Original Article - Comparative Study

Three-dimensional evaluation of surgical techniques in neonates with orofacial cleft

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ABSTRACT

Background: Individuals with cleft lip and palate have many anatomic and functional alterations compromising esthetics, hearing, speech, occlusion, and development/craniofacial growth. The rehabilitative treatment of these patients is very challenging and starts at birth aiming at the best treatment for all functional demands. This study aimed to evaluate the dimensional alterations of the dental arches of neonates with cleft lip and palate after two different primary surgical techniques. **Materials and Methods:** The sample comprised 114 digital models of children aged from 3 to 36 months, with unilateral complete cleft lip and palate divided into two groups. Two different phases were evaluated: precheiloplasty and 1 year after palatoplasty. The evaluation was performed through the digital models of each child obtained by scanning digitalization (3D Scanner). Dental arches measurements were accomplished through Appliance Designer software. The following measurements were assessed: dental arch area, anterior amplitude of the cleft, total length of dental arch, intercanine distance, and intertuberosity distance. *t*-test was applied to compare differences between groups. **Results:** No statistically significant differences were observed between groups at precheiloplasty phase. At 1 year after palatoplasty, the groups differed in the total length of dental arch (P = 0.002), with greater values for Group I. **Conclusion:** This study suggests that the results of the different surgical techniques may alter the growth and development of the dental arches of neonates with cleft lip and palate.

Keywords: Cleft lip, cleft palate, dental arch

INTRODUCTION

Individuals with oral clefts undergo a long and complex rehabilitative treatment starting at the 1st months of life through primary plastic surgeries – cheiloplasty and palatoplasty. These procedures are the main approach of the rehabilitative protocol[1] because they correct the anatomic defect resulting in esthetic and functional repair and enable favorable conditions for a satisfactory quality of life.[2,3]

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The surgical approaches play a paradoxical role in rehabilitation[4] because the repair of the anatomic-functional defect causes sagittal and transversal alterations in the maxillofacial growth and development, consequently influencing on interarch relationship.[5-8] The postsurgical healing tissue impairs the tissue distension negatively influencing on the face's skeletal growth, mainly in individuals with large cleft lip and palate because in these cases, a greater mucoperiosteal displacement occurs and creates thicker fibrous tissue.[2,7] Notwithstanding, the literature lacks consensus on the type of primary plastic surgery, suitable technique, and surgical time that would cause the most restrictive effects in these individuals.[6,9]

The dimensional alterations of the palatal bone plates and the cleft amplitude should be recorded since birth through dental impressions to obtain dental models - indispensable records in the files of the institution providing the morphofunctional rehabilitation.[3] The scanning of dental plaster models[4,5,10] allows the noninvasively acquisition of three-dimensional (3D) images justifying its use.[10] Furthermore, the scanning enables the storage of the images that can be enlarged, rotated and makes easy the information exchange among professionals from different areas and institutions.[5,11,12]

The quantitative analysis of the dental models through preestablished anatomic points has been used in the evaluation of individuals with cleft lip and palate.[4-7,10-12] The virtual analysis of the dental arch morphology from birth to skeletal maturity is easy, favors the diagnosis, and enables to tailor the therapeutic planning during the anatomic-functional rehabilitation.[13] Thus, this study aimed to evaluate the dimensional alterations of the dental arches of neonates with unilateral complete cleft lip and palate before and after two different primary surgery techniques.

MATERIALS AND METHODS

The Institutional Review Board approved the protocol of this study (CAAE: #26320413.7.0000.5441) regarding ethical aspects. The sample was collected conveniently according to the hospital routine. Inclusion criteria comprised children of both genders, aged from 3 to 36 months with unilateral complete cleft lip and palate, with or without Simonart's band. The children with syndromes or other malformation associated with the cleft lip and palate and those with incomplete documentation were excluded from the study.

One hundred and fourteen plaster dental casts of 57 children were selected and divided into two groups: Group I – 26 neonates in whom the cheiloplasty occurred at 3 months through Millard's technique and total palatoplasty occurred at 12 months through von Langenbeck's technique (VL); Group II – 31 neonates in whom lip closure was accomplished through Millard's technique, nose wing correction (McComb or Skoog technique), and anterior palatoplasty through vomer flap at 3 months; posterior palatoplasty was carried out at 12 months through VL technique. The models were analyzed at two phases: (T1) precheiloplasty and (T2) 1 year after palatoplasty.

The plaster dental models were obtained after the reliable copy of the dental arch through addition silicone impression (Express-3M/ESPE), aiming at reaching the perfect reproduction of the maxillary dental arch. The impressions were performed through customized acrylic resin trays previously selected according to the neonate size. The impressions were poured with white dental stone. The models were cut to obtain standardized bases proportional to the dentoalveolar areas. All materials were used according to the manufacturers' recommendations.

All plaster dental models were scanned through 3D Scanner (3Shape's R700™ Scanner, 3Shape, Copenhagen, Denmark) coupled to a computer, and the images were saves at 3SZ format. The digital models were analyzed through specific software (3D Software Appliance Designer, 3Shape, Copenhagen, Denmark). The reference anatomic points [Tables 1 and 2] were marked on the dental arches to perform the measurements [Figure 1].

The area of the dental arches [Table 2] was obtained by marking the palatal bone plates from the alveolar ridge crest bypassing all the segments adjacent to the cleft palate space. The cleft surface was also marked. All marks were carried out with the aid of the appliance software and saved at STL format. The calculation of the area of the dental arches was performed through Mimics® software (Materialise NV, Leuven, Belgium).

All statistical tests were performed in software (Statistica software (version 11.0, StatSoft Inc, Tulsa, OK, USA), with level of

Table 1: Reference anatomic landmarks

Anatomic points	Legend	Definition
Interincisive	I	Point located on the papilla between the maxillary primary central incisors
Canine	C	Point of the canine eruption on the great palatal bone plate
Canine	C′	Point of the canine eruption on the small palatal bone plate
Tuberosity	T	Point located on the junction of the alveolar ridge crest and the contour of the tuberosity on the great palatal bone plate
Tuberosity	T′	Point located on the junction of the alveolar ridge crest and the contour of the tuberosity on the small palatal bone plate

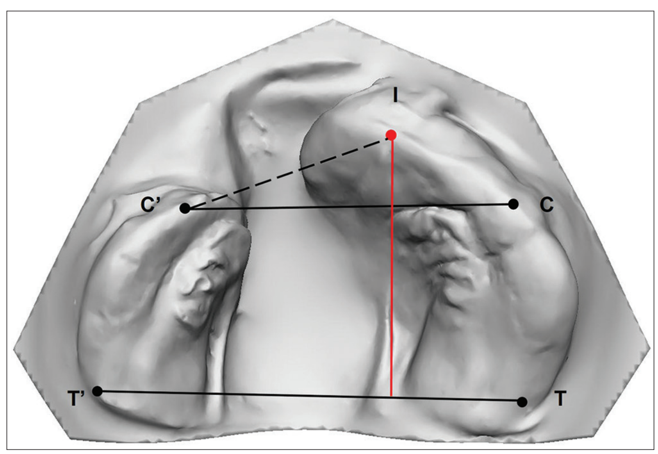

Figure 1: Linear measurements obtained from the reference anatomic points

significance of 5%. To analyze the intraexaminer error, paired *t*-test was applied in the repeated measurements of 19 children, randomly selected, 30 days after the first measurement. The casual error was determined by Dahlberg's formula. Shapiro–Wilk test was applied and indicated the normal distribution of the data. For intergroup evaluation, unpaired *t*-test was applied to compare the differences at precheiloplasty and 1 year after palatoplasty.

RESULTS

The study sample comprised 57 neonates (18 girls and 39 boys). Group I (n = 26) had 8 girls (30.7%) and 18 boys (70.3%) while Group II (n = 31) had 10 girls (32.2%) and 21 boys (68.8%).

The intraexaminer test showed no statistically significant differences in the repeated measurements [Tables 3 and 4]. All measurements were sufficiently reproducible.

At precheiloplasty, the maxillary dimensions of Groups I and II exhibited no statistically significant differences for the following measurements: C-C′, T-T′, I-TT′, I-C′, gPPlate, sPPlate, Clf, and total area [Table 5]. At 1 year after palatoplasty, the maxillary dimensions of Groups I and II showed no statistically significant differences in the measurements C-C′, T-T′, I-C′, and total area [Table 6]. However, the linear measurement I-TT′ had statistically significant differences between groups with greater values for Group I.

DISCUSSION

In this present study, the neonates with cleft lip and palate underwent cheiloplasty as of 3 months of life. According to the surgical technique chosen by the plastic surgeon, palatoplasty could be performed at more than one surgical phase. One-stage palatoplasty, so-called total palatoplasty, is accomplished at 12 months of life while two-stage palatoplasty comprises the anterior palatoplasty through vomer flap together with the cheiloplasty and posterior palatoplasty at 12 months of life. Before each surgical step, the neonates are screened through physical and laboratorial tests to verify whether the presurgical health conditional is favorable.[3]

Early plastic surgeries restrict the maxillary growth of the developing child.[14-16] Individuals with cleft lip and palate who were not submitted to primary surgeries have the maxilla with normal growth potential in relation to the sagittal dimension.[17-19] That is, primary surgeries cause inhibitory effects on transversal or anterior-posterior development of the dental arches, depending on either the surgery type performed or the rehabilitative protocol chosen.[1] The literature lacks consensus, on which primary surgery provokes greater interference on maxillary growth – cheiloplasty or palatoplasty because some studies report a decrease in the maxillary height both with lip and palate surgeries while others reported these effects only after lip surgery.[20-22] Some studies[19,23,24] report that the palatoplasty affects growth, but others show that the maxillary growth disturbs caused by the lip and palate repair were not significant smaller than that caused by the lip repair.

Aiming at decreasing the restriction of the maxillary growth and reaching a normal speech condition, different protocols have been proposed to treat these patients.[25] The surgeon's expertise and skill in performing a given technique and thus achieving

Table 2: Linear measurements and areas of the dental arches

	Definition
Linear measurements (mm)	
C-C′	Intercanine distance-transversal line between points C and C′
T-T′	Intertuberosity distance-transversal line between points T and T′
I-C′	Anterior cleft amplitude-line between points I and C′
I-TT′	Total length of the dental arch-sagittal line from point I to distance T-T′
Area (mm^2)	
gPPlate	Area of the great palatal bone plate
sPPlate	Area of the small palatal bone plate
Clf	Area of the cleft palate
Total area	Sum of the areas of the cleft palate, great and small palatal bone plates

Table 3: Paired *t*-test applied to the variables to evaluate the intraexaminer reliability at T1

Variables	Mean (SD)		*P*
	First measurement	Second measurement	
C-C′	27.21 (2.28)	27.42 (2.18)	0.4592
T-T′	32.47 (2.74)	32.75 (2.49)	0.4404
I-TT′	27.58 (2.83)	28.13 (2.39)	0.2049
I-C′	16.53 (2.24)	17.89 (5.05)	0.3094
gPPlate	1161.49 (201.68)	1174.71 (208.54)	0.5081
SPPlate	901.60 (351.54)	952.11 (227.62)	0.3794
Clf	654.28 (271.36)	645.92 (256.41)	0.6571
Total area	2768.63 (554.71)	2772.75 (539.21)	0.9033

SD=Standard deviation

Table 4: Paired *t*-test applied to the variables to evaluate the intraexaminer reliability at T2

Variables	Mean (SD)		*P*
	First measurement	Second measurement	
C-C′	27.14 (3.57)	26.82 (3.72)	0.6119
T-T′	37.32 (2.81)	44.69 (23.24)	0.3683
I-TT′	30.07 (3.65)	31.56 (3.15)	0.0733
I-C′	14.62 (3.05)	14.76 (2.89)	0.6188
Total area	2162.32 (431.26)	2183.56 (403.63)	0.5109

SD=Standard deviation

Table 5: Unpaired *t*-test to compare the maxillary dimensions between groups at T1

Variables	Mean (SD)		*P*
	Group I (n=26)	Group II (n=31)	
C-C′	31.10 (3.98)	29.69 (4.05)	0.1933
T-T′	33.44 (3.74)	34.76 (3.19)	0.1586
I-TT′	28.03 (2.58)	27.73 (2.32)	0.6483
I-C′	21.00 (3.78)	18.99 (3.62)	0.3729
gPPlate	1243.29 (237.29)	1268.48 (210.17)	0.6725
sPPlate	968.08 (209.73)	927.323 (203.67)	0.4609
Clf	837.546 (221.06)	731.957 (242.58)	0.0940
Total area	3048.92 (487.72)	2837.22 (590.46)	0.1506

SD=Standard deviation

Table 6: Unpaired *t*-test to compare the maxillary dimensions between groups at T2

Variables	Mean (SD)		*P*
	Group I (*n*=26)	Group II (*n*=31)	
C-C′	27.32 (2.29)	26.98 (2.55)	0.4461
T-T′	38.18 (1.95)	37.73 (2.63)	0.5072
I-TT′	30.65 (2.52)	29.39 (2.63)	0.0020*
I-C′	13.65 (2.80)	15.12 (3.96)	0.2246
Total area	2256.84 (293.08)	2087.56 (302.74)	0.1659

*Statistically significant difference. SD=Standard deviation

better outcomes seems to be a key factor in the maxillary growth outcome. In this study, we evaluated the alterations of the maxillary arches of neonates submitted to early cheiloplasty and palatoplasty at 3 and 12 months of age, respectively, through two different techniques. In an attempt to avoid bias, the neonates were treated for the same period, by two experienced surgeons, according to a standardized protocol. This allowed the analysis of the earliest effects of the primary surgeries on the dental arches of neonates with cleft lip and palate. We found a significant increase in the anterior-posterior distance of neonates submitted to one-stage palatoplasty compared to those submitted to two-stage palatoplasty. This result differs from that of the study of Mikoya *et al*., 2015,[6] who did not find anterior-posterior differences between one- and two-stage palatoplasty, but they found differences in the transversal relation which was better in the group submitted to two-stage palatoplasty. Xu *et al*., 2015,[21] concluded that the maxillary sagittal length may be impaired by palate repair performed at one or two stages.[6,21] In general, it is difficult to compare the results of different studies because the definition of the parameters, the therapeutic approaches, and the observation period should be observed.[26]

Some studies are based on cephalometric radiographs to analyzed the face of operated individuals[21-24] and observe whether the growth was disturbed due to the surgical protocol used. Notwithstanding, the cephalometric evaluation of individuals with craniofacial anomalies is sometimes imprecise, and some characteristics are difficult to analyze, for example, cephalometric point A in individuals with unilateral cleft lip and palate because the anterior region of the maxilla is impaired by the cleft.[17] This information together with the recent advancements in computer science lead to the increasing use of 3D images in dentistry,[27,28] justifying the use of 3D technology by this present study to analyze the craniofacial growth and development of neonates through digital models.

Different palate repair techniques are used worldwide: vomer plasty, two-flap, and VL,[29,30] two-stage palate repair with delay in closing hard palate,[31] and association of hard palate closure together with the lip repair, followed by soft palate repair (Oslo Protocol).[32] In this present study, VL technique was employed to close the palate. Previous studies affirmed that VL technique had fewer surgical complications than vomer plasty and two-flap technique with greater complication risks.[29,30] Considering the palate repair time and sequence, this study suggests that cheiloplasty at 3 months and total palatoplasty at 12 months (Group I) showed greater anterior-posterior development than the association of cheiloplasty, nose wing correction, and anterior palate surgery at 3 months and posterior palate at 12 months (Group II). This results disagree of those from Mølsted *et al*., 1992.[33] Some authors affirmed that the key factor is the moment of hard palate closure rather than the sequence of hard and soft palate closure.[21,34,35] The growth and development following up of individuals with cleft lip and palate provide important information on treatment outcomes, by outlining step-by-step the alterations occurred, which is a fundamental aspect for the rehabilitation process.

CONCLUSION

This study suggests that the results of the different surgical techniques may alter the growth and development of the dental arches of neonates with cleft lip and palate.

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Conflicts of interest

There are no conflicts of interest.

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