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Research

Orthodontic treatment results evaluated for individual teeth according to the Objective Grading System

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ABSTRACT

Background: The evaluation of orthodontic treatment outcome is usually performed using the Objective Grading System (OGS) developed by the American Board of Orthodontics (ABO). The objective of this study was to evaluate individual tooth contribution to the final OGS score in patients who have finished the orthodontic treatment at the graduate program at Antioquia University.
Method: Descriptive, retrospective, cross-sectional study of 40 nonrandomly selected patients. Using the eight OGS criteria, each tooth characteristic was evaluated.
Results: The total average OGS score was 30.7 ± 8.0. The variable giving the lowest score was for interproximal spaces and the higher was for buccolingual inclination (5.4 ± 2.7). For teeth groups, there are significant differences ($P < 0.05$). The major contributors to the final score were second molar teeth (9.9 ± 3.7) and per individual tooth was the upper right second molar for buccolingual inclination and marginal ridges (2.73 ± 1.2). There is no correlation between OGS variables except for upper central incisor scores.
Conclusions: Second molar teeth are the main contributors to OGS final score, specifically right second molar inclination. Interproximal spaces are the least relevant aspects to the score. Knowledge of differential tooth and variable contribution is useful to the clinician's care of relevant details.

1. Introduction

The aim of orthodontic treatment, particularly the finishing stage, is to provide excellent occlusion, adequate alignment, and an esthetic smile [1]. The American Board of Orthodontics (ABO) developed and implemented the Objective Grading System (OGS) with the purpose of standardizing the evaluation of orthodontic treatment outcomes in dental cast and panoramic radiographs [2]. The OGS, also known as the Grading System for Cast and Panoramic Radiographs, evaluates eight criteria: alignment, marginal ridges, buccolingual inclination, occlusal relationships, occlusal contacts, overjet, interproximal contacts, and root angulation. Scores less than or equal to 20 are considered satisfactory, scores between 20 and 27 are acceptable, but scores greater than 27 are unacceptable [3].

Some authors [4] used the ABO criteria to evaluate different orthodontic treatment protocols. They found that treated patients without extractions had lower scores in terms of sagittal dental relationships, occlusal contacts, and root parallelism. Detterline et al. [5] evaluated cases treated with 0.018 and 0.022 slot brackets and found no clinical differences between them, although there are statistically significant differences in treatment time and OGS-ABO scores. Song et al. [6] validated the OGS-ABO system to classify the treatment outcome in Chinese patients, and they reduced the cutoff point for satisfactory treatment outcome to 16 points or fewer, not including root angulation score.

Other researchers [7–9] at the Universities of Puerto Rico, Indiana, and Okayama, respectively, used the OGS score to evaluate the treatment outcomes in their patients.

These studies have shown that OGS is a validated method to evaluate the outcomes of orthodontic treatment; however, none has discussed the contributions of each tooth to the final OGS score.

It is important to mention the different strategies used to optimize final dental placement. Andrews [10,11], Taylor and Cook [12] and Creekmore [13] considered that poor bracket positioning eliminates the advantages obtained by preadjusted brackets. Other authors recommend different tools to achieve optimal end-results, such as archwire bending, use of elastics, and even interproximal reduction [14]. Poling [15] suggests that "an orthodontist may have to reposition brackets or bend the arch to obtain an excellent finished result." These strategies should be applied to a specific tooth before the end of treatment.

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Therefore, to improve orthodontic treatment outcomes, teeth that contribute more to the OGS score, as well as the variables responsible for more frequent problems, must be identified.

The objective of this study was to identify the contribution of individual teeth to the final OGS-ABO score and identify the specific characteristics responsible for this contribution.

2. Materials and methods

From 99 patients who completed orthodontic treatment, a convenience sample of 40 (21 women and 19 men) was selected according to the following inclusion criteria: patients must have been finishing the active phase of treatment at the postgraduate orthodontic program at the University of Antioquia, Colombia, during the years 2010 to 2011, and not scheduled for prosthetic, esthetic, periodontal, or maxillofacial surgical treatments. One exclusion criterion required the absence of complete dental cast and panoramic radiographs.

Dental casts and panoramic radiographs were obtained immediately after the removal of fixed appliances. All criteria applicable to dental casts were evaluated at scanned computer images of the dental casts with Motion View's Ortho Insight 3D LLC from IMAX (Imágenes Maxilofaciales S.A., Medellín, Colombia). This scanner complies to ABO requirements for digital models [16].

Because the scanner's measurement of marginal ridges was found to be unreliable, it was manually measured using a measuring gauge built according to ABO specifications [2] and calibrated by a specialized company (Metrología Biomédica, Medellín, Colombia). Root inclination was manually evaluated in panoramic radiographs. The measurements were made by one trained, calibrated (Kappa and intraclass correlation coefficient >0.85), and experienced orthodontist.

The final OGS score is the sum of cumulative scores for each set of criteria, strictly following ABO indications [2,13].

To establish the tooth contribution to OGS-ABO score, teeth were grouped as follows: central, lateral, cuspid, first bicuspids, second bicuspids, first molars, and second molars [3,16]. As recommended by the ABO, canines were not included in the panoramic radiographs, as well as the variable of canine-premolar contact in marginal ridges [2–17].

2.1. Ethical issues

All research procedures complied to the Helsinki 2008 [18] international norm and the 008430 Resolution from the Ministry of Health, Colombia, 1993 [19].

2.2. Statistical analysis

The SPSS package, version 17 (SPSS Inc., Chicago, IL) was used for calculations. Qualitative variables are described by absolute frequency and percentage. Quantitative variables are expressed by the average ± standard deviation. Bivariate analysis was carried out by one-way ANOVA and post hoc Bonferroni test for score differences between teeth. Additionally, the Pearson correlation coefficient was applied to correlate scores for different teeth groups. The level of significance was ≤ 0.05.

3. Results

The sample distribution per gender was similar (21 women; 19 men) and the ages of the patients were 15.97 ± 5.79 years (Table 1). The OGS for the whole sample was 30.7 ± 8.0.

The most relevant criterion for OGS was buccolingual inclination, followed by marginal ridges and occlusal contacts. The least relevant was interproximal contacts followed by alignment (Table 2).

Table 1
Demographic and treatment characteristics of the sample

Variable	Frequency
	n = 40 (100%)
Gender, n (%)	
Men	19 (47.5)
Women	21 (52.5)
Treatment, n (%)	
No extraction	22 (57.5)
Extraction (2 teeth)	3 (2.5)
Extraction (4 teeth)	15 (40.0)
Total teeth evaluated	894

Considering the contribution to the general score by each dental group, the most relevant was second molars, which contribute 9.9 ± 3.7 points to the average OGS total score, followed by first molar teeth that contribute 6.9 ± 3.1 points. For second molars, the criteria that added the most points were buccolingual inclination and marginal ridges. In the first molar teeth group, the most relevant criteria were marginal ridges and buccolingual inclinations. The teeth group providing the least points to the OGS-ABO was cuspid. The criterion adding the most points in this dental group was occlusal relationships (Table 3).

Considering individual tooth contributions to the general OGS, the highest was from the upper right second molar (8.9%), followed by lower left second molar (8.0%). The weakest contributor was the lower left central incisor (0.2%). For tooth 17, problems in buccolingual inclination, and for teeth 16, 26, 36, and 46, problems in the marginal ridge were the most frequent. Teeth contributing the most to overjet were upper incisors, and root parallelism was higher for teeth 12 and 22. The contribution of tooth 44 to root parallelism is also relevant (Table 4).

There is no significant correlation between the OGS variables. Correlation between individual tooth OGS scores was significant only for contributions of teeth 11 and 21 (Pearson correlation coefficient $r = 0.72$). No statistically significant differences were found when the general OGS for patients with extractions were compared to those without (Table 5).

4. Discussion

Although the use of preadjusted appliances contributes to excellent occlusion, the final results are always limited by the ability of the operator and the patient's individual conditions [20]. The orthodontist must recognize errors as soon as possible during the treatment to minimize final adjustments [21,22].

The ABO-OGS identifies which variables have the higher and lower scores [2,3]. Information about specific dental positions at the end of treatment is limited.

The average OGS score for patients treated at the University of Antioquia was 30.7 ± 8.0. This result is similar to values reported for

Table 2
Scores and percentage distribution of contribution to Objective Grading System (OGS)

Variable	Score	Average score (SD)	Percentage of contribution to OGS
Alignment	91	2.3 (2.2)	7.4
Marginal ridges	209	5.2 (2.9)	17.0
Buccolingual inclination	214	5.4 (2.7)	17.4
Occlusal relationships	130	3.3 (2.2)	10.6
Occlusal contacts	200	5.0 (3.5)	16.3
Overjet	199	5.0 (2.7)	16.2
Interproximal contacts	5	0.1 (0.3)	0.4
Root parallelism	181	4.5 (2.2)	14.7
Total	1229	30.7 (8.0)	100