Influence of Different Brushing Times on Oral Hygiene in Orthodontic Patients with Fixed Appliances

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ABSTRACT

Objectives: To investigate the most appropriate and adequate time for tooth brushing among orthodontic patients with fixed appliances.

Methods: Two hundred fixed orthodontic appliance patients from various Jordanian orthodontic clinics were randomly assigned to four groups (n=50 for each group) and subjected to different tooth brushing time treatments (T1 =3 min, T2=5 min, T3=7 min, and T4 = 10 min, respectively) using a manual toothbrush. A periodontist examined the patients to assess the plaque index (PI) after they had brushed their teeth with an orthodontic toothbrush for the prescribed amount of time.

Results: A total of 200 patients (36.5% males and 63.5% females) with an average age of 18.1 ± 3.5 years (18.6 ± 4.9 male, 17.7 ± 2.3 female) and ages ranging from 12 to 40 years were included in the study. The results indicated highly significant statistical differences among the treatment groups for PI scores (P-value ≤ 0.05). The PI scores were higher in the T1 group; conversely, the scores were lower and very close in T2, T3, and T4 groups. The Kruskal-Wallis H test revealed that the groups exhibited significant differences with a P-value ≤0.05. The T1 group illustrated 60% good oral hygiene and no excellent oral hygiene, while the T2, T3, and T4 groups showed 88%, 82%, and 86% good oral hygiene in addition to 10%, 14%, and 12% excellent oral hygiene, respectively.

Conclusion: This study demonstrated that the 3 minutes brushing time with a manual orthodontic toothbrush was least effective for orthodontic patients. Contrarily, the 5 minutes brushing time was most effective, advantageous, and acceptable. Therefore, this brushing strategy should be suggested to orthodontic patients with fixed appliances to maintain good oral hygiene.

Keywords: Dental hygiene; fixed appliance; Orthodontic patients; Plaque index; Tooth brushing

INTRODUCTION

Orthodontic treatment involves straightening or repositioning teeth in order to enhance their look and function. During orthodontic treatment, maintaining oral hygiene is challenging because the archwires, brackets, and other elements may promote the buildup of plaque and interfere with traditional hygiene practices (1–3).

Therefore, orthodontic patients are more likely to develop gingivitis (1,4–6). Moreover, they also have a higher risk of enamel decalcifications that can lead to the formation of caries and white spots (6–8). Thus, maintaining dental hygiene is necessary during orthodontic treatment. Professional assistance, patient motivation, and appropriate tools play a critical role in achieving compliance during orthodontic treatment (9).

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The role of orthodontic patients' motivation for oral hygiene has not been extensively studied. The few studies investigating this crucial aspect of oral health suggested that motivation plays an essential and influential part in reducing plaque and inflammation (10–12). Orthodontic treatment with fixed appliances may cause unintended side effects if appropriate measures are not taken. Among these, incipient carious development is the most common.(10)

Previous researches indicates that around 25 percent of patients acquire develop decalcification while receiving treatment with fixed appliances (13,14). This high occurrence is caused by retention of the plaque due to complexity of orthodontics brackets design which leading to continued biofilm deposition on tooth surfaces of plaque due to appliance components that hinder brushing (15). Therefore, different approaches have been proposed to avert these serious issues (16). The eradication of biofilm is vital to deter the chances of gingivitis, caries, periodontal disease, and decalcification. Especially, using fluoride toothpaste can help serve the purpose (17).

Earlier studies have shown that tooth brushing habits significantly impact oral hygiene parameters (18–20). The current study examines and compares the effects of different tooth brushing times on the oral hygiene of orthodontic patients with fixed appliances. This was achieved by analyzing clinical and oral hygiene parameters using the plaque index. The previous studies were investigating the type of brushing tools like manual and electrical tooth brush. Others investigate different tooth brushing techniques. But there were few studies in literature investigate the time factor for manual tooth brush for orthodontic patients with multiple brackets(21) or patients without orthodontic brackets (22–26).and therefor this study aimed to investigate the most appropriate and effective time for tooth brushing among orthodontic patients with fixed appliances. Additionally, the effect of tooth brushing on plaque index (Pl) scores was also explored.

METHODS

A double-blinded randomized clinical trial was performed in multiple Orthodontic clinics (Royal Medical Services clinics and Private clinics) in Amman, Karak, and Aqaba cities in Jordan Between June 2018 to March 2021. A total of 200. Participants were allocated to four groups. the participants were collected from Orthodontics clinics in armed hospital and private sector and the Dental assistant in each clinic prepare list of all patients that they will have fixed appliance in the next month and she flip a coin for each name to be in the study or not then the final name lists were generated and gather all the patients in specific days so the examiner can be in these days for examination. the examiner (A.A) were there in the time of bonding the fixed appliance and the participants and their parents were informed about the study and verbal consent were taken from them since no medication or drugs or any intensive procedures were taken verbal consent was adopted .The patients were handed an envelope mentioning the group number she/he was assigned to. The random allocation sequence was block randomization to produce equal sample size between the groups. The four groups were divided as per the brushing time (T1-3 minutes (controlled Group), T2-5 minutes, T3-7 minutes, and T4-10 minutes). The patient then utilized one of four time-preprogrammed watches based on their group. All participants were given a proper tooth brushing instruction using Charter's technique with no additive like interdental brush or mouthwash were used just before distributing them in to the groups. After brushing their teeth with an orthodontic toothbrush (Foramen Stander V shape orthodontic toothbrush and foramen toothpaste contain 1040 ppm), patients were examined using WHO periodontal prob by a periodontist to assess the plaque index for each participant by examining all presented permanent teeth, which had been included within fixed orthodontic appliance by brackets or bands. Patient group assignment was been unveiled to periodontist. The periodontist in this research (4th author AA) who was familiar with this research was the only examiner for all patients to reduce intra and inter examiners bias. (A.A) were the only examiner so only

Intra examiner test were performed. (A.A) were had test for reliability by examining 20 patients prior the research with the same criteria of the research and kappa coefficient 0.92. The exclusion criteria were smoking, use of antibiotics or antibacterial mouth rinses in the previous six months, neurological or psychiatric disorders, physical or mental disability, and addiction.

In Jordan there were 130 orthodontic specialists (27) with Maximum number of patients 52000-78000 patients that they can be under active treatments. Jordan population in 2019 10.1 million with prevalence of (0.8%) (n=Z2 P (1-P)/d2 → n= (1.96)2 * 0.008(1-0.008)/ (0.5)2 → n=12.19 participants).12 participants for each group enough to be representative .The final sample size taken in this study were 200 participants (50 participants for each group).

The study protocol was approved by the Royal Medical Services Ethical Committee board.

The Plaque Index System Scores (28)

- **Score 0:** No plaque
- **Score 1:** A film of plaque adhering to the free gingival margin and adjacent area of the tooth. Plaque can only be seen after applying a disclosing solution or by using a probe.
- **Score 2:** Moderate buildup of soft deposits visible with the naked eye within the gingival pocket or the tooth and gingival margin.
- **Score 3:** Plenty of soft matter in the gingival pocket and/or on the tooth and gingival margin.
  The patients were divided to four groups according to the total PI score as following(28,29):
  Excellent Oral Hygiene   (0)   Good Oral Hygiene   (0.1–0.9)   Fair Oral Hygiene   (1.0–1.9)   Poor Oral Hygiene   (2.0–3.0)

Statistical analysis

Data were entered and coded using SPSS version 26.0 (Chicago, IL, USA). Values were reported as descriptive, frequency, cross tabulation, and mean ± standard deviation. The differences in the means of different groups were analyzed using Kruskal-Wallis H test, and the associations between variables (Plaque Score, brushing time) were tested using Spearman's correlation tests. P values of less than or equals 0.05 were deemed statistically significant.

RESULTS

A total of 200 patients (73 male 36.5%, 127 female 63.5%) with an average age of 18.1±3.5 years (18.6 ± 4.9 male, 17.7 ± 2.3 female) and ages ranging from 12 to 40 years were included in the study.

The mean plaque index scores for males and females were similar, with a mean of 0.55±0.35 and 0.54 ±0.43, respectively (Table I). We observed that the PI score was high in the T1 group. On the other hand, the scores were comparatively low and very close in the T2, T3, and T4 groups (Table II; Figure 1). To evaluate the differences across four groups for most effective tooth brushing time was tested using Kruskal Wallis Test x^2(3, n200) =96.25, p<0.05. The study showed a significant difference between T1 group and other groups .T2, T3, T4 regarding tooth brushing time (P<0.05. the test revealed significant differences (Asymp.Sig.=.000) in the preference to tooth brushing time (T1 Groupe, n=50; T2 Groupe, n=50; T3 Groupe, n=50; T4 Groupe, n=50) (Table III,Figure 2).

Spearman's correlation indicated that there was a statistically significant negative moderate correlation between study groups and PI score. Rho=-0.375, p<0.001, N=200 indicating long timing of brushing associated with low PI Score.

Regarding oral hygiene, interesting observations were recorded. The T1 group illustrated less oral hygiene among all of the groups. Only 60% of the participants in this group exhibited good oral hygiene and none showed excellent oral hygiene. Conversely, the T2, T3, and T4 groups recorded good oral hygiene in 88%, 82%, and 86% of the cases (Table IV). Moreover, a good percentage of these groups also possessed excellent oral hygiene (10%, 14%, and 12%, respectively). Thus, our results depicted highly statistically significant differences among groups and PI score values with a P-value ≤0.05.

Table I: Mean of plaque index score of different genders.

Gender	Mean	N (Total N=200)	Std. Deviation
Male	.5484	73	.35
Female	.5395	127	.43
Total	.5428	200	.40

Table II: Mean of plaque index score of different brushing time groups.

Group	N	PI Mean ±(SD)	P value
T1	50	1.03±0.40	0.000*
T2	50	.43±0.23	
T3	50	.36±0.26	
T4	50	.35±0.23	
Total	200		
Spearman's Correlation	Correlation Coefficient = -.375		

 * The mean difference is significant at the 0.05 level.

Table III: Kruskal Wallis H Test & Pairwise comparisons of groups.

Kruskal-Wallis Test

Ranks

	Group	N	Mean Rank
Plaque Score	T1(3 min)	50	168.40
	T2(5 min)	50	91.87
	T3(7 min)	50	71.87
	T4(10 min)	50	69.86
	Total	200	

Test Statistics[a,b]

	Plaque Score
Kruskal-Wallis H	96.247
Df	3
Asymp. Sig.	.000

a. Kruskal Wallis Test
b. Grouping Variable: Group

Pairwise Comparisons of Group

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
T4(10 min)-T3(7 min)	2.010	11.571	.174	.862	1.000
T4(10 min)-T2(5 min)	22.010	11.571	1.902	.057	.343
T4(10 min)-T1(3 min)	98.540	11.571	8.516	.000	.000
T3(7 min)-T2(5 min)	20.000	11.571	1.728	.084	.503
T3(7 min)-T1(3 min)	96.530	11.571	8.342	.000	.000
T2(5 min)-T1(3 min)	76.530	11.571	6.614	.000	.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
 Asymptotic significances (2-sided tests) are displayed. The significance level is .05.
a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

Table IV: Distribution of plaque index score among different groups.

Group		Excellent	Good	Fair	Poor	Total
Group	**T1(3 min)**	0	30	18	2	50
	T2(5 min)	5	44	1	0	50
	T3(7 min)	7	41	2	0	50
	T4(10 min)	6	43	1	0	50
	Total	18	158	22	2	200
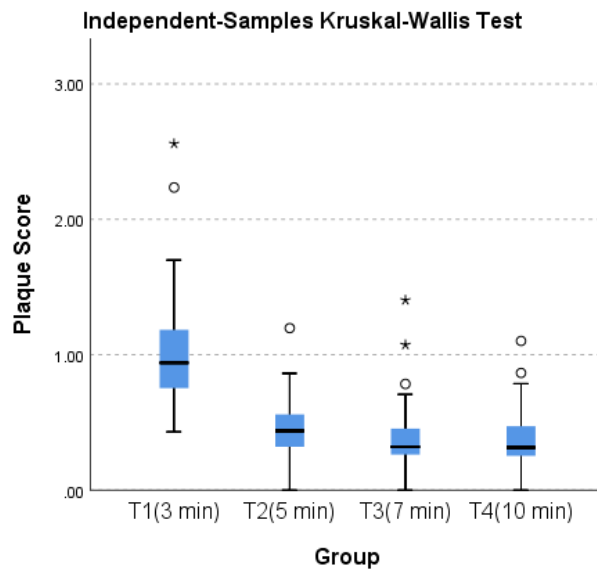
Figure 1: Distribution of plaque index score means between different groups of teeth brushing time.

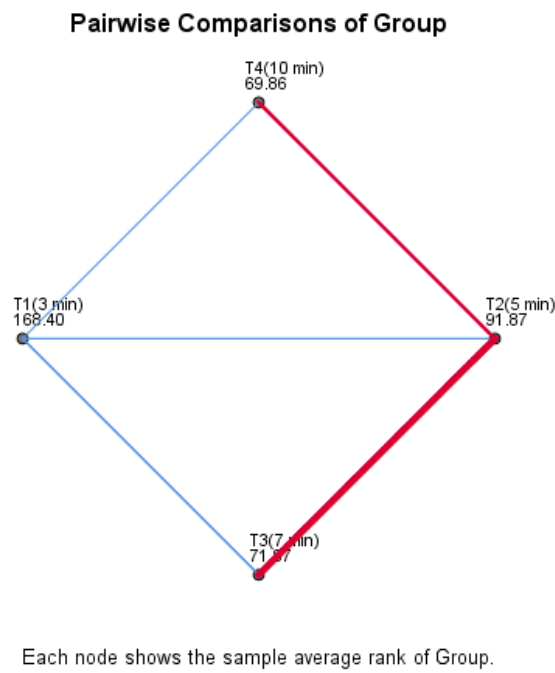Each node shows the sample average rank of Group.

Figure 2: Pairwise Group comparison show correlation and rank for groups (significance Blue line, Insignificance Red line)

DISCUSSION

Dental plaque is the most common cause of the prevalence of oral diseases. Therefore, patients with fixed orthodontic appliances must practice strict oral hygiene to prevent the deposition of dental plaque.(30)

This study evaluated the effect of different tooth brushing times by measuring the PI score in orthodontic patients. The results manifested that the PI score significantly reduced with increased tooth brushing time. Moreover, a significant decrease in PI score between T1 and T2, T3, and T4 was recorded; conversely, the statistical differences among T2, T3, and T4 were non-significant (Table II),(Fig 1) which show dramatic change between T1 and the other groups which are close in PI score to each other's.

Acharya et al. (10), Ay et al. (11), and Lalic et al. (12) demonstrated the significance of oral hygiene motivation in reducing plaque and inflammatory signs in orthodontic patients. However, previous researches that looked into the association between repeated oral hygiene index (OHI) and patient motivation (10,31). Nevertheless, Acharya et al and colleagues were explored the differences among the three motivating methods and did not compare the effectiveness of recurrent OHI on oral hygiene, differentiating with the comparing it to a single OHI session at baseline. Ida and Marinia et al were comparing combination between motivation with single or multiple repetition (31)

Many earlier studies (32–36) looked into the effectiveness of various kinds of toothbrushes in removing plaque in orthodontic patients yielding conflicting results with some studies suggesting that electric toothbrush is relatively effective in reducing PI and other authors reporting that electric and manual toothbrushes are equally effective (33,35,37,38). For patients with fixed orthodontic appliances, oral hygiene can be performed primarily with a manual orthodontic toothbrush, with the addition of some additive means such as an interdental toothbrush for plaque removal in a tight area. Nonetheless, there is little scientific evidence to support the use of an interdental brush (39–41).

In this study, we investigated the time factor of tooth brushing and how it affects the PI score, as well as the minimum time for effective tooth brushing with simple orthodontic toothbrushes for a patient receiving fixed appliance treatment. This study demonstrated that the T2 group that used 5 minutes tooth brushing offered 98% of patients with excellent and good oral hygiene with PI score less than 0.50; on the other hand, the T1 group with 3 minutes of tooth brushing illustrated a PI score of more than 1.0 and only 60% of excellent and good oral hygiene. Which mean more tooth brushing time will lead for better oral hygiene level of orthodontic patient with at least 5 minutes, less time could be not enough to have an excellent or good oral hygiene for the majority of patients with fixed orthodontic appliances. This is agreed with previous research by Wang Te et al which concluded that is the best brushing time duration were 5-7 minutes.(21) And the results show in this study go along previous studies which investigate the tooth brushing duration for non-orthodontic patients that the more time of brushing more plaque removal.(22–25) Furthermore, there was no substantial difference among the PI scores of T2, T3, and T4 groups, and their excellent and good oral hygiene percentage was 98%, 96%, and 98%, respectively. With these differences between groups T2, T3 and T4 which show little differences in the level of oral hygiene and PI score but all of them are highly effective.

Overall, the T2 group produced the most promising results. Therefore, this approach of 5 minutes of minimum of tooth brushing is suggested for patients receiving fixed orthodontic treatment.

LIMITATIONS

The PI-scoring system used in this study is subject to the examiner's subjectivity, even PI system used in this research were the simplest index for any patients and known by all dentists but it will more researches used other methods and Indexes which will be more specific for patients with Multiple fixed brackets like Orthodontic Plaque Index OPI.

CONCLUSION

The results of the present study showed that the 3 minutes brushing time with a manual orthodontic toothbrush was least effective for orthodontic patients. Contrarily, the 5 minutes brushing time was effective, advantageous, and acceptable as a minimum brushing time. Moreover, the other two treatments of 7 and 10 min also offered good oral hygiene with more time of brushing needed. It is crucial to use an appropriate brushing strategy for orthodontic patients with fixed appliances to maintain oral hygiene, and therefore, recommended strategies should be adopted.

Competing Interests

The authors have no competing interests to declare.

Acknowledgements

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