UNIVERSIDADE DE SÃO PAULO
HOSPITAL DE REABILITAÇÃO DE ANOMALIAS CRANIOFACIAIS

GRACE ALEJANDRA CABEZAS CANTOS

**3D analysis of dental arch area and occlusal index of
children with cleft lip and palate at 5 years of age**

BAURU
2020

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**3D analysis of dental arch area and occlusal index of
children with cleft lip and palate at 5 years of age**

**Análise 3D da área do arco dentário e do índice oclusal de
crianças com fissura labiopalatina aos 5 anos de idade**

Dissertação em formato alternativo apresentada ao Hospital de Reabilitação de Anomalias Craniofaciais da Universidade de São para obtenção do título de Mestre em Ciências da Reabilitação.

Área de concentração: Fissuras Orofaciais e Anomalias relacionadas.

Orientadora: Profa. Dra. Thais Marchini de Oliveira

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UNIVERSIDADE DE SÃO PAULO
HOSPITAL DE REABILITAÇÃO DE ANOMALIAS CRANIOFACIAIS

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FOLHA DE APROVAÇÃO

Grace Alejandra Cabezas Cantos

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“Perder tudo, tudo, tudo para nos mergulharmos na vontade de Deus do momento presente. Assim teremos DEUS somente e o amaremos com tudo o coração. Sim porque aqui na terra é tudo questão de coração: o coração nos trai, o coração nos distrai, o coração nos salva, conforme aquilo que ele ama”

CHIARA LUBICH

RESUMO

Cabezas GA. Análise 3D da área do arco dentário e do índice oclusal de crianças com fissura labiopalatina aos 5 anos de idade [dissertação]. Bauru: Hospital de Reabilitação de Anomalias Craniofaciais, Universidade de São Paulo; 2019.

Objetivo: O objetivo deste trabalho foi correlacionar a área do arco dentário e a oclusão das crianças com fissura de lábio e palato aos 5 anos utilizando o índice de Attack. **Material e Métodos:** A amostra foi composta por 124 modelos digitais de crianças com fissura completa de lábio e palato unilateral. A medida da área dos arcos dentários foi obtida pelo Software do Sistema de Estereofotogrametria. O índice oclusal de Attack foi utilizado para analisar a oclusão nos modelos digitalizados. O coeficiente de correlação interclasse avaliou a reprodutibilidade intraexaminador e o coeficiente de correlação de Spearman verificou a correlação entre a área da arcada dentária e o índice oclusal. **Resultados:** Para análise da concordância intraexaminador, as medidas da 1ª e 2ª medidas da metade da amostra foram obtidas 15 dias após a primeira medição. O ICC mostrou alta concordância (0,83). O índice oclusal de Attack apresentou prevalência de índice 4 (34,64%). Em relação às medidas de área (cm²), o valor mediano foi de 7,28, valor mínimo de 4,90 e máximo de 11,89. A correlação entre a área da arcada dentária e o índice oclusal foi negativa (-0,35). **Conclusão:** De acordo com os resultados, a área do arco dentário não tem correlação com a oclusão dentária das crianças com fissura de lábio e palato aos 5 anos.

Descritores: Fenda labial. Fissura palatina. Modelos Dentários. Desenvolvimento. Imagem Tridimensional.

ABSTRACT

Cabezas GA. 3D analysis of dental arch area and occlusal index of children with cleft lip and palate at 5 years of age [dissertation]. Bauru: Hospital of Rehabilitation the Craniofacial Anomalies, University of São Paulo; 2019.

Objective: The aim of this study was to correlation the dental arch area and occlusion of children with cleft lip and complete unilateral palate at 5 years using the Attack occlusal index. **Material and Methods:** The sample consisted of 124 digital models of children with cleft lip and unilateral palate. The measurement of the area of the dental arches was obtained by Stereophotogrammetry System Software. Attack occlusal index analyzed the occlusion on digitized dental models. The Interclass Correlation Coefficient was used to analyze the intra-examiner reproducibility and the Spearman correlation coefficient verified the correlation between the dental arch area and occlusal index. **Results:** For intra-examiner agreement analysis, measurements of the 1st and 2nd measurements of half of the sample were obtained 15 days after the first measurement. The ICC showed high agreement (0.83). The Attack occlusal index presented with a prevalence of index 4 (34.64%). Regarding the measurements of area (cm²), the median value was 7.28, minimum value 4.90 and a maximum 11.89. The correlation between the dental arch area and occlusal index was negative (-0.35). **Conclusion:** According to the results, the dental arch area has no correlation with the dental occlusion of children with cleft lip and palate at 5 years of age.

Keywords: Cleft lip; Cleft palate; Dental models; Development; Three-dimensional image.

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1 General Introduction

1. General Introduction

According to the World Health Organization, craniofacial anomalies affect a considerable proportion of the world, representing a substantial problem in public health (WHO, 2004). Among craniofacial malformations, cleft lip and palate stand out as the most frequent anomaly in humans, isolated or associated with syndromes (HALLAC et al., 2017).

In its etiology, cleft lip and palate is multifactorial, with association of genetic and environmental factors (DIXON et al., 2011; FREITAS et al., 2012c). The vast array of potential etiological factors difficult to find specific factors which could cause this anomaly (DIXON et al., 2011). Because orofacial embryological development occurs very early intrauterine life, between the 4th and 12th week, any disturbance might lead to the absence of maxillofacial fusion resulting at this congenital malformation. Moreover, orofacial clefts could affect the lip, the alveolar bone and both soft and hard palate (FREITAS et al., 2012c; BEATY et al., 2016).

Also, several adverse clinical events come along with orofacial clefts, in functional, anatomical, and aesthetic fields. Therefore, depending on the severity of this malformation, the non-pathological development of maxillofacial complex could be compromised (LA et al., 2000).

1.1 General aspects of the rehabilitation protocol

The rehabilitation of individuals with cleft lip and palate is complex, following well established protocols; Even though, the treatment is design according to individual needs, also respecting expectations of the patient and family. Due to the aesthetic, functional and psychological disorders, the participation of an interdisciplinary team with professionals from different areas, including medicine, dentistry and speech therapy (FREITAS et al., 2012c, VARGERVIK et al., 2009).

Rehabilitation begins shortly after birth and continues into adulthood until the individual reaches skeletal maturity (FREITAS et al., 2012b). The rehabilitation process requires an interdisciplinary protocol with standardized therapeutic procedures seeking to promote the patient's anatomical and

functional rehabilitation with aesthetic results aimed at maximum lip and nose symmetry (FREITAS et al. 2012a; HALLAC et al. 2017).

Primary plastic surgery, cheiloplasty and palatoplasty, are part of the rehabilitation protocol of patients with cleft lip and palate. However, although primary plastic surgery rehabilitates aesthetics and function in an early childhood patient, it can disrupt craniofacial development, especially impairing jaw growth, affecting the middle third of the face (ZHENG et al., 2016).

Factors that may influence maxillomandibular growth and development of individuals with cleft lip and palate are: cleft severity (CHIU et al., 2011); inherent palatine tissue hypoplasia (MEAZZINI et al., 2011); intrinsic factors such as initial amplitude of the cleft palate (STANCHEVA et al., 2015); surgical technique of election (CARRARA et al. 2016); timing of the surgery (ROHRICH et al., 2000); and surgeon skills (STANCHEVA et al., 2015).

Treatment outcomes is assessed by balancing facial appearance, speech and facial growth (FREITAS et al., 2012). Knowledge of the morphological changes in the dental arches of patients with cleft lip and palate helps to better guide the rehabilitation treatment plan (FALZONI et al., 2016; ZHENG et al., 2016). Thus, it can be inferred early that patients whose skeletal discrepancy is marked, increased mandibular growth and short maxillary length are considered eligible to undergo orthognathic surgery (FREITAS et al., 2012b).

1.2 Evaluation of surgery outcomes using 3D models

In order to evaluate primary surgeries, literature has shown different methodologies, such as dimensional and anatomical measurements performed on the study models (ROUSSEAU et al., 2013); evaluation on imaging exams such as photographs (LIM et al., 2017) and radiographs (YANG et al., 2012), in longitudinal studies performed on individuals with cleft lip and palate.

The arrival of 3D technology has enabled advances in the study of craniofacial morphology and growth through the laser scanning and stereoscopic photography. The international research in three-dimensional models have been increasing in recent years, becoming an alternative to plaster models in the evaluation of arch width and palatal morphology (MELLO et al. 2013; MENEZES et al. 2016). Errors might occur, either during patient positioning or during information analysis, In addition, there is a considerable inconvenience at transporting documentation in comparative research between study models. Therefore alternative methods have been developed, such as three-dimensional digital imaging. (ROSATI et al., 2014). Three-dimensional analysis of dental arches represents a significant change in data collection (MENEZES et al., 2016) and morphological evaluation of anatomical structures. It overcomes the limitations of two-dimensional measurements, especially in palate depth measurements (RUSSELL et al., 2015).

1.3 The Attack index

Even at early age, from complete deciduous dentition and incomplete plastic surgery protocol, it is possible to define morphology and growth pattern in children at 5 years of age (SILVA et al., 2008). The development of temporary dentition helps the practitioner to classify the type of dental or skeletal malocclusion. The tissues of the face may cover a skeletal deficiency in the middle facial third of these patients (GOMEZ, 2017). Usually, compensation for maxillary deficiency produces protrusion of the upper incisors and retraction of the lower ones (VARELA, 2005).

The occlusal index analysis of these children is performed at some point. Specially, the Attack index is taken at 5 years of age (ATACK et al., 1997). The choice of this specific age range is due to growth preservation by the genetic pattern, allowing the identification of facial pattern and definition of treatment protocols (SILVA, 2008). In addition, this index is measured on a scale from 1 to 5, considering that the higher the number, the worse the patient's facial profile,

ranging from normal occlusion to anterior and posterior crossbite (ATACK et al., 1997).

There is few literature evidences in this field, mainly when it comes to retrospective comparative studies of occlusal anthropometric analyzes in children with and without orofacial anomalies. Moreover, through the analysis of the occlusal index, it can be evaluated if children with cleft lip and palate suffered any restriction on facial growth after the completion of primary surgeries.

2 Objectives

2. Objective

To correlation the dental arch area and occlusion of children with complete unilateral cleft lip and palate at 5 years of age using the Atack occlusal index.

3 Manuscript

3D analysis of dental arch area and occlusal index of children with cleft lip and palate at 5 years of age

ABSTRACT

Objective: The aim of this study was to correlation the dental arch area and occlusion of children with cleft lip and complete unilateral palate at 5 years using the Attack occlusal index. **Material and Methods:** The sample consisted of 124 digital models of children with cleft lip and unilateral palate. The measurement of the area of the dental arches was obtained by Stereophotogrammetry System Software. Attack occlusal index analyzed the occlusion on digitized dental models. The Interclass Correlation Coefficient was used to analyze the intra-examiner reproducibility and the Spearman correlation coefficient verified the correlation between the dental arch area and occlusal index. **Results:** For intra-examiner agreement analysis, measurements of the 1st and 2nd measurements of half of the sample were obtained 15 days after the first measurement. The ICC showed high agreement (0.83). The Attack occlusal index presented with a prevalence of index 4 (34.64%). Regarding the measurements of area (cm²), the median value was 7.28, minimum value 4.90 and a maximum 11.89. The correlation between the dental arch area and occlusal index was negative (-0.35). **Conclusion:** According to the results, the dental arch area has no correlation with the dental occlusion of children with cleft lip and palate at 5 years of age.

Keywords: Cleft lip; Cleft palate; Dental models; Development; Three-dimensional image.

INTRODUCTION

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In order to evaluate primary surgeries, literature has shown different methodologies, such as dimensional and anatomical measurements performed on the study models (ROUSSEAU et al., 2013); evaluation on imaging exams such as photographs (LIM et al., 2017) and radiographs (YANG et al., 2012), in longitudinal studies performed on individuals with cleft lip and palate.

The arrival of 3D technology has enabled advances in the study of craniofacial morphology and growth through the laser scanning and stereoscopic photography. The international research in three-dimensional models have been increasing in recent years, becoming an alternative to plaster models in the evaluation of arch width and palatal morphology (MELLO et al. 2013; MENEZES et al. 2016).

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Even at early age, from complete deciduous dentition and incomplete plastic surgery protocol, it is possible to define morphology and growth pattern in children at 5 years of age (SILVA et al., 2008). The development of temporary dentition helps the practitioner to classify the type of dental or skeletal malocclusion. The tissues of the face may cover a skeletal deficiency in the middle facial third of these patients (GOMEZ, 2017). Usually, compensation for maxillary deficiency produces protrusion of the upper incisors and retraction of the lower ones (VARELA, 2005).

The occlusal index analysis of these children is performed at some point. Specially, the Attack index is taken at 5 years of age (ATAACK et al., 1997). The choice of this specific age range is due to growth preservation by the genetic pattern, allowing the identification of facial pattern and definition of treatment protocols (SILVA, 2008). In addition, this index is measured on a scale from 1 to 5, considering that the higher the number, the worse the patient's facial profile, ranging from normal occlusion to anterior and posterior crossbite (ATAACK et al., 1997). There is few literature evidences in this field, mainly when it comes to retrospective comparative studies of occlusal anthropometric analyzes in children with and without orofacial anomalies. Moreover, through the analysis of the occlusal index, it can be evaluated if children with cleft lip and palate suffered any restriction on facial growth after the completion of primary surgeries. Thus, the aim of this study was to correlation the dental arch area and occlusion of children with cleft lip and complete unilateral palate at 5 years using the Attack occlusal index.

MATERIAL AND METHODS

The study was approved by the local Institutional Review Board (Hospital for Rehabilitation of Craniofacial Anomalies of the University of São Paulo). Protocol number 07871318.9.0000.5441. The sample was composed by dental models of upper and lower dental arches, of children with unilateral cleft lip and palate from the Hospital documentation file, respecting the following inclusion criteria: Children between 4 and 6 years of age; unilateral complete cleft lip and palate; absence of orthodontic and/or orthopedic treatment; complete documentation file of both superior and inferior arches. Exclusion criteria: children with deleterious oral habits; presence of syndromes and/or other anomalies; poor quality dental models, side of the fissure without specific.

The sample size was calculated with the minimum of 29 patients (LO et al., 2003). Significance level was considered at 5% and power test at 80%. The minimum difference to be detected will be 50mm².

The dental plaster models were digitized using a commercial laser scanner system (3Shape's R700TM Scanner) coupled to a computer (CARRARA et al., 2016; FALZONI et al., 2016; SADOKA et al., 2017, RANDO et al., 2018). Measurements of dental arches area were obtained using the Stereophotogrammetry System Software (Figura 1).

Figure 1 Points in the dental arch

Atack occlusal index was used to analyze the dental models scanned (Table 1). The digital models were scored from 1 to 5 (ATACK et

CODE	DESCRIPTION	PROGNOSTIC
1	Positive horizontal overlap. Normal or palatal inclination of the upper incisors. No crossbite or open bite.	Excellent
2	Positive horizontal overlap. Normal or buccal inclination of maxillary incisors. Tendency to crossbite and unilateral crossbite. Tendency to open bite on the fissure side	Good
3	Anterior end-to-bite. Upper incisor inclination to / buccal or horizontal overlap with inclined palatal incisors, tendency to open bite on the cleft side.	Regular
4	Negative horizontal overflow. Upper incisor inclination to buccal or normal, tendency to open bite on the fissure side. Tendency to unilateral or bilateral posterior crossbite.	Bad
5	Negative horizontal overflow. Tilting of the upper incisors for the buccal. Bilateral crossbite.	Too bad

al., 1997).

Table 1: Atack Index classification (Atack et al., 1997)

To analyze the intra-examiner reproducibility, Interclass Correlation Coefficient (ICC) was used. The Spearman correlation coefficient was used to verify correlation between the dental arch area and Attack occlusal index.

RESULTS

A total of 295 patients were selected. From that initial number, after applied the inclusion and exclusion criteria; 14 unconcluded dates in the tassy system; 26 side fissure's without register; 70 individuals were excluded due to molding dates; 11 rehabilitate, 18 due to other anomalies; 19 with poor quality and 12 due to the presence of an orthopedic device, resulting in 124 models fitting the inclusion criteria.

The median year of age at the timing of molding was 5.54, minimum of 4.23 and a maximum of 6.01. Anthropometric findings and sample description are in Table 2.

Table 2: Sample description regarding gender distribution and cleft side.

	<i>Gender</i>			<i>Cleft Side</i>		
	Female	Male	Total	Right	Left	Total
<i>N</i>	45	79	124	14	110	124
<i>%</i>	36.3	63.7	100%	11.3%	88,7	100%

P= <0.001

For intra-examiner agreement analysis, measurements of the 1st and 2nd measurements of half of the sample were obtained 15 days after the first measurement. The ICC showed high agreement (0.83). Table 3 shows data from the Attack occlusal index, with a prevalence of index 4 (34.64%). Regarding the measurements of area (cm²), the median value was 7.28, minimum value 4.90 and a maximum 11.89. The correlation between the dental arch area and occlusal index was negative (-0.35) (Table 3).

Table 3: Comparison among values of dental arch area and Attack Occlusal Index.

ATAACK INDEX		1	2	3	4	5	TOTAL
N (%)		9 (7.25)	24 (19.35)	30 (24.19)	43 (34.67)	18 (14.51)	124 (100)
AREA	Minimum	6,76	5,57	6,25	4,95	4,90	
	Medium	8,01	7,30	7,54	7,17	6,49	
	Max	11,89	11,16	10,92	9,94	8,38	

DISCUSSION

The results showed no correlation among Attack index and palatal area, represented by the majority of index 4 with a poor prognosis, but no correlation with values of palatal area.

Also, it is vitally important to evaluate the outcome after surgery because there are currently several surgical protocols in the treatment of cleft lip and palate depending on the rehabilitation and surgery center (FREITAS, 2012 & FALZONI et al., 2016).

Surprisingly, it was found that in 201 European Cleft Palate treatment centers 194 different protocols were used (BENNUN, 2015). As stated in the article by SABELIS et al., 2016 It is necessary to go beyond the sagittal relationship of molars, the arrangement of teeth and cephalometric analysis. Occlusion is only a clinical sign of the disease and cephalometry represents only the two-dimensional part (HACKE, 2015).

Many authors describe the maxillary deficiency present in patients with cleft lip and palate after primary plastic surgery (SHEFTYE & EVANS, 2006), but it is necessary to qualify the changes, but objectively, using the occlusion indexes along with the dimensions of the area.

Aforetime, one of the main arguments against using 3D digital models is that they are expensive and not universally accepted (SANTORO et al., 2003). However, this is changing with new electronic media evolving rapidly and

becoming a more significant part of everyday clinical practice (ZILBERMAN et al., 2003). Digital photographs and digital radiographs are already in regular use and patient records are becoming widely available in electronic format (QUIMBY et al., 2004 & STEVENS et al., 2006).

The coming of the digitalization of the plaster models made possible a better selection and measurement especially of the structures that present more variability, such as the maxilla of the patients with cleft lip and palate. ZILBERMAN et al., 2003 and QUIMBY et al., Were the first authors to develop these technologies, concluding in their studies, the ease and accuracy of the analysis of 3D measurements. The feasibility of measurements accompanied by maxillofacial growth stages has been proven by (ASQUITH & MCINTYRE 2012) and BISHARA et al., 2015. Even though these technologies have been in use for over a decade, there are still some limitations in terms of high cost and lack of publications to compare data and studies (SHETYE, 2010).

The 2012 CHAWLA study compared plaster models, with photographs, and digital models, and clearly demonstrated that 5-year-old 3D digital models can be a promising alternative to 5-year-old physical models age.

The preponderance of males in the sample studied is constant with the evidence describing a higher prevalence of unilateral cleft lip and palate in this gender (SILVA, 2008) and was also observed by Márquez et al. 2015 in the longitudinal study of patients with UCLP.

The scandcleft study whith compare the the Modified Huddart and Bodenham index of 8-year-old children concluded that when this are compared between of 5-year-old this are more negative (KARSTEN et al., 2020). This study using de 3D for the area and analyses oclusal de Atack but in the future can be compare whith others index and others ages.

In the present study, the Attack index, together with the 3D Area measurements, helped us to relate the occlusion of 5-year-old children to the palate area; in the future, it would be good to compare these results with children without cleft. Establish normality standards in the maxillary and mandibular measurements.

CONCLUSION

According to the results, the dental arch area has no correlation with the dental occlusion of children with cleft lip and palate at 5 years of age.

CONFLICT OF INTEREST

The authors report no conflict of interest.

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CNPQ (Conselho Nacional de Desenvolvimento Científico)

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4 General Conclusions

4. GENERAL CONCLUSIONS

According to the results, the dental arch area has no correlation with the dental occlusion of children with cleft lip and palate at 5 years of age.

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Appendix

APPENDIX

Appendix 1: Declaration of exclusive use of the article in dissertation; Portuguese version.

DECLARAÇÃO DE USO EXCLUSIVO DE ARTIGO EM DISSERTAÇÃO	
Declaramos estarmos cientes de que o trabalho “Análise 3D da área do arco dentário e do índice oclusal de crianças com fissura labiopalatina aos 5 anos de idade” será apresentado na Dissertação da aluna Grace Alejandra Cabezas Cantos e que não foi e nem será utilizado em outra dissertação ou tese do Programa de Pós-Graduação do HRAC-USP.	
Bauru, de 20 .	
_____	_____
Autor	Assinatura
_____	_____
Autor	Assinatura
_____	_____
Autor	Assinatura
_____	_____
Autor	Assinatura

Appendix 2: Declaration of exclusive use of the article in dissertation; English version.**DECLARATION OF EXCLUSIVE USE OF THE ARTICLE IN DISSERTATION**

We hereby declare that we are aware of the article “3D analysis of dental arch area and occlusal index of children with cleft lip and palate at 5 years of age” will be included in Dissertation of the student Grace Alejandra Cabezas Cantos was not used and may not be used in other works of Graduate Programs at the Bauru School of Dentistry, University of São Paulo.

Bauru, de 20 .

Author

Signature

Author

Signature

Author

Signature

Author

Signature

Annexes

Público

Pesquisador

Alterar Meus Dados

Grace

DETALHAR PROJETO DE PESQUISA

- DADOS DA VERSÃO DO PROJETO DE PESQUISA

Título da Pesquisa: Análise 3D da área do arco dentário e do índice oclusal de crianças com fissura labiopalatina aos 5 anos de idade.
 Pesquisador Responsável: Grace Alejandra Cabezas Cantos
 Área Temática:
 Versão: 1
 CAAE: 07871318.9.0000.5441
 Submetido em: 14/02/2019
 Instituição Proponente: Hospital de Reabilitação de Anomalias Craniofaciais da USP
 Situação da Versão do Projeto: Parecer Consubstanciado Emitido (Aprovado)
 Localização atual da Versão do Projeto: Pesquisador Responsável
 Patrocinador Principal: Financiamento Próprio

- LISTA DE APELACÕES DO PROJETO

Apreciação *	Pesquisador Responsável *	Versão *	Recepção *	Submissão *	Modificação *	Primeira Submissão *	Relator *	Situação *	Exclusiva do Centro Coord. *	Ação
PO	Grace Alejandra Cabezas Cantos	1	14/02/2019	14/02/2019	01/03/2019	03/12/2018	Izabel Maria Marchi de Carvalho	Parecer Consubstanciado Emitido(Aprovado)	Não

- HISTÓRICO DE TRÂMITES

Apreciação	Data/Hora	Tipo Trâmite	Versão	Autor	Perfil	Origem	Destino	Informações
PO	01/03/2019 10:44:57	Parecer liberado	1		Coordenador	USP - Hospital de Reabilitação de Anomalias Craniofaciais da Universidade de São Paulo - URAC/USP	PESQUISADOR	Projeto Aprovado.