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Research Article

Longitudinal Anthropometric Analysis of Digital Models After Different Techniques of Palatoplasty in Unilateral Cleft Lip and Palate Children

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Abstract

The purpose of this study was to perform a longitudinal comparative analysis of the palatoplasty techniques on the palatine surfaces in patients with Unilateral Cleft Lip and Palate (UCLP) surgeries. The subjects were divided into two groups:

Group 1 (G1) - subjects who underwent cheiloplasty (Millard technique) and palatoplasty (von Langenbeck); Group 2 (G2) - subjects who underwent cheiloplasty (Millard technique) and palatoplasty in two stages: Hard palate palatoplasty (Hans Pichler technique) and palatoplasty (Sommerlad technique). The evaluation was performed in the following phases: T1 - pre-cheiloplasty, T2 - post-cheiloplasty and T3 - post-palatoplasty.

The repeated measures ANOVA, followed by Tukey's test and the independent and paired T-test were used to verify the results. During the intra-group analysis, in G1 there was an increase in ∠IC'T' between phases T1 and T2 ($p=0.004$). Inversely, in ∠ICT there was a reduction between phases T1 and T2 ($p<0.001$). In G2, IC'T' increased between phases T1 and T2 ($p<0.001$). In contrast, there was a reduction in the measure ∠ICT between phases T1 and T2 ($p<0.001$). During the inter-group analysis, in G2 there was a considerable increase in the parameter ∠IC'T' when compared to G1 ($p=0.004$). Both groups showed soft palate asymmetry ($p<0.001$). This study concluded that patients who underwent palatoplasty in two stages showed better growth results in T2 when compared with patients who underwent palatoplasty in one stage. In T3, there were no statistically significant differences between the groups.

Keywords: Cleft Lip; Cleft Palate; Growth and Development; Tridimensional Imaging; Palate; Dental Arch; Operative Surgical Procedures

Abbreviations

MsC: Master of Science; UCLP: Unilateral Cleft Lip and Palate;∠IC'T': Interincisors deciduous canine and tuber of the lesser segment; ∠C'T'T: Deciduous canine and tuber of the lesser segment and tuber of the greater segment; Contralateral angles ∠ICT and ∠CTT'.

Introduction

Clefts affect lip and palate. The use of protocols in cleft lip and palate rehabilitation promotes improvement in function, aesthetics, facial and palate symmetry. The Millard technique for cheiloplasty involves loosen incisions, which will allow the

tissue rotation to realize the lip closure [1-24]. The most used technique for palatoplasty is the Von Langenbech [25]. The Pichler and Sommerlad technique are used for the hard and soft palate respectively [26,27]. The comparative longitudinal evaluation of the dimensions of the palatine surfaces aimed to search for the best benefits to the success of the rehabilitation.

Methodology

Before the execution of this retrospective study, it was approved by the Institutional Review Board for Human Research of the Hospital for the Rehabilitation of Craniofacial Anomalies, University of São Paulo (HRAC/USP), reference number 6.599.261, CAAE number 75622723.5.0000.5441.

Trial Design

According to the inclusion criteria, children with unilateral cleft lip and palate cleft participated in the study, both genders, aged between 3 months and 2 years and 5 months, operated by the same plastic surgeon and who had their dental model filed at HRAC/USP up to five years old. The exclusion criteria were patients with syndromes and/or associated malformation, improper digital models at any stage of the research and subjects who started the rehabilitation treatment in a different institution. The sample calculation was realized according to the study of Ambrosio et al. The test power was 80% with a significance level of 5%. It was considered the standard deviation of 7,36º for the CTT' angle in the pre-surgical stage and the minimum difference clinically detected was 6º. The minimum size of each sampling group was 25 subjects. Each sampling set was composed of 30 subjects and divided as described below:

- Group 1 (G1): Children who were submitted to cheiloplasty (Millard technique) at 3 months and palatoplasty (von Langenbeck) in a single stage at 12 months (Fig. 1)
- Group 2 (G2): Children submitted to cheiloplasty (Millard technique) at 3 months and palatoplasty in 2 stages: anterior palatoplasty (Hans Pichler technique) at 3 months, in the first stage; and posterior palatoplasty (Sommerlad technique) at 1 month, in the second stage (Fig. 1)

The subjects were evaluated in the following phases: T1 - pre-cheiloplasty, T2 - post-cheiloplasty and T3 - post-posterior palatoplasty.

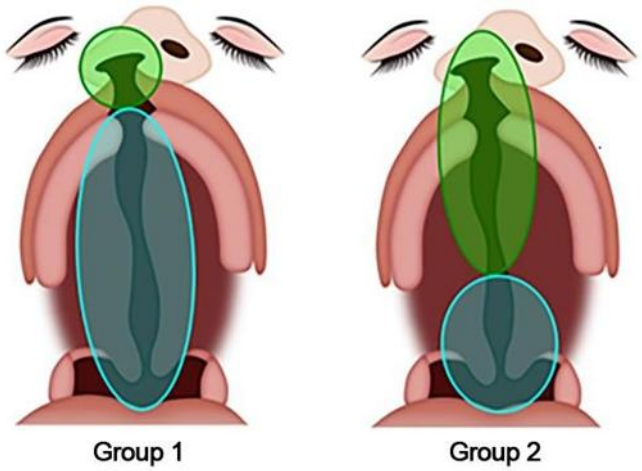

Figure 1: G1 - Cheiloplasty with Millard technique at 3 months of age and palatoplasty with the von Langenbeck technique at 12 months (cheiloplasty and palatoplasty in a single stage). G2 - Cheiloplasty with the Millard technique with anterior palatoplasty using Hans Pichler technique at 3 months and posterior palatoplasty with Sommerlad technique at 12 months (cheiloplasty and the second stage of palatoplasty). Source: Falzoni, et al. [41].

Digitalized Dental Models and Anthropometric Analysis

All the 180 plaster dental models, regarding the 60 subjects divided into 2 groups in phase 3, which were used in the study, belonged to the file database of HRAC/USP. They were tridimensional copies of the original cast models using a 3D laser scan (3Shape´s R700TM Scanner, Copenhagen, Denmark [28-32] and analyzed in Standard Triangle Language file format (STL) [33]. The digital models had a scanning pattern, the ones that did not follow it were dismissed.

The dental model analyses were made using the Stereophotogrammety imaging system (VAM, version 2.8.3., biult 2008), which has proven accuracy and reproducibility [34]. The angle measurements were defined according to previously published studies [6]. The parameters used were IC'T', an angle formed by the points inter-incisive (I), deciduous canine (C') and the tuberosity (T') on the smaller bone segment; ICT, the angle formed by the points inter-incisive (I), deciduous canine © and the tuberosity (T) on the greater bone segment; C'T'T, the angle formed by the deciduous canine (C') a the tuberosity (T') on the smaller bone segment with the tuberosity (T) on the greater segment; and the CTT', angle formed by the deciduous canine (C) and the tuberosity (T) on the greater bone segment with the tuber (T') on the smaller segment. The angle measurements are quantified in degrees (o) (Fig. 2).

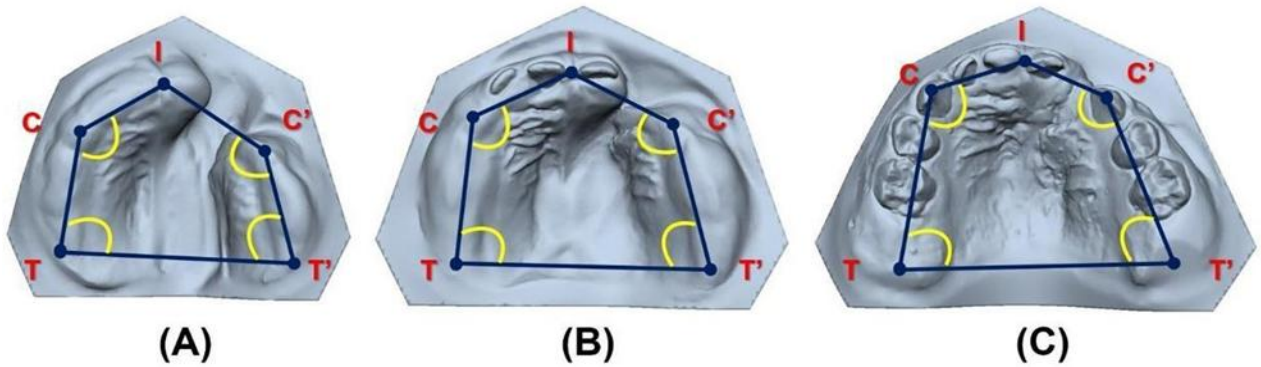

Figure 2: Digitalized dental model angular measurements (IC'T', ICT, C'T'T e CTT'). A) T1, pre-cheiloplasty; B) T2, post-cheiloplasty; C) T3 post-palatoplasty.

Statistics Analysis

The statistical tests were realized by Sigma Plot for Windows, version 14.5 Build 14.5.0.101 (Grafiti LLC, Palo Alto, CA, USA), adopting the significance level of 5% so that the statistical significance could be considered. The methodology reliability was evaluated by 3 examiners using the Intraclass Correlation Coefficient, with 1/3 of the sample being evaluated twice in a period of 15 days. The Shapiro-Wilk normality test was applied. The ANOVA test for repeated measurements, followed by the Tukey test, were applied in the analysis in each group, while the independent t-test was used to verify the results between the groups. The paired t-test was applied for the intra-group comparison. The data was shown in average and standard deviation. Non-parametric tests were applied when necessary. The non-parametric test applied were the Mann-Whitney test for the inter-group evaluation regarding the effect of the dependent variable age and the Chi-square test was for the inter-group assessment of the dependent variables, side of the cleft and gender.

Results

The sample comprised 180 digital models of dental arches from 60 subjects with unilateral cleft lip and palate, equally divided into two groups and the three phases. The subjects had their dental impression taken at an average in T1 from 0.31 and 0.4 years after birth. In T2, 1.03 and 1.29; 1.83 and 2.45 years in T3, for G1 and G2. There was no statistically significant difference regarding the side of the cleft (chi-square test p=0.781) nor gender (chi-square test p=0.067). In the intra-examiner's analysis, the reliability test indicated that the measurements were properly reproduced (IC'T' CCI=0.97, ICT CCI=0.88, C'T'T CCI =0.93 and CTT' CCI =0.83). In the inter-examiner analysis, the reliability was very good for the anterior measurements IC'T' (CCI = 0.86 and 0.82) and ICT (CCI= 0.72 e 0.74) and good for the posterior measurements C'T'T (CCI = 0.68 and 0.61) and CTT' (CCI = 0.52 and 0.69).

Intra-group Analyses

The angular changes in both groups in all phases. In G1, there was a significant increase in ∠IC'T' parameter, p=0,004, between phases T1 and T2 (4.23º) and between phases T1 and T3 (5.22º), for p=0.004. Inversely, in ∠ICT parameter, there was a significant reduction, p<0,001, between phases T1 and T2 (-5.57º) and between phases T1 and T3 (-8.5º). In G2, there was a significant increase, p< 0,001, for ∠IC'T' measure between phases T1 and T2 (9.96º) and between phases T1 and T3 (8.27º). In contrast, for ∠ICT measurement, there was a significant reduction, p<0,001, between phases T1 and T2 (-5.45º) and between phases T1 and T3 (8.75º) (Table 1).

	T1		T2		T3		
Variable	**Average**	**SD**	**Average**	**SD**	**Average**	**SD**	***P***
Group 1							
∠IC′T′	128.24 A	7.91	132.47 B	9.69	133.46 B	11.59	0.004*
∠ICT	131.05 A	6.89	125.48 B	5.43	122.55 B	8.36	<0.001*
∠C′T′T	71.62	6.01	69.87	6.12	70.67	5.32	0.30
∠CT T′	79.50	5.87	77.92	5.69	79.97	5.63	0.23
Group 2							
∠IC′T′	127.96 A	7.91	137.92 B	8.31	136.23 B	10.02	<0.001*
∠ICT	129.52 A	8.49	124.07 B	6.62	120.77 B	5.17	<0.001*
∠C′T′T	71.10	6.64	69.02	4.79	69.78	5.49	0.20
∠CT T′	78.82	5.05	80.95	8.91	79.51	4.21	0.37
* Statistically significant differences. The different capital letters on the same line mean the statistically significant differences.							

Table 1: Intra-group comparison using the analysis of variance for repeated measures (ANOVA test for repeated measures followed by Tukey test).

Intra-Group Comparison of the Palate Anterior Symmetry (G1)

The analyses of the palate anterior symmetry in G1 indicated that before the cheiloplasty (T1), the groups were symmetric (∠IC′T′ equal to 128.24o, ∠ICT equal to 131.05o, p=0.13). Before the palatoplasty (T2), both groups showed asymmetries (∠IC′T′ equal to 132.47o, ∠ICT equal to 125.48o, p< 0.001), as well as post- palatoplasty (T3; ∠IC′T′ equal to 133.46o, ∠ICT equal to 122.55o, p< 0.001; Table 2).

		∠IC′ T′		∠IC′ T′			
G1	**Unit**	**Average**	**SD**	**Average**	**SD**	***P***	**95% IC**
T1	o	128.24	7.91	131.05	6.89	0.13	-6.54 to 0.91
T2	o	132.47	9.69	125.48	5.43	< 0.001*	3.25 to 10.73
T3	o	133.46	11.59	122.55	8.36	< 0.001*	6.70 to 15.13
Δ=T2-T1	o	4.23	7.23	-5.58	7.54	< 0.001*	6.45 to 13.16
Δ=T3-T1	o	0.99	9.25	-2.93	7.50	< 0.01*	9.38 to 18.07
Δ=T3-T2	o	5.22	9.27	-8.51	9.75	0.05*	-0.02 to 7.86
Gr=T2-T1	%	3.37%	5.71%	-4.06%	5.52%	< 0.001*	0.05 to 0.10
Gr=T3-T1	%	4.12%	7.14%	-6.31%	7.33%	< 0.001*	0.07 to 0.14
Gr=T3-T2	%	0.87%	6.89%	-2.30%	5.91%	0.038*	0.002 a 0.06
* Statistically significant difference. Gr = growth. Δ = Difference. Source: Created by the author.							

Table 2: Intra-group comparison of the Palate Anterior Symmetry (∠IC′ T′ vs. ∠IC′ T′), paired t-test in G1.

Intra-Group Comparison of the Palate Posterior Symmetry (G1)

The palate posterior symmetry analyses in G1 identified that before cheiloplasty (T1), the groups were asymmetric (∠C′T′T equal to 71.62º, ∠CTT′ equal to 79.50º, p=0.001). Before palatoplasty (T2), both groups showed asymmetry (∠C′T′T equal to 69.87º, ∠CT T′ equal to 77.92º, p< 0.001), as well as in the post- palatoplasty (T3; ∠C′T′T equal to 70.67º, ∠CT T′ equal to 79.97º, p< 0.001; Table 3).

		∠C′T′T		∠C′T′T			
G1	**Unit**	**Average**	**SD**	**Average**	**SD**	***P***	**95% IC**
T1	o	71.62	6.01	79.50	5.87	**< 0.001***	-10.87 to -4.90
T2	o	69.87	6.12	77.92	5.69	**< 0.001***	-11.35 to -4.77
T3	o	70.67	5.32	79.97	5.63	**< 0.001***	-12.07 to -6.54
Δ=T2-T1	o	-1.75	6.23	-1.57	6.36	0.90	-3.06 to 2.71

Δ=T3-T1	o	-0.95	6.33	0.47	6.94	0.32	-4.29 to 1.45
Δ=T3-T2	o	0.80	5.64	2.04	6.91	0.41	-4.28 to 1.78
Gr=T2-T1	%	-2.05%	9.12%	-1.65%	8.20%	0.84	-0.04 to 0.04
Gr=T3-T2	%	1.56%	8.42%	3.03%	9.09%	0.48	-0.06 to 0.03
Gr=T3-T1	%	-0.81%	9.85%	1.00%	8.91%	0.34	-0.06 to 0.02
* Statistically significant difference. Gr = growth. Δ = Difference. Source: Created by the author.							

Table 3: Intra-group comparison of the Palate Posterior Symmetry (∠C'T'T vs. ∠CTT'), paired t-test in G1.

Intra-Group Comparison of the Palate Anterior Symmetry (G2)

The palate anterior symmetry analysis in G2 identified that before cheiloplasty (T1), the groups were symmetric (∠IC'T equal to 127.96º, ∠ICT equal to 129.52º, p=0.50). Before palatoplasty (T2), both groups showed asymmetry (∠IC'T equal to 137.9 º, ∠ICT equal to 124.07º, p< 0.001), as well as post-palatoplasty (T3; ∠IC'T equal to 136.23º, ∠ICT equal to 120.77º, p< 0.001; Table 4).

		∠IC' T'		∠ICT			
G2	**Unit**	**Average**	**SD**	**Average**	**SD**	***P***	**95% IC**
T1	o	127.96	7.91	129.52	8.49	0.50	-6.25 to 3.14
T2	o	137.92	8.31	124.07	6.62	**< 0.001***	9.94 to 17.76
T3	o	136.23	10.02	120.77	5.17	**< 0.001***	12.37 to 18.56
Δ=T2-T1	o	9.96	7.39	-5.45	10.26	**< 0.001***	9.81 to 21.01
Δ=T3-T1	o	8.27	9.82	-8.75	8.67	**< 0.001***	11.97 to 22.07
Δ=T3-T2	o	-1.69	9.88	-3.31	6.64	0.44	-2.62 to 5.85
Gr=T2-T1	%	7.96%	6.06%	-3.84%	7.51%	**< 0.001***	0.08 to 0.16
Gr=T3-T1	%	6.67%	7.96%	-6.45%	6.22%	**< 0.001***	0.09 to 0.17
Gr=T3-T2	%	-1.06%	7.10%	-2.49%	5.17%	0.35	-0.02 to 0.05
* Statistically significant difference. Gr = growth. Δ = Difference. Source: Created by the author.							

Table 4: Intra-group comparison palate anterior symmetry (∠IC' T' vs. ∠ICT), paired t-test in G2.

Intra-Group Comparison of Palate Posterior Symmetry (G2)

The palate posterior symmetry analysis in G2 indicated that, before the cheiloplasty (T1), the groups were asymmetric (∠C'T'T equal to 71.10º, ∠CT T' equal to 78.82º, p< 0,001). Before the palatoplasty (T2), both groups showed to be asymmetric (∠C'T'T equal to 69.02º, ∠CT T' equal to 80.95º, p< 0,001), as well as post- palatoplasty (T3; ∠C'T'T equal to 69.78º, ∠CT T' equal to 79.51º, p< 0.001; Table 5).

		∠C'T'T		∠C'T'T			
G2	**Unit**	**Average**	**SD**	**Average**	**SD**	***P***	**95% IC**
T1	o	71.10	6.64	78.82	5.05	**< 0.001***	-10.53 to -4.90
T2	o	69.02	4.79	80.95	8.91	**< 0.001***	-16.02 to -7.84
T3	o	69.78	5.49	79.51	4.21	**< 0.001***	-12.01 to -7.45
Δ=T2-T1	o	-2.08	6.47	2.13	9.33	0.07	-8.77 to 0.35
Δ=T3-T1	o	-1.32	6.80	0.70	5.28	0.12	-4.56 to 0.53
Δ=T3-T2	o	0.77	5.74	-1.43	9.65	0.25	-1.59 to 5.99
Gr=T2-T1	%	-2.34%	9.14%	2.96%	11.90%	0.08	-0.11 to 0.01
Gr=T3-T1	%	-1.30%	9.58%	1.17%	6.75%	0.17	-0.06 to 0.01
Gr=T3-T2	%	1.39%	8.73%	-0.94%	9.21%	0.24	-0.02 to 0.06
* Statistically significant difference. Gr = growth. Δ = Difference. Source: Created by the author.							

Table 5: Intra-group comparison of the Palate Posterior Symmetry (∠C'T'T vs. ∠CTT'), paired t-test in G2.

Comparison Analysis of the Inter-groups Angular Parameter

There were different changes in palate growth during the analyzed periods between the studied groups. In G2 (137.92º) there was a considerable increase in the parameter ∠IC'T', 7.96%, when compared with G1 (132.47º), 3,37% (p=0.004) (Table 6). There were no statistically significant differences in parameters ∠ICT, ∠C'T'T and ∠CT T' between both groups during the different phases (Table 7).

		G1		G2				
∠IC'T'	**Phase**	**Average**	**SD**	**Average**	**SD**	**Dif. G1-G2**	***P***	**95% IC**
	T1	128.24	7.91	127.96	7.91	0.28	0.89	-3.81 to 4.37
	T2	132.47	9.69	137.92	8.31	-5.46	**0.023***	-10.12 to -0.79
	T3	133.46	11.59	136.23	10.02	-2.77	0.33	-8.37 to 2.83
Δ %	T2 vs 1	3.37%	5.71%	7.96%	6.06%	-4.58%	**0.004***	-0.08 to -0.02
Δ %	T3 vs 2	0.87%	6.89%	-1.06%	7.10%	1.93%	0.29	-0.02 to 0.06
Δ %	T3 vs 1	4.12%	7.14%	6.67%	7.96%	-2.55%	0.20	-0.07 to 0.01
* Statistically significant difference. Δ = Difference. Source: Created by the author.								

Table 6: Inter-group comparison of the anterior angle of the smaller segment (∠IC'T'), independent t-test.

		G1		G2				
Variable	**Phase**	**Average**	**SD**	**Average**	**SD**	**Dif. G2-G1**	***P***	**95% IC**
∠ICT								
	T1	131.05	6.89	129.52	8.49	1.54	0.45	-2.46 to 5.53
	T2	125.48	5.43	124.07	6.62	1.41	0.37	-1.72 to 4.53
	T3	122.55	8.36	120.77	5.17	1.78	0.33	-1.83 to 5.38
Δ (%)	T2 vs 1	-4.06%	5.52%	-3.84%	7.51%	-0.22%	0.90	-0.05 to 0.03
Δ (%)	T3 vs 2	-2.30%	5.91%	-2.49%	5.17%	0.20%	0.89	-0.03 to 0.03
Δ (%)	T3 vs 1	-6.31%	7.33%	-6.45%	6.22%	0.14%	0.94	-0.03 to 0.04
∠C'T'T								
	T1	71.62	6.01	71.10	6.64	0.52	0.75	-2.76 to 3.79
	T2	69.87	6.12	69.02	4.79	0.85	0.55	-1.99 to 3.69
	T3	70.67	5.32	69.78	5.49	0.88	0.53	-1.91 to 3.68
Δ (%)	T2 vs 1	-2.5%	9.12%	-2.34%	9.14%	0.29%	0.90	-0.04 to 0.05
Δ (%)	T3 vs 2	1.56%	8.42%	1.39%	8.73%	0.17%	0.94	-0.04 to 0.05
Δ (%) **∠CT T'**	T3 vs 1	-0.81%	9.85%	-1.30%	9.58%	0.48%	0.85	-0.05 to 0.06
	T1	79.50	5.87	78.82	5.05	0.68	0.63	-2.15 to 3.51
	T2	77.92	5.69	80.95	8.91	-3.02	0.12	-6.89 to 0.84
	T3	79.97	5.63	79.51	4.21	0.46	0.72	-2.12 to 3.03
Δ %	T2 vs 1	-1.65%	8.20%	2.96%	11.90%	-4.61%	0.09	-0.10 to 0.01
Δ %	T3 vs 2	3.03%	9.09%	-0.94%	9.21%	3.97%	0.10	-0.01 to 0.09
Δ %	T3 vs 1	1.00%	8.91%	1.17%	6.75%	-0.17%	0.94	-0.04 to 0.04
* Statistically significant difference. Δ = Difference. Source: Created by the author.								

Table 7: Inter-group comparison of the anterior angle of the greater segment (∠ICT) and posteriors of minor segment (∠I'C'T) and greater (∠ICT'), independent t-test.

Correlation Between the Palate Parameters

There was a negative correlation between ∠IC'T' versus ∠C'T'T (r equal -0.57), a moderated negative for ∠ICT versus ∠CT T' (r equal -0.34) and a weak negative for ∠ICT versus ∠C'T'T (r equal -0.26; Fig. 3).

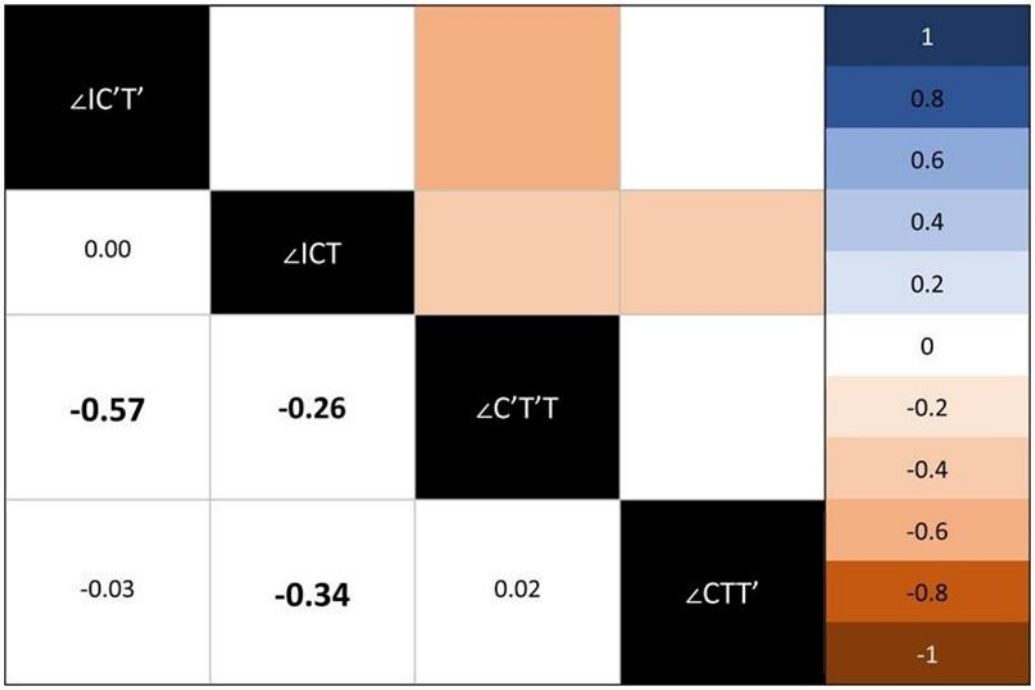

Figure 3: Pearson correlation matrix. Source: Created by the author. The coefficients are shown in the top right corner, as well as the white colors in the bottom left corner show the same coefficient but in numbers. The correlation matrix shows the values of Pearson correlation, which measures the degree of angular relation between each measured parameter. The right column shows the color of the caption according to the coefficient, ranging from -1 (brown) to +1 (dark blue). Coefficients close to -1 indicate parameters inversely proportional, while the ones close to +1 indicate directly proportional parameters. The coefficient with a zero value (white) indicates a weak correlation. Source: Created by the author.

Discussion

Morphometric studies of maxillary development, in accurate digital models, may offer theoretical bases to solve bone problems, they have been considered one of the greatest stimuli for the cleft lip and palate treatment progress [29,35]. The rehabilitation centers work with different surgical techniques, ages and scheduling times for palate surgery [1,36-37]. In this study, the maxillary morphology and symmetry were evaluated by comparing the anterior angles with each other and the same was realized with the posterior angles of the cleft and non-cleft sides in both groups.

The G1 group, palate closure in one stage, showed a significant increase in parameter ∠IC'T' and inversely, on parameter ∠ICT there was a considerable reduction, consistent with the literature [38]. According to Mazaheri, et al., 1971, this happened probably due to the inter-incisives point movement (I) towards a meso-palatine position, supporting the present study's findings [39]. Mello, et al., and Falzoni, et al., found a reduction in the anterior or total length of the dental arch (I-CC' or I-TT') [40,41]. Carrara, et al., and Ambrosio et al., observed a reduction in the cleft anterior width and approaching of the palatine segments [6,28].

In the present study, anterior symmetry was found in G1 before the primary surgeries, but after the cleft lip and palate surgeries, the asymmetries were manifested in both groups. Regarding the posterior asymmetries, it was shown in all the phases, both in G1 and G2. Zheng, et al., evaluated the symmetry using the angles ICT, IC'T', CTT', C'T'T, ITT' and IT'T in digitalized models, linear measurements, in children with unilateral cleft lip and palate not submitted to surgery in the first month of life [14]. The first four angular parameters were the same used in this study methodology. The authors concluded that the asymmetries are inherent to the unilateral cleft lip and palate.

In group G2, palate closure in two stages, there was an increase in ∠IC'T' parameter compared with G1, in phases T1 and T2, therefore, indicating alterations in the dental arch shape. Falzoni, et al., obtained similar results, which happened probably because the lip correction was realized at the same time as anterior palate closure, in the first stage [41]. This evaluation suggests the posterior transversal growth did not change in the first year and half of life regarding the choice of the palatoplasty technique used, both in one or two stages. Mazaheri, et al., Sakoda, et al., found similar results, however, contrary to Pontes, et al., [16, 32,39]. In the present study, group G2 showed an increase in ∠IC'T' parameter compared to G1, from phase 1 to phase 2, however, after posterior palatoplasty in G2, the parameters approached, being favorable in G2. Ambrosio, et al., found that palatoplasty in two stages is more favorable for maxillary growth [42].

Both groups in this analysis, groups G1 and G2, showed a significant reduction in ∠ICT parameters, corroborating with previous studies of Huang, et al., and Kongprasert, et al., [43,44]. Both groups, G1 and G2, did not show significant changes in the mean values of ∠C'T'T, ∠CT T'. However, ∠IC'T' and ∠ICT showed significant changes in the evaluation of the palate anterior region because the palatine segments are more susceptible to the healing forces of the lip tissue, according to Haque, et al. and Falzoni et al., reported similar findings in clefts with the same phenotype and treatment protocol [19,41]. According to Huang, et al., Mello, et al., Kongprasert, et al., Jaklová, et al., and Reiser, et al., the pressure of the lip submitted to surgery on the palatine segments results in anterior alveolar constriction [40,43-46]. The reduction of the cleft amplitude in the different surgery phases reduces future tensions caused by healing over the palate, according to Sommerl AD and Jorge, et al., [27,47]. The posterior parameters in both groups of this study did not show significant changes, which coincides with the studies of Honda, et al. and Sakoda, et al., but differs from the analyses of Jorge, et al., Mello, et al., Huang, et al., Hoffmannova, et al., and Agell Sogbe, et al., which report an increase of the dimensions after cheiloplasty [13,32,38,40,43,47,48].

The similarity between the anterior parameters ∠IC'T' and ∠ICT, in the study, when groups G1 and G2 were compared, in phases 2 and 3, was reported in the literature by Generali, et al., [50]. Between T2 and T3, in both G1 and G2 groups, there was a significant increase in parameters ∠IC'T' while the ∠ICT showed a significant reduction, probably due to the tension effect of the lip healing, as it occurred before the posterior palatoplasty, causing an improvement in anterior inclination of the segments and the conformation of the arches, improving this way, the midline, which has been corroborated by Honda, et al., and Sakoda, et al., [32,48].

This study also evaluated the palate symmetry with the method proposed by Park, et al., and Zhen, et al., [14,49]. The initial data indicated that, before cheiloplasty (T1), G1 and G2 groups were not treated yet, were symmetric. In the pre-palatoplasty phase (T2), the anterior parameter of the smaller segment ∠IC'T' showed measurements significantly greater in group G2 (two-stage palatoplasty) compared to group G1 (single-stage palatoplasty), indicating better growth compared to group G1, this can probably be due to the surgery technique used. In phase post-palatoplasty (T3), the parameters were equalized to the growth, despite the technique used. The present study indicated that before cheiloplasty (T1), groups G1 and G2 showed posterior symmetry. In the pre-palatoplasty phase (T2), the posterior parameters, in the smaller and greater segments mean values ∠C'T'T, ∠CT T', did not show significant differences between group G1 (single-stage palatoplasty) and group G2 (two stages palatoplasty) indicating posterior symmetric growth of the palate, despite the surgery techniques used. Jaklová, et al., found a significant reduction in ∠CTT' and related it to the type of the cleft and a reduction less significant in ∠C'T'T. G1 and G2 groups present posterior symmetry in the post-palatoplasty phase (T3) [45]. The palate symmetry in the first years of life was poorly analyzed in the literature. In addition, the literature did not agree about surgical treatment and palate symmetry according to Ark, et al, Ambrosio, et al., and Zhen, et al., [6,14,49]. The asymmetry is inherent to children with unilateral cleft lip and palate due to the unilateral bone absence around 2 mm according to the study of Zheng, et al. [14].

The present study showed a negative correlation for ∠IC'T' versus ∠C'T'T (r equal -0.57), moderated negative for ∠ICT versus ∠CTT' (r equal -0.34) and a weak negative for ∠ICT versus ∠C'T'T (r equal -0.26). According to Haque, et al., 2020 [19] and Jaklová, et al., the approaching of the smaller and greater palatine segments occurs without any relation to the surgical protocol, probably caused by the bending of the anterior part of the greater palatine segment after cheiloplasty, despite the extension of the same segment, which could explain the inverse correlation between ∠IC'T' and ∠C'T'T, as well as the negative correlation between ∠ICT and ∠CTT' observed in this study [45]. Semb, et al., Kato, et al., Heliövaara, et al., did not find evidence of the superiority of one technique over the other in a long-term study in children's maxillary growth; in contrast, Matsumura, et al., 2022 found advantages for single-stage palatoplasty when evaluating the dental arch width [20,37,51,52]. There is a need for

different diagnoses and treatments for patients with unilateral cleft lip and palate, considering the severity in childhood, according to Tomita, et al. [53]. The speech was not evaluated and could be considered in the future [3,23,54]. The limitations found in this analysis were inappropriate digital models, which were immediately dismissed, a short time for analysis and rare literature correlated to angular measurements with palatoplasty. The data found allows a better understanding of the impact of the treatment protocol choice on the dental arch development in children with cleft lip and palate in their first years of life. This study's results evidence the initial benefits of palate closure in two stages in the post-cheiloplasty phase, but these dissipate in the post-palatoplasty phase of the posterior palate in the first year of life. More studies are required to offer information about the interaction of angular dimensions and dental arches development.

Conclusion

The study concluded that in children who had two-phase palatoplasty, there was an initial inclination to better results regarding growth on the first phase, but after the primary surgery, there was no significant difference between the two surgical techniques used.

Conflict of Interest

It was declared any conflicts of interest that may have influenced the research, authorship or publication of the article.

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Informed Consent Statement

Consent was obtained from the participant involved in this study.

Authors' Contributions

All authors have contributed equally to this work and have reviewed and approved the final manuscript for publication.

Consent for Publication

Consent for publication was obtained from the patient involved in this case report, as documented in the manuscript.

Ethical Statement

Before the execution of this retrospective study, it was approved by the Institutional Review Board for Human Research of the Hospital for the Rehabilitation of Craniofacial Anomalies, University of São Paulo (HRAC/USP), CAAE number 75622723.5.0000.5441.

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