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CHANGES IN THE DENTAL ARCHES THAT OCCURRED IN TRANSITION FROM MIXED DENTITIONS TO PERMANENT DENTITIONS: A LONGITUDINAL STUDY

KARIŞIK DİŞLENMEDEN DAİMİ DİŞLENMEYE GEÇİŞTE DİŞ KAVİSLERİNDE MEYDANA GELEN DEĞİŞİKLİKLER: LONGİTUDİNAL ÇALIŞMA

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ABSTRACT

The purpose of this study is to provide information on the normal growth and development of the dental arches.

Materials were longitudinal dental casts obtained from 30 (15 males, 15 females) children with acceptable occlusion. The dental casts were taken first at the early mixed dentition and then five years later for the purpose of assessment of dental arch changes. Six transversal, one vertical and five sagittal measurements were made to evaluate changes in the dental arches that occurred in transition from mixed dentition to permanent dentition. The Student's t test was used to determine if there were any differences between the measurements with regard to sex. First and second set of dental cast measurements were evaluated with a paired t test to determine the changes that occurred with growth

The results of the Student's t test showed that there was no significant difference between males and females in the majority of the parameters. The results of paired t test showed that in the combined group, significant changes occurred both in maxilla and mandible with growth.

It was determined that there were statistically significant changes in all the measurements except for total arch length in maxilla but the changes in distances between incisors and between canines in mandible were not significant while the changes in the other measurements were of statistical significance. The results of this study showed that changes in the dental arches that occurred in transition from mixed dentition to permanent dentition should be well considered in order to obtain acceptable outcomes from orthodontic treatment

Key Words: *Mixed dentition, Permanent dentition, Dental arch*

ÖZET

Bu çalışmanın amacı diş kavsinin normal büyüme ve gelişimi hakkında bilgi sağlamaktır. Bu çalışmanın materyalini kabul edilebilir oklüzyona sahip 30 çocuğun longitudinal ortodontik modelleri oluşturmaktadır. Diş kavsindeki değişiklikler hakkında bilgi elde etmek için, ortodontik modeller erken karışık dişlenme döneminde ve beş yıl sonrasında alınmıştır. Karışık dişlenmeden daimi dişlenmeye geçişte diş kavsinde meydana gelen değişiklikleri değerlendirmek için 6 transversal, 5 sagittal ve 1 vertikal ölçüm yapılmıştır. Cinsiyete göre ölçümler arasında farklılık olup olmadığını değerlendirmek için Student's t testi kullanılmıştır. Büyüme ile meydana gelen deşiklikleri değerlendirmek için eşleştirilmiş t testi kullanılmıştır. Student's t testi sonuçları ölçümlerin çoğunda cinsiyet farklılığı olmadığını göstermiştir. Eşleştirilmiş t testi sonuçları birleşik grupta maksilla ve mandibulada büyüme ile önemli değişikliklerin meydana geldiğini göstermiştir. Maksillada total ark uzunluğu dışında diğer ölçümlerde istatiksel olarak önemli değişikliklerin olduğu; mandibulada ise keserler ve kaninler arası mesafelerdeki değişikliklerin önemli olmadığı ve diğer ölçümlerdeki değişikliklerin istatiksel olarak önemli olduğu tespit edilmiştir. Bu çalışmanın sonuçları, ortodontik tedaviden iyi bir sonuç elde edebilmek için karışık dişlenmeden daimi dişlenmeye geçişte diş kavsinde meydana gelen değişikliklerin iyi bilinmesi gerektiğini göstermiştir.

Anahtar Kelimeler: *Karışık dişlenme Daimi dişlenme, Dental ark*

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INTRODUCTION

One of the important objectives of the orthodontic treatment is the establishment of normal occlusion and its maintenance. Therefore, there is a need for further knowledge of the concurrent skeletal and dental changes that occur in the untreated normal person during the active growth years and beyond. Such information would form the baseline from which to plan orthodontic therapy and would provide an insight into normal developmental changes and their relationship to results achieved by orthodontic treatment.

Dental arch dimensions are not static; they change systematically during the period of intensive growth and development.[1-4] Causes of changes in size and form of the dental arch are multifactorial, such as sutural expansion in the maxilla, remodeling of alveolar bone,[5-7] interarch relationships of the teeth, and contractile properties of supracrestal fibers[8]. In the dental arch, relatively rapid changes occur during transitional dentition, and once a functional permanent dentition is established, smaller changes are observed to continue[9]. The understanding of the sagittal and transversal changes that occur between mixed and permanent dentitions in the maxillary and mandibular arches is crucial for the clinician interested in early orthodontic treatment.

A lot of studies[2,10,11] have been performed to evaluate changes in the dental arches but the results of these studies do not agree with each other, because a number of factors affect dental arch growth. Researchers[12-16] reported that size and form of the dental arch exhibit considerable variability within and among human groups. Especially there is a marked variation between the dental arches of different ethnic groups.[17]

The purpose of this study was to investigate dental arch changes that occurred in transition from mixed dentition to permanent dentition in Turkish children.

MATERIALS AND METHODS

Dental casts of 30 subjects (15 males and 15 females) were selected from the growth archives of Orthodontic Department of Atatürk University Dental Faculty. Selection of the subjects was based on clinically normal occlusion, eruption of the first molars and permanent incisors at the beginning of study and a history of no orthodontic treatment. All subjects were healthy and free from any chronic problems known to affect growth. According to crowding index identified by Little,[18] minimal crowding (± 3 mm) was accepted as normal. The mean age of the sample at the beginning of this study was 9.7 ± 1.2 years for the males and 9.6 ± 0.6 years for the females.

Dental casts were made from alginate impressions taken at the beginning of early mixed dentition and five years later they were obtained from subjects fitted to these criterions. The following measurements were made in upper and lower dental casts to determine the changes that occurred in the dental arch.

Transversal measurements:

Inter central incisor width (I_1-I_1)

Inter lateral incisor width (I_2-I_2)

Inter canine width (3-(III) 3 (C-C))

Inter first premolar width (DM_1 (PM_1) - DM_1 (PM_1))

Inter second premolar width (DM_2 (PM_2) – DM_2 (PM_2))

Inter first molar width (M1 - M_1)

Anterior- posterior measurements:

Incisor-canine (I_1-C): the distances between the most mesial point on the central incisor and the most distal point on the canine.

Canine-first molar (C-M_1): the distances between the most mesial point on the canine and the most distal point on the first molar.

Incisor-first molar (I_1 -M_1): the distances between the most mesial point on the canine and the most distal point on the first molar.

Total arch length (TAL): the sum of the distances between the most mesial point on the canine and the most distal point on the first molar on both sides.

Dental arch length (DAL): the distance between inter molar distance line and the labial surface of the most prominent central incisor.

Vertical measurement:

Palate depth of maxilla (PD)

Transversal and anterio-posterior measurements were made as defined by Foster et al.[17] Transversal measurements of the biggest and smallest distances between right and left identical teeth of the jaws were obtained by calculating their means (Fig.1). Anterior-

posterior measurements were made only on the left side (Fig.2). Furthermore, palate depth of maxilla was measured in the region of first molars. Palate depth and dental arch length measurements were made by Korhaus compasses (Dentaurum 028-353) and the others were made to an accuracy of 0.1mm using a special odontometric caliper.

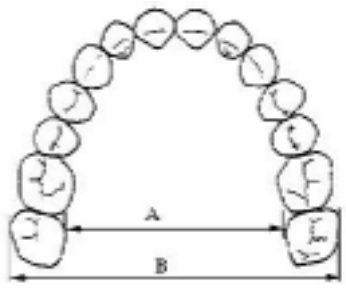

Fig 1. Transversal measurements were measured between corresponding teeth on each side of the dental arch. For each pair of teeth, the width was calculated as the mean of the maximum and minimum distances between the (A+B/2).

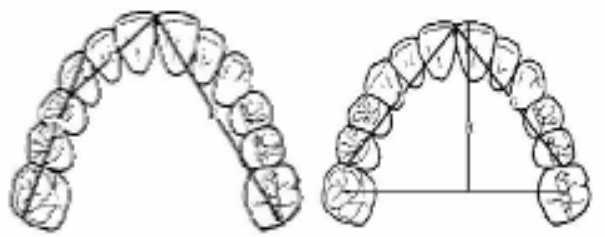

Fig 2. Dimensions of dental arch length. İncisor- canine (C), Canine –first molar (D), Incisor- first molar (E), Total arch length (F+G), Dental arch length (H).

To determine the method error, all measurements of twenty randomly selected dental casts were remade by the same examiner. No significant mean differences between the two series of records were found, and the reliability coefficients (r) ranged between 0.93 and 0.98.

The Student's *t* test was used to determine if the groups were different with regard to sex. Males and females were combined because there were not found any statistical differences in the majority of the parameters. First and second dental cast measurements were compared by using a paired *t* test to determine the changes that occurred with growth in the combined group.

RESULTS

No statistically significant difference existed between the chronological ages of the genders at the beginning and in the last part of this study according to Student's *t* test (Table 1).

Table 1. Results of Student's t test and Age and Sex distribution of the sample (years).

		First measurement			Second measurement		
		Mean	S.D	t	Mean	S.D	t
Crn.Age	Male	9.7	1.2	0.15	14.9	0.9	0.94
	Female	9.6	0.6		14.6	0.5	

Descriptive statistics, including the mean and standard deviation values, were determined for the first and second measurement periods for both genders, and are shown in Table 2 for maxilla and in Table 3 for mandible. The results of the Student's *t* test showed that there was not a significant difference between males and females, except for dental arch length in the mandibular measurements. In the maxilla, there were statistically significant differences between genders in the first measurements of inter second deciduous molar width and permanent inter first molar width and in the second measurement of inter lateral incisor width; first and second inter premolar widths and first molar width.

As can be seen in Table 4 and Table 5, inter first and second premolar widths, inter first molar width in maxilla and mandible, incisor-canine and palate depth ($p < .001$), and inter canine width ($p < .01$) in only maxilla showed significant increases. On the other hand, in maxilla, inter central incisor width, central–first molar and dental arch lengths ($p < .001$), canine - molar lengths ($p<.01$), inter lateral incisor width($p<.05$) , and in mandible, canine–molar, central–first molar, total arch and dental arch lengths ($p < .001$) exhibited significant decreases. Significant changes were not found in the other measurements.

Table 2. Results of Student's t test in Maxilla, means and standard deviations of first and second measurement for each gender.

		First measurement			Second measurement		
		Mean	S.D	t	Mean	S.D	t
I_1-I_1	M	9.05	0.67	1.35	8.69	0.55	1.86
	F	8.71	0.69		8.36	0.41	
I_2-I_2	M	23.12	1.75	1.17	22.82	1.48	2.06*
	F	22.27	2.05		21.61	1.70	
C-C	M	31.60	2.22	1.50	32.39	1.84	1.93
	F	30.42	1.98		31.02	1.94	
PM_1-PM_1	M	36.08	2.20	1.68	37.67	2.38	2.23*
	F	34.60	1.98		35.75	2.26	
PM_2–PM_2	M	41.49	2.16	2.43*	43.09	2.40	2.43*
	F	39.34	2.65		40.87	2.51	
M_1 - M_1	M	46.25	2.16	3.44*	47.57	2.76	2.85**
	F	43.74	1.71	*	44.69	2.99	
I_1-C	M	21.30	1.58	0.23	22.59	13.3	0.88
	F	21.18	1.28		22.18	1.24	
C - M_1	M	33.27	1.23	1.97	32.85	1.11	2.47
	F	32.32	1.41		31.64	1.53	
I_1- M_1	M	45.50	1.88	1.27	44.87	2.00	1.32
	F	44.62	1.92		43.86	2.04	
TAL	M	70.73	3.55	0.77	70.47	3.019	1.25
	F	69.80	3.04		68.95	3.52	
DAL	M	32.82	2.12	-0.66	31.75	2.26	0.34
	F	32.87	2.07		31.47	2.18	
PD	M	15.50	1.58	-048	19.07	1.82	0.73
	F	15.77	1.37		18.60	1.65	

** p<.05, **p<.01*

Table 3. Results of Student's t test in Mandibula, means and standard deviations of first and second measurement for each gender.

		First measurement			Second measurement		
		Mean	S.D	t	Mean	S.D	t
I_1-I_1	M	5.82	1.19	1.23	5.72	1.00	1.24
	F	5.42	0.23		5.38	0.28	
I_2-I_2	M	17.3	2.63	1.63	16.85	2.06	2.12
	F	15.82	0.56		15.59	0.54	
C-C	M	25.70	2.34	0.75	26.02	1.43	2.04
	F	25.09	1.37		24.76	1.71	
PM_1-PM_1	M	32.36	2.04	1.67	34.25	1.64	1.85
	F	30.88	2.14		33.10	1.57	
PM_2–PM_2	M	38.57	2.09	1.77	39.76	2.09	1.09
	F	37.24	1.48		38.81	2.43	
M_1 - M_1	M	44.04	1.69	1.40	45.65	1.93	1.67
	F	43.22	1.37		44.23	2.43	
I_1-C	M	17.14	1.70	2.01	17.63	2.33	0.78
	F	15.82	1.75		17.14	0.81	
C - M_1	M	33.71	1.57	1.18	32.29	1.35	1.48
	F	32.90	2.02		31.41	1.79	
I_1- M_1	M	42.31	2.19	1.32	41.11	2.05	1.26
	F	41.26	2.03		40.18	1.86	
TAL	M	64.74	3.92	0.73	61.89	3.58	1.28
	F	63.75	3.22		60.32	2.85	
DAL	M	31.58	1.73	1.46	29.85	1.76	2.68*
	F	30.61	1.72		28.32	1.08	

** p<.05*

Table 4. Means and standard deviations of first and second measurement and differences for Maxilla, and results of paired t test.

	First measurement		Second measurement		Differences		
	Mean	S.D	Mean	S.D	Mean	S.D	t
I_1-I_1	8.88	0.69	8.53	0.50	-0.36	0.41	-4.79***
I_2-I_2	22.70	1.92	22.19	1.69	-0.54	1.06	-2.72*
C-C	30.99	2.15	31.73	1.98	0.74	0.97	3.61**
PM_1 -PM_1	35.44	2.19	36.68	2.48	1.02	0.87	5.67***
PM_2 – PM_2	40.41	2.61	41.94	2.66	1.48	1.18	6.02***
M_1 - M_1	44.95	2.29	46.13	3.01	1.10	1.06	5.51***
I_1-C	21.24	1.41	22.39	1.28	1.15	1.01	6.22***
C - M_1	32.80	1.39	32.24	1.45	-0.55	0.96	-3.16**
I_1- M_1	45.06	1.92	44.37	2.05	-0.69	1.02	-3.71***
TAL	70.26	3.28	69.71	3.39	-0.55	1.84	-1.65
DAL	32.84	2.05	31.60	2.18	-1.24	0.98	-6.71***
PD	15.64	1.46	18.83	1.72	3.19	1.11	15.54***

** p<.05, **p<.01, ***p<.001*

Table 5. Means and standard deviations of first and second measurement and differences for Mandibula, and results of paired t test.

	First measurement		Second measurement		Differences		
	Mean	S.D	Mean	S.D	Mean	S.D	
I_1-I_1	5.62	0.86	5.55	0.74	-0.07	0.21	-1.75
I_2-I_2	16.40	1.93	16.20	1.59	-0.21	0.66	-1.61
C-C	25.42	1.94	25.39	1.67	-0.01	1.64	-0.04
PM_1 -PM_1	31.72	2.17	33.70	1.68	1.98	1.47	6.45***
PM_2– PM_2	37.92	1.89	39.30	2.26	1.23	1.29	4.66***
M_1 - M_1	43.63	1.57	44.97	2.26	1.32	1.27	5.40***
I_1-C	16.48	1.82	17.37	1.73	0.89	1.38	3.44**
C - M_1	33.30	1.82	31.85	1.62	-1.45	1.37	-5.63***
I_1- M_1	41.79	2.14	40.64	1.98	-1.15	1.19	-5.12***
TAL	64.24	3.56	61.10	3.27	-3.14	2.13	-7.79***
DAL	31.07	1.76	29.06	1.62	-2.02	1.01	-10.34***

***p<.01, ***p<.001*

DISCUSSION

There are a number of studies investigating changes in dental arches during the period of growth. Some of these studies showed that dental arch form and size were affected variability in eruptive paths of the teeth, growth of the supporting bones [4,19,20], and movement of the teeth after emergence due to habits and unbalanced muscular pressure[21-23]. Subjects evaluated in this study had no parafunction, but had

normal occlusion and acceptable aesthetic. Therefore, we considered that the changes observed in the study were physiological.

Knott[3] reported that there was a decrease in transition from mixed dentition to permanent dentition in the inter lateral incisor width in maxilla 0.9 mm and mandible 0.5 mm, which is in agreement with our findings. In maxilla, inter lateral incisor width reduction was more than mandible because there was physiological diestema in maxilla.

Slaj et al[24] compared dental arch changes in early and late mixed dentitions. They found that there was a statistically significant increase in inter canine width in maxilla; whereas in the mandibular inter canine width there was no statistically significant decrease. In our study, maxillary inter canine width showed a significant increase (0.74 mm), while mandibular inter canine width decreased (0.1mm) during the study period. Although, similar to our findings, Sincliar and Little[25] reported similar to our findings that inter canine width decreased in mandible, Knott[3] reported that inter canine width increased in both jaws. The cause of inter canine width increase in maxilla was growth in the median suture during normal growth.

In this study, inter premolar and inter molar widths showed significant changes at the level of $P < .001$. These results are concordant with the results of Michigan Growth study[26-28].

In this study, incisor-canine length increased in both jaws where increase in maxilla was greater than increase in mandible because sizes of maxillary incisors and canines were wide. On the other hand canine-molar, incisor-molar, total arch and dental arch lengths decreased both in maxilla and mandible. These decreases were bigger in mandible than maxilla due to the greatness of leeway space in mandible. These results are in agreement with the results of Richardson et al,[29] De Kock[30]and Moores et al.[31]

Björk and Skieller[32] and Redman et al[33] reported that palate depth increased with age in both sexes. Lebret[34] also found that difference in the palate depth between 15-18 ages was 3.6 mm. Similar to previous studies, increase in palate depth was 3.19 mm in the present study.

The results in this study showed that most arch width dimensions should be estimated in mixed dentition, which is in accordance with Bishara et al[11]. Width changes that occur during permanent dentition are not among the factors that should influence a treatment plan because these changes are generally minimal. The results of this study indicate that controlling the reduction of total arch length in the transition period from mixed dentition to permanent dentition may be helpful for the early treatment of crowding.

CONCLUSIONS

After the longitudinal dental arch changes in 30 subjects with normal occlusion were evaluated in a five - year period, it could be concluded that:

- Decreases were found in inter incisor width of both maxilla and mandible. Inter canine width increased in maxilla, while it decreased in mandible. Changes in maxilla were statistically significant, but changes in mandible were not statistically significant.
- A significant increase was observed in inter premolar and inter molar widths of both maxilla and mandible.
- Significant mesial migration was observed in maxillary and mandibular molars.

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