http://dx.doi.org/10.1590/1981-86372016000100053005

Retrospective study on the angle of the upper permanent second molars in schoolchildren with normal occlusion[1]

Estudo retrospectivo da angulação dos segundos molares superiores permanentes em escolares com oclusão normal

Rodrigo RABELO[2]
Roberta Tarkany BASTING[3]

ABSTRACT

Objective
The aims of this study were to evaluate the angle of permanent second molars in schoolchildren with a normal occlusion, using panoramic radiographs and plaster models, and to evaluate the correlation between measurements obtained by these two methods.

Methods
Thirty Brazilian schoolchildren with a mean age of 14 years and 7 months were selected. These individuals had not previously undergone orthodontic interventions, required a minimum of four of Andrews' six keys of occlusion, with the first key (interarch relation) being mandatory, and significant facial asymmetry was absent. Angulation of the maxillary second molars was measured using panoramic radiographs and plaster models.

Results
The mean angulation, according to panoramic radiography, was 105.8º in the distal direction (standard deviation of 5.1º). The plaster models revealed a mean angulation of -5.8º, indicating a distal angulation of the crown. Pearsons' correlation test demonstrated a negative and weak relationship (p = 0.009; r2 = - 0.474), with a greater angle in the panoramic radiographs and a smaller angle in plaster models. This was considered an inverse proportional relationship.

Conclusion
Measurements of the panoramic radiographs showed an angulation of 105.8º in the distal direction, while the plaster models revealed an angulation of -5.8º. Therefore, one should consider these angulations in order to personalize the placement of accessories on the upper permanent second molars. Correlation of this angulation using these two methods was negative; however, due to the weak correlation, both methods are needed when evaluating the angle of the upper second molar.

Indexing terms: *Dental occlusion. Panoramic Radiography. Planning.*

RESUMO

Objetivo
Avaliar a angulação dos segundos molares superiores permanentes em escolares com oclusão normal, utilizando radiografias panorâmicas e modelos de gesso, e avaliar a correlação entre as medidas obtidas pelos dois métodos.

Métodos
Trinta escolares brasileiros com média de idade de 14 anos e 7 meses foram selecionados. Os escolares não tinham sido submetidos ao tratamento ortodôntico prévio, deveriam apresentar no mínimo quarto das seis chaves de oclusão de Andrews, com a primeira chave (relação interarco) sendo mandatória, e ausência de significativa assimetria. A angulação dos segundos molares superiors foi mensurada usando radiografia panorâmica e modelos de gesso.

Resultados
A media de angulação, de acordo com a radiografia panorâmica, foi de 105,8º com direção distal (desvio padrão de 5,1º). Os modelos de gesso apresentaram média de angulação dos segundos molares de -5,8º, indicando angulação distal da coroa. O teste de correlação de Pearson demonstrou relação negative e fraca (p = 0,009; r2 = - 0,474), com maior angulação nas radiografias panorâmicas e menor angulação nos modelos de gesso, sendo esta correlação considerada inversamente proporcional.

Conclusão
As medidas nas radiografias panorâmicas mostraram angulação de 105,8º em direção distal, enquanto que os modelos de gesso revelaram angulação média de -5,8º. Assim, deve-se considerar essas angulações para individualizar a angulação de colagem de acessórios ortodônticos em segundos molares superiores permanentes. A correlação da angulação obtida entre os dois métodos foi negativa; entretanto, devido à fraca correlação, ambos os métodos devem ser empregados para se avaliar a angulação dos segundos molares superiores.

Termos de indexação: Oclusão dentária. Radiografia Panorâmica. Planejamento.

[1] Article based on a Master of Science dissertation: Retrospective study on the angle of the upper permanent second molars in schoolchildren with normal occlusion. São Leopoldo Mandic Research Center, 2014. 70 p.

[2] Faculdade São Leopoldo Mandic, Curso de Odontologia, Departamento de Ortodontia. Campinas, SP, Brasil.

[3] Faculdade São Leopoldo Mandic, Curso de Odontologia, Departamento de Odontologia Restauradora e Materiais Dentários. Rua José Rocha Junqueira, 13, Swift, 13045-755, Campinas, SP, Brasil. Correspondência para / *Correspondence to*: RT BASTING. *E-mail*: <rbasting@yahoo.com>.

INTRODUCTION

The upper second molars are the last permanent teeth of the upper arch to erupt, following a posterior eruption route at a negative angle that may progressively become less negative, possibly positive, as the occlusion matures. This may be influenced by many factors including space, facial biotype, inclination of the occlusal plane, anatomy and treatment strategies[1-2].

In the vast majority of cases, the second molars receive little attention on the part of the orthodontist[3-4], which can be verified by the lack of studies on this theme in the literature, particularly in terms of angulation. Historically, it was Andrews[5] who evaluated more than 100 individuals with a natural and seemingly perfect occlusion, with regards to angle, inclination, prominence, width and length of each tooth crown. Over recent years, this study has continually been revised, updated and applied to several ethnic groups, and has been used in order to create and evaluate an ideal orthodontic bracket prescription[6-9].

Over the years, the original prescription proposed by Andrews has been changed, with the development of new prescriptions aimed at creating more natural, faster, safer and better cost benefit results[6-7]. However, in order to develop a prescription that can position the teeth closer to the normal natural, studies are needed on the position and angle that are deemed normal[3-4].

Some techniques that are widely used in orthodontics favor an angle of 0º for the upper permanent second molars[6-7]. Andrews[8], in his different prescriptions, favored 5.0º, at a minimum, average and maximum translation of 3.0º, 2.0º and 1.0º, respectively. However, when banding teeth and placing an accessory at a 0º angle with borders perfectly adapted to the marginal ridges and parallel to the buccal cusps, this would result in an angle of 5º to the tooth[9]. Although, routinely, the first and second molars at primed at a positive angle of 5º, a tendency towards mesialization of these teeth has been confirmed, which emphasizes the importance of reducing the angle of these teeth due to the additional natural affinity of mesialization with maturation of the occlusion[1].

Therefore, the aim of this study was to evaluate the angulation deemed satisfactory and normal in a population group with a normal occlusion, using plaster models and panoramic radiographs, evaluating the correlation between the two methods, ultimately permitting individualization of accessory bonding. Thus, the aim of this study was to assess the angle of the upper permanent second molars in 30 Brazilian schoolchildren with a normal occlusion, using panoramic radiographs and plaster models, as well as to evaluate the correlation between the measurements obtained by both methods.

METHODS

This research project was approved by the Research Ethics Committee of the local institution, according to resolution 196/1996 of the Ministry of Health (CNS), under protocol number 2009/0311.

Sample selection

A retrospective study was performed using a convenient sample from the local institution. In order to obtain the sample, 660 individuals residing in the municipality of Campinas (SP) had their patient records assessed with the aim of selecting those who adhered to the inclusion criteria of a normal occlusion: presenting permanent dentition; never having been submitted to any type of orthodontic and/or orthopedic facial treatments; with a static occlusion, with a minimum of four of the six keys of occlusion as defined by Andrews[5], with the presence of an interarch relationship (the first key of Andrews) being compulsory for all cases.

The final sample size used to perform this study was composed of 30 Brazilian individuals, 12 males and 18 females. The average age in the sample was 14 years and 7 months, with a standard deviation of 1 year and 8 months, ranging between 11 years and 3 months and 17 years and 1 month.

Panoramic radiographs and measuring the angle of the upper second molars

For each of the 30 individuals selected, one panoramic radiograph was taken for tracing. The individuals were placed with their occlusal plane parallel and the medial sagittal plane perpendicular, both in relation to the ground, with occlusion of the teeth prevented via a tongue depressor placed between the anterior teeth.

The method previously described by Tavano et al.[10] was used to obtain the tracings of the skeletal-dental structures. The tracings were performed using a light-box, in a low-light environment, aided by black paper shades to help visualize the anatomic structures. A single trained researcher perfomed the traces. In order to obtain the highest confidence in the values observed, the angle of the upper right and left second molars was measured

in panoramic radiographs at two moments, with a time interval of 30 days between measurements.

The following anatomical structures were traced: the inferior outline of the orbits and the external contour of the permanent second molars. The following points were also highlighted: the most inferior point of the orbital cavity of the right (ROr) and left (LOr) orbit. The demarcated reference lines were: the interorbital line (IO), which passes through the ROr and LOr; the long axis of the upper permanent second molars, which was determined via the image of the canal of the palatine root. After linear demarcation, the angles formed by the superior and inferior reference lines, as well as that formed by the long axis of the upper permanent second molars (Figure 1) were measured with a protractor in each radiograph, and the values were recorded.

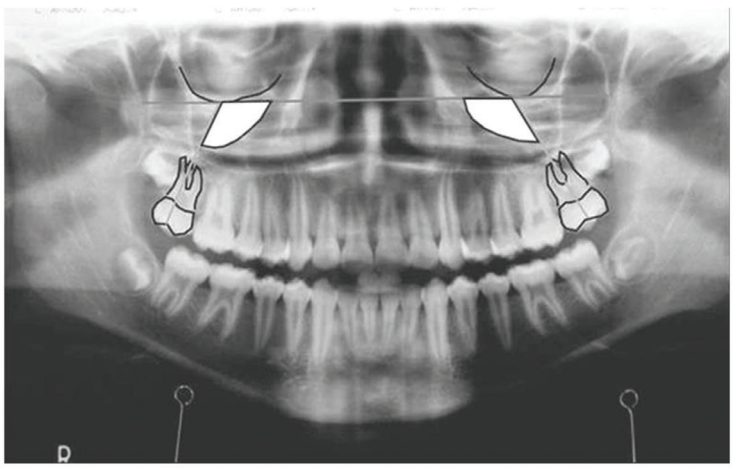

Figure 1. Measures of the angles formed by the intersection of the reference lines after highlighting the points most inferior point of the orbital cavity of the right (ROr) and left (LOr) orbit.

Measurements of the angle of the upper second molars in plaster models

The plaster models of the 30 participants were used to measure the angle of the upper second molars. The method previously described by Andrews5, in which the angle of the crown of the upper second molar is calculated by the angle formed between the central sulcus and a line perpendicular to the occlusal plane, was used. In order to measure this angle, an acrylic sheet was made for each plaster model, to represent the occlusal plane. This acrylic sheet was approximately 2 mm thick with a relief in the canine region, as they are the longest teeth in the dental arch (Figure 2). A protractor with a fixed arm parallel to the acrylic sheet, representing the occlusal plane (Figure 3A) and a movable arm parallel to the buccal axis of the clinical crown (Figure 3B) was positioned over the acrylic sheet. When the movable arm of the protractor reached 90°, an angle of 0° to the second molar was obtained; and if the movable arm marked to the mesial aspect of the protractor, a positive value was recorded, starting from 90° (0°). If the movable arm moved distally, a distal angulation of the crown was suggested and the value was considered negative. The values were then recorded.

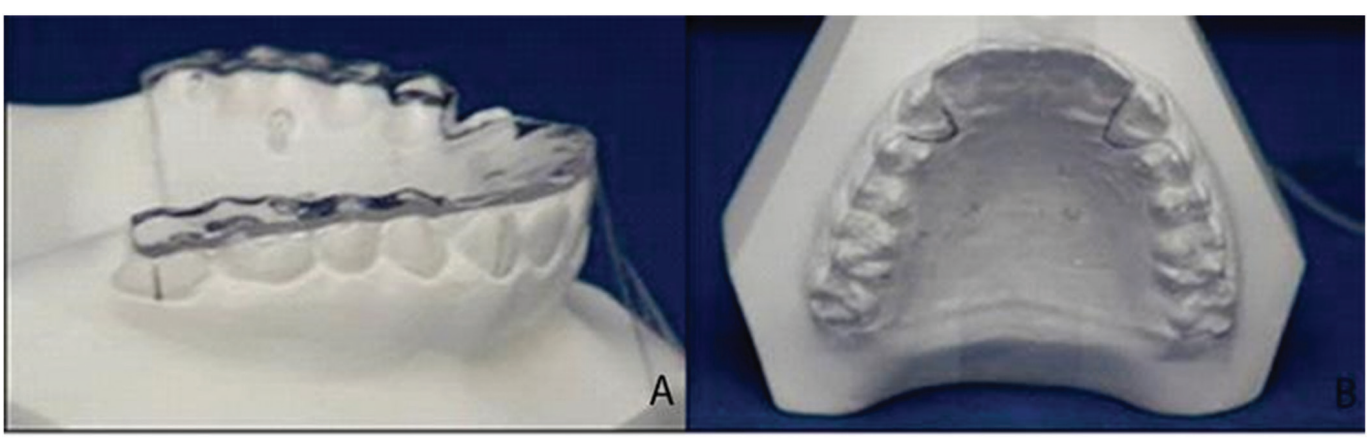

Figure 2. 2.0 mm thick acrylic sheet with relief in the canine regions. A) Lateral View; B) Occlusal View.

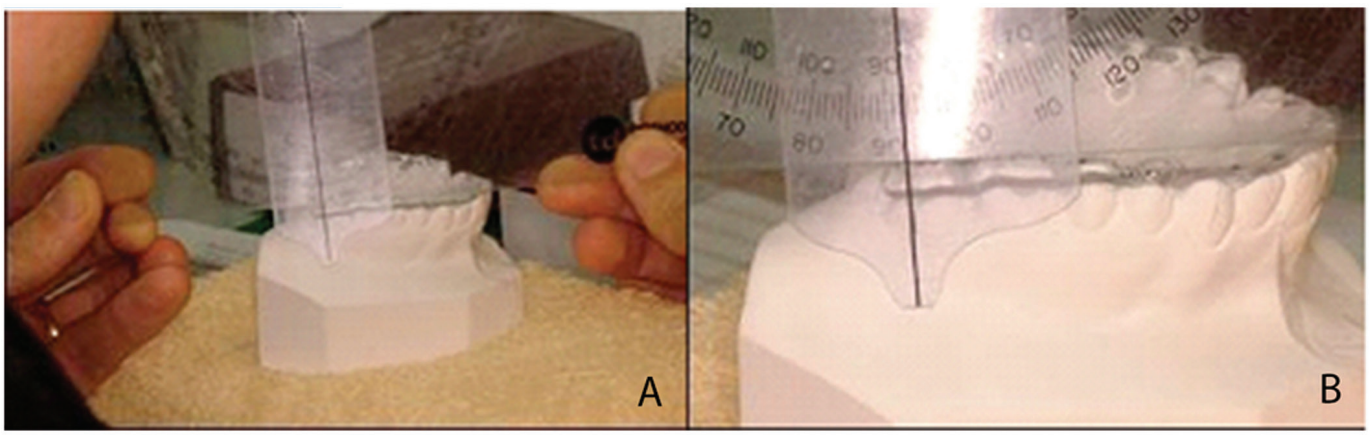

Figure 3. Positioning of the protractor to obtain the angle of the upper second molars in plaster models. A) Positioning of the base of the protractor over the acrylic sheet; B) Movable arm parallel to the vestibular axis of the clinical crown / Measure of the angle of the second molar in plaster model.

As with the panoramic radiographs, the angle of the left and right upper second molars was measured in the plaster models at two distinct moments, with a time of interval of 30 days between measurements.

Statistical analysis

The means of the angles of the left and right sides taken at the first and second moments of evaluation for the panoramic radiographs and the plaster models were obtained. The mean value obtained for the angles between these two moments was then evaluated. Pearson's test was used to evaluate the correlation between the measures obtained from both the panoramic radiographs and plaster models, at the first and second moments of evaluation. The significance level adopted was 5%, with statistical calculations performed on the IBM SPSS Statistics program, version 20.0.

RESULTS

Table 1 presents the mean and standard deviation of the angle of the upper second molars, according to the panoramic radiographs and plaster models, performed by the same researcher at two distinct time intervals, 30 days apart.

Table 1. Mean and standard deviation of the angulation values of the upper second molars obtained by the same observer at two distinct moments with a time interval of 30 days using panoramic radiographs and plaster models.

Analysis	Mean	Standard Deviation
Panoramic Radiograph	105.80	5.10
Plaster Model	-5.8º	5.85º

A significant correlation was observed between the angle on panoramic radiographs and the plaster models at the first moment of analysis ($p = 0.009$; $r^2 = - 0.474$), with the correlation being negative and weak. At the second moment of analysis, a significant correlation was also demonstrated for the angulation values between the panoramic radiographs and plaster models, also considered as negative and weak ($p = 0.027$; $r^2 = - 0.410$) (Figure 4).

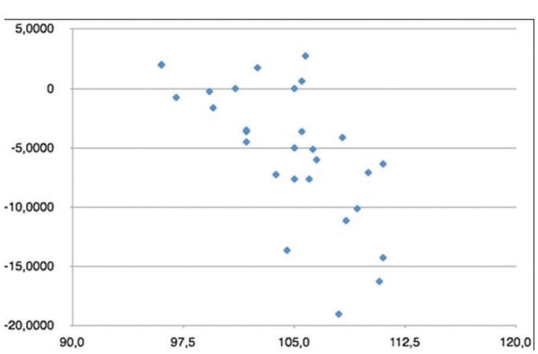

Figure 4. Scatter plot revealing the correlation between the angles of the upper second molars by panoramic radiography and in plaster models. Each of the dots represents a patient in the sample. The vertical axis (X) represents the mean incline obtained from the plaster models. The horizontal axis (Y) represents the mean incline obtained from the panoramic radiographs.

DISCUSSION

During orthodontic movements, the teeth need to resist the tension that this movement can generate,

which may include the intentional distal angulation of the second molars, being that a tooth angled distally is more resistance to anterior dislocation. If the tooth were to be angled mesially, logically there would be less resistance to anterior dislocation. This situation would be worse still should the second molar naturally present a distal angulation, and during treatment, being primed into a mesial angle. This could considerably interfere with the correction of malocclusion, allowing, hypothetically, the creation or worsening of a class II malocclusion with loss of anchorage. Therefore, in general, orthodontists have believed that the correct angle of the second molar is in the value found in bracket prescriptions, being 0º, yet after banding, it would have a final angle of 5º to 6.8º.

Holdaway[11] recommended a distal angulation of the maxillary molars for anchorage against traction of the anterior teeth. While Alexander[6] recommended the Gable effect after the omega, i.e., giving a distal angulation to the second molars, Capelozza Filho et al.[12] suggested that the second molar be bonded rather than banded in order to imprint a distal angulation to the crown, based on individual analyses to meet the goals of treatment and obtain the best magnitude of this angle.

Panoramic radiography is a valuable tool in the diagnosis, planning and follow-up of orthodontic treatment[13], and to date, has been used for this purpose. One should consider that errors in patient positioning when taking the radiograph could alter the angles seen, especially in the upper and lower molars[14], as well as the natural incline of the occlusal plane of the patient, where the greater the incline of the occlusal plane, the greater the angle of the second molars.

In order to evaluate the angle of the second molar, the method described by Tavano et al.[10] was used, which states that the plane traced between the two orbital points (right and left) was the most stable to measure the angle of the upper teeth in panoramic radiographs. It is well understood that this axis can present a slightly more negative angle than the axis traced between the bifurcation of the roots; however, demarcation of this axis allows a better comparison with other studies[5,15-16].

In the present study, the mean angle observed was 105.8º, with this value being close to that reported by Capeloza Filho & Machado[17] (mean of 115º). Capeloza Filho & Machado[17] observed that the patients analyzed had been previously submitted to orthodontic treatment, yet their second molars were not included in the mechanical apparatus and, therefore, probably influenced by the mechanics of the treatment of a Class II malocclusion, possibly exaggerating the distal angle of the second molars.

In order to establish a comparison of the measures obtained with the two-dimensional radiograph, the angulation of the second molars was assessed using plaster models, following the technique described by Andrews[5]. The present study revealed a mean angle of -5.8º, which is considerably lower than that found by Andrews[5] (0.39º). The results obtained also differed from those by Currim & Wadkar16 and Watanabe & Koga[15], who reported means of 3º and 4º, respectively. The values found in the present study are similar to those observed by Tong et al.[4] with an upper second molar angle of -6.33º. Such disparity in the values is probably explained by the fact that the second molar presents a distal eruption trajectory, which, as the occlusion matures, a progressive decrease in the distal angulation of the crown may occur[2]. Other factors that may explain these differences are the association with age group, which in the present study showed a mean age of 14.6 years, while Andrews[5] and Currim & Wadkar16 used a population with a mean age of 16 and 18.7 years, respectively. Tong et al.[4] also used a different age range (12 to 36 years), with a mean age of 21.6 years. Therefore, one may conclude that despite the higher age, there was not, in most cases, such a condition where the second molar could follow its natural course, which would lead to an increase in the angle that occurs during maturation of the occlusion.

The correlation between the measures obtained from the plaster models and the panoramic radiographs was negative, where the more distal the tooth was in the radiograph, the more positive the value was, while in the plaster models, the more distal, the more negative the value was, an inversely proportional relationship. Because of a weak correlation, both methods should be used together, where one must not substitute the other during treatment planning. Although a more precise measure would involve the use of an acrylic sheet to analyze the plaster models, in clinical practice, a simple visualization of the second molars, imagining a line that would become the orthodontic wire on the Straight Wire appliance could, with great certainty, provide a vision of the movement that would occur with this tooth, should the accessory be positioned in the traditional way (with the vertical axis parallel to the vestibular axis of the clinical crown). Generally, one perceives a more distalized second molar, mainly in younger patients or adults with some element of malocclusion. At this point, it could be considered that

even with a dentition deemed perfect, one would find a more distal second molar, generally -6.0º; therefore, when considering the use of a band, when positioning the accessory with a 0º angle, the second molar could produce an angle of 6.0º. In other words, to produce an angle of -6.0º in a second molar with a band, an angle of -12.0º would be necessary for the accessory. The best way to do this would be indirect bonding, where with the models to hand and a perfect visualization of the Straight Wire arch line, one could consider the mechanics to be employed in terms of the necessity of a distal anchorage and use a greater or lesser angle to the second molar. Once orthodontic treatment is finished, with the canines, premolars and first molars occluding perfectly against the opposite arch, one would expect that the second molar tooth reaches occlusal maturity, improving occlusal interlocking and, most likely having a less distal angle.

CONCLUSION

According to the results from this study, one may conclude that in panoramic radiographs a mean distal angle of 105.8º was observed, while with the plaster models the angle found was -5.8º. These angles may be considered when bonding accessories to the permanent upper second molars. The correlation of the angles between both methods used was negative; however, the fact that the correlation was weak deems it necessary to use both methods when evaluating the angle of the upper second molars.

Collaborators

R RABELLO and RT BASTING participated in all stages of the product development process.

REFERENCES

1. Dewel BF. Clinical observations on the axial inclination of teeth. Am J Orthod. 1949; 35(2):98-115.
2. Madeira MC, Oliveira JA. Anatomia do dente. 7ª ed. São Paulo: Sarvier; 2014.
3. Tong H, Enciso H, Elslande DV, Major PW, Sameshima GT. A new method to measure mesiodistal angulation and faciolingual inclination of each whole tooth with volumetric cone-beam computed tomography images. Am J Orthod Dentofacial Orhop. 2012;142(1):133-43. doi: 10.1016/j.ajodo.2011.12.027
4. Tong H, Kwon D, Shi J, Sakai N, Enciso R, Sameshima GT. Mesiodistal angulation and faciolingual inclination of each whole tooth in 3-dimensional space in patients with near-normal occlusion. Am J Orthod Dentofacial Orthop. 2012;141(5):604-17. doi: 10.1016/j.ajodo.2011.12.018
5. Andrews LF. The six keys to normal occlusion. Am J Orthod. 1972;62(3):296-309.
6. Alexander RG. The vari-simplex discipline part 1: concept and appliance design. J Clin Orthod. 1983;17(6): 380-92.
7. Roth RH. The straight-wire appliance 17 years later. J Clin Orthod. 1987; 21(9):632-42.
8. Andrews LF. Straight Wire: The concept and Appliance. San Diego: LA Wells; 1989.
9. McLaughlin RP, Bennett JC. The transition from standard edgewise to preadjusted appliance systems. J Clin Orthod. 1989;23(3):142-53.
10. Tavano O, Ursi WJS, Almeida RR, Henrriques JFC. Determinação de linhas de referência para medições anglares em radiografias ortopantomográficas. Odontol Mod. 1989;16(9):22-5.
11. Holdaway RA. Bracket angulation as applied to the edgewise appliance. Angle Orthod. 1952;22(4):227-36.
12. Capelozza Filho L, Silva Filho OG, Ozawa TO, Cavassan AO. Individualização de braquetes na técnica de straight-wire: revisão de conceitos e sugestões da indicação para o uso. Rev Dent Press Ortodon Ortopedi Maxilar. 1999;4(4):87-106.
13. Catić A, Celebić A, Valentić-Peruzović M, Catović A, Jerolimov V, Muretić I. Evaluation of the precision of dimension measurements of the mandible on panoramic radiographs. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1998;86(2):242-8. doi: 10.1034/j.1600-0501.1996.070408.x
14. Hardy TC, Sury L, Stark P. Influence of patient head positioning on measured axial tooth inclination in panoramic radiography. J Orthod. 2009;36(2):103-10. doi: 10.1179/14653120723013
15. Watanabe K, Koga M. A morphometric study with setup models for bracket design. Angle Orthod. 2001;71(6):499-511.
16. Currim S, Wadkar PV. Objective assessment of oclusal and coronal characteristics of untreated normals: a measurement study. Am J Orthod Dentofacial Orthop. 2004;125(5):582-8. doi: 10.1016/j.ajodo.2003.06.008
17. Capelozza Filho L, Machado GB. Inclinação axial mésio distal do primeiro molar superior na ortopantomografia: sugestão de modificação do método de avaliação. Rev Soc Bras Ortodont. 1994;2(5):142-4.

Received on: 25/6/2015
Final version resubmitted on: 3/8/2015
Approved on: 10/9/2016