The Effects of Different Bracket Types on Orthodontic Treatment Evaluated with the Objective Grading System

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ABSTRACT

Background: Standard edgewise and preadjusted Roth are two bracket types widely used for orthodontic treatment. Whether one of these bracket types offers better treatment results than the other requires further evaluation. The Objective Grading System created by the American Board of Orthodontics (ABO) is one of the most reliable indices used to evaluate treatment outcomes. Objectives: To determine the effects of using two different bracket types on treatment outcomes by using the Objective Grading System. Methods: The sample for this study consisted of 64 randomly selected post-treatment dental casts and panoramic radiographs. Of these samples, 32 were treated with a standard edgewise bracket, and the others were treated with a preadjusted Roth bracket. Patient samples were included if they had non-extraction Class I malocclusion (minor crowding < 4 mm for both bracket types, ANB = 2° ± 2°), no history of dental trauma, complete teeth (except third molars), and no growth or development disturbances. All samples were evaluated using eight parameters of the Objective Grading System and statistically analyzed using Mann–Whitney and chi-squared tests. The score range for each tooth in each parameter was 0 – 2. Results: The total score was 19.00 ± 12.00 for the standard edgewise bracket and 15.00 ± 7.00 for the preadjusted Roth bracket, with no statistically significant differences between the two bracket types (p = 0.149). There were also no statistically significant differences in the scores of the eight parameters of the Objective Grading System between these brackets (p > 0.05). The highest score was found for the buccolingual inclination parameter, and the lowest score was for interproximal contacts. Conclusion: According to the Objective Grading System, there are no statistically significant differences between the orthodontic treatment outcomes obtained using a standard edgewise or a preadjusted Roth bracket.

Keywords: brackets, orthodontics, objective grading system
Background

Fixed orthodontic treatment has progressed quite significantly, especially in the orthodontic bracket system. In 1928, Edward H. Angle introduced the edgewise appliance, which has a rectangular bracket slot and a rectangular wire that enable control of tooth movement in three occlusal planes. In the standard edgewise bracket, the tipping and the torquing of the bracket are 0°, and there is no in-out design on the bracket base; thus, a complicated wire bending procedure is required (first-, second-, and third-order bends) to obtain the desired tooth movement.1,2

Faced with the above dilemma, in 1970, Andrews conducted a study and established six keys to normal occlusion. He introduced the "preadjusted" appliance, which enabled tipping, torquing, and in-out design in each bracket for each tooth.3,4 However, some clinicians modified the system proposed by Andrews and created their own prescriptions.5,6 The preadjusted Roth bracket prescription is widely used, including by the Orthodontic Clinic in the Faculty of Dentistry at University of North Sumatera, Medan. The use of this preadjusted bracket is claimed to reduce or eliminate the complex wire bending procedure, shorten the working time of clinicians, reduce patient chairtime, and simplify the treatment mechanism used to achieve ideal tooth inclination, angulation, and in-out while enabling better treatment outcomes.7,8

A study on the evaluation of the success of orthodontic treatments is indispensable for identifying and improving the quality of treatment outcomes. However, assessment of orthodontic treatments is often solely based on subjective opinions and clinician experiences, so the obtained results are invalid and unreliable. Therefore, several indices have been introduced to evaluate treatment outcomes more objectively and accurately.9–11

The Objective Grading System proposed by the American Board of Orthodontics (ABO) in 1999 was applied in this study to evaluate treatment outcomes using post-treatment dental casts and panoramic radiographs. There were eight parameters to be assessed, namely alignment, marginal ridges, buccolingual inclination, occlusal contacts, occlusal relationships, overjet, interproximal contacts, and root angulation.10–13

Jain et al. have used the ABO Objective Grading System to evaluate orthodontic treatment results obtained using Roth and MBT prescription brackets. They found significant differences in the total scores between the two groups; the MBT bracket had a lower total score and lower scores in the buccolingual inclination and occlusal contacts parameters. They found that treatment with the MBT bracket achieved better outcomes.12

The main purpose of the present study was to determine whether there were statistically significant differences between the orthodontic treatment outcomes obtained with the standard edgewise and the preadjusted Roth brackets based on the ABO Objective Grading System. This evaluation was conducted by comparing the scores for each of the eight parameters of the ABO Objective Grading System, the total scores, and the success rates of the two types of brackets.

Materials and Methods

This retrospective study collected 64 post-treatment samples (based on a minimum sample size calculation) in the form of dental casts and panoramic radiographs from patients treated with standard edgewise and preadjusted Roth 0.018-in slot Mini Gamma brackets from SD Orthodontic, made in the United States of America. These samples were collected from 2008 to 2017 and were divided into two equal groups. All samples and medical record data of patients aged between 18 and 35 years old with no gender differences were collected randomly by one operator from the Orthodontics Clinic in the Dental and Oral Hospital at the Faculty of Dentistry at University of North Sumatera, Medan. Research ethics approval was obtained from the Ethics Commission for Health Research in the Faculty of Medicine at University of North Sumatera, Medan.

Patient samples were included in this study if they exhibited non-extraction skeletal Class I malocclusion (minor crowding < 4 mm for both types of brackets, ANB angle = 2° ± 2°), no history of dental trauma, complete teeth except the third molars, and no growth or development disturbances. In addition, patient samples exhibiting a bad condition or damaged dental casts and panoramic radiographs, the use of dental prostheses,
dentofacial anomalies (e.g. cleft lip and palate), and/or congenitally missing teeth were excluded from this study.

Each sample was evaluated using the eight parameters of the ABO Objective Grading System according to the standard measurement using special measurement tools, such as the ABO measuring gauge (Fig. 1). Seven parameters of the ABO Objective Grading System—namely alignment, marginal ridges, buccolingual inclination, occlusal contacts, occlusal relationships, overjet, and interproximal contacts were evaluated using the dental casts of the patients, whereas the root angulation parameter was evaluated using the panoramic radiographs of the patients. The score range of each tooth in each parameter was 0 – 2. A score of 0 indicated a good occlusion and alignment, whereas a score of 1 or 2 indicated deviation from the norm. The treatment was declared successful when the measurement score for each sample was ≤ 27. The measurement was taken twice by an operator, and an intra-rater reliability test was performed. Furthermore, the Kolmogorov–Smirnov test was also used to evaluate the normality of the measurement data. The study was continued by measuring the statistical differences in each of the eight parameters and the total scores between both types of brackets using the Mann–Whitney test with a significant $p$-value of < 0.05. The total scores of the standard edgewise and preadjusted Roth brackets are shown in Table 1. There was no statistically significant difference in the total scores between the two types of brackets ($p = 0.149; p > 0.05$). Table 2 compares the measurement scores for the eight parameters of the ABO Objective Grading System between the two types of brackets. Based on the Mann–Whitney results, there were no statistically significant differences between the brackets, with $p > 0.05$. The differences in the median values of the eight parameters between the two brackets can be seen in Fig. 2. The rates of successful treatment for both bracket types are shown in Table 3. The successful treatment (defined as a score of < 27 for each sample) rate for the standard edgewise bracket was 75% and for the preadjusted Roth bracket was 81.2%. Thus, there was no statistically significant difference between the success rates of the two bracket types ($p = 0.762; p > 0.05$).

Result

The intra-rater reliability test showed that the results of the first and second data measurements were consistent, with an alpha value > 0.8. Thus, data were collected from one of the measurement results. The Kolmogorov–Smirnov test showed that the measurement results of the two types of bracket samples were not normally distributed ($p < 0.05$). The data were analyzed using the Mann–Whitney test. The significance value used was < 0.05. The total scores of the standard edgewise and preadjusted Roth brackets are shown in Table 1. There was no statistically significant difference in the total scores between the two types of brackets ($p = 0.149; p > 0.05$). Table 2 compares the measurement scores for the eight parameters of the ABO Objective Grading System between the two types of brackets. Based on the Mann–Whitney results, there were no statistically significant differences between the brackets, with $p > 0.05$. The differences in the median values of the eight parameters between the two brackets can be seen in Fig. 2. The rates of successful treatment for both bracket types are shown in Table 3. The successful treatment (defined as a score of < 27 for each sample) rate for the standard edgewise bracket was 75% and for the preadjusted Roth bracket was 81.2%. Thus, there was no statistically significant difference between the success rates of the two bracket types ($p = 0.762; p > 0.05$).

Figure 1. ABO measuring gauge. Part A is used to measure discrepancies in alignment, overjet, occlusal contacts, interproximal contacts, and occlusal relationships, part B to measure discrepancies in the buccolingual inclination of mandibular posterior teeth, part C to measure discrepancies in marginal ridges, and part D to measure discrepancies in the buccolingual inclination of the maxillary posterior teeth.
Table 1. Differences in the total scores between samples treated with standard edgewise and preadjusted Roth brackets

<table>
<thead>
<tr>
<th>Variable</th>
<th>Bracket Type</th>
<th>Median Total Score</th>
<th>Interquartile Range</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score</td>
<td>Standard Edgewise</td>
<td>19.00</td>
<td>12</td>
<td>.149</td>
</tr>
<tr>
<td></td>
<td>Preadjusted Roth</td>
<td>15.00</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Differences in the median and interquartile ranges of each parameter between samples treated with standard edgewise and preadjusted Roth brackets

<table>
<thead>
<tr>
<th>Variable</th>
<th>Bracket Type</th>
<th>Median±Interquartile Range</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alignment</td>
<td>Standard Edgewise</td>
<td>3.00±2</td>
<td>.353</td>
</tr>
<tr>
<td></td>
<td>Preadjusted Roth</td>
<td>2.00±2</td>
<td></td>
</tr>
<tr>
<td>Marginal ridges</td>
<td>Standard Edgewise</td>
<td>2.00±2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Preadjusted Roth</td>
<td>2.00±2</td>
<td>.608</td>
</tr>
<tr>
<td>Buccolingual</td>
<td>Standard Edgewise</td>
<td>4.50±3</td>
<td>.051</td>
</tr>
<tr>
<td>inclination</td>
<td>Preadjusted Roth</td>
<td>4.00±3</td>
<td></td>
</tr>
<tr>
<td>Overjet</td>
<td>Standard Edgewise</td>
<td>2.00±2</td>
<td>.596</td>
</tr>
<tr>
<td></td>
<td>Preadjusted Roth</td>
<td>2.00±2</td>
<td></td>
</tr>
<tr>
<td>Occlusal contacts</td>
<td>Standard Edgewise</td>
<td>2.00±1</td>
<td>.554</td>
</tr>
<tr>
<td></td>
<td>Preadjusted Roth</td>
<td>2.50±3</td>
<td></td>
</tr>
<tr>
<td>Occlusal</td>
<td>Standard Edgewise</td>
<td>1.00±3</td>
<td>.551</td>
</tr>
<tr>
<td>relationships</td>
<td>Preadjusted Roth</td>
<td>2.00±2</td>
<td></td>
</tr>
<tr>
<td>Interproximal</td>
<td>Standard Edgewise</td>
<td>.00±1</td>
<td>.211</td>
</tr>
<tr>
<td>contacts</td>
<td>Preadjusted Roth</td>
<td>.00±0</td>
<td></td>
</tr>
<tr>
<td>Root angulation</td>
<td>Standard Edgewise</td>
<td>2.00±2</td>
<td>.599</td>
</tr>
<tr>
<td></td>
<td>Preadjusted Roth</td>
<td>1.00±2</td>
<td></td>
</tr>
</tbody>
</table>
Since the introduction of the standard edgewise bracket by Angle, new advances have occurred in the invention of orthodontic brackets. The recently developed preadjusted bracket is a modification of the standard edgewise bracket designed to overcome the shortcomings of the standard edgewise bracket. The preadjusted bracket has tipping and torquing prescriptions and an in-out design so that it can simplify the treatment mechanism, reduce patient chair time, and facilitate the achievement of better treatment results.7,8,14,15

There are several indices used to assess treatment success, one of which is the Objective Grading System from the ABO. The ABO established eight parameters to evaluate treatment outcomes. Seven parameters—namely alignment, marginal ridges, buccolingual inclination, overjet, occlusal contacts, occlusal relationships, and interproximal contacts are measured from post-treatment dental casts, whereas the root angulation parameter is measured from the post-treatment panoramic radiographs. Treatment is considered successful if the total score of the eight parameters for each sample is ≤ 27.11–13,16,17

This retrospective study aimed to determine whether different bracket types—the standard edgewise and preadjusted Roth brackets had significantly different
effects on the orthodontic treatment performed. In addition, this study evaluated the success of orthodontic treatment outcomes, the differences in ABO total scores, and the individual scores of the eight parameters of the ABO Objective Grading System in non-extraction Class I malocclusion cases treated with the two different bracket types.

For the standard edgewise bracket, 24 out of 32 samples (75%) had a score ≤ 27, which was categorized as successful. For the preadjusted Roth bracket, 26 out of 32 samples (81.2%) had a score ≤ 27, which was categorized as successful. It can be concluded that the treatment of non-extraction Class I malocclusions was equally successful using standard edgewise and preadjusted Roth brackets, and there was no statistically significant difference between the treatment success rates of the two types of brackets.

The total score of treatment outcomes for Class I non-extraction malocclusion using the standard edgewise bracket was 19.00 ± 12, whereas the total score of treatment using the preadjusted Roth bracket was 15.00 ± 7. These results indicate that the treatment score obtained using the standard edgewise bracket was higher than that obtained using the preadjusted Roth bracket, although the difference was not statistically significant. This is in line with a study by Kattner and Schneider, which compared the treatment results of both types of brackets using two treatment outcome evaluation indices, namely the Ideal Tooth Relationship Index (ITRI) and Andrews' six keys to normal occlusion. The study results showed no statistically significant difference between the total scores of ITRI obtained using the two types of brackets.

In this study, statistical analysis was used to compare eight parameters of the ABO Objective Grading System between the two types of brackets, and no statistically significant differences were found. This is slightly different from the results of a study conducted by Kattner and Schneider, which stated that the angulation and inclination of maxillary posterior teeth were superior after the use of preadjusted Roth brackets. Similarly, Soltaniet al. examined orthodontic treatment outcomes using the standard edgewise bracket and the MBT bracket. They found a significant difference in the buccolingual inclination parameters between the two brackets; the MBT prescription resulted in a superior buccolingual inclination due to the design of the torque in the bracket, which created a more symmetrical and precise inclination.

In this study, no significant difference was found in the buccolingual inclination parameters between the two types of brackets. This result is in line with a study conducted by Ugur and Yukay that did not find any statistically significant differences between the torque values of cases treated with standard edgewise and preadjusted Roth brackets. This may be due to the use of non-full-size finishing wire (rectangular wire with a size of 0.016 in x 0.022 in) in the 0.018-in bracket slot, which would have prevented the torque in the preadjusted Roth bracket from being fully expressed. Another possibility might be the lack of precision in the preadjusted bracket manufacturing process, resulting in improper design of the tip and torque. A study by Awasthi et al. on three preadjusted bracket products showed that none of the products had precise tip and torque values. Furthermore, the modifications made with wire bending to torque certain teeth using standard edgewise brackets can also affect the score for the buccolingual inclination parameter.

The buccolingual inclination parameter had the highest score in this study, with 4.50 for the standard edgewise bracket and 4.00 for the preadjusted Roth bracket. Yang-Powers et al. (2002, cited in Mislik et al.) and Norena et al. reported similar results. This is because of the difficulty in controlling torque in the posterior teeth. Moreover, discrepancies in the posterior segment are more difficult to monitor and correct than those in the anterior segment. The exclusion of the second molar tooth in this study was enough to influence the score of the buccolingual inclination parameter. The use of non-full-sized wire, less precise bracket manufacturing in the preadjusted Roth bracket, and the lack or inadequacy of torquing wire in the standard edgewise bracket also influenced the total score of the buccolingual inclination parameter.

Interproximal contact is the parameter with the lowest score in this study. This result is in accordance with studies conducted by Jain et al. and Mislik et al. These studies suggest that it is relatively easy for orthodontists to identify and correct the closure of interproximal spaces. Based on the measurement data, eight parameters of the ABO Objective Grading System had a higher score in the standard edgewise bracket than in the
preamplified Roth bracket. This result may be due to the prescriptions of tip, torque, and in-out in the preadjusted bracket design, which can facilitate tooth angulation, inclination, and interdigititation.

In this study, the second molar tooth, which was not included in the treatment, increased the ABO Objective Grading System score, especially the score of the buccolingual inclination parameter. Norena et al.8 and Jain et al.12 reported similar results. This may be because the second molar tooth is often not monitored or is even ignored by clinicians and patients because the tooth is in the back of the mouth and therefore does not affect the patient's aesthetics; thus, this tooth is usually not included in orthodontic treatment.9,11,13

According to the results of this study and the Objective Grading System, there was no statistically significant difference between the orthodontic treatment outcomes obtained using the standard edgewise bracket and the preadjusted Roth bracket.

**Conclusion**

This study showed that the orthodontic treatment outcomes of non-extraction skeletal Class I malocclusions treated with standard edgewise and preadjusted Roth brackets showed similar results, with no statistically significant differences between the results obtained with these bracket types based on the Objective Grading System.

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**Conflicts of Interest**

The authors declare that there are no conflicts of interest.

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