UNIVERSIDADE DE SÃO PAULO
FACULDADE DE ODONTOLOGIA DE BAURU

RODRIGO ANDRÉS NAVEDA ARAQUE

**Dentoskeletal and facial features comparison between individuals
treated with four first premolar extraction in the 1970s and in the
new millennium**

**Comparação das características dentoesqueléticas e faciais de
pacientes tratados com extração de 4 primeiros pré-molares na
década de 70 e no novo milênio**

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Orientador: Prof^a. Dr^a. Daniela Gamba Garib Carreira

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"Descobri que, quanto mais eu trabalho,
mais sorte eu pareço ter"

– Thomas Jefferson –

ABSTRACT

ABSTRACT

Dentoskeletal and facial features comparison between individuals treated with four first premolar extraction in the 1970s and in the new millennium

Introduction: The frequency of first premolar extractions in Orthodontics has remarkably decreased in the last 40 years. **Objective:** The aim of this study was to compare the dentoskeletal initial features of patients treated with four first premolar extractions in the 1970s and in the new millennium. **Materials and Methods:** Group 1 was composed by 30 subjects with Class I malocclusion (mean age of 12.8 years, 10 males, 20 females) treated in the 1970s with four first premolar extraction and comprehensive orthodontic treatment. Group 2 comprised 30 subjects with Class I malocclusion (mean age of 13.4 years, 13 males, 17 females) treated in the new millennium similarly to Group 1. Initial dental models and lateral cephalograms were digitized and measured using OrthoAnalyzerTM 3D software and Dolphin Imaging 11.0 software, respectively. Initial dentoskeletal features were analyzed and compared. Intergroup comparison was performed using independent t tests ($p < 0.05$). **Results:** Group 2 showed an increased maxillary and mandibular protrusion, a greater maxillary and mandibular body lengths and an increased incisor protrusion in comparison to Group 1. Group 2 also showed a greater lower anterior facial height and a greater vertical development of molars and maxillary incisors. **Conclusion:** Patients with Class I malocclusion treated with four first premolar extraction in the new millennium present an increased degree of maxillomandibular, dental and labial protrusion, an increased lower anterior facial height, an acute nasolabial angle and similar anterior dental crowding compared to patients treated similarly in the 1970s decade. Severe bimaxillary skeletal and dental protrusion determined first premolars extractions in the new millennium.

KEY WORDS: Angle Class I Malocclusion. Tooth extraction. Bicuspid. Dental esthetics.

RESUMO

RESUMO

Comparação das características dentoesceléticas e faciais de pacientes tratados com extração de 4 primeiros pré-molares na década de 70 e no novo milênio

Introdução: A frequência de extração de quatro primeiros pré-molares tem diminuído significativamente nos últimos 40 anos. **Objetivo:** O objetivo desse estudo foi comparar as características dentoesceléticas iniciais de pacientes tratados com extração de quatro primeiros pré-molares na década de 70 e o novo milênio. **Materiais e Métodos:** O Grupo 1 estava composto por 30 pacientes com maloclusão de Classe I (idade média de 12.8 anos, 10 homens, 20 mulheres) tratados na década de 1970 com extração de quatro primeiros pré-molares e ortodontia fixa. O Grupo 2 estava composto por 30 pacientes com maloclusão de Classe I (idade média de 13.4 anos, 13 homens, 17 mulheres) tratados no novo milênio similar ao Grupo 1. Modelos e telerradiografias iniciais foram digitalizadas e medidas utilizando o OrthoAnalyzerTM 3D software e Dolphin Imaging 11.0 software, respectivamente. As características dentoesceléticas iniciais foram analisadas e comparadas. A comparação intergrupo foi realizada utilizando o teste t independente ($p < 0.05$). **Resultados:** O Grupo 2 mostrou maior protrusão maxilar e mandibular, maior tamanho efetivo da maxila e da mandíbula e uma maior protrusão dos incisivos em relação ao grupo 1. O Grupo 2 também mostrou maior altura facial anteroinferior e maior desenvolvimento vertical dos molares e incisivos superiores. **Conclusão:** Em pacientes com maloclusão de Classe I é a severidade da bripotrusão inicial que determina a necessidade de realizar extração de primeiros pré-molares no novo milênio.

PALAVRAS CHAVE: Má Oclusão de Angle Classe I. Extração dentária, Dente pré-molar. Estética dentária.

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LIST OF ABBREVIATIONS AND ACRONYMS

SD	Standar deviation.
PAR Index	Peer Assessment Rating Index.
OGS	Objective Grading System.
SNA	Angle formed by SN and NA planes.
A-Nperp	Maxillary protrusion.
Co-A	Maxillary body length.
SNB	Angle formed by SN and NB planes.
Pog-Nperp	Mandibular protrusion.
Co-Gn	Mandibular body length.
ANB	Angle formed by NA and NB planes.
Wits	Anteroposterior maxillomandibular relationship.
SNGoGn	Angle formed by SN and GoGn planes.
FMA	Angle formed by Frankfort plane and PNS-ANS (PP) planes.
PP.FH	Angle formed by PP and Frankfort plane.
OP.FH	Angle formed by Occlusal Plane and Frankfort plane.
UAFH	Upper anterior face height.
LAFH	Lower anterior face height.
Mx1.FH	Maxillary incisor inclination related to Frankfort plane.
Mx1-APog	Maxillary incisor protrusion.
Mx1-PP	Maxillary incisor height.
Mx6-PP	Maxillary first molar height.

IMPA	Mandibular incisor inclination related to Mandibular plane.
Md1-APog	Mandibular incisor protrusion.
Md1-MP	Mandibular incisor height.
Md6-MP	Mandibular first molar height.
UL-E plane	Upper lip protrusion.
Cant UL	Upper lip inclination.
LL-E plane	Lower lip protrusion.

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1 INTRODUCTION

1 INTRODUCTION

Orthodontic philosophies influence have varied over the years (PROFFIT, 1994; WAHL, 2005). Since the beginning of the XX century Orthodontics have confronted the extraction vs nonextraction debate, reflected in the frequency variability of extraction treatments over the years (PROFFIT, 1994; JANSON; MARIA; BOMBONATTI, 2014; JACKSON et al., 2017). In 1907, Angle proposed an orthodontic philosophy based in the conservation of all teeth in order to achieve stable occlusion and esthetic facial results (ANGLE, 1907). This nonextraction philosophy was accepted by most professionals, and due to the influence of Angle's studies, it was almost not questioned.

After 10 years of private practice following the nonextraction philosophy, Tweed observed unsatisfactory facial results and absence of posttreatment stability (TWEED, 1944, 1945). After evaluating no treated patients with more esthetic profiles and stable occlusion and retreating the patients that he considered as orthodontic failures, he observed that the position of the mandibular incisor was the main characteristic in the successfully treated cases (TWEED, 1944, 1945). So, in the 1940's, he proposed the extraction philosophy which aimed an uprighthing position of the mandibular incisor in the basal bone, with the objective of improving facial esthetic result and treatment stability (TWEED, 1944, 1945, 1946).

A great variability of extraction frequency was observed in the second half of the XX century (PROFFIT, 1994; JANSON; MARIA; BOMBONATTI, 2014; JACKSON et al., 2017). The extraction philosophy was spread among the orthodontists, and in the 1950s more than half of the orthodontic patients had some tooth removed for mechanic purposes (PROFFIT, 1994). This approach showed great acceptance until the 1970s decade, when extraction treatment frequency began to decrease (PROFFIT, 1994; JANSON; MARIA; BOMBONATTI, 2014; JACKSON et al., 2017).

The decrease of extraction treatment frequency had multifactorial reasons (PROFFIT, 1994; JANSON; MARIA; BOMBONATTI, 2014; JACKSON et al., 2017). Changes in the perception of ideal facial esthetics and concern related to treatment stability were the main reasons for the decrease of extraction treatments (LITTLE; WALLEN; RIEDEL, 1981; HOLDAWAY, 1983, 1984; LITTLE, 1990; BRAVO, 1994).

While esthetic trends changes were observed towards a fuller and more protrusive dentofacial pattern (PECK; PECK, 1970; AUGER; TURLEY, 1999), flattened profiles were associated with incisor uprighting position in the basal bones (DROBOCKY; SMITH, 1989; OH et al., 2009). Extraction treatments also aimed a better long-term stability (TWEED, 1944, 1945), however, similar results were noticed between extraction and nonextraction approaches (LITTLE; WALLEN; RIEDEL, 1981; LITTLE, 1990).

In addition, other factors were also considered when deciding between extraction and nonextraction treatment. The development of orthopedic treatments (HAAS, 1970; FRANKEL, 1974), two-phase treatments (O'BRIEN et al., 2003; CANCADO et al., 2008), interproximal reduction (SHERIDAN, 1987; SHERIDAN; HASTINGS, 1992), concerns with temporomandibular disorders (WYATT, 1988; LUECKE; JOHNSTON, 1992; MCLAUGHLIN; BENNETT, 1995), complexity of orthodontic mechanics (ALEXANDER; SINCLAIR; GOATES, 1986), prolonged treatment time (IARED et al., 2017), space reopening (GARIB et al., 2016) and an increased degree of external root resorption (SAMESHIMA; SINCLAIR, 2001) also had an influence in the decrease of extraction treatment frequency. Due to the aforementioned factors, extraction frequency has shown a constant decrease since the 1970s decade (PROFFIT, 1994; JANSON; MARIA; BOMBONATTI, 2014). In the end of the XX century and the beginning of the XXI century four first premolar extraction treatment showed a prevalence of approximately 10% (JANSON; MARIA; BOMBONATTI, 2014; JACKSON et al., 2017).

Great differences are observed between extraction and nonextraction treatments, from the initial features to the expected results (KONSTANTONIS; ANTHOPOULOU; MAKOU, 2013; IARED et al., 2017; KONSTANTONIS et al., 2018; MORAIS et al., 2018). Minor skeletal discrepancies and mild-to-moderate dental discrepancies are usually treated with a non-extraction approach (KONSTANTONIS; ANTHOPOULOU; MAKOU, 2013; KONSTANTONIS et al., 2018). Extraction treatment is frequently used in cases with dentoalveolar protrusion and moderate-to-severe crowding (KONSTANTONIS; ANTHOPOULOU; MAKOU, 2013; KONSTANTONIS et al., 2018). Four first premolar extraction is the most frequent protocol (PROFFIT, 1994; JANSON; MARIA; BOMBONATTI, 2014; JACKSON et al., 2017), probably because of the position of these teeth in the dental arch (NANCE, 1949; AL-ANI; MAGEET, 2018;

OMAR et al., 2018), which allows the dental movement of posterior and anterior segments. Dental arch modifications are usually observed when the posterior segment is mesialized, nevertheless, anterior segment retraction may modify the facial profile (MORESCA, 2014; IARED et al., 2017; AL-ANI; MAGEET, 2018). Nowadays, the characteristics that leads to an extraction decision in patients with Class I malocclusion are crowding, facial profile, labial protrusion, increased overjet and decreased overbite (KONSTANTONIS; ANTHOPOULOU; MAKOU, 2013; KONSTANTONIS et al., 2018).

Four first premolar extraction is a great ally in the orthodontic practice, so understanding the evolution of its indication is relevant for the orthodontist practice in order to support treatment plan decisions and professional confidence. Therefore, the purpose of this study was to compare the dentoskeletal initial features of patients treated with four first premolar extractions in the 1970s and in the New Millennium. The null hypothesis is subjects treated with extraction in the 1970s and in the new millennium have similar initial features.

2 ARTICLE

2 ARTICLE

The article presented in this dissertation was formatted according to the American Journal of Orthodontics and Dentofacial Orthopedics instructions and guidelines for article submission.

Dentoskeletal comparison between individuals treated with extractions in the 1970's and in the new millennium

ABSTRACT

Objective: The aim of this study was to compare the dentoskeletal initial features of patients treated with four first premolar extractions in the 1970s and in the new millennium. **Materials and Methods:** Group 1 was composed by 30 subjects with Class I malocclusion (mean age of 12.8 years, 10 males, 20 females) treated in the 1970s with four first premolar extraction and comprehensive orthodontic treatment. Group 2 comprised 30 subjects with Class I malocclusion (mean age of 13.4 years, 13 males, 17 females) treated in the new millennium similarly to Group 1. Initial dental models and lateral cephalograms were digitized and measured using OrthoAnalyzerTM 3D software and Dolphin Imaging 11.0 software, respectively. Initial dentoskeletal features were analyzed and compared. Intergroup comparison was performed using independent t tests ($p < 0.05$). **Results:** Group 2 showed an increased maxillary and mandibular protrusion, a greater maxillary and mandibular body lengths and an increased incisor protrusion in comparison to Group 1. Group 2 also showed a greater lower anterior facial height and a greater vertical development of molars and maxillary incisors. **Conclusion:** Patients with Class I malocclusion treated with four first premolar extraction in the new millennium present an increased degree of maxillomandibular, dental and labial protrusion, an increased lower anterior facial height, an acute nasolabial angle and similar anterior dental crowding compared to patients treated similarly in the 1970s decade. Severe bimaxillary skeletal and dental protrusion determined first premolars extractions in the new millennium.

INTRODUCTION

Orthodontics has confronted an extraction vs nonextraction debate in the last hundred years.¹⁻⁵ In the beginning of the XX century, Angle proposed nonextraction orthodontic interventions, which were accepted and almost not questioned for over 30 years.⁵ However, concerns regarding treatment stability⁴ and dental protrusion associated with inadequate facial esthetics^{1,2} reintroduced tooth extraction in the orthodontic field. Extraction treatment had such a great impact in the 1950s, 1960s and 1970s that more than half of patients presented some tooth removed for orthodontic purposes.^{6,7} Nevertheless, a decrease of tooth extraction frequency was observed subsequently, especially in the new millennium.⁶⁻⁸

The decrease of tooth extraction frequency had multifactorial reasons. Excessive incisor uprighting showed a detrimental effect on facial esthetics, leading to a more flattened profile.⁹⁻¹¹ In the second half of the XX century, changes in the perception of an ideal facial esthetics were observed towards a fuller and more protruded dentofacial profile.^{12,13} Additionally, extraction cases showed similar treatment stability compared to nonextraction treatments.^{14,15} The development of orthopedic treatments,^{16,17} two-phase interventions,^{18,19} interproximal reduction,^{20,21} and concerns with temporomandibular disorders²²⁻²⁴ also had an influence in the decrease of tooth extraction. Complexity of orthodontic mechanics,²⁵ prolonged treatment time,²⁶ space reopening²⁷ and an increased degree of external root resorption²⁸ were also previous concerns in extraction cases.

In Class I malocclusion patients, extraction treatment is frequently used in cases with dentoalveolar protrusion and moderate-to-severe crowding.^{26,29} Facial esthetics, labial protrusion, overjet and overbite are also considered.^{8,26,29} In the 1970s, the frequency of four first premolar extraction cases started to decrease.^{6,7} At 1990s, the frequency of extractions was approximately 10%. In the new millennium, frequency of first premolar extraction ranges from 9% to 16%.^{7,8}

No previous study has directly compared facial and occlusal initial morphology of Class I patients treated with premolar extractions in the past and currently. Understanding trend changes overtime might support treatment plan decisions and professional confidence. Therefore, the purpose of this study was to compare the dentoskeletal initial features of patients treated with four first premolar extractions in

the 1970s and in the New Millennium. The null hypothesis is that subjects treated with extractions in the 1970s and in the new millennium have similar initial features.

MATERIAL AND METHODS

This retrospective study was approved by the institutional research ethics committee of the University of São Paulo in Brazil (process #71638417.9.0000.5417), and written consents were obtained from all subjects. The sample was selected from the orthodontic records of over 4,000 patients treated between 1973 to 2013 in the Orthodontic Department from Bauru Dental School, University of São Paulo. Sample size calculation was based on a standard deviation for maxillary irregularity index of 2.6³⁰, a minimum intergroup difference of 2 mm, an alpha value of 5% and a statistical power of 80%. The sample size for each group was 28 subjects.

The inclusion criteria were: (1) Class I malocclusion treated with four first premolar extractions, (2) complete and adequate initial records, (3) permanent dentition and (4) absence of tooth agenesis. Exclusion criteria were: (1) patients with history of previous orthodontic treatment and (2) craniofacial anomalies. After applying these criteria, 30 patients were selected for each group.

Group 1 was composed by 30 patients (10 males and 20 females) with an initial mean age of 12.8 years (SD=1.17) treated from 1973 to 1979. Group 2 comprised 30 patients (13 males and 17 females) with an initial mean age of 13.4 years (SD=1.33) treated from 2000 to 2013.

Dental models and lateral cephalograms were used. Initial dental models were digitized using 3D 3Shape R700 scanner (3Shape A/S, Copenhagen, Denmark) and analyzed in the software OrthoAnalyzerTM 3D (3Shape A/S, Copenhagen, Denmark). The initial lateral cephalograms were digitized using the Microtek ScanMaker i800 scanner (Santa Fe Springs, CA, USA) and analyzed with Dolphin® 11.5 imaging software (Chatsworth, CA, USA).

Both maxillary and mandibular digital dental models were initially oriented with the occlusal plane parallel to the horizontal plane. The maxillary occlusal plane passed through the mesiolingual cusp tip of permanent first molars bilaterally and through the mesio-incisal angle of the right central incisor. The mandibular occlusal plane passed through the distobuccal cusp tip of permanent first molars bilaterally and through the

mesio-incisal angle of the right central incisor. Incisor irregularity index³¹ was measured on the occlusal view of the digital dental models.

PAR index was evaluated using the physical dental models according to Richmond et al.³²

Cephalometric variables are shown in Figures 1 and 2.

Error Study

All the dental model and cephalometric variables were measured twice in 50% of the sample after a minimum 30-day interval by the same examiner (RN). Random and systematic errors were calculated with Dahlberg's³³ and dependent t test, respectively ($p < 0.05$).

Statistical Analyses

Variables showed normal distribution according to Kolmogorov-Smirnov test. Intergroup comparison was performed using t tests ($p < 0.05$). Statistical analyses were performed using Statistica software (Statistica for Windows version 11.0; StatSoft Inc., Tulsa, OK).

RESULTS

The random errors ranged from 0.47 to 2.20 (Maxillary irregularity index and PAR Index, respectively) for the dental model variables (Table I). The random errors ranged from 0.35 mm to 1.34 mm (Molar relationship and Co-A, respectively) for cephalometric linear variables and from 0.54 to 2.88 (ANB and Nasolabial angle, respectively) for the angular measurements. No significant systematic error was found.

The groups were comparable regarding sex and initial age (Table II).

The dental model analysis showed a similar anterior dental crowding and a similar initial malocclusion severity in both groups (Table III).

Cephalometric analysis comparison showed that Group 2 presented a significantly greater maxillary and mandibular protrusion, a greater maxillary and mandibular body lengths and a greater labial tipping and protrusion of maxillary and mandibular incisors compared to Group 1. Group 2 presented a greater lower anterior facial height, and greater vertical development of maxillary incisors, maxillary and mandibular molars in comparison to Group 1 (Table III).

Soft tissue evaluation showed that Group 2 displayed a more acute nasolabial angle, a greater cant of the upper lip and a more protruded lower lip than Group 1 (Table III).

DISCUSSION

Accuracy and reproducibility of cephalometric and digital dental model analyses are well documented.³⁴ Digital lateral cephalograms and dental models have been widely used in orthodontic research.³⁴⁻³⁶ Our study showed adequate reproducibility within acceptable limits corroborating previous studies^{29,37-39} (Table I).

Class I malocclusion associated with dental crowding is commonly seen in the orthodontic practice,⁴⁰ and crowding severity is considered a determinant factor in extraction decision.²⁹ Previous studies reported a low self-esteem associated with severe crowding.⁴¹ In this study, no intergroup differences were found for the initial amount of maxillary and mandibular anterior crowding (Table III). Both groups showed a severe initial dental crowding. Initial malocclusion severity can also determine the need for tooth extraction. The greater the malocclusion severity, the greater the probability that tooth extraction will be needed.⁴² In this study, both groups presented similar malocclusion severities. Therefore, over the last 30 years, no differences were found for severity of both anterior dental crowding and initial malocclusion in patients treated with four premolar extractions.

A greater bimaxillary skeletal and dental protrusion was found in patients treated with extractions in the new millennium in comparison to patients treated in the past (Table III / Figs. 3 and 4). These results corroborate previous studies that indicated four first premolar extraction when an important biprotrusion was present, reporting straightening and improvement of the facial profile.^{9,26,43,44} Esthetics evaluation showed that straight profiles have been considered the most attractive.⁴⁵⁻⁴⁷ Despite the modern esthetic trend towards a more fuller and protrusive profile,^{12,13} severe biprotrusion and excessive convex profiles are considered to impair facial esthetics.^{46,47} In other words, in the new millennium four premolar extractions were performed in extremely biprotrusive patients. Conversely, in 1970s decade four premolar extractions were performed even when a slight degree of incisor protrusion was present probably leading to a flattened facial profile more often.

No differences in growth facial pattern was found between groups (Table III). Both groups showed a predominant hyperdivergent growth pattern. These findings were expected considering that previous studies have indicated four first premolar extraction in patients with hyperdivergent pattern⁴⁸⁻⁵⁰. The control of the vertical dimension was thought to occur by a counterclockwise rotation of the mandible through the forward movement of posterior teeth.⁴⁸⁻⁵⁰ A greater increase in the LAFH has been observed after nonextraction treatment when compared to extraction treatment.^{48,51,52} Our results are in accordance with the indication of four first premolar extractions predominantly in hyperdivergent pattern, both in the 1970s decade and in the new millennium. Group 2 showed an increased lower anterior facial height and a greater development of maxillary incisors and molars compared to group 1 (Table III). The possible explanation for these differences was the greater mandibular length found in Group 2. We would expect the LAFH increases more as the mandible grows forward and downward.

Soft tissue evaluation showed a more acute nasolabial angle, a greater cant of the upper lip and a more protruded lower lip in Group 2 compared to Group 1 (Table III / Figs. 3 and 4). These differences reflect the above-mentioned greater skeletal and dental protrusion in group 2. Soft tissue features have been considered a determinant factor for extraction decision.^{26,29,43} Recent studies have indicated four first premolar extraction in patients with increased lip prominence,^{26,29} observing a decrease of the soft tissue procumbency.^{26,49,53} Premolar extraction followed by anterior retraction lead to a more pleasing profile in patients with protruded lips.^{29,53} Lip response to anterior teeth retraction shows great variance and depends on the inherent characteristics of each individual as ethnic background, lip thickness and quality of the lip musculature.^{49,53} Despite the variance of lip-to-incisor-retraction correlation,⁵³ improvement of the facial profile in biprotrusive patients is expected after four first premolar extraction.^{26,53}

In summary, four premolar extractions are currently indicated in cases coupling severe anterior dental crowding and extreme jaw/incisor/lip protrusion. In the past, extractions were performed in cases with severe dental crowding even in front of an adequate degree of jaw/incisor/lip protrusion. These evolutionary trends are in consonance with the facial profile preferences and the decrease of tooth extractions over the last decades.^{6-8,10-13,26} Because of the limitations of having a sample

composed by patients treated in a single center, future studies should consider multicenter patients in order to confirm these tendencies.

CONCLUSIONS

The null hypothesis was rejected. Patients with Class I malocclusion treated with four first premolar extraction in the new millennium present an increased degree of maxillomandibular, dental and labial protrusion, an increased lower anterior facial height and an acute nasolabial angle compared to patients treated similarly in the 1970s decade. Severe bimaxillary skeletal and dental protrusion determined first premolars extractions in the new millennium.

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FIGURE LEGENDS

Fig 1. Cephalometric angular variables measured in the study: 1 - SNA, 2 - SNB, 3 - ANB, 4 – SN.GoGn, 5 – FMA, 6 – PP.FH, 7 – OP.FH, 8 – Mx1.FH, 9 – IMPA, 10 – Nasolabial Angle, 11 – Cant UL.

Fig 2. Cephalometric linear variables measured in the study: 1 – A-Nperp, 2 – Co - A, 3 – Pog-Nperp, 4 – Co-Gn, 5 – Wits, 6 – UAFH, 7 – LAFH, 8 – Overjet, 9 – Overbite, 10 – Molar relationship, 11 – Mx1-APog, 12 – Mx1-PP, 13 – Mx6-PP, 14 – Md1-APog, 15 – Md1-Mp, 16 – Md6-MP, 17 – UL-E plane, 18 – LL-E plane.

Fig 3. Superimposition (S-N in S) of the average cephalometric tracings of both groups.

Fig 4. Example of lateral cephalograms of Group 1 (A to C) and Group 2 (D to F). Observe the greater incisor biprotrusion in group 2.

FIGURES

Fig. 1

Fig. 2

Fig. 3

Fig. 4

TABLES

Table I: Error study (Dahlberg formula and paired t tests).

Measurement	Measurement 1 Mean	SD	Measurement 2 Mean	SD	Dahlberg	p
DENTAL MODEL ANALYSIS						
Maxillary incisor irregularity Index	7.90	4.35	8.04	4.18	0.47	0.278
Mandibular incisor irregularity Index	7.91	4.66	8.00	4.70	0.48	0.463
PAR Index	23.97	7.93	23.67	7.31	2.20	0.606
CEPHALOMETRIC ANALYSIS						
Maxillary skeletal components						
SNA	80.95	4.16	81.30	4.39	0.78	0.085
A-Nperp	0.66	4.26	1.07	4.16	0.89	0.075
Co-A	82.74	3.45	82.49	3.53	1.34	0.478
Mandibular skeletal components						
SNB	77.39	3.71	77.65	3.74	0.58	0.073
Pog-Nperp	-4.20	7.59	-3.77	7.29	0.95	0.066
Co-Gn	110.81	5.38	110.23	5.02	1.23	0.067
Maxillomandibular relationship						
ANB	3.57	2.02	3.64	1.87	0.54	0.608
Wits	0.36	2.34	0.32	2.25	0.74	0.824
Vertical component						
SN.GoGn	35.52	5.19	35.32	5.09	0.88	0.396
FMA	28.51	5.38	28.29	4.80	0.92	0.354
PP.FH	-2.34	3.71	-2.38	3.46	0.86	0.849
OP.FH	6.94	5.01	6.87	4.48	0.88	0.775
UAFH	48.64	2.55	48.82	2.59	0.61	0.271
LAFH	64.31	4.94	64.60	4.88	0.57	0.051
Interdental						
Overjet	3.75	1.51	3.62	1.48	0.38	0.186
Overbite	1.56	2.21	1.66	2.07	0.37	0.293
Molar Relationship	-1.01	1.09	-0.93	1.07	0.35	0.363
Maxillary dentoalveolar components						
Mx1.FH	116.73	7.25	117.62	7.38	1.99	0.083
Mx1-APog	8.49	3.03	8.35	3.13	0.63	0.411
Mx1-PP	27.72	3.01	27.83	2.77	0.58	0.483
Mx6-PP	17.80	2.23	18.10	2.20	0.83	0.163
Mandibular dentoalveolar components						
IMPA	95.35	8.51	94.68	8.27	1.55	0.093
Md1-APog	4.84	3.21	4.68	3.10	0.41	0.121
Md1-MP	36.14	2.43	36.26	2.58	0.42	0.286
Md6-MP	28.50	2.32	28.62	2.57	0.66	0.489
Soft tissue profile						
Nasolabial Angle	108.53	8.72	109.26	8.72	2.88	0.330
UL-E plane	-1.93	2.23	-2.15	2.32	0.50	0.077
Cant UL	10.89	9.84	11.23	9.86	1.29	0.317
LL-E plane	1.33	2.87	1.50	2.90	0.70	0.376

Table II: Intergroup comparisons for initial age and sex distribution (t test and Chi-square test).

Variable		Group 1 (n=30)		Group 2 (n=30)		p
		Mean	S.D.	Mean	S.D.	
Initial age (years)		12.8	1.17	13.4	1.33	0.093
Sex	Male	10		13		0.425
	Female	20		17		

Table III: Intergroup comparisons for dental models and cephalometric variables (t tests).

Variables	Group 1		Group 2		p
	Mean	SD	Mean	SD	
DENTAL MODEL ANALYSIS					
Maxillary Incisor Irregularity Index	7.42	3.36	8.47	5.52	0.376
Mandibular Incisor Irregularity Index	8.04	4.26	8.22	5.61	0.892
PAR Index	23.93	7.99	20.10	8.85	0.083
CEPHALOMETRIC ANALYSIS					
Maxillary skeletal components					
SNA	80.67	4.48	82.77	4.38	0.071
A-Nperp	-0.45	2.89	2.28	3.74	0.002*
Co-A	80.43	3.55	82.58	3.14	0.016*
Mandibular skeletal components					
SNB	77.34	3.69	78.97	4.41	0.126
Pog-Nperp	-5.52	5.37	-1.61	7.07	0.019*
Co-Gn	107.61	5.35	111.84	5.55	0.004*
Maxillomandibular relationship					
ANB	3.32	2.10	3.79	2.38	0.421
Wits	0.37	2.12	-0.29	2.68	0.288
Vertical component					
SNGoGn	35.04	4.45	33.82	6.41	0.394
FMA	28.95	4.83	27.04	5.03	0.140
PP.FH	-1.71	3.07	-3.18	3.79	0.103
OP.FH	7.45	4.10	6.41	4.83	0.370
UAFH	47.13	2.77	48.00	3.69	0.304
LAFH	61.99	4.71	64.71	4.22	0.022*
Interdental					
Overjet	4.28	2.20	3.50	1.92	0.150
Overbite	1.61	1.97	1.25	1.77	0.456
Molar Relationship	-0.52	1.26	-0.79	1.03	0.357
Maxillary dentoalveolar components					
Mx1.FH	115.93	7.43	120.23	6.84	0.023*
Mx1-APog	7.87	2.62	9.79	2.66	0.006*
Mx1-PP	26.23	2.62	28.14	2.73	0.007*
Mx6-PP	16.51	2.01	17.96	2.52	0.016*
Mandibular dentoalveolar components					
IMPA	93.11	6.55	99.53	8.02	0.001*
Md1-APog	3.69	2.74	6.35	2.66	<0.001*
Md1-MP	35.59	2.90	36.09	2.45	0.474
Md6-MP	27.82	2.11	29.30	2.10	0.008*
Soft tissue profile					
Nasolabial Angle	111.08	9.23	102.01	9.74	<0.001*
UL-E plane	-1.77	2.23	-0.83	2.48	0.129
Cant UL	9.18	9.19	18.07	10.43	<0.001*
LL-E plane	0.66	2.61	2.62	2.33	0.003*

*Statistically significant

3 DISCUSSION

3 DISCUSSION

The initial features taken in consideration in the orthodontic treatment can be divided in malocclusion characteristics which are evaluated in the dental models, and dentoskeletal and facial characteristics which are evaluated in the lateral cephalograms.

Dental models allows the direct evaluation of dental characteristics that help in the orthodontic treatment planning phase (KONSTANTONIS; ANTHOPOULOU; MAKOU, 2013). Class I malocclusion associated with dental crowding is commonly seen (SAYIN; TURKKAHRAMAN, 2004), and the severity of crowding is considered a determinant factor in the extraction decision (KONSTANTONIS; ANTHOPOULOU; MAKOU, 2013). Severe crowding has been related to lower self-esteem of young patients (JUNG, 2015). Mandibular crowding is the main occlusal reason for extraction in Class I patients (KONSTANTONIS; ANTHOPOULOU; MAKOU, 2013). In this study no significant differences between groups was observed for the initial crowding (Table III). The amount of crowding observed for both groups was severe and has been previously indicated for four premolar extraction (GUIRRO et al., 2016). Depending on the amount of crowding and the age of the patient, crowding can be treated by rapid palatal expansion, dentoalveolar compensation, interproximal reduction or with tooth extraction (HAAS, 1970; SHERIDAN, 1987; SHERIDAN; HASTINGS, 1992; KONSTANTONIS; ANTHOPOULOU; MAKOU, 2013). Moderate-to-severe crowding treated without extractions increase teeth labial tipping and soft tissue procumbency (MORAIS et al., 2018), so other factors, such as profile characteristics must be considered (KONSTANTONIS et al., 2018). Malocclusion severity can also determine the necessity of teeth extraction. Severe malocclusions have greater probability of needing teeth extraction (KAMAL; SHAIKH; FIDA, 2016). PAR index was used to evaluate the malocclusion severity. Severe malocclusions indicated for extraction was observed for both groups (KAMAL; SHAIKH; FIDA, 2016), without significant intergroup differences (Table III). The absence of significant differences in the initial dental characteristics may show that the indication for extraction treatment have no change regarding the initial malocclusion severity over the last 30 years.

The evaluation of dentoskeletal and facial characteristics through the cephalometric analysis have been widely use in the planning phase of the orthodontic treatment (WAHL, 2006). Authors like Tweed, Steiner, McNamara, among others, created cephalometric analysis that provided standard objectives for all patients, mainly based in the antero-posterior position of the basal bones and in the mandibular incisor position (WAHL, 2006). However, lack of balance and harmony related to an uprighting position of the mandibular incisor proved that soft tissue reacts different in each patient and that the achievement of an ideal cephalometric position might not always lead to an esthetic profile (HOLDAWAY, 1983, 1984; BOWMAN, 1999). Mandibular incisor uprighting position was also related to better posttreatment stability, however, it was proved that extraction and nonextraction treatment show the same stability (LITTLE; WALLEN; RIEDEL, 1981; LITTLE, 1990). The disproven of this two facts are the main reason for the decrease in the extraction treatment frequency (PROFFIT, 1994; JANSON; MARIA; BOMBONATTI, 2014; JACKSON et al., 2017). The contrasts observed between the prevalence of 50% of four first premolar extraction in the 1950s with the 10% observed in the new millennium shows an evolution towards a more conservative orthodontic treatment (PROFFIT, 1994; JANSON; MARIA; BOMBONATTI, 2014; JACKSON et al., 2017), based more in the patient's needs rather than the cephalometric objectives.

Antero-posterior position of bones and teeth have been widely studied. Straight profiles are considered the most attractive (CZARNECKI; NANDA; CURRIER, 1993; MEES et al., 2013; MORESCA, 2014). In general, it has been observed a trend towards a more full and protrusive profile since the second half of the past century (PECK; PECK, 1970; AUGER; TURLEY, 1999). Differences between races have also been reported (SCOTT; JOHNSTON, 1999; BOWMAN; JOHNSTON, 2000). Several studies indicated differences between the skeletal and dental antero-posterior position between caucasians, korean and blacks (SCOTT; JOHNSTON, 1999; BOWMAN; JOHNSTON, 2000; LIM; KO; HWANG, 2008). Blacks and korean tend to present a greater biprotrusion than Caucasian (SCOTT; JOHNSTON, 1999; LIM; KO; HWANG, 2008), which is considered normal and esthetic. Nevertheless, the presence of severe protrusion or excessive convex profiles have been considered the less esthetic (MEES et al., 2013; MORESCA, 2014). In this study a greater bimaxillary skeletal and dental protrusion was observed in Group 2 (Table III), treated in the new millennium. Dental

protrusion has a great impact in the facial profile, and is also an indication for extraction (BILLS; HANDELMAN; BEGOLE, 2005). Previous studies have indicated extractions in patients with protruded teeth (BILLS; HANDELMAN; BEGOLE, 2005; IARED et al., 2017). Premolar extraction and anterior retraction is the protocol used in patients with biprotrusion (BILLS; HANDELMAN; BEGOLE, 2005; IARED et al., 2017). These results are in accordance with recent scientific findings that shows a greater enhancement of facial profile in more protruded patients after extraction treatment (BOWMAN; JOHNSTON, 2000; IARED et al., 2017).

Antero-posterior relationship showed no significance difference between groups, probably due to the similar initial malocclusion and absence of significance skeletal discrepancies.

Vertical development has shown a great influence in the orthodontic treatment phase. Increased hyperdivergent pattern is considered less attractive when compared with equilibrated or hypodivergent patterns (DE SMIT; DERMAUT, 1984; ABU ARQOUB; AL-KHATEEB, 2011). A predominant hyperdivergent growth pattern was observed for both groups (Table III), without significant intergroup differences. Hyperdivergent patients are usually treated with extractions, due to the better vertical control by a counterclockwise rotation of the mandible through the forward movement of posterior teeth (PEARSON, 1978). Despite the absence of significant vertical changes reported between extraction and nonextraction treatments, greater vertical development is expected with nonextraction approaches (KOCADERELI, 1999; KUMARI; FIDA, 2010; BEIT et al., 2017). Vertical component analysis showed a significantly increased LAFH for group 2, which is in accordance with other studies that indicated extractions in patients with increased LAFH (KOCADERELI, 1999; KUMARI; FIDA, 2010; BEIT et al., 2017). Group 2 showed an increased lower anterior facial height and a greater development of maxillary incisors and molars compared to group 1. The possible explanation for these differences was the greater mandibular length found in Group 2. We would expect the LAFH increases more as the mandible grows forward and downward.

Facial initial features are a fundamental part in the extraction or nonextraction decision (BOWMAN; JOHNSTON, 2000; KONSTANTONIS; ANTHOPOULOU; MAKOU, 2013). Severe protrusion has been related to lower self-esteem of young patients (JUNG, 2015). Flattened profiles are usually treated without extractions.

(IARED et al., 2017) Greater pretreatment initial procumbency is associated with better results of four first premolar extractions (IARED et al., 2017). Soft tissue evaluation showed a more acute nasolabial angle, a greater cant of the upper lip and a more protruded lower lip in Group 2 compared to Group 1 (Figure 3). These differences reflect the above-mentioned greater skeletal and dental protrusion in group 2. Labial protrusion is one of the main reasons for four premolar extractions in patients with Class I malocclusion (KONSTANTONIS; ANTHOPOULOU; MAKOU, 2013). Recent studies have indicated four first premolar extraction in patients with increased lip prominence (KONSTANTONIS; ANTHOPOULOU; MAKOU, 2013; IARED et al., 2017), and observed decrease of the soft tissue procumbency to a more esthetic profile (BILLS; HANDELMAN; BEGOLE, 2005; IARED et al., 2017; SUNDARESWARAN; VIJAYAN, 2017). Premolar extraction followed by anterior retraction lead to a more pleasing profile in patients with protruded lips (KONSTANTONIS; ANTHOPOULOU; MAKOU, 2013; SUNDARESWARAN; VIJAYAN, 2017). Lip response to anterior teeth retraction shows great variance and depends on inherent characteristics as ethnic background and lip thickness (BILLS; HANDELMAN; BEGOLE, 2005; SUNDARESWARAN; VIJAYAN, 2017). Despite the variance of lip-to-incisor-retraction correlation (SUNDARESWARAN; VIJAYAN, 2017), enhancement in the facial profile of biprotrusive patients is expected after four first premolar extraction (SUNDARESWARAN; VIJAYAN, 2017).

In summary, four premolar extractions is currently indicated in cases with severe dental crowding and extreme protrusion. In the past, extractions were performed in cases with severe dental crowding even in front of an adequate degree of facial procumbency. These evolutionary trends are in consonance with the decrease of tooth extractions over the last decades (PECK; PECK, 1970; HOLDAWAY, 1983, 1984; PROFFIT, 1994; AUGER; TURLEY, 1999; JANSON; MARIA; BOMBONATTI, 2014; IARED et al., 2017; JACKSON et al., 2017), which shows a clear evolution of four first premolar extraction.

4 FINAL CONSIDERATIONS

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Despite the abuse of extractions in the mid-XX century and the clear decrease of extraction frequency in the last decades (PROFFIT, 1994; JANSON; MARIA; BOMBONATTI, 2014; JACKSON et al., 2017), this approach has proved to be a valuable instrument in the orthodontic practice (KONSTANTONIS; ANTHOPOULOU; MAKOU, 2013; IARED et al., 2017; KONSTANTONIS et al., 2018). Four first premolar extraction has a prevalence of around 10% in the new millennium (JANSON; MARIA; BOMBONATTI, 2014; JACKSON et al., 2017). showing an evolution towards a more conservative orthodontic treatment.

Facial profile is a determinant factor for premolar extraction (HOLDAWAY, 1983, 1984; IARED et al., 2017). Orthodontic treatment has the ability of modifying facial profile, and the results will depend principally in the extraction or nonextraction approach (DROBOCKY; SMITH, 1989; BRAVO, 1994; BILLS; HANDELMAN; BEGOLE, 2005; ANTHOPOULOU; KONSTANTONIS; MAKOU, 2014; IARED et al., 2017). In patients with Class I malocclusion four first premolar removal and anterior retraction is expected to decrease the dentoalveolar protrusion and cause a retraction of upper and lower lips (DROBOCKY; SMITH, 1989; BRAVO, 1994; BILLS; HANDELMAN; BEGOLE, 2005; ANTHOPOULOU; KONSTANTONIS; MAKOU, 2014; IARED et al., 2017). Due to these effects premolar extraction is usually used in patients with increased facial procumbency (IARED et al., 2017). Better results are expected in more protrusive patients (IARED et al., 2017). This is in accordance with the results of this study. A severe skeletal and dental protrusion was found in the patients treated in the new millennium, confirming the evolutionary trend of extractions.

Nowadays, fuller and more protrusive facial profiles are esthetically accepted (PECK; PECK, 1970; AUGER; TURLEY, 1999) and considered an inherent characteristic of some ethnic groups (ANTHOPOULOU; KONSTANTONIS; MAKOU, 2014). Nevertheless, severe biprotrusion and excessive convex profiles are considered the less esthetics (MEES et al., 2013; MORESCA, 2014), so four first premolar extraction shall be considered in the presence of this initial feature.

Dental crowding is also a determinant factor for teeth extraction (KONSTANTONIS; ANTHOPOULOU; MAKOU, 2013). Currently there are different nonextraction treatments for solving dental crowding, such as rapid palatal expansion, dentoalveolar compensation and interproximal reduction (HAAS, 1970; SHERIDAN, 1987; SHERIDAN; HASTINGS, 1992; MORAIS et al., 2018). However, nonextraction treatment can increase facial procumbency (MORAIS et al., 2018), principally in the presence of moderate-to-sever crowding. So, four first premolar extraction must be considerate in the presence of crowding associated with biprotrusion.

This study confirms the evolution of four first premolar extraction indication. Understanding trend changes overtime might support treatment plan decisions and professional confidence. The results of this study shall be considered when deciding between extraction or nonextraction treatments in patients with severe protrusive profiles.

5 CONCLUSION

5 CONCLUSION

The null hypothesis was rejected. Patients with Class I malocclusion treated with four first premolar extraction in the new millennium present an increased degree of maxillomandibular, dental and labial protrusion, an increased lower anterior facial height and an acute nasolabial angle compared to patients treated similarly in the 1970s decade. Severe bimaxillary skeletal and dental protrusion determined first premolars extractions in the new millennium.

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REFERENCES

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APPENDIX

**Appendix A - DECLARATION OF EXCLUSIVE USE OF THE ARTICLE IN
DISSERTATION/THESIS**

We hereby declare that we are aware of the article "DENTOSKELETAL AND FACIAL FEATURES COMPARISON BETWEEN INDIVIDUALS TREATED WITH FOUR FIRST PREMOLAR EXTRACTION IN THE 1970S AND IN THE NEW MILLENNIUM" will be included in Dissertation of the student Rodrigo Andrés Naveda Araque and may not be used in other works of Graduate Programs at the Bauru School of Dentistry, University of São Paulo.

Bauru, December 4th, 2018.

Rodrigo Andrés Naveda Araque
Author

Signature

Daniela Garib
Author

Signature

Author

Signature

Author

Signature

ANNEXES

ANNEX A – Ethics Committee approval, protocol number 71638417.9.0000.5417.

USP - FACULDADE DE
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USP

PARECER CONSUBSTANCIADO DO CEP**DADOS DA EMENDA**

Título da Pesquisa: Comparação das características dentoesceléticas e faciais de pacientes tratados com extração de 4 primeiros pré-molares na década de 70 e no novo Milênio.

Pesquisador: Rodrigo Andrés Naveda Araque

Área Temática:

Versão: 3

CAAE: 71638417.9.0000.5417

Instituição Proponente: Universidade de São Paulo

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 3.030.239

Apresentação do Projeto:

Idem ao do Parecer: 2.332.824

Adicionando por Emenda mais 12 participantes da pesquisa com dados de prontuários e modelos antigos.

Objetivo da Pesquisa:

Número do Parecer: 2.332.824

Avaliação dos Riscos e Benefícios:

Número do Parecer: 2.332.824

Comentários e Considerações sobre a Pesquisa:

Número do Parecer: 2.332.824 e a adição dos 12 participantes não modifica a proposta da pesquisa, está sendo adicionado para ter força estatística.

Considerações sobre os Termos de apresentação obrigatória:

Há solicitação de dispensa de TCLE por ser a pesquisa utilizando prontuários e modelos muito antigos, onde pacientes não tem mais contato para ser estabelecido.

Conclusões ou Pendências e Lista de Inadequações:

Aprovado, lembrando aos pesquisadores que este CEP aceita o pedido de dispensa de TCLE, mas que em próximas pesquisas o TCLE, mesmo só para uso de dados de prontuários, seja realizado e

Endereço: DOUTOR OCTAVIO PINHEIRO BRISOLLA 75 QUADRA 9
Bairro: VILA NOVA CIDADE UNIVERSITARIA **CEP:** 17.012-901
UF: SP **Município:** BAURU
Telefone: (14)3235-8356 **Fax:** (14)3235-8356 **E-mail:** cep@fob.usp.br

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USP**

Continuação do Parecer: 3.030.239

executado seguindo as normas da CONEP.

Considerações Finais a critério do CEP:

A emenda apresentada pelo(a) pesquisador(a) foi considerada APROVADA na reunião ordinária do CEP de 10/10/2018, 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.

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_1221434_E1.pdf	19/09/2018 23:26:30		Aceito
Outros	Encaminhamento_ao_CEP_enmenda.pdf	19/09/2018 22:21:48	Rodrigo Andrés Naveda Araque	Aceito
Projeto Detalhado / Brochura Investigador	Projeto_de_pesquisa.pdf	19/09/2018 22:21:18	Rodrigo Andrés Naveda Araque	Aceito
Folha de Rosto	Folha_de_rostro.pdf	19/09/2018 22:20:23	Rodrigo Andrés Naveda Araque	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLE.pdf	15/09/2017 13:27:11	Rodrigo Andrés Naveda Araque	Aceito
Outros	Questionario_tecnico_sobre_o_projeto_de_pesquisa.pdf	20/07/2017 16:42:22	Rodrigo Andrés Naveda Araque	Aceito
Declaração de Pesquisadores	Declaracao_do_pesquisador.pdf	20/07/2017 16:40:47	Rodrigo Andrés Naveda Araque	Aceito
Outros	Encaminhamento_ao_CEP.pdf	20/07/2017 16:30:26	Rodrigo Andrés Naveda Araque	Aceito

Situação do Parecer:

Aprovado

Necessita Apreciação da CONEP:

Não

Endereço: DOUTOR OCTAVIO PINHEIRO BRISOLLA 75 QUADRA 9
Bairro: VILA NOVA CIDADE UNIVERSITARIA **CEP:** 17.012-901
UF: SP **Município:** BAURU
Telefone: (14)3235-8356 **Fax:** (14)3235-8356 **E-mail:** cep@fob.usp.br

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Continuação do Parecer: 3.030.239

BAURU, 21 de Novembro de 2018

Assinado por:
Ana Lúcia Pompéia Fraga de Almeida
(Coordenador(a))

Endereço: DOUTOR OCTAVIO PINHEIRO BRISOLLA 75 QUADRA 9
Bairro: VILA NOVA CIDADE UNIVERSITARIA **CEP:** 17.012-901
UF: SP **Município:** BAURU
Telefone: (14)3235-8356 **Fax:** (14)3235-8356 **E-mail:** cep@fob.usp.br

ANNEX B – Patient's informed consent exoneration.

Universidade de São Paulo Faculdade de Odontologia de Bauru

Departamento de Odontopediatria, Ortodontia e
Saúde Coletiva

Bauru, 12 de Setembro de 2017.

Dispensa de Termo de Consentimento Livre Esclarecido e Termo de Assentimento

Como parte da documentação solicitada pelo Comitê de Ética em Pesquisa para a avaliação de projetos de pesquisas envolvendo seres humanos, encaminho justificativa para a dispensa de TCLE e Termo de Assentimento no Projeto de Pesquisa **“Comparação das características dento-esqueléticas e faciais de pacientes tratados com extração de 4 primeiros pré-molares na década de 70 e no novo Milênio”** tendo como Responsável Principal Rodrigo Andrés Naveda Araque, sob orientação da Profa. Dra. Daniela Gamba Garib Carreira.

A pesquisa será realizada avaliando os prontuários, telerradiografias e modelos, de pacientes tratados desde a década de 70. Pela dificuldade de localizar esses pacientes, solicitamos ao Comitê de Ética em Pesquisa a dispensa destes Termos.

Atenciosamente,

Rodrigo Andrés Naveda Araque
Responsável Principal

Al. Dr. Octávio Pinheiro Brisolla, 9-75 – Bauru-SP – CEP 17012-901 – C P 73
e-mail: veragato@fob.usp.br – Fone/FAX (014) 3235-8369
<http://www.fob.usp.br>