Original Article

Clinical Outcomes of 0.018-Inch and 0.022-Inch Bracket Slot Using the ABO Objective Grading System

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ABSTRACT

Objective: To determine if there is a significant difference in the clinical outcomes of cases treated with 0.018-inch brackets vs 0.022-inch brackets according to the American Board of Orthodontics (ABO) Objective Grading System (OGS).

Materials and Methods: Treatment time and the ABO-OGS standards in alignment/rotations, marginal ridges, buccolingual inclination, overjet, occlusal relationships, occlusal contacts, interproximal contacts, and root angulations were used to compare clinical outcomes between a series of 828 consecutively completed orthodontic cases (2005–2008) treated in a university graduate orthodontic clinic with 0.018-inch- and 0.022-inch-slot brackets.

Results: A two-sample *t*-test showed a significantly shorter treatment time and lower ABO-OGS score in four categories (alignment/rotations, marginal ridges, overjet, and root angulations), as well as lower total ABO-OGS total score, with the 0.018-inch brackets. The ANCOVA—adjusting for covariants of discrepancy index, age, gender, and treatment time—showed that the 0.018-inch brackets scored significantly lower than the 0.022-inch brackets in both the alignment/rotations category and total ABO-OGS score.

Conclusions: There were statistically, but not clinically, significant differences in treatment times and in total ABO-OGS scores in favor of 0.018-inch brackets as compared with the 0.022-inch brackets in a university graduate orthodontic clinic (2005–2008). (*Angle Orthod.* 2010;80:528–532.)

KEY WORDS: American Board of Orthodontics; Bracket slot size; Clinical outcomes; Treatment time; Objective grading system

INTRODUCTION

When Edward H. Angle introduced the edgewise fixed appliance system, he reoriented the slot from vertical to horizontal and inserted a rectangular archwire in the slot.[1] After extensive experimentation with the edgewise appliance, Angle adopted the dimensions of 0.022-inch × 0.028-inch as his slot size because it allowed better control of crown and root position in all three planes of space using the precious metal archwires available to him at the time.[2] In the 1930s, stiffer, less expensive stainless steel archwires were introduced, replacing the softer precious metal archwires.[3] These advances in metallurgy allowed orthodontists to provide similar clinical forces with smaller archwires. This change in materials made it feasible to downsize from the traditional 0.022-inch bracket slot to the smaller 0.018-inch slot.[4]

Since the 1950s, there has been debate about the relative advantages of the two systems. Because most brackets are manufactured with specific first-, second-, and third-order corrections directly in the brackets, it is imperative that the orthodontist completely fill the slot in order to fully express the prescription of the bracket. The 0.018-inch bracket slot can be filled earlier in treatment to provide early torque control of anterior teeth.[5] Also, the smaller, more flexible finishing archwires used with the 0.018-inch slot are easier to manipulate late in clinical orthodontic treatment.[6]

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Conversely, the 0.022-inch slot in a preadjusted appliance allows more freedom of movement for the starting wires, which keeps forces lighter initially.[7] Later in treatment, the steel rectangular working wires of 0.019-inch × 0.025-inch are stiffer, and they show less deflection (47% less than 0.016-inch × 0.022-inch) and binding during space closure.[7] The larger slot allows easier archwire insertion at the initial visit, more choices in wire size and composition, and less frictional binding on the more misaligned teeth during initial alignment.[8]

Another factor in determining clinical outcome of an orthodontic case is treatment time. Although archwires of the same size and material have been shown in studies to align the mandibular anterior teeth faster using the 0.022-inch brackets than the 0.018-inch brackets,[9] total treatment time with 0.022-inch brackets is longer compared with 0.018-inch brackets.[10,11] However, none of these studies measured the quality of the outcomes of any of the completed cases.

With little clinical evidence to show advantages of either of the bracket systems, orthodontists are forced to make clinical decisions with little scientific guidance. The purpose of this study was to quantitatively compare the clinical outcomes of orthodontic cases treated in a university graduate orthodontic clinic using the American Board of Orthodontics (ABO) Objective Grading System (OGS)[12] to determine whether there is a difference in the clinical outcomes of cases treated with 0.018-inch brackets vs 0.022-inch brackets.

MATERIALS AND METHODS

This retrospective study compared the clinical outcomes of orthodontic care using 0.018-inch and 0.022-inch brackets in a university graduate orthodontic clinic. The study received institutional review board approval to review patient records. Clinical outcomes measured by the ABO-OGS were compared between a series of consecutively completed orthodontic cases (2005–2008) treated with either 0.018-inch or 0.022-inch brackets.

The following inclusion criteria were used for case selection from a pool of 881 records completed between 2005 and 2008: treated with comprehensive orthodontic care using maxillary and mandibular fixed labial appliances, completed in full permanent dentition (cases with missing teeth other than third molars or orthodontic extractions were excluded), and treated without the aid of orthognathic surgery. The final sample consisted of 828 cases (613 with 0.018-inch brackets, 215 with 0.022-inch brackets). The sample contained 516 females and 312 males with an average age at start of treatment of 16.3 years.

Every case had pretreatment and posttreatment orthodontic records including panoramic and cephalometric radiographs, as well as dental casts. Using the pretreatment records, a discrepancy index (DI)[13] was determined for each case by one examiner. All the cases were evaluated by one examiner using the ABO-OGS cast/radiograph evaluation[12] in all eight categories: alignment/rotations, marginal ridges, buccolingual inclinations, overjet, occlusal contacts, occlusal relationships, interproximal contacts, and root angulations. The examiner was calibrated by the ABO to grade cases using the OGS. Each case was categorized as being treated with either 0.018-inch or 0.022-inch brackets. The supervising faculty member for each case was coded and recorded. ABO-OGS scores in each of the eight categories and total case scores measured in the cast/radiograph evaluation form were recorded. Treatment time was calculated using the dates of initial bonding and removal of fixed appliances. Patients debonded prior to estimated time of treatment were rare and not recorded. The gender and initial age of the patient were also recorded.

Statistical Methods

Two-sample *t*-tests were used to compare the mean age, DI, and treatment time between the 0.018-inch and 0.022-inch brackets. A mixed-effects analysis of covariance (ANCOVA) model was used to compare the mean ABO-OGS score using the 0.018-inch brackets with the mean ABO-OGS score from the 0.022-inch brackets. The pretreatment DI score was used as a covariate to adjust for potential differences in the initial complexity of each case. Additional covariates included age, gender, and length of treatment. A random effect for the faculty orthodontist was included in the model to account for the repeated cases seen by the 13 faculty members. The adjusted mean difference between the two slot sizes along with an appropriate 95% confidence interval, was estimated. A P value less than or equal to 0.05 was accepted as significant. Similar analyses were performed on each of the eight subcategories of the ABO OGS. Analyses were performed using SAS version 9.1 (SAS Institute, Cary, NC).

RESULTS

The age, DI, and treatment time for the two groups are summarized in Table 1. There was a significantly shorter ($P < .001$) mean treatment time (3.9 months) with the 0.018-inch brackets. Results from the ABO-OGS scores are presented in Table 2. After adjusting for the covariates (DI, age, gender, and treatment time), we found that the 0.018-inch bracket group had a statistically significant ($P = .041$) 0.5-point lower score in alignment/rotations, but no statistically signif-

Table 1. Comparison of Age, Treatment Time, and Discrepancy Index Between 0.018-Inch and 0.022-Inch Brackets

	0.018[a]				0.022[b]				Difference[c]			
	Mean	SD[d]	95% CI		Mean	SD	95% CI		Mean[e]	95% CI		*P* Value
Age, y	16.5	8.6	15.8	17.2	15.7	8.4	14.6	16.9	0.8	−0.6	2.1	0.251
Treatment time, mo	30.2	12.9	29.2	31.2	34.1	14.4	32.1	36.0	−3.9	−5.9	−1.8	<0.001
Discrepancy index	16.1	9.6	15.4	16.9	16.6	8.9	15.5	17.8	−0.5	−2.0	1.0	0.491

[a] N = 613.
[b] n = 215.
[c] Difference calculated by subtracting 0.022-inch mean from 0.018-inch mean.
[d] SD = standard deviation.
[e] Negative mean indicates a lower score in the 0.018-inch category.

icant differences were found within any of the other categories. The total ABO-OGS score was 2.7 points lower in the 0.018-inch bracket group ($P = .017$).

DISCUSSION

Similar to our study, previous studies have shown a longer treatment time associated with 0.022-inch slot brackets compared with 0.018-inch brackets.[10,11] There is, however, a large discrepancy in the length of treatment between these studies. Vu et al[10] found a large difference of treatment time (9.5 months longer) with 0.022-inch brackets compared with 0.018-inch brackets. The authors analyzed a smaller sample size (455) than in our study and suggested that the difference could be explained by the sample bias related to the low number of cases treated with 0.022-inch brackets (less than 20%).[10] The 0.022-inch slot cases in our study showed an increased treatment time of 3.8 months on average. The difference between the two studies could be explained by the exclusion of orthognathic surgery cases from our study since Vu et al[10] showed a greater treatment time of 7.4 months for orthognathic surgery cases. The study comparing cases treated by one practitioner in private practice using both bracket-slot sizes showed a small difference (only 1.5 months) in treatment time in favor of the 0.018-inch bracket slot.[11] The number of cases in the study was small (64) and the clinical significance of this small amount of time is minimal.

Our study includes the results of treatment mechanics practiced by multiple practitioners working with graduate orthodontic residents. After adjusting for the DI of the case and other covariates, the difference in total ABO-OGS score was 2.7 points, showing that the outcome for the 0.018-inch brackets was better than that of the 0.022-inch brackets. However, only the alignment/rotations category was shown to be statistically significant. The largest discrepancy in any one category was only 0.5 points in the alignment/rotations, overjet, and occlusal relationships categories. While such small differences are statistically different, they probably are not clinically significant. The difference of 2.7 points observed in this study is highly unlikely to fail an ABO candidate's case. A difference of 5 points in the total ABO-OGS score and a difference of 6 months in treatment time would be considered clinically significant. The large sample size used in this study leads to finding

Table 2. Comparison of ABO-OGS Scores

	0.018[a]				0.022[b]				Difference[c]			
	Mean	SD[d]	95% CI		Mean	SD	95% CI		Mean[e]	95% CI		*P* Value
Alignment/rotations	3.2	1.9	3.1	3.4	3.6	2.2	3.3	3.9	−0.5	−0.9	0.0	0.041
Marginal ridges	3.0	2.0	2.8	3.2	3.4	2.2	3.1	3.7	−0.4	−0.8	0.0	0.061
Buccolingual	3.9	2.3	3.7	4.1	3.8	2.3	3.5	4.1	0.1	−0.3	0.5	0.618
Overjet	4.4	3.5	4.1	4.7	5.0	3.9	4.5	5.5	−0.5	−1.1	0.1	0.075
Occlusal contacts	4.9	3.5	4.6	5.2	4.9	3.3	4.5	5.4	0.0	−0.7	0.6	0.993
Occlusal relationships	4.0	3.4	3.8	4.3	4.3	3.6	3.8	4.8	−0.5	−1.2	0.2	0.183
Interproximal contacts	0.6	1.5	0.5	0.7	0.7	1.7	0.5	1.0	−0.1	−0.4	0.2	0.382
Root angulations	2.3	1.7	2.2	2.4	2.6	1.8	2.4	2.9	−0.3	−0.6	0.1	0.102
ABO total score	26.3	10.0	25.5	27.1	28.5	11.3	27.0	30.1	−2.7	−4.9	−0.5	0.017

[a] N = 613.
[b] n = 215.
[c] Difference calculated by subtracting 0.022-inch mean from 0.018-inch mean using a mixed-effects ANOVA model with the discrepancy index, age, sex, and treatment time as covariates.
[d] SD = standard deviation.
[e] Negative mean indicates a lower score in the 0.018-inch category.

statistically significant but not clinically meaningful differences for the study as a whole, but would have allowed for reporting of subgroup analyses if necessary.

Treatment time and outcome can be affected by early debondings and by patient compliance. However, debondings before estimated treatment time were rare and not included in the analyses. Patient compliance includes missed or broken appointments, broken appliances, noncompliance with usage, and oral hygiene. However, patient compliance was not recorded consistently or reliably enough to be considered as a covariate.

Likely causes of the small differences seen between the two groups are the number of clinicians who treated these cases. The cases evaluated in this study were treated by graduate orthodontic residents under the supervision of 13 different faculty members. The differences in clinical skill of the residents and the considerable differences in treatment philosophy of each supervisor could account for the small differences. For example, one of the faculty members using the 0.022-inch bracket treated mostly multidisciplinary adult patients and others used the 0.022-inch brackets with 0° prescription or concurrent functional appliances. The added technique sensitivity of these faculty members' treatment options could account for increased treatment time and higher ABO-OGS scores in a graduate clinic. Because of the low number of cases that some faculty members treated, no clear conclusions can be drawn. Given the large range of treatment philosophies, the two groups' scores were remarkably similar over this time range.

The small differences in efficiency and clinical outcome shown in this study suggest that educational institutions and commercial companies need to reassess the need for multiple appliances. According to a 2002 survey conducted by the *Journal of Clinical Orthodontics*, 54% of orthodontists preferred the 0.022-inch slot size, while 40.5% used 0.018-inch. The remaining 5% used either the bidimensional technique or another bracket style.[14] Some orthodontists are calling for the orthodontic community to agree on a standard orthodontic slot size.[3,4] The proposed benefits of such standardization would not only ease the transfer of orthodontic patients but it would foster the advancement of orthodontic technology.[4] An estimated 10% of US orthodontic patients relocate each year.[4] With little clinical evidence to show differences in the efficiency and outcomes between the two bracket sizes, orthodontists continue to be split on the decision. After evaluating more than 800 consecutively treated cases supervised by multiple faculty members with different treatment philosophies, we found the difference in ABO-OGS scores to be minimal. These data support the hypothesis that bracket-slot size does not affect the quality of treatment. With orthodontists in the United States split down the middle on this debate,[14] these data suggest that the orthodontic community should be able to agree on one slot size without fear of affecting treatment quality.

Future studies could compare similar groups of cases from private practices to determine if the differences are similar to the results from a graduate orthodontic clinic. The differences in efficiency and treatment protocol in a private practice compared with a graduate orthodontic clinic could provide a clearer view of the effects of slot size on treatment efficiency and quality of outcome. Also, critical examination of the differences in ABO-OGS scoring between cases treated with differing bracket prescriptions could be beneficial. Regardless of the orthodontic community's decision to adopt a universal slot size, pretipped and pretorqued brackets will continue to be mainstream. Understanding the influence of these prescriptions on treatment outcomes will be important for clinicians to decide what bracket systems to use in the future.

CONCLUSIONS

- There were statistically, but not clinically, significant differences in mean treatment time (3.9 months) and in total ABO-OGS score (2.7) in favor of 0.018-inch brackets as compared with 0.022-inch brackets in a university graduate orthodontic clinic (2005–2008).

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