Vertical analysis of patients with late lower arch crowding

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ABSTRACT

Background: Because of many factors play a role in the developing of late lower arch crowding, therefore the objective of the current study is to do vertical analysis for subjects with late lower dental arch crowding. The conducted study is the first attempt to do vertical analysis for Iraqi subjects with late lower arch crowding to see if there is a vertical discrepancy in such patients.

Subjects and methods: Eighty subjects were selected according to certain inclusion criteria from patients attending the Orthodontic Department in the College of Dentistry, Baghdad University, patients ranged between 18-25 years old. The 80 patients were divided into two groups (crowding and normal), 40 patients each (20 males and 20 females). A study cast of lower dental arch was obtained, and then Nance's space analysis made for each cast, Cephalometric radiographs were also taken for each patient involved in the current study and digitization was done to calculate nine vertical linear and twelve angular measurements.

Results: Most of linear measurements showed higher mean values in crowding than normal subjects except S-Go, Ar-Go, and PFH/AFH, also subjects with crowding had significantly higher (P<0.05) anterior facial height (ANS-Me) than normal subjects, and that difference occurred only in the lower part of the face, the Jaraback Ratio (PFH/AFH) was also low in crowding subjects, also higher mean values of LADH, UADH and UPDH in crowding group, may be due to compensatory over eruption of teeth as a result a bite opening occurred, indicating that patients with crowding have tendency toward posterior rotation. Regarding the angular measurements, subjects (total males and females) with crowding had larger mean values than normal. There were no interactions between total mean values of normal and crowding subjects for any outcome angular parameter, except four of the twelve angular measurements (SN-MP, Occ-MP, PP-MP, and sum S.A.G angles) showed an interaction, with females in both normal and crowding groups exhibited higher mean values than males.

Conclusions: Subjects with late lower arch crowding can have and/or affect on the vertical dimension, and the vertical discrepancy in late lower arch crowding should be considered during diagnosis and treatment plane of orthodontic cases, active treatment, and retention phase, in order to have stable end result in long term prognosis in orthodontics.

Keywords: Vertical analysis, late lower arch crowding. (J Bagh Coll Dentistry 2013; 25(2):149-154).

الخلاصة: بسبب العوامل الكثيرة التي تلعب دورا في تكون تراكب الاسنان المتأخر للفك السفلي. عملنا هذه الدراسة لتقيم البعد العمودي للرأس للاشخاص ذوي التراكب السني المتأخر في الفك السفلي. و تعتبر هذه الدراسة هي الاولى في هذا المجال للمرضى العراقيين. تتألف عينة البحث من ثمانين شخصا, اختيروا وفق بعض الضوابط من المرضى الذين راجعوا فرع تقويم الاسنان في كلية طب الأسنان, جامعة بغداد, تراوحت اعمارهم بين 18-25 عاما. الاشخاص الثمانون وزعوا الى مجموعتين (الاعتياديون وذوي الاسنان المتراكبة). كل مجموعة تتألف من اربعين شخصا (20 ذكرا و 20 انثى). القوالب التشخيصية للفك السفلي صنعت و عمل لها تحليل الفراغات السنية بطريقة نانس, وتم اخذ اشعات قياسية للرأس وتم تحليل تسعة قياسات خطية واثنى عشر زاوية. وقد تبين من نتيجة البحث بأن معظم القياسات الخطية كانت اعلى في الاشخاص ذوي التراكب السني للفك السفلي من ما هو عليه في الاشخاص الاعتياديين ما عدا ابعاد S-Go و Ar-Go , و PFA/AFH , كذلك الاشخاص ذوي التراكب السني المتأخرللفك السفلي لديهم قيمة معنوية عالية وملحوظة في بعد الوجه الامامي وهذا الاختلاف وجد في الجزء السفلي من الوجه, وان UADH, LADH,و UPDH اعلى في المجموعة المتراكبة بينما نسبة جاراباك كانت منخفضة, ويمكن ان يعزى هذا الاختلاف الى زيادة نمو الاسنان العمودي نتيجة العضة المفتوحة مما يدل على ان الاشخاص ذوي التراكب السني للفك السفلي لديهم ميل نحو الدوران الخلفي للفك السفلي. اما فيما يخص القياسات الزاوية فلم تكن هناك اختلافات معنويه ملحوظة بين مجموع متوسطات القيم لأي معلمة الا في اربع معلمات زاوية (Sn-MP, PP-MP,Occ-MP و مجموع S.A.G), نستنتج من هذه الدراسة بأنه يوجد فرق معنوي ملحوظ في قياسات الوجه العمودية بين الاشخاص الاعتياديين والاشخاص ذوي تراكب السني المتأخر للفك السفلي, وهذا الفرق يجب ان يأخذ بعين الاعتبار أثناء التشخيص ووضع الخطة العلاجية للحصول على افضل النتائج التقويمية المستقرة الطويلة الامد في علاج تقويم الاسنان.

INTRODUCTION

As crowding is considered as one of the most common malocclusion faced by an orthodontist during the professional carrier [1,2]. Van der Linden in 1974 has classified crowding on the basis of etiology into the categories of primary, secondary, and tertiary crowding. Primary crowding is defined as inherent discrepancy of tooth size and jaw size discrepancy, mainly of genetic origin. Secondary crowding is that type caused by environmental factors acting on the dentition, the most important of these is premature loss of deciduous teeth. Tertiary crowding is that type developed in the middle or late teens. It has also been referred to as late crowding or post-adolescence crowding [3].

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The crowding may affect the whole arch or be localized to the anterior segment, though crowding in the anterior segment is reported to be the more common than in the posterior segment of the lower arch[4].

A variety of factors have been reported to be responsible for lower incisor segment such as inclination of mandibular incisors during mixed dentition [4], inclination and size of mandibular permanent first molars [5], high mandibular plane angles, short mandibular body lengths, great upper face height, and small vertical dimensions in upper posterior segments [6]. Premature loss of deciduous teeth, morphology of the mandibular incisors and size of dental arch are also seemed to be contributing factors to lower incisors crowding [7-12]. The role of the third molar has been studied and debated at some length, and there is evidence to support the view that, in the untreated lower

arch, the third molar or lack of space for it may contribute to the development of crowding farther forward [13,14]. It is the nevertheless obvious that the third molar is not the only factor responsible for the development of such crowding, Bjork in 1969 suggested that extreme mandibular rotation could result in increased lower arch crowding [15], also complicated facial development may be responsible for the late crowding [16]. Researchers claimed that lower arch crowding was caused by specific pattern of growth and type of skeletal pattern that is susceptible to crowding at the beginning of adolescence or even at the late adulthood [6]. Studies showed a change in vertical pattern of patient can affect the lower incisor inclination [17,18]. However no study has aimed in detailed findings the vertical analysis of the patient with late lower arch crowding, therefore the objective of the current study is to do vertical analysis for patients with late lower dental arch crowding.

SUBJECTS AND METHODS

Out of 350 patients attending the Orthodontic Department in the College of Dentistry, Baghdad University, 80 patients were selected, dental study casts and lateral cephalometrics were evaluated in this study, the age of the patients ranged between 18-25 years old. All the patients were fulfilled the criteria of the sample selection which were:
1. The patients have not undergone previous orthodontic, orthopedic, facial, and surgical treatments.
2. They have complete permanent dentition, with no supernumerary, missing, or impacted tooth.
3. They have class one skeletal relation (ANB angle equals to 2-4 degrees).
4. The third molars were excluded.
5. No history of trauma to the dento-facial structures.
6. No massive carious lesion or bulky restorations.

The sample (80 patients) was divided into two groups, the first group composed of 40 patients with normal lower arch (20 males and 20 females), and the second group composed of 40 patients with late lower arch crowding (20 males and 20 females). A study cast of lower dental arch was obtained by taking an alginate impression and poured with stone, and then Nance's space analysis [19] made for each cast.

Space condition= Space available – Space required

Space available has been calculated as the length of a brass wire modeled in relation to the individual shape of the lower arch form right to left mesial marginal ridge of the lower first molar passing through incisal margins and buccal cusps of the posterior teeth. Space required has been calculated as the sum of the mesio-distal width of all teeth between the mesial contact points of the right and left lower first molar by using digital boley gauge caliber as shown in figure 1, negative values for space condition indicating crowding [19].

Cephalometric radiographs were taken for each patient involved in the current study with Planmeca ® (IL, USA) digital x-ray unit. Each lateral cephalometric radiograph was analyzed by Autocad (2011) software computer program to calculate nine vertical linear and twelve angular measurements (Figures 2 and 3).

Cephalometric landmarks: (Figure 2)
1. Point N (Nasion): The most anterior point of nasofrontal suture in the mid-sagittal plane [21-23].
2. Point S (Sella): The center of the shadow of the sella turcica [1,20,21].
3. Point Gn (Gnathion): The most anterior and inferior point of the bony chin, it is located where the bisector of the angle formed between the facial plane and the mandibular plane intersects the outline of the symphysis [20,21].
4. Point Ar (Articulare): The point of the intersection of the posterior margin of the ascending ramus and the outer margin of cranial base [20,21].
5. Point Go (Gonion): The point of intersection of the tangent to the posterior margin of the ascending ramus and the mandibular base [20,21].
6. Point Me (Menton): The most caudal point in the outline of the symphysis. It is regarded as the lowest point of the mandible [20,21].
7. Point ANS (Anterior nasal spine): The anterior tip of the sharp bony process of the maxilla at the lower margin of the anterior nasal opening [1,20,21].
8. Point PNS (Posterior nasal spine): The posterior spine of the palatine bone constituting the hard palate coincides with the lowest point of the pterygomaxillary fissure [1,20,21].
9. Point B (Supramentale): The most posterior midline point in the concavity of the mandible between the most superior point on the alveolar bone overlaying the roots' tips of mandibular incisors [20,21].

Vertical linear Measurements: (Figure 2):
Nine vertical linear skeletal measurements are

recorded to the nearest half millimeter:

1. N-Me (Total anterior facial height): The distance from point N to point Me[22].
2. ANS-Me (Lower anterior facial height): The distance from anterior nasal spine to menton[22].
3. S-Go (Total posterior facial height): The distances from point S to point Go.[20, 22].
4. Ar-Go (ramus height): The distance from point Ar to point Go [22].
5. LADH (Lower anterior dental height): It is the perpendicular distance from lower incisal edge projected at a right angle to the mandibular plane (GO-Me) [23].
6. LPDH (Lower posterior dental height): It is the perpendicular distance from mesiobuccal cusp of the lower first molar to the mandibular plane [24].
7. UADH(Upper Anterior Dental Height) which is the perpendicular distance from upper incisal edge projected at a right angle to the palatal plane (ANS-PNS)[23].
8. UPDH (Upper Posterior Dental Height) which is the perpendicular distance from the mesiobuccal cusps of the upper first molar to the palatal plane [25].
9. PFH/AFH (Posterior facial height/Anterior facial height): It is the ratio of the total posterior facial height (S-Go) to the total anterior facial height (N-Me)[20-23].

Angular measurements:(Figure 3)

1. N.S.Gn (Y-axis): This angle determines the position of the mandible relative to the cranial base [20].
2. N.S.Ar (saddle) angle: It is the angle between the anterior and posterior cranial base, this angle determines the position of glenoid fossa [19-26].
3. S.Ar.Go (articular) angle: It is the angle between the posterior border of the ramus and posterolateral cranial base [19].
4. Ar.Go.Me (gonial) angle: It is the angle between the posterior border of the ramus (Ar-Go), and the lower border of the mandible or mandibular plane (Go-Me); it expresses the form of the mandible and plays a role in growth prognosis [19,25].
5. SN-MP angle: It represents the inclination of the mandible to the anterior cranial base [20].
6. SN-Occ angle: It represents the inclination of the occlusal plane to the anterior cranial base [20,21]
7. Occ-MP angle: This angle is formed between occlusal and mandibular planes, this angle is important for assessing the prognosis for opening the bite [20,27-29].
8. PP-MP (Basal plane) angle: It is the angle of inclination of the mandible to the maxillary base. This angle serves to determine rotation of the mandible [20].
9. 1̄ -PP angle (dental):It is the angle between the long axis of the most prominent upper incisor with the palatal plane posteriorly[20].
10. ī-MP angle (dental):It is the angle between the long axis of the most prominent lower incisor with the mandibular plane posteriorly [20,27].
11. ii angle (dental): Interincisal angle between the long axis of the upper and lower central incisors posteriorly [20].
12. Sum S.A.G: It is the sum of saddle, articular, and gonial angles [20].

Statistical analysis

All the data of the sample were subjected to computerized statistical analysis using SPSS software comport program version 15, in which the descriptive statistics included mean, and standard deviation, and the inferential statistics included Student's t –test , probability values were considered significant at P<0.05, and highly significant at P<0.01.

RESULTS

The descriptive statistics (mean and standard deviation) for linear and angular measurements are shown in tables 1 and 2.

Regarding the linear measurements, most of these measurements showed higher mean values in crowding than normal subjects except S-Go, Ar-Go, and PFH/AFH, in which the crowding group showed lower mean values as demonstrated in table 1. On the other hand, there were highly significant differences (P<0.01) between normal and crowding subjects for total males and total group (total males-females) in regard to ANS-Me, LADH, UADH, and UPDH measurements using Student's t- test, because these measurements showed higher mean values in total crowding subjects than normal subjects, while there was significant difference (P<0.05) between normal and crowding subjects for total group (total males-females) regarding PFH/AFH parameter, this is due to the lower mean values in total crowding than normal subjects, in addition the total anterior facial height (N-Me) showed no significant difference (P>0.05) using Student's t-test, as illustrated in table 1 .

Regarding the angular measurements, subjects (total males and females) with crowding had larger mean values than normal. There were no interactions between total mean values of normal and crowding subjects for any outcome angular parameter, except four of the twelve angular

measurements (SN-MP, Occ-MP, PP-MP, and sum S.A.G angles), exhibited statistically significant differences at P<0.05 (for sum S.A.G angles) and highly significant differences at P<0.01 (for SN-MP, Occ-MP, and PP-MP angles) between normal and crowding subjects using Student's t- test as shown in table 2. On the other hand the SN-MP, Occ-MP, PP-MP, and sum S.A.G parameters showed that females in both normal and crowding groups exhibited higher mean values than males, therefore there was a significant difference (P<0.05) between normal and crowding subjects for total group (total males-females) in regard to sum S.A.G angles, and highly significant differences (P<0.01) in regard to SN-MP, Occ-MP, and PP-MP angular measurements using Student's t- test as shown in table 2.

DISCUSSION

Subjects falling within 18-25 years old were chosen because of the fact that most of the growth would have been completed by that time. Also a constant skeletal pattern gets established, as Schudy [30] said that the facial patterns once established did not change much. Studies have shown that the growth changes of the facial tissues, although not completed occurred predominantly before the age 18 years [31, 32].

The current study pointed on vertical parameter of facial morphology between normal and crowding subjects because many orthodontists deal with crowding, which is one of the most frequent types of malocclusion as only tooth-arch size discrepancy, in fact many other factors play a role in the developing of crowding, one of the most significant is vertical discrepancy and it is proved that the most difficult cases to be treated and which have the least favorable prognosis are frequently those in which there is a vertical discrepancy. This fact was amply by the fact that relapses in the vertical dimension of an orthodontically treated case is the first sign to be noted in patients with late lower arch crowding [33].

Lower anterior facial height ANS-Me was significantly higher in crowding than normal subject, while total anterior facial height (N-Me) showed no significant difference, thus indicating that the difference occurred only in the lower part of the face, this result agreed with Rasul et al [18], and disagreed with Miethke and Menthel [33].

The significant low mean values of Jaraback Ratio (PFH/AFH) in crowding than normal subjects may be due to the higher value of posterior facial height (S-Go) in normal than crowding subjects, this result agreed with Leighton and Hunter [5].

The significant higher mean values of LADH, UADH and UPDH in crowding group may be due to compensatory over eruption of teeth as a result, a bite opening occurred, indicating that patients with crowding have tendency toward posterior rotation.

SN-MP, Occ-MP, PP-MP and sum S.A.G. angular measurements were significantly higher in crowding than normal subject, indicated that patients with crowding have tendency toward posterior rotation, this come in accordance with Sakuda et al [6], Leighton and Hunter [5], and Rasul et al [18], who they found hyper-divergent cases showed the highest percentage of lower incisor crowding, since the new position of the dentition should be compatible with the dynamics of the muscular and occlusal forces in all planes, thus there is a serious risk of extreme migration after extraction in vertical facial types, in other words, posterior rotation case, and secure anchorage is required [5,6,18].

It can be concluded that subjects with late lower arch crowding can have a vertical discrepancy, and this discrepancy should be considered during diagnosis and treatment plane of orthodontic cases, active treatment, and retention phase, in order to have stable end result in long term prognosis in orthodontics.

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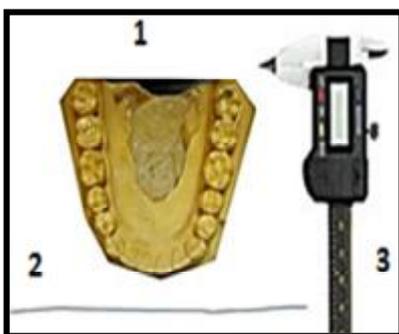
Figure 1: (1) Lower dental cast, (2) Brass wire and (3) Boley gauge caliber.
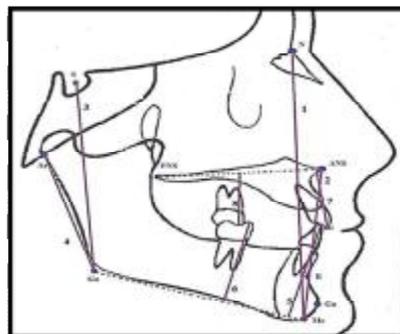
Figure 2: Cephalometric landmarks, and vertical linear measurements
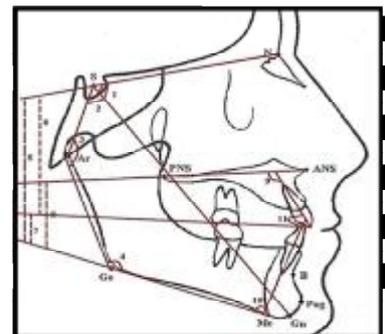
Figure 3: Cephalometric landmarks and angular measurements

Table 1: Descriptive and comparative statistics for linear measurements in normal and crowding subjects, in males, females, and total groups

		Normal			Crowding			Normal versus Crowding								
		Male	Female	Total	Male	Female	Total	Male (DF=38)			Female (DF=38)			Total (DF=78)		
		N=20	N=20	N=40	N=20	N=20	N=40	MD	T-Test	P-Value	MD	T-Test	P-Value	MD	T-Test	P-Value
N-Me	Mean	139.12	129.6	134.3	141.6	131.6	136.6	2.4	1.06	0.295	1.9	1.07	0.289	-2.3	1.2	0.23
	S.D.	7.12	4.52	7.6	7.6	6.7	8.71									
ANS-Me	Mean	77.27	71.8	74.5	82.5	77.3	79.9	5.2	3.73	0.001	5.47	3.8	0	-5.4	4.6	0
	S.D.	4.15	2.99	4.51	4.6	5.5	5.7									
S-Go	Mean	93.45	83.3	88.4	91.3	82.5	86.9	2.15	1.12	0.266	0.82	0.46	0.644	1.5	0.89	0.375
	S.D.	6.11	6.65	8.11	5.9	4.2	6.7									
Ar-Go	Mean	57.4	50.4	53.9	55.4	49.6	52.5	2	1.19	0.238	0.82	0.58	0.564	1.4	1.08	0.28
	S.D.	5.11	4.86	6.04	5.4	4.06	5.5									
LADH	Mean	47.82	43.7	45.7	50.5	46.9	48.7	2.7	2.8	0.007	3.17	3.27	0.002	-3	3.68	0
	S.D.	2.72	2.36	3.2	3.2	3.6	3.8									
LPDH	Mean	37.3	33.4	35.3	37.7	35.9	36.8	0.45	0.43	0.665	2.42	2.49	0.017	-1.5	1.84	0.068
	S.D.	3.8	2.91	3.8	2.6	3.2	3.04									
UADH	Mean	32.5	31.4	31.9	35.4	33.05	34.2	2.95	2.97	0.005	1.6	2.07	0.045	-2.3	3.4	0.001
	S.D.	3.2	1.82	2.6	3.06	2.9	3.2									
UPDH	Mean	27.1	25.8	26.4	29.6	26.7	28.1	2.5	3.34	0.002	0.95	1.22	0.229	-1.7	2.93	0.004
	S.D.	2.19	2.06	2.2	2.5	2.7	2.9									
PFH/AFH	Mean	67.24	64.02	65.6	64.3	62	63.1	2.9	1.71	0.094	2.02	1.2	0.208	2.5	2.08	0.041
	S.D.	5.81	5.07	5.6	5	4.9	5									

Table 2: Descriptive and comparative statistics for angular measurements in normal and crowding subjects, in males, females, and total groups

		Normal			Crowding			Normal versus Crowding								
								Male (DF=38)			Female(DF=38)			Total(DF=78)		
		Male	Female	Total	Male	Female	Total	MD	T-Test	P-Value	MD	T-Test	P-Value	MD	T-Test	P-Value
		N=20	N=20	N=40	N=20	N=20	N=40									
N.S.Gn	Mean	67.8	70	68.9	70	70.8	70.4	2.2	1.45	0.154	0.8	0.4	0.69	-1.43	1.27	0.208
	S.D.	4.07	5.8	5.11	5.3	4.6	5									
N.S.Ar	Mean	124	124.8	124.6	124.8	122.5	123.6	0.8	0.28	0.777	2.37	1.05	0.299	1	0.66	0.449
	S.D.	4.7	7.7	5.9	5.7	7.1	6.5									
S.Ar.Go	Mean	143	144.5	143.8	143.8	148.4	146.1	0.8	0.33	0.741	3.9	1.58	0.122	-2.3	1.46	0.146
	S.D.	5.3	7.2	6.3	5.11	8.3	7.1									
Ar.Go.Me	Mean	126	126.5	126.2	128.4	127.6	128	2.4	1.42	0.164	1.1	0.7	0.483	-1.8	1.54	0.126
	S.D.	5.4	4.3	4.8	5.2	5.1	5.1									
SN-MP angle	Mean	32.3	35.5	33.9	36.3	38.5	37.4	4	1.72	0.093	2.92	1.6	0.106	-3.5	2.34	0.021
	S.D.	7.03	4.9	6.2	7.6	6.1	6.9									
SN-Occ angle	Mean	14.9	18.2	16.5	15.4	18.3	16.8	0.5	0.36	0.716	0.1	0.06	0.947	-0.3	0.28	0.77
	S.D.	4.2	4.2	4.5	4.4	5.1	4.9									
Occ-MP angle	Mean	17.7	18.02	17.8	21.5	19.8	20.6	3.85	2.7	0.009	1.77	1.49	0.144	-2.8	3.06	0.003
	S.D.	4.8	3.4	4.1	3.9	4.07	4.04									
PP-MP angle	Mean	23.4	25.2	24.3	28.8	29.1	28.9	5.4	2.9	0.005	3.9	2.63	0.012	-4.6	3.97	0
	S.D.	6.21	3.4	5.05	5.3	5.6	5.4									
1̱ -PP angle	Mean	116	114	115	113	115	113.6	3.55	1.65	0.107	0.85	0.45	0.649	1.4	0.947	0.346
	S.D.	7	6.1	7.08	5.6	5.5	5.5									
ī -MP angle	Mean	93.6	92.9	93.2	93.2	92.3	92.8	0.35	0.17	0.862	0.55	0.22	0.82	0.4	0.29	0.77
	S.D.	7.1	7.3	7.1	5.3	7.8	6.6									
ii angle	Mean	127.9	129.07	128.5	125.8	124.1	124.9	2.15	0.82	0.414	4.92	1.54	0.131	3.6	1.73	0.087
	S.D.	9.4	9.9	9.5	6.7	10.2	8.6									
Sum S.A.G	Mean	389.4	395	392.7	397.2	398.7	397.9	7.8	1.6	0.117	3.75	1.4	0.168	-5.27	1.99	0.049
	S.D.	20.3	15.5	15.07	7.7	6.7	7.2									