



MESTRADO PROFISSIONAL EM ORTODONTIA

Karen Christina Soares Tenório

**QUALIDADE DE FINALIZAÇÃO ORTODÔNTICA: UMA
COMPARAÇÃO ENTRE OS ÍNDICES OCLUAIS PAR E SOA**

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Dissertação apresentada ao curso de Odontologia da UNG Universidade para obtenção do título de Mestre em Ortodontia.

Orientador: Profa. Dra. Marina Guimarães Roscoe.

Co-orientador: Prof. Dr. Murilo Fernando Neuppmann Feres.

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Ao meu querido filho José Luccas, por iluminar meus dias com sua doçura e carinho...

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“Os que se encantam com a prática sem a ciência são como os timoneiros que entram no navio sem timão nem bússola, nunca tendo certeza do seu destino”.

(Leonardo da Vinci)

RESUMO

A avaliação objetiva e contínua dos resultados do tratamento ortodôntico é fundamental para avaliar a eficácia dos diferentes aparelhos e terapias ortodônticas. Este estudo retrospectivo objetivou: (1) verificar se existe correlação entre os resultados obtidos pelos índices oclusais PAR e SOA; e (2) avaliar a contribuição de cada componente avaliado pelos índices oclusais em sua respectiva pontuação total. Sessenta e dois conjuntos de modelos iniciais e finais de pacientes tratados por professores da área de Ortodontia, com pelo menos 15 anos de experiência profissional, foram selecionados. A avaliação dos resultados do tratamento foi realizada por meio de dois índices oclusais: PAR e SOA. Um único investigador mediu cada conjunto de modelos de estudo iniciais e finais e avaliou as radiografias panorâmicas. As correlações entre os resultados de PAR e SOA, bem como a contribuição de cada componente avaliado pelos índices para a sua respectiva pontuação total, foram avaliadas pelo Coeficiente de Correlação de Spearman. Os dados foram analisados, adotando um nível de significância de 5%. A maioria dos casos (82%) obteve "grande melhora" de acordo com o índice PAR, e foram considerados "bem finalizados" (92%), de acordo com os resultados obtidos pelo SOA. No entanto, não houve correlação estatisticamente significativa entre resultados obtidos por meio dos índices PAR e SOA ($Rho: 0.145$). Overjet ($Rho: 0,766$), relação oclusal posterior esquerda ($Rho: 0,718$) e posterior direita ($Rho: 0,648$) exibiram correlação estatisticamente significativa e positiva com o escore PAR inicial. Overjet ($Rho: 0,645$), inclinações vestibulolinguais ($Rho: 0,547$) e relações oclusais ($Rho: 0,519$) exibiram correlação moderada com o escore do SOA. Para o índice PAR, o componente que obteve maior pontuação na fase inicial de tratamento foi relacionado ao alinhamento ântero-superior, enquanto que para o SOA, o componente mais crítico durante a finalização foi relacionado às inclinações vestibulolinguais.

Descritores: Ortodontia; Ortodontia Corretiva; Má Oclusão; Resultado do Tratamento.

ABSTRACT

The continuous evaluation of the orthodontics treatment results using objectives methods is essential to evaluate the efficacy of different appliances and therapies. This retrospective study aimed to: (1) Verify the correlation between the results obtained by the two occlusal indexes PAR and OGS; and (2) Asses the contribution of each component evaluated by the PAR and OGS indexes to its respectively score. Sixty-two inital and final treatment records from patients treated by orthodontic teachers, with at least 15 years of professional experience, were selected. The evaluation of the orthodontic treatment outcomes was performed using two assessment tools: PAR and OGS. One calibrated investigator measured each set of study casts and panoramic radiographs. The correlations between PAR and OGS results, as well as the contribution of each component evaluated by the indexes to its respectively score were assessed using Spearman's correlation coefficient. Data were analyzed, adopting a significance level of 5%. Most cases (82%) "Greatly improved" according to the PAR index, and most cases (92%) were considered "well finished" (92%), according to the results obtained by the OGS. Still, there was no statistically significant correlation between the OGS and the PAR index grading systems ($Rho: 0.145$). Overjet ($Rho: 0.766$), left posterior occlusion ($Rho: 0.718$) and right posterior occlusion ($Rho: 0.648$) relationships were estatiscally significant correlated with the pre-treatment PAR score. Overjet ($Rho: 0.645$), buccolingual inclinations ($Rho: 0.547$), and occlusion relationships ($Rho: 0.519$) were moderately correlated with the OGS score. For the PAR index, the component with the highest score in the pre-treatment was the upper alignment, while for the OGS index, the most deficient component for finishing was related to the buccolingual inclinations.

Keywords: Orthodontics; Corrective Orthodontics; Malocclusion; Treatment outcome.

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1. INTRODUÇÃO

A excelência na finalização ortodôntica constitui desafio crescente para o ortodontista (Kokich, 2003), e visa a obtenção da qualidade máxima em restabelecer os aspectos funcionais, morfológicos e estéticos da oclusão dentária. Tradicionalmente, a qualidade de finalização do tratamento ortodôntico tem sido avaliada de forma subjetiva, baseada em opiniões e experiências clínicas dos especialistas (de Freitas et al., 2008). Entretanto, com o objetivo de estabelecer metas e padronizar as avaliações de qualidade de finalização ortodôntica, métodos objetivos de avaliação dos resultados de tratamentos ortodônticos têm sido desenvolvidos.

Diversos índices quantitativos para avaliação da necessidade ou dos resultados oclusais do tratamento ortodôntico têm sido propostos na literatura, tais como o Índice de Prioridade de Tratamento (IPT, 1967), o Índice de Estética Dental (DAI, 1996), o Índice de Complexidade, Resultado e Necessidade (ICON, 2000), etc. Dentre estes, destacam-se o índice de avaliação oclusal PAR (Peer Assessment Rating - PAR) (Chalabi et al., 2015; González-Gil-de-Bernabé et al., 2014; Fadiga et al., 2014; Ponduri et al., 2011; Freitas et al., 2008; Onyeaso et al., 2007), e o Sistema Objetivo de Avaliação do *Board* Americano (SOA-Board) (Akinci Cansunar & Uysal, 2016; Mislik et al., 2016; Chalabi et al., 2015; Li et al., 2015; Anthopoulou et al., 2014; Cansunar & Uysal, 2014; Onyeaso et al., 2007).

O índice PAR foi um dos primeiros índices desenvolvidos (Richmond et al., 1992a; Richmond et al., 1992b) e tem sido amplamente utilizado para avaliação da severidade das más oclusões e dos efeitos dos tratamentos corretivos (Chalabi et al., 2015; González-Gil-de-Bernabé et al., 2014; Fadiga et al., 2014; Ponduri et al., 2011; Freitas et al., 2008; Onyeaso et al., 2007). Foi elaborado para mensurar os resultados da terapia ortodôntica, levando em consideração as alterações oclusais presentes no início do tratamento. A diferença na pontuação entre pré e pós-tratamento reflete o grau de melhora e o sucesso do tratamento (Richmond et al.,

1992a; Richmond et al., 1992b). A pontuação é efetuada por meio da análise dos modelos de estudo dos pacientes e calculadas baseadas em um peso pré-definido para cada item medido.

Este índice oferece padronização para avaliar o resultado do tratamento ortodôntico, o qual é categorizado em três grupos: (1) Piora ou sem diferença: quando não há redução no índice PAR inicial ou quando a redução foi menor que 30%, respectivamente; (2): Melhora: quando a redução na pontuação PAR está entre 30% e 70%; (3) Grande melhora: quando a pontuação PAR é reduzida em 70% ou mais (Richmond, 1992).

O índice PAR foi desenvolvido no Reino Unido (PAR UK) (Richmond, 1992), e validado nos Estados Unidos (PAR US) (DeGuzman, 1995) (Firestone et al., 2002), porém utilizando diferentes ponderações e eliminando o componente do alinhamento ântero-inferior. Apesar de demonstrar excelente confiabilidade e uniformidade para avaliar os resultados do tratamento ortodôntico (Richmond et al., 1992a; Richmond et al., 1992b), este índice não é capaz de mensurar efeitos iatrogênicos; tais como lesões de esmalte, perdas ósseas e reabsorções radiculares (Linge & Linge, 1991); e necessita dos modelos iniciais e finais para gerar uma pontuação válida (Jain et al., 2013).

Com o objetivo de elevar a confiabilidade do exame de certificação, o *Board* Americano de Ortodontia elaborou, em 1999, o Sistema Objetivo de Avaliação (Objective Grading System - OGS) e o oficializou como a terceira fase do exame de certificação. O sistema de pontuação foi desenvolvido sistematicamente para avaliação de sete critérios utilizando os modelos de estudo finais (alinhamento, cristas marginais, inclinação vestibulo-lingual, relações oclusais, contatos oclusais, trespasse horizontal, e contatos interproximais) e um critério utilizando radiografias panorâmicas (angulação das raízes) (Casko et al., 1998; Cangialosi et al., 2004; Akinci Cansunar & Uysal, 2016; Mislik et al., 2016; Chalabi et al., 2015; Li et al., 2015; Anthopoulou et al., 2014; Cansunar & Uysal, 2014; Onyeaso et al., 2007).

Idealmente, os diferentes critérios de avaliação deveriam estabelecer

estimativas de sucesso de tratamento semelhantes. No entanto, poucos estudos avaliaram a correlação entre os resultados do tratamento ortodôntico avaliados pelos índices PAR e SOA (Deguchi et al., 2005; Onyeaso & Begole, 2007; Chalabi et al., 2015). Dessa forma, parece oportuno verificar se existe correlação entre os resultados da qualidade de finalização obtidos pelos índices PAR e SOA, e determinar quais são os componentes mais críticos para obtenção da excelência durante a finalização ortodôntica.

3. PROPOSIÇÃO

3.1. OBJETIVO GERAL

Comparar a qualidade de finalização de casos tratados ortodonticamente por meio dos índices Peer Assessment Rating – (PAR) e do Sistema Objetivo de Avaliação do *Board* Americano de Ortodontia (SOA-BAO).

3.2. OBJETIVOS ESPECÍFICOS

- Verificar se existe correlação entre os resultados da qualidade de finalização obtidos pelos índices oclusais SOA-BAO e PAR; e
- Avaliar a contribuição de cada critério, definido pelos índices PAR e SOA, no respectivo escore final.

4. DESENVOLVIMENTO

Orthodontic treatment outcomes assessed by PAR and OGS: Indexes correlation and components contribution for finishing occlusion quality

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Abstract

Introduction: The continuous evaluation of the orthodontics treatment results using objectives methods is essential to evaluate the efficacy of different appliances and therapies. *Aims:* This retrospective study aimed to: (1) Verify the correlation between the results obtained by the two occlusal indexes PAR and OGS; and (2) Assess the contribution of each component evaluated by the PAR and OGS indexes to its respectively score. *Materials and methods:* Sixty-two initial and final treatment records from patients treated by orthodontic teachers, with at least 15 years of professional experience, were selected. The evaluation of the orthodontic treatment outcomes was performed using two assessment tools: PAR and OGS. One calibrated investigator measured each set of study casts and panoramic radiographs. The correlations between PAR and OGS results, as well as the contribution of each component evaluated by the indexes to its respectively score were assessed using Spearman's correlation coefficient. Data were analyzed, adopting a significance level of 5%. *Results:* Most cases (82%) "Greatly improved" according to the PAR index, and most cases (92%) were considered "Well-finished" according to the OGS. Still, there was no statistically significant correlation between the OGS and the PAR index grading systems ($Rho: 0.145$). Overjet ($Rho: 0.766$), left posterior occlusion ($Rho: 0.718$) and right posterior occlusion ($Rho: 0.648$) relationships were significantly correlated with the pre-treatment PAR score. Overjet ($Rho: 0.645$), buccolingual inclinations ($Rho: 0.547$), and occlusion relationships ($Rho: 0.519$) were moderately correlated with the OGS score. *Conclusions:* No correlation was found between the results of finishing occlusion quality obtained by PAR and OGS scores. For the PAR index, the component with the highest score in the pre-treatment was related to the upper alignment, while for the OGS index the most deficient component for finishing was related to buccolingual inclinations.

Introduction

Excellence in orthodontic outcomes represents a challenge for clinicians (Kokich, 2003). It pursues maximum quality in restoring the functional, morphological and aesthetic occlusal parameters. Treatment outcomes had been mostly evaluated subjectively, based on specialists opinions and clinical experience (de Freitas et al., 2008; Dyken et al., 2001). In order to set goals and standardize the assessments of treatment results, quantitative indexes have been proposed in the literature, such as the Peer Assessment Rating (PAR) (Chalabi et al., 2015; González-Gil-de-Bernabé et al. 2014; Fadiga et al., 2014; Ponduri et al., 2011; Freitas et al., 2008; Onyeaso et al. 2007), and the Objective Grading System (OGS) (Akinci Cansunar & Uysal, 2016; Mislik et al., 2016; Chalabi et al., 2015; Li et al., 2015; Anthopoulou et al. 2014; Cansunar & Uysal, 2014; Onyeaso et al., 2007).

The PAR index was one of the first assessment tools developed and has been widely used and validated over the countries (Richmond et al. 1992a; Richmond et al., 1992b; DeGuzman et al., 1995; Firestone et al., 2002). This tool evaluates malocclusions severity and reflects the effect of orthodontic treatment, since it takes into account the occlusal alterations existent in the initial condition (Chalabi et al. 2015; González-Gil-de-Bernabé et al., 2014; Fadiga et al., 2014; Ponduri et al., 2011; Freitas et al., 2008; Onyeaso et al., 2007). The difference between pre- and post-treatment scores reflects the degree of orthodontic improvement (Richmond et al., 1992a; Richmond et al., 1992b). A percentage of improvement greater than 70% in the PAR score indicates a high quality of orthodontic treatment (Stalpers et al., 2007; Firestone et al., 2002; de Freitas et al., 2006; Ahmad et al., 2010).

In order to increase the reliability of the certification exam, the American Board of Orthodontics (ABO) has developed the Objective Grading System (OGS). The OGS scores seven criteria by using post-treatment dental casts (tooth alignment, marginal ridge heights, bucco-lingual tooth inclination, occlusal contacts, occlusal relationships, interproximal contacts, overjet) and a criterion by using panoramic radiographs (root angulation) (Casko et al., 1998; Cangialosi et al., 2004; Akinci Cansunar & Uysal, 2016; Mislik et al., 2016; Chalabi et al., 2015; Li et al., 2015; Anthopoulou et al., 2014; Cansunar & Uysal, 2014; Onyeaso et al., 2007). An increasingly higher score indicates unsatisfactory outcomes. In general, a case that scores more than 30 points will fail assessment, while a case that scores less than 30 points will pass.

It is known that the achievement of therapy efficacy depends on the continuous evaluation of the orthodontic treatment results, using objective methods. Still, the non-uniformity between the available objective evaluation criteria leads to variable and confusing estimates of treatment success. Only a few research studies have assessed the correlation between orthodontic treatment outcomes measured by both PAR and OGS indexes (Deguchi et al., 2005; Onyeaso & Begole, 2007; Chalabi et al., 2015).

Therefore, this retrospective study aimed to: (1) Verify the correlation between the results of finishing occlusion quality obtained by the US PAR and OGS occlusal indexes; and (2) Assess the contribution of each component evaluated by these two indexes to its respective score.

Materials and methods

After approval by the Research Ethics Committee of Guarulhos University (#1.943.754), sixty-two initial and final treatment records from patients treated by teachers in Orthodontics, with at least 15 years of professional experience were selected. The sample represented a mixture of malocclusion types, ethnic groups, gender and ages. Based on a previous study, a sample size of 50 was considered statistically adequate to detect a significant difference between pre- and post-treatment PAR measurements and between the PAR and OGS systems (Chalabi et al., 2015).

The inclusion criteria for selecting the sample were: patients treated with maxillary and mandibular fixed appliance; absence of supernumerary teeth; absence of anomalies regarding the size and / or shape of the teeth; availability of pre- and post-treatment study casts without attached appliances, and a final panoramic radiograph. Treatment protocols, appliances and mechanics were not used as an exclusion criteria. Therefore, any orthodontic treatment performed with fixed appliances were able to be included.

The following information was recorded for each case from the selected sample: gender, duration of treatment, and ages at the start and at the end of treatment. The evaluation of the orthodontic treatment outcomes was performed using two assessment tools: (1) Peer Assessment Rating (PAR), and (2) Objective

Grading System (OGS). One calibrated investigator (KCST) measured each set of study casts and panoramic radiographs.

Peer review index (PAR)

To evaluate the PAR index, components regarding maxillary labial segment alignment, overbite, overjet, midline, right posterior segment occlusal relationship, and left posterior segment relationship, were measured in the initial dental cast (PAR T1) and post-treatment dental cast (PAR T2) of each patient. The initial and final scores were calculated based on the weightings of each criterion, presented in Table I. A digital caliper (Mitutoyo Sul Americana Ltda., São Paulo Brazil) was used to perform all measurements.

The percentage of reduction of the PAR index was calculated to evaluate the degree of orthodontic improvement. The outcomes of orthodontic treatment were categorized in three categories: (1) Worse-no difference: there is no reduction in the initial PAR score or the reduction was less than 30%; (2) Improved: the total PAR score reduction was between 30% and 70%; (3) Greatly improved: the total PAR score reduction was greater or equal to 70% (Richmond et al., 1992b).

Table I. Criteria evaluated by the PAR and weightings

PAR Component	US weightings
Upper labial segment alignment	1
Overbite	3
Overjet	5
Midline	3
Right posterior occlusion relationship	2
Left posterior occlusion relationship	2

Objective Grading System (OGS)

The evaluation of the OGS index was carried out using a specific rule used by the American Board of Orthodontics. An examiner of the Board of Orthodontics calibrated the single investigator (KCST). The OGS index comprised eight measurements, regarding tooth alignment, marginal ridge heights, buccolingual tooth inclinations, occlusal contacts, interproximal contacts, occlusal relationships, overjet, and root angulation. A perfect post-treatment result would have a score equal to

zero. In the third phase of the American Board of Orthodontics Examination, the orthodontic treatment is considered "well finished" with up to 30 negative points and, and "poorly finalized" with 30 negative points or more, according to the score presented in the Table II. The present study considered 3 categories: (1) Failure: cases that lost more than 30 points; (2) Borderline: cases that lost 20 to 30 points; and (3) Well-finished: cases that lost less than 20 points (Chalabi et al., 2015).

Table II. Criteria evaluated by the Objective Grading System (OGS) and weightings

	OGS Component	Weightings
Tooth alignment	< 0.5	0
	0.5 to 1 mm	1
	> 1 mm	2
Marginal ridges	< 0.5 mm	0
	0.5 to 1 mm	1
	> 1 mm	2
Buccolingual inclinations	< 1 mm	0
	1 to 2 mm	1
	> 2 mm	2
Occlusal contacts	0 mm	0
	< 1 mm	1
	> 1 mm	2
Occlusal relationships	< 1 mm	0
	1 to 2 mm	1
	> 2 mm	2
Overjet	0 mm	0
	Less than 1 mm	1
	> 1 mm	2
Interproximal contacts	< 0.5 mm	0
	0.5 to 1 mm	1
	> 1 mm	2
Root angulations	Root parallelism	0
	Roots are not parallel	1
	Roots are contacting the adjacent tooth	2

Intra-examiner reliability

Thirty sets of records were randomly selected and re-measured by the same investigator after an interval of 3 months. The measurements were performed according to the US PAR and the OGS. The systematic errors were analyzed by applying the t test paired (Houston, 1983).

Statistical analysis

Descriptive statistics were initially conducted for all variables. Inferential statistics were performed in order to verify correlations and associations between the variables under study. Data were analyzed using the SPSS software package (version 17.0), adopting a significance level of 5%.

The relationships between the PAR and OGS indexes and the gender was assessed using Chi-square tests. The correlation between the PAR and OGS indexes and the age was determined using Spearman's correlation coefficient.

The correlation between the outcomes of orthodontic treatment with the initial malocclusion, measured by PAR scoring method, was determined using Spearman's correlation coefficient. The correlations between PAR and OGS results and mean treatment duration, as well as the contribution of each component evaluated by the US PAR and OGS indexes to its respectively score were assessed using Spearman's correlation coefficient.

The association between the results obtained for PAR and OGS categories was determined using Fisher's exact test.

Results

This study retrospectively evaluated sixty-two orthodontic treatment cases, from which 41 were females (66.1%) and 21 males (33.9%). The mean treatment duration was 43.0 months (95% CI. 37.9–38.1 months). The average age pre-treatment was 18.29 (95% CI. 15.18-21.40), and post-treatment was 21.35 years (95% CI. 18.2-24.5).

The intra-examiner reliability analysis showed that no systematic errors were detected (Table III).

Table III. Intra-examiner reliability analysis assessed by the t test paired

Indexes	<i>p</i> value
OGS	0.59
PAR US pre-treatment	0.14
PAR US post-treatment	0.63

PAR

The PAR T1 index mean was 17.56 (95 % CI. 14.74-20.39), and the PAR T2 index mean was 1.97 (95 % CI. 1.24-2.70). The degree of improvement, classified in the three categories, indicated that 4 cases (7%) presented “No difference” (reduction was less than 30%), 7 cases (11%) “Improved” (reduction was between 30% and 70%), and 51 cases (82%) “Greatly improved” (reduction was greater or equal to 70%).

None of the categorical variables studied influenced significantly the treatment outcomes regarding the PAR (gender, $p=0.700$; pre-treatment age, $p=0.728$; and post-treatment age, $p=0.600$). In the quantitative variables, no association was found between average treatment duration and PAR reduction ($p=0.526$). No correlation was found between treatment duration and PAR T1 index ($Rho: -0.016$; $p=0.901$), nor between the age ($Rho: -0.025$; $p=0.849$). Moreover, no correlation was found between the outcomes of orthodontic treatment with the initial malocclusion ($Rho= -0.025$; $p=0.849$).

Overjet ($Rho: 0.766$; $p=0.000$), left posterior occlusion ($Rho: 0.718$; $p=0.000$) and right posterior occlusion ($Rho: 0.648$; $p=0.000$) relationships were significantly correlated with the PAR T1 score. Overbite ($Rho: 0.324$; $p=0.010$) and upper segment alignment ($Rho: 0.408$; $p=0.001$) presented a weak correlation with the PAR T1 score. The midline component was not significantly correlated with PAR T1 score ($Rho: 0.196$; $p=0.127$) (Table IV). Instead, none of the components were significantly correlated with PAR T2 variations (Table V).

Table IV. Correlation between the PAR components and the pre-treatment score

Components	<i>Rho</i>	<i>p</i> value
Overjet	0.766	0.000
Overbite	0.324	0.010
Right posterior occlusion relationship	0.648	0.000
Left posterior occlusion relationship	0.718	0.000
Midline	0.196	0.127
Upper alignment	0.408	0.001

Table V. Correlation between the US PAR components and the final score

Components	<i>Rho</i>	<i>p</i> value
Overjet	-0.146	0.258
Overbite	0.179	0.164
Right posterior occlusion relationship	-0.126	0.331
Left posterior occlusion relationship	-0.123	0.341
Midline	0.100	0.442
Upper alignment	-0.012	0.928

The analysis of PAR T1 index showed that the differences between the initial total score of the groups “Greatly Improved” and “Improved” were not statistically significant (8.08 ± 4.15^A versus 8.43 ± 3.99^A , respectively). For both groups, the component with the highest score in the pre-treatment was upper alignment (30% and 40.7%). Still, for the group considered “Worse-no difference”, the initial total score was much lower than the others two groups (2.75 ± 1.26^B), and the difference between them was statistically significant. Upper alignment (45.45%), was also the component with the highest score in the pre-treatment analysis.

Table VI. PAR Index Component Scores without weightings (mean \pm SD) for the three improvement degree categories

Variables	Reduction \geq 70% (n=51)	%	Reduction 30%-70% (n=7)	%	Reduction \leq 30% (n=4)	%	<i>p</i> value
Overjet	1.12 \pm 1.39	13.8%	1.00 \pm 1.00	11.8%	0.00 \pm 0.00	0.0%	0.159
Overbite	1.10 \pm 1.15	13.6%	1.29 \pm 0.95	15.3%	0.75 \pm 0.96	27.27%	0.681
Right posterior occlusion	1.65 \pm 1.66	20.4%	0.86 \pm 1.07	10.2%	0.75 \pm 1.50	27.27%	0.311
Left posterior occlusion	1.53 \pm 1.50	18.9%	1.43 \pm 1.51	16.9%	0.00 \pm 0.00	0.0%	0.074
Midline	0.27 \pm 0.49	3.3%	0.43 \pm 0.53	5.1%	0.00 \pm 0.00	0.0%	0.313
Upper alignment	2.46 \pm 0.97	30.0%	3.43 \pm 3.05	40.7%	1.25 \pm 0.50	45.45%	0.051
Initial total score	8.08 \pm 4.15 ^A	100.0%	8.43 \pm 3.99 ^A	100.0%	2.75 \pm 1.26 ^B	100.0%	0.006*

OGS

The occlusal outcomes measured using the OGS score indicated an average score of 19.4 points (95% CI. 17.3–21.5 points).

Similarly to the PAR index, none of the categorical variables studied influenced significantly the treatment outcomes regarding the OGS score (gender, $p=0.118$; pre-treatment age, $p=0.642$; and post-treatment age, $p=0.964$). In the quantitative variables, no correlation was found between treatment duration and OGS index ($Rho: 0.173$; $p=0.180$), or between the age ($Rho: -0.064$; $p=0.629$).

Overjet ($Rho: 0.645$; $p=0.000$), buccolingual inclinations ($Rho: 0.547$; $p=0.000$), and occlusion relationships ($Rho: 0.519$; $p=0.000$) were moderately correlated with the OGS score. Tooth alignment ($Rho: 0.322$; $p=0.11$) and marginal ridges height ($Rho: 0.391$; $p=0.002$) presented a weak correlation with the OGS score. Instead, occlusal contacts ($Rho: 0.102$; $p=0.430$), interproximal contacts ($Rho: 0.149$; $p=0.249$), and root angulation ($Rho: 0.132$; $p=0.308$) components were not correlated with OGS scores. (Table VII).

Table VII. Correlation between the OGS components and the final score

Components	<i>Rho</i>	<i>p</i> value
Tooth alignment	0.322	0.011
Marginal ridges	0.391	0.002
Buccolingual inclinations	0.547	0.000
Occlusal relationships	0.519	0.000
Occlusal contacts	0.102	0.430
Overjet	0.645	0.000
Interproximal contacts	0.149	0.249
Root angulation	0.132	0.308

* Statistically significant difference ($p<0.05$)

The intra-groups analysis between the components and the OGS scores revealed that alterations in index score were significantly determined by variations in marginal ridges ($p=0.012$), buccolingual inclination ($p=0.000$), occlusal relationships ($p=0.000$), and overjet components ($p=0.003$). Tooth alignment, occlusal contacts, interproximal contacts, and root angulation components were not significantly responsible for OGS score variations ($p>0.05$) (Table VIII). The analysis intra-groups

revealed that the buccolingual inclination was the components with greater difficulty in finishing, since presented the highest percent score in the 3 groups (24.8%, 24.5%, and 23.4% of the total score).

Table VIII. OGS Index Component Scores (mean±SD) for the three categories assessed.

Variables	Score ≤ 20 (n=38)	%	Score 21-30 (n=19)	%	Scores ≥ 31 (n=5)	%	<i>p</i> value
Tooth alignment	0.9 ± 1.3 A	6.2%	1.3±1.5 A	5.3%	3.2±3.6 A	8.5%	0.282
Marginal ridges	2.8 ± 2.0 A	19.3%	4.7±2.0 B	19.2%	5.0±4.1 AB	13.3%	0.012*
Buccolingual inclination	3.6 ± 2.6 A	24.8%	6.0±2.8 B	24.5%	8.8±4.2 C	23.4%	0.000*
Occlusal relationships	2.6 ± 2.1 A	17.9%	4.8±3.3 B	19.6%	7.8±2.0 C	20.7%	0.000*
Occlusal contacts	0.8 ± 1.7 A	5.5%	1.1±3.0 A	4.5%	5.6±6.5 A	14.9%	0.133
Overjet	2.8 ± 2.8 A	19.3%	5.0±2.6 B	20.4%	6.4±2.2 B	17.0%	0.003*
Interproximal contacts	0.2 ± 0.5 A	1.4%	0.2±0.4 A	0.8%	0.0±0.0 A	0.0%	0.543
Root angulation	0.8 ± 1.2 A	5.5%	1.4±1.5 A	5.7%	0.8±1.1 A	2.1%	0.207
Total	14.5 ± 2.2 A	100%	24.5 ± 2.1 B	100%	37.6± 3.0 B	100%	0.000*

* Statistically significant difference ($p < 0.05$)

Comparison of the OGS and the PAR

There were no statistically significant associations between the results assessed by the categories of OGS and the PAR indexes ($p = 0.723$) (Table IX). In addition, there was no significant correlation between PAR and OGS results ($Rho: 0.145$).

Table IX. PAR scoring *versus* OGS scoring

PAR categories	OGS categories (N)			Total
	Score ≥ 31	Score 21-30	Score ≤ 20	
≥ 70% (Greatly improved)	4	15	32	51
30 – 70% (Improved)	1	3	3	7
≤ 30% (No difference)	0	1	3	4
	5	19	38	62

Discussion

The PAR index demonstrates excellent reliability and uniformity to evaluate the efficacy of the orthodontic treatment (Richmond et al., 1992a; Richmond et al., 1992b), and requires the initial condition of malocclusion to generate a valid score (Jain et al., 2013). Changes from pre-treatment to post-treatment stages are important when evaluating orthodontic treatment effectiveness. Therefore, in the present study, it was expected that the severity of initial malocclusion would affect the attainable of ideal treatment results. Still, no correlation was found between the outcomes of orthodontic treatment with the mean severity of the initial malocclusion, assessed by the PAR T1 index.

Some authors believe that the initial malocclusion might affect treatment goals and results (Leon-Salazar et al., 2014). It has been reported that the more severe the malocclusion, the greater will be the treatment changes (Freitas et al., 2008; Leon-Salazar et al., 2014). Still, others studies also did not found either clinical or statistically significant correlations between pre-treatment PAR and corrections obtained in the post-treatment stage (Woods et al., 2000). Comparison must be made cautiously, and differences in sample and methodology need to be considered. This study sample included orthodontic cases with several malocclusion types, which were treated with various treatment protocols, appliances and mechanics. These factors might have influenced the achieved results.

In the present study, results of the statistical analysis showed a mean PAR T1 index of 17.56 (95 % CI. 14.74-20.39), which was reduced to a mean of 1.97 (95 % CI. 1.24-2.70) in the post-treatment stage. The present results showed an 82% mean PAR reduction. Similarly, previous studies (Dyken et al., 2001; Freitas et al., 2008; Gonzales-Gil-of-Barnabé et al., 2014) found percentages of PAR reduction between 78.54% and 87.9%. Based on the present results, it can be stated that orthodontic cases finished indicated an orthodontic finishing closer to the considered good standard, since only 7% of cases presented less than 30% of reduction between PAR-T1 and PAR-T2.

To assess the influence of each criterion that composes the score, each variable was correlated to the final score in the pre-treatment and post-treatment stages. Overjet and posterior occlusion relationships were significantly correlated with the pre-treatment PAR score. Overbite and upper segment alignment presented

only a weak correlation, and the midline component presented no correlation with the pre-treatment PAR score. After orthodontic treatment, none of the components were significantly correlated with post-treatment PAR scores.

Contrasting PAR index, the OGS defines only the treatment outcome and cannot take into account severity of the malocclusion or difficulty of the treatment. The goal of the ABO examiners is to assess final detailing of treatment results (Casko et al., 1998). To assess the influence of each criterion that composes the score, each variable was correlated to the OGS score. Overjet, buccolingual inclinations, and occlusion relationships were moderately correlated with the OGS score. Tooth alignment and marginal ridges height presented a weak correlation with the OGS score. Instead, occlusal contacts, interproximal contacts, and root angulation components were not correlated with OGS scores.

In addition, in order to identify components that can be predictive of greater difficulty in finishing, the OGS was defined in three categories: (1) Failure, (2) Borderline, and (3) Well-finished (Chalabi et al., 2015). There were significant differences in the OGS scores for all of the groups. The statistical analysis revealed that alterations in index score were significantly determined by variations in buccolingual inclination, marginal ridges, occlusal relationships and overjet components. Tooth alignment, occlusal contacts, interproximal contacts, and root angulation components were not significantly responsible for OGS score variations.

In all of the three categories, the most deficient component was related to buccolingual inclinations. These results suggest a deficiency in torque control of the buccal segments. Previous authors found similar results and suggested that these improper buccolingual inclinations could be related to the increased use of preadjusted appliances, and to appliance prescriptions that might overcompensate and provide excessive torque within the bracket slot (Yang Powers et al., 2002). The lowest average score in all groups was that for interproximal contacts. This result supports the fact that orthodontists have no trouble recognizing and correcting spaces in the arch (Yang Powers et al., 2002).

Regarding the duration of the orthodontic treatment, no statistically significant correlation was observed between total treatment duration and PAR or OGS scores. Still, it is worth to state that extended treatment may be associated with several detrimental side effects, including apical root resorption (Segal et al., 2004; Roscoe et al., 2015), increased plaque accumulation, leading to gingivitis and white spot

lesions (Czochrowska E et al,1988; Chen H et al., 2013; Kumar et al., 2018). The mean treatment duration was 43.0 months, which can be considered relatively long. The average pre-treatment age was 18 years, which means that the sample comprise mostly adult patients.

The mixed results achieved by the studies whose samples comprise adults have raised doubts regarding the factors that may interfere on the duration of orthodontic treatment in adults (Beckwith et al., 1999, Fink et al., 1992, Haralabakis et al., 2004). It is known that treatment time can be influenced by several factors such as: initial malocclusion; extraction indications; presence or absence of impacted teeth; involvement of surgery for the management of dentofacial deformities; use of removable or fixed appliances; one- or two-phase treatment; prescriptions and techniques for fixed orthodontic appliance; provision of the orthodontic services; and criteria for assessing post-treatment results (Mavreas et al., 2008). In the present study, the sample subjects presented several malocclusion types and were treated with various treatment protocols, appliances and mechanics. These factors might have interfered with the total duration of orthodontic treatment, but the influence of these factors was not assessed, since did not represent a research question for this study.

Although the correlation between the two objectives evaluation indexes that estimates treatment success is desired, the present study showed no statistically significant correlations between OGS and PAR results. Others studies also indicate poor correlation between orthodontic treatment outcomes measured by PAR and OGS indexes (Deguchi et al., 2005; Onyeaso & Begole, 2007; Chalabi et al., 2015). This absense of correlation seems to be due to basic differences in the evaluation principles: while the PAR index considered that changes from pre-treatment to post-treatment stages are important when evaluating orthodontic treatment effectiveness, the goal of the ABO examiners is to assess only the final detailing of treatment results. In the present sample, four cases, which were considered less difficulty to treat (with lower PAR T1 score), presented a lower percentage of improvement and were classified as “No difference” by the PAR classification. Still, these four cases would pass in the third phase of the American Board Examination, since scored less than 31 points.

Ideally, these objectives indices should contemplating not only the evaluation of the occlusion, but also take into account the relationship between hard and soft

tissues, iatrogenic damages (such as enamel lesions, bone loss and root resorption), facial and smile aesthetics. Therefore, it is suggested for future studies the evaluation of the existence of positive correlation between the finishing quality and the pleasantness of the face and the smile, since in contemporary society the concern with the attractiveness of the face and the smile is the main reason related to the demand for orthodontic treatment.

Conclusions

- (1) No correlation was found between the results of finishing occlusion quality obtained by PAR and OGS scores.
- (2) For the PAR index, the component with the highest score in the pre-treatment was related to the upper alignment. Still, for the OGS index, the most deficient component for finishing was related to buccolingual inclinations.

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5. CONCLUSÕES

Baseando-se nos resultados obtidos por meio dos índices PAR e SOA, pôde-se concluir que:

- Não existe correlação estatisticamente significativa entre os resultados de qualidade de finalização oclusal mensurados pelos índices oclusais PAR e SOA.
- Para o índice PAR, o componente que obteve maior pontuação no pré-tratamento foi o alinhamento superior, enquanto que para o SOA o componente mais crítico durante a finalização foi relacionado às inclinações vestibulolinguais dos dentes posteriores.

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