ORIGINAL RESEARCH

Variation of Tooth Crown Size in Cleft Lip and Palate Patients

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Abstract

Aim: This study aims to compare the mesiodistal (MD) and buccolingual (BL) tooth crown size (TCS) of adult patients with cleft lip and palate (CL/P) and patients without CL/P.

Materials and Methods: The sample of this study consisted of 146 adult patients, of both genders, of which 73 were included in the case group (with CL/P) and 73 were included in the control group (without CL/P). Data regarding gender and age and cleft type were collected. In addition, dental models were evaluated to obtain the TCS in the maximum distance of the MD and BL dimensions of all erupted permanent teeth (except third molars). The results were submitted to statistical analysis with a significance level of 0.05.

Results: In the upper arch, the central incisors (CI) were smaller in the case group for the MD and BL dimensions ($p < 0.05$). The lateral incisors (LI) and canine (C) were smaller only in the BL width ($p < 0.05$) and the second molars (SM), were smaller only in the MD dimensions. In the lower arch, there were significant differences only in the BL width between groups, the CI and LI presented smaller measurements in CL/P patients, while the left first molar (FM) and right first premolar (FPM) were larger ($p < 0.05$) than in patients without CL/P.

Conclusion: Patients with CL/P have different sizes in certain teeth compared to patients without CL/P.

Clinical relevance: Cleft lip and palate patients usually present important dental anomalies; thereby, the knowledge about trends in tooth size variations in CL/P patients can aid in dental and orthodontic treatment planning to obtain a stable, functional, and esthetic occlusion.

Keywords: Cleft lip and palate, Dental anomalies, Permanent dentition, Tooth size.

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Introduction

Cleft lip and palate are considered one of the most common congenital disorders affecting approximately 1/700 individuals, with a wide geographical variation.[1] These anomalies can be classified according to the anatomical regions involved: cleft lip only (CLO), cleft palate only (CPO), or cleft lip and palate (CL/P).[2]

Cleft lip and palate is a multifactorial condition in which environmental and genetic factors play a major role in its etiology.[2,3] Numerous environmental factors can be attributed to CL/P including, the nutritional deficit, use of insecticides, consumption of alcohol, smoking, and use of medications during pregnancy.[1,3,4] Regarding genetic factors, patients who exhibit disorders in the regular process of craniofacial growth and development, may have inherited genes that predispose them to morphological craniofacial alterations.[5]

The occurrence of CL/P and the development of tooth germs are closely related in terms of anatomical position and embryological period.[6] Tooth development is characterized by a complex interaction between the dental epithelium and the mesenchyme derived from the cranial neural crest.[7] These interactions contain several signaling pathways of inductive and permissive processes that lead to the determination, differentiation, and organization of odontogenic cells that will influence tooth size.[8–10] It has been reported that 96.7% of patients with CL/P have at least one dental anomaly. Among the most common dental anomalies are tooth agenesis, supernumerary teeth, microdontia, fused teeth, ectopic eruption, and taurodontism (enlargement of the dental crown and the pulp chamber of the tooth and shortening of the root).[11,12] Besides, other studies report that patients with CL/P have a delay in dental age in relation to chronological age.[13,14]

Studies have reported that CL/P patients have smaller permanent TCS compared to patients without CL/P.[15,16] Despite the high incidence of size variation in teeth close to the defect, some studies also report differences in the sizes of posterior teeth in CL/P patients.[15,17–19] Besides, increasing evidence in the literature suggests that patients with CL/P are more susceptible to having taurodontism in the first molars.[20–22]

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In light of this, it is hypothesized that individuals with CL/P have smaller TCS compared to individuals without CL/P, especially in the elements close to the cleft. Additionally, variations in the size of the upper first molars may be observed. Clinically, it is known that the size and shape of the teeth are characteristics that can directly influence the clinical conduct in dental treatments of individuals, such as orthodontics, endodontics, and restorative dentistry.[23] Therefore, it is important to determine the variations in size and shape of the teeth in patients with CL/P. The knowledge of these variations will contribute to the adequate planning of dental and orthodontic treatments, with greater predictability, providing more satisfactory aesthetic and functional results. In the literature, there are few studies that measure the mesiodistal and buccolingual distance in patients with CL/P.[24–27] Therefore, the aim of this study was to compare mesiodistal (MD) and buccolingual (BL) dental measurements in adult patients with CL/P and patients without CL/P.

Materials and Methods

Ethical Considerations

This study was approved by the local ethics committee under protocol numbers: CAAE: 03047318.4.0000.0093 and CAAE: 80846317.8.0000.0093. All participants were informed of the study and signed an informed consent form. This study was carried out in accordance with the Declaration of Helsinki and followed the guidelines of the Reporting of Observational Studies in Epidemiology (STROBE).[28]

Study Design and Sample Selection

This case-control study was realized in Curitiba, PR, Brazil, at the Integral Care Center Cleft Lip and Palate (CAIF) and at the Department of Oral and Maxillofacial Surgery of Positivo University (UP) and Federal University of Paraná (UFPR). All patients with CL/P who attended the CAIF, from January 2018 to January 2020, were reviewed for inclusion and exclusion criteria to participate in this study. Of the patients evaluated, 73 attended the inclusion criteria, then, a convenience sample of 73 patients made up the case group.

The inclusion criteria for the case group, were adult patients with CLP, of both genders, with permanent dentition and at least 11 teeth per arch. The exclusion criteria were syndromic patients, patients with extensive restorations on teeth, compromising to the MD and BL surface, patients with severe dental crowding, patients with more than three missing teeth per arch, and patients with dental prostheses. A convenience sample of 73 patients was included in the case group, of which 06 patients had CL, 04 patients had CPO, and 63 had CLP.

For the control group, it was selected patients without CL/P, that were under treatment in the Department of Oral and Maxillofacial Surgery at Positivo University and at the Federal University of Paraná, from January 2018 to January 2020, matching the groups by gender. The inclusion criteria for the control group were adult patients without CL/P, of both genders, with permanent dentition and at least 11 teeth per arch. The exclusion criteria were syndromic patients, patients with extensive restorations on teeth, compromising to the MD and BL surface, patients with severe dental crowding, patients with more than three missing teeth per arch, and patients with dental prostheses. A total of 73 patients were included in the control group.

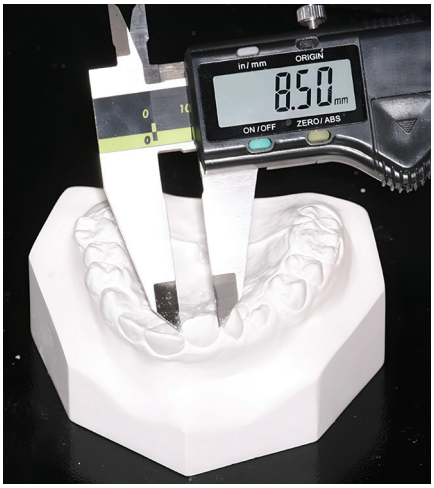

Fig. 1: Mesiodistal width of the upper left central incisor of a patient with CL/P

Fig. 2: Mesiodistal width of the upper left central incisor of a patient without CL/P

Data Collection

Data of gender (male and female) and age were collected at the moment of the dental impressions. To evaluate the TCS, dental models obtained from the upper and lower arches were used.

The measurements were obtained on a flat surface, under the same uniform illumination, using a digital caliper with straight and parallel tips (Mitutoyo 500-752-20 Digimatic Digital Caliper, Suzano, SP, Brazil), with precision near 0.1 mm. The maximum MD and BL dimensions of all erupted permanent teeth were considered (Figs 1 to 4). The dimensions were obtained by trained examiners and calibrated following the method proposed by Moorrees and Reed.[29] Each tooth was measured three times by the same operator, and the average value was used to perform the statistical analysis.

Statistical Analysis

The results of the measurements of teeth were submitted to descriptive and inferential analyses with a significance level of $p < 0.05$. To evaluate the data reliability of dental models, the intraclass correlation coefficient (ICC) was calculated. The TCS variables were submitted to the Kolmogorov-Smirnov test, showing

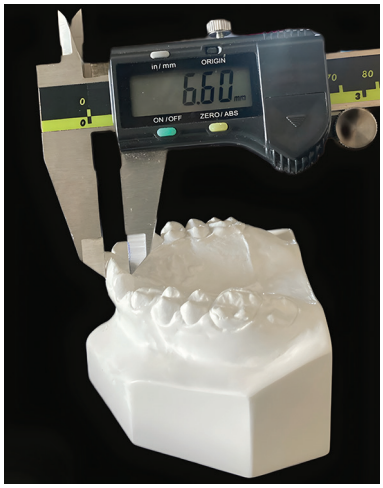

Fig. 3: Buccolingual width of the upper left central incisor of a patient with CL/P

Fig. 4: Buccolingual width of the upper left central incisor of a patient without CL/P

a parametric distribution. In order to analyze the associations between groups, the Student *t*-test was used. The analyses were performed using the IBM SPSS (Statistical Package for Social Sciences, Chicago, IL, USA) software version 21.0.

Results

To evaluate the ability, to measure the data in the dental models, the intraclass correlation coefficient (ICC) was calculated to assess the inter-examiner (ICC: 0.912/95% CI) and intra-examiner calibration (Examiner 01: ICC 0.999/95% CI; Examiner 02: ICC 0.999/95% CI; Examiner 03: ICC 0.978/95% CI).

A total of 146 individuals were included in the study, of which, 73 formed the case group (patients with CL/P) and 73 formed the control group (patients without CL/P). In the total sample, 78 individuals were male (53.4%), and 68 were female (46.6%). Since permanent TCS present sexual dimorphism, of the groups were paired by gender ($p > 0.05$).[30] The mean age and standard deviation of the case and control groups were 22.68 ± 4.94 and 27.79 ± 8.53, respectively.

In the TCS analysis between case and control groups, and MD length, patients with CL/P presented smaller upper central incisors (right side $p = 0.013$; left side $p = 0.003$) and smaller upper second molars (right-side $p = 0.008$; left-side $p = 0.035$) compared to individuals in the control group. In addition, patients in the case group presented larger upper first molars compared to individuals in the control group (right-side $p = 0.005$; left-side $p = 0.002$, respectively). There was no association of MD length in the lower arch.

When the MD dimension in the TCS, was evaluated, the patients with CL/P compared to individuals without CL/P, had smaller BL dimensions in the SCT of the right central incisor ($p < 0.001$), right lateral incisor ($p = 0.013$), right canine ($p < 0.001$), left central incisor ($p < 0.001$), left lateral incisor ($p = 0.024$) and left canine ($p < 0.001$). In the lower arch, the central (right-side $p < 0.001$; left-side $p < 0.001$) and lateral (right-side $p < 0.001$; left-side $p = 0.003$) incisors, on both sides showed smaller BL distance, in individuals with FL/P, than in control group. Furthermore, individuals with CL/P presented larger BL width in the left first molar and right first premolar of the lower arch than individuals without CL/P ($p = 0.025$ and $p < 0.001$, respectively).

Table 1: Association of TCS in the upper arch between groups

		MD length				*BL width*			
Tooth	*Group*	*n*	*Mean*	*SD*	*p-value*	*n*	*Mean*	*SD*	*p-value*
				Right side					
CI	Case	68	8.23	0.67	**0.013**	40	6.61	1.15	**<0.001**
	Control	71	8.49	0.58		70	7.53	0.78	
LI	Case	44	6.73	0.87	0.327	22	6.14	1.01	**0.013**
	Control	70	6.58	0.65		69	6.71	0.89	
C	Case	57	7.34	0.61	0.166	30	7.31	1.30	**<0.001**
	Control	71	7.49	0.60		70	8.29	0.80	
FPM	Case	62	8.93	0.42	0.336	35	9.28	0.76	0.390
	Control	69	6.83	0.72		68	9.11	1.44	
SPM	Case	58	6.52	0.71	0.331	34	9.26	0.71	0.923
	Control	62	6.39	0.71		60	9.24	0.91	
FM	Case	72	10.25	0.67	**0.005**	41	11.07	0.77	0.485
	Control	68	9.90	0.79		67	10.95	0.90	
SM	Case	59	9.71	0.71	**0.008**	32	10.99	1.29	0.968
	Control	70	10.07	0.75		69	10.98	1.18	

(Contd...)

Table 1: (*Contd...*)

		MD length				*BL width*			
Tooth	*Group*	*n*	*Mean*	*SD*	*p-value*	*n*	*Mean*	*SD*	*p-value*
				Left side					
CI	Case	69	8.10	0.58	**0.003**	37	6.34	1.21	**<0.001**
	Control	71	8.42	0.65		70	7.54	0.86	
LI	Case	25	6.71	0.60	0.223	12	6.17	1.01	**0.024**
	Control	68	6.51	0.71		68	6.79	0.84	
C	Case	59	7.32	0.67	0.247	32	7.18	1.13	**<0.001**
	Control	70	7.45	0.55		69	8.24	0.94	
FPM	Case	58	6.96	0.51	0.131	35	9.06	0.83	0.905
	Control	68	6.80	0.68		66	9.09	0.82	
SPM	Case	54	6.57	0.48	0.215	33	9.33	0.75	0.369
	Control	59	6.43	0.69		57	9.11	1.21	
FM	Case	71	10.29	0.80	**0.002**	41	11.1	0.75	0.075
	Control	69	9.87	0.78		68	10.7	1.20	
SM	Case	63	9.81	0.90	**0.035**	35	10.8	1.06	0.559
	Control	70	10.14	0.89		69	10.7	1.57	

Bold values indicate statistical significance. Student *t*-test with significance level of 0.05. Values in bold are of mean statistical significance. BL, buccolingual; CI, central incisor; C, canine; FM, first molar; FPM, first premolar; LI, lateral incisor; MD, mesiodistal; SM, second molar; SPM, second premolar

Table 2: Association of TCS in the lower arch between groups

		MD length				*BL width*			
Tooth	*Group*	*n*	*Mean*	*SD*	*p-value*	*n*	*Mean*	*SD*	*p-value*
				Right side					
CI	Case	72	5.42	1.00	0.744	43	5.80	0.65	**<0.001**
	Control	71	5.48	1.13		69	6.28	0.67	
LI	Case	71	5.84	0.83	0.725	42	5.96	0.81	**<0.001**
	Control	72	5.80	0.51		69	6.53	0.72	
C	Case	65	6.64	0.63	0.368	36	6.94	1.06	**0.015**
	Control	72	6.55	0.58		69	7.47	0.82	
FPM	Case	63	7.01	0.54	0.244	34	7.90	0.67	0.210
	Control	69	6.89	0.58		68	7.69	0.97	
SPM	Case	57	6.96	0.50	0.493	30	8.34	0.73	0.452
	Control	66	7.05	0.95		64	8.20	0.88	
FM	Case	69	10.96	0.70	0.356	39	10.61	0.68	**0.025**
	Control	66	10.83	0.82		65	10.24	0.98	
SM	Case	60	10.76	0.84	0.878	31	10.16	0.86	0.947
	Control	66	10.73	0.92		65	10.17	0.96	
				Left side					
CI	Case	71	5.34	0.67	0.348	43	5.75	0.71	**< 0.001**
	Control	71	5.25	0.50		68	6.25	0.70	
LI	Case	71	5.78	0.65	0.866	40	5.92	0.74	**0.003**
	Control	72	5.80	0.55		69	6.39	0.80	
C	Case	66	6.57	0.47	0.170	35	7.05	0.91	0.059
	Control	72	6.45	0.55		69	7.39	0.79	
FPM	Case	62	6.99	0.51	0.742	32	7.96	0.59	**< 0.001**
	Control	67	6.96	0.62		66	7.35	0.90	
SPM	Case	58	7.12	0.47	0.229	30	8.32	0.77	0.089
	Control	64	7.00	0.63		62	8.01	0.85	
FM	Case	67	10.74	0.88	0.548	38	10.59	0.67	0.076
	Control	64	10.84	0.82		63	10.29	1.01	
SM	Case	60	10.59	0.82	0.427	30	10.37	0.77	0.183
	Control	67	10.70	0.82		66	10.07	1.09	

Bold values indicate statistical significance. Note: Student *t*-test with significance level of 0.05. Values in bold are of mean statistical significance. BL, buccolingual; CI, central incisor; C, canine; FM, first molar; FPM, first premolar; LI, lateral incisor; MD, mesiodistal; SM, second molar; SPM, second premolar

In summary, in the upper arch, the CIs were smaller in the case group for the MD and BL dimensions. The LIs and Cs were smaller only in the BL width. In the lower arch, there were significant differences only in the BL width between groups. The CI and LI presented smaller measurements in patients with CL/P, while the left first molar and right first premolar were larger in these patients.

All the analyses between case and control groups of the TCS in upper and lower arches are presented in Tables 1 and 2, respectively.

Discussion

The TCS is important data for dental, especially orthodontic treatment planning. The variation of the TCS of patients with CL/P is widely discussed in the literature.[15,17,23,31] The knowledge of these variations will imply a correct diagnosis and treatment plan. For this, methods such as software (orthoCAD and OnyxCeph) and digital calipers are used to measure the TCS. Studies show, that the digital caliper has demonstrated greater or equal precision and reproducibility in the measuring of the TCS, when compared to software, configuring a suitable method for measuring TCS.[32,33] By means of the digital caliper, the present study demonstrated important variations in the TCS in patients with CL/P.

These teeth are the most impacted by CL/P.[15] In our study the patients with CL/P, had a significantly smaller BL distance of all LIs (upper and lower) compared to the control group. In the literature, few studies have measured the BL dimension in the TCS in patients with CL/P. Akcam et al. through an analysis of dental models of patients with CL/P and without CL/P, identified smaller BL dimensions of the upper and lower LIs in patients with CL/P. Walker et al. and Kaplan et al. also found the BL dimensions of the upper and lower LIs, were reduced in patients with CL/P. These results are in agreement with the present study.[24,26,27] In addition to the LIs, all the ICs, and canines of the CL/P patients, showed a smaller BL dimension when compared to the control group patients. This result is in agreement with Akcam et al. and Walker et al. who demonstrate in their studies, a reduction of the TCS, in all BL dimensions in patients with CL/P, when compared to patients without CL/P. Some authors have hypothesized that the smaller teeth may be a consequence of the compromised potential growth of patients with CL/P. In addition, genetic and environmental factors, such as surgical interventions and nutrition, are considered determinant factors for TCS.[34,35]

Concerning the MD distance of the upper LIs, in this study, there was no statistically significant difference between the case and control groups. Akcam et al. in their study, demonstrate a smaller MD dimension of the left upper LIs in patients with bilateral and unilateral left cleft lip and palate; and the right LIs showed no statistically significant differences when compared to the control group. It is suggested that the reduction of the MD dimension of the upper LIs may be associated with the type and side of the cleft. Studies justify the reduction of these teeth by the proximity of the cleft or the prevalence of microdontia in the upper LIs, especially on the left side, the side that is usually more associated with the cleft.[17,34,36,37] Lewis et al. compared in their study the cleft side with the non-cleft side, demonstrating smaller MD dimensions of the LIs and ICs on the cleft side.[38,39] In the present study, patients with CL/P showed a statistically significant reduction in the MD distance of the upper ICs. Although in this study no association between cleft types was made, we can say that this result is partially in agreement with the findings of Lewis et al.

Regarding the posterior teeth of the upper arch, the upper SMs of patients with CL/P showed a statistically significant reduction in the MD dimension, while the upper FMs showed a greater MD dimension in patients with CL/P compared to patients without CL/P. This was a surprising finding because, although some studies have reported that there is no link between the cleft and the morphology of teeth distant to the cleft, no studies were found reporting greater MD dimension of first molars in patients with CL/P.[40] On the contrary, Hermann et al. demonstrate in their study, through radiographic analyses, shows delayed follicular maturation and consequent reduction in the size of the follicle/crown/tooth of the upper FMs in patients with CL/P.[39] Kaplan et al. in a comparative analysis of the cleft vs non-cleft sides, found a greater MD dimension of the upper FMs on the non-cleft side.[24] However, a justification for the increased MD dimension of the upper FMs of CL/P patients found in these studies is the possible presence of anomalies such as taurodontism;[19] since there are studies suggesting a higher prevalence of taurodontism in CL/P patients compared to the general population.[15,17,18] Akcam et al. in their study demonstrated an incidence of taurodontism was 1.9% in the upper molars of patients with CL/P.[17] Kuchler et al. found that the prevalence of taurodontism in populations with CL/P was nine times higher compared to the people without CL/P.[18] However, it is worth mentioning that the diagnosis of taurodontism requires a radiographic evaluation of dental crown measurements, as well, as the extension of the pulp chamber and length of the root and, this analysis was not performed in the present study.

Concerning the lower arch teeth, evidence suggests that the dental anomalies in this group are more related to genetic factors than environmental factors.[33] De Sabóia et al. suggested that the variations of TCS may also be part of the phenotypic spectrum of the oral cleft, and for this reason, the inclusion of the lower teeth in the study is important.[10] In our results, we found that patients with CL/P have smaller BL width, statistically significant, in the CIs, LIs, and canines; and larger BL dimension in the lower left FM and lower right first premolar when compared to individuals without CL/P. This result is partially contrasting with the Akcam et al. and Walker et al. findings, which show a smaller BL dimension on the TCS in all lower teeth of patients with CL/P. However, when we talk about variation in the TCS of the mandibular molars and premolars, different results are found in the literature.[17] Kaplan et al. reported that mandibular premolars could be larger in the MD and BL dimensions on the cleft side.[24] Other previous studies have also shown, an increase in the mandibular premolars on the fissure side.[25,38] This result is more similar to our study.

The present study evaluates the MD and BL dimensions of the teeth individually in dental models. However, since other tools as imaging exams were not disposable for analysis, it was not possible to measure the total length of the tooth or the pulp chamber volume. Another limitation of this study is the difference in sample size for each cleft type, making a comparison between cleft types impossible. It is worth mentioning that further studies, with larger samples, are necessary to confirm these findings.

Given the variety of TCS changes in patients with CL/P, it is worth mentioning the influence of these changes on dental treatments.[23] We know that the size, shape, or space that these teeth occupy in the arch will direct the planning of dental treatment, especially orthodontics. Thus, knowledge of these alterations is essential for adequate dental treatment planning in patients with CL/P, aiming at a harmonic and stable occlusion, with aesthetic and functional gains. Finally, satisfactory results.

Conclusion

Individuals with CL/P have smaller MD and BL dimensions of the teeth compared to patients without CL/P. Knowing these tooth crown size variations, in CL/P patients, is important for treatment planning, aiming at a stable, functional, and harmonic occlusion.

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