Comparison of dental arch dimensions in models of preschool children with cleft lip/palate repaired by means of surgery alone versus controls

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Background
Cleft lip and palate (CLP) anomaly is one of the most prevalent congenital defects causing disturbances of dental arch dimensions. This study aimed at investigating differences in these dimensions between preschool children with cleft lip/palate and a matched control group representing healthy individuals with normal occlusion (NO).

Materials and methods
The sample of this cross-sectional analytical study consisted of 108 plaster models of children aged from 4 to 5.5 years. They were divided into five groups: the cleft lip group, the cleft palate (CP) group, the unilateral cleft lip and palate group, the bilateral cleft lip and palate group, and the NO group. The NO group was used as a control group. All cleft-affected children were treated only with surgery. Dental arch length and widths were measured.

Results
The dental arch dimensions of the cleft lip group were nearly similar to those in the controls. Moreover, the mandibular transverse widths of the CP group were close to those in the controls. However, the mandibular arch length and all maxillary dimensions of the CP group were smaller than those in the controls. In the unilateral cleft lip and palate group, the arch lengths in both jaws and the maxillary transverse widths were smaller than those in the controls, whereas the mandibular transverse widths were similar to those in the controls. In the bilateral cleft lip and palate group, the arch lengths in both jaws were close to those in the controls, but both arches were narrower than those in the controls.

Conclusion and recommendations
The various types of CLP were found to be associated with differences in most maxillary and some mandibular arch dimensions. These data can be used for cleft patient counseling and treatment planning.

Keywords:
cleft lip/palate, dental arch dimensions, normal occlusion, preschool children

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Introduction

Cleft lip and palate (CLP) is the most frequent congenital malformation in the craniofacial region [1], with complications ranging from missed and malformed teeth to a midface deficiency [2]. Its rate of occurrence was reported to be one in every 500–1000 births worldwide [3]. Patients with CLP may exhibit growth, feeding, speaking, hearing, and psychosocial problems [1]. Therefore, treatment is greatly through a multidisciplinary approach. This extensive treatment plan can be a large burden on the public health sector [4].

With regard to dentistry, two competing philosophies are used to treat patients with CLP. The first includes the correction of the cleft deformity with surgery alone, whereas the second includes surgery connected to presurgical nasoalveolar molding, also known as presurgical infant orthopedics [1]. Presurgical nasoalveolar molding is any orthopedic manipulation of the segments of the cleft maxilla in a newborn with unilateral cleft lip and palate (UCLP) or bilateral cleft lip and palate (BCLP) aiming at producing a more normal maxillary alveolar arch or at retracting a protruding premaxilla to facilitate the surgical repair of the lip [5].

Outcomes of the surgical repair of CLP vary significantly. Thus, there is no agreement about the best surgical protocol [6,7], such as the controversy about the timing of hard palate repair and the number of stages in palatoplasty techniques [7]. Nevertheless, most centers fulfill hard palate closure before 3 years of age [8]. Delayed closure of the hard palate may not only diminish growth disturbance but also have a harmful influence on speech [7]. Stancheva *et al.* [9] mentioned that the timing of hard palate closure is not a critical factor for maxillary growth, and reported that the surgeon's skills and intrinsic factors such as presence of tooth buds and initial cleft width appear to be much more influential. Besides, most researchers found no difference between one-stage and two-stage palatoplasty techniques for

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midfacial growth [7], but others indicated that the two-stage palate repair has less negative impact on maxillary growth and yields good speech outcomes [6].

There are several associations in craniofacial dimensions between parents and children with CLP, emphasizing the role of genetic factors [10]. In addition, the inheritance and the conflicting results in different populations imply the existence of true biological differences [11]. Data on CLP patients are lacking in Syria. Assessment of the dental arch dimensions is important for treatment planning. The objective of this study was to investigate differences in the dimensions of the dental arches between preschool children with CLP managed with surgery alone and a matched control group representing healthy individuals with normal occlusion (NO).

Materials and methods

Study design and setting

This cross-sectional analytical study was carried out on plaster models of children aged 4–5.5 years, which were collected from the documentation files of orthodontic departments of dental schools in Damascus and Al-Baath and Hama Universities, Syria. Because patients who seek treatment at orthodontic clinics of those Universities come from all over the country, this sample was assumed to be representative of the Syrian population.

Sampling and participants

The sample size was calculated using G*Power software, version 3.0.6 (Franz Faul, Universität Kiel, Germany) with one-way analysis of variance, a selected study power of 80%, a number of groups of five, a significance level of 0.05, and effect size of 0.5. The analysis showed that 11 patients were required in each group.

Retrieval of the documentations in the universities yielded 108 models fulfilling the inclusion criteria. This sample was divided into five groups: 12 models of children with cleft lip (CL), 13 models of children with cleft palate (CP), 18 models of children with UCLP, 15 models of children with BCLP, 50 models of children with no craniofacial deformities, normal facial morphology, normal overjet and overbite, no crossbite or transverse anomalies, flush or mesial step terminal plane (i.e. NO). The sex, age, and medical history of all children were extracted from their records.

The inclusion criteria were good quality dental models of Syrian children of both sexes having primary dentition and ranging in age from 4 to 5.5 years with cleft lip/palate repaired only by means of surgery or with NO. The exclusion criteria comprised dental models of children with associated syndrome, neurological problems, previous history of orthodontic treatment, supernumerary teeth, or a history of trauma.

All cleft-affected children had been treated only by means of surgery, in which triangular flap cheiloplasty was performed in those between 2.5 and 9.2 months of age (mean = 6.7; SD 1.2), soft palate repair in those between 6.3 and 10.4 months of age (mean = 7.5; SD 0.9), and two-stage palatoplasty using vomer flap in those between 11.1 and 23.8 months of age (mean = 20.4; SD 1.4).

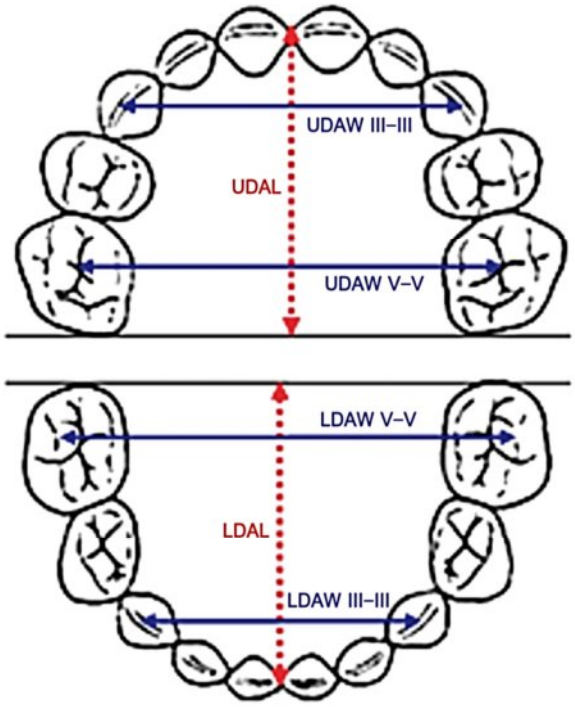
Data collection

All accurately trimmed models were identified only using random identification numbers appended to the base of the models. After that, all dental arch dimensions were recorded independently by the two researchers to the nearest 0.01 mm using a digital sliding caliper. For each dental model, the transverse widths (intercanine and intermolar width) were measured according to the method of Warren *et al.* [12], and the arch length was recorded according to the method of Baume [13] (Fig. 1 and Table 1).

Statistical analysis

The measures were recorded on paper sheets. Later, the data obtained were entered into Statistical Package for Social Sciences (SPSS) software, version 20 (IBM Corp., Armonk, New York, USA) for analysis. The Kolmogorov–Smirnov test was performed to detect the normality distribution of the data. As all data were normally distributed, the parametric statistical tests were chosen. The reliability of the interexaminer measurements was calculated using the intraclass correlation coefficient. The two-sample *t*-test was used to compare data between male and female patients. The analysis of variance was used to compare the mean values between the groups, and then the results were subjected to Tukey's honest significant difference test. A *P* value of 0.05 or less was considered statistically significant.

Figure 1.



The measured dental arch dimensions.

Table 1. Parameters measured on the dental cast models of Syrian preschool children

	Parameters	Symbols
Intercanine width	Upper dental arch width in the canine region	UDAW III-III
	Lower dental arch width in the canine region	LDAW III-III
Intermolar width	Upper dental arch width in the second primary molar region	UDAW V-V
	Lower dental arch width in the second primary molar region	LDAW V-V
Length of arch	Upper dental arch length	UDAL
	Lower dental arch length	LDAL

Table 2. Distribution of the sample of Syrian preschool children according to age (years)

		Male			Female			Total			*P*
Groups	Range	*N*	Mean	SD	*N*	Mean	SD	*N*	Mean	SD	value[a]
CL	4.0–5.3	7	4.71	0.38	5	4.83	0.46	12	4.77	0.42	0.564
CP	4.1–5.5	5	4.93	0.28	8	4.71	0.31	13	4.82	0.30	
UCLP	3.9–5.5	11	4.87	0.24	7	5.10	0.31	18	4.99	0.27	
BCLP	4.0–5.4	9	5.00	0.14	6	4.72	0.53	15	4.86	0.31	
NO	4–5.5	25	4.90	0.42	25	4.80	0.61	50	4.85	0.53	

BCLP, bilateral cleft lip and palate; CL, cleft lip; CP, cleft palate; NO, normal occlusion; UCLP, unilateral cleft lip and palate.
[a]The comparison of the total means between groups using the one-way analysis of variance test.

Results

Table 2 displays the distribution of the study sample according to age. There was no difference between groups as regards age.

The interexaminer reliability was high, with intraclass correlation coefficients ranging from 0.83 to 0.94. For each dental arch dimension, the mean value based on the measurements of the two examiners was established for the five groups.

There were no differences between the arch dimensions for male and female patients. Thus, these data were integrated in all subsequent comparisons. The dental arch dimensions of the total integrated sample of preschool children without and with cleft lip/palate are shown in Table 3.

Tables 4 and 5 show that the transverse widths and length dimensions of both arches in the CL group were nearly similar to those of the control group. Moreover, the mandibular transverse widths of the CP group were close to that of the control group. However, the mandibular arch length and all maxillary dimensions of the CP group were smaller than those in the control group. In the UCLP group, the arch length in both jaws and the maxillary transverse widths were smaller than those in the control group, whereas the mandibular transverse widths were similar to those of the control group. In the BCLP group, the arch length in both jaws was close to that of the control group. Nevertheless, both arches were narrower than those in the control group.

Table 3. Maxillary and mandibular dental arch dimensions in cleft-affected and noncleft Syrian preschool children at 5 years of age

		Maxilla		Mandible	
Groups	Parameters	Mean	SD	Mean	SD
CL	DAL	30.08	1.92	25.65	1.46
	DAW III-III	29.51	1.81	23.07	1.74
	DAW V-V	36.2	2.13	38.3	1.74
CP	DAL	27.76	1.75	24.72	1.55
	DAW III-III	27.09	1.94	21.89	1.65
	DAW V-V	33.32	2.41	36.82	1.81
UCLP	DAL	26.32	1.54	24.82	1.34
	DAW III-III	24.67	2.43	22.09	1.32
	DAW V-V	33.27	3.19	38.47	2.13
BCLP	DAL	29.15	2.04	25.8	1.26
	DAW III-III	19.88	3.04	21.06	1.36
	DAW V-V	29.97	2.13	35.69	2.13
NO	DAL	30.33	1.36	26.32	1.35
	DAW III-III	29.61	2.04	23.38	1.55
	DAW V-V	36.51	2.13	38.37	1.75

BCLP, bilateral cleft lip and palate; CL, cleft lip; CP, cleft palate; DAL, dental arch length; DAW III-III, dental arch width in the canine region; DAW V-V, dental arch width in the second primary molar region; NO, normal occlusion; UCLP, unilateral cleft lip and palate.

The overall sizes of the maxillary and mandibular transverse widths of the BCLP group were smaller than those of the CL, CP, UCLP, and control groups. Moreover, the overall size of the maxillary arch length in the UCLP group was smaller than those of the CL, BCLP, and control groups. Although CLP children had short mandibular arch length when compared with the control group, this dimension was only significantly shorter in the CP and UCLP groups.

Discussion

Patients with CLP are likely to have significant problems that need to be addressed and resolved; moreover, individual development must be balanced during treatment since birth [14]. Thus, the current study was conducted to assess the changes that could occur in the dental arch dimensions due to the scar tissue formation after the surgical interventions in preschool children with CLP. They were compared with a matched control group representing healthy individuals with NO.

The interexaminer correlation coefficients during the field work of the current study varied from 0.83 to 0.94, showing good correlations of measurements. Therefore, the results are considered reliable.

This study showed that there were no differences in dental arch dimensions between the two sexes in the five groups, which may be attributed to the relatively young age of the current sample. These findings are in agreement with those of Reiser *et al.* [15], who reported no sex differences in the Swedish UCLP patients in terms of arch dimensions at 5 years of age, and with those of Harila *et al.* [16], who found no statistically significant differences in dental arch dimensions between Finnish cleft boys and girls at the mean age of 5.6 months. However, our findings are not in agreement with those of Nyström and Ranta [17], who referred that the arch dimensions of the male patients were greater than those of

Table 4. Differences in dimensions of the dental arches between cleft-affected and noncleft Syrian preschool children groups at 5 years of age

	CL		CP		UCLP		BCLP		NO			
Parameters	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	*F*	*P* value[a]
UDAL	30.08	1.92	27.76	1.75	26.32	1.54	29.15	2.04	30.33	1.36	21.01	<0.001***
UDAW III-III	29.51	1.81	27.09	1.94	24.67	2.43	19.88	3.04	29.61	2.04	73.89	<0.001***
UDAW V-V	36.20	2.13	33.32	2.41	33.27	3.19	29.97	2.13	36.51	2.13	21.15	<0.001***
LDAL	25.65	1.46	24.72	1.55	24.82	1.34	25.80	1.26	26.32	1.35	6.97	0.006**
LDAW III-III	23.07	1.74	21.89	1.65	22.09	1.32	21.06	1.36	23.38	1.55	6.40	0.008**
LDAW V-V	38.30	1.74	36.82	1.81	38.47	2.13	35.69	2.13	38.37	1.75	6.78	0.007**

BCLP, bilateral cleft lip and palate; CL, cleft lip; CP, cleft palate; LDAL, lower dental arch length; LDAW III-III, lower dental arch width in the canine region; LDAW V-V, lower dental arch width in the second primary molar region; NO, normal occlusion; UCLP, unilateral cleft lip and palate; UDAL, upper dental arch length; UDAW III-III, upper dental arch width in the canine region; UDAW V-V, upper dental arch width in the second primary molar region.
[a]Using the one-way analysis of variance test.
**$P \leq 0.01$.
***$P \leq 0.001$.

Table 5. Multiple comparisons in the dimensions of dental arches between cleft-affected and noncleft Syrian preschool children groups at 5 years of age

			Maxillary arch		Mandibular arch	
Dependent variables	Groups (I)	Groups (J)	Mean difference (I – J)	*P* value[a]	Mean difference (I – J)	*P* value[a]
DAL	CL	CP	2.32	0.008**	0.93	0.154
		UCLP	3.76	<0.001***	0.82	0.232
		BCLP	0.93	0.431	−0.16	0.992
		NO	−0.26	0.986	−0.67	0.402
	CP	UCLP	1.44	0.110	−0.10	0.998
		BCLP	−1.39	0.128	−1.08	0.081
		NO	−2.57	0.004**	−1.60	0.009**
	UCLP	BCLP	−2.83	0.002**	−0.98	0.124
		NO	−4.02	<0.001***	−1.49	0.014*
	BCLP	NO	−1.18	0.228	−0.51	0.634
DAW III-III	CL	CP	2.42	0.029*	1.18	0.235
		UCLP	4.84	<0.001***	0.98	0.389
		BCLP	9.63	<0.001***	2.01	0.021*
		NO	−0.10	0.998	−0.31	0.973
	CP	UCLP	2.42	0.030*	−0.20	0.994
		BCLP	7.21	<0.001***	0.83	0.541
		NO	−2.53	0.023*	−1.49	0.098
	UCLP	BCLP	4.79	<0.001***	1.03	0.346
		NO	−4.95	<0.001***	−1.29	0.176
	BCLP	NO	−9.73	<0.001***	−2.32	0.009**
DAW V-V	CL	CP	2.88	0.035*	1.48	0.252
		UCLP	2.93	0.032*	−0.17	0.999
		BCLP	6.23	<0.001***	2.61	0.019*
		NO	−0.31	0.995	−0.07	0.998
	CP	UCLP	0.05	0.997	−1.65	0.176
		BCLP	3.35	0.014*	1.13	0.478
		NO	−3.19	0.020*	−1.55	0.218
	UCLP	BCLP	3.30	0.016*	2.78	0.013*
		NO	−3.24	0.018*	0.10	0.999
	BCLP	NO	−6.54	<0.001***	−2.68	0.017*

BCLP, bilateral cleft lip and palate; CL, cleft lip; CP, cleft palate; DAL, dental arch length; DAW III-III, dental arch width in the canine region; DAW V-V, dental arch width in the second primary molar region; NO, normal occlusion; UCLP, unilateral cleft lip and palate.
[a]Using the Tukey honest significant difference test.
*$P \leq 0.05$.
**$P \leq 0.01$.
***$P \leq 0.001$.

the female patients in the control and CP groups, but the dimensions of the female patients were often greater in the CL, UCLP, and BCLP groups in 3-year-old children of Finland. These differences might be ascribed to the very small sample size of some groups in their study.

There were large variations in dental arch dimensions between different groups in the current study. These variations may be ascribed to the primary anomalies and the surgical procedures.

The current study demonstrated that there were no statistically significant differences between the CL group and the control group in dental arch dimensions of both jaws. This finding is in line with that of Nyström and Ranta [17] and Garrahy *et al.* [18], who mentioned that the dental arch dimensions of children with CL were about the same as in noncleft children.

In this study, it was observed in the CP group that the transverse widths in the mandible were close to those of

the control group, whereas in the maxilla they were smaller than those in the control group, which pointed to a crossbite tendency. These findings are not in agreement with those of Nyström and Ranta [17], who found that both dental arches of the CP children were smaller than that in the noncleft children at the age of 3 years. Differences in these findings may be explained by the differences in the age of children between that study and the current study. In addition, the mandibular and maxillary arch lengths of the CP group in the current study were smaller than those in the control group. These findings are in agreement with those of Nyström and Ranta [17].

In the UCLP group of the current study, the arch length in both jaws and the transverse widths in the maxilla were smaller than those in the control group, which may exist because of collapse of the alveolar arch following lip and palate surgery. These findings are in line with those of Reiser *et al.* [15], who found that the transverse growth was decreased in the children with UCLP after hard palate closure. In addition, our study demonstrated that the mandibular transverse widths were similar to those of the control group. These findings may imply a noticeable discrepancy between the sizes of the corresponding dental arches in UCLP children. In accordance with our findings, Reiser [19] revealed that crossbite was a common malocclusion at the age of 5 years in children with UCLP. Moreover, Nyström and Ranta [17] found that the maxillary dimensions of the UCLP group were 11–19% smaller than that in the noncleft group, but the mandibular dimensions were only 0–4% smaller than that in the noncleft group. In addition, Garrahy *et al.* [18] reported that maxillary arch dimensions were significantly different between children with UCLP and noncleft controls of the Caucasus at 3 years of age, whereas there were no significant differences in mandibular arch dimensions between the two groups. However, the current findings are not in agreement with those of Opitz and Kratzsch [20], who noted that in UCLP children the posterior transverse arch widths stayed within normal measure 2 years after surgery, but the maxillary arch length deficiency was recorded. These differences may be attributed to difference in the time of surgery; the children in the former study were operated on at 3 years of age, which may be considered relatively late in comparison with the current study.

Our results revealed that the arch lengths of both jaws in the BCLP group were close to those of the control group, expressing normal positioning of the premaxilla in BCLP patients. These findings are in agreement with those of Heidbuchel and Kuijpers-Jagtman [21], who reported that the dental arch lengths of both jaws did not differ between the BCLP group and the normal group in Dutch children at 5 years of age. In contrast to our finding, Nyström and Ranta [17] found that the maxillary arch was 6% shorter than that in the control group in 3-year-old children from Finland. These differences might be ascribed to age and ethnic differences.

This study showed that the dental widths of both jaws in the BCLP group were narrower than those in the control group. It appears that the mandibular arch widths were affected by the changes in the maxillary arch. Therefore, the narrower mandibular arch may be attributed to compensatory lingual inclination of the teeth in the mandible. These findings are in line with the data reported by Nyström and Ranta [17], but they are contradictory to those of Heidbuchel and Kuijpers-Jagtman [21], who noted that mandibular dental arch widths in the BCLP and the control groups were very similar, whereas only the maxillary dental arch widths in the BCLP group were smaller than those in the control group. It must be mentioned that about 50% of their sample received presurgical orthopedic treatment. Keeping in mind that this treatment included expansion of the maxilla to retrieve the original widths, we can claim that this expansion prevented the mandibular arch to compensate the maxillary one.

The results of this study showed that the overall sizes of the transverse widths in the maxilla of the BCLP group were smaller than those of the CL, CP, UCLP, and control groups. These differences could be caused by the specific type of the cleft, surgical procedures, or inherent growth deficiency. In contrast to our findings, Harila *et al.* [16], when they examined maxillary arch dimensions in cleft infants in Northern Finland, found that the anterior arch width was the smallest in CP patients and the posterior arch width was the smallest in CL patients. These differences could be ascribed to age and ethnic differences. Furthermore, the overall sizes of the mandibular transverse widths in the BCLP group of the current study were smaller than those of the CL, CP, UCLP, and control groups. This finding may be caused by inherent developmental deficiency or compensatory lingual inclination of the teeth in the mandible. This result is not in agreement with that of Nyström and Ranta [17], who reported that the overall size of the mandibular dental arch in the CP group was somewhat smaller than that in the UCLP and BCLP groups. This difference may be attributed to age and ethnic differences.

The present study demonstrated that the overall size of maxillary arch length in the UCLP group was smaller than that of CL, BCLP, and control groups. In line with this finding, Nystrom and Ranta found that the arch length in the maxilla of the UCLP group was smaller than that of the CL, BCLP, and control groups in 3-year-old Finnish children [17]. In addition, Harila *et al.* [16] reported that the arch length in the maxilla of UCLP patients was smaller than that of CL, CP, and BCLP patients of Finland at the age of 5.6 months. In the current study, all cleft-affected groups showed reduction in the mandibular arch length in comparison with the control group without significant differences in terms of the CL and BCLP groups, but with significant differences in terms of the CP and UCLP groups. These findings are in agreement with those of Nyström and Ranta [17].

Generalizability and limitations

The adequate numbers of models of children with and without cleft lip/palate and the diversity of the sources of data provided good representation of the

measurements of dental arches in Syrian preschool children with cleft palate. In addition, the mean age of the participants in all groups was nearly 5 years without significant differences between them, which makes comparisons possible.

This research was designed as a cross-sectional analytical study including 5-year-old children. Therefore, supplemental investigations need to be achieved on various ages. Moreover, longitudinal studies need to be conducted to assess the effects of cleft on the development and growth of the individuals.

Conclusion and recommendations

The current results demonstrated large variations in dental arch dimensions between different groups. In addition, there was an apparent discrepancy between the dental arch dimensions in CP and UCLP children. The maxillary transverse widths of the BCLP group were smaller than those of the CL, CP, UCLP, and control groups, whereas the maxillary arch length of the UCLP patients was smaller than that of CL, BCLP, and control groups. On account of the differences observed in the dental arch dimensions, it is recommended that orthodontic treatment is essential for CP, UCLP, and BCLP children to compensate affected growth. Our data obtained from the Syrian children without and with cleft lip/palate can be utilized as an aid in diagnosis and treatment planning for the cleft lip/palate patients.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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