

PONTIFÍCIA UNIVERSIDADE CATÓLICA DE MINAS GERAIS  
Programa de Pós-graduação em Odontologia

Tarsila Cordeiro Mafra

**A TERAPIA COM ARCO LINGUAL ALTERA A ANGULAÇÃO DOS MOLARES  
E PREMOLARES INFERIORES DURANTE A TRANSIÇÃO DA DENTIÇÃO  
MISTA TARDIA PARA A PERMANENTE?**

Belo Horizonte  
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Orientador: Flávio Ricardo Manzi

Coorientador: Dauro Douglas Oliveira

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**A meus pais,  
pelo amor e dedicação incondicional.**

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## RESUMO

O arco lingual (LLA) é um mantenedor de espaço eficiente, de baixo custo, e fácil manuseio clínico. Portanto, é amplamente utilizado na Ortodontia Contemporânea. O LLA é frequentemente usado em tratamentos sem extrações preservando o Leeway Space e o perímetro do arco por meio do controle da mesialização dos molares e da retroinclinação dos incisivos inferiores. Apesar de seu uso ser difundido em todo o mundo, pouco se tem estudado sobre os seus efeitos. O objetivo deste estudo consiste em avaliar os efeitos que um LLA pode causar no padrão de erupção e na angulação dos dentes posteriores inferiores e para comparar estes resultados com uma amostra não tratada (Grupo Controle). Radiografias panorâmicas de 189 indivíduos foram selecionadas e divididas em dois grupos: (1) Tratada com um arco lingual (CAL) ( $n = 96$ ), com idade média de  $9,3 \pm 1,4$  anos, (2) Tratada sem arco lingual (SAL) ( $n = 93$ ) com idade média de  $8,7 \pm 1,2$  anos. Radiografias panorâmicas antes do tratamento ( $T_0$ ) e pelo menos com 10 meses de acompanhamento ( $T_1$ ) foram examinadas para determinar as mudanças na angulação de premolares e molares inferiores. Grupos CAL e SAL mostraram diferenças estatisticamente significativas de  $T_0$  para  $T_1$ , com exceção dos segundos premolares em CAL e primeiros molares no SAL. Os segundos premolares mostraram aumento da mesialização no grupo SAL. O uso de um LLA contribuiu para a verticalização dos primeiros premolares, primeiros e segundos molares de  $T_0$  para  $T_1$ . Além disso, também evitou o aumento da angulação mesial dos segundos pré-molares.

Palavras chave: Dentição mista. Dentição permanente. Ortodontia interceptora. Mantenedor de espaço.

## ABSTRACT

The lower lingual arch (LLA) is an efficient, low cost and easily clinically managed space maintainer. Therefore, it is widely used in Contemporary Orthodontics. A LLA is frequently used in nonextraction treatments to preserve the Leeway Space and the arch perimeter by means of avoiding mesial drift of the molars and retroclination of the mandibular incisors. Despite its widespread use worldwide, relatively little has been studied about its effects. The aim of this study is to evaluate the effects that a LLA may cause on the eruption pattern and on the inclination of the mandibular posterior teeth and to compare these results to an untreated control sample. Panoramic radiographs of one hundred and eighty nine individuals were selected and divided into 2 groups: (1) Treated with a lingual arch (TWLA) ( $n = 96$ ), mean age of  $9.3 \pm 1.4$  years; (2) Untreated (UT) ( $n = 93$ ) mean age of  $8.7 \pm 1.2$  years. Panoramic radiographs before treatment ( $T_0$ ) and 24 month least follow up ( $T_1$ ) were examined to determine the changes in inclination of mandibular premolars and molars. Groups TWLA and UT showed statistically significant differences from  $T_0$  to  $T_1$ , except the second premolars on TWLA and first molars on UT. The second premolars showed increased mesial inclination in the UT group. The use of a LLA seemed to have contributed to the uprighting of the first premolars, first and second molars from  $T_0$  to  $T_1$ . In addition, it also avoided the increase in mesial inclination of the second premolars.

Keywords: Mixed dentition. Permanente dentition. Interceptive orthodontics. Space maintainer.

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## SUMÁRIO

|                                                                                     |           |
|-------------------------------------------------------------------------------------|-----------|
| <b>1 INTRODUÇÃO .....</b>                                                           | <b>15</b> |
| <b>2 OBJETIVOS .....</b>                                                            | <b>17</b> |
| <b>2.1 Objetivo Geral .....</b>                                                     | <b>17</b> |
| <b>2.2 Objetivos Específicos.....</b>                                               | <b>17</b> |
| <b>3 ARTIGO .....</b>                                                               | <b>18</b> |
| <b>4 CONSIDERAÇÕES FINAIS.....</b>                                                  | <b>35</b> |
| <b>REFERÊNCIAS .....</b>                                                            | <b>36</b> |
| <b>ANEXO A - Cópia da aprovação do projeto no Comitê de Ética da PUC Minas.....</b> | <b>37</b> |

## 1 INTRODUÇÃO

Há décadas, cirurgiões-dentistas têm buscado e incentivado maiores cuidados na prevenção de problemas orais. Hoje em dia, o acesso a esta orientação está muito mais fácil e disponível para a maioria da população. Essa conduta conservadora reflete-se também na Ortodontia, com o crescente interesse por tratamentos interceptores (BRENNAN; GIANELLY, 2000).

Dentro do leque de procedimentos preventivos e interceptores, a gestão de espaço por meio da utilização do Espaço Livre de Nance (NANCE, 1947) representa uma das abordagens mais críticas do tratamento ortodôntico na dentadura mista. A deficiência do comprimento do arco dentário como resultado da perda precoce de dentes decíduos pode levar ao desenvolvimento de problemas relevantes na dentição permanente, como por exemplo, apinhamento e impactação (GIANELLY, 1995; BROTHWELL, 1997; OWAIS, 2011).

Em 1947, Hays Nance descreveu o Espaço Livre de Nance. Naquela época, Nance creditou tal “sobra” de espaço à diferença da soma dos diâmetros méso-distais dos caninos e molares decíduos era maior do que a soma dos diâmetros méso-distais dos caninos e pré-molares. Sendo essa diferença de diâmetro é de 1,8 mm na maxila e 3,4 mm na mandíbula.

Em 1977, Gianelly aprimorou tal conceito, mostrando que os diâmetros méso-distais dos caninos e 1º molar decíduo não contribuem com o Espaço Livre de Nance, mas que apenas as dimensões do 2º molar decíduo é que representam o conceito da tal “sobra” de espaço. Sendo este espaço chamado de Espaço E. A oportunidade de aproveitamento do Espaço E acontece durante a fase de dentadura mista final. Normalmente isto é feito pelo uso do arco lingual. (REBELLATO et al., 1997; REBELLATO et al., 2011).

Na Ortodontia preventiva e interceptora, o uso do arco lingual é um procedimento comumente aceito (ODOM, 1983) por ser um ótimo aparelho mantenedor de espaço, que preserva o comprimento do arco por meio do controle do movimento mesial dos molares permanentes e da retroinclinação dos incisivos inferiores (MIOTTI, 1984; BRENNAN; GIANELLY, 2000; VIGLIANISI, 2010).

Este dispositivo é considerado uma excelente opção para os ortodontistas por ser um aparelho eficiente, não depender da cooperação do paciente, de fácil

construção e manutenção, bem como de baixo custo (KINZINGER; FRITZ; DIEDRICH, 2004).

Atualmente, boa parte dos trabalhos sobre os efeitos do arco lingual são relatos de casos clínicos que avaliaram sua eficácia em prevenir a migração mesial dos primeiros molares permanentes, mantendo assim as dimensões do arco dentário na transição da dentadura mista para a dentição permanente (FERDIANAKIS; LASKOU; SPYROU, 1998; ALMEIDA et al., 2011).

Assim, o objetivo desta pesquisa é testar a hipótese nula de que existem diferenças significativas entre as angulações dos dentes posteriores em crianças que usaram o arco lingual, durante as dentaduras mistas tardias e permanente jovem, em comparação com crianças que não usaram tal aparelho.

## **2 OBJETIVOS**

### **2.1 Objetivo Geral**

Estudar a angulação dos dentes posteriores inferiores permanentes após o uso do arco e comparar tais resultados com indivíduos não tratados.

### **2.2 Objetivos Específicos**

- a) avaliar a angulação dos primeiros e segundos premolares inferiores após o uso do arco lingual aproveitando o Espaço E;
- b) determinar a angulação dos primeiros e segundos molares inferiores após o uso do arco lingual aproveitando o Espaço E.

### 3 ARTIGO

**Does lingual arch therapy change the angulation of molars and premolars during the transition from late mixed to permanent dentition?**

Proposta de artigo a ser submetido à revista: *International Journal of Paediatric Dentistry* (Qualis A1).

*Normas para submissão de artigos podem ser visualizadas no endereço eletrônico:*

*[http://onlinelibrary.wiley.com/journal/10.1111/\(ISSN\)1365263X/homepage/ForAuthos.html](http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1365263X/homepage/ForAuthos.html).*

## **Does lingual arch therapy change the angulation of molars and premolars during the transition from late mixed to permanent dentition?**

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**Running title:** Effect of the lingual arch angulation of the posterior teeth.

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**Summary**

*Aim.* To test the null hypothesis that mandibular posterior teeth angulation after lower lingual arch therapy is not significantly different from the observed angulation in the same teeth of untreated children (CG) during the transition from late mixed to permanent dentition.

*Design.* The sample included 96 late mixed dentition children treated with LLA for space management (WLA) and 93 CG, matched by age, gender and stage of dental development. The panoramic radiographs of all children were evaluated at baseline ( $T^0$ ) and after an average of 24 months ( $T^1$ ). Superimposition of the radiographs on a fiduciary reference line allowed the measurement of the angulation changes of lower molars and premolars.

*Results.* Statistically significant differences ( $p < 0.05$ ) were found between WLA and CG on the mandibular posterior teeth angulation from  $T^0$  to  $T^1$ . The use of a LLA promoted the uprighting of first premolars, first and second molars and prevented greater mesial angulation of second premolars.

*Conclusions.* The null hypothesis was rejected. The use of a lower lingual arch significantly changed the eruption pattern of the mandibular permanent posterior teeth.

## **Introduction**

A major goal of pediatric dentists is to reach an esthetic and functional occlusion at adolescence and adulthood. Thus, guidance of eruption and development of the primary, mixed, and permanent dentitions is an integral component of comprehensive oral health care for all pediatric dental patients (ref guidelines AAPD). New knowledge about this subject may contribute to improve the quality of dental childcare and treatment.

Mandibular arch space discrepancy is highly prevalent during late mixed dentition and leeway space [1] management is one of the many responsibilities of pediatric dentists (guidelines aapd). Evidence-based data have shown that arch length decrease can be effectively treated during late mixed dentition with a lower lingual arch [2-4]. In addition to preserving dental arch perimeter, other effects have been credit to LLA as the posterior dentoalveolar vertical growth control [12],vertical control of the mandibular incisor position and the increased rates of second molars impaction [9, 12].

Although the primary objective of LLA is to prevent mesial displacement of the first permanent molars [2, 5, 7], some questions about the effects of a LLA on the mandibular posterior teeth angulation during the transition from late mixed to permanent dentition remain unanswered. Does first molar mesio-distal angulation change despite the anchorage effects obtained with the heavy stainless-steel wire used to construct a LLA? Are the path of eruption and the angulation of the adjacent teeth affected?

Therefore, the purpose of the present study was to test the null hypothesis that mandibular posterior teeth angulation after LLA therapy is not significantly different from the observed angulation in the same teeth of untreated children during the transition from late mixed to permanent dentition.

## **Material and methods**

This study was approved by the Institutional Review Board for research on Human Subjects of the Pontifical Catholic University of Minas Gerais (PUC Minas) under the CAAE number 05685312.8.0000.5137.

### *Sample*

Panoramic radiographs of 189 children (97 girls and 92 boys) were selected by retrospective review of the charts from the patients treated at the PUC Minas interceptive orthodontics clinic and from the private offices of 2 pediatric dentists and 2 orthodontists of Belo Horizonte, Brazil. The radiographs of these children were divided into two groups: (1) space management with a lower lingual arch only (WLA) and (2) untreated control children (CG).

WLA group had 39 boys and 57 girls with a mean age of 9 years and 3 months ( $\pm 1$  year and 4 months). CG had 51 boys and 42 girls, with mean age of 8 years and 7 months ( $\pm 1$  year and 2 months). No orthodontic treatment were performed in CG before and along the study duration.

All patients had a panoramic radiograph taken during their first consultation with the pediatric dentist or orthodontist for overall screening. These images were obtained when the patients were in the late mixed dentition ( $T^0$ ). Another panoramic radiograph was taken after all permanent teeth, except the third molars, had fully erupted ( $T^1$ ), as part of their initial orthodontic records for fixed appliance therapy. The mean observation periods between  $T^0$  and  $T^1$  were 2.7 years  $\pm 1$  year for the WLA group and 2.6 years  $\pm 11$  months for the CG.

The sample inclusion criteria were: (1) presence of second deciduous molars at  $T^0$ ; (2) both premolars and second molars germs presenting at least Nolla stage 7 at the  $T^0$  radiograph [11]; (3) complete permanent dentition at  $T^1$ ; (4) have the  $T^1$  radiograph of the WLA group taken before the LLA was removed; and (5) have good quality panoramic radiographs at both  $T^0$  and  $T^1$ .

Conversely, the exclusion criteria were: (1) presence of any mechanical obstacle that could compromise teeth eruption, such: tumors, cysts and/or odontomas; (2) dental agenesis; and (3) present any type of craniofacial deformity or syndromes.

### *Methods of measurements*

The same researcher (TCM) performed all measurements after calibration with a experienced clinical researcher (BQS). The radiographs were evaluated in a dark room. The radiographs were positioned in a view box and fixed with adhesive tape for stabilization. Acetate tracing paper (GAC Orthodontics, Islandia, NY, USA) was placed on each radiograph and the anatomic references of the teeth were identified with a 0.3 mm mechanical pencil.

As references for first permanent molars, the following points were determined: the most mesial (MMCP) and the most distal point of the crown (MDCP) and mesial (MCEJ) and distal (DCEJ) cement-enamel junction. These references were based on the work of McNamara Jr et al [6]. These points were diagonally connected, generating two intersecting lines. This intersection determined two other points (DMD and DME), which were used to trace the fiduciary occlusal plane (OP) (Fig. 1). The angulation of the evaluated teeth was determined by the intersection between OP and the long axis of each tooth (Fig. 2).

The acetate papers with all dental angulations registered were scanned on a conventional table scanner (HP Deskjet 3550, Hewlett-Packard, Palo Alto, CA, USA) at a resolution of 600 dpi. The generated files were converted to *dxf* files to be used on the AutoCAD 2000 software (Autodesk Inc. Mill Valley, CA, USA).

### *Error analysis*

In order to determine possible measurement or anatomical landmarks identification errors and to confirm the reliability of the intra and extra examiner readings, 27 radiographs were randomly selected and retraced and remeasured 15 days latter. The random error was calculated with Dahlberg's equation [17] and the systematic error was evaluated with a paired t-test ( $p < 0.05$ ).

The systematic error of measurement did not exceed  $0.13^\circ$ . The correlation coefficient was higher than 0.9 for all measurements, which showed that systematic reading errors were not significant. The random error ranged from  $0.03^\circ$  to  $0.08^\circ$  and there were no statistically significant differences between the measurements ( $p < 0.05$ ).

### *Statistical Analysis*

Data were statistically analyzed using the SPSS 12.0 software (SPSS Inc., Chicago, IL, USA). The results from Kolgomorov-Smirnov and Levene tests demonstrated compliance with the assumptions of normality and homocedasticity, which allowed the comparison between the means of both groups with parametric tests (t-test for independent samples). The level of significance was established at 5%.

## **Results**

Comparisons between the mean and standard deviation values of mandibular posterior dental angulations obtained in WLA and CG are shown on Table 1. Premolars and molars angulations registered in the late mixed dentition ( $T^0$ ), in the permanent dentition ( $T^1$ ) and the

comparisons of changes between these stages of occlusal development stages for both groups are presented.

Mesio-distal angulation of premolars and molars showed no statistically significant difference ( $p > 0.05$ ) between WLA and CG in  $T^0$ , except for the left second premolar and the right first molar. However, intragroup comparison both in  $T^0$  and  $T^1$ , showed that the differences between right and left sides were not significant ( $p > 0.05$ ).

There were significant changes on most mandibular posterior teeth angulation among the individuals that used a LLA during the transition from late mixed to permanent dentition. The first premolars and both first and second molars showed statistically significant ( $p < 0.05$ ) uprighting from  $T^0$  to  $T^1$ , while the second premolars maintained their mesio-distal angulation.

In the CG, first premolars and second molars also showed statistically significant ( $p < 0.05$ ) uprighting during the evaluation period, while the first molars maintained their mesial angulation. Conversely, the mandibular second premolars presented statistically significant ( $p < 0.05$ ) increase of the mesial angulation from late mixed to permanent dentition. Fig. 3 illustrates the changes in mesio-distal angulation of mandibular molars and premolars from  $T^0$  and  $T^1$ .

## Discussion

Pediatric dentists and orthodontists have long and widely been using LLA to manage the mandibular dental crowding. However, some of the effects that a LLA may have on the mandibular posterior teeth angulation remain unclear. The effect in the mesio-distal angulation of mandibular molars and premolars during the transition from late mixed to permanent dentition has not been investigated yet. Our clinical investigation evaluated panoramic radiographs of 189 individuals to answer this question.

Although the use of cephalometric radiographs to evaluate angular changes after orthodontic interventions has been more frequently used in the literature [2, 4, 6], we opted to use panoramic radiographs because in lateral cephalograms it is the difficulty to precisely identify molars and premolars due to the overlapping of the images from right and left sides. Thus, in the present investigation, such problem was not faced since panoramic radiographs allow a clear image outline of mandibular posterior teeth. Previous studies have shown that angular and linear measurements performed on panoramic radiographs obtained at different time intervals are reliable as long as the Frankfurt Horizontal plane was maintained at a constant angulation, thus not varying more than 10 degrees clock or counterclockwise [18].

Besides that, to collect cephalometric radiographs to comprise a control sample was not possible. Untreated children eligible to composed the CG did not have a significant malocclusion that ethically justified the request of complete orthodontic records during their first consultation ( $T^0$ ) with the pediatric dentist or orthodontist. Therefore, at that appointment, only a screening panoramic radiograph was taken to check for dental agenesis, eruptive pattern problems or pathologies such as cists and odontomas and orthodontic intervention was postponed to after all permanent teeth had erupted. This is not an uncommon clinical situation, since there is enough evidence in the literature showing that a significant number of malocclusions may be more efficiently treated with a one-phase orthodontic therapy [19, 20].

Previous studies that also evaluated LLA effects performed a analysis sample to estimate the population variance of the study [4, 6, 16]. We used a convenience sampling technique, but the power of the test was considerably high (ranging from 0.6 to 1.0) in all measurements. Most measurements presented a power of 100%. Only second premolars angulation in the WLA angulation and first molars angulation in CG presented a power below 0.8.

The results of this investigation showed that first molar angulation of untreated patients were maintained from  $T^0$  to  $T^1$ , while in children treated with LLA there was an uprighting of this teeth. This finding was unexpected because the LLA, despite been a passive appliance, changed the physiologic path of eruption of the abutment teeth. Our results are contrary to previous reports where no change in the angulation of the lower first permanent molars in relation to the mandibular plane was found [3, 4, 7], but are in tune with other who found even a slight distal movement of this teeth [9, 12]. This change in the first molar angulation might represent a therapeutic gain in the stability of crowding treatment in the lower incisors region because of the lessening of horizontal masticatory forces, as well as a better dentoskeletal vertical growth control. The maintenance of the first molar angulation in the CG may be due to the action of the occlusal forces along the inclined planes of their cusps. All these assumption, however, need to be tested in a future investigation.

An additional benefit of the LLA was the reduction of the mesial angulation trend of the lower second premolars. As second premolars in WLA did not suffer from the action of first molar mesial movement their  $T^0$  angulation was maintained. However, the CG showed marked mesial inclination of these teeth. The significant mesial angulation increase registered for the CG second premolars may be due the lack of the preservation of the Leeway space. The first premolars may have suffered the action of the anterior teeth and lip muscles

indirectly, what may justify their more uprighted position at T<sup>1</sup>. This study seems to be the first to report on the changes of mandibular premolar angulations after LLA therapy.

In the second molars region, the WLA children showed a greater uprighting than CG because of the change in the first permanent molars angulation. During its eruption is guided by the distal coronary convex surface of the first molar, the second molars eruption is changed up righting.

But what would lead to an uprighting of the first molar in WLLA group? Since the device does not present active vocation and scientific works made [3, 8, 9] are in agreement on the point that even with the arch, there is a mesial migration and inferior incisors projection. In our understanding, one of the factors that help explain, would be the fact that, with the arch resting on the inclined plan of the lingual surface of the inferior incisors, a small slip of the arch on that surface, favored by the lever arm of the device, would provoke an up righting of the first molars long axis. As the vertical is about six degrees, a little slip in the incisal direction necessarily occurs and enables such up righting (Tab 1).

Based on the results of this study, we concluded that use of a lower lingual arch significantly changed the eruption pattern of the mandibular permanent posterior teeth. It promoted the uprighting of first premolars, first and second molars and prevented greater mesial angulation of second premolars. These findings are pioneer and open perspectives for future investigations to evaluate potential benefits to patients that used a LLA and reached the permanent dentition presenting the mandibular posterior teeth in a more uprighted position.

**What does this study add?**

- Presents pioneer information about changes in the eruption pattern axis of mandibular posterior teeth after the use of a lower lingual arch.
- May open new perspectives for the use of this appliance.

**Why is this study important for pediatric dentists?**

- Shows evidence that after the use of a LLA, the first permanent mandibular molars upright.
- Mandibular second premolars do not mesially incline during the transition from the late mixed to permanent dentition if a LLA is used;
- Reinforces the concept that, during the final stages of the mixed dentition, pediatric dentists must be alert to the correctly recommend the use of a LLA.

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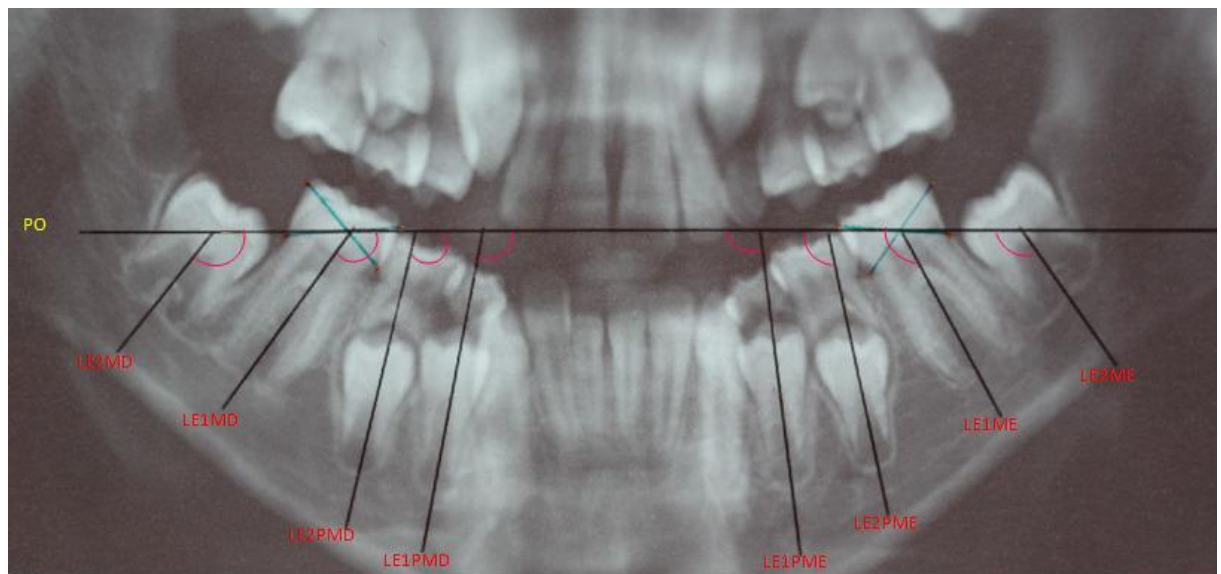
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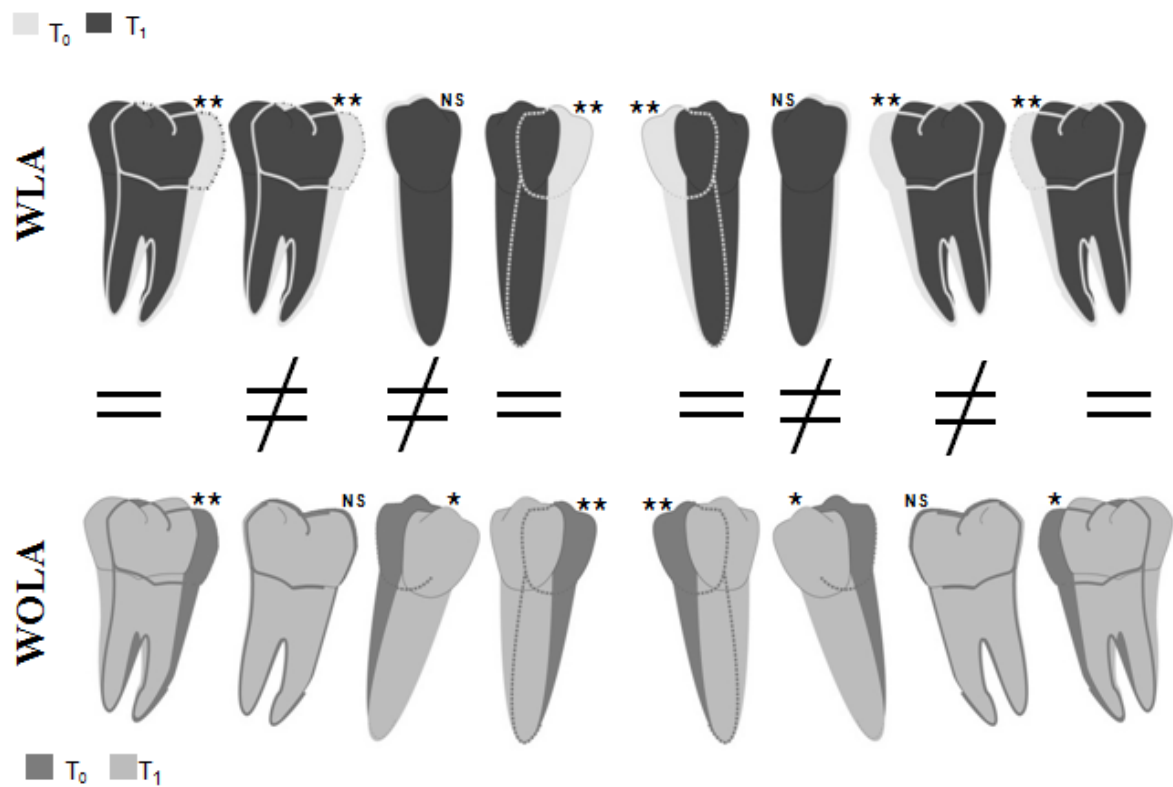
## Figuras e Tabelas



**Fig. 1:** Representação esquemática da construção do plano oclusal de referência.



**Fig. 2:** Determinação das inclinações dentárias avaliadas.



$p > 0.05$  NS;  $P < 0.05 > 0.001$  \*;  $P < 0.001$  \*\*; = means no difference between groups; ≠ means difference between groups

**Fig. 3:** Mudanças na inclinação mesiodistal de premolares e molares inferiores entre  $T_0$  e  $T_1$ .

Tab. 1. Measurements of the angle of the premolars and molars left and right in the groups with lingual arch(TWLA) and without lingual arch(WOLA) in the mixed dentition( $T_0$ )phases end and young permanent dentition ( $T_1$ )

| Measurements           | WLA<br>(n = 96) |           | WLA<br>paired<br>t-test<br>( $T^1 - T^0$ ) | WOLA<br>(n = 93) |           | WOLA<br>paired<br>t-test<br>( $T^1 - T^0$ ) | Independent<br>t-test at $T^0$<br>(WLA vs. WOLA) | Independent<br>t-test at $T^1$<br>(WLA vs. WOLA) |
|------------------------|-----------------|-----------|--------------------------------------------|------------------|-----------|---------------------------------------------|--------------------------------------------------|--------------------------------------------------|
|                        | $T^0$           | $T^1$     | <i>p</i> -<br>value                        | $T^0$            | $T^1$     | <i>p</i> -<br>value                         | <i>p</i> - value                                 | <i>p</i> - value                                 |
| Right first premolars  | 101.8±7.9       | 97.3±6.1  | 0.000**                                    | 102.3±7.1        | 98.3±5.5  | 0.000**                                     | 0.637                                            | 0.260                                            |
| Left first premolars   | 100.1±8.6       | 95.6±5.1  | 0.000**                                    | 100.2±7.9        | 96.6±6.6  | 0.000**                                     | 0.908                                            | 0.060                                            |
| Right second premolars | 106.5± 9.6      | 105.6±5.3 | 0.445 NS                                   | 105.0±9.1        | 107.2±5.7 | 0.028*                                      | 0.293                                            | 0.000                                            |
| Left second premolars  | 105.3± 8.3      | 104.8±5.2 | 0.599 NS                                   | 102.7±9.9        | 106.0±5.7 | 0.003*                                      | 0.048                                            | 0.000                                            |
| Right first molars     | 113.2± 6.2      | 106.1±5.2 | 0.000**                                    | 115.5±5.3        | 115.4±5.0 | 0.897 NS                                    | 0.003                                            | 0.235                                            |
| Left first molars      | 110.0± 5.7      | 102.8±5.9 | 0.000**                                    | 111.9±7.8        | 111.5±4.6 | 0.621 NS                                    | 0.059                                            | 0.138                                            |
| Right second molars    | 122.9± 9.3      | 115.0±8.0 | 0.000**                                    | 124.0±7.6        | 120.4±7.0 | 0.000**                                     | 0.381                                            | 0.000                                            |
| Left second molars     | 123.4± 8.6      | 111.0±9.6 | 0.000**                                    | 121.5±11.7       | 117.6±7.3 | 0.002*                                      | 0.231                                            | 0.000                                            |



#### 4 CONSIDERAÇÕES FINAIS

Esse trabalho avaliou os efeitos do uso do arco lingual na inclinação mesiodistal de premolares e molares inferiores, bem como no padrão irruptivo desses dentes. Os achados são pioneiros e nos habilita a tecer algumas conclusões quanto ao grupo de pacientes que usaram ou não o arco lingual:

- a) a manutenção do espaço E durante a fase da dentadura mista final por meio do arco lingual tem associação com a mudança angular dos dentes permanentes adjacentes;
- b) a manutenção do espaço E durante a fase da dentadura mista final por meio do arco lingual tem associação com a mudança angular dos primeiros molares permanentes inferiores ancorados pelo arco lingual.

Os achados desse estudo contribuem para melhor compreensão dos efeitos deste importante aparelho de prevenção e interceptação das más oclusões e podem evidenciar novas perspectivas para o uso do arco lingual. Outros estudos podem ser pensados para continuar a investigar os efeitos do arco lingual. Uma alternativa interessante seria conceber um estudo clínico randomizado com tomografias de feixes cônicos para avaliar esses efeitos nos três planos do espaço.

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**ANEXO A - Cópia da aprovação do projeto no Comitê de Ética da PUC Minas.**

PONTIFÍCIA UNIVERSIDADE  
CATÓLICA DE MINAS GERAIS -  
PUCMG

**COMPROVANTE DE ENVIO DO PROJETO****DADOS DO PROJETO DE PESQUISA**

**Título da Pesquisa:** AVALIAÇÃO DOS EFEITOS DO ARCO LINGUAL EM PACIENTES EM  
CRESCIMENTO COM DIFERENTES PADRÕES FACIAIS, NOS TRÊS PLANOS DO

**Pesquisador:** Tarsila Cordeiro Mafra  
**Versão:** 2

**CAAE:** 05685312.8.0000.5137

**Instituição Proponente:** Pontifícia Universidade Católica de Minas Gerais - PUCMG

**DADOS DO COMPROVANTE**

**Número do Comprovante:** 021781/2012