UNIVERSIDADE DE SÃO PAULO
HOSPITAL DE REABILITAÇÃO DE ANOMALIAS CRANIOFACIAIS

AURA SOFIA CACERES MANFIO

Evaluation of micro esthetics characteristics of maxillary anterior teeth after orthodontic treatment in UCLP: A digital dental model study

Avaliação das caracteristicas micro estéticas em dentes anterossuperiores após o tratamento ortodôntico em pacientes com fissura completa e unilateral: Um estudo em modelos digitais

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Área de concentração: Fissuras Orofaciais e Anomalias Relacionadas

Orientadora: Profa. Dra. Ana Lúcia Pompéia Fraga de Almeida

Coorientadora: Profa. Dra. Daniela Gamba Garib

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Aura Sofia Caceres Manfio

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Todo pasa y todo queda,

pero lo nuestro es pasar,

pasar haciendo caminos,

caminos sobre el mar.

Caminante, son tus huellas

el camino, y nada más;

caminante, no hay camino,

se hace camino al andar.

Al andar se hace camino,

y al volver la vista atrás

se ve la senda que nunca

se ha de volver a pisar.

Caminante, no hay camino,

sino estelas en la mar...

Antonio Machado

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ABSTRACT

Introduction: The purpose of this study was to evaluate in digital models the dental and gingival characteristics composing the anterior micro esthetic of the smile in unilateral cleft lip and palate (UCLP) individuals with missing lateral incisors in the cleft area after comprehensive orthodontic treatment and, to compare the cleft side (CS) with the non cleft side (NCS) and, those measurements with a control group of normal occlusion (NO). **Methods:** The experimental group included 57 dental casts of patients with UCLP (31 males, 26 females; mean age, 20.4 years) with comprehensive orthodontic treatment associated to canine substitution for the missing maxillary lateral incisor and premolar substitution of the canine. The control group comprised 48 dental casts of noncleft individuals with normal occlusion (NO) (25 males, 23 females; mean age, 16.5 years). The dental and gingival features evaluated included: (1) crown height, (2) crown width, (3) crown width-to-height proportion (Width/Height ratio), (4) mesiodistal dimension of anterosuperior teeth in a frontal perspective (Anterior View Width), (5) incisal edge symmetry between homologous teeth, (6) central-to-lateral incisal step, and central-to-canine incisal step, (7) gingival margin symmetry between homologous teeth, (8) central-to-lateral gingival step, and central-to-canine gingival step, (9) crown angulation and (10) crown inclination. The paired t test was used for intragroup comparisons, and the independent t test was used for intergroup comparisons. After Bonferroni correction the level of significance considered was of $p<0.016$ for all measurements except width ratio, gingival step, incisal step and angulation ($p<0.025$). **Results:** When compared to the NCS, the CS canine substituting the lateral incisor missing had augmented crown height ($p<.001$) and width ($p<.001$), the premolar had diminished crown height ($p<.001$), consequently the width/height ratio for the premolar was altered ($p<.001$); there was asymmetry between the gingival level of central ($p<.001$) and lateral incisors ($p<.001$) and, the central incisor was in a more vertical position ($p=.005$). Between the CS of UCLP and NO the canine substituting the lateral incisor presented an augmented mesiodistal size ($p<.001$) and it affected the anterior view width ($p<.001$). Central and lateral incisors in the C side had higher crown height ($p<.001$) and the premolar substituting the canine had a diminished crown height ($p<.001$). Central incisor ($p<.001$) and lateral incisors ($p=.006$) were more uprighted

and premolars substituting canines had decreased lingual inclination (p=.010). The NCS and the NO had fewer differences, the lateral incisors were slightly wider (p<.001) and the gingival step between central incisor and canine was augmented (p<.001). Tooth vestibular inclination was increased especially in central incisors (p=.012) and canines (p=.004) when compared to the normal occlusion group. **Conclusions:** Differences were found in the micro esthetics elements that comprises the anterior dental and gingival esthetics between cleft and non cleft sides of UCLP and between UCLP and NO. These differences were more pronounced when considering the cleft side. Therefore, specific esthetic procedures should be performed in cases with canine substitution for missing lateral incisors of UCLP in association with the orthodontic treatment, aiming to provide a more harmonious and natural smile.

Key-words: dental models, cleft lip, cleft palate, anodontia, dental esthetics.

RESUMO

Introdução: A proposta deste estudo é avaliar em modelos digitais as características dentárias e gengivais que compõem a micro estética anterior do sorriso de indivíduos com fissura transforame incisivo unilateral (FTIU) e agenesia de incisivos laterais após o tratamento ortodôntico e, compará-las entre os lados com fissura (CF) e sem fissura (SF) e, com um grupo controle representado por uma oclusão normal (ON). **Métodos:** O grupo experimental incluiu 57 modelos digitais de indivíduos com FTIU (31 homens, 26 mulheres; idade média 20.4 anos) em que o tratamento ortodôntico incluiu a substituição do incisivo lateral ausente pelo canino e do canino pelo primeiro pré-molar. O grupo controle (ON) foi composto por 48 modelos digitais de indivíduos com oclusão normal (25 homens, 23 mulheres; idade média: 16.5 anos). As características dentárias e gengivais avaliadas incluíram: (1) altura da coroa, (2) largura da coroa, (3) proporção largura/altura, (4) dimensão mesiodistal dos dentes anterossuperiores em uma perspectiva frontal, (5) simetria entre bordos incisais de dentes homólogos, (6) degrau incisal entre incisivo central e lateral e, entre incisivo central e canino, (7) simetria entre as margens gengivais de dentes homólogos, (8) degrau gengival entre incisivo central e incisivo lateral e, entre incisivo central e canino, (9) angulação dentária e (10) inclinação dentária. O teste t pareado foi utilizado para as comparações intra-grupos e o teste t independente foi utilizado nas comparações inter-grupos, os resultados foram submetidos à correção de Bonferroni considerando um nível de significância de $p<0.016$ para todas as medidas exceto proporção mesiodistal anterior, degrau gengival, degrau incisal e angulação, para estas medidas o nível de significância foi de $p<0.025$. **Resultados:** Comparando os lados SF e CF, o canino substituindo o incisivo lateral ausente no lado CF apresentava altura ($p<.001$) e largura ($p<.001$) de coroa aumentadas; a altura da coroa do pré-molar estava diminuída no lado CF ($p<.001$). Observou-se assimetria entre os níveis gengivais de incisivos centrais ($p<.001$) e laterais ($p<.001$) e, uma posição mais verticalizada dos incisivos centrais ($p=.005$). Entre o lado CF e ON o canino substituindo o incisivo lateral teve a largura aumentada ($p<.001$), afetando a proporção mesiodistal em vista anterior ($p<.001$). Incisivos centrais e caninos no lado CF apresentaram maior altura de coroa ($p<.001$), já o pré-molar substituindo o canino teve a altura diminuída ($p<.001$).

A angulação dos incisivos central (p<.001) e canino (substituindo o incisivo lateral) (p=.006) se encontrava diminuída e a inclinação do pré-molar estava aumentada (p=.010). As diferenças encontradas entre os lados SF e ON foram sutis, no lado SF os incisivos laterais apresentaram-se um pouco mais largos (p<.001), o degrau gengival entre incisivos centrais e caninos estava aumentado (p<.001) e a inclinação dos incisivos (p=.012) e caninos (p=.004) estava aumentada. **Conclusões:** Foram encontradas diferenças entre os componentes da micro estética dentária para os lados CF e SF e entre os grupos FTIU e ON. Dessa forma, esses achados sugerem que os procedimentos de refinamento estético, em casos de mesialização de caninos e pré-molares no tratamento de agenesias de incisivos laterais em pacientes com fissura, devem ser conduzidos associados ao tratamento ortodôntico visando proporcionar um sorriso harmônico e natural.

Palavras-chave: Fenda labial, fissura palatina, anodontia, modelos dentários, estética dentária.

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1 INTRODUCTION

1 INTRODUCTION

Cleft lip and palate (CLP) represents the most frequent congenital craniofacial abnormality (RANTA, 1986; WORLD HEALTH ORGANIZATION, 2002), its incidence varies according to the studied population (DERIJCKE; EERENS; CARELS, 1996). Individuals with CLP might have decreased facial and dental esthetics, resulting in low self-confidence and difficulties in social interactions (MEYER-MARCOTTY; STELLZIG-EISENHAUER, 2009). Therefore, besides achieving function, the rehabilitation aims to reestablish patient's facial esthetics and function while improving psychosocial aspects (MARCUSSON; AKERLIND; PAULIN, 2001).

The interdisciplinary treatment protocol is extensive and includes primary surgeries such as cheiloplasty and palatoplasty, orthodontic expansion, secondary alveolar bone graft (SABG), orthodontic treatment associated or not to orthognathic surgery and final plastic surgeries (ALJOHAR; RAVICHANDRAN; SUBHANI, 2008; FREITAS et al., 2012). Even after a successful functional rehabilitation treatment, patients still have concerns about the appearance of cleft-related features (MARCUSSON; AKERLIND; PAULIN, 2001; SINKO et al., 2005). The importance of esthetics in CLP should not be neglected since facial appearance is related to individual social wellbeing and the developing of the self-concept (NOOR; MUSA, 2007; STELZLE et al., 2017). A successful treatment could be defined as an association of objective measurements and self-reported quality of life assertion (KLASSEN et al., 2012). Therefore, smile reconstruction in CLP should be guided considering patient's expectations and the limitations of each case (ESPER et al., 2009).

The evidence suggests that a higher number of dental anomalies in the permanent dentition are noted in individuals born with oral clefts (RANTA, 1986; HELIÓVAARA; RANTA; RAUTIO, 2004; AKCAM et al., 2008; TANNURE et al., 2012) affecting clinical decisions during dental treatment. It is relevant to emphasize that patients with CLP commonly have agenesis of the maxillary lateral incisors in the cleft area (VANZIN; YAMAZAKI, 2002; LOURENÇO RIBEIRO et al., 2003; HALPERN; NOBLE, 2010). The gold standard treatment plan after alveolar bone graft surgery in these cases is to mesially move the maxillary canines in order to

replace the missing lateral incisor (AIELLO; SILVA FILHO; FREITAS, 2000; CASSOLATO et al., 2009). Specific orthodontic movement, dental and periodontal esthetic procedures might be performed employing similar conducts than the ones proposed for noncleft patients with maxillary lateral incisor agenesis with the aim to provide natural and esthetic smile (NORDQUIST; MCNEILL, 1975; ROSA; ZACHRISSON, 2001; KOKICH; KINZER, 2005; ZACHRISSON; ROSA; TORESKOG, 2011). The usual esthetic procedures include: 1. Individualized extrusion and intrusion during the mesial movement of the canine and the first premolar respectively. 2. Reduction in the incisogingival and mesiodistal dimensions of the canine associated to flattening of the labial surface, steepening of the lingual convexity, bleaching and composite bonding or veneering to mimic the replaced tooth. 3. Increasing the length and width of the intruded first premolars with porcelain veneers or resin buildups. 4. Simple minor surgical procedures for localized clinical crown lengthening (ZACHRISSON; ROSA; TORESKOG, 2011).

Because of its subjective nature, it is difficult to qualify and quantify the beauty of a smile (PINHO et al., 2007; MCLEOD et al., 2011). However, the measurement of what is beautiful or the perception of beauty in dentistry is fundamental to provide scientific data that could guide diagnosis and treatment planning (PINHO et al., 2007).

Even when excellent occlusal relationships are obtained after orthodontic treatment, individual variability such as: shape of the teeth, curls of the lips, and mouth expression could lead to a smile esthetically pleasant or not (AKYALCIN et al., 2014).

The smile components were classified as: 1) mini-esthetics: corresponding to the relationship between teeth and lips, including aspects such as symmetry between facial and dental midlines, incisor exposition during rest and smile, inclination of the occlusal plane, transverse dimension of the smile and smile bow; 2) micro-esthetics: corresponding to the dental aspect, including dental proportions of height and width, golden proportion between upper anterior teeth, gingival heights (shape, contour and interdental papillae), presence of black triangles and points of contact (PROFFIT; SARVER; ACKERMAN, 2007).

Studies have been performed considering the opinion of different population (laypeople, dentists and dental specialists), in order to identify the factors that comprise pleasant smiles in non cleft patients, so that evidence based dental and orthodontic treatment (associated or not with other specialties in dentistry) could be defined (KOKICH; KIYAK; SHAPIRO, 1999; SARVER; ACKERMAN, 2003a, 2003b; KOKICH; KOKICH; KIYAK, 2006; PINHO et al., 2007; BROUGH; DONALDSON; NAINI, 2010; MACHADO; MOON; GANDINI, 2013; AKYALCIN et al., 2014; MACHADO, 2014; MACHADO et al., 2016). Between the many issues evaluated the ones that comprise the micro-esthetics included the: gingival composition and symmetry (SARVER, 2004; KOKICH; KOKICH; KIYAK, 2006; PINHO et al., 2007; SPRINGER et al., 2011), incisal composition and symmetry (SPRINGER et al., 2011; MACHADO; MOON; GANDINI, 2013; MACHADO, 2014; MACHADO et al., 2016), tooth proportionality height and width (GILLEN et al., 1994; SARVER, 2004; BRANDÃO; BRANDÃO, 2013), proportion and symmetry between central incisors (MACHADO, 2014) and proportion between anterossuperior teeth (MACHADO, 2014).

Few studies analyzed the smile esthetics of cleft lip and palate patients (ESPER et al., 2009; ESPER et al., 2012). While evaluating soft tissue characteristics and the degree of satisfaction of UCLP individuals after complete rehabilitation it was found that only 13.3% of individuals considered their smile as esthetically unpleasant, however, none reported dissatisfaction with the gingival component. Therefore, the smile might be probably considered unaesthetic due to dental aspects for example: shape of teeth, tooth positioning, contour and color of teeth, lip shape or height among other factors (ESPER et al., 2009). When associating gingival esthetics and oral health-related quality of life in patients with CLP it was found that cases with higher oral esthetics in the cleft area had a direct relation with the oral health-related quality of life and that sites where patient's own teeth was integrated into the cleft area showed superior esthetics when compared to cases with implants or dental prosthetics (STELZLE et al., 2017). The visibility of the periodontum (smile line) and the esthetics of smile (thickness of upper lip and curve of upper lip) in UCLP the varied according to the type of smile (natural or forced), being scored as average at the cleft and noncleft sides, with a low prevalence of high and very high smile line (ESPER et al., 2012).

No previous research has evaluated the micro esthetics characteristics of anterior maxillary teeth that compose the smile of UCLP individuals, after orthodontic treatment with canine substitution of missing lateral incisors. Therefore, the purposes of this study were to compare the micro esthetics in cleft and noncleft sides. An additional aim was to compare cleft and noncleft sides with noncleft individuals with a normal occlusion group.

2 PURPOSES

2 PURPOSES

Through the use of digital dental models and measurement of the micro esthetic components of the smile in unilateral cleft lip and palate (UCLP) and in a normal occlusion (NO) group, the aims of this study were to:

1. Compare the results between cleft and noncleft sides of the UCLP group;

2. Compare the results between the UCLP group with the NO group.

The null hypothesis is that there is no difference in the anterior dental micro esthetics between cleft side, noncleft side and the normal occlusion.

3 ARTICLE

3 ARTICLE

Anterior dental micro esthetics after orthodontic treatment in UCLP: a digital dental model study

ABSTRACT

Introduction: This study aimed to evaluate the anterior micro esthetic components between cleft side (CS) and noncleft side (NCS) of unilateral cleft lip and palate (UCLP) individuals and, those measurements with a normal occlusion group (NO). **Methods:** The UCLP group included 57 digital dental casts of finished orthodontic treatment with canine substitution (U2) for missing maxillary lateral incisors and, premolar substitution (U3) of the canines in the CS. The NO comprised 48 subjects. The evaluated features included: (1) crown height and width, (2) width/height ratio, (3) anterior view width, (4) incisal and gingival symmetry, (5) incisal and gingival step, (6) crown angulation and inclination. Paired t test and independent t tests were used for intragroup and intergroup comparisons. The level of significance was of $p<0.016$ for all measurements except width ratio, angulation, gingival and incisal steps ($p<0.025$). **Results:** Compared to the NCS, the CS U2 had augmented height ($p<.001$) and width ($p<.001$), U3 had diminished height ($p<.001$), the width/height ratio for U2 was altered ($p<.001$). There was asymmetry between the gingival level ($p<.001$) of central and lateral incisors and, the central incisor was more uprighted ($p=.005$). Between CS and NO, U2 was wider ($p<.001$) affecting the anterior view width ($p<.001$). Central incisor and U2 had higher height ($p<.001$) and, U3 diminished height ($p<.001$). Central incisor ($p<.001$) and U2 ($p=.006$) were more uprighted and, U3 had decreased lingual inclination ($p=.010$). Differences between NCS and NO were subtle. **Conclusions:** Differences were found between C and NC sides and, UCLP and NO.

INTRODUCTION

Cleft lip and palate (CLP) is the most frequent craniofacial anomaly.[1,2] The individuals with CLP might have facial and dental esthetics impairment, resulting in low self-steem and difficulties in social interactions.[3] Therefore, besides the achievement of adequate function, the rehabilitation aims to normalize the appearance of the nose, lips, teeth and improve patients quality of life. [4,5]

Individuals with CLP often have agenesis of the maxillary lateral incisors in the cleft area.[6,7] The gold standard treatment plan after secondary alveolar bone graft (SABG) surgery in these cases is to mesially move the maxillary canines in order to replace the missing lateral incisor.[8,9] Orthodontic space closure in cases of missing maxillary lateral incisors in non cleft individuals can provide excellent aesthetics and functional results when specific multidisciplinary conducts are performed.[10-12] In young patients the main advantages in this alternative of rehabilitation consist in finishing treatment in adolescence or early adulthood without the need for removable or resin-bonded retainers until the placement of implants.[13,14] When compared to the use of implants, this conduct avoids potential complications around implant-supported crowns such as progressive infraocclusion[15-17], disharmonious marginal gingival levels,[15] blue coloring of the gingiva and resorption of the labial bone.[18] In CLP individuals there is evidence that orthodontic space closure contributes also to periodontal health, to the maintenance of the SABG at the cleft area[19, 20] and provide superior esthetics when compared to cases with implants or dental prosthetics[21].

Few studies have been conducted in order to assess the anterior dental esthetics of CLP individuals.[21-23] In the evaluation of the smile soft tissue features in individuals with unilateral cleft lip and palate (UCLP) and the degree of satisfaction after complete rehabilitation only 13.3% of individuals considered their smile as esthetically unpleasant. The most common reasons for the dissatisfaction included the shape of teeth, tooth positioning, contour and color of teeth, lip shape or height. In this study there was no discrimination if the rehabilitation in the cleft area was performed with a prosthesis, implant or canine substitution.[22] Another study aimed to investigate which dental and surgical treatment options had a more positive influence in the oral esthetic appearance and to identify the impact of gingival esthetics on the oral health-related quality of life (OHRWoL) in a group of CLP. It was found that sites with patient's own teeth integrated into the cleft area showed superior esthetics and

that this result was directly related with fewer problems regarding OHRWoL.[21] When evaluating the visibility of the periodontum (smile line) and the esthetics of smile (thickness of upper lip and curve of upper lip) in UCLP the authors concluded that the simile line varied according to the type of smile (natural or forced), being scored as average at the cleft and noncleft sides, with a low prevalence of high and very high smile line.[23]

No previous research has evaluated the micro esthetics characteristics of anterior maxillary teeth in UCLP individuals, after orthodontic treatment with canine substitution of missing lateral incisors. Therefore, the purposes of this study were to compare the micro esthetics in cleft and noncleft sides. An additional aim was to compare cleft and noncleft sides with noncleft individuals with a normal occlusion. The null hypothesis is that there is no difference in the anterior dental esthetics between cleft side, noncleft side and the normal occlusion.

MATERIAL AND METHODS

This study was approved by the Institutional Review Board of the Hospital for Rehabilitation of Craniofacial Anomalies, University of São Paulo (protocol number 1.471.470).

Calculation of the sample size was based on the ability to detect a difference in maxillary dental height for central incisors of 0.5 mm (SD, 1.30), with an alpha error of 5% and a power of 80%. The sample size required was of 56 subjects.

Patients from a single center with finished comprehensive orthodontic treatment between 2011 and 2016 were screened. The inclusion criteria were: (1) presence of final dental casts (2 to 6 months after debonding), (2) ages between 15 and 30 years, (3) history of cheiloplasty and palatoplasty, (4) history of SABG surgery with iliac crest autogenous bone between 9 and 12 years old, (5) presence of both maxillary lateral incisor and canine in the noncleft side (NCS), (5) agenesis of the lateral incisor at the cleft side (CS), (6) comprehensive orthodontic treatment including mesial movement of the maxillary canines and first premolars toward the grafted alveolar cleft. The exclusion criteria were: (1) presence of syndromes, (2) edentulous space in the anterosuperior region, (3) prosthetic rehabilitation in the anterosuperior region, (4) fractured anterior teeth. A final sample comprised dental models of 57 patients (31 males and 26 females) with a mean age of 20.4 years.

The control group was composed by a sample of 48 individuals (25 males and 23 females) with a mean age of 16.5 years and normal occlusion from the Orthodontic Department of the University of São Paulo. This sample was collected in the 70' decade and was composed by individuals with Class I molar relationship, proper overjet and overbite and well-aligned tooth.

The dental models of both experimental and control group were scanned using laser scanner 3Shape R700 3D (3Shape A/S, Copenhagen, Denmark). The images were saved in .STL format and measurements were performed using the software OrthoAnalyzer 3D (3Shape A/S, Copenhagen, Denmark). An occlusal plane was defined (Fig 1, *A*) and used as a reference in the positioning of dental models in a frontal view with the occlusal plane parallel to the ground (Fig 1, *B*).

The dental features evaluated included: (1) crown height, (2) crown width, (3) crown width-to-height proportion (Width/Height ratio), (4) mesiodistal dimension of anterosuperior teeth in a frontal perspective (Anterior View Width), (5) incisal edge symmetry between homologous teeth, (6) central-to-lateral incisal step, and central-to-canine incisal step, (7) gingival margin symmetry between homologous teeth, (8) central-to-lateral gingival step, and central-to-canine gingival step, (7) crown angulation and (8) crown inclination as seen in Figures 2 and 3.

For measuring dental crown width and height the dental casts were positioned in order to observe each tooth in a frontal view (Fig 2, *A*). The width dimension of the crown was considered the maximum distance between the mesial and distal contact points of each tooth.[24] The crown height was measured from the gingival zenith to the incisal edge.[24] The ratio between width and height was calculated after each value was recorded.

Using a tool for linear measurement, the anterior view width of each tooth was registered and the proportion that relates the virtual width of lateral incisors with central incisors, and canines with lateral incisors was calculated (Fig 2, *B*).

A line parallel to the occlusal plane and tangent to the most cervical position of the gingival margin of the central incisor of the NCS in the UCLP group, and for the right central incisor in the control group was drawn to evaluate the gingival margin and incisal edges (Fig 2, *C*).

Using a tool for linear measurement the distance from the drawn line to the most cervical position of the gingival margin of each tooth was registered (Fig 2, *D*). These values allowed evaluating symmetry between homologous teeth and to

calculate the central-to-lateral gingival step and the central-to-canine gingival step of each side.

The distance from the line to the incisal edge of each teeth was measured to evaluate the symmetry of incisal edges between homologous teeth and to calculate in each side the central-to-lateral incisal step and the central-to-canine incisal step of each side (Fig 2, *E*).

The crown angulation of central and lateral incisors was evaluated in a frontal view with a specific tool of the software (Fig 2, *F*). To measure the inclination of the anterior teeth the tool of virtual setup was used and each tooth long axis was represented as an arrow. On the distal view of each tooth, the arrow was buccolingually manipulated to represent crown torque (Fig 3), according to Andrews (1972).[25] The software automatically calculated the angular measurements, those values were computed after the subtraction of 90º.

STATISTICAL ANALYSIS

Teeth were measured twice with an interval of at least 3 weeks by one investigator (A.S.C.M). Intrarater reliabilities were assessed with intraclass correlation coefficients. Statistical analysis was performed, taking into account the mean of the 2 measurements.

The comparisons between the cleft and noncleft sides in the experimental group were evaluated using paired t tests. Comparisons between the experimental and control groups were assessed with independent t tests. Bonferroni correction for multiple comparisons was performed. The statistical analyses were conducted with statistical software *Statistical Package for the Social Sciences* (SPSS), version 21 (SPSS Inc, Chicago, EUA). After Bonferroni correction the level of significance considered was 1.66% for all measurements except width ratio, gingival step, incisal step and angulation that was 2.5%.

RESULTS

Intraclass correlation coefficients for the linear and angular measurements were high (ICC≥0.75) and satisfactory (0.4≤ICC<0,75), respectively. Mean

differences between the linear and angular measurements were smaller than 0.5 mm and 1°, respectively.

Cleft versus noncleft side (Table I)

The cleft side showed greater mesiodistal width and height for the central incisor (U1) and lateral incisor (U2) when compared to noncleft side. Conversely, first premolar (U3) replacing the canines at the cleft side showed smaller mesiodistal width and height in comparison to canines at the noncleft side significantly affecting the width/height ratio for this measurement. In the cleft side the anterior view width was increased for U2 and decreased for U3 when compared to contralateral teeth, significantly affecting U2/U1 and U2/U3 width ratio.

An asymmetry was observed for the gingival levels that were more apically displaced in the cleft side for the central and lateral incisor. A slight asymmetry was also observed for the leveling of central incisor and canines that were less extruded at the cleft side.

The mesiodistal angulation was different between CS and NCS for the central incisors. The CS central incisor was more upright compared to the contralateral tooth.

Cleft side versus normal occlusion (Table II)

The cleft side revealed a higher crown width and height for the central and lateral incisors compared to the normal occlusion sample. On the other hand, the height of the first premolar replacing the canines at the cleft side was smaller than the crown height of the canines in the normal occlusion group. The crown width/height ratio was increased for the lateral incisor and canines at the cleft side compared to the normal occlusion individuals. In the frontal perspective, the canine replacing the lateral incisor at the cleft side was wider compared to the control group, affecting the U2/U1 and U3/U2 width ratio.

When compared to the normal occlusion, in the cleft side the incisal step between U1 to U3 was decreased.

The CS central and lateral incisor demonstrated lower mesiodistal angulation when compared to normal occlusion. At the cleft side, the first premolars replacing the canines showed a decreased lingual inclination compared to normal occlusion.

Non-cleft side versus normal occlusion (Table III)

The width and height of central incisors in the NCS was slightly augmented, for the lateral incisors at noncleft side the mesiodistal width was slightly wider than the homologous teeth in the normal occlusion individuals, affecting the width/height ratio for lateral incisors. In the frontal view, all noncleft side anterior teeth were wider than normal occlusion anterior teeth.

In both groups the gingival margin of the canines was positioned below the margin of the central incisor. However, this negative step was more pronounced for the NCS compared to normal occlusion. The incisal step between the central and lateral incisors was decreased in the noncleft side compared to normal occlusion.

At the cleft side, the central incisors showed a greater buccal inclination and the premolars substituting canines showed a decreased lingual inclination compared to normal occlusion.

DISCUSSION

The first step in any type of successful dental therapy is to establish treatment objectives. The excellence in final orthodontic treatment is an association with a correct diagnosis, multidisciplinary planning and bonding.[26] Considering that orthodontics plays an important rule during the long process of multidisciplinary rehabilitation of cleft lip and palate patients, we believe that in order to optimize finishing dental procedures the dental/orthodontic planning should aim the anterior esthetics final outcome in association with other specialties such as periodontics and restorative dentistry. This attention might result in a minor finishing phase, which is positive whereas diminishes the burden of care and costs.

In our results the augmented width for canines substituting lateral incisors when compared to contralateral teeth of the UCLP or with the lateral incisors of the NO group (Fig 4) might lead us to consider that the original crown anatomy of the canine was either maintained or slightly modified. The difficulty in achieving an acceptable esthetic outcome when camouflaging the canine into a lateral incisor exists because of this tooth inherent size.[27] Naturally the canine is wider than the lateral incisor, its' width can be reduced mesiodistally with interdental enamel

reduction to improve final esthetic results.[12,28,29] When evaluating U1 and U3 mesiodistal width for the cleft side the first value was slightly augmented while the second one was slightly reduced when compared to the NCS or to the NO group, even though the values were statistically relevant we believe that they did not achieved clinical relevance. However, the literature suggests that the mesiodistal width of premolars substituting canines could be increased with porcelain veneers or resin buildups in specific cases.[12]

The augmented value for U2 crown height in the CS when compared to the lateral incisor in the NCS and NO can be associated to morphology differences between the lateral incisor and the canine (Fig 4),[29] for this reason, specific procedures such as incisal reduction should be performed in the canine substituting the lateral incisor missing.[12,28] The reduced value found for the U3 crown height in the CS when compared to the canines of the NCS (Fig 4, *B* and *C*) and the NO is a consequence of the variation between the morphology of canine and premolar; an increase in the buccal cusp of the premolar associated or not to small periodontal surgery or orthodontic intrusion can camouflage this difference.[12]

The aforementioned altered width and height in the CS significantly affected the width/height ratio for U3 (Table I, II) when compared to the NCS and the NO (Table III, IV), which presented values similar to the normality 80-85%[30] or 76-81%[31]. The width/height ratio for U2 of the CS (Table II) and NCS (Table III) when compared to the NO was altered, the values found also diverged from the 66%-70%[31] described in the literature.

In an anterior view, the CS width for U2 was higher and for U3 was diminished affecting the width ratio (Table I). Considering the NO, only the CS U2 anterior view width was altered affecting the width ratio (Table II). All the measurements for the NCS were increased when compared to the NO however, it did not affect the width ratio (Table III). Further studies should be performed in order to know if the asymmetry found between CS and NCS has clinical relevance. In our study the concept of the “Golden Proportion“, defined as anterior view width and width ratio, was not found in the UCLP group or in the normal occlusion group. There is no evidence supporting that the golden proportion should be considered the ideal esthetic standard when replacing missing lateral incisors,[32,33] it is suggested that the anterior view proportion should be represented by a range instead of a single value, the 67% to 72% lateral-to-central width proportion were preferred between

evaluators,[34] those values are in agreement with the ones found in the normal occlusion group (69.5%) (Table IV) and for the NCS (72%) (Table I). In another study, generally narrow canines were preferred in the position of lateral incisors.[29]

Considering the symmetry of gingival margins, the more apical position of U1 in the cleft side compared to the noncleft side (Fig 4, *B* and *C*) might be justified due to a increased height of these teeth (Table I) associated or not to a usual contra-angulated and rotated position of these teeth in the cleft area.[9] This condition could represent a risk factor for inflammation of the periodontal tissues because hygiene in the region may be compromised in long-term. Furthermore, buccal flaps performed during the SABG surgery can result in mobile and unkeratinized mucosa crossing the former alveolar cleft, resulting in a vulnerable area subjected to inflammatory changes and gingival recession.[35,36] Tooth rotation correction might produce buccal bone dehicences.[37] When evaluating the symmetry between U2 in the UCLP it was found that the gingival level in the CS was positioned more apically (Fig 4). A possible explanation is that when canines substitute lateral incisors the gingival level asymmetry occurs especially because of the differences in the morphology between these elements, the gingival margins of canines are usually higher when compared to the lateral incisors. For this reason and since it might affect the final esthetic outcome it is recommended orthodontic extrusion of the canine substituting the lateral incisor,[10] to achieve this result the bracket can be bonded in a more cervical position[13] or a step down bend can be made in the arch. In cleft patients the reposition for the lateral incisor missing may impair the balance of the gingival level when compared to the contralateral tooth, usually leading to a more apical tissue margin on the cleft side.[22] The results found by Esper et al,[22] showed irregularities in the soft tissue margin of 1-2mm when the tooth adjacent to the cleft was compared with the contralateral tooth. These values are higher than the ones found in our study (0.81mm), however their sample included patients with prosthesis, implants and canine substitution. Gingival margins asymmetries in maxillary homologous teeth were perceived as unaesthetic by orthodontists when reaching 0.5mm however, this value for laypeople was of 1.0 to 1.5 for central incisors[38] and up to 2mm[39]. Considering these results, the need of some aesthetic therapeutic approaches to correct small asymmetries is questionable and might reflect an exaggerated concern by professionals.[38,39] However, in our opinion every case should be discussed with the patients considering their expectations, specific dental/bone anatomic variations

and the smile line. The smile line in UCLP is usually classified as average and is represented by small gingival exposure.[23]

The search for symmetry between central incisors edges is based on the clinical opinion that, when closer to the midline there is a greater need for symmetry while, slight asymmetries are acceptable to teeth distant to the midline.[40] Considering this aspect, even though U1 and U3 had statistical significant differences in UCLP and U2 had significant difference in the NO group the specific values are bellow 0.5mm therefore, the homologous teeth were considered symmetric.

In our findings the U1 to U2 and U1 to U3 incisal step was symmetric for the C and NC sides (Table I). However, when comparing the CS with the NO sample, the step between U1 to U3 was smaller in the former (Table II) and the U1 to U2 step between the NCS was diminished when compared to NO. Even though the difference between UCLP and NO is small, the incisal design in the UCLP group does not achieve the minimum parameters determined in the literature therefore, reshaping central incisors, lateral incisors and canines can provide more esthetic results.[12] It has been suggested that in an esthetic smile, the maxillary central incisors and canines should be positioned approximately in level with each other and with the incisal edge of the lateral incisor positioned in an apical direction (0.5 to 1.5 mm) when compared to the incisal edge of the central incisor.[34,41-43] A difference of 1 to 1.5mm,[34,42] 1mm[44] contributed for a natural and more attractive appearance of anterosuperior teeth. There was a general agreement that smiles with both very long lateral incisor setting (0.5mm shorter than central) and very short arrangements (2.5mm shorter than central) were perceived as “least attractive”.[34]

Considering the crown angulation, central incisors at the cleft side were more uprighted when compared to the contralateral teeth (Table I) (Fig 4,*C*). These differences were also noted when the cleft side was compared to normal occlusion (Table II). The possible explanation is the initial contra-angulated position of central incisors at the cleft side, which might not have been completely corrected during comprehensive orthodontic treatment.[9] In our opinion a clinical solution would be increasing the bracket angulation in the cleft side central incisor. Other difference regarding tooth angulation was a decreased angulation for the cleft side canine that replaced the missing lateral incisor (Table II). Depending on the amount of mesiodistal tipping, the space occupied by a tooth can be altered, modifying the arch length or filling previous spacing.[45] We speculate that the final upright position of the

canine replacing the laterals occurred in order to compensate its increased mesiodistal width.

Regarding tooth buccolingual inclination, the cleft side first premolar substituting the canines and the noncleft side canines showed an increased buccal inclination compared to normal occlusion (Table II and III). Two probable reasons for these findings are that canines and first premolars are anchorage tooth for maxillary expansion frequently necessary before alveolar bone graft in UCLP.[9] Another explanation is the mechanism of transversal compensation for the Class III skeletal relationship[46] that is usually seen in UCLP. The noncleft side central incisor also showed a tendency for an increased inclination compared to normal occlusion (Table III) possibly as an effect of the orthodontic camouflage. This is a limitation of our study sample since it comprised surgical (25%) and non surgical (75%) cases. Nevertheless, micro esthetics parameters should be pursued independently of the treatment planning. Another limitation of this study was evaluating the final orthodontic result and not the complete rehabilitation; on the other hand, it allowed analyzing the reality of the orthodontic finishing at this center without interference from other specialties. Future studies should assess periodontal characteristics, teeth shape and color. It is also relevant to evaluate the real impact that the differences found in dental micro esthetics have in the face, the smile and self-image of CLP individuals.

CONCLUSIONS

The null hypothesis was rejected. At the cleft side, the canine substituting the missing lateral incisor showed an increased crown height and width and, the first premolar had a decreased crown height. The gingival level of cleft side central and lateral incisors was apically displaced. The cleft side central incisor and canines (replacing lateral incisors) tend to be more uprighted. An increased buccal inclination was observed for noncleft side canines and cleft side premolars in individuals with UCLP. The differences between the noncleft side and the normal occlusion group were slight.

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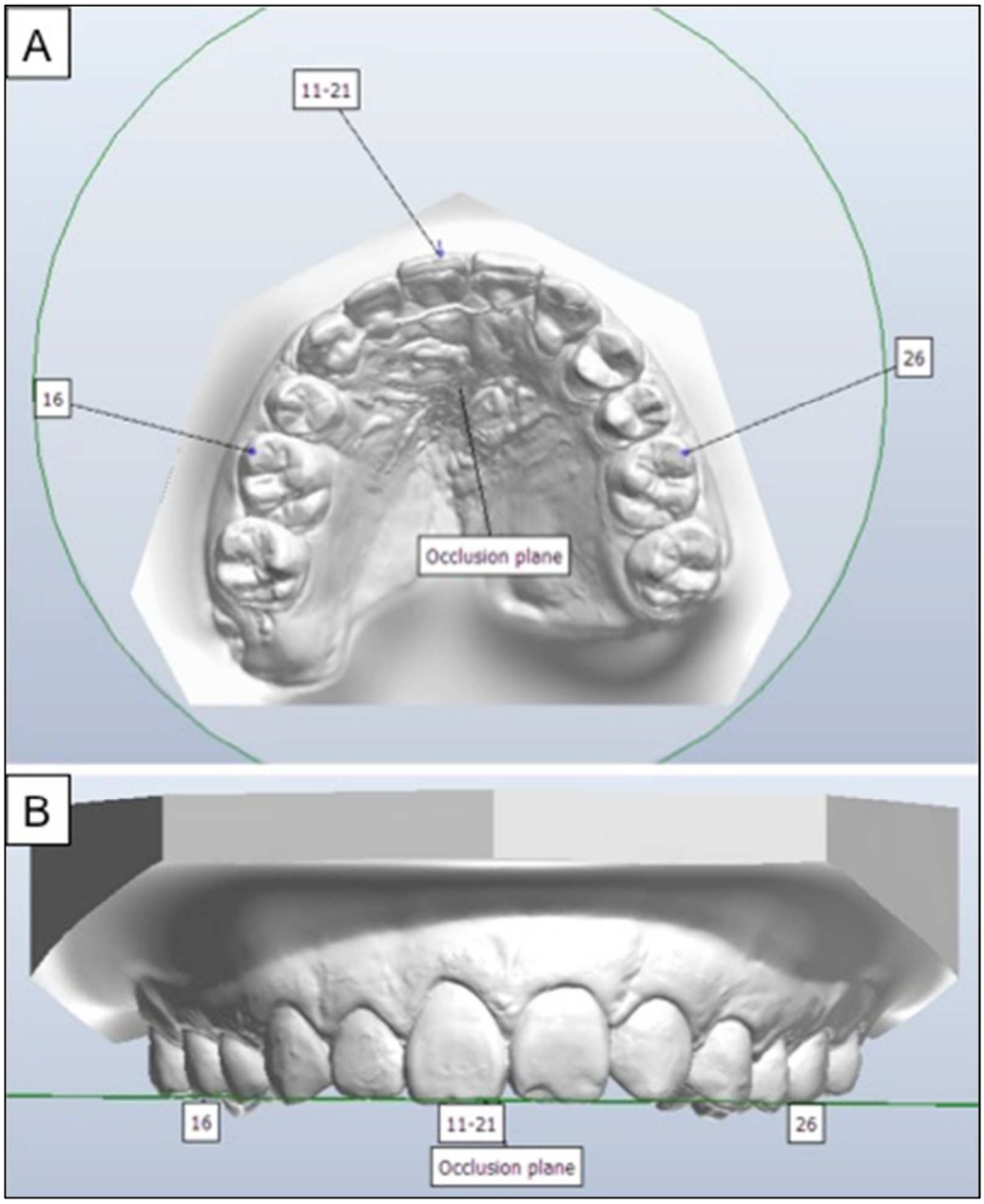

Fig 1. Occlusal Plane: **A,** the occlusal plane was defined as a plane passing bilaterally through the mesiobuccal cusp tip of the maxillary first molars and the mesioincisal point of the central incisor. For the UCLP group it was used the central incisor of the NC side and for the Control Group the right central incisor. **B,** occlusal plane positioned parallel to the ground.

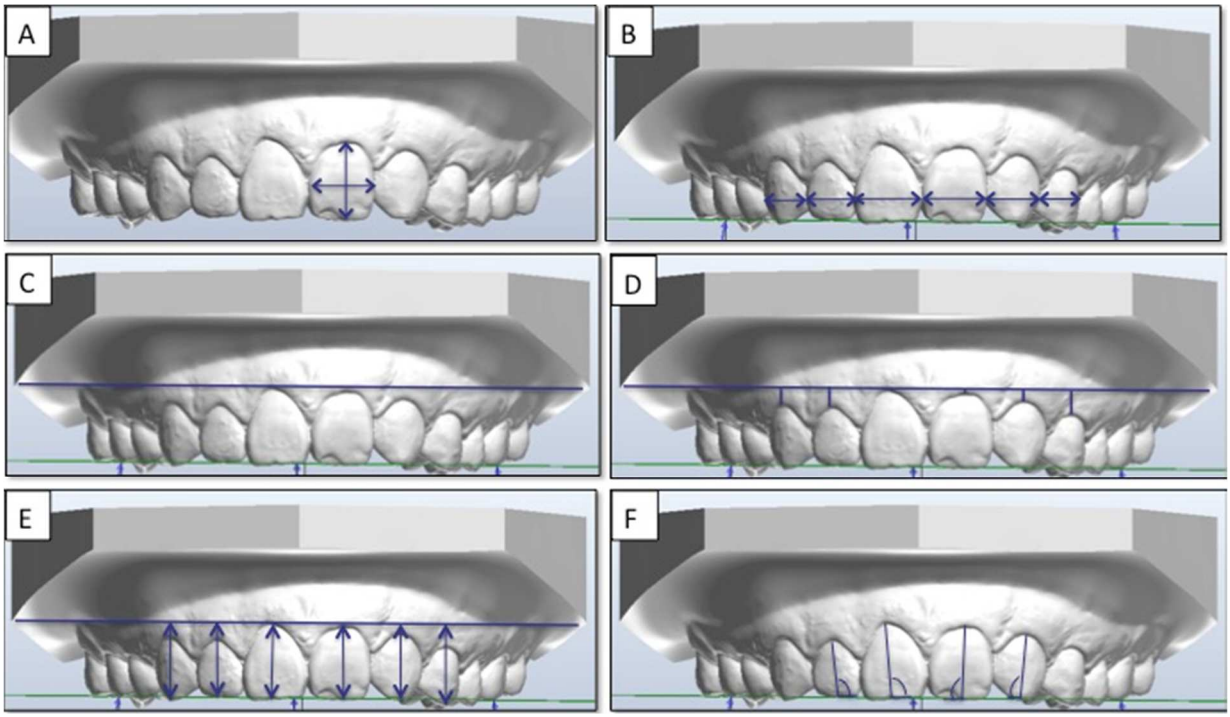

Fig 2. Digital dental model measurements: **A,** crown width and height. B, anterior view width. **C,** definition of a parallel line to the occlusal plane. **D,** gingival level. **E,** incisal level. **F,** angulation of central and lateral incisors.

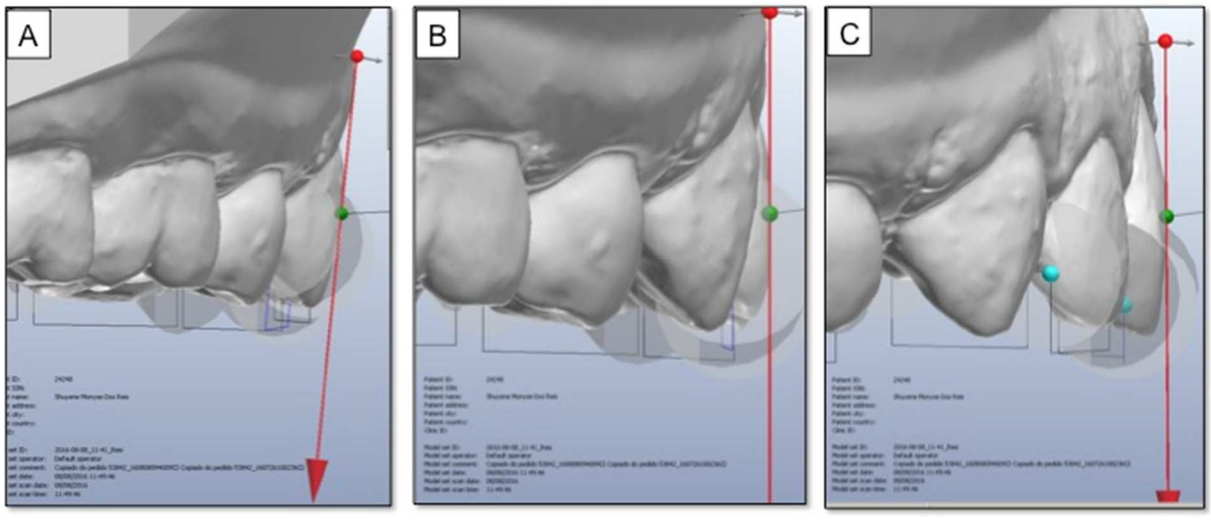

Fig 3. Anterior tooth inclination measurementes between the crown long axis and occlusal plane: **A,** canine. **B,** lateral incisor and **C,** central incisor.

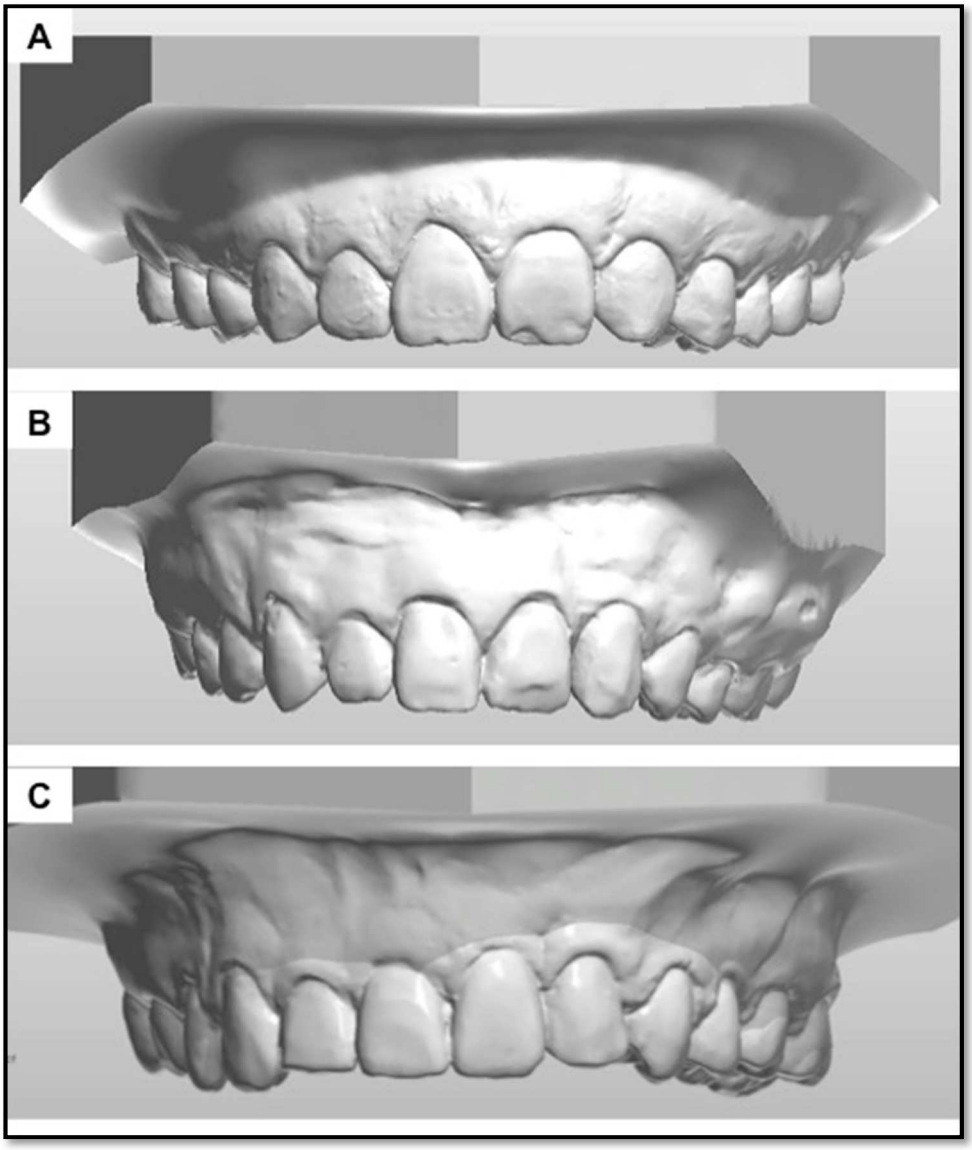

Fig 4. The figure ilustrates trhee subjects from the UCLP group.

Table I. Intragroup comparisons for Cleft and Non Cleft sides (paired *t* tests)

		Cleft Side (n=57)		**Non Cleft Side (n=57)**			
Variable	**Teeth**	**Mean**	**SD**	**Mean**	**SD**	**Diff.**	***p***
Real width (mm)	U1	8.69	0.70	8.49	0.53	0.19	.005*
	U2	7.75	0.50	7.07	0.59	0.67	<.001*
	U3	7.32	0.56	7.68	0.52	-0.35	<.001*
Height (mm)	U1	10.61	0.88	10.21	0.83	0.40	<.001*
	U2	9.28	1.09	8.50	0.91	0.77	<.001*
	U3	8.02	1.06	9.41	1.04	-1.39	<.001*
Width/Height ratio	U1	0.82	0.09	0.83	0.08	-0.01	.023
	U2	0.84	0.09	0.84	0.10	-0.00	.079
	U3	0.92	0.13	0.82	0.09	0.10	<.001*
Anterior view Width (mm)	U1	8.45	0.89	8.41	0.49	0.04	.712
	U2	6.36	0.26	6.07	0.49	0.28	<.001*
	U3	5.03	0.55	5.36	0.62	-0.32	.005*
Width ratio	U2/U1	0.76	0.11	0.72	0.06	0.03	.019*
	U3/U2	0.79	0.09	0.89	0.13	-0.09	<.001*
Gingival Symmetry (mm)**	U1	0.62	0.83	0.00	0.00	0.62	<.001*
	U2	-0.40	1.19	-1.21	1.19	0.81	<.001*
	U3	-0.80	2.45	-1.34	0.94	0.54	.156
Incisal Symmetry (mm)***	U1	-0.16	0.44	0.00	0.00	-0.16	.007*
	U2	-0.40	0.54	-0.33	0.48	-0.06	.509
	U3	0.01	0.48	0.39	0.65	-0.37	.002*
Gingival Step (mm)**	U1 to U2	-1.02	1.16	-1.21	1.19	0.18	.349
	U1 to U3	-1.42	2.83	-1.34	0.94	-0.07	.854
Incisal Step (mm)***	U1 to U2	-0.24	0.65	-0.33	0.48	0.09	.303
	U1 to U3	0.18	0.54	0.39	0.65	-0.20	.046
Angulation (°)	U1	0.70	4.18	2.82	3.57	-2.12	.005*
	U2	2.81	4.28	4.32	3.96	-1.51	.033
Inclination (°)****	U1	8.28	4.68	8.63	4.45	-0.34	.388
	U2	7.41	4.22	8.36	4.65	-0.94	.186
	U3	-5.59	3.02	-5.41	2.97	0.18	.691

U1, Central Incisor; U2, Lateral Incisor; U3, Canine.
*Statistically significant.
** Negative values indicate an incisal position of the variable.
*** Negative values indicate an apical position of the variable.
**** Negative values indicate lingual inclination of the variable.

Table II. Intergroup comparisons for the cleft side and the control group (independent *t* tests)

		Cleft Side (n=57)		Normal Occlusion (n=48)			
Variable	**Teeth**	**Mean**	**SD**	**Mean**	**SD**	**Diff.**	***p***
Width (mm)	U1	8.69	0.70	8.21	0.48	0.47	<.001*
	U2	7.75	0.50	6.52	0.45	1.23	<.001*
	U3	7.32	0.56	7.53	0.45	-0.20	.044
Height (mm)	U1	10.61	0.88	9.74	0.89	0.86	<.001*
	U2	9.28	1.09	8.33	0.84	0.95	<.001*
	U3	8.02	1.06	9.28	1.04	-1.25	<.001*
Width/Height ratio	U1	0.82	0.09	0.84	0.08	-0.02	.161
	U2	0.84	0.09	0.78	0.07	0.05	<.001*
	U3	0.92	0.13	0.82	0.08	0.10	<.001*
Anterior view Width (mm)	U1	8.45	0.89	8.11	0.42	0.33	.020
	U2	6.36	0.26	5.65	0.41	0.71	<.001*
	U3	5.03	0.55	4.92	0.50	0.11	.277
Width ratio	U2/U1	0.76	0.11	0.69	0.04	0.06	<.001*
	U3/U2	0.79	0.09	0.87	0.10	-0.08	<.001*
Gingival Step(mm)**	U1 to U2	-1.02	1.16	-0.89	0.49	-0.13	.462
	U1 to U3	-1.42	2.83	-0.68	0.76	-0.73	.084
Incisal Step(mm)***	U1 to U2	-0.24	0.65	-0.63	0.40	0.39	.028
	U1 to U3	0.18	0.54	0.24	0.49	-0.06	.013*
Angulation(°)	U1	0.70	4.18	3.56	2.10	-2.86	<.001*
	U2	2.81	4.28	4.81	2.57	-2.00	.006*
Inclination(°) ****	U1	8.28	4.68	6.44	4.24	1.84	.038
	U2	7.41	4.22	6.64	3.36	0.77	.308
	U3	-5.59	3.02	-7.30	3.63	1.71	.010*

U1, Central Incisor; U2, Lateral Incisor; U3, Canine.
*Statistically significant.
** Negative values indicate an incisal position of the variable.
*** Negative values indicate an apical position of the variable.
**** Negative values indicate lingual inclination of the variable.

Table III. Intergroup comparisons for the non cleft side and the control group (independent *t* tests)

		Non Cleft Side (n=57)		Normal Occlusion (n=48)			
Variable	**Teeth**	**Mean**	**SD**	**Mean**	**SD**	**NC-CG**	***P***
Width (mm)	U1	8.49	0.53	8.21	0.48	0.28	.006*
	U2	7.07	0.59	6.52	0.45	0.55	<.001*
	U3	7.68	0.52	7.53	0.45	0.14	.127
Height (mm)	U1	10.21	0.83	9.74	0.89	0.46	.007*
	U2	8.50	0.91	8.33	0.84	0.17	.325
	U3	9.41	1.04	9.28	1.04	0.13	.509
Width/Height ratio	U1	0.83	0.08	0.84	0.08	-0.01	.487
	U2	0.84	0.10	0.78	0.07	0.05	.004*
	U3	0.82	0.09	0.82	0.08	0.00	.833
Anterior view Width (mm)	U1	8.41	0.49	8.11	0.42	0.29	.002*
	U2	6.07	0.49	5.65	0.41	0.42	<.001*
	U3	5.36	0.62	4.92	0.50	0.44	<.001*
Width ratio	U2/U1	0.72	0.06	0.69	0.04	0.02	.025
	U3/U2	0.89	0.13	0.87	0.10	0.01	.560
Gingival Step (mm)**	U1 to U2	-1.21	1.19	-0.89	0.49	-0.32	.084
	U1 to U3	-1.34	0.94	-0.68	0.76	-0.65	<.001*
Incisal Step(mm)***	U1 to U2	-0.33	0.48	-0.63	0.40	0.30	.002*
	U1 to U3	0.39	0.65	0.24	0.49	0.15	.258
Angulation (º)	U1	2.82	3.57	3.56	2.10	-0.74	.205
	U2	4.32	3.96	4.81	2.57	-0.48	.469
Inclination (º)	U1	8.63	4.45	6.44	4.24	2.18	.012*
	U2	8.36	4.65	6.64	3.36	1.72	.035
	U3	-5.41	2.97	-7.30	3.63	1.89	.004*

U1, Central Incisor; U2, Lateral Incisor; U3, Canine.
*Statistically significant.
** Negative values indicate an incisal position of the variable.
*** Negative values indicate an apical position of the variable.
**** Negative values indicate lingual inclination of the variable.

Table IV. Intragroup comparisons for right and left sides of the normal occlusion group (paired t tests)

		Right Side (n=48)		Left Side (n=48)			
Variable	**Teeth**	**Mean**	**SD**	**Mean**	**SD**	**Diff.**	***p***
Width (mm)	U1	8.21	0.56	8.22	0.46	-0.01	.853
	U2	6.54	0.51	6.50	0.52	0.03	.602
	U3	7.57	0.56	7.49	0.42	0.08	.149
Height (mm)	U1	9.72	0.88	9.77	0.94	-0.43	.425
	U2	8.27	0.87	8.39	0.90	-0.12	.115
	U3	9.21	1.07	9.35	1.10	-0.14	.111
Width/Height ratio	U1	0.84	0.08	0.84	0.08	0.00	.944
	U2	0.79	0.08	0.78	0.07	0.01	.097
	U3	0.83	0.08	0.81	0.09	0.02	.060
Anterior view Width (mm)	U1	8.16	0.44	8.07	0.44	0.08	.015*
	U2	5.71	0.43	5.59	0.47	0.11	.021
	U3	5.01	0.54	4.83	0.57	0.17	.020
Width ratio	U2/U1	0.70	0.05	0.69	0.05	0.00	.212
	U3/U2	0.88	0.11	0.87	0.12	0.01	.482
Gingival Symmetry (mm)*	U1	0.00	0.00	0.12	0.50	-0.12	.090
	U2	-0.74	0.64	-0.91	0.60	0.16	.107
	U3	-0.54	0.87	-0.71	0.94	0.17	.191
Incisal Symmetry (mm)**	U1	0.00	0.00	-0.04	0.30	0.04	.309
	U2	-0.71	0.41	-0.52	0.52	-0.18	.013*
	U3	0.15	0.67	0.37	0.62	-0.22	.077
Gingival Step (mm)*	U1 to U2	-0.74	0.64	-1.03	0.59	0.29	.008*
	U1 to U3	-0.54	0.87	-0.83	0.84	0.29	.013*
Incisal Step (mm)**	U1 to U2	-0.71	0.41	-0.56	0.55	-0.15	.020*
	U1 to U3	0.15	0.67	0.33	0.64	-0.18	.031
Angulation (°)	U1	3.87	3.16	3.26	1.72	0.60	.155
	U2	5.28	3.57	4.34	2.80	0.94	.095
Inclination (°)	U1	6.45	4.41	6.43	4.33	0.02	.929
	U2	6.68	3.92	6.59	3.52	0.09	.845
	U3	-7.34	3.61	-7.26	4.21	-0.85	.844

U1, Central Incisor; U2, Lateral Incisor; U3, Canine.
*Statistically significant.
** Negative values indicate an incisal position of the variable.
*** Negative values indicate an apical position of the variable.
**** Negative values indicate lingual inclination of the variable.

4 CONCLUSION

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The null hypothesis was rejected. There were differences between the elements that comprise the anterior dental and gingival micro esthetics especially when comparing the cleft side and noncleft side of UCLP individuals and, between the cleft side and the normal occlusion group. Few differences were found between the noncleft side and the normal occlusion group.

At the cleft side, the canine substituting the missing lateral incisor showed an increased crown height and width and, the first premolar had a decreased crown height. The gingival level of cleft side central and lateral incisors was apically displaced. The cleft side central incisor and canines (replacing lateral incisors) tend to be more uprighted. An increased buccal inclination was observed for noncleft side canines and cleft side premolars in individuals with UCLP. There were few differences between the noncleft side and the normal occlusion group.

Specific esthetic procedures should be planned in cases with canine substitution for missing lateral incisors of UCLP in association with the orthodontic treatment, aiming to provide a more harmonious and natural smile.

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ANNEX

ANNEX

HOSPITAL DE REABILITAÇÃO
DE ANOMALIAS
CRANIOFACIAIS DA USP

Plataforma Brasil

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Estética anterior pós reabilitação em pacientes com fissura completa e unilateral: um estudo com modelos digitais

Pesquisador: AURA SOFIA CACERES MANFIO

Área Temática:

Versão: 1

CAAE: 53829416.7.0000.5441

Instituição Proponente: Hospital de Reabilitação de Anomalias Craniofaciais da USP

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 1.471.470