.25 (NS)
		ratio	87.86	6.15	88.18	5.61	88.02	5.85	-0.25	0.81 (NS)

Table 3: Mean values and comparison between normal and severe mandibular anterior teeth crowding groups

Tooth			Mean values		Group difference	
			Normal	Severe	t-test	p-value
Lateral incisor	Left	MD	6.25	6.37	-1.44	0.16 (NS)
		FL	6.71	6.80	-0.99	0.33 (NS)
		ratio	93.39	93.95	-0.37	0.71 (NS)
	Right	MD	6.16	6.41	-2.96	0.000 ***
		FL	6.60	6.71	-1.21	0.23 (NS)
		ratio	93.63	95.75	-1.28	0.20 (NS)
	Both	MD	6.2	6.39	-3.08	0.002 **
		FL	6.65	6.75	-1.55	0.12 (NS)
		ratio	93.51	94.85	-1.2	0.23(NS)
Central incisor	Left	MD	5.61	5.84	-2.90	0.000 ***
		FL	6.44	6.65	-1.87	0.06 (NS)
		ratio	87.43	88.14	-0.48	0.63 (NS)
	Right	MD	5.64	5.82	-2.11	0.04 *
		FL	6.40	6.63	-2.36	0.21 (NS)
		ratio	88.53	88.9	0.44	0.66 (NS)
	Both	MD	5.63	5.83	-3.55	0.001 ***
		FL	6.42	6.64	-2.98	0.3 (NS)
		ratio	87.98	88.02	-0.04	0.97 (NS)

Table 4: Mesio-distal, facio-lingual dimensions and tooth shape ratio in different studies

Author(s)	Year	Country	Gender	State	No.	Central Incisor			Lateral Incisor		
						MD	FL	Ratio	MD	FL	Ratio
Peck and Peck	1972	USA	Female	Perfect	90	5.16	5.84	88.4	5.68	6.29	90.4
				Control	130	5.39	5.72	94.4	5.91	6.11	96.8
Bau	1973	Australia	Male	Perfect	16	5.18	5.39	87.53	5.75	6.41	90.03
				Crowded	60	5.37	6.03	89.29	5.99	6.37	94.2
Smith *et al.*	1982	USA	Male	Orthodontic patients	36	5.6	6	94	6.2	6.1	102
		Canada		Hutterite	50	5.2	6.3	83	5.8	6.5	90
		USA	Female	Orthodontic patients	64	5.5	5.8	95	6	6.1	98
		Canada		Hutterite	42	5.1	6.1	85	5.7	6.2	91
Imai *et al.*	2006	Japan	Mixed	Normal	27	5.26	5.45	97.32	5.9	5.66	105.1
				Crowded	13	5.54	5.73	97.17	6.21	5.86	106.59
Agenter *et al.*	2009	USA	Male	Good occlusion	42	5.31	5.91	-	5.78	6.28	-
				malocclusion	90	5.53	6.13	-	6.08	6.38	-
Present study	2013	Iraq	Mixed	Normal	40	5.63	6.42	87.98	6.2	6.65	93.51
				Crowded	40	5.83	6.64	88.02	6.39	6.75	94.85