Changes in mandibular anterior teeth alignment of 12-14 year olds during a 4-year follow up in Qazvin

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Abstract

Aim: One of the core parts of clinical orthodontics is the analysis of dentofacial growth. Changes that occur in the shape, form and size of dentoalveolar arch may result in various problems during diagnosis and treatment planning. The aim of this study was to investigate the late changes of alignment in the anterior teeth of mandible during 4-years follow up in young adults with normal occlusion in Qazvin.

Materials and Methods: This was a longitudinal descriptive survey with 23 samples (13 girls and 10 boys). Subjects with an age range of 13±1 were selected for dentoalveolar change assessment. Two dental models were prepared from each subject one at the start of the investigation and one at the 4 year follow up; photographs of each model were taken at the time. Inter-canine distance, anterior arch depth, arch shape index, anterior teeth width (6 anterior teeth), anterior arch circumference (ATSALD) were measured using AutoCAD 2004 software and digital caliper. Means and standard deviations were measured using Npar test analysis. Data were compared at 0 and 4 years and between two genders using Wilcoxon test ($P<0.05$).

Results: The most prevalent changes in samples belonged to ATSALD (2.2mm increase) over the four years. The least changes were detected in arch shape index. Anterior arch circumference and ATSALD were the dominant changes in boys and girls, respectively.

Conclusion: During this critical growth period, anterior crowding of mandibular teeth increases in both boys and girls, while the inter-canine distance and arch shape index decrease.

Key words: Late irregularity, Crowding, Mandibular arch, Longitudinal study, Normal occlusion
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Investigating and gaining insight into dentoalveolar growth patterns is an essential element of didactic and clinical orthodontics. [1] According to Meredith, growth is defined as all the anatomic and physiologic changes occurring from the post-natal stage of life which continues throughout life. Primary growth occurs from childhood till preadolescence and secondary growth occurs from adolescence to adulthood.[2]

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The changes that arise in the shape and size of dentoalveolar arch result in different diagnostic and treatment planning problems in orthodontics, which may subsequently affect the esthetic and stability of the dental system.[1] There is an increasing need for orthodontic treatment in adults, and therefore, adequate knowledge regarding the craniofacial and dental changes that occur is required.[1] Growth changes are complicated and each person has an individual growth pattern which is influenced by different genetic, environmental, and internal factors. Factors such as mesio-distal width of unerupted teeth, sequence and time of eruption, jaw growth direction, alveolar process growth and also inter-muscular balance also affects this pattern. [2,3] Irregularity,crowding and malpositioned anterior

teeth are the most prevalent dentoalveolar changes during adolescence; these occur due to various factors which may occur simultaneously or through different growth stages of the adolescent. Factors include jaw growth, mandibular rotation, abnormal tooth attrition or wear due to diet/habit, induced forces from wisdom teeth, delayed growth of mandible, mesial forces in the posterior dental arch, distal forces in the anterior dental arch, occlusal changes, tooth eruption and growth direction, tooth morphology, periodontal forces, degenerative changes of connective tissue[4], tooth size, width, depth and length of dental arch[5], as well as head and neck posture[6]. Crowding of lower anterior teeth has been observed as normal variation in adolescence.[7] Different values for crowding and dimensional changes of the mandible have been reported previously. [8] The different findings of these studies may be due to their dissimilar study designs or statistical analyses.[2]

Previous analytical studies in orthodontics were based on dental casts which was a technique sensitive procedure and provided only linear information. Recently digital cameras have become popular; they can provide more precise information which can be used on an individual or comparative basis for different persons or times.

Studies focused on the dimensional changes in the mandible are scarce in Iran; therefore the aim of this study was to assess mandibular changes in preadolescents and adolescents within the age range of 13±1 to 17±1, with normal occlusion and class I molar relationship in Qazvin.

Materials and Methods

This descriptive longitudinal study was performed on the study models of 60 patients in the age range of 12- 14 years in Orthodontic Department archives of Qazvin dental faculty in 1383-1384. Inclusion criteria consisted of favorable frontal view, normal overjet and overbite on skeletal midline and maximum intercuspation in normal occlusion. Carious interproximal surfaces, mild rotations and crowding of 1-2 mm were ignored. However as only 23 (10 male and 13 female with the age range of 12-14) patients were available for 4-year follow up, the study sample was reduced to 23 subjects. They showed normal overjet, overbite and molar relation. During imaging all study models were positioned identically. Images of dental casts were taken using digital camera at a 20 cm distance to achieve a superior image quality. Images were saved and were analyzed using Auto CAD 2004, mechanical desktop software; they were then scaled with 1×1 magnification using a ruler. Images related to each sample were stored individually.

Second rugae was connected to a midpoint between the two fovea palatines (which were evident on the casts). The midpalatine raphe (midline of the maxilla) is defined by two anatomical points on the palatine raphe as the reference plane for the transverse symmetry analysis.The anterior point is the cross section between the second palatine rugae with the palatine raphe and the posterior point is the cross section of the border of the hard and soft palate with the palatine raphe. These are the reference points for transverse symmetry analysis.[9] The mandibular midline was then assigned through adaptation of upper on the lower casts in centric occlusion relation, this was then directly transferred to the mandible.

The maxillary midline which was transferred to mandible cast via real contact points was called Y axis. In order to define X axis, through adaptation of mandibular midsagital lines related to T1 (77) and T2 (81), images were moved anterio-posteriorly until mid point of mesial line angles of centrals were overlapped at T1 and T2. Geometric triangle was formed consisting of right arch segments (cord), left arch cord and inter-canine width. The mesial angle tips of central incisors were connected to canine tips to form the triangle; the two canine tips were also joined to form a complete triangle. All measurements were carried out in the formed axis. Anterior-posterior depth of arch was measured with

$$\sqrt{\left(\frac{\text{left chord}^2+\text{right chord}^2}{2}\right)-\left(\frac{\text{inter canines width}^2}{4}\right)}$$



Figure 1 : Anterior geometric triangle used for ATSALD calculations

The values were approximated to 0.001mm. Since mesial and distal contact points and arch circumference could not be calculated exactly by software, the measurements were performed directly on the casts using a digital caliper with 0.001 mm of accuracy. Anterior arch length was measured as the distance between contact points of central incisors to distal contact of canines on each side. Anterior tooth size to arch length discrepancy was then measured as the difference between arch circumference and the sum of the mesio-distal widths of 6 anterior teeth. Negative values indicated crowding and positive values indicated spacing.

Data were measured twice by an observer before their means were calculated. Non parametric test were used for analysis. Data were compared between genders and at two stages with Wilcoxon test. (CI=95%)

Digital images were taken from the occlusal surfaces, and then analyzed using computerized Auto CAD 2004 software. Digital calipers with 0.001 mm of accuracy were also used to evaluate dental arch changes.

Results

Lower inter-canine width showed almost 0.67mm decrease (P<0.24) (Table1) (0.18 mm in females (P<0.75) and about 0.85 mm in males (P<0/02) (Table 2). The changes in inter-canine width between two genders were not statistically significant. Almost 0.1 mm of decrease was observed in incisors-canines distance (P<0.2) (Table 1) (0.14 mm in females (P<0.55) and 0.27 mm in males (P<0.16). The mean of DGLC decrease was 0.2 mm (P<0.19) (Table 1) (0.14 mm in females (P<0.55) and 0.27 mm in males (P<0.16).

The mean decrease in arch form index (width/depth) was 0.001mm (P<0.001) (0.002mm in females (P<0.002) and about 0.001 in males (P<0.005).

Anterior arch circumference decrease was 0.45 mm (P<0.183) (1.04 mm decrease in females (P<0.01) versus 0.33 mm increase in males (P<0.21)).

Table 2 showed that ATSALD increased approximately 2.20mm after 4 years, (P<0/000) (1.59 mm increase in females (P<0.002) and 1.50 mm in males (P<0.003). Differences between two genders were not statistically significant.

Depth of Lower canines = DLC; Inter-canine Width= ICW; The sum of lower teeth width (Width Sum) =WS; Anterior Arch length= AAL; Depth of Geometric in Lower Canine= DGLC ; Anterior tooth size arch length discrepancy= ATSALD; Arch Form Index =AAFI

Table1: Mean and standard deviation related to arch indices of all samples and according to gender (1377-1381).

variant	In 1377						In 1381					
	female		men		All sample		female		men		All sample	
	mean	SD	Mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
DLC	7.52	1.05	7.58	0.46	7.55	0.67	7.37	0.81	7.31	0.36	7.35	0.806
ICW	37.60	1.73	28.77	2.17	28.11	1.97	27.43	1.51	27.93	1.67	27.64	1.56
DGLC	7.53	0.81	7.60	0.45	7.56	0.67	7.38	1.04	7.33	0.34	7.36	0.8
AAFI	0.27	0.04	0.263	0.03	0.27	0.30	0.268	0.035	0.262	0.02	0.264	0.035
WS	34.32	1.85	35.08	1.90	34.65	1.86	35.12	1.28	36.64	1.04	35.78	1.44
AAL	35.06	1.68	35.20	1.28	35.13	1.44	34.02	1.64	35.53	1.41	34.67	1.69
TSALD	0.57	1.28	0.147	1.57	0.39	1.58	-1.02	1.23	-1.03	1.77	-1.05	1.44

Table2: Significance test of arch indices 1377-1381 (Females and Males)

Variety	Significance (Female-Male), 1999		Significance (Female-Male), 2003		Significance in Females (1999-2003)		Significance in Males (1999-2003)	
DLC	052.8	NS	0.438	NS	0.552	NS	0.169	NS
ICW	0.352	NS	0.620	NS	0.753	NS	0.028	S
DGLC	0.852	NS	0.495	NS	0.552	NS	0.169	NS
AAFI	0.75	NS	0.80	NS	0.001	S	0.005	S
WS	0.347	NS	0.007	S	0.04	S	0.02	S
AAL	0.823	NS	0.027	S	0.01	S	0.21	NS
TSALD	0.537	NS	0.894	NS	0.002	S	0.003	S

ATSALD; Arch Form Index =AAFI



Figure 2 . Mean dimension of anterior triangle in all the samples (1999-2003)



Figure 3 . Mean dimension of anterior triangle in male (1999-2003)

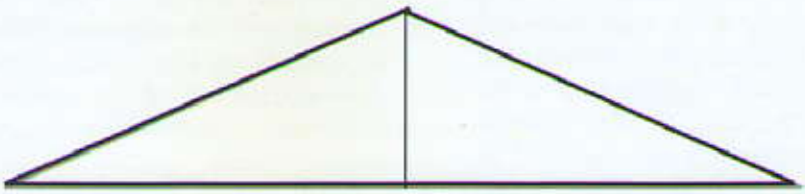


Figure 4 . Mean dimension of anterior triangle in female (1999-2003)

Discussion

In our study the change in the mandibular anterior segments were studied in a 4 year period. This can be a reference for understanding physiological variations occurring during adolescence. Moreover we can understand what should be done in order to prevent relapse of orthodontic treatment results and how to retain them.On the other hand, recent advances in digital imaging has caused the growth studies to be more precise and comparable.

This was also the issue in our study. We took photographs from the cast and correct the size and superimposed the defined distances on the images.

In our study inter- canine width decreased in all subjects; however, this was not statistically significant. This decrease implies that following the eruption of lower incisors, mandibular arch width remained constant. After the eruption of permanent teeth from adolescent and there is a mild decrease in mandibular inter-canine width, Ross Powell showed that mandibular inter-canine width increases during the ages 3-16 years and that no changes occurred in the dental arch width after the eruption of canines.[10] Bishara in 2001 reported a decrease of approximately 1.2mm in mandibular inter-canine width through 13-15 years of age.[1] Mandibular alveolar process has a parallel and vertical growth pattern which leads to a decrease in inter-canines width.[10]

Eslambolchi et al [11] studied mandibular incisor alignment in untreated subjects. The mean number of years between initial and final observations were 29.8 years for children and 33.7 years for the parents. Overjet, overbite, mandibular inter-canine width, mandibular arch length, incisor irregularity index were measured to an accuracy of 0.01mm. They showed that there were no statistically significant ($P>0.01$) differences between the sexes for the variables measured. Incisor irregularity index continued to increase in all groups ($P<0.01$), although this rate appeared to be lower in the parent group. Inter-canine width and arch lengths continued to decrease with age.

Ross Powell and Harris demonstrated that maxillary and mandibular depth decreased between the ages of 3-18. [10] They also showed a decrease in arch form index (arch depth ratio to arch width) in all samples. When arch depth decreases less than arch width, the form index reduces and vice versa. [11] According to the present study, anterior arch depth reduced less than the inter-canine width so that the total anterior arch form index decreased; this demonstrates a short and narrow alveolar arch form. Crowding in mandibular anterior segment occurred in all subjects (males and females). This could be due to reasons outlined below:

Late growth of mandible; mesial drift of posterior teeth; distolingual movement of incisors; pressure due to third molar eruption; and /or due to decrease of arch length [1].

Richarson in 1995 showed that lower arch crowding increased 2.63mm in boys and 2.06 in girls, between the ages of 18 and 30 years. [12] Buschang and Shulman described that 22% of people among 15-50 years old almost had 4-7mm of crowding, 17% of them had more than 7mm and about 50% are with mild crowding or without crowding. [13] Thilander demonstrated that increase of age causes mandibular crowding even in patients with third molar missing. [14]

Ross powell and Harris expressed arch form become shorter and wider during primary dentition (3-5years old). During mixed dentition 5-11 years old and permanent incisor eruption, arch depth showed greater increase compared to arch width; this is because of the increased inclination (buccal inclination) of the permanent incisors than primary ones .[10]

Conclusion

Mandibular inter-canine width (canine to canine) and arch depth decreased; this was observed more in males than females. Arch form index decreased in all cases (female>males). Anterior arch circumference decreased overall in all subjects and in all female subjects however it demonstrated a mean increase in males .Crowding increased in all samples (female>males).

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