UNIVERSIDADE DE SÃO PAULO
FACULDADE DE ODONTOLOGIA DE BAURU

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Effects of Class II elastics in the treatment of Class II malocclusion

Alterações dentoalveolares e esqueléticas consequentes ao uso de elásticos para tratamento da má-oclusão de Classe II

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Dissertação constituída por artigo apresentada à Faculdade de Odontologia de Bauru da Universidade de São Paulo para obtenção do título de Mestre em Ciências no Programa de Ciências Odontológicas Aplicadas, na área de concentração Ortodontia.

Orientador: Prof. Dr.Guilherme Janson

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“A mente que abre a uma nova ideia

jamais voltará ao seu tamanho original.”

Oliver Wendell Holmes Sr.

RESUMO

Introdução: O objetivo deste trabalho foi comparar as alterações resultantes do tratamento da má-oclusão de Classe II com o uso de elásticos intermaxilares de Classe II com as alterações resultantes do tratamento do mesmo tipo de má-oclusão com o uso do aparelho fixo associado ao aparelho extrabucal. **Métodos**: Uma amostra composta de 53 pacientes com má-oclusão de Classe II foi dividida em dois grupos. O Grupo Elástico (GE) foi composto por 26 pacientes tratados com aparelho fixo associado aos elásticos de Classe II. O Grupo Controle (GC) foi composto por 27 pacientes tratados com aparelho fixo associado ao aparelho extrabucal. Os grupos foram compatibilizados de acordo com a idade inicial, o tempo de tratamento, a severidade da má-oclusão de Classe II inicial e a distribuição por sexos. Telerradiografias laterais iniciais e finais do tratamento foram avaliadas. O teste t foi utilizado para comparar a condição inicial e as alterações do tratamento dos grupos. **Resultados:** Ocorreu uma rotação horária do plano oclusal no GE. Os incisivos superiores apresentaram uma maior inclinação palatina e maior retrusão, e os incisivos inferiores mostraram uma menor extrusão no GE que no GC. **Conclusão:** Apesar das pequenas diferenças nos efeitos dos tratamentos, eles não podem ser geralmente considerados como clinicamente desfavoráveis em todas as situações.

Palavras-chave: Má-oclusão de Classe II de Angle. Elásticos intermaxilares. Plano oclusal.

ABSTRACT

Effects of Class II elastics in the treatment of Class II malocclusion

Introduction: The objective of this study was to compare the effects of Class II malocclusion correction with Class II elastics with those produced by Class II malocclusion correction with extraoral headgear associated with multibracket appliances. **Methods:** A sample of 53 patients with Class II malocclusion was divided into two groups. The elastic group (EG) consisted of 26 patients who were treated with fixed appliances associated with Class II elastics. The control group (CG), consisted of 27 patients treated with fixed appliances and extraoral headgear. The groups were matched regarding initial age, treatment time, initial severity of Class II molar relationship and sex distribution. Pre- and posttreatment lateral cephalometric radiographs were evaluated. T tests were performed to compare the initial status and the treatment changes of the groups. **Results:** There was occlusal plane clockwise rotation in the EG. The maxillary incisors presented greater palatal tipping and retrusion and the mandibular incisor experienced smaller extrusion in the elastic than in the control group. **Conclusion:** Despite these small differences in treatment effects, they cannot be considered generally clinically unfavorable in every situation.

Key words: Angle Class II malocclusion. Intermaxillary elastics. Occlusal plane.

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LIST OF ABBREVIATIONS AND ACRONYMS

A	Point A - subspinale
ANS	Anterior nasal spine
Ar	Articulare
B	Point B - supramentale
CG	Control group
Co	Condylion
EG	Elastic group
Gn	Gnathion
Go	Gonion
LL	Lower lip
L1apex	Lower incisor root apex
L1tip	Lower incisor tip
L6ds	Lower first molar distal surface
L6ms	Lower first molar mesial surface
L6occ	Lower first molar occlusal surface
Me	Menton
N	Nasion
Or	Orbitale
PNS	Posterior nasal spine
Po	Anatomical porion
Pog	Pogonion
Pog’	Soft tissue pogonion
Prn	Pronasale
S	Sella
Sn	Subnasale
UL	Upper Lip
U1apex	Upper incisor root apex
U1tip	Upper incisor tip
U6ds	Upper first molar distal surface
U6ms	Upper first molar mesial surface
U6occ	Upper first molar occlusal surface

SUMMARY

1 INTRODUCTION

1 INTRODUCTION

Class II malocclusion presents a variety of treatment protocols and it is therefore a controversial subject in contemporary orthodontics. In order to choose the protocol to be used, the malocclusion severity and the degree of patient compliance must be taken into account.(SALZMANN, 1966; JANSON et al., 2010; VEEROO et al., 2014)

The mostly used treatment protocols for this type of malocclusion are the extraoral headgear, functional appliances, Class II intermaxillary elastics associated with fixed appliance, intraoral distalization, extractions and orthognathic surgery.(TADIC; WOODS, 2007; JANSON et al., 2012; GREC et al., 2013; JANSON et al., 2013; CASSIDY et al., 2014; HENRIQUES et al., 2015; ZYMPERDIKAS et al., 2015)

Some approaches can be performed with a combination of the protocols mentioned above, such as the use of Class II intermaxillary elastics associated with fixed appliances and the headgear to assist maintenance of posterior anchorage(FIDLER et al., 1995; WEHRBEIN; FEIFEL; DIEDRICH, 1999; UZEL; UZEL; TOROGLU, 2007; BACCETTI; FRANCHI; KIM, 2009; BACCETTI; FRANCHI; STAHL, 2009) or the use of functional appliance associated with intermaxillary elastics.(HERRERA et al., 2011)

The use of intermaxillary elastics associated with fixed appliances is a widespread Class II malocclusion treatment protocol in Orthodontics.(JANSON et al., 2006) These elastics are easy to install and efficient to correct the Class II anteroposterior molar relationship.(NELSON; HANSEN; HÄGG, 1999; JANSON et al., 2004; UZEL; UZEL; TOROGLU, 2007)

Orthodontic Elastics

The first reports of the use of elastics in orthodontic practice dates from the end of the 19th century.(ASBELL, 1990b) Elastics were introduced in orthodontics in 1879 when Kingsley applied the headgear force directly on the anterior teeth, thus introducing orthodontic occipital anchorage treatment.(ASBELL, 1990b; WAHL,

2005) In 1893, Calvin Case described the use of intermaxillary force using elastics between the upper and lower jaws.(ASBELL, 1990b; WAHL, 2005) Henry E. Baker (1893) was the first author to really define the use of elastics by introducing the first treatment with intermaxillary elastics, known as "Baker Anchorage", which was interpreted at the time by some orthodontic practitioners as the end of the need for extraction.(ASBELL, 1990a)

The orthodontic elastics main characteristic is their versatility and creativity in their application, requiring proper planning by the professional on the disposition of the elastics, taking into account aspects such as anchorage control, the force application points, the quantity of used force, the type of elastic to be used, the goals to be reached and patient compliance.(EGOLF; BEGOLE; UPSHAW, 1990; ARAS; CINSAR; BULUT, 2001; OESTERLE et al., 2012)

Class II intermaxillary elastics

Class II elastics are auxiliary forces that can be classified as active elements and can be used in the correction of Class II malocclusions since the beginning of treatment.(UZEL; UZEL; TOROGLU, 2007) These elastics are effective in correcting Class II malocclusions and their effects are primarily dentoalveolar.(NELSON; HANSEN; HÄGG, 1999, 2000; UZEL; UZEL; TOROGLU, 2007) Molar relationship correction occurs primarily as a result of skeletal and dental changes. (NELSON; HANSEN; HÄGG, 1999; JANSON et al., 2013)

A few studies have been performed concerning the elastic effects, but without comparing with another group.(NELSON; HANSEN; HÄGG, 1999; REDDY et al., 2000) Thus, it is not possible to know if the found changes were caused by the treatment with Class II elastics or by natural growth.

Some comparative studies have been performed to assess the effectiveness of the treatment with intermaxillary elastics and other fixed functional appliances used for correction of Class II malocclusion.(NELSON; HANSEN; HÄGG, 2000; NELSON et al., 2007; JONES et al., 2008) In a comparison between the treatment with Class II elastics and with Herbst appliance(NELSON; HANSEN; HÄGG, 2000; NELSON et al., 2007) the authors found an increased lower anterior facial height, an overbite decrease and an increased mandibular plane angle in the Class II elastic

group.(NELSON; HANSEN; HÄGG, 2000) However, in a follow-up study of these same groups, the authors noticed that the only variable that were not reversed during the follow-up period were the lower anterior facial height.(NELSON et al., 2007) When comparing the non-extraction treatment with Class II elastics and the Forsus appliance, no statistically significant differences between treatments were found.(JONES et al., 2008)

A study that compared the skeletal results of the Light wire appliance with Class II elastic, Edgewise technique with extraoral headgear and Fränkel appliance, found no statistical difference between the treatments.(GIANELLY; ARENA; BERNSTEIN, 1984) Another study was performed comparing two types of treatment associated with elastics and the author did not find statistical difference between the groups.(UZEL; UZEL; TOROGLU, 2007).

Despite its proven effectiveness in correction of the Class II anteroposterior relationship, there are some reports of undesirable effects from the use of elastics, attributed to the vertical vectors of elastic forces.(RA, 1959; REDDY et al., 2000; COMBRINK et al., 2006; UZEL; UZEL; TOROGLU, 2007)

It is speculated that the use of Class II elastics can cause extrusion of the mandibular molars with consequent clockwise rotation of the mandibular plane, in addition to side effects like loss of mandibular anchorage, proclination of the mandibular incisors, maxillary incisor extrusion and increase of maxillary gingival display upon smiling.(STEWART; CHACONAS; CAPUTO, 1978; DYER; HARRIS; VADEN, 1991; NELSON; HANSEN; HÄGG, 1999)

Moreover, a recent systematic review showed that Class II elastics are effective for Class II malocclusion correction and its long term effects are similar to fixed functional appliances.(JANSON et al., 2013)

Due to the controversy regarding the effects of Class II elastics in Class II malocclusion correction, the objective of this study was to evaluate its effects in comparison to Class II malocclusion treatment performed without its use.

2 ARTICLE

2 ARTICLE

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EFFECTS OF CLASS II ELASTICS IN THE TREATMENT OF CLASS II MALOCCLUSION

Abstract

Introduction: The objective of this study was to compare the effects of Class II malocclusion correction with Class II elastics with those produced by Class II malocclusion correction with extraoral headgear associated with multibracket appliances. **Methods:** A sample of 53 patients with Class II malocclusion was divided into two groups. The elastic group (EG) consisted of 26 patients who were treated with fixed appliances associated with Class II elastics. The control group (CG) consisted of 27 patients treated with fixed appliances and extraoral headgear. The groups were matched regarding initial age, treatment time, initial severity of Class II molar relationship and sex distribution. Pre- and posttreatment lateral cephalometric radiographs were evaluated. T tests were performed to compare the initial status and the treatment changes of the groups. **Results:** There was occlusal plane clockwise rotation in the EG. The maxillary incisors presented greater palatal tipping and retrusion and the mandibular incisor experienced smaller extrusion in the elastic than in the control group. **Conclusion:** Despite these small differences in treatment effects, they cannot be considered generally clinically unfavorable in every situation.

Key words: Angle Class II malocclusion. Intermaxillary elastics. Occlusal plane.

INTRODUCTION

The use of Class II elastics is somewhat controversial in Orthodontics. At the beginning of modern Orthodontics, Class II and Class III malocclusions were approached with extraoral headgears.[1]. After development of Class II and Class III elastics, in 1892, which are more comfortable for the patients, the use of extraoral headgear for Class II malocclusion correction was set aside as a secondary treatment alternative. Its use was reintroduced in 1936 by Oppenheim, who demonstrated its favorable effects without the collateral unfavorable effects of Class II elastics.[2] After this period, the use of extraoral headgear regained its position as a

primary treatment option for Class II malocclusion correction, while the unfavorable collateral effects of Class II elastics were emphasized and consequently their use were not recommended.[3]

The unfavorable collateral effects attributed to the use of Class II elastics were that they produced extrusion of the maxillary incisors and mandibular molars, causing accentuated clockwise rotation of the occlusal plane, and protrusion of the mandibular incisors.[4-7] Additionally, there were claims that they were not able to correct the Class II malocclusion. If correction had occurred, it was not stable and the Class II elastics also produced abnormal root resorption.[8-12] Despite these criticisms, some orthodontic techniques still made use of Class II elastics, such as the Tweed and Begg techniques.[13,14]

Because of these controversies, the effects of Class II elastics have been investigated. When used with the Begg technique, their effects were mostly favorable, without clinically significant unfavorable effects.[5,6,15] When used with the Begg, segmented or Edgewise technique and compared to functional appliances, their effects were mostly similar, with clockwise rotation of the occlusal plane in the experimental groups.[4,16-19] It has also been demonstrated that the use of Class II elastics does not cause greater root resorption than treatment with extraoral headgear associated with fixed appliances.[20]

Despite these comparative studies showing that the effects of Class II elastics in Class II malocclusions are mostly favorable, the comparisons were performed with functional appliances.[4,15,16,18] Some of the unfavorable effects of Class II elastics also occur with the use of functional appliances, such as extrusion of the maxillary incisors and mandibular molars, causing accentuated clockwise rotation of the occlusal plane, and protrusion of the mandibular incisors.[4,18] Then, one could conclude that this type of comparison is not satisfactory. Therefore, the objective of this study was to compare the effects of Class II malocclusion correction with Class II elastics with those produced by Class II malocclusion correction with extraoral headgear associated with multibracket appliances in order to shed some light in these controversies.

MATERIAL AND METHODS

Material

This study was approved by the Ethics in Research Committee of Bauru Dental School, University of São Paulo, under protocol number 43933215.0.0000.5417.

The sample was selected from the files of the Orthodontic Department at Bauru Dental School. The primary selection criteria consisted of patients with bilateral Class II malocclusion (at least half Class II molar relationship),[21] treated without extractions (excluding third molars), with good quality pre- and posttreatment lateral cephalograms. The additional selection criteria were: (1) no previous orthodontic treatment, (2) no history of facial trauma that could have altered growth of the apical bases, (3) absence of tooth agenesis or supranumerary teeth, and (4) complete orthodontic records. To select the sample, only the initial anteroposterior relationship was considered. No other dentoalveolar or skeletal characteristic was taken into consideration.

The sample was divided into two groups, according to the treatment protocol used to correct the Class II malocclusion. The mechanics in the groups consisted of standard fixed edgewise or Roth preadjusted appliances with 0.022 x 0.028-in slots and a usual wire sequence characterized by an initial 0.015-in twist-flex or a 0.016-in nickel-titanium alloy, followed by 0.016, 0.018, 0.020, and 0.019 x 0.025 or 0.018 x 0.025-in stainless steel archwires. To correct deep overbite, reversed and accentuated curve of Spee were used. The elastic group (EG) consisted of patients treated with fixed appliances associated with Class II intermaxillary elastics on both sides to correct the Class II anteroposterior discrepancy, used for at least six months, 15 to 18 hours a day, with a mean force of 200 g, measured with a tension gauge. The control group (CG) consisted of patients treated with fixed appliances and extraoral headgear to correct the anteroposterior Class II discrepancy.

To detect a minimum difference of 1mm in molar relationship correction, with a standard deviation of 1.2mm, with a significance level of 0.05 and 80% of test power, sample size calculation demonstrated that 24 patients were needed in each group.[18] Therefore, the elastic group (group 1) consisted of 26 patients treated with Class II intermaxillary elastics with an initial mean age of 12.49 years and with a treatment

time of 2.70 years. The control group (group 2) consisted of 27 patients treated without Class II intermaxillary elastics, with an initial mean age of 11.93 years and with 2.23 years of treatment time.

Methods

The pretreatment and posttreatment lateral cephalograms were scanned to allow the acquisition of images by Dolphin® Imaging 11.5 (Patterson Dental Supply, Inc., Chatsworth, CA). The magnification factors of the radiographic images that varied from 6% to 9.8% were corrected by the cephalometric software depending on which machine had been used. Landmark identifications were performed on the software by 1 investigator (RSP) (Table I). The software generated the cephalometric tracing and the landmarks generated 30 variables (Table II and Figs.1 and 2).

Error study

Thirty-two lateral cephalograms were randomly selected and retraced by the same examiner (R.S.P.), with a month interval. Random errors were calculated according to Dahlberg's formula[22] ($Se^2 = \Sigma d^2/2n$), where S^2 is the error variance and d is the difference between 2 determinations of the same variable. Paired t tests were used to estimate the systematic errors, at $P<0.05$.[23]

Statistical Analyses

Means and standard deviations for each variable were calculated to enable characterization of the groups. Normal distributions were verified by Kolmogorov-Smirnov tests. The results were non-significant for all variables.

Comparability of the groups regarding the initial age and treatment time were evaluated with t tests. Chi-square test evaluated the intergroup Class II malocclusion anteroposterior occlusal severity and sex distribution.

T tests were also used to compare the initial cephalometric characteristics and the intergroup treatment changes. Results were considered significant at $P<0.05$. All tests were performed with Statistica software (Release 7, StatSoft Inc., Tulsa, OK, USA).

RESULTS

The random errors ranged from 0.24 mm (Overjet) to 1.10 mm (Pg-Nperp) and from 0.34° (SNB) to 2.12° (Nasolabial angle). There were no significant systematic errors.

The groups were comparable regarding initial age, treatment time, initial malocclusion severity, sex distribution, and all the pretreatment cephalometric variables investigated (Tables III and IV).

Group 1 had significantly greater apical base relationship improvement (Wits), occlusal plane clockwise rotation (OP.SN), greater maxillary incisors palatal tipping and retrusion, and smaller extrusion of the mandibular incisors (Md1-MP) than group 2, with treatment (Table V).

DISCUSSION

Initially, the sample should include only patients with full cusp Class II malocclusions. However, to have comparable initial characteristics between the groups, it was necessary to include patients with ½ and ¾ cusp Class II malocclusions[24,25] because the elastic group did not have enough patients that presented with initial full cusp Class II malocclusions (Table III).

The control group consisted of individuals treated with the extraoral headgear associated with fixed appliances, which has been traditionally used for a long time, and its effects are widely described in literature,[26-35] Other types of appliances, such as fixed functional appliances have been compared with the effects of Class II elastics.[4,16,18]

At the pretreatment stage the groups were very similar ensuring that most likely the different changes produced in the groups are only consequent to the different devices used to correct the Class II malocclusion[25] (Table IV).

The elastic group showed greater apical base skeletal anteroposterior improvement only in relation to the Wits appraisal, but not regarding the ANB. This improvement may have been consequent to the clockwise rotation of the occlusal plane in the EG and counterclockwise rotation in the CG. The perpendicular projections of landmarks A and B in the occlusal plane tend to approximate when

there is clockwise rotation of the occlusal plane and tend to recede from each other, when there is counterclockwise rotation. Then, it would be more logical to conclude that both treatment protocols produced similar apical base anteroposterior correction. Other studies have also shown similar results when comparing the effects of Class II correction with elastics with other types of appliances.[4,15,17,18]

During treatment, the EG presented clockwise rotation of occlusal plane, while the CG presented counterclockwise rotation, which were significantly different (Table V). These results corroborate other studies.[30,35-37] Some Class II elastic studies show clockwise rotation of the occlusal plane and attribute this effect to mandibular molar extrusion.[7,18,37] Although there was clockwise rotation in the EG, there was no significantly greater molar extrusion than in the control group (Table V). Despite the clockwise rotation, it was of only 2.21 degrees, which is small and very likely not clinically significant. Other studies have demonstrated that this type of effect frequently also occurs with functional appliances and is not considered to be unfavorable in most situations.[18,38-40] This effect would be unfavorable in vertical patients already presenting with excessive gingival exposure at the pretreatment stage.[41,42]

These results may be explained by the forces applied in each group. With adequate control of the extraoral headgear the force vector passes above the center of resistance of the maxillary dentition, which tends to cause a counterclockwise rotation of the occlusal plane.[35,43] With Class II elastics, the force vector passes below the center of resistance of the maxillary dentition, which causes a clockwise rotation of the occlusal plane.[43]

Treatment in the EG demonstrated significantly greater palatal tipping and retrusion of the maxillary incisors in relation to the CG (Table V). Part of these differences may be attributed to the initially numerically greater labial tipping of the maxillary incisors in the EG (Table IV). Part may have been actually due to lack of control of the collateral effects of the use of Class II elastics, which include palatal tipping of the maxillary incisors.[5,6] To control this, resistant labial crown torque should be applied to the maxillary incisors.[44,45] The greater retrusion of the maxillary incisors in the elastic group could be explained by the association of several initial characteristics that were numerically more severe in the EG, such as the apical base anteroposterior discrepancy, maxillary incisor linear position, overjet and molar relationship. Therefore, to camouflage them, more retrusion of the maxillary incisors

was necessary.[46] These are not considered to be unfavorable effects. They can be considered unfavorable if they are excessive. This can be prevented by controlling them with resistant labial crown torque, when necessary.[44,45]

There was significantly greater extrusion of the mandibular incisors in the CG (Table V). In the EG, extrusion of the mandibular incisors was controlled by the resultant extrusive forces on the maxillary incisors, from the Class II elastics.[43] In the control group, if the forces of the extraoral headgear are controlled to pass above the center of resistance of the maxillary dentition, there will be a tendency for it to experience counterclockwise rotation, which will be followed by the mandibular dentition, with extrusion of the mandibular incisors.[30] As the occlusal plane in the CG did experience some counterclockwise rotation, it seems that this was what occurred.

It is interesting to notice that there were no significantly greater mesialization of the mandibular molars or labial tipping and protrusion of the mandibular incisors in the EG, as has been attributed to the use of Class II elastics.[5,7] This demonstrates that either there was good control of these unfavorable side effects or that generally, these effects are not accentuated as usually thought. Nevertheless, one can assume that the second option seems to be more reasonable to accept. Even when there is labial tipping and protrusion of the mandibular incisors, this does not mean that these effects are unfavorable. These are also common effects produced by functional appliances. If, initially, the mandibular incisors are lingually tipped and retroclined, these effects are favorable. In some cases, when they are well positioned, some protrusion may be tolerated, depending on the amount of keratinized labial mucosa.[47,48] Therefore, labial tipping and protrusion of the mandibular incisors cannot always be regarded as an unfavorable effect, whether produced by Class II elastics, functional appliances or any other orthodontic device.

Slight clockwise rotation of the occlusal plane may not be considered a clinically significant unfavorable effect of Class II elastics in most cases.[49,50] However, it may be clinically significant in hyperdivergent Class II patients with excessive gingival display upon smiling. In these cases, mini-implants could be used to control extrusion of the maxillary incisors and still allow use of Class II elastics.[51] Additionally, some studies suggest that the clockwise occlusal plane rotation may be temporary, however, follow-up studies are needed to investigate this hypothesis.

CONCLUSIONS

Class II malocclusion treatment with Class II elastics in comparison with treatment with extraoral headgear and fixed appliances produced the following differences:

- Occlusal plane clockwise rotation;
- Greater palatal tipping and retrusion of the maxillary incisors;
- Smaller mandibular incisor extrusion;
- However, these effects cannot be considered generally clinically unfavorable in every situation.

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Figure legends:

Fig. 1 – Unusual cephalometric measurements. 1) Mx6-Svert; 2) Md6-Svert

Fig. 2 – Unusual cephalometric measurements. 1) Mx6-PP; 2) Md6-MP; 3) Mx1-PP; 4) Md1-MP

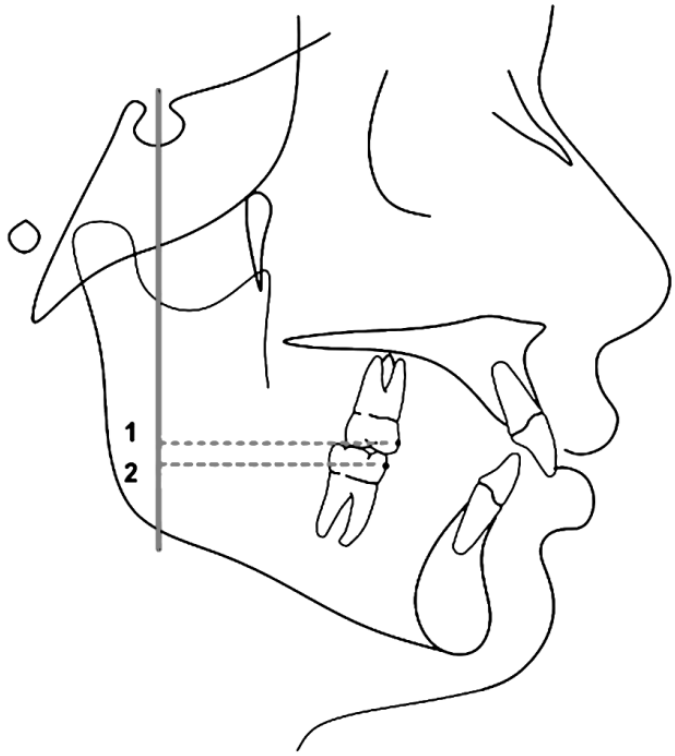

Fig. 1

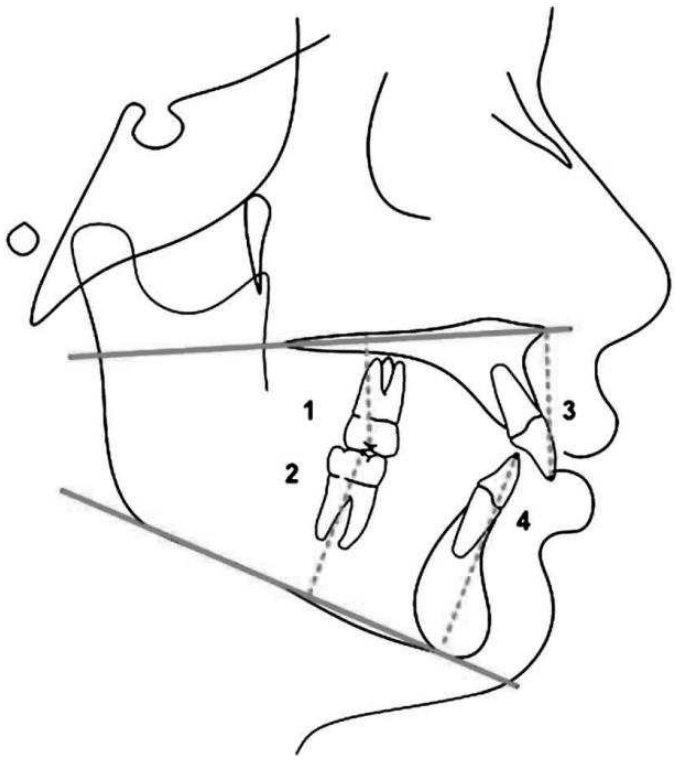

Fig. 2

Table I – Definitions of abbreviations of the cephalometric variables used.

	Landmarks	Description
S	Sella	Center of the pituitary fossa of the sphenoid bone.
N	Nasion	Intersection of the internasal suture with the nasofrontal suture in the midsagittal plane.
Po	Anatomical Porion	Most superior point of the external auditory meatus.
Or	Orbitale	Most inferior point of the external border of the orbital cavity.
A	Point A - subspinale	Deepest point of the curve of the maxilla, between anterior nasal spine (ans) and the dental alveolus.
B	Point B - supramentale	Most posterior point in the concavity along the anterior border of the symphysis.
Pog	Pogonion	Most anterior point on the mid-sagittal symphysis.
Gn	Gnathion	Midpoint between the most anterior and inferior point on the bony chin.
Me	Menton	Most inferior point oh the symphysis.
Go	Gonion	Most convex point along the inferior border of the ramus
Ar	Articulare	posterior border of the neck of the condyle.
Co	Condylion	Most posterior point of the condyle.
ANS	Anterior nasal spine	The tip of the anterior nasal spine
PNS	Posterior nasal spine	Tip of the posterior nasal spine.
U6Occ	Upper first molar occlusal surface	Mesial buccal cusp tip of the maxillary molar.
L6Occ	Lower first molar occlusal surface	Mesial buccal cusp of the mandibular molar.
U6ds	Upper first molar distal surface	Distal surface of the upper first molar, perpendicular to the occlusal plane
U6ms	Upper first molar mesial surface	Mesial surface of the upper first molar, perpendicular to the occlusal plane.
L6ds	Lower first molar distal surface	Distal surface of the lower first molar, perpendicular to the occlusal plane.
L6ms	Lower first molar mesial surface	Mesial surface of the lower first molar, perpendicular to the occlusal plane.
U1tip	Upper incisor tip	Incisal tip of the upper central incisor
U1apex	Upper incisor root apex	Root apex of the upper central incisor.
L1tip	Lower incisor tip	Tip of the lower central incisor
L1apex	Lower incisor root apex	Root apex of the lower central incisor.
Prn	Pronasale	Point of the anterior curve of the nose.
Sn	Subnasale	Point where the nose connects to the center of upper lip.
UL	Upper lip	Most anterior point on the curve of the upper lip.
LL	Lower lip	Most anterior point on the curve of the lower lip.
Pog’	Soft tissue pogonion	Point on the anterior curve of soft tissue chin

Table II - Skeletal and dental cephalometric variables.

Maxillary skeletal componentes	
SNA	SN to NA angle
A-Nperp	A point to nasion-perpendicular
Mandibular skeletal componentes	
SNB	SN to NB angle
Pg-Nperp	Pogonion to nasion-perpendicular
Maxillomandibular relationship	
ANB	NA to NB angle
Wits	Distance between perpendicular projections of Points A and B on the functional occlusal plane
Growth pattern	
SN.GoGn	SN to GoGn angle
OP.SN	Occlusal Plane to SN angle
FMA	FH plane to MP angle
LAFH	Lower Anterior Face Height: distance from Anterior Nasal Spine (ANS) to menton
Maxillary dentoalveolar components	
Mx1.NA	Maxillary incisor long axis to NA angle
Mx1-NA	Distance between most anterior point of crown of maxillary incisor and NA line
Mx1-PP	Perpendicular distance between incisal edge of maxillary incisor and palatal plane
Mx6-PP	Mean perpendicular distance between mesial and distal cusp of maxillary first molar and palatal plane
Mx6 -SVert	Perpendicular distance between mesial of maxillary first molar and S vertical line
Mandibular dentoalveolar components	
Md1.NB	Mandibular incisor long axis to NB angle
Md1-NB	Distance between most anterior point of crown of mandibular incisor and NB line
Md1 -MP	Distance between mandibular incisal edge and mandibular plane
Md6 - MP	Distance between mandibular distance between mesial and distal cusp of mandibular first molar and mandibular plane
Md6-SVert	Perpendicular distance between mesial of mandibular first molar and S vertical line
Dental relationship	
Overjet	Distance between incisal edges of maxillary and mandibular central incisors, parallel to occlusal plane
Overbite	Distance between incisal edges of maxillary and mandibular central incisors, perpendicular to occlusal plane
Molar relationship	Distance between mesial cusp tips of maxillary and mandibular first molars, parallel to functional occlusal plane
Soft tissue profile	
Nasolabial Angle	Cl.Sn.UL angle
Upper lip – S line	Distance from the upper lip to Steiner's S line (line from Pg' to Cl)
Lower lip – S line	Distance from the lower lip to Steiner's S line

Table III – Intergroup comparisons of initial age, treatment time, initial occlusal malocclusion severity and sex distribution

	EG (Elastic Group)		**CG (Control Group)**		
	n= 26		**n= 27**		
Variable	**Mean**	**SD**	**Mean**	**SD**	**p**
Initial age	12.49	2.17	11.93	1.02	0.237€
Treatment time	2.70	1.08	2.23	1.04	0.110€
Occlusal malocclusion severity					
•Full cusp Class II malocclusion	6		6		
•Full cusp Class II malocclusion on one side and ¾ or ½ cusp Class II malocclusion on the other	7		1		0.556¥
•¾ cusp bilateral Class II or ¾ cusp Class II malocclusion on one side and ½ cusp Class II malocclusion on the other	4		2		
•½ cusp bilateral Class II	9		18		
Sex					
•Male	7		11		0.288¥
•Female	19		16		

€ t test

¥ Chi-square test

Table IV – Intergroup comparisons at the pretreatment stage (t test)

		Group 1 (Elastic Group)		Group 2 (Control Group)		
		n= 26		n= 27		
Variable	Unit	Mean	SD	Mean	SD	p
Maxillary skeletal components						
SNA angle	°	81.83	3.92	81.75	3.51	0.944
A-Nperp	mm	-0.79	3.71	-1.00	2.91	0.819
Mandibular skeletal components						
SNB angle	°	76.73	3.39	77.45	3.63	0.463
Pg-Nperp	mm	-8.73	6.52	-8.34	6.28	0.823
Maxillomandibular relationship						
ANB angle	°	5.08	2.76	4.32	2.21	0.273
Wits	mm	3.67	2.44	2.39	2.39	0.058
Growth pattern						
SN.GoGn	°	31.28	5.88	30.98	6.28	0.860
OP.SN	°	14.73	3.76	14.76	3.28	0.976
FMA	°	26.26	6.72	26.01	6.06	0.885
LAPH	mm	59.86	4.67	62.46	5.98	0.085
Maxillary dentoalveolar components						
Mx1.NA	°	26.08	6.10	23.87	6.28	0.200
Mx1-NA	mm	5.59	2.77	5.16	2.27	0.536
Mx1-PP	mm	26.49	2.40	27.54	2.84	0.151
Mx6-PP	mm	20.48	2.35	21.10	2.20	0.330
Mx6-Svert	mm	40.81	2.81	41.51	5.58	0.569
Mandibular dentoalveolar components						
Md1.NB	°	25.86	6.72	25.31	5.70	0.748
Md1-NB	mm	5.60	2.45	5.43	1.85	0.775
Md1 – MP (LADH)	mm	37.43	2.74	38.18	3.07	0.353
Md6 - MP	mm	27.40	2.56	28.83	2.86	0.061
Md6-Svert	mm	38.18	3.34	39.56	6.20	0.319
Dental relationships						
Overjet	mm	6.75	2.14	5.51	2.37	0.051
Overbite	mm	3.41	1.80	2.52	2.37	0.132
Molar relationship	mm	2.59	1.55	1.93	1.45	0.119
Soft tissue profile						
Nasolabial angle	°	111.10	7.90	106.99	7.27	0.054
Upper Lip – S line	mm	1.68	2.04	1.80	1.85	0.836
Lower Lip – S line	mm	2.20	2.58	2.01	2.38	0.778

Table V – Intergroup comparisons of treatment changes (t test).

		Group 1 (Elastic Group)		Group 2 (Control Group)		
		n= 26		n= 27		
Variable	Unit	Mean	SD	Mean	SD	p
Maxillary skeletal components						
SNA angle	°	-0.40	2.56	-0.15	2.02	0.705
A-Nperp	mm	-0.39	1.73	-0.37	1.96	0.971
Mandibular skeletal components						
SNB angle	°	0.55	1.66	0.98	1.45	0.324
Pg-Nperp	mm	0.88	2.79	1.47	3.73	0.516
Maxillomandibular relationship						
ANB angle	°	-0.95	1.91	-1.17	1.30	0.624
Wits	mm	-2.66	2.27	-1.06	2.06	0.009*
Growth pattern						
SN.GoGn	°	0.25	2.57	-0.47	2.28	0.281
OP.SN	°	2.21	3.05	-0.90	3.31	<0.001*
FMA	°	-0.10	2.07	-0.24	2.02	0.803
LAFH	mm	3.18	2.48	3.79	3.03	0.432
Maxillary dentoalveolar components						
Mx1.NA	°	-4.90	6.59	-0.51	6.15	0.015*
Mx1-NA	mm	-1.69	2.81	-0.13	1.52	0.014*
Mx1-PP	mm	1.36	1.64	0.76	2.12	0.261
Mx6-PP	mm	1.67	1.45	2.13	1.74	0.306
Mx6-Svert	mm	1.03	3.24	0.58	2.49	0.576
Mandibular dentoalveolar components						
Md1.NB	°	4.07	4.81	2.32	5.37	0.217
Md1-NB	mm	1.16	1.74	1.15	1.94	0.984
Md1 – MP (LADH)	mm	0.32	1.81	2.30	2.43	0.001*
Md6 - MP	mm	2.42	1.64	2.26	1.77	0.728
Md6-Svert	mm	3.77	3.18	2.98	3.31	0.379
Dental relationships						
Overjet	mm	-3.83	2.15	-2.68	2.49	0.077
Overbite	mm	-1.77	1.58	-1.01	2.36	0.173
Molar relationship	mm	-2.72	1.50	-2.38	1.86	0.462
Soft tissue profile						
Nasolabial angle	°	-0.03	9.72	-1.47	7.82	0.554
Upper Lip – S line	mm	-1.45	1.75	-1.65	1.58	0.662
Lower Lip – S line	mm	-0.19	2.01	-0.42	1.74	0.653

*Statistically significant at $P<0.05$.

3 DISCUSSION

3 DISCUSSION

Some speculations have been performed in orthodontics about treatments, diagnosis and stability. A lot of these ideas are widespread without scientific evidence about their efficiency. The side effects of Class II elastics is one of them. Reviewing the literature, few studies on the issue were found and most of them did not demonstrate effectively such collateral effects due to use of Class II intermaxillary elastics.(GIANELLY; ARENA; BERNSTEIN, 1984; DYER; HARRIS; VADEN, 1991; NELSON; HANSEN; HÄGG, 2000; UZEL; UZEL; TOROGLU, 2007; JONES et al., 2008) Although some studies demonstrate such effects, they do not compare them to any other Class II treatment protocol.(NELSON; HANSEN; HÄGG, 1999; REDDY et al., 2000) In this way, it is not possible to state that these found effects are harmful or they are common effects of another type of Class II malocclusion treatment.

The sample of this study was supposed to include only patients with full cusp Class II malocclusions. However, to have comparable initial characteristics between the groups, it was necessary to include patients with ½ and ¾ cusp Class II malocclusions(ANDREWS, 1972; WHEELER et al., 2002) because the elastic group did not have enough patients that presented with initial full cusp Class II malocclusions (Table III). The groups were comparable regarding initial age, treatment time, initial malocclusion severity, sex distribution, and all the pretreatment cephalometric variables investigated (Table III and IV).

In order to compare these results to another treatment protocol, the control group was composed by patients with similar malocclusion, treated with headgear associated with fixed appliances. Extraoral headgear is a traditional largely used Class II malocclusion treatment protocol, and its effects are widely described in literature.(ZERVAS et al.; TORTOP; YUKSEL, 2007; ANGELIERI et al., 2008; MANN et al., 2011; ALIO-SANZ et al., 2012; ANTONARAKIS; KILIARIDIS, 2015; D'ANTO et al., 2015; FARRET et al., 2015; HENRIQUES et al., 2015; LIONE et al., 2015; PAPAGEORGIOU et al., 2016)

When the treatment changes of the EG and CG were compared, only 5 variables were significantly different. The major difference was found in the occlusal

plane. The elastic group showed greater apical base skeletal anteroposterior improvement only in relation to the Wits appraisal, but not regarding the ANB. This improvement may have been consequent to the clockwise rotation of the occlusal plane in the EG and counterclockwise rotation in the CG. The perpendicular projections of landmarks A and B in the occlusal plane tend to approximate when there is clockwise rotation of the occlusal plane and tend to recede from each other, when there is counterclockwise rotation. Then, it would be more logical to conclude that both treatment protocols produced similar apical base anteroposterior correction. Other studies have also shown similar results when comparing the effects of Class II correction with elastics with other types of appliances.(GIANELLY; ARENA; BERNSTEIN, 1984; NELSON; HANSEN; HÄGG, 2000; UZEL; UZEL; TOROGLU, 2007; JONES et al., 2008)

Some Class II elastic studies show clockwise rotation of the occlusal plane and attribute this effect to mandibular molar extrusion.(DYER; HARRIS; VADEN, 1991; JONES et al., 2008; ZIMMER; NISCHWITZ, 2012) Although there was clockwise rotation in the EG, there was no significantly greater molar extrusion than in the control group (Table V). These results may be explained by the forces applied in each therapy. In the headgear therapy the force is near the center of resistance of the maxilla, while with Class II elastic therapy the force is more anterior, near the premaxilla.(KUHN, 1968; LIONE et al., 2015) Besides, Class II elastics present a vertical vector force when the direction of force is decomposed.(STEWART; CHACONAS; CAPUTO, 1978; ZIMMER; NISCHWITZ, 2012)

Treatment in the EG demonstrated significantly greater palatal tipping and retrusion of the maxillary incisors in relation to the CG (Table V). Part of these differences may be attributed to the initially numerically greater labial tipping of the maxillary incisors in the EG (Table IV). These changes in EG, possibly occurred due to posterior traction that elastics produced on maxillary incisors and this is an expected effect such as those found in anterior retraction after premolar extraction.(WERNECK et al., 2014) To control this, resistant labial crown torque should be applied to the maxillary incisors.(GERAMY; SODAGAR; HASSANPOUR, 2014) The greater retrusion of the maxillary incisors in the elastic group could be explained by the association of several initial characteristics that were numerically

more severe in the EG, such as the apical base anteroposterior discrepancy, maxillary incisor linear position, overjet and molar relationship.

There was significantly greater extrusion of the mandibular incisors in the CG (Table V). If the forces of the extraoral headgear are controlled to pass above the center of resistance of the maxillary dentition, there will be a tendency for it to experience counterclockwise rotation, which will be followed by the mandibular dentition, with extrusion of the mandibular incisors.(LIONE et al., 2015) As the occlusal plane in the CG did experience some counterclockwise rotation, it seems that this was what occurred.

It is interesting to notice that harmful effects like increased mandibular eruption, increased maxillary molar intrusion, mesialization of the mandibular molars, increased maxillary incisors eruption and increased mandibular incisor intrusion attributed to the use of Class II elastics, were not significantly greater in the EG.(DYER; HARRIS; VADEN, 1991; REDDY et al., 2000) This demonstrates that either there was good control of these unfavorable side effects or that generally, these effects are not accentuated as usually thought.

Slight clockwise rotation of the occlusal plane may not be considered a clinically significant unfavorable effect of Class II elastics in most cases.(SPYROPOULOS; ASKARIEH, 1976; BATWA et al., 2012) However, it may be clinically significant in hyperdivergent Class II patients with excessive gingival display upon smiling. In these cases, mini-implants could be used to control extrusion of the maxillary incisors and still allow use of Class II elastics.(UPADHYAY; YADAV; NANDA, 2010)

The other 22 variables did not present intergroup significant differences, which demonstrate that Class II elastics are an efficient Class II treatment protocol (Table V). Additionally, some studies suggest that the clockwise occlusal plane rotation may be temporary; however, follow-up studies are needed to investigate this hypothesis.

4 CONCLUSION

4 CONCLUSIONS

Class II malocclusion treatment with Class II elastics in comparison with treatment with extraoral headgear and fixed appliances produced the following differences:

- Occlusal plane clockwise rotation;
- Greater palatal tipping and retrusion of the maxillary incisors;
- Smaller mandibular incisor extrusion;
- However, these effects cannot be considered generally clinically unfavorable in every situation.

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APPENDIX

APPENDIX A – Declaration of exclusive use of the article in dissertation.

DECLARATION OF EXCLUSIVE USE OF THE ARTICLE IN DISSERTATION/THESIS

We hereby declare that we are aware of the article EFFECTS OF CLASS II ELASTICS IN THE TREATMENT OF CLASS II MALOCCLUSION will be included in Dissertation of the student Raquel Silva Poletto and may not be used in other works of Graduate Programs at the Bauru School of Dentistry, University of São Paulo.

Bauru, december 02nd,2016.

Raquel Silva Poletto
Author

Raquel Silva Poletto
Signature

Guilherme Janson
Author

Signature

ANNEX

ANNEX A – Ethics Committee Approval

FACULDADE DE ODONTOLOGIA DE BAURU-USP

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Alterações dentoalveolares e esqueléticas consequentes ao uso de elásticos para tratamento da má oclusão de Classe II

Pesquisador: Raquel Silva Poletto

Área Temática:

Versão: 1

CAAE: 43933215.0.0000.5417

Instituição Proponente: Universidade de Sao Paulo

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 1.051.603

Data da Relatoria: 29/04/2015

Apresentação do Projeto:

O Projeto de Pesquisa: Alterações dentoalveolares e esqueléticas consequentes ao uso de elásticos para tratamento da má oclusão de Classe II, de autoria de Raquel da Silva Poletto sob a orientação do Prof Drº Guilherme dos Reis Pereira Janson, trata-se de um projeto de mestrado.

A Hipótese do trabalho

Não há diferença entre as alterações dentoalveolares e esqueléticas encontradas no grupo tratado com elásticos de classe II e no grupo tratado sem

uso do elástico de classe II.

Objetivo Primário:

Avaliar as alterações cefalométricas resultantes do tratamento da má oclusão de Classe II com uso de elásticos intermaxilares de Classe II

comparando-as aos resultados de outro protocolo de tratamento da má oclusão de Classe II sem o uso de elásticos.

metodologia aplicada

Para composição da amostra, serão selecionados 62 pacientes do arquivo da Disciplina de Ortodontia da FOB/USP. Os pacientes serão divididos em dois grupos, um grupo experimental e um grupo controle, de acordo com o protocolo de tratamento utilizado para a correção da má

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Continuação do Parecer: 1.051.603

oclusão de Classe II. No grupo 1, experimental, denominado Grupo Elástico (GE), serão incluídos os casos de má oclusão de Classe II, de amos os sexos,
tratados sem extração e com uso de elásticos de Classe II bilateral, com tempo mínimo de uso de 10 meses. No grupo 2, Grupo Controle (GC), serão incluídos os casos de má oclusão de Classe II, de ambos os sexos, tratados sem extração e sem associação de elásticos de Classe II. Ambos os grupos deverão ter uma média de idade e de tempo de tratamento compatíveis.Serão obtidas dos arquivos telerradiografias em norma lateral de
cada paciente estudado, de ambos os grupos. As tomadas radiográficas devem ter sido realizadas ao início do tratamento (T1) e imediatamente após a conclusão do tratamento (T2).Para realização do traçado anatômico, demarcação dos pontos de referência e medição das grandezas cefalométricas, as telerradiografias serão digitalizadas e será utilizado o programa de planejamento ortodôntico Dolphin®11.5 (Patterson Dental Supply, Chatsworth, EUA).

Objetivo da Pesquisa:

Avaliar as alterações cefalométricas resultantes do tratamento da má oclusão de Classe II com uso de elásticos intermaxilares de Classe II
comparando-as aos resultados de outro protocolo de tratamento da má oclusão de Classe II sem o uso de elásticos.

Avaliação dos Riscos e Benefícios:

Sendo este um estudo com amostra de caráter retrospectivo, não apresenta riscos e a pesquisadora se compromete a manter o sigilo dos pacientes estudados.

Benefícios:

Com os resultados da pesquisa, haverá benefícios para a população com um todo, uma vez que os resultados servirão como embasamento científico para manutenção ou mudança do protocolo de tratamento da má oclusão de classe II com uso de elásticos de classe II.

Comentários e Considerações sobre a Pesquisa:

Trata-se de uma pesquisa retrospectiva que pretende avaliar telerradiografias de 62 pacientes do Arquivo da Disciplina de Ortodontia da Faculdade de Odontologia de Bauru.

Serão obtidas dos arquivos telerradiografias em norma lateral de cada paciente estudado, de ambos os grupos.

O projeto trabalhará com a hipótese de que não há diferença entre as alterações dentoalveolares e esqueléticas encontradas no grupo tratado com elásticos de classe II e no grupo tratado sem uso do elástico de classe II.

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Considerações sobre os Termos de apresentação obrigatória:
Toda documentação necessária para aprovação da pesquisa foi apresentado.

Recomendações:
Não se aplica

Conclusões ou Pendências e Lista de Inadequações:
Não se aplica

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

Considerações Finais a critério do CEP:
Esse projeto foi considerado APROVADO na reunião ordinária do CEP de 29.4.2015, com base nas normas éticas da Resolução CNS 466/12. Ao término da pesquisa o CEP-FOB/USP exige a apresentação de relatório final. Os relatórios parciais deverão estar de acordo com o cronograma e/ou parecer emitido pelo CEP. Alterações na metodologia, título, inclusão ou exclusão de autores, cronograma e quaisquer outras mudanças que sejam significativas deverão ser previamente comunicadas a este CEP sob risco de não aprovação do relatório final. Quando da apresentação deste, deverão ser incluídos todos os TCLEs e/ou termos de doação assinados e rubricados, se pertinentes.

BAURU, 06 de Maio de 2015

Assinado por:
Izabel Regina Fischer Rubira Bullen
(Coordenador)

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