UNIVERSIDADE DE SÃO PAULO
FACULDADE DE ODONTOLOGIA DE BAURU

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Extractions in Orthodontics: a treatment time evaluation and a profile susceptibility study

Extrações em Ortodontia: uma avaliação sobre tempo de tratamento e susceptibilidade do perfil

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Orientador: Prof. Dr. Guilherme Janson

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(Albert Einstein)

ABSTRACT

Extractions in Orthodontics: a treatment time evaluation and a profile susceptibility study

Able to significantly help in some malocclusions treatment, premolar extractions for orthodontic reasons has been extensively researched. The present thesis evaluated different aspects related to this type of extraction. The first study aimed to evaluate treatment duration of cases treated with four first premolars extraction, with and without dental crowding. After evaluating 150 Angle Class I malocclusion cases treated likewise, 74 selected individuals were divided into groups with mild and severe crowding. Although the treatment time was higher in the mild crowding group, that difference only became statistically significant difference after the groups were reselection of with more extreme crowding amounts. To achieve that, the groups were reduced. It is suggested this research should be repeated with a greater sample. The second study, through a certain type of article – a systematic review of the literature – was based on the common concern from orthodontists that their treatment could impact patients' soft tissue profiles, especially treatments based on extractions. Lips projection and nasolabial angle values obtained from attractive samples were gathered. Results varied according to ethnicity and sex, showing that each patient must be evaluated considering the context he/she is inserted in. The orthodontic patients who show cephalometric values of lips projection and nasolabial angle similar to those reported in this study and are considered already attractive should be treated not changing the lips position.

Key-words: Tooth extraction. Efficiency. Face. Esthetics. Orthodontics.

RESUMO

Extrações em Ortodontia: uma avaliação sobre o tempo de tratamento e a susceptibilidade do perfil

Capaz de auxiliar significativamente o tratamento de diferentes más oclusões, as extrações de pré-molares por indicação ortodôntica têm sido alvo de vasta investigação na comunidade científica. O presente trabalho avaliou diferentes aspectos relacionados a este tipo de extrações. No primeiro estudo, o objetivo foi avaliar o tempo de tratamento em casos tratados com extração de quatro primeiros pré-molares com e sem apinhamento dentário. Após avaliar 150 casos de má oclusão de Classe I de Angle assim tratada, 74 indivíduos foram selecionados e divididos em dois grupos, com apinhamento suave e severo. Embora o tempo de tratamento tenha sido maior no grupo sem apinhamento, esta diferença só se tornou estatisticamente significante após a seleção de grupos com graus mais extremos de apinhamento. Dado que para isso os grupos se reduziram, sugere-se que esta investigação seja repetida com uma amostra maior. O segundo estudo, por meio de um tipo diferente e específico de artigo – uma revisão sistemática da literatura ortodôntica – focou na constante preocupação dos ortodontistas quanto à repercussão de seus tratamentos nos perfis dos pacientes, especialmente daqueles apoiados em extrações. Valores de projeção labial e ângulo nasolabial obtidos de perfis esteticamente julgados por avaliadores como atraentes em pesquisas científicas foram reunidos. Os resultados variaram conforme etnia e sexo, mostrando que cada paciente deve ser avaliado considerando o contexto em que se insere. Os pacientes ortodônticos que apresentarem valores cefalométricos de projeção labial e ângulo nasolabial similares aos reportados neste estudo e que já forem considerados esteticamente agradáveis devem ser tratados sem grande acometimento da posição labial.

Palavras-chave: Extração dentária. Eficiência. Face. Estética. Ortodontia.

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LII	Little Irregularity Index
MC	Mild crowding
SC	Severe crowding
OGS	Objective Grading System
ABO	American Board of Orthodontics
PICOS	People, Intervention, Comparison, Outcomes and Study Design)
LP	Lips projection
NLA	Nasolabial angle (ColSnLs)
Ls-E	Distance from upper lip to Rickets' Esthetic line
Li-E	Distance from loeer lip to Rickets' Esthetic line
Ls-S	Distance from upper lip to Steiner's S line
Li-S	Distance from lower lip to Steiner's S line
Li-H	Distance from lower lip to Holdaway's H line
Ls-PRV	Distance from upper lip to Profile Root Vertical Line
Li-PRV	Distance from lower lip to Profile Root Vertical Line
Ls-SnPg'	Distance from upper lip to SnPg' line
Li-SnPg'	Distance from lower lip to SnPg' line
Ls-Pg'N	Distance from upper lip to Pg'N' line
Li-Pg'N	Distance from lower lip to Pg'N' line
LsGPg'	Angle formed by Labrale superius, Glabela and Soft tissue pogonion
LiGPg'	Angle formed by Labrale inferius, Glabela and Soft tissue pogonion
LsNPg'	Angle formed by Labrale superius, Nasion and Soft tissue pogonion
LiNPg'	Angle formed by Labrale inferius, Nasion and Soft tissue Pogonion
ILA	Interlabial angle (formed by the lines Soft tissue A point-Labrale superius and Soft tissue B point-Labrale inferius – A'LsLiB')
LMA	Labiomental angle (formed by Labrale inferius, Soft tissue B point and Soft tissue pogonion – LiB'Pg')

LISTA DE SÍMBOLOS

mm	milímetros
º	graus
*	estatisticamente significante para *P*=<0,05
[a]	Chi-square test
[b]	Mann Whitney Test
[c]	Independent t Test

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INTRODUCTION

1 INTRODUCTION

Premolar extractions in Orthodontics may be indicated in some specific situations, such as severe crowding (Germec and Taner 2008) and anteroposterior problems (Janson, Brambilla Ada et al. 2004). Initially repudiated by Edward Angle (Angle 1907), defended by Calvin Case (Case 1964) and finally strengthened by Charles Tweed (Tweed 1941), premolar extractions have been dividing opinions ever since, and have been the target of several researches (Baumrind, Korn et al. 1996, Baumrind, Korn et al. 1996).

In severe crowding cases, extractions provide space for teeth alignment (Konstantonis, Anthopoulou et al. 2013). When one or more dental arches are protruded, the extraction spaces enable anterior teeth retraction and consequently lips harmony (Leonardi, Annunziata et al. 2010). In Class II and Class III malocclusions, this process can help camouflage treatment of skeletal discrepancies (Janson, Leon-Salazar et al. 2009, Janson, Araki et al. 2011). In this context, the extractions were used for a long time, sometimes indiscriminately, which could have made it detrimental in particular cases where their choice was not correct (Basciftci and Usumez 2003).

The orthodontic literature usually highlights dental extractions as one of the main factors for increased treatment time (Vig, Weyant et al. 1998). Because malocclusion severity is an inherent characteristic that cannot be controlled, efforts have been made to quantify the influence of extractions on the duration of orthodontic treatment (Fink and Smith 1992). In fact, the number of teeth extracted has been positively correlated with treatment time (Fink and Smith 1992, Vig, Weyant et al. 1998, Skidmore, Brook et al. 2006) .

However, it is not always true. Contrary to those findings, Beckwith et al stated that the difference in treatment time between extraction and non-extraction protocols is not significant (Beckwith, Ackerman et al. 1999). The aforementioned correlation was confirmed in complete Class II malocclusions where it was demonstrated that treatment time is shorter with a two maxillary premolar extraction protocol than with a four premolar extraction protocol (Janson, Maria et al. 2006). However, it did not hold true when it was found that in complete Class II malocclusions, treatment time is also

shorter with a two maxillary premolar extraction protocol than with a non-extraction protocol, suggesting that in this malocclusion, the antero-posterior discrepancy severity and the treatment protocol play a major role in treatment time (Janson, Barros et al. 2007, Janson, Janson et al. 2008). The greater the Class II anteroposterior discrepancy severity, the smaller the probability of success in a nonextraction treatment (Janson, Valarelli et al. 2009).

When the molar relationship is normal, premolar extractions may still be applied, in patients with severe crowding or dental protrusion. In these types of cases, the duration of the space closure may be related to the amount of crowding and the desired quantity of retraction. In cases of crowding, part of the space is used with the teeth alignment, leaving not too much space for retraction. On the other hand, when there is no crowding, mainly all the space has to be purely retracted (Freitas, Freitas et al. 2008).

An important concern extractions bring to orthodontists is related to the post-treatment soft tissue profile (H.G. Barrer 1971, Bowman 1999). In the final decades of the twentieth century, facial esthetics became clearly important in Orthodontics. The concern was that anterior retraction after extractions could be excessive, reducing lips support, straightening facial profile, and possibly intensifying facial signs like the nasolabial sulcus (Bravo 1994).

This new trend originated several scientific researches about the impact of extractions on facial profile (Looi and Mills 1986, Klapper, Navarro et al. 1992, Bishara and Jakobsen 1997, Stephens, Boley et al. 2005, Erdinc, Nanda et al. 2007, Germec and Taner 2008, Lim, Ko et al. 2008, de Almeida-Pedrin, Henriques et al. 2009, Khan and Fida 2010, Janson, Junqueira et al. 2015). To estimate these effects, especially in the lips region, researchers use cephalometric measurements. Some of the most popular ones are the distances that upper and lower lips establish to certain esthetic lines (Steiner 1953, Burstone 1959, Ricketts 1961, Holdaway 1983). Also important is the nasolabial angle, composed by Columela, Subnasale and the anterior limit of the upper lip. These parameters intend to translate into numbers the lips protrusion amount, for particular patients, populations, ethnicities or to compare the stages before and after orthodontic treatment.

Due to a great potential in lips posterior replacement (Kocadereli 2002), extractions may be beneficial or not. The distinction between these types of cases will lay on our patients' features, previously to treatment. Some of them will require

extractions to improve lips position. Some others not only will not, but also would benefit from lip augmentation. It is up to the Orthodontist to distinguish these cases and establish in which of them extractions may be applied. In this evaluation, it is necessary to know our patients profiles, and moreover, how is the profile they would like to have? In other words, if we could cephalometrically increase facial attractiveness, which standards would we look for?

The two following current studies concerning extractions intend to clarify the following questions:

- When treated with premolar extractions, do the crowded cases complete treatment before the non-crowded cases?
- What are the amounts of lip protrusion and nasolabial angle considered suitable for orthodontic patients? What cephalometric parameters should we aim/preserve in our treatments? Which patients have a facial profile more susceptible to extractions and which of them would benefit from it?

Scientific Production

2 SCIENTIFIC PRODUCTION

The articles below were written according to the American Journal of Orthodontics and Dentofacial Orthopedics instructions.

2.1 First article

EXTRACTION TREATMENT TIME OF CLASS I MALOCCLUSION WITH AND WITHOUT CROWDING

ABSTRACT

Introduction: In extraction cases, crowding is quickly solved after the canines are distalized toward the first premolar spaces. Treatment time of 4-premolar extraction cases without crowding may be greater than crowded cases, since significant anterior retraction is required. **Methods:** Crowding of 150 Class I cases treated with 4 first premolar extractions, was measured with Little´s Irregularity Index (LII). Maxillary crowding delimited mild crowding (MC) and severe crowding (SC) groups, with 37 individuals each, with LII smaller than 7.83m and greater than 12.18mm, respectively. The groups were matched regarding sex, initial age and Objective Grading System index. **Results:** Reproducibility errors were within the normal range. Treatment time was statistically similar between both groups. However, there was a significantly shorter treatment time in cases with extreme maxillary incisor irregularity as compared to cases with insignificant maxillary incisor irregularity. **Conclusion:** Therefore, in 4-first premolar extraction Class I cases, only extremely severe maxillary incisor irregularity will present significantly smaller treatment time than cases with insignificant maxillary incisor irregularity.

Key-words: Malocclusion, Angle Class I, tooth extraction, Time-to-Treatment

INTRODUCTION

In Class I malocclusion cases, where no anteroposterior problems need to be addressed, four premolar extractions may be indicated when there is moderate to severe crowding or dental protrusion.[1] After the canines are distalized, the spaces are partially or completely transferred to the anterior region.[2,3] At this time, alignment and leveling of the crowded incisors takes place.[4] When crowding is severe, most of the space provided is dispersed, and the amount of incisor retraction is minimally reduced to the residual spaces.[5]

In other Class I cases, although there is no significant crowding, dental protrusion may cause excessively convex profiles, often with lip incompetence. It may also be necessary to remove the four first premolars, allowing subsequent incisor and lip retractions.[6-8] In order to match patients' expectations, it is originally desired substantial retraction, consuming most of the space provided by premolars removal. This concern encourages professionals to reinforce anchorage.[9]

Most patients who seek for orthodontic treatment are concerned about treatment duration. This information may be provided based on subjective factors, such as clinical experience.[10] Factors influencing orthodontic treatment time have been studied in orthodontic literature,[11,12] including the severity of the initial malocclusion.[3] Grewe and Hermanson, in 1973, classifying cases regarding their initial complexity, using index like TPI (Treatment Priority Index),[13] found no statistically significant correlation between duration of treatment and occlusal severity.[14] Other studies show a longer treatment in cases with greater malocclusion severity.[10] Nevertheless, in none of these studies a single type of malocclusion was studied. Samples involved malocclusions of Class I, II and II, masking the influence of the anteroposterior molar relationship in treatment time. In some studies, Class II molar relationship correction was considered as a factor responsible for increased treatment time.[2,3]

Given the large spaces to be closed by the anterior teeth in cases of Class I biprotrusion, preferably without concomitant mesialization of the posterior teeth, it is speculated that treatment time in this type of case may be longer. On the other hand, in Class I cases with severe crowding, after the canine is distalized toward the extraction space, the subsequent leveling and alignment occur rapidly, since much space is consumed by the dissolution of crowding and small or no anterior retraction is needed.[2,5]

Knowing how quickly anterior crowding dissolves toward the premolar space, it is suspected that treatment time in Class I cases treated with 4-premolar extractions with biprotrusion, but without crowding, will be longer than severely crowded cases, because the anterior teeth must be retracted for a great amount of space. In this context, the aim of this study was to compare the treatment times in cases of Class I malocclusion treated with 4-first premolar extractions, with mild and severe crowding.

MATERIAL AND METHODS

This study was approved by the Research Ethics Committee of _____ (protocol number _____).

Sample selection

Using the records of orthodontically treated patients at Bauru Dental School, University of São Paulo, Brazil, an initial sample was retrospectively composed by 150 patients who fit the following criteria:

- availability of orthodontic records in good conditions (initial and final dental casts, final panoramic radiographs and legible charts);
- presence of all permanent teeth fully erupted up to first molars;
- no agenesis, extranumerary or retained elements;
- bilateral Class I malocclusion,
- no posterior crowding greater than 2 mm per side in each arch;
- orthodontically treated with Edgewise type appliances with 4-first premolar extractions;
- all permanent teeth up to second molars present in the final casts (except first premolars).

From the clinical charts, the following data were extracted: identification, sex, birth date, initial and final treatment dates, treatment protocol and mechanics employed. Using those dates, patient ages at the beginning of treatment, and the total treatment time were calculated.

Orthodontic mechanics included 0.022x0.028-inch appliances. Cases with severe initial anterior tooth crowding required initial canine retraction, followed by leveling and alignment with the usual wire sequence, characterized by an initial

0.015-inch twist-flex or a 0.016-inch nickel-titanium, followed by 0.016, 0.018, 0.020, and 0.019x0.025-inch stainless steel archwires (Unitek, Monrovia, California, USA). Deep bite was corrected with accentuated and reversed curve of Spee. The extraction spaces were closed with sliding “en masse” retraction of the anterior teeth on a rectangular archwire. As anchorage resources, extraoral appliances were used in the maxillary arch and lip bumpers in the mandibular arch.

Treatment times were taken from the orthodontic records, where starting date was considered the date when first molar bands were placed or first direct bonding occurred, whereas final date was considered as the date when the appliances were removed.

Sample size

Sample size was calculated for each group based on an alpha error of 0.05, a power test of 80%, to detect a mean difference of 4.6 months between the groups, with an estimated standard deviation of 5.86 months.[2] The results showed that 26 individuals were needed in each group.

Crowding evaluation

The amount of crowding was evaluated using the Little Irregularity Index (LII), which corresponds to the sum, in millimeters, of the 5 distances between the anatomic contacts from the mesial aspect of the left canine through the mesial aspect of the right canine.[15] All initial casts were digitized by a 3Shape R700 scanner (3Shape A/S, Copenhagen, Denmark), and the LII Index was applied to all mandibular and maxillary initial arches using the OrthoAnalyzerTM 3D software (3Shape A/S, Copenhagen, Denmark).

Two posterior and one anterior orientation points were used for tracing each occlusal mandibular and maxillary plane (Fig. 1). For the mandibular occlusal planes, they were the mesiobuccal cusp tips of both mandibular first molars and the midpoint of the incisal edge of the mandibular right central incisor. For the maxillary occlusal planes, they were the mesiopalatal cusp tips of both maxillary first molars and the midpoint of the incisal edge of the maxillary right central incisor. In this way, all dental arches had the LII applied exclusively on its own actual occlusal plane,[16] as originally recommended.[15] The operator was able to use the zoom tool, in order to closely visualize the contact points, and more precisely identify them (Fig. 2).[16]

The maxillary LII was used to create two groups with mild and severe

crowdings. As this variable did not show normal distribution (Shapiro Wilk test, p=0.000), the lower and upper quartiles (7.83 and 12.18, respectively) were used to compose two groups. All the cases with LII in the middle quartiles were excluded. The remaining individuals (N=74) were grouped in Mild Crowding (MC) and Severe Crowding (SC) groups, as follows:

- Group MC (N=37): individuals with LII smaller than 7.83 mm.
- Group SC (N=37): individuals with LII greater than 12.18 mm.

The maxillary and mandibular LII values were also used to check if they had an influence on treatment time, with the whole sample (N=150).

Groups comparability

For an accurate comparison, the groups should be comparable regarding sex, age at the start of treatment and the quality of occlusal orthodontic outcomes.

Orthodontic outcome analysis

Quality of the orthodontic outcomes was verified with the Objective Grading System (OGS), of the American Board of Orthodontics.[17] The OGS index consists of evaluation of eight items (alignment, marginal ridges levels, buccolingual inclination, overjet, anteroposterior occlusal relationships, occlusal contacts, interproximal contacts and roots parallelism). To evaluate the casts, a metal gauge with 0.5 mm thickness and 1.0 mm height was used (ABO Measuring Gauge, St. Louis, USA). This thickness and height allow it to be used as a parameter to measure deviations from normal (Fig. 3).

For each failure, one or two points were subtracted from the case, depending on the severity of the problem (Table I). The final individual OGS index corresponded to the sum of lost points in each of the eight factors.

Method error

For the intra-examiner error analyses, 30% of the initial sample (N= 45) were randomly chosen for having the LII and OGS indexes reapplied, 30 days after the first evaluation.

To estimate random errors, Dahlberg's formula was used.[18] For systematic errors, paired t tests were applied.[19] These tests were calculated through a Microsoft Excel 2010 worksheet, preformatted for this purpose.

Statistical Analyses

Means and standard deviations were calculated and Shapiro Wilk tests were applied in each variable to evaluate normal distribution. Age and treatment time did not show normal distribution, therefore the intergroup comparisons for these variables were performed non-parametric tests.

Chi-square was used to compare sex distribution in the groups. Mann-Whitney tests were used to evaluate comparability regarding the initial ages. Regarding the OGS index, comparability was tested by t tests. The treatment times of the two groups were compared by Mann-Whitney test.

Pearson correlation test was used to investigate the relationship between treatment time and maxillary and mandibular LII individually, and also to check the same relationship between maxillary and mandibular LII. All these tests were performed using Statistica software (Version 7.0; StatSoft Inc., Tulsa, OK, USA). Results were considered significant at $P<0.05$.

RESULTS

The random errors were within acceptable levels[20,21] (Table II). Significant systematic errors were found in marginal ridges and interproximal contacts evaluation.

The groups were comparable regarding sex distribution, initial age and OGS (Table III).

Treatment times were statistically similar in both groups (Table IV) and did not present significant correlations with maxillary or mandibular LII (Table V). Maxillary and mandibular irregularities were significantly correlated to each other (Table V).

Although there was no significant difference between treatment time in the groups, treatment time in the severe crowding group was numerically smaller than the mild crowding group. Therefore, intending to compose groups of extreme values of severe and mild crowding, several comparisons of treatment time were performed in subgroups with extreme values of mild and severe crowding in the maxillary arch, with different quantities of individuals in each subgroup. When the extreme subgroups had until 15 individuals each, the results showed that the extremely crowded cases had significantly smaller treatment time than cases with negligible maxillary crowding (Table VI).

DISCUSSION

Sample

The aim of this study was to evaluate whether extensive anterior retraction would require greater treatment time than correcting severe crowding in Class I malocclusions. To achieve that, these two conditions had to be isolated from other variables that could possibly mask the true answer. Since anteroposterior problems are able to increase treatment time,[2,22] a Class I malocclusion sample was chosen.

A Class I patient may have four first premolars extracted mainly due to severe crowding[23] and excessive dental protrusion, when usually teeth are reasonably aligned.[7] Dividing the groups according to the amount of crowding formed authentic groups of severe crowding and protruded patients, represented by the mild crowding group. With that organization, the results found are quite trustful, as the most genuine are the groups compared, more reliable the results.

The maxillary arch was chosen to divide the groups. This was based on the greater time that maxillary anterior retraction usually takes compared to the same process in the mandible, due to the increased difficulty in torque control.[24] With larger crowns, longer and wider roots, the movement happens slower, specially considering the higher incidence of root reabsorption found in maxillary incisors.[25] Furthermore, maxillary and mandibular values of the Little Irregularity Index were correlated (Table VI). Therefore, if the groups had been separated according the mandibular LII, the results probably would be similar.

Lastly, the groups were comparable regarding sex, age and quality of occlusal outcomes, which reduced the risk of confounding and selection bias. The index chosen to match them regarding the quality of orthodontic treatment was the Objective Grading System, since it is strongly recommended by the American Board of Orthodontics.[17,26,27]

Methods

The Little Irregularity Index, published in 1975, initially focused on the distances between the contact points of mandibular anterior teeth.[15] Afterwards the maxillary version of the index was created[28] and it started to be used in several researches on anterior crowding.[29,30]

Originally, the index was designed to be manually applied in dental casts, using tools such as a caliper. When adopted according to this original technique, the

index may be criticized, due to the discrepancies between examiners.[31] That may happen due to cumbersome difficulties in the original method, such as carefully hand-keeping the caliper parallel to the occlusal plane all the time, and also visually identifying the contact points, without the help of digital magnification.

However, with the recent digital models technology,[32,33] the usual measurements developed for dental casts, including Little Irregularity Index may be performed by softwares, saving time and assuring much more precision.[16,34,35] That becomes clear while analyzing the high reproducibility achieved in the LII measurements in this research (Table II).

The LII absolute values found for the MC group (Table III) may seem high to express mild crowding. However, they are in accordance to initial LII values found for 4-premolar extraction groups from other studies.[29,36] Another reason may have contributed to that. A digital zoom tool, as the one available in this study, improves so much the contact points visualization that it is unlikely for a irregularity site to be measured as zero or close to it, as it has been previously demonstrated.[16] Even in the well-aligned arches, as the example shown in Fig. 4, the five values individually measured are low but not zero, in the maxilla and mandible. After they are added, the whole values became greater than 2 mm each.

Results

Mild crowding and severe crowding groups had treatment times of 30.75 and 27.73 moths, respectively. Although this difference was not statistically significant, the presence of crowding somehow decreased the treatment time, considering that all other factors were controlled.

Mechanical consideration may be applied to this result. In protruded patients, anterior retraction with no mesial movement of molars is desired, due to its effects on the final profile.[7] Pure retraction requires skeletal anchorage,[37,38] and it may take more time, since space is consumed exclusively from mesial to distal direction. On the other hand, anterior retraction with concomitant anchorage loss may abbreviate space closure, since it is consumed in both directions.[39,40]

In this retrospective sample, there may have been some mesial movement of molars, since all cases were treated with conventional anchorage. In the more crowded cases, only the canines were partially distalized, while the incisors were subsequently aligned, so there was not too much space for anchorage loss.[2,5] In mild

crowding cases, the six anterior teeth were supposed to be extensively translated, which was conventionally anchored on molars, allowing reciprocal movement during all the retraction.[41] That may have made MC group treatment time smaller than expected, therefore not statistically different than the SC group.

The amount of retraction was not an objective of this study and the Objective Grading System does not consider cephalometrics. The groups were both well finished according to OGS index. If all cases had experienced pure retraction, the difference in treatment time could have been significant.

Because there was a numerical difference in treatment time between the mild and severe crowding groups, subgroups with extremely low and severe maxillary incisor irregularity were further compared. In Table VII, it is possible to observe that when very extreme groups of insignificant and extremely severe maxillary crowding were selected, treatment time was significantly smaller in the severely crowded group. This result shows that although not strong, there is some correlation between maxillary crowding and treatment time. Future studies with larger groups should be conducted to confirm this tendency.

CONCLUSIONS

- There was no significant difference in treatment time of Class I malocclusions with mild and severe crowding, treated with 4-first premolar extractions.
- However, there was significantly shorter treatment time in cases with extreme maxillary incisor irregularity as compared to cases with insignificant maxillary incisor irregularity.

FIGURES

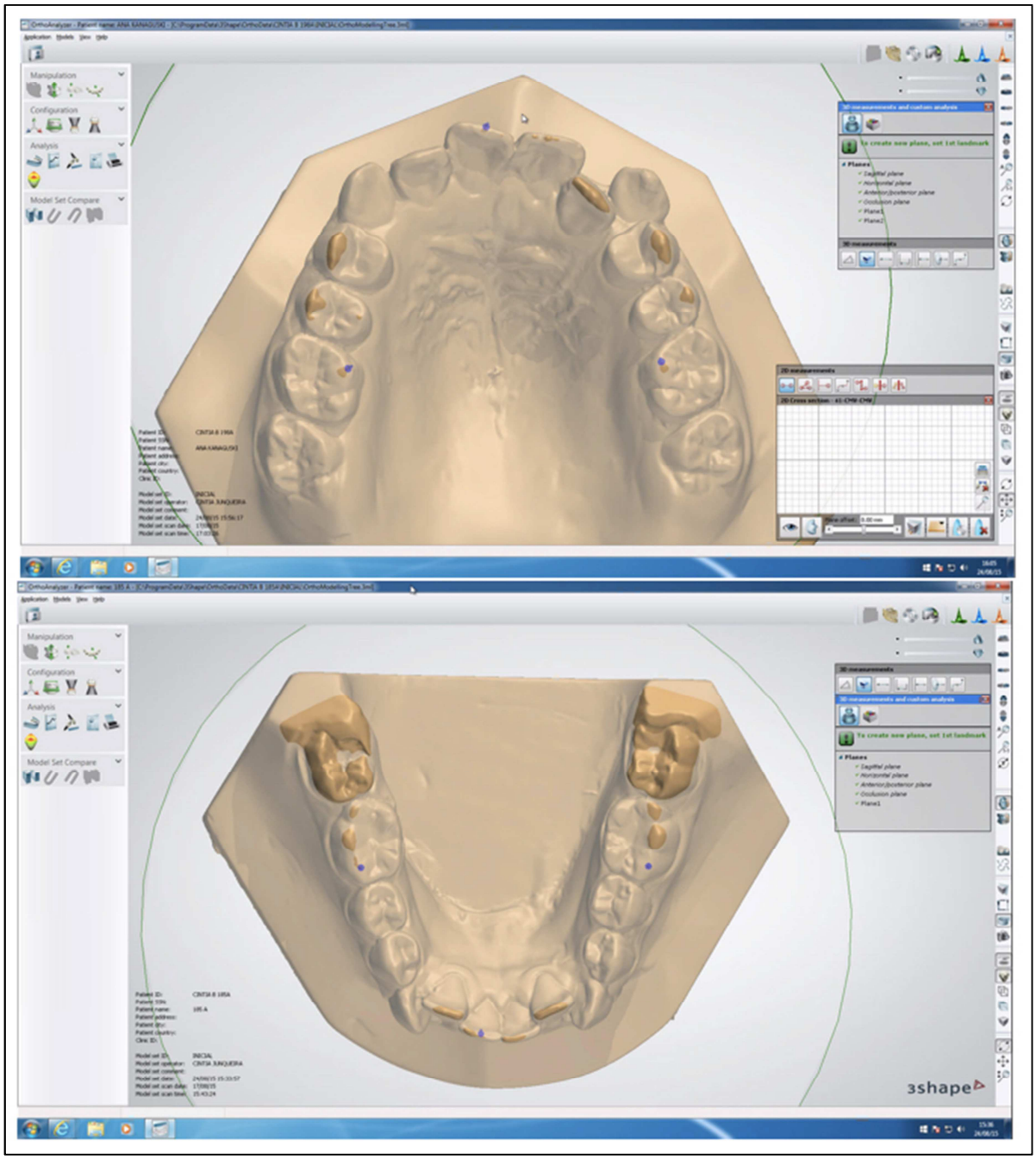

Figure 1. Maxillary and mandibular orientation points for their respective occlusal planes.

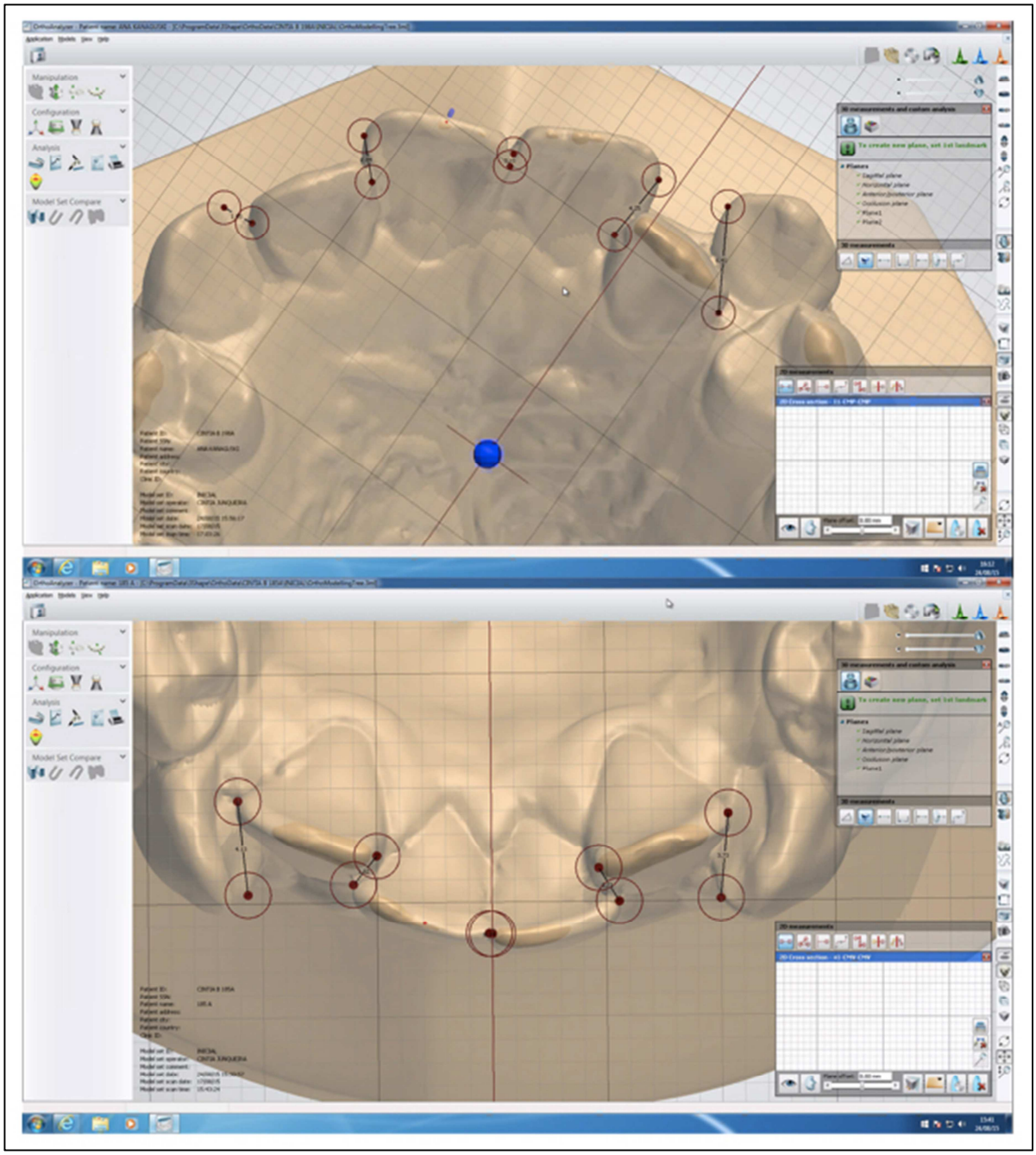

Figure 2. Maxillary and mandibular crowding evaluation with Little Irregularity Index, using the OrthoAnalyzerTM 3D software.

Figure 3. ABO Measuring Gauge, St. Louis, USA.

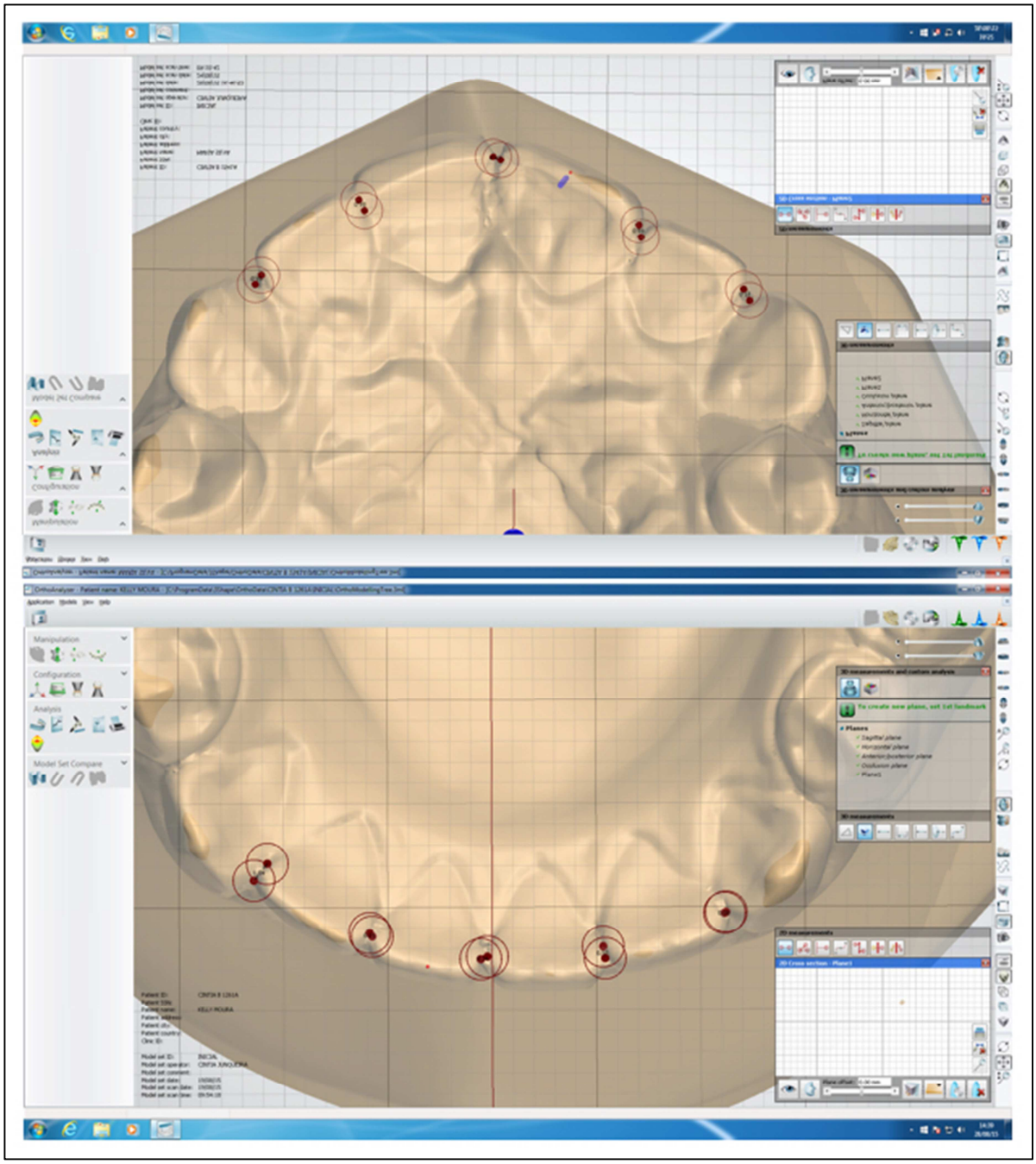

Figure 4. Mild crowding arch examples, where the LII values were low.

TABLES

Table I. Objective Grading System summarized description[17]

Item	Marginal error	Subtracted points
Alignment	0.5 to 1 mm	1 per each deviated teeth
	1 mm or	2 per each deviated teeth
Marginal ridges leveling	0.5 to 1 mm	1 per each posterior interproximal contact
	1 mm or more	2 per each posterior interproximal contact
Buccolingual inclination	1.1 to 2 mm	1 per each posterior teeth
	2 mm or more	2 per each posterior teeth
Occlusal contacts	Until 1 mm	1 per each posterior teeth with no contact
	1 mm or more	2 per each posterior teeth with no contact
Anteroposterior relationship	1 to 2 mm	1 per each superior teeth from canine to 2nd molar
	2 mm or more	2 per each superior teeth from canine to 2nd molar
Overjet	Until 1 mm	1 per each superior teeth with no contact
	More than 1 mm	2 per each superior teeth with no contact
Interproximal contacts	0.6 a 1 mm	1 per each interproximal contact
	More than 1 mm	2 per each interproximal contact
Root angulation	Not parallel roots	1 per each occurrence
	Root contacts the adjacent	2 per each occurrence

Table II. Intra-examiner random and systematic errors (Dalhberg's formula and dependent t tests) for Little Irregularity Index and Objective Grading System Index

		1st Measurement		2nd Measurement		Dalhberg	p
		Mean	**SD**	**Mean**	**SD**		
LII	Maxilla	9.97	2.63	9.91	2.67	0.73	0.697
(N=45)	Mandible	8.87	3.14	8.91	3.14	0.78	0.817
OGS (N=23)		23.00	8.15	23.57	8.78	2.30	0.416

Table III. Descriptive analysis, results of the normality test and intergroup comparability regarding sex, initial age and OGS

Variables	**MC Group (N=37)**		**SC Group (N=37)**		
	Mean	**SD**	**Mean**	**SD**	
Maxillary LII (mm)	6.47	1.02	15.36	3.40	
Mandibular LII (mm)	7.70	2.63	9.61	3.61	
	Male	**Female**	**Male**	**Female**	p
Sex (N/%)	14 (45.16)	23 (53.49)	17 (54.84)	20 (46.51)	0.480[a]
	Mean	**SD**	**Mean**	**SD**	p
Age (years)	13.94	2.32	14.69	3.86	0.563[b]
OGS (lost points)	21.68	7.50	24.11	8.75	0.203[c]

[a] Chi-square test

[b] Mann Whitney test

[c] T test

Table IV. Intergroup comparison regarding treatment time (Mann Whitney test)

	Group MC (N=37)		**Group SC (N=37)**		
	Mean	**SD**	**Mean**	**SD**	**P**
Treatment time (months)	30.75	9.84	27.73	10.13	0.149

Table V. Results of the Pearson correlation test between treatment time and maxillary and mandibular LII; and maxillary and mandibular LII

N=150	R	p
Treatment time X Maxillary LII	-0.0914	0.266
Treatment time X Mandibular LII	-0.0765	0.352
Maxillary LII X Mandibular LII	0.2138	0.009*

* Statistically significant at $P<0.05$

Table VI. Descriptive analysis, comparability between the most extreme groups regarding sex, initial age, OGS and comparison of treatment times

Variables	**MC Group (N=15)**		**SC Group (N=15)**		
	Mean	SD	Mean	SD	
Maxillary LII	5.50	0.85	18.34	3.61	
Mandibular LII	6.40	2.04	9.42	4.31	
	Male	Female	Male	Female	p
Sex (N/%)	4 / 26.67	11 / 73.33	9 / 60.00	6 / 40.00	0,065[a]
	Mean	SD	Mean	SD	p
Age (years)	14.67	2.69	14.38	2.38	0.757[b]
OGS (lost points)	24.00	7.79	23.73	9.58	0.443[c]
T time (months)	35.00	9.13	27.54	10.35	0.014[c]*

[a] Chi-square test

[b] Independent t test

[c] Mann Whitney Test

[*] Statistically significant at $P<0.05$

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2.2 Second article

LIPS PROJECTION AND NASOLABIAL ANGLE IN ATTRACTIVE FACES: A SYSTEMATIC REVIEW

ABSTRACT

Objective: To search orthodontic literature for the amount of lips projection (LP) and nasolabial angle (NLA) found in attractive faces. **Material and Methods:** With the keywords “facial attractiveness”, “facial esthetics”, “facial aesthetics” and “Orthodontics”, PubMed, Scopus, Web of Science, Embase and Cochrane databases were searched for studies published until October 2015. They had to present LP and/or NLA in objective parameters, extracted from attractive groups or digitally manipulated images, submitted to the judgment of at least 10 non-Dentist raters or a professional team on esthetics. The evaluated samples/images, number/type of raters, method of evaluation, the author’s conclusion and the risk of bias were evaluated. **Results**: Thirteen articles were selected. The distances between upper (Ls-E) and lower (Li-E) lips to Ricketts’ E line, in White attractive groups, ranged from -7.2 to -1.65 mm and from -5.05 to -0.67 mm, respectively, while NLA ranged from 100.42° to 109.6°. In Black attractive groups, LP was mostly described by the angles LsGPg’ and LiGPg’ – Labrale superius and Labrale inferius with Glabela-Soft tissue pogonion, which varied from 6.9 to 7.6°, and from 5.0 to 5.5°, respectively. The NLA, ranged from 95.8° to 98.3°. In Japanese/Korean attractive groups, Ls-E ranged from -6.9 to -0.3 mm, Li-E from -5.3 to 1.09 mm and NLA from 95° to 112°. **Conclusions:** LP and the NLA may widely vary according to ethnicity and sex.

Key-words: Lip; Cephalometry; Orthodontics; Esthetics.

INTRODUCTION

Facial attractiveness is one of the primary objectives of orthodontic treatment.[1-4] It is always expected from orthodontists to preserve the good facial features or improve them. The lips contour may dramatically change during treatment.[5] Therapies based on extractions followed by anterior retraction may significantly change lip posture. In specific situations, it may also influence nose

appearance and other aspects related to the lower facial third. This effect upon the soft-tissue profile has to be carefully planned.

For a long time, extractions used to be a frequent solution for several malocclusions, despite the patients´ age or amount of lips support.[6] The assumption that extraction treatment with excessive retrusion can impair the facial profile has discouraged this treatment approach.[7] However, treatment with or without extractions may benefit the facial profile, if it is properly planned.[4,8]

Orthodontists are historically used to evaluate facial aspects of their patients according to cephalometric measurements. Usually, concerns are on lips projection (LP) and on the nasolabial angle (NLA), which may be affected according to incisors anteroposterior position. When anterior retraction is excessive, an older looking may result, while fuller lips provide younger looking.[9]

Different amounts of LP, as well as obtuse or acute NLA, may be adequate or not for a specific person or population. The fear of the "dished-in" profile[4,10] sometimes may deprive a patient from a treatment alternative, such as having teeth extracted. In order to use what is adequate for each patient, orthodontists should be aware of how different facial attributes are analyzed by their patients.

Moved by these questions, this study searched the literature for updated studies that submitted faces and/or profiles to non-professional judgment and reported clear and objective parameters regarding their attractiveness. Therefore, the aim of this systematic review was to describe the reported values of lips projection and nasolabial angle for good facial attractiveness, for the main ethnic groups.

MATERIAL AND METHODS

Search methods

A computerized search was conducted in dental journals in the following electronic databases: PubMed, Scopus, Web of Science, Embase and Cochrane. With the help of a senior librarian, the keywords "Orthodontics", "facial attractiveness", "facial esthetics" and "facial aesthetics" were chosen (Table 1). The initial search was performed by title and abstract.

Selection criteria

The PICOS (People, Intervention, Comparison, Outcomes and Study Design) concept was followed to identify potential articles (Table 2).[11] The initial inclusion criteria of the studies were:

- published until October 2015,
- conducted with adult samples (minimum 16-year-old),[12,13] or carefully manipulated digital images,
- minimum of 10 raters, discarding professional judgment, such as orthodontists, oral or plastic surgeons (studies that used esthetic professional judgments, such as reference magazines or websites specialized in facial beauty, assuming that they included experts on facial beauty and esthetic preferences, were also included),[12,14]
- reporting the amount of LP and/or NLA found in profiles/groups considered attractive, in objective cephalometric parameters.

This selection process was independently conducted by two examiners. Thereafter, the articles from the selected abstracts were independently evaluated by three investigators. Interexaminer conflicts were resolved by discussion on each article to reach a consensus regarding which articles fulfilled the main selection criteria. The references used in all the selected articles were hand-searched for additional studies (Table 1).

Risk of bias

The ultimately selected articles were analyzed based on the Cochrane Collaboration risk of bias tool (Table 3).[15] An overall assessment classified each included study as with high, unclear or low risk of bias. Studies with at least 1 criterion classified as unclear or high risk of bias were regarded as having a unclear or high risk of bias overall, respectively.

Data collection and analyses

Description of evaluated images, raters, method of judging attractiveness, and the author's findings were extracted from the eligible studies to analyze them. Eventually, when some important information was not available on the articles, contact was made with the authors requesting them. After solving the inconsistencies, the articles were finally included in the sample or not.

RESULTS

From PubMed, Web of Science, Scopus, Embase and hand search, 377, 186, 435, 289 and 4 articles were retrieved (Table 1). After excluding repetitions, 491 titles and abstracts remained, from which 189 full-text articles were assessed for eligibility. The main reasons for exclusions were: children samples, lack of standardized images, absence of esthetic judgment (only cephalometric measures reported) and professional judgment. In this systematic review, 13 articles met the initial inclusion criteria (Figure 1). After risk of bias analysis, six articles were classified as low, two as unclear and five as high (Table 4).

Lips projection and nasolabial angle were investigated in thirteen and nine articles, respectively. Eight studies evaluated samples of actual subjects, from White, Black, Japanese/Korean or Indian populations. The other five studies evaluated LP or NLA in digital images. Three studies reported the same parameters for pooled sexes, while ten separated their results according to sex (Table 5).

Cephalometric variables

Several variables reported LP found in attractive faces (Table 6). The most frequent parameter was the distance between upper and lower lips to Ricketts' E line, in 11[12,14,16-22] out of 13 studies. All studies that investigated the NLA in attractive faces considered it as the angle formed by Columella, Subnasale and Labrale superius (CmSnLs).

Lips projection and nasolabial angle in attractive faces

Table 7 describes the evaluated samples/images, number and type of raters, method of evaluation and the author's conclusion about preferred LP and NLA. To analyze the results the following rationale was used:

When there was more than one ethnic group,[16,22,23] the results were organized according to the ethnicity (Figures 4, 5 and 6); when there was more than one group of raters,[17,20,24] all were considered. For studies that divided their samples according to periods, only the more recent was considered.[14,21] When a range of lip protrusion was reported, the mean value was calculated.[16]

In White attractive groups, Ls-E ranged from -7.2 to -1.65 mm; Li-E from -5.05 to -0.67 mm and NLA from 100.42 to 109.6° (Figure 4). In Black attractive groups, the most common variables describing LP were LsGPg' and LiGpg', which varied from

6.9 to 7.6° and from 5.0 to 5.5°, respectively. The NLA ranged from 95.8 to 98.3° (Figure 5). In Japanese/Korean attractive groups, Ls-E ranged from -6.9 to -0.3 mm; Li-E from -5.3 to 1.09 mm and NLA from 95° to 112° (Figure 6). The study about Indian population reported preferred NLA as 103.84°, Ls-E as -3.36 mm and Li-E as -1.45 mm.

DISCUSSION

This review aimed to provide to the orthodontists a guide about the preferable amount of lips projection and nasolabial angle in different phenotypes. This will help in choosing a treatment alternative, according to particular preferences regarding lips protrusion or retrusion.

Elegibility criteria

Although influenced by heredity, culture and environment,[3] esthetic is a very subjective concept,[25] which requires evaluation of significant samples. The simple comparison of pre- and posttreatment cephalometric values is limited, and may infer nothing about the esthetic preference. Numbers extracted from judged faces help to establish patterns for different patients.[26]

The requirement of lay raters prevented expected conflicts against professional judgment, who see their optimal facial objectives technically.[27] Consequent of being trained in facial analyses, professionals may have a biased perspective, not representing the genuine opinion of patients, who hold the most important opinion regarding facial esthetics.[28] Any investigation on facial esthetics in which subjective evaluations are necessary, lay group's opinions about "acceptable faces" should be carefully analysed.[29,30]

Some studies choose magazines or Internet database as a sample source in facial esthetics. Although they may have relied on factors such as popularity, success and power, the celebrities used to set fashion trends during the article's publication period.[23] As fashion editors are considered experts on current esthetic preferences,[12,13] those photographs depicted the preferred profile of their time.[14]

Risk of bias

The reported results deeply minimized biased opinion, since laypeople's representatives judged the images, ensuring those were actually attractive groups.

Individual features such as eyes or hairstyle, may be considered confounding factors. However, the large-size samples made it difficult for the studies to be impaired by this kind of heterogeneity. Even though personal features may influence judgment of esthetics, it could have happened with all the samples. Indeed, attractive groups would not have similar lips projection or nasolabial angle purely at random. The profile might have played a role on the attractiveness rating.

In studies with "digitally manipulated images", they had to look natural, so that the raters fairly evaluated the images. Reasonable modifications reassured that lower grades were not consequent to artificial profile contour, especially in the chin, lips or nose.

From the most diverging LP results regarding the E-line, three did not come from actual patients, but from digitally manipulated images.[16,17,24] These studies had results somewhat different than those with actual images, which were more homogeneous,[12,21,22] and seemed more reliable, not vulnerable to the quality of the simulations.[31]

Lips projection and nasolabial angle in attractive faces

Although the use of distinct reference lines may produce different results,[2] the E-line was preferred to discuss the present results for being the most cited and for allowing assessment of lip profile in the important context of nasal protrusion.

According to Ricketts, the ideal distance from the upper and lower lips to the E-line is -3 and -2 mm, respectively, in Caucasians.[20] Nevertheless, different ethnic groups and sexes may have different amounts of lips protrusion. These two factors will be simultaneously addressed.

Sexual and ethnic dimorphism

In the seven studies that analysed White attractive groups, Ls-E and Li-E widely varied. That may be explained by the variety in methodologies. Some of them analysed attractive subjects, and others, celebrities or digitally manipulated images.

As clearly observed in Figure 4, the more retruded preferred lips and the wider NLA values reported were obtained from male images.[14,22] It may be inferred that

more retruded lips are better accepted in men. The results with attractive women showed more protruded lips,[12,20,21] which means female standards require fuller lips than males.

Almost all the studies preferred lips position behind the E-line, except Yehezkel[18] and Alcalde[19], in their African American and Japanese female groups, respectively. Again, Black, Japanese and females seem to have more protruded lips, compared to white and males, respectively, explained by the aforementioned sexual and ethnic particularities.[32]

Less used but still important is the interlabial angle, from which the largest values were found in attractive White males[12] and females[21] (Figure 3). As expected, they came from White groups that generally show flatter profiles then Black.[33]

In Black attractive groups, the most common variables describing LP were LiGPg' and LiGPg', which varied from 6.9 to 7.6° and from 5.0 to 5.5°, respectively, showing slightly more protruded upper than lower lips (Figure 3). The smallest values found for the ILA came from Black females[23] and for African American females,[18] in agreement with their phenotype, likely to have greater lips protrusion.[26]

The NLA in Blacks ranged from 95.8° to 98.3° (Figure 5). The groups of Black attractive women[18,23] showed smaller NLA than White attractive women [12,21,23], confirming the greater tendency of Blacks towards lips protrusion.[18,23]

The NLA values found in attractive men with different ethnicity were very close to each other,[12,14,16] which suggests that preferred male lips protrusion does not widely vary according to racial types. Nevertheless, no study with Black samples selected here included male individuals. If so, probably more protruded lips would have been reported, as happened to women. This lack of information shows the need for further clarification regarding preference in male protrusion according to ethnicity.

In one study, the female NLA showed a negative slope through decades, which reflects a trend to greater lips projection.[12] On the other hand, the male LMA showed a positive slope, confirming a retrusive trend for male lips.[12]

In Japanese/Korean attractive groups, Ls-E ranged from -6.9 to -0.3 mm; Li-E from -5.3 to 1.09 mm and NLA from 95° to 112° (Figure 6). The expected sex tendency was observed, since female lips showed more protrusion than male. Conversely, that was not observed in the NLA, in which male values were more acute than female (Figure 6). Although these values were extracted from attractive groups, they partially follow the tendencies observed in this kind of population.

Oriental populations generally have a less convex skeletal profile, probably related to a retruted maxilla,[19] specially in men.[34] Also they show protruded upper lip, probably related to labioversion of the upper incisors,[19] a natural dental compensation that pushes the upper lip forward, so as in the general population.

In attractive Japanese/Korean subjects, the results confirmed that facial esthetics are related to racial preferences.[35] Although Japanese samples show more acute nasolabial angle and more anteriorly positioned upper lip regarding Nasion,[36] they apparently prefer flatter profiles than their typical esthetic feature.[16,19] An hypothesis to explain it is that American and European media may have influenced Japanese laypeople's preferences.[36]

Judges Heterogeneity

Judges´ ethnicity may have contributed to lip projection preferences. All studies included in this review came from different countries, with diverse culture and attractiveness standards. Judges' own criteria of beauty bring a strong cultural background. That could partially explain the variation of lips projection preferences.

CONCLUSIONS

It was possible to conclude that in attractive faces:

1. The distance from the upper lip to E-line ranged from -6.92 to 0.7 mm in females and from -6.92 to -1.97 mm in males; and the distance from the lower lip to E-line ranged from -1.91 to 1.09 mm in females and from -4.91 to 0 mm, in males.
2. The interlabial angle ranged from 108.77° to 130.00°, and the nasolabial angle from 95.8° to 115°.
3. Lips projection and the nasolabial angle may widely vary according to sex and ethnicity.

FIGURES

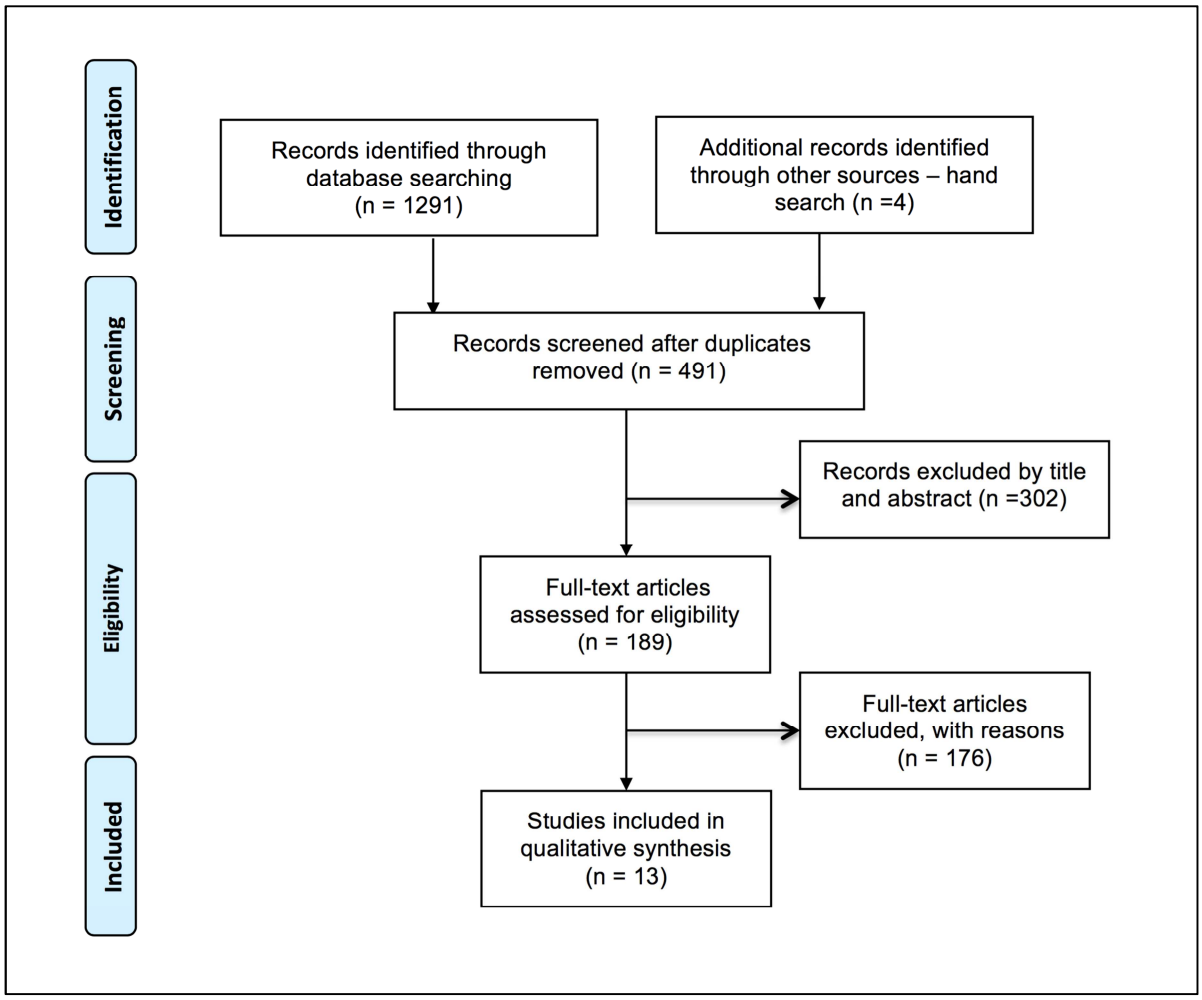

Figure 1. PRISMA Flow diagram.

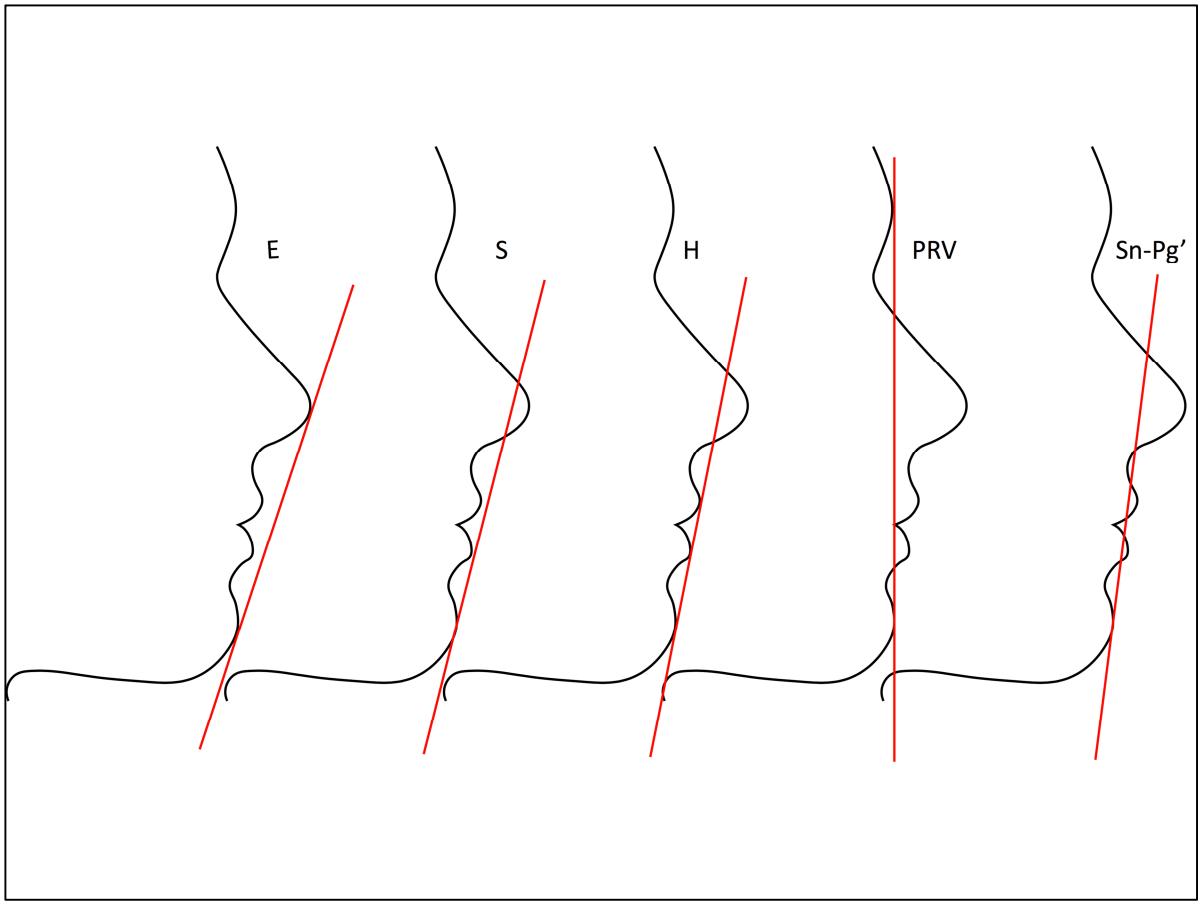

Figure 2. E, Ricketts' E line. **S,** Steiner's S line. **H,** Holdaway's H line. **PRV,** Profile Root Vertical Line. **Sn-Pg',** Sn-Pg' line.

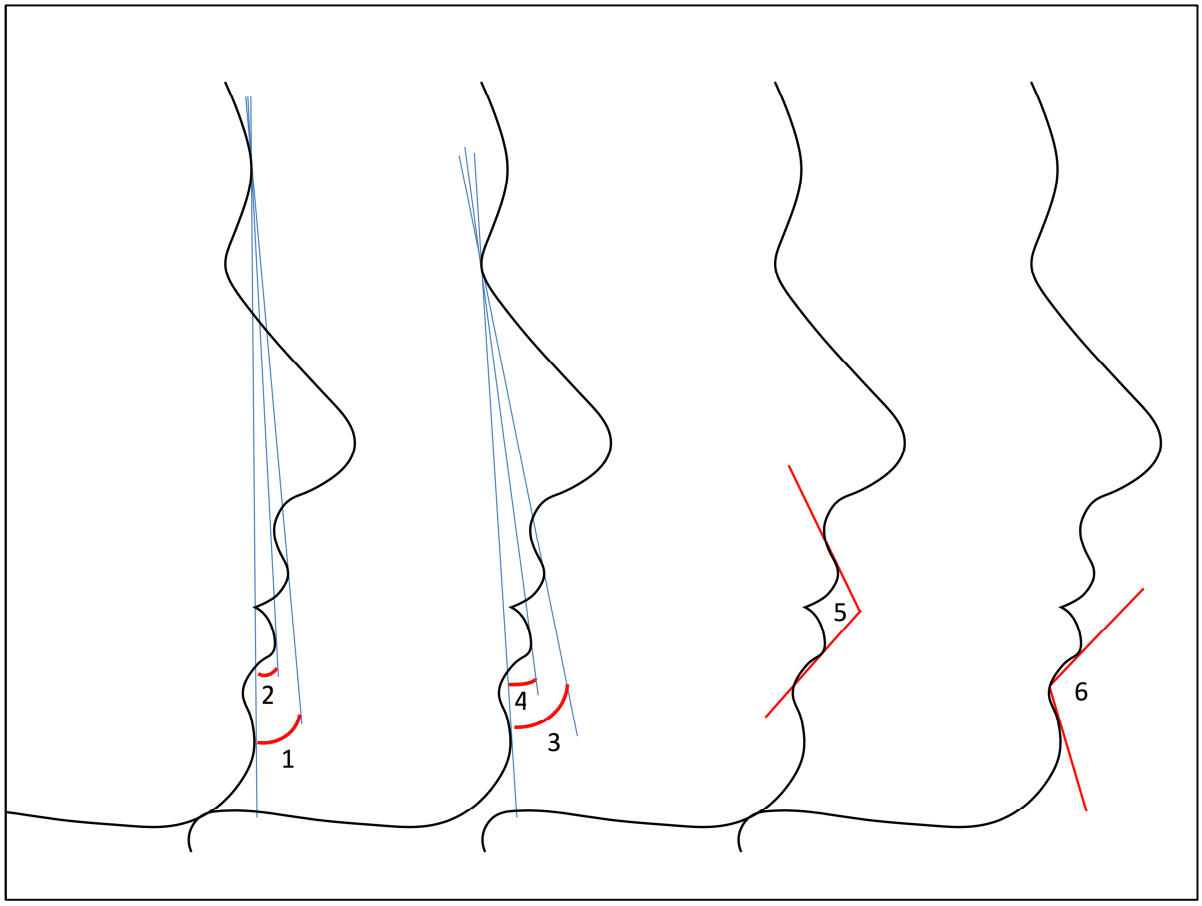

Figure 3. 1, LsGPg'. **2,** LiGPg'. **3,** LsNPg'. **4,** LiNPg'. **5,** A'LsLiB'. **6,** LiB'Pg'.

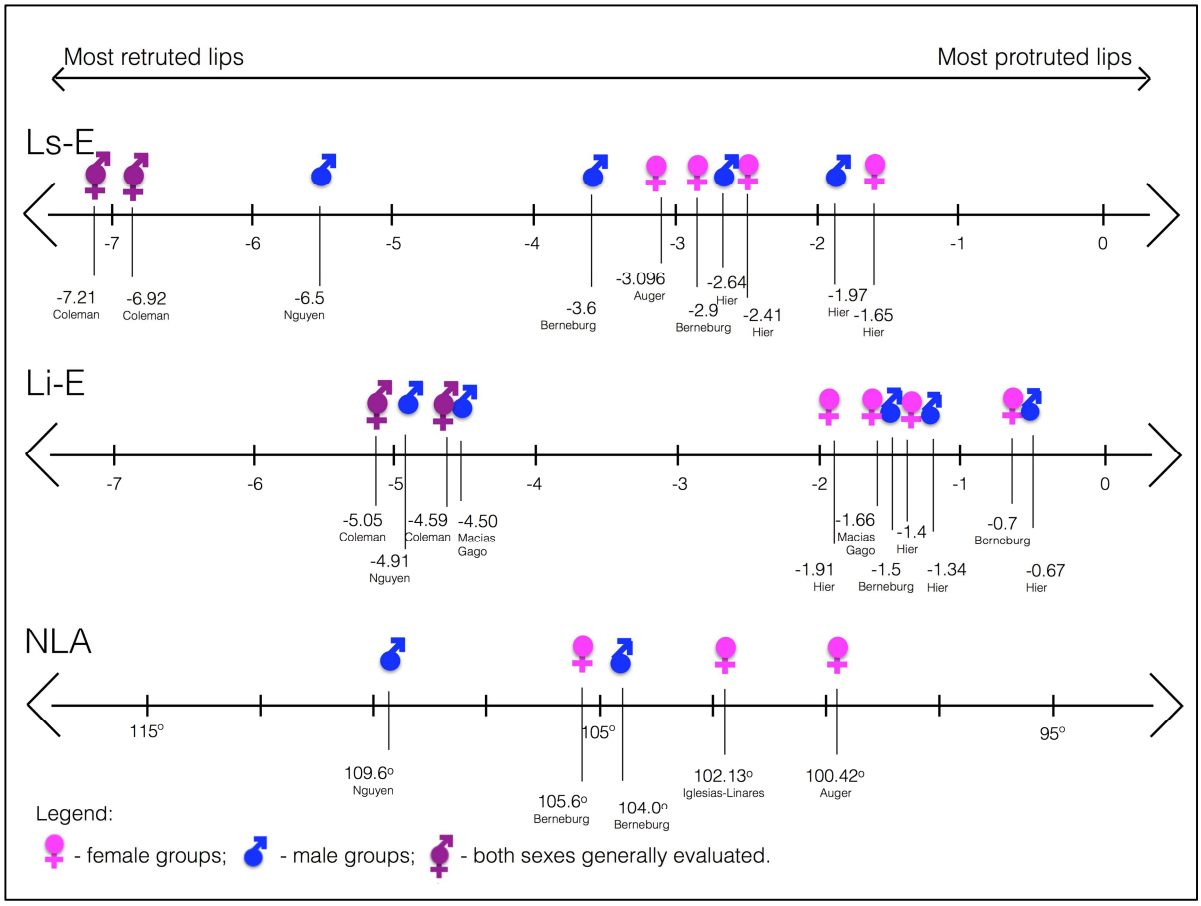

Figure 4. Values of Ls-E, Li-E and NLA for White attractive groups.

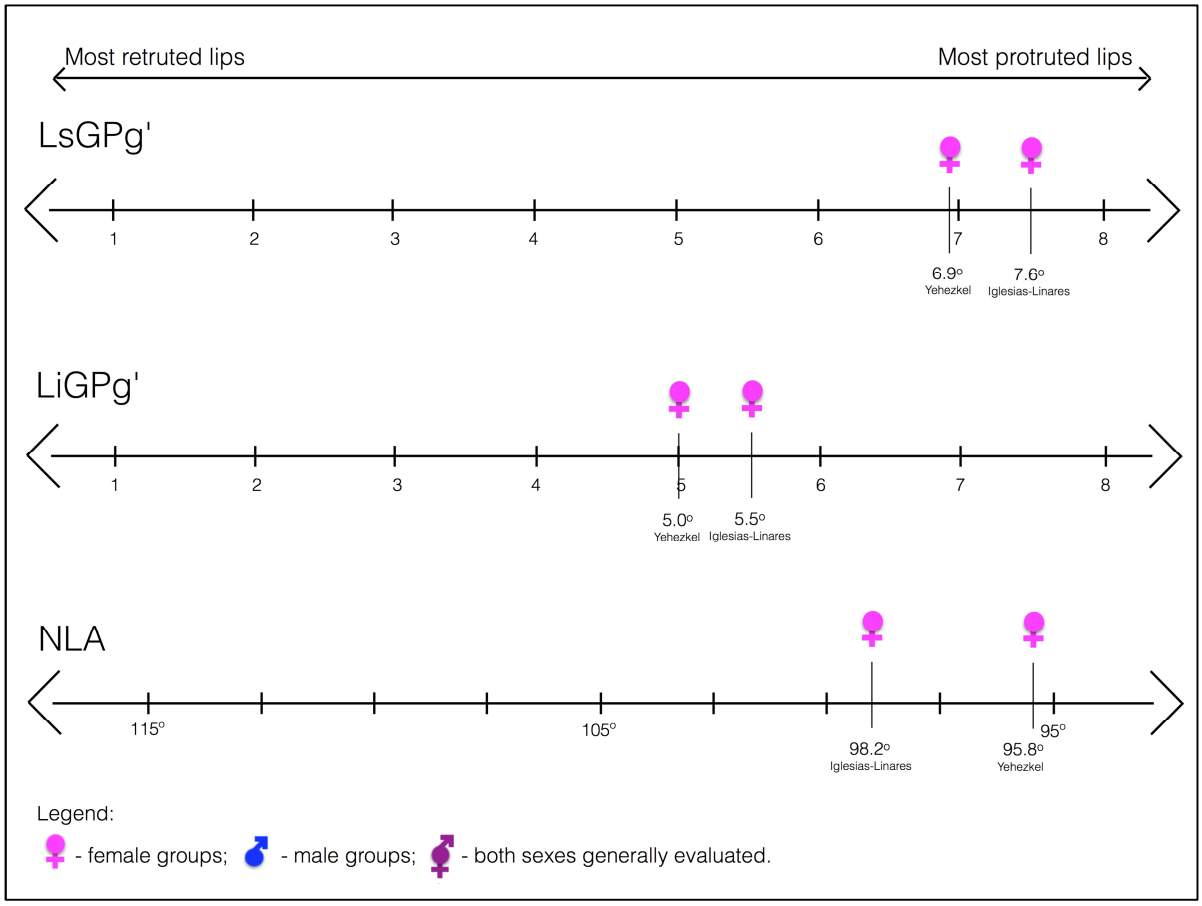

Figure 5. Values of LGPg' and LiGPg' and NLA for Black attractive groups.

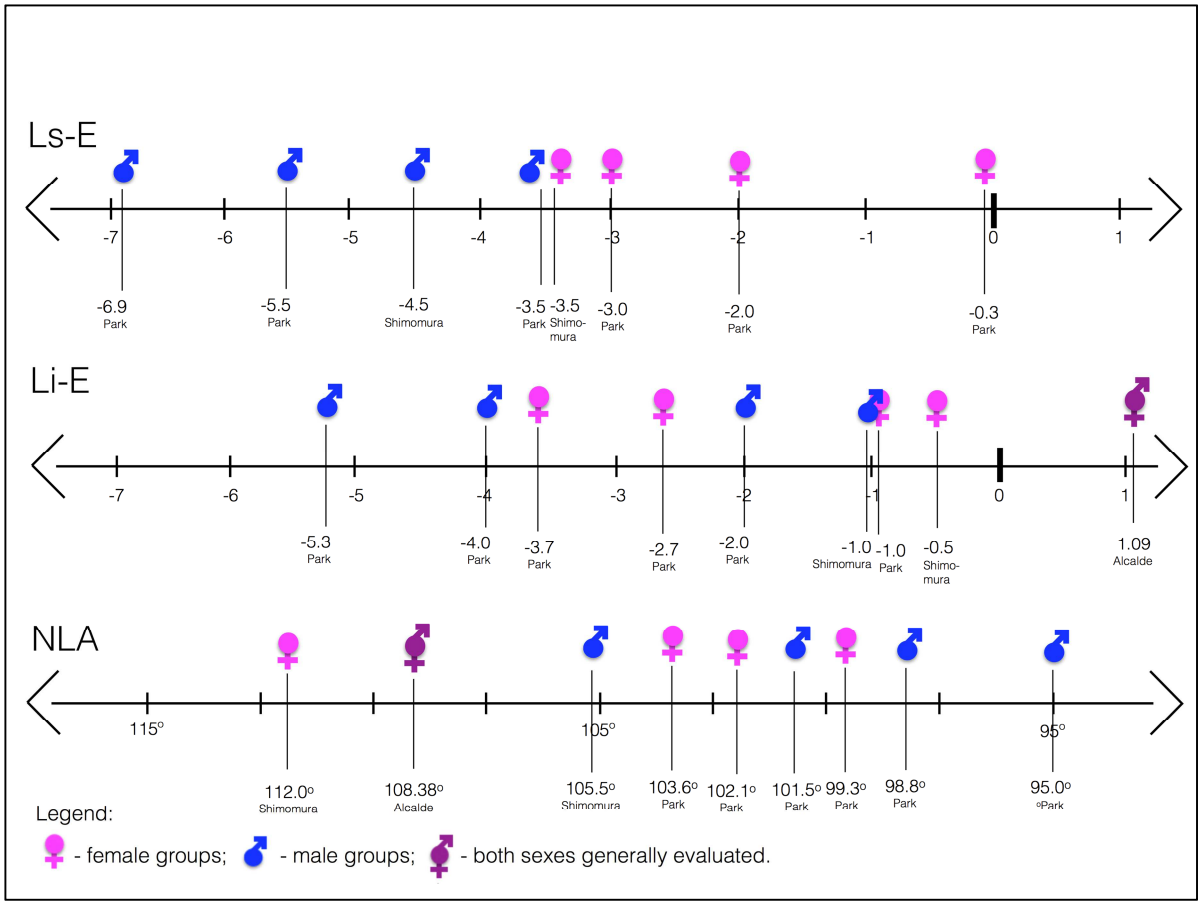

Figure 6. Values of Ls-E, Li-E and NLA for Japanese/Korean attractive groups.

TABLES

Table 1. Search terms and number of articles in each selection phase

Database	Key Words	Results	Selected
PUBMED	("facial attractiveness" AND orthodont*) OR ("facial esthetics" AND orthodont*) OR ("facial aesthetics" AND orthodont*)	377	
WEB OF SCIENCE	("facial attractiveness" AND orthodont*) OR ("facial esthetics" AND orthodont*) OR ("facial aesthetics" AND orthodont*)	186	
SCOPUS	("facial attractiveness" OR "facial esthetics" OR "facial aesthetics") AND orthodont*	435	
EMBASE	("facial attractiveness" AND orthodont*) OR ("facial esthetics" AND orthodont*) OR ("facial aesthetics" AND orthodont*)	289	
COCHRANE	("facial attractiveness" AND orthodont*) OR ("facial esthetics" AND orthodont*) OR ("facial aesthetics" AND orthodont*)	4	
HAND SEARCH		4	
Subtotal		1295	
TOTAL (without repetitions)		491	13

Table 2. PICOS (People, intervention, Comparison, Outcomes and Study Design) concept, followed to identify potential articles

People	Wide adult samples (minimum 16 years old) or carefully manipulated digital images.
Intervention	Individuals should have been submitted to the aesthetic judgment of at least 10 raters, such as laypeople or experts in facial beauty, creating an attractive group.
Comparison	Attractive groups were not supposed to have been necessarily compared to others, having been already segregated from the normal ones due to the judgment process.
Outcomes	The studies had to have reported the amount of lips projection and/or nasolabial angle found in attractive faces, in objective and clear cephalometric parameters.
Study design	Cross-sectional studies

Table 3. Risk of bias evaluating criteria

Data		Criteria used to judge each item
Selection bias	**Random sequence generation**	As this systematic review analysed cross-section studies, most of them did not have more than one group. The whole sample was basically composed by one group, which has to be properly described.
	Allocation concealment	Authors should clearly establish the origin and features of the evaluated faces or profiles, whether actual or digital. For those studies that used digitally created images, it had to be based on images derived from faces considered as having normal and standard characteristics, and it should be stated exactly which of the facial features were digitally altered and to what extent.
Performance bias	**Allocation concealment**	Confounding factors such as hairstyle, accessories or other individual characteristics should have been eliminated. Particularly for studies with actual patients, the sample had to be described as homogenous in ethnicity. For the studies performed with digitally altered images, they had to show natural modification of profile features. Besides having reasonable similarity with actual faces, the digitally manipulated images had to be based on original well-balanced profiles, such as normal Class I individuals with no cephalometric discrepancies.
		To enable a fair judgment, photographs, radiographs or whatever was the evaluated image should have been generated and exhibited in a standardized manner. For those who used professional judgment, the source had to be reliable and described in detail.
Detection bias	**Blinding of outcome assessment**	Cephalometric values had to be collected by a scientifically accepted method and statistical analyses had to have been appropriately performed.
Attrition bias	**Incomplete outcome data**	It should not remain doubts about the objective parameters assessed.
Reporting bias	**Selective reporting**	The objectives initially proposed which were pertinent to this review had to be clearly achieved by the end of research

Table 4. Risk of bias of the included studies, according to the Cochrane collaboration's tool for assessing risk of bias

Study	**Selection bias**		**Performance bias**	**Detection bias**	**Attrition bias**	**Reporting bias**	**Final risk of bias of each study**
	Random sequence generation	**Allocation concealment**	**Blinding of participants and personnel**	**Blinding of outcome assessment**	**Incomplete outcome data**	**Selective reporting**	
Gupta[37]	Low	Low	Low	High	Low	Low	HIGH
Park[24]	Low	Low	Low	Low	Low	Low	LOW
Macias Gago[22]	Low	Low	Low	High	Low	Unclear	HIGH
Iglesias-Linares[23]	Low	High	Low	Low	Low	Low	HIGH
Ousehal[38]	Low	Low	Low	Low	Low	Unclear	UNCLEAR
Shimomura[16]	Low	Low	Low	Low	Low	Low	LOW
Berneburg[12]	Low	Low	Low	Low	Unclear	Low	UNCLEAR
Coleman[17]	Low	High	High	Low	Low	Low	HIGH
Yehezkel[18]	Low	Low	Low	Low	Low	Low	LOW
Alcalde[19]	Low	Low	Low	Low	Low	Low	LOW
Hier[20]	Low	High	High	Low	Low	Low	HIGH
Auger[21]	Low	Low	Low	Low	Low	Low	LOW
Nguyen[14]	Low	Low	Low	Low	Low	Low	LOW

Table 5. Aspects related to the included articles

Article	Year of Publication	Quoted issue		Evaluated images		Sex specifically evaluated	
		Lips Projection	Nasolabial Angle	Actual patients	Digitally altered images	Male	Female
Gupta[37]	2014	X	X	X		X	X
Park[24]	2013	X	X		X	X	X
Macias Gago[22]	2012	X			X	X	X
Iglesias-Linares[23]	2011	X	X	X			X
Ousehal[38]	2011	X		X		Both sexes generally evaluated	
Shimomura[16]	2011	X	X		X	X	X
Berneburg[12]	2010	X	X	X		X	X
Coleman[17]	2007	X			X	Both sexes generally evaluated	
Yehezkel[18]	2004	X	X	X			X
Alcalde[19]	2000	X	X	X		Both sexes generally evaluated	
Hier[20]	1999	X			X	X	X
Auger[21]	1999	X	X	X			X
Nguyen[14]	1998	X	X	X		X	
Total	13	13	9	8	5	7	9

Table 6. Variables representing lips projection

Type of variable and definitions	**Landmarks involved**	**Abbreviation**
Linear measurements (Fig. 2): distance from the most anterior point of the upper and lower lips to the following lines	Rickets' Aesthetic line (Pronasal-Soft tissue pogonion)[12,14,16-22,24,37]	Ls-E Li-E
	Steiner's S line (Columella-Soft tissue pogonion)[12,14,18,21,38]	Ls-S Li-S
	Holdaway's H line (Soft tissue pogonion-Labrale superius)[19,37]	Li-H
	Profile Root Vertical Line (Glabela-Soft tissue pogonion)[12,14,18,21]	Ls-PRV Li-PRV
	SnPg' (Subnasale-Soft tissue pogonion)[16,19]	Ls-SnPg' Li-SnPg'
Angular measurements (Fig. 3): angle composed by	Labrale superius, Glabela and Soft tissue pogonion[18,23]	LsGPg'
	Labrale inferius, Glabela and Soft tissue pogonion[18,23]	LiGPg'
	Labrale superius, Nasion and Soft tissue pogonion[14]	LsNPg'
	Labrale inferius, Nasion and Soft tissue Pogonion[14]	LiNPg'
	The lines Soft tissue A point-Labrale superius and Soft tissue B point-Labrale inferius[12,18,21,23] (Interlabial angle)	ILA (A'LsLiB')
	Labrale inferius, Soft tissue B point and Soft tissue pogonion[12,23] (Labiomental angle)	LMA (LiB'Pg')

Table 7. Summarized data of the 13 studies Included in the review

Author and Year	Evaluated subjects or images	Lay raters (number and type)	Method of evaluation	Author's findings about the most attractive individuals
Gupta[37]	Facial frontal and profile photographs of 120 subjects (60 males and 60 females) older than 18 years of age	20 layman	A 100 mm visual analogue scale, from very unattractive to very attractive, with a line on which the tens from 0 to 100 were indicated	NLA (°): 105.43 (female); 102.24 (male); 103.84 (general) Ls-E (mm): -3.39 (female); -3.32 (male); -3.36 (general) Li-E (mm): -0.98 (female); -1.93 (male); -1.45 (general) Li-H (mm): 1.00 (female); 0.08 (male); 0.54 (general)
Park[24]	Two sets of 13 male and 13 female silhouettes, based on averages Korean sex-specific profiles, were created by centering average profile and shifting upper and lower lips in 1 mm increments to anterior and posterior	70 Korean raters: a young adult group (20–39 years), a middle-aged group (40–54 years), and a senior group (55–70 years)	Raters selected the three preferred profile silhouettes for each gender. For the three most-preferred male and female silhouettes selected for each sex, cephalometric measurements were taken	Ls-E (mm): Young raters: -0.3 (female); -3.5 (male) Middle-aged raters: -2.0 (female); -5.5 (male) Senior raters: -3.0 (female); -6.9 (male) Li-E (mm): Young raters: -1.0 (female); -2.0 (male) Middle-aged raters: -2.7 (female); -4.0 (male); Senior raters: -3.7 (female); -5.3 (male) NLA (°): Young reaters: 99.3 (female); 95.0 (male) Middle-aged raters: 102.1 (female); 98.8 (male) Senior raters: 103.6 (female); 101.5 (male)
Macias Gago[22]	Frontal relaxed, frontal smiling and profile photographs of 89 European individuals (77 females, 12 males), between 20 and 34 years of age	34 Physiotherapy students (30 female and 4 male)	5-point attractiveness scale with values from 1 (very unattractive) to 5 (very attractive)	Li-E (mm): female: -1.66; male: -4.50; general: -2.18
Iglesias-Linares[23]	Lateral photographs of 40 black and 40 white women selected from *People* magazine's 100 most beautiful people in the previous 10 years	More than 100 American readers	The selected individuals were considered the most beautiful people on each year during the last previous years by a multiethnic, global judgment regarding beauty	LsGPg' (°): 7.16 (white), 7.60 (black) LiGPg' (°): 5.12 (white), 5.50 (black) ILA (°): 114.27 (white); 108.77 (black) LMA (°): 108.75 (white), 104.77 (black) NLA (°): 102.13 (white), 98.28 (black)
Ousehal[38]	Full face, profile and three-quarter face smile photographic views of 100 normal Moroccan Dental Medicine students (52 women, 48 men)	10 members, different socio-economic and cultural backgrounds	Through a visual analog scale (VAS), the eight most attractive subjects were elected	Ls-S: 0.0 to 1.3mm Li-S: -0.75 to 0.0mm and exceed it in 1 case
Shimomura[16]	From Japanese average profiles, 13 male and 13 female profiles were developed, with lips protruded or retruded in 1 mm increments from the average profile	150 Japanese orthodontic patients (minimum 15 years of age)	The raters chose the top 3 most favored, well-balanced profiles for each sex. The top 3 most-favored male and female profiles were evaluated cephalometrically	Ls-E (mm): -4.5 to -2.5 (female); -5.5 to -3.5 (male). Mean -3.5 (female); -4.5 (male) Li-E (mm): -1.5 to 0.5 (female); -2.0 to 0 (male). Mean -0.5 (female); -1.0 (male) Ls-SnPg'(mm): 2.5 to 4.5mm (female); 3.4 to 5.4(male). Mean 3.5 (female); -4.4. (male) Li-SnPg'(mm): 2.4 to 4.4 (female); 2.7 to 4.7 (male). Mean 3.5 (female); 3.7 (male) NLA (°): 109.0 to 115.0 (female); 104.0 to 107.0 (male). Mean 112.0 (female); 105.5 (male)
Beneburg[12]	Profile photographs of 200 men and 200 white women considered attractive between 1940 and 2008 were downloaded from Internet, grouped by decades for analysis	Websites that provided images to the research	This approach was selected because databases of this type specialize in depicting high-profile people universally admired for their attractiveness	Ls-E (mm): -2.9mm (female); -3.6(male) Li-E (mm): -0.7 (female); -1.5 (male) Ls-S (mm): -1.5 (female); -2.0(male) Li-S (mm): -0.0 (female); -0.6 (male) Li-PRV' (mm): 2.8 (female); 2.7 (male) ILA (°): 122.1 (female); 130.0 (male) LMA (°): 126.9 (female); 124.9* (men) NLA (°): 105.6* (female); 104.0 (male) *Mean value from 1940 to 2008 - preferences changed significantly with time.

Coleman[17]	A dental and skeletal Class I white patient had the upper and lower lips drawn, from a retruded to a protruded position beyond Ricketts' E-plane	20 male and 20 female white adolescent orthodontic patients and 20 male and 20 female white parents of orthodontic patients	Each evaluator was able to choose the most pleasing positions to the upper and lower lips	Ls-E (mm)*: -6.92 (patient raters); -7.21 (parent raters) Li-E (mm)*: -4.59 (patient raters); -5.05 (parent raters) *Class I group - facial convexity angle of -11°
Yehezkel[18]	17 lateral photographs of African American female models from 1990 to 1999	African American fashion magazines issues	Issues were reviewed searching for photographs that matched specific inclusion criteria	Ls-E (mm): -0.7 Li-E (mm): 1.3 Ls-S (mm): 1.0 Li-S (mm): 2.4 Ls-PRV (mm): 7.0 Li-PRV (mm): 6.2 LsGPg'(°): 6.9 LiGPg' (°): 5.0 ILA (°): 111.5 NLA (°): 95.8
Alcalde[19]	A black soft tissue profile obtained from lateral photographs of 211 Japanese adults (92 males; 119 females) from 20 to 28 years of age; who met specific inclusion criteria	10 Japanese lay judges from 25 to 65 years of age	Each profile was evaluated as very pleasant (5 points), pleasant (4 points), average (3 points), below average (2 points), and unpleasant (1 point)	Li-E (mm): 1.09 Li-H (mm): 0.58 Ls-SnPg' (mm): 4.68 Li-SnPg' (mm): 3.05 NLA* (°): 108.38
Hier[20]	From a profile photograph of a 28-year-old Caucasian male, 14 extreme retrusive and 14 extreme protrusive positions of the upper and lower lips were created, horizontally distorting the lips to result in 29 frames for each sex	28 female and 25 male university students from 17 to 30 years of age	Judges indicated the most pleasing lip position and about a range of acceptability, related to the lip protrusion X retrusion	Ls-E (mm): Female: -2.41 (male raters); -1.65mm (female raters) Male: -2.64 (male raters); -1.97 mm (female raters) Li-E (mm): Female: -1.4 (male raters); -0.65 (female raters) Male: -1.34 (male raters); -0.67 mm (female raters)
Auger[21]	Profile photographs of 25 white female, from 18 to 35 years of age	Current fashion magazines	The photographs were used if they met specific criteria	Ls-E (mm): -3.096 Li-E (mm): -1.91 Ls-S (mm): -0.89 Li-S (mm): -0.89 Ls-PRV (mm): 4.84 Li-PRV (mm): 3.34 LsGPg' (°): 6.98 LiGPg'(°): 4.02 ILA (°): 125.27 NLA (°): 100.42
Nguyen[14]	43 Caucasian male profile photographs from leading fashion magazines published between 1983 and 1995	Current fashion editors	Fashion editors were considered experts on facial beauty, so the photographs used depicted the preferred or esthetic profile of their time	Ls-E (mm): -6.5 Li-E (mm): -4.91 Ls-S (mm): -3.9 Li-S (mm): -3.2 Ls-PRV (mm): 5.3 Li-PRV (mm): 5.3 LsNPg'(°): 5.6; LiNPg' (°): 2.5 NLA (°): 109.6

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Discussion

3 DISCUSSION

Treatment protocol and malocclusion severity are factors that influence treatment time (Vig, Weyant et al. 1998, Mavreas and Athanasiou 2008). Generally, it has been shown that the number of extractions is directly proportional to increase in treatment time (Fink and Smith 1992). These results may not reflect what actually happens. Extractions may not be exclusively the main cause because they are usually used in severe malocclusion cases. Therefore, the main factor would not be the extractions per se, but rather the malocclusion severity. Additionally, these results have been obtained in malocclusions in general. Consequently, this generalizability cannot be applied to every malocclusion.

When treatment times of complete Class II malocclusion treated non-extraction was compared to 2-maxillary premolar extractions, without using skeletal anchorage, the results demonstrated that treatment duration was longer in non-extraction cases (Janson, Barros et al. 2007). The main reason for this is that more patient compliance in using removable devices such as extraoral headgear or Class II elastics is needed to correct the posterior teeth Class II anteroposterior discrepancy, in non-extraction treatment protocol. Therefore, this is an occasion in which the number of extractions was not directly proportional to the increase in treatment time. Additionally, it shows that a factor that plays an important role in treatment time is the treatment mechanics employed. Correction of complete Class II or III malocclusions anteroposterior discrepancies non-extraction are time consuming procedures because they demand intense patient compliance in using the removable devices to correct them (Arvystas 1985, Sabri 2015). Therefore, these are reasons that show that treatment time has to be individually evaluated in each type of malocclusion.

Within extraction cases, it is known that posterior crowding may decrease treatment time because after the extractions an impacted or blocked out teeth may simply erupt, occupying the extraction space, which will not need any mesiodistal movement mechanics, needing less time to close the space. It was then speculated whether the amount of anterior crowding could also influence treatment time, and the first investigation was performed to test this by comparing two groups of Class I

malocclusion with mild and severe crowding.

The results demonstrated that, although treatment time was numerically smaller in the severely crowded group, there was no significant difference between the groups and there was no significant correlation of maxillary or mandibular crowding with treatment time. However, only when patients with extremely accentuated maxillary crowding were compared to those with insignificant maxillary crowding, a significantly shorter treatment time was demonstrated by the former. This happens because when there is severe crowding, after the extractions, the initial canine retractions will be large enough to practically close the extraction spaces, leaving almost no space to be closed with anterior retractions. Anterior retraction is one of the treatment phases that usually takes more time (Li, Hu et al. 2011, Kwon, Ahn et al. 2014, Nakamura, Toyodome et al. 2015, Wahabuddin, Mascarenhas et al. 2015). Consequently, treatment time tend to be smaller.

Therefore, these results show that there is a tendency for treatment time to be smaller in cases with severe anterior crowding. This demonstrates that cases that appear to be more complex regarding treatment time, due to their unesthetic appearance, are the ones that will tend be resolved relatively more quickly.

As already known, premolar extractions followed by incisor retraction may have a considerable impact on lips position (Hayashida, Ioi et al. 2011). In Class II treatment, the nasolabial angle may increase from 2.4 to 5.4^{o} in 2-premolar extraction protocol and from 1 to 6.84^{o} in 4-premolar extraction protocol (Janson, Mendes et al. 2015). According to our second article, ideal profiles have the nasolabial angle ranging from 100.42° to 109.6°, in White groups; from 95.8° to 98.3°, in Black groups and from 95° to 112°, in Japanese/Korean groups. In patients with an already pleasant face and acceptable profile, the nasolabial angle and lips projection probably fit around these values, comparably to the studied attractive samples. However, even if they do not, their nasolabial angle and lips projection should not change significantly with orthodontic treatment, which is supposed to improve the face and profile. If a treatment protocol, especially the 4-premolar extraction, may significantly change an already satisfactory profile, it should be avoided. After all, this protocol is more likely to affect soft tissue profile than 2-premolar extractions (Janson, Mendes et al. 2015).

Nowadays, lips protuberance is related to high attractiveness and youth (Berneburg, Dietz et al. 2010). Some patients who seek for orthodontic treatment

show wider nasolabial angle and relative lips retrusion, compared to the parameters shown in our systematic review. In these kind of patients, additional care should be taken, once excessive incisor retraction could strongly worsen the scenario. Not because their cephalometric measures are different from the ones found in attractive groups, but probably because they have a straight or retrusive profile, which does not contribute to facial esthetics.

Opportunely, a long-term comparison showed no differences between facial esthetics of Class II malocclusion patients who had undergone nonextraction, 2- and 4-premolar extractions (Janson, Junqueira et al. 2015). Also apparent age was not different between the groups. This shows that most probably the extraction protocols were correctly applied in these patients.

CONCLUSIONS

4 CONCLUSIONS

- Class I extreme crowded cases, when treated with extractions, tend to have a shorter treatment time than less crowded cases.
- Each patient's soft-tissue profile has to be carefully evaluated, in order to correctly choose an orthodontic treatment plan. If extractions are performed, the soft tissue parameters should be respected.

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ANNEX

ANNEX – ETHICS COMMITTEE APPROVAL

FACULDADE DE ODONTOLOGIA DE BAURU-USP

Plataforma Brasil

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Estudo comparativo do tempo de tratamento de casos com má oclusão de Classe I com e sem apinhamento tratados com extrações
Pesquisador: Cintia Helena Zingaretti Junqueira
Área Temática:
Versão:
CAAE: 32077814.7.0000.5417
Instituição Proponente: Universidade de São Paulo - Faculdade de Odontologia de Bauru
Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 703.101
Data da Relatoria: 25/06/2014

Apresentação do Projeto:
O projeto "Estudo comparativo do tempo de tratamento de casos com má oclusão de Classe I com e sem apinhamento tratados com extrações" é uma tese (doutorado em andamento) de autoria da aluna Cintia Helena Zingaretti Junqueira, sob orientação do Prof. Dr. Guilherme Janson (ortodontia).
O projeto está bastante claro quanto a sua justificativa (científica), apresenta revisão da literatura e descrição adequada da metodologia. Em resumo os autores pretendem comparar os tempos de tratamento em casos de Classe I tratados com extração de quatro primeiros pré-molares, em maior e menor grau de apinhamento. Para isso os autores apresentam como proposta um estudo retrospectivo com a análise de prontuários (fichas, radiografias, modelos de gesso, etc) do arquivo da Disciplina de Ortodontia da Faculdade de Odontologia de Bauru – USP. A seleção das amostras (total de 60 pacientes) será feita respeitando os critérios de seleção descritos adequadamente no projeto. O projeto tem mérito científico e os envolvidos (doutoranda e orientador) apresentam experiência no tema proposto.

Objetivo da Pesquisa:
o objetivo deste trabalho é comparar os tempos de tratamento em casos de Classe I tratados com extração de quatro primeiros pré-molares, em maior e menor grau de apinhamento.

Endereço: DOUTOR OCTAVIO PINHEIRO BRISOLLA 75 QUADRA 9
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FACULDADE DE ODONTOLOGIA DE BAURU-USP

Continuação do Parecer: 709.101

Avaliação dos Riscos e Benefícios:

Nenhum risco ou benefício.

Segundo os autores: "Indiretamente todos se beneficiarão desta pesquisa uma vez que ela corrobora com o cenário científico e acadêmico da Ortodontia."

Comentários e Considerações sobre a Pesquisa:

A pesquisa está bem justificada do ponto de vista científico e os objetivos estão claros. Toda metodolgia foi descrita com os detalhes necessários. Tanto a aluna como o orientador apresentam experiência no tema proposto.

Considerações sobre os Termos de apresentação obrigatória:

Os autores apresentaram toda documentação e justificaram a dispensa do TCLE.

Também foi apresentada a autorização do responsável pelo arquivo da disciplina.

Os autores justificaram a dispensa do TCLE descrevendo que o arquivo da disciplina de ortodontia foi iniciado no ano de 1973. Por isso o contato de vários pacientes está desatualizado, inviabilizando a localização e consequente o consentimento.

Na visão dessa relatoria os autores apresentaram uma justificativa adequada.

Recomendações:

Nenhuma.

Conclusões ou Pendências e Lista de Inadequações:

O projeto foi apresentado de maneira adequada e detalhada: justificativa, objetivos e metodologia. Os documentos necessários foram enviandos e a solicitação de dispensa do TCLE está fundamentada, na visão dessa relatoria. Os autores são especialistas no tema proposto da pesquisa.

Ainda segundo essa relatoria, o projeto não apresenta comprometimento do ponto de vista ético. Portanto sugerimos sua aprovação.

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 25.6.2014, 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

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BAURU, 30 de Junho de 2014

Assinado por:
Izabel Regina Fischer Rubira Bullen
(Coordenador)

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