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Bhavna Shroff

Virginia Commonwealth University

Steven J. Lindauer

Virginia Commonwealth University

Caroline Carrico

Virginia Commonwealth University

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Effects of active reminders and motivational techniques on oral hygiene and gingival health in
orthodontic patients: a randomized clinical trial

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science
in Dentistry at Virginia Commonwealth University.

By

Jennifer Shim, D.D.S.

Virginia Commonwealth University, 2014

Virginia Commonwealth University, 2018

Thesis advisor: Bhavna Shroff, D.D.S., M.Dent.Sc., M.P.A.
Department of Orthodontics

Virginia Commonwealth University

Richmond, Virginia

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Abstract

EFFECTS OF ACTIVE REMINDERS AND MOTIVATIONAL TECHNIQUES ON ORAL HYGIENE AND GINGIVAL HEALTH IN ORTHODONTIC PATIENTS: A RANDOMIZED CLINICAL TRIAL

By: Jennifer Shim, D.D.S.

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Dentistry at Virginia Commonwealth University.

Virginia Commonwealth University, DATE

Thesis Advisor: Bhavna Shroff, D.D.S., M.Dent.Sc., M.P.A.

Department of Orthodontics

Purpose: To compare repeated oral hygiene instructions and motivation to text message reminders in improving oral hygiene compliance

Methods: For this prospective, randomized controlled clinical trial, 60 patients were assigned to one of four groups. Group 1 served as a control. Group 2 received weekly text message for oral hygiene. Group 3 received in-person oral hygiene instructions at each visit. Group 4 received both text messages and in person oral hygiene instructions. Oral hygiene was measured with Bleeding Index (BI), Modified Gingival Index (MGI), and Plaque Index (PI). Baseline measurements were obtained at the day of bonding (T0) and then at the subsequent 3 adjustment visits (T1, T2, T3).

Results: Repeated measures ANOVA was used to determine the effect of the intervention groups on the change in oral hygiene across the visits. The average age was 15 and 43% were male. Based on the data from 242 total visits, intervention group was not associated with a significant change in plaque index ($p=0.26$), modified gingival index ($p=0.78$), or bleeding index ($p=0.12$).

Conclusions: Patients who presented with good oral hygiene initially were able to maintain it during the first four months of treatment regardless of the intervention. Practitioners should highly consider a patient's pretreatment oral hygiene status before starting orthodontic treatment.

Introduction

Oral hygiene compliance remains a consistent challenge during orthodontic treatment. The use of fixed appliances makes normal oral hygiene practice difficult and increases plaque accumulation around the brackets.¹ A change in periodontal health indices can be detected immediately after placing brackets and bands.² Prolonged plaque accumulation can lead to gingival inflammation and enamel demineralization, which can eventually lead to white spot lesions.³ They can quickly develop within one month after placing fixed appliances.^{4,5} The incidence of at least one white spot lesion per patient during orthodontic treatment was found to be 50% on average.⁶ Prevention of white spot lesions is extremely important to reduce damage to the enamel, which can lead to unesthetic results for the patient. Orthodontists, general dentists, and patients and parents agree that white spot lesions detract from the final orthodontic result.⁷

Orthodontic treatment can tend to have an undesired effect on the oral health status of patients.¹ Patients with fixed appliances have been shown to have increased growth of pathogenic bacteria and anaerobes.² At their debonding appointment, 62% of patients were considered to be high caries risk, with increased levels of *Mutans streptococci* and *Lactobacillus casei* being significantly higher and then decreased 6 weeks after debonding.⁴ Patients undergoing orthodontic treatment for more than one month had more than six species of bacteria compared to controls.² Inflammation and a decline in periodontal health was associated with the increase in number of anaerobic bacteria found in subgingival plaque.

Numerous studies in medicine have looked at ways to improve medication adherence in patients with systemic conditions such as hypertension and diabetes, including pharmacist intervention via phone calls and behavioral interviewing.^{8,9} In both medicine and dentistry, the use of reminders has improved appointment attendance and reduced the no-show rates.¹⁰⁻¹⁴ Studies in dentistry have demonstrated the use of text message reminders or mobile applications to improve compliance, especially for oral hygiene.¹⁴⁻¹⁸ Text messages sent weekly were able to significantly improve plaque removal in as short as 3 months.¹⁵ Increased frequency of text messages were more effective in improving compliance.¹⁹

Effective oral hygiene requires a combination of frequency and proper technique. Previous studies showed that repeated oral hygiene instruction and motivation with a hygienist significantly improved plaque scores in orthodontic patients.²⁰⁻²³ Using verbal technique to instruct followed by self-application by the patient was effective for plaque elimination and improving periodontal health.²⁴

The aim of this study was to compare repeated oral hygiene instructions and motivation to text message reminders in improving oral hygiene compliance. The hypothesis is that there was no difference in oral hygiene status if interventions begin at the same time treatment begins. The results from this study will help clarify the most effective way to obtain compliance with toothbrushing in patients with fixed appliances.

Methods

For this prospective, randomized controlled clinical trial, approval was granted by the Virginia Commonwealth University Institutional Review Board (IRB HM20014910). Inclusion criteria consisted of patients between the ages of 11 and 20, were ready to start treatment involving full fixed appliances in both arches, who owned a cellphone with a plan allowing for text messaging, and no significant medical or dental history. Any patients that required antibiotic prophylaxis for dental procedures and patients with intellectual disabilities were excluded.

Patients were randomly assigned to one of four groups using a block randomization protocol generated by a statistician. Group 1 served as the control group and received brief home care instructions the day of bonding appliances. Group 2 received an SMS text message once weekly at 5:15 PM (Eastern time) from an automated messaging service. The two different text messages were scripted as follows and were sent every week in an alternating order: “This is a friendly reminder to brush your teeth after every meal. Cleaning your teeth will help keep them healthy and beautiful”, “Don’t forget to brush your teeth for 2 minutes after each meal!”. Group 3 received standardized oral hygiene instructions at each visit, including demonstration of proper brushing and flossing technique on a typodont model followed by patient demonstration on his or her own teeth. Group 4 received both the text message reminders and oral hygiene instructions.

Starting at baseline, readings of the Ramfjord teeth (maxillary right first molar, maxillary left central incisor, maxillary left first premolar, mandibular left first molar, mandibular right central incisor, mandibular right first premolar) were recorded for bleeding index (BI), modified gingival index (MGI), and plaque index (PI) using a University of North Carolina probe. The

baseline visit (T0) was the initial appointment where patients received full fixed appliances. At this visit, all patients received an oral hygiene kit, which included a pamphlet with written instructions and photos on proper brushing technique. Measurements were then taken at the following three adjustment appointments, typically ranging 4-8 weeks apart. Study measurements were all performed by a single blind examiner who was calibrated by a graduate periodontal resident. Each patient had elastomeric ties and wires removed and instructed to brush prior to being examined.

Bleeding Index was measured according to Saxton and van der Ouderaa by probing the mesio-buccal, straight buccal, and disto-buccal sulci of the teeth (Table 1).²⁵ One PI measurement was scored according to a modified scoring system from Quigley and Hein and measured the buccal surface of each Ramjford tooth (Table 2).²⁶ One measurement for MGI was recorded on the buccal surface using an index developed by Lobene et al (Table 3).²⁷ The average of each tooth was calculated, followed by an average of all the teeth.

Subjects received a text message through an automated patient communication system (Groups 2 and 4). The message consisted of a short reminder to brush their teeth that was sent once a week at the same time. Subjects receiving oral hygiene instruction received standardized, scripted instructions where their doctor demonstrated proper brushing and flossing technique on a typodont, then had the patient demonstrate it back on the typodont. The patients were then asked to demonstrate it on their own teeth, and corrections were made as needed.

Changes in mean BI, PI, and MGI were compared across the four visits using repeated measures analysis of variance. Significance level was set at $p=0.05$. The software used for all analyses was SAS EG (v.6.1).

Based on results seen in Eppright, a sample size of 8 was suggested for each of the four groups.¹⁶ This would allow for at least 80% power to detect a difference in the trends across the 4 visits for average bleeding index. This was chosen since it demonstrated the greatest changes. Power calculations assumed a 5% reduction in scores at each time point for the addition of OHI.

Table 1. Bleeding Index (BI)

Score	Description
0	Absence of bleeding after 30 seconds
1	Bleeding observed after 30 seconds
2	Immediate bleeding observed

Table 2. Plaque Index (PI)

Score	Description
0	No plaque
1	Isolated areas of plaque at gingival margin
2	Thin band of plaque at gingival margin (≤ 1 mm)
3	Plaque covering up to 1/3 of tooth surface
4	Plaque covering between 1/3 and 2/3 of tooth surface
5	Plaque covering $\geq 2/3$ of tooth surface

Table 3. Modified Gingival Index

Score	Description
0	Absence of inflammation
1	Mild inflammation – slight change in color, little change in texture of but not entire marginal or gingival unit

2	Mild inflammation – criteria as above but involving entire marginal or papillary gingival unit
3	Moderate inflammation – redness, edema, and/or hypertrophy of marginal or papillary gingivla unit
4	Severe inflammation – marked redness, edema, and/or hypertrophy of marginal or papillary gingival unit, spontaneous bleeding

Results

A total of 67 patients were recruited for the study. Four patients were lost due to poor attendance. There were total 36 females and 27 males with a mean age of 15.4 years, ranging from 11-20. Patients received full fixed appliances at T0 and were measured at the subsequent three adjustment visits (T1-T3), which ranged at least 4-6 weeks apart. The average time from T0 to T3 was 4.8 months. Table 4 summarizes the average study duration for each group.

	Mean duration	Range
Group 1 (n=17)	4.57	3.44, 6.89
Group 2 (n=14)	5.14	3.44, 7.11
Group 3 (n=16)	4.83	3.21, 6.75
Group 4 (n=16)	4.69	3.67, 6.20

Table 4. Mean duration from T0 to T3 (months) and ranges

Table 5 summarizes the baseline values for Bleeding Index (BI), Plaque Index (PI), and Modified Gingival Index (MGI). At baseline, Group 3 had higher mean measurements for PI and BI with p values of 0.1 and 0.09, but these differences were not statistically significant.

	Mean PI	Mean MGI	Mean BI
Group 1 (n=17)	0.1204	0.2500	0.0278
Group 2 (n=14)	0.1795	0.0950	0.0119

Group 3 (n=16)	0.4479	0.3330	0.1458
Group 4 (n=16)	0.3137	0.3824	0.0980
p-value	0.1234	0.1307	0.0902

Table 5. Mean BI, PI, and MGI baseline (T0) measurements

Table 6 summarizes the comparison of mean PI scores across the four visits among the four groups. There were no statistically significant differences among the groups across the four time points ($p=0.2601$). There were no statistically significant differences in PI among the four groups averaged across the four visits ($p=0.4234$). There were no statistically significant differences in PI across the four visits averaged across the four groups ($p=0.5836$). Throughout treatment, average PI remained less than 0.5. Figures 1-4 represent the average PI scores of all patients across the four visits for each group. The solid lines represent an overall regression line.

Group	T0	T1	T2	T3
1	0.12	0.26	0.43	0.33
2	0.18	0.40	0.28	0.14
3	0.45	0.29	0.46	0.29
4	0.31	0.39	0.14	0.20

Table 6. Mean Plaque Index for each group at T0, T1, T2, T3

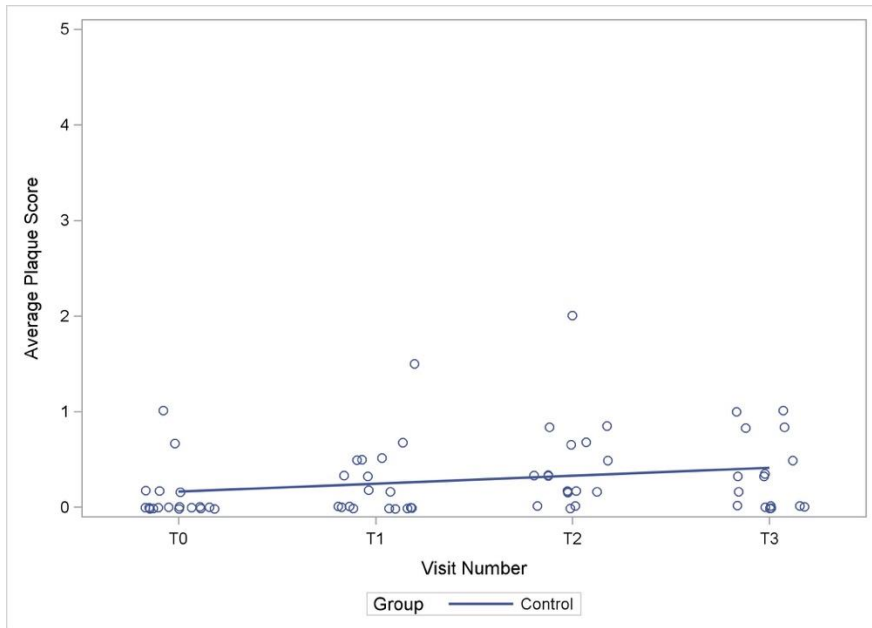


Figure 1. Average PI scores across the four visits for Group 1

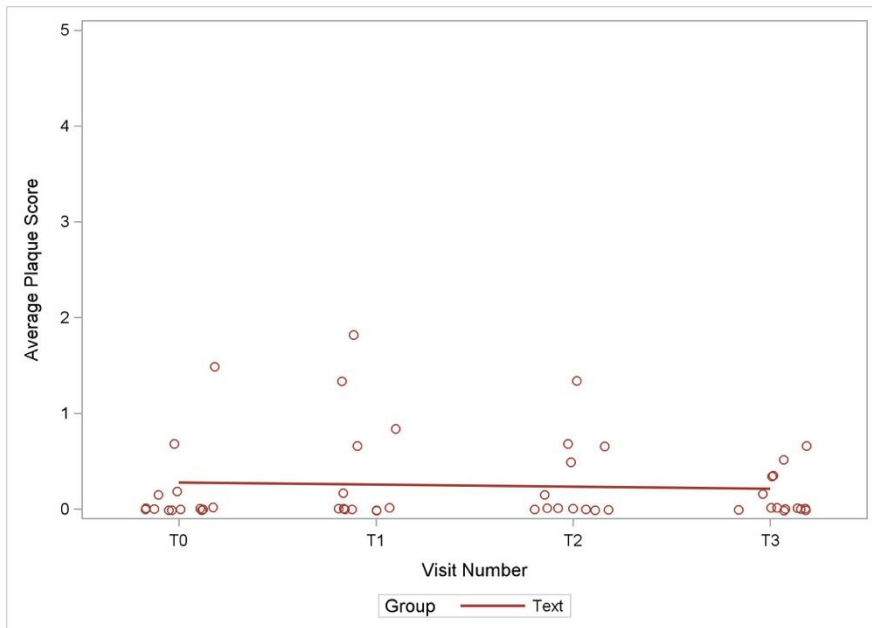


Figure 2. Average PI scores across the four visits for Group 2

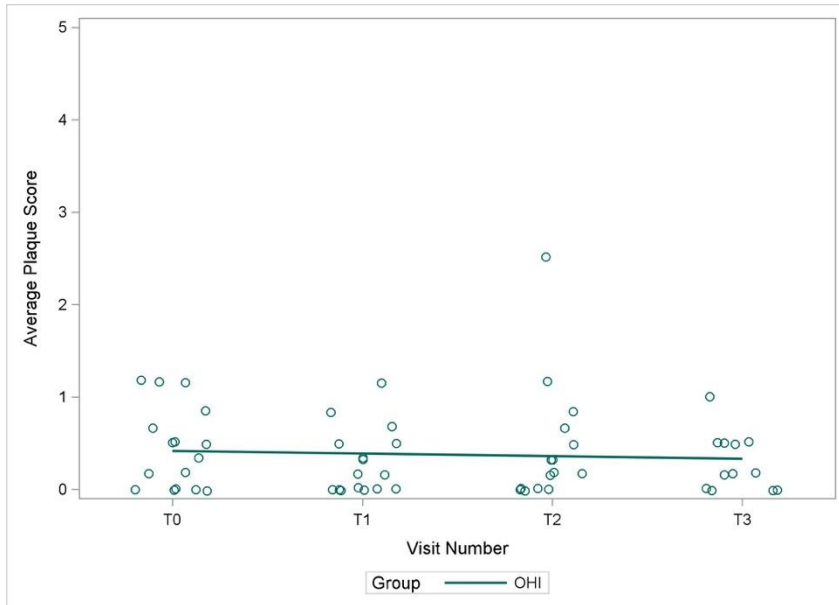


Figure 3. Average PI scores across the four visits for Group 3

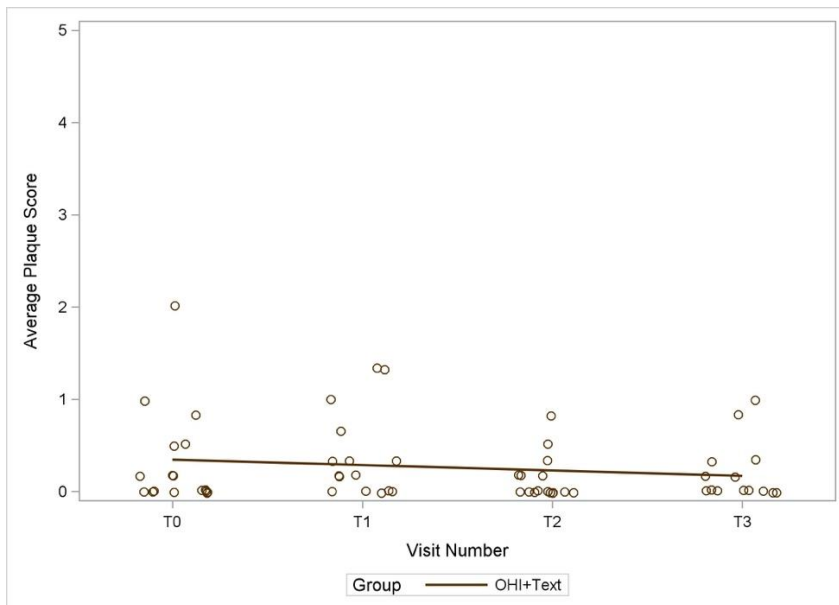


Figure 4. Average PI scores across the four visits for Group 4

Table 7 summarizes the comparison of mean MGI scores across the four visits. There were no statistically significant differences between the groups across the four visits ($p=0.7750$). There were no statistically significant differences in MGI among the four groups averaged across the four visits ($p=0.8866$). There were no statistically significant differences in MGI across the four visits averaged across the four groups ($p=0.1126$). Mean MGI values remained less than 0.5 across time. Figures 5-8 represent the average MGI scores of all patients across the four visits for each group.

Group	T0	T1	T2	T3
1	0.25	0.37	0.35	0.32
2	0.10	0.44	0.35	0.18
3	0.33	0.36	0.34	0.22
4	0.38	0.42	0.26	0.18

Table 7. Mean Modified Gingival Index for each group at T0, T1, T2, T3

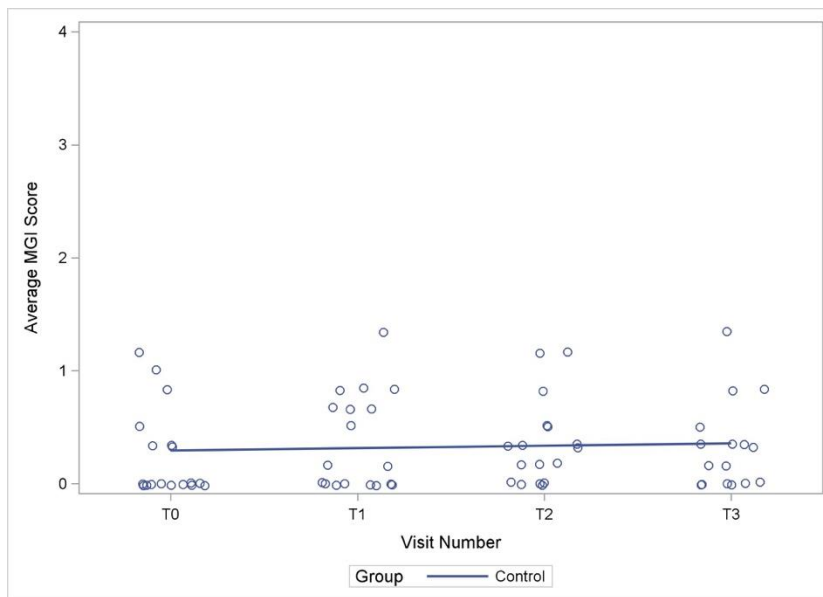


Figure 5. Average MGI scores across the four visits for Group 1

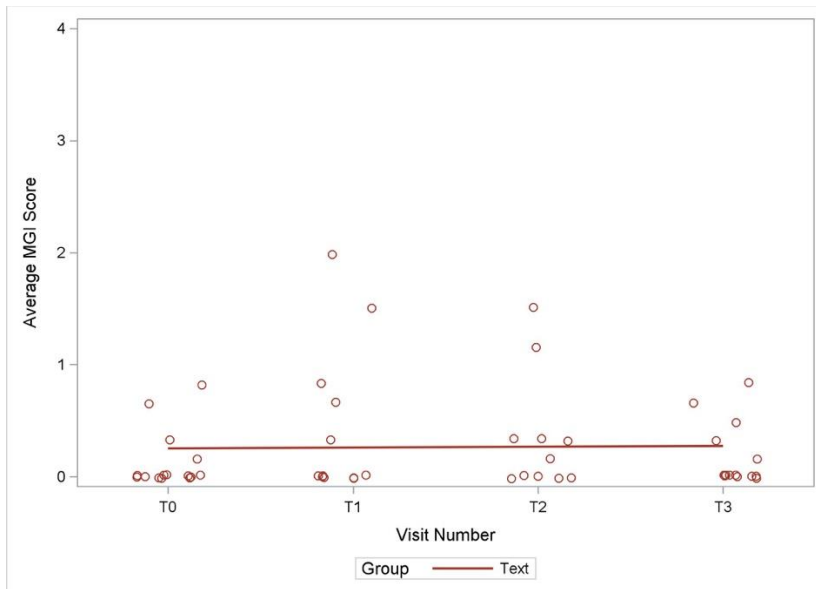


Figure 6. Average MGI scores across the four visits for Group 2

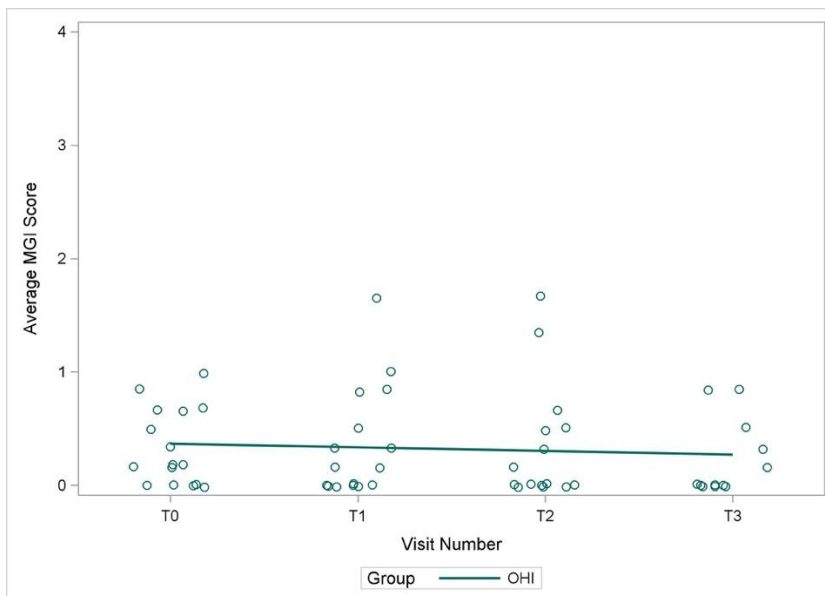


Figure 7. Average MGI scores across the four visits for Group 4

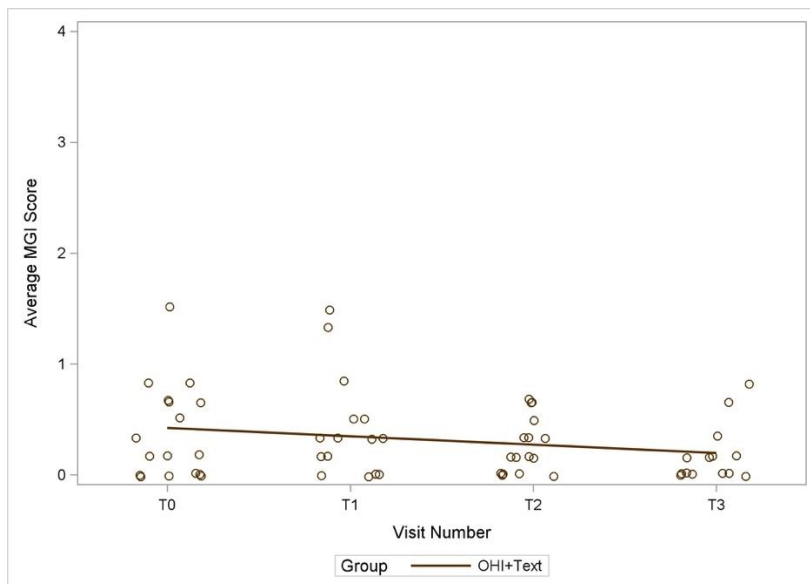


Figure 8. Average MGI scores across the four visits for Group 4

Table 8 summarizes the comparison of mean BI scores. There were no statically significant differences between the groups across the four visits ($p=0.1237$). There were no statistically significant differences in BI among the four groups averaged across the four visits ($p=0.7626$). There were no statistically significant differences in PI across the four visits averaged across the four groups ($p=0.5765$). Mean BI values remained less than 0.2 across the four visits. Figures 9-12 represent the average MGI scores of all patients across the four visits for each group.

Table 8. Mean Bleeding Index for each group at T0, T1, T2, T3

Group	T0	T1	T2	T3
1	0.03	0.13	0.13	0.09
2	0.01	0.06	0.10	0.10
3	0.15	0.06	0.04	0.07
4	0.10	0.20	0.04	0.05

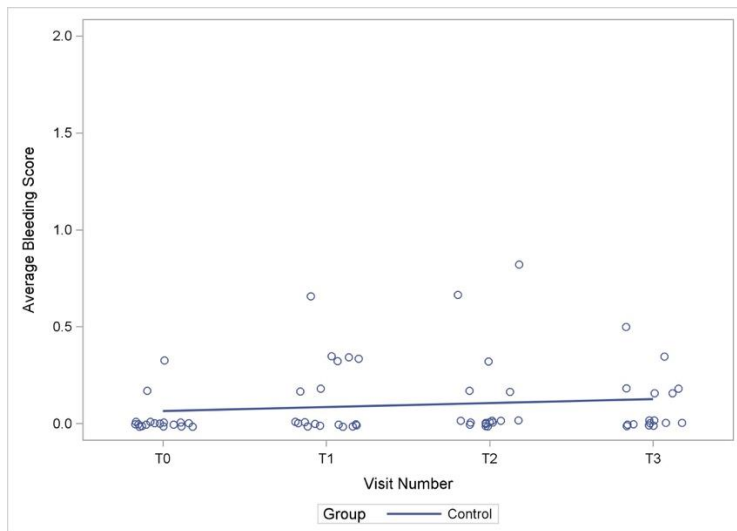


Figure 9. Average BI scores across the four visits for Group 1

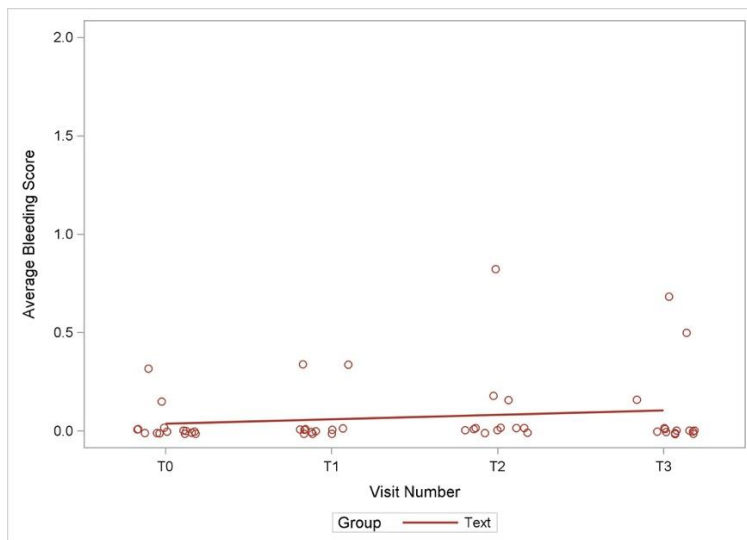


Figure 10. Average BI scores across the four visits for Group 2

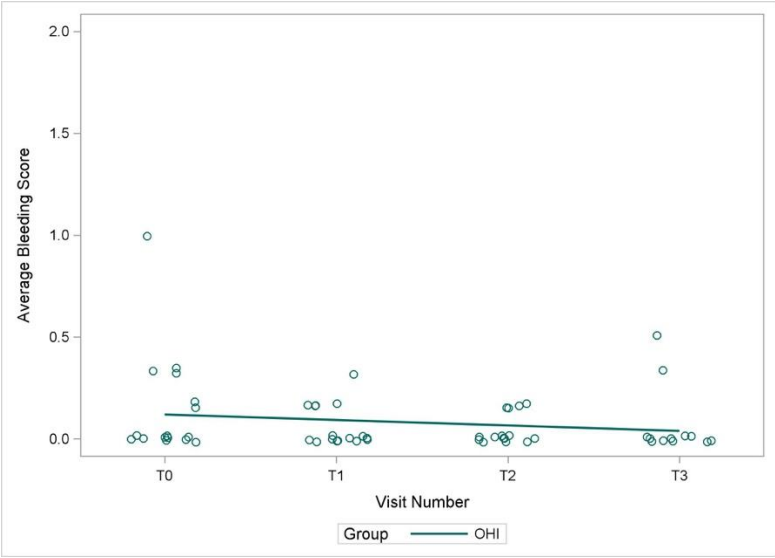


Figure 11. Average BI scores across the four visits for Group 3

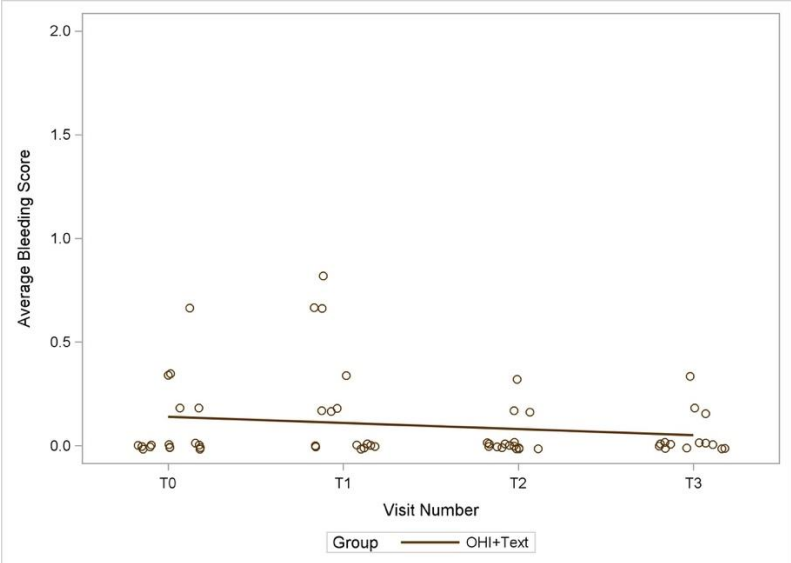


Figure 12. Average BI scores across the four visits for Group 4

Discussion

Oral hygiene compliance is an important factor for successful orthodontic treatment outcomes. Oral health decreases as a result of fixed appliances and patients are more at risk of developing white spot lesions.^{2,28} This can cause many problems during orthodontic treatment,

ranging from gingival inflammation to white spot lesions and active decay.^{1,5} A previous study showed that white spot lesions worsen the final esthetic outcome of orthodontic treatment.⁷ Many methods have been tested to improve oral hygiene compliance, such as text reminders or the use of cellphone applications. Some studies emphasize the importance of the frequency of reminding patients to brush and demonstrated that reminding patients at least once a week can increase oral hygiene compliance compared to no reminders.^{14–19,29}

Proper oral hygiene requires not only frequency of brushing, but correct technique since fixed appliances impede the ability to brush. Few studies have looked at repeated oral hygiene motivation and demonstration. Repeated oral hygiene motivation and verbal instructions can decrease plaque levels and improve gingival health.^{20,23,24} This study compared the use of weekly text message reminders and motivational oral hygiene instructions on improving oral hygiene. Patients were assigned to a control, text message only, oral hygiene instruction only, or combination of text and oral hygiene instruction group. Bleeding index (BI), plaque index (PI), and modified gingival index (MGI) have been used in previous studies to measure oral hygiene compliance and have high sensitivity and specificity for assessing periodontal health.^{30,31} These indices were used in the present study to evaluate patients' oral hygiene.

No significant differences in BI, PI, or MGI were found between any groups at the end of the study. These results are inconsistent with previous studies. The following factors may have contributed to the differences observed in the present study: timing of intervention, initial oral hygiene status, a patient's self-efficacy, and possible behavioral modifications from participants in the control group.

Previous studies tested interventions at variable times during orthodontic treatment. Acharya et al started at the beginning of orthodontic treatment, but the baseline and follow-up

measurements were significantly higher than those reported here.²⁰ The higher baseline measurements indicate that oral hygiene started off with signs of inflammation and were not controlled before starting orthodontic treatment. Other studies started at least four months after orthodontic treatment was initiated and the baseline measurements were also higher than in the present study, with the control groups worsening with time.^{15,16,19,24} Patients in the present study were enrolled at the start of their orthodontic treatment in an effort to see if they could maintain their initial oral hygiene status. Typically, patients and parents were advised that they can start treatment when they could demonstrate good oral hygiene with no signs of gingivitis or active caries. The treating providers are responsible for only initiating treatment when patients can demonstrate that their oral hygiene has improved to an acceptable level. The time range from T0 to T3 was 3.2 to 7.1 months, with an average of 4.8 months. This would have allowed sufficient time for hygiene to decline. The results indicate that all patients, including those in the control group, were able to maintain adequate oral hygiene regardless of the intervention during the first four months of treatment.

Measurements at all timepoints were significantly and consistently lower than those reported in other studies.^{16,17,19,20,23} Patients have higher motivation and interest in their treatment early on. As treatment progresses, patients' motivation and cooperation decreases and patients are less willing to brush than they were at the start of treatment.^{32,33} Mei et al reported that patients who were self-motivated for orthodontic treatment were more cooperative during treatment and had significantly less biofilm formation than patients who were family-motivated or both family and self-motivated.³⁴ Studies have found that patients who are motivated to start orthodontic treatment have a positive correlation with their reported cooperation during

treatment.^{32,33} The baseline measurements of this study were obtained when the patients were the most motivated and this could explain the discrepancy between previous studies.

Certain risk factors can indicate that some patients are more likely to develop white spot lesions with fixed appliances than others. Patients who have fair or poor oral hygiene pretreatment had three times the risk of developing white spot lesions compared to those who had good pretreatment oral hygiene.³⁵ Males overall have worse oral health and tend to brush and floss less frequently, as well as younger patients at the start of treatment.³⁵ Knowing these risk factors, doctors may be more apprehensive to start treatment on patients that present with poor oral hygiene. Even though patients were identified as the most responsible for preventing white spot lesions, orthodontists were identified as the second highest group responsible alongside parents.⁷ Patients and parents are informed that their hygiene must be impeccable before starting orthodontic treatment. If a patient presents with poor hygiene at their initial exam, orthodontic treatment should be deferred until there is significant improvement of the oral hygiene. Requiring good oral hygiene before initiating treatment could have contributed to the low measurements in this study and may explain why oral hygiene was sustained for those that started treatment.

Oral hygiene-related self-efficacy has been shown to be positively correlated to important hygiene parameters.³⁶ Self-efficacy can be defined as an individual exercising control over his or her own health habits.³⁷ Patients that reported being confident that they could brush, clean interproximally, or attend their dental visits in different taxing situations positively predicted their behavior in the outcomes assessed.³⁶ Despite difficult circumstances, patients that prioritize their hygiene will continue to do so. Patients that possess self-efficacy might not be influenced by any kind of intervention or motivation induced by the orthodontist since the patients are

inherently self-motivated already. Since patients were randomly distributed, self-efficacy could have been a confounding factor leading to no significant differences between the groups.

The control group consistently had good hygiene, not differing from any of the intervention groups.^{16,19} This could result from patients being aware that they were involved in a scientific study. Subjects in a study may alter their behavior as a result of their awareness of the study. The Hawthorne effect describes that individuals may change their behavior upon being observed or assessed.³⁸ The John Henry effect describes that the control group's behavior changes resulting from fear of being outperformed.³⁹ During the consent process, patients were informed that they would be randomly assigned to one of four groups and each group was described. Patients may have guessed that they were assigned to the control group since they did not receive a text or oral hygiene instructions at each visit. The control patients were measured at each visit, which could pressure them into maintaining good hygiene since they were aware that they were not receiving any additional intervention.

One main limitation of the study was the timing of the intervention. If patients were in fixed appliances for at least six months before beginning the study, oral hygiene may have declined and then interventions could have shown statistical differences from baseline. However, it should be considered that maintaining good hygiene for the first six months of treatment is commendable. Potential bias could have resulted from the patients not being blinded. Duration of the study could have been longer to minimize the Hawthorne effect and to assess if patients may revert to bad habits as treatment duration increases since a previous systematic review found that the effects of the Hawthorne effect did not persist after six months.⁴⁰

Previous studies have demonstrated the benefits of frequently reminding patients and motivational techniques. The results of this study show that patients' oral hygiene parameters did

not change depending on the group. A patient's initial oral hygiene presentation could play an important role in how their oral hygiene will progress throughout treatment and should be heavily considered by practitioners before beginning orthodontic treatment.

Conclusion

1) Patients who presented with good oral hygiene initially were able to maintain it during the first four months of treatment regardless of the intervention.

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