Evaluation of the mesiodistal angulations of lower canines, pre-molars and molars with and without lower third molars

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Abstract

Objectives: The purpose of the present research was to compare the normal average values of the mesiodistal axial angulation, proposed by Ursi in 1989, with the mesiodistal axial angulation of canine teeth, pre-molars and lower molars in individuals with and without the presence of the third lower molars and ages between 18 and 25 years. Additionally, the values of the mesiodistal axial angulation of these teeth were compared in these two situations. **Methods:** Forty panoramic x-rays were used from individuals of both sexes who had not received orthodontic treatment. These subjects were divided into two groups: Group I, containing 20 x-rays that didn't present third lower molars and Group II, formed of 20 x-rays with the presence of the third lower molars. **Results and Conclusions:** Through statistical analysis of the results, it was concluded that both Groups exhibited lower pre-molars and molars with enhanced angulation in the mesial direction, when compared to normal occlusion. On the other hand, the mesiodistal axial angulation of lower canine teeth was shown to be similar to the angulation presented in cases of normal occlusion. The two Groups, when compared together, exhibited similar angular values of the canine teeth, pre-molars and lower molars, indicating that the presence of the third molars didn't exercise an influence on these dental angulations.

Keywords: Third molar. Panoramic radiography. Dental angulation. Tooth movement.

INTRODUCTION

Throughout orthodontic history, different ways of obtaining the correct angulation of teeth at the end of orthodontic treatment have been used. Initially, angulations were obtained with artistic bends in the wires, followed by soldering angulated brackets to the bands, according to Holdaway[13] and ending with the most recent evolution for achieving this purpose in Orthodontics: completely preadjusted brackets developed by Andrews[2], which have built-in necessary requirements for obtaining the "six keys for normal oc-

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clusion," disposing, in most cases, of the majority of archwire bends.

The constant search for the appropriate mesiodistal angulation of teeth occured because tooth positioning is an extremely important factor for the stability of the stomathognathic system by optimizing occlusal forces in normal function[21,22].

In this sense, the anterior force component is intimately related to well defined contact points, dependent of a correct axial angulation and of the occlusal relationship of one tooth against two teeth. Therefore, the appropriate axial angulation should be included in the orthodontic treatment objectives, because an accurate angulation is directly related to dental alignment, apart from being a determinant factor for long term maintenance of the results reached with treatment[8,11].

The orthopantomograph, commonly known as panoramic x-ray constitutes an auxiliary diagnostic method, allowing the visualization of a series of anatomical structures and relevant factors for dentistry, in a manner that its denomination suggests a general panoramic view of the stomatognathic system. The simplicity in equipment operation and the increased amount of information obtained, combined with patient comfort and minimal amount of exposure to radiation, makes the panoramic x-ray an instrument well used in dentistry, and especially in orthodontics, which developed methods to use them for the evaluation of mesiodistal angulations of teeth[26,28].

On the other hand, the third molars are being a very discussed subject in dentistry. Robinson (1859, apud Southard[23]) affirmed that the irregularities in tooth positioning are, frequently, the result of the pressure exerted by the third molars. Ever since, these teeth have generated a lot of controversies, in the clinical-scientific context, as for the most appropriate procedure when they are present.

There are two theories concerning the development of the third molars. The first and older theory, affirms that these teeth are capable of causing interferences, generating certain irregularities in the positioning of the adjacent teeth[3,15,16,29]. However, the second theory defends the fact that the third molars do not have the capacity to provide so many harmful effects[1,14,18,19,20,23,24,30].

Despite the great number of studies on this subject, there are many uncertainties regarding the appropriate treatment of the countless situations and if the presence of the third molars is capable of causing alterations in the position of other teeth.

In this context, there is a shortage of publications that relate the possible variation that the presence or absence of third molars can cause in the mesiodistal angulation of the adjacent teeth, which motivated the elaboration of the present research.

Third molars

The literature review regarding the presence, the development and the influence of the third molars demonstrates several controversies because there are two distinct reasoning lines that concern the development of these teeth.

In 1989, Richardson[19] inferred that the pressure exerted in the posterior area and the presence of the third molar can constitute the cause of late crowding in the lower arch, but she explained that there are other etiological factors involved. Five years later, the same author explained that late mandibular growth, maturation of the soft tissues, periodontal forces, dental and skeletal structures, as well as, occlusal factors and growth pattern are the multifactorial essence for the alteration of the position of lower teeth [20].

The prevalence of the idea involving the influence of third molars on the position of adjacent teeth was evidenced in a study by Laskin.[15] In a research with more than 600 orthodontists and 700 dental surgeons, he concluded that 65% of the professionals shared the opinion that the third molars can produce lower anterior crowding.

MESIODISTAL ANGULATION

Orthodontic treatment objectives depend on some factors and among them is the correct mesiodistal angulation of teeth , described by Andrews in his classic article[2] published in 1972. The long axis of teeth, when correctly positioned, supply appropriate conditions to reach occlusal balance and is an important requirement for obtaining stable results generated by the treatment[9,12].

Therefore, the search for dental mesiodistal angulations similar to those of "normal" occlusion is due to the fact that this occlusion presents harmony between the stomathognathic system components[28]. In these cases, the long axis of teeth come, in agreement with it's location in the arch, with the roots distally angulated in different levels[2]. The space for each tooth varies according to these angulations, which generate tight interdental contacts, , as well as, an harmonic relationship in the anteroposterior direction[2].

Ursi's[28] 1989 research evaluated a sample of 42 young Brazilian adults with "normal" occlusion, leukoderms, with ages between 12 and 17 years. The panoramic x-ray was described as a reliable method for obtaining angular measurements and a pattern for the axial mesiodistal angulations was established.

On the other hand, considering the dynamics of the stomathognathic system , the occlusal forces should be directed towards the long axis of the teeth[25]. A portion of these forces is eliminated by the anterior component, beginning in the posterior teeth[8,11]. Complete neutralization happens exactly in the midline, with the force coming from the opposite side of the arch[11]. An appropriate dissipation of the occlusal forces depends on the dental angulations and on the inclined planes of the occlusal surfaces[8,11,21].

When the mesiodistal angulations are inadequate, there is an increased possibility of space reopening of orthodontically closed spaces, due to the incorrect root parallelism[9,12,13,25]. The increase in these angulations can, still, compensate certain dental size discrepancies between arches and optimize the alignment stability of lower anterior teeth[27].

As for the stability of tooth position obtained by orthodontic treatment and relapse, Ferrario et al.[10] explained that changes in dental angulation related to age can be an effect of a progressive mesial displacement.

The search for clinically obtaining the correct mesiodistal axial angulation involved since alterations in bracket positioning[13,22], to building in these changes in the bracket[5,22]. Researches that compared the effectiveness of techniques[4], investigations concerning the mesiodistal position of permanent upper incisors in the mixed dentition phase[6], and studies that evaluated the achievement of correct axial angulations comparing it at the beginning and at the end of treatment[17], enforce the importance of the subject.

However, this important factor involved with occlusal stability is little discussed regarding the possibility of alterations related to the presence of third molars, which was the fact that motivated the development of this research.

PROPOSITION

The purpose of this research is to compare the normal mean values of the dental mesiodistal angulation, proposed by Ursi[28], to the mesiodistal angulation of lower canines, pre-molars and molars in individuals with and without lower third molars, as well as to compare the values of the mesiodistal angulation of lower canines , pre-molars and molars in those two clinical situations.

MATERIALS AND METHODS

For this study, the sample consisted of 40 panoramic x-rays of Brazilian subjects with a mean age of 22.35 years, range 18-25, that had not received orthodontic treatment and presented all teeth, except for the 20 patients that were missing their third molars due to agenesis. The x-rays were distributed into two groups; Group I consisting of 20 x-rays with absence of the lower third molars due to agenesis (Figure 1), while Group II consisted of 20 x-rays with the presence of the lower third molars (Figure 2). Figures 1 and 2 presents panoramic radiographs of individuals from Groups I and II, respectively, and allow for visualization of both analysed conditions.

It is important to point out that all subjects presented malocclusions. In Group I, 12 exhibited Class I malocclusion (six women and six men) and eight presented Class II malocclusion (five women and three men).

Considering the five Class II women , three exhibited a Class II, division 1 malocclusion and two presented a Class II, division 2 malocclusion. On the other hand, the three Class II men exhibited Class II, division 1 malocclusion.

Additionally, in Group II, 10 subjects presented Class I malocclusion (six women and four men) and the other half had a Class II malocclusion (four women and six men).

Considering the Class II women , two exhibited Class II, division 1 malocclusion and two presented Class II, division 2 malocclusion. On the other hand, evaluating the six Class II men , four exhibited Class II, division 1 malocclusion and only two presented Class II, division 2 malocclusion.

All the x-rays were obtained in the same x-ray unit (Rotograph Plus, Del Medical Imaging Corp, USA) and by a single operator.

Radiographs were traced using: Ultraphan® acetate paper with 21.0cm in length and 14.5cm in width and thickness of 0.07mm, transparent adhesive tape, mechanical pencil with a 0.5mm lead, soft white eraser and a millimeter ruler.

During selection of x-rays for Group II, it was established that the third molars should present root development at least in the F development stage according to Demirjian et. al.[7] (root length equal to the crown length - 1:1 proportion). This stage was chosen because the tooth presents great part of it's root development and high eruption potential, apart from sample quantification and standardization for Group II.

To determine the 1:1 minimum proportion between root and crown length, first a line was drawn in the lower third molar occlusal area joining the mesial and distal cusps. Then the mesial and distal limits were established, perpendicular to the occlusal plane and the long axis of the tooth was also perpendicular to the occlusal plane, crossing the midpoint of the mesiodistal width of the crown. According to the definition of the D development stage by Demirijian et. al.[7], the crown reaches it's complete formation when the cementoenamel junction is formed. In this way, the determination of the cementoenamel junction and root limits, parallel to the occlusal plane, allowed the measurement of the crown and root lengths along the long axis (Figure 3).

The crown and root lengths were measured

FIGURE 1 - Panoramic x-ray belonging to Group I (without lower third molars).

FIGURE 2 - Panoramic x-ray belonging to Group II (with lower third molars).

directly on the x-rays, with a digimatic caliper, Mitutoyo Sul Americana Ltda, with certificate 500-143B.

A sheet of acetate paper with 21.0cm in length and 14.5cm in width and 0.07mm thickness was placed over each x-ray. The dentoalveolar and skeletal structures drawn on the x-rays, according to Tavano et al.[26], were the external mandibular contour, mental foramen and the contours of the lower canines, pre-molars and molars. Later, the central points of the right (rMF) and left mental foramen (lMF) were marked.

The intermental line (IM) was the reference used to perform the angular measurements of the lower teeth in the panoramic x-rays, which, according to Tavano et al.[26] should pass through the center of the mental foramina (Figure 4).

To determine the long axes of the single-rooted teeth (canine, first and second pre-molars), the longest image of the root canal was used, while the long axes of the double-rooted teeth (first and second molars) followed the average image of the mesial and distal root canals, according to Ursi et al.[28] (Figures 4 and 5).

The angles formed by IM and the long axis of the teeth (Figure 3) were:

$\hat{A}_{33}$ and $\hat{A}_{43}$ – angles formed by the intersection of the long axes of the lower left and right canines, respectively, with the intermental line.

$\hat{A}_{34}$ and $\hat{A}_{44}$ – angles formed by the intersection of the long axes of the lower left and right first premolars, respectively, with the intermental line.

$\hat{A}_{35}$ and $\hat{A}_{45}$ – angles formed by the intersection of the long axes of the lower left and right second premolars, respectively, with the intermental line.

$\hat{A}_{36}$ and $\hat{A}_{46}$ – angles formed by the intersection of the long axes of the lower left and right first molars, respectively, with the intermental line.

$\hat{A}_{37}$ and $\hat{A}_{47}$ – angles formed by the intersection of the long axes of the lower left and right second molars, respectively, with the intermental line

The tracings were made by the researcher and checked by two other professionals. Then the tracings were digitized with a scanner and the angles $\hat{A}_{43}$, $\hat{A}_{33}$, $\hat{A}_{44}$, $\hat{A}_{34}$, $\hat{A}_{45}$, $\hat{A}_{35}$, $\hat{A}_{46}$, $\hat{A}_{36}$, $\hat{A}_{47}$ and $\hat{A}_{37}$, formed by the intersection of the long axes of the teeth with the intermental line[13] were determined using an AutoCAD program.

Statistical analysis

The means were independently compared between the Groups, in other words, Group I x Con-

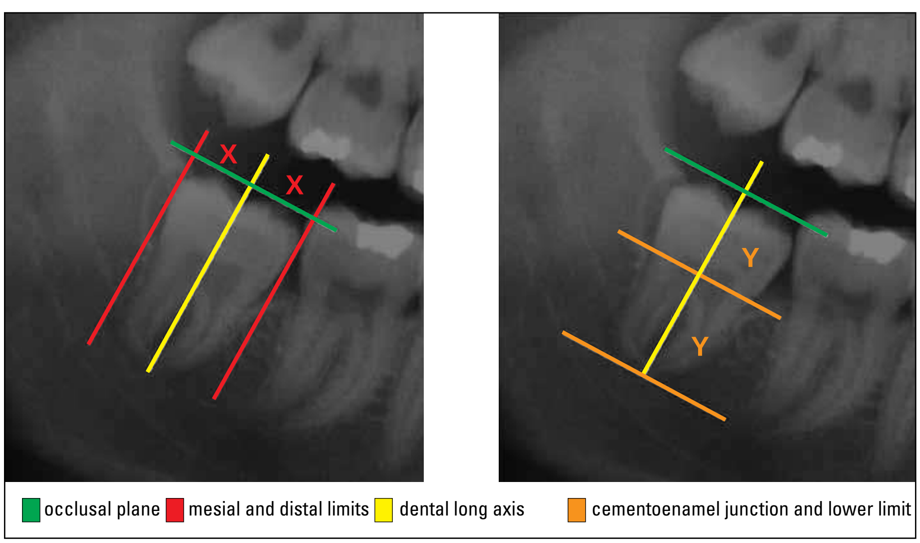


FIGURE 3 - Method used for selection of the x-rays with the presence of lower third molars (Group II).

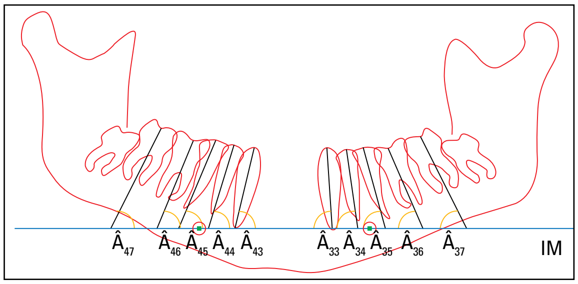


FIGURE 4 - Tracing depicting points rMF and IMF, as well as the intermental line (IM) and the dental long axes of Group II (with lower third molars).

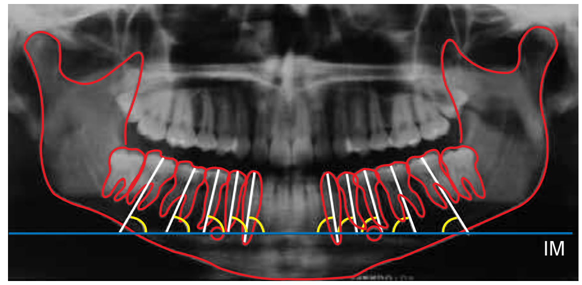


FIGURE 5 - Panoramic X-ray from Group II (with lower third molars) with a tracing that delimits dentoalveolar and skeletal structures, points rMF and IMF, the intermental line (IM), long axes of the teeth and angles formed by the intermental line and the long axes of the teeth.

trol Group, Group II x Control Group and Group I x Group II. For this comparison, the Student "t" test was used with a significance level established at 5%.

Method of error assessment

The error of the method was verified by the random selection of 10 panoramic x-rays from Group I and 10 panoramic x-rays from Group II that were drawn and measured twice by the same operator at different times. With this repetition, random and systematic errors were obtained.

The random error was determined by the Dahlberg formula: $S_e^2 = \sum d^2/2n$, while the systematic error was determined by the Student's "t" test.

RESULTS

Previously to the specific results of the research, Tables 1 and 2 demonstrate the data used to establish the possibility of a method error.

Considering the investigation of Pedrin et al.,[17] the Dahlberg values were recognized as significant when above 1.5 degrees.

The analysis of Tables 1 and 2 confirms that the results obtained with the method used in this study were shown to be within acceptable parameters, therefore, it did not compromise the reliability of our conclusions.

Tables 3 and 4 provide the mean values and standard deviations obtained for canines, pre-molars and molars in Groups I and II, respectively, while Table 5 presents the means of Groups I, II and Control Group.

Tables 6 and 7 exhibit the normal mean values of each tooth, extracted from Ursi,[28] and used in this research as the Control Group values, as well as the means of the values obtained in Groups I and II, and their p values.

Finally, Table 8 presents the angular value means for each tooth and the comparison of the values obtained for Groups I and II, as well as the p values, considering any value of $p<0.05$ as being statistically significant.

DISCUSSION

The present research was concerned in evaluating not only the angular positioning of the first and second molars, pre-molars and canines, but also in enlarging the knowledge regarding the occlusion, independent of the treatment accomplishment.

The third molars seem to exert influence on the development of the dental arches, which doesn't justify the removal of the dental germ or extraction of this tooth, unless in exceptional circumstances[3].

The possibility of the third molars to cause alterations to the other teeth and the doubt about different dental angulations involving individuals with and without lower third molars motivated

TABLE 1 - Means and standard deviations of the differences, "t" values (systematic error), p values and Dahlberg values (casual error) obtained in Group I (with lower third molars).

TOOTH	MEAN	s.d.	t	P	DAHLBERG
47	0,87	0,48	-4,02	0,99	0,98
46	1,05	0,59	-2,34	0,98	1,43
45	0,88	0,76	-2,53	0,98	1,31
44	1,13	0,39	-2,93	0,99	1,42
43	0,92	0,47	-3,83	0,99	1,05
33	1,03	0,55	-2,64	0,99	1,34
34	1,06	0,49	-2,75	0,99	1,36
35	1,03	0,60	-2,45	0,98	1,39
36	1,05	0,56	-2,52	0,98	1,38
37	0,95	0,34	-5,03	0,99	1,01

TABLE 2 - Means and standard deviations of the differences, "t" values (systematic error), p values and Dahlberg values (casual error) obtained in Group II (with lower third molars).

TOOTH	MEAN	s.d.	t	P	DAHLBERG
47	0,95	0,34	-5,03	0,99	1,01
46	0,93	0,62	-2,84	0,99	1,23
45	1,05	0,56	-2,52	0,98	1,38
44	1,06	0,49	-2,75	0,99	1,36
43	1,05	0,59	-2,34	0,98	1,43
33	1,13	0,39	-2,93	0,99	1,42
34	0,88	0,76	-2,53	0,98	1,31
35	1,03	0,60	-2,45	0,98	1,39
36	0,92	0,47	-3,83	0,99	1,05
37	0,87	0,48	-4,02	0,99	0,98

TABLE 3 - Means and standard deviations of the mesiodistal angulations of lower canines, pre-molar and molars for Group I (without lower third molars).

TOOTH	PANORÂMIC X-RAYS (n)	MEAN	s.d.
47	20	58,72	5,15
46	20	65,36	5,50
45	20	75,73	4,11
44	20	82,14	4,65
43	20	87,96	5,69
33	20	84,60	5,77
34	20	82,28	4,19
35	20	73,58	4,26
36	20	67,24	4,93
37	20	60,93	5,70

TABLE 4 - Means and standard deviations of the mesiodistal angulations of lower canines, pre-molar and molars of Group II (with lower third molars).

TOOTH	PANORÂMIC X-RAYS (n)	MEAN	s.d.
47	20	61,63	7,45
46	20	68,06	6,09
45	20	73,89	5,33
44	20	81,67	3,49
43	20	85,76	3,44
33	20	84,84	5,70
34	20	82,14	4,66
35	20	73,49	5,85
36	20	68,97	6,61
37	20	62,79	7,93

the elaboration of this investigation.

First, the values obtained in Groups I and II were compared individually with the normal mean values from Ursi[28], which were used as a Control Group.

Additionally, in accordance to the method used, smaller angular values than those shown by the Control Group represent a situation of accentuated crown angulation in mesial direction.

The results of the comparison among angular values from Groups I and Control demonstrated that there is a statistically significant difference ($p<0.05$) for pre-molars and molars (Graph 1).

In a similar way, the angular values regarding Group II, when compared to the Control Group, exhibited a statistically significant difference ($p<0.05$) for pre-molars and molars (Graph 2).

In both Groups I and II, the angles obtained

TABLE 5 - Means of the mesiodistal angulations of lower canines, pre-molars and molars of Groups I, II and Control.

TOOTH	MEAN GI	MEAN GII	MEAN CONTROL GROUP
47	58,72	61,63	74,92
46	65,36	68,06	82,64
45	75,73	73,89	88,47
44	82,14	81,67	86,42
43	87,96	85,76	88,02
33	84,60	84,84	86,11
34	82,28	82,14	85,57
35	73,58	73,49	88,69
36	67,24	68,97	85,50
37	60,93	62,79	76,92

TABLE 6 - Normal mean values (Control Group) for the mesiodistal angulations of each tooth individually, mean values obtained in Group I (without lower third molars) and p values.

TOOTH	MEAN CONTROL GROUP	MEAN GI	P
47	74,92	58,72	0,0001*
46	82,64	65,36	0,0001*
45	88,47	75,73	0,0001*
44	86,42	82,14	0,0001*
43	88,02	87,96	0,95
33	86,11	84,60	0,25
34	85,57	82,28	0,0001*
35	88,69	73,58	0,0001*
36	85,50	67,24	0,0001*
37	76,92	60,93	0,0001*

*Statistically significant difference p<0.05

TABLE 7 - Normal mean values (Control Group) for the mesiodistal angulations of each tooth individually, mean values obtained in Group II (with lower third molars) and p values.

TOOTH	MEAN CONTROL GROUP	MEAN GII	P
47	74,92	61,63	0,0001*
46	82,64	68,06	0,0001*
45	88,47	73,89	0,0001*
44	86,42	81,67	0,0001*
43	88,02	85,76	0,02
33	86,11	84,84	0,32
34	85,57	82,14	0,0001*
35	88,69	73,49	0,0001*
36	85,50	68,97	0,0001*
37	76,92	62,79	0,0001*

*Statistically significant difference p<0.05

TABLE 8 - Mean values obtained in Group I (without lower third molars), mean values obtained in the Group II (with lower third molars) and p values.

TOOTH	MEAN GI	MEAN GII	P
47	58,72	61,63	0,15
46	65,36	68,06	0,14
45	75,73	73,89	0,22
44	82,14	81,67	0,89
43	87,96	85,76	0,14
33	84,60	84,84	0,89
34	82,28	82,14	0,92
35	73,58	73,49	0,95
36	67,24	68,97	0,35
37	60,93	62,79	0,40

*Statistically significant difference p<0.05.

were smaller than those exhibited by the Control Group. It can be inferred that in Class I and Class II malocclusions that either do or do not present third molars, the pre-molars and molars present their crowns more angulated in the mesial direction then when compared to a normal occlusion.

Considering that orthodontic cases should present the same mesiodistal angulation as in normal occlusion which is a goal at the end of treatment[28], it can be affirmed that the axial mesiodistal angulation of lower pre-molars and molars should receive special attention at the end of the treatment. This is because, as the results of this research indicate, the angular values observed in malocclusions were smaller in relation to the normal occlusion.

It demonstrates that in a large part of the orthodontic treatments, the posterior teeth, premolar and molars, need a less angulated positioning. However, this alteration in the position of the posterior segment can provide an increase of the vertical dimension, in this manner, demanding a more complex evaluation of the effects that this change can cause in the individual facial pattern.

This situation is evident when Graphs 1 (Group I) and 2 (Group II) are observed.

However, when the means of the mesiodistal angulation of lower canines, pre-molars and molars in the presence (Group I) and in the absence (Group II) of lower third molars were compared (Graph 3), there were no differences between Groups.

Considering the results and the statistical analysis, it can be observed that individuals who presented malocclusion and did not receive orthodontic treatment presented lower pre-molars and molars with increased angulation in the mesial direction, independent of the presence of the lower third molars.

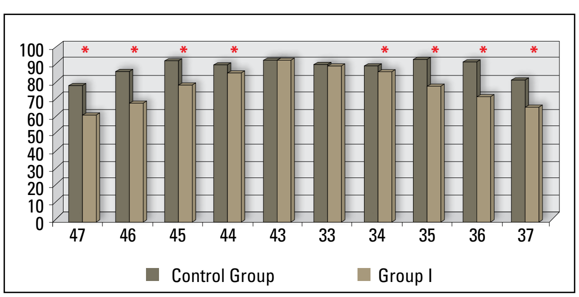
The correction of pre-molar and molar angulation during orthodontic treatment should be established as one of the requirements for the correction of malocclusions, apart from the presence of third molars.

The reduced angular values, corresponding to the accentuated mesial crown angulation found in the Groups I and II, can be related to other factors inherent to the malocclusion. These other factors include a deep curve of Spee, an influence of the anterior component of forces carried out by the functional vectors and dental wear. The evidences presented in this work demonstrate that the third molars exert little or no influence in the mesiodistal angular positioning of the lower canines, premolars and molars.

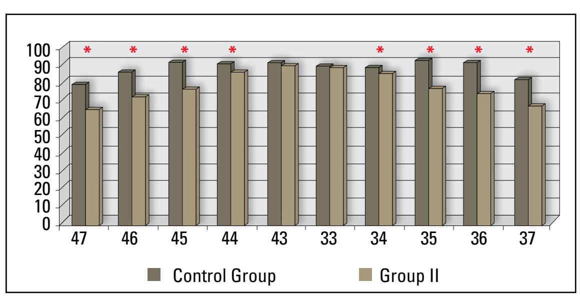
Considering the two lines of thought that involve the development of the third molars, the results of this research corroborate with the more recent theory[1,14,18,19,20,23,24,30], agreeing that third molars do not present the capability to provide all the harmful effects that the older theory suggests[3,15,16,29].

The etiology of these alterations is multifactorial and involves the dynamics of the stomathognathic system, as the anterior component of forces[30] and the presence of correct interdental contacts[16].

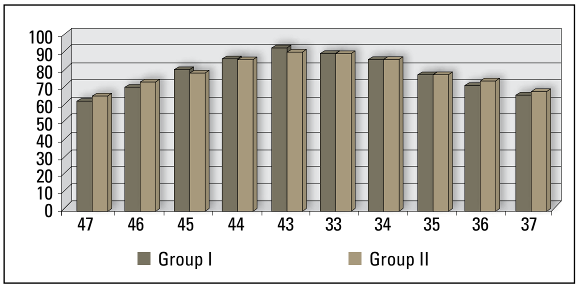
As an objective of this research, normal mean pattern of the mesiodistal angulations of lower canines, pre-molars and molars were compared to the values of these angulations in individuals that presented (Group I), as in those that did not exhibit (Group II) lower third molars. Additionally, this research compared the values of these two



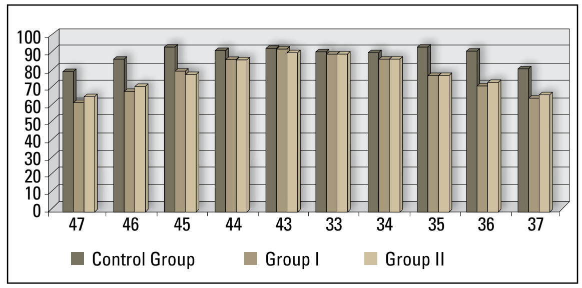
GRAPH 1 - Means of the mesiodistal angulations of Groups I and Control.
* Statistically significant difference p<0.05



GRAPH 2 - Means of the mesiodistal angulations of Groups II and Control.
* Statistically significant difference p<0.05.



GRAPH 3 - Means of the mesiodistal angulations of Groups I and II.



GRAPH 4 - Means of the mesiodistal angulations of Groups I, II and Control.

Groups between themselves. The similarity of the values between the Groups and the difference of these values in relation to the normality pattern, presented in Graph 4, endorses the previous statements.

Considering the similarity between the mesiodistal angulation of lower canines, pre-molars and molars, of subjects with and without lower third molars, the results of this study suggest that the professional does not have to worry with the presence of these teeth, because they do not constitute a factor capable to alter them.

Individuals with Class I and Class II malocclusions did not exhibit pre-molar and molar angulations similar to those with normal occlusion.[28] These teeth presented smaller values, or in other words, they exhibited crowns more angulated in the mesial direction when compared with the normality pattern.

The canines did not suffer an influence of the malocclusion from the third molars. Therefore, according to the present study, the canines present mean values similar to the normality pattern.

CONCLUSIONS

Groups I and II, with and without lower third molars, composed of individuals that had never received orthodontic treatment and presented malocclusion, when compared to a Control Group of normal occlusion, showed:

- Lower pre-molars and molars more angulated in the mesial direction.

- Lower canine teeth with similar mesiodistal angulations.

The two appraised Groups presented similar values of mesiodistal angulations for the lower canines, pre-molars and molars so that:

- The presence of the third molars did not exert an influence on these dental angulations.

- The largest mesiodistal angulation of lower pre-molars and molars of both Groups suggests that this is a characteristic related to the factors inherent to malocclusion with very little involvement of the third molars.

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