International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Evaluation of Effectiveness of An Essential Oil Mouth Rinse in Improving Oral Health in Orthodontic Patients in Uttar Pradesh Population

Farhan Farooqshah[1], Sunanda Roy Choudhury[2], Karanveer Singh[3], Manshi Papnoi[4]

[1]MDS, Shree Bankey Bihari Dental College, Ghaziabad

[2]Professor & Head Department of Orthodontics & Dentofacial Orthopedics Shree Bankey Bihari Dental College Ghaziabad

[3]Private Practice, Hapur dental clinic Uttar Pradesh

[4]MDS, Shree Bankey Bihari Dental College, Ghaziabad

[1]Corresponding Author: *mail2drfarhanshah[at]gmail.com*

Abstract: ***Purpose: The purpose of this study was to determine whether the use of Listerine (Johnson & Johnson pvt ltd India) mouthrinse in addition to the standard oral hygiene regimen (tooth brushing) has a beneficial effect for orthodontic patients in maintaining proper oral health. Materials and Methods: Patients within their first 6 months of orthodontic treatment were assigned either to the brushing (Group I; n=20) or Rinse (Group II; n= 20) group. Initially, all participants underwent an oral prophylaxis and were given instructions on oral hygiene maintenance. Measurements were recorded for the bleeding index (BI), modified gingival index (MGI) and plaque index (PI) that provided baseline values (T0). Subsequent measurements were taken at 3 months (T1) and 6 months (T2). Mean BI, MGI, and PI at T0, T1, and T2 were compared statistically between the groups. Results: The scores of BI, MGI, and PI over time were significantly different between the two groups. Patients who had Listerine in their daily oral hygiene regimen exhibited significantly lower scores for BI and MGI at T2 than the patients who only brushed. Conclusions: Use of a mouth rinse in addition to the standard oral hygiene regimen is found to be beneficial for orthodontic patients in maintaining proper oral health. Adding Listerine to the daily oral hygiene regimen reduces plaque accumulation and gingivitis development in orthodontic patients over a 6-month period.***

Keywords: Malocclusion, Mouthrinse, Plaque, Gingivitis

1. Introduction

During orthodontic treatment, the development of white spot lesions is almost inevitable if oral hygiene is poor.[24,29] Demineralization is more commonly seen on the buccal surfaces of orthodontically treated teeth than on untreated teeth.[13] This is due to the prolonged plaque retention around the brackets, which causes a decrease in pH when certain bacteria interact with sugars.[8,22,24,27,39] These incipient lesions can appear in as little as 2 to 3 weeks after plaque accumulation in buccogingival areas of the teeth.[24] The presence of white spot lesions may lead to patient dissatisfaction at the end of orthodontic treatment and may necessitate cosmetic intervention by a dentist.

The development of gingivitis and hyperplastic gingiva is also a well-recognized problem during orthodontic treatment with fixed appliances.[24,29] The primary causative factor in the development of gingivitis is the insufficient removal of supragingival plaque. The presence of orthodontic fixed appliances makes tooth brushing more difficult and predisposes the patient to plaque buildup on the buccal surfaces of teeth around the brackets. Additionally, many orthodontic patients, especially children and adolescents, fail to brush and floss because they find this procedure time-consuming and tedious in the presence of orthodontic archwires.[4] Clinical studies have shown an increase in the levels of Streptococcus mutans and lactobacilli, the main pathogens associated with the initiation and development of caries, in the dental plaque after placement of orthodontic attachments.[9,24,32]

A common strategy to improve mechanical plaque removal is to incorporate a chemotherapeutic agent, such as an essential-oil mouth rinse, into the oral hygiene regimen.[1] Essential oils (EOs) are organic compounds that are extracted from plants with various distillation methods.[42] Numerous periodontal studies have confirmed the ability of the essential-oil mouth rinses to kill a broad spectrum of microorganisms in vitro and in vivo.[17,18] Clinical trial evidence is available showing that oral hygiene status is significantly improved when antibacterial mouth rinses are added to daily oral hygiene measures compared with tooth brushing alone.[35]

EO-derivatives were found to be efficient in the management of orofacial pain due to their analgesic properties. Furthermore, studies indicated that EOs are capable of the management of dental anxiety before certain surgical procedures.[43]

The bactericidal efficacy of Listerine, the essential oil containing mouth rinse, has long been recognized.[17,18] The clinical benefits associated with the bactericidal activity of Listerine include prevention and reduction of supragingival plaque and gingivitis, decreased intrinsic oral malodor and a significant decrease in viable bacteria contained in the aerosols that are generated during dental procedures.[17,18]

Listerine can significantly reduce the accumulation of supragingival plaque and development of gingivitis. Hence the purpose of this study was to determine whether the use of Listerine mouthwash in addition to the standard oral hygiene regimen (tooth brushing) has a beneficial effect for orthodontic patients in maintaining proper oral health in the regional population.

2. Materials and Methods

Materials

This prospective clinical trial study was conducted in the Department of Orthodontics and Dentofacial Orthopedics on 40 patients. Informed consent was obtained from subjects and their parents. This study protocol was approved by the institutional committee ethical committee. Sample size was determined by a power analysis based on mean and standard deviation values for periodontal indices presented in a previous study by Charles CA et al.[10] The enrolment criteria for patients were as follows: patients requiring fixed orthodontic treatment, Age between 13-30, Complete permanent dentition (except third molars). Patients with previous orthodontic treatment, presence of any prosthesis, intra oral infection, any medical condition, systemic disease or medication, history of bad habits (tobacco chewing, smoking) were excluded from the study.

Methods

The patients were assigned in an alternate manner either to the Group I (Control Group) (n=20) or Group II (Rinse Group) (n=20).At the beginning of the study, all of the subjects were given instructions on proper method of brushing and importance of oral hygiene maintenance. Each participant was given an initial oral prophylaxis. Subjects in the control group were given oral-B toothbrushes **(Fig 1a)** and instructed to brush twice daily. Subjects in the rinse group were given Listerine mouthwashes along with Oral-B tooth brushes **(Fig 1b)** and instructed to rinse vigorously for 30 seconds twice daily with 20 ml of Listerine in addition to their basic oral hygiene regimen (tooth brushing)

The Bleeding Index (BI), Modified Gingival Index (MGI), and Plaque Index (PI) were measured at three time intervals. T0: Pre treatment, T1: (3 months), T2: (6 months. All clinical measurements were performed by the same examiner at T0, T1 and T2. All of the subjects in the mouthrinse group were monitored monthly for compliance by having them bring back empty mouthrinse bottles from the previous month.

In the present study BI (**Fig 2**) was scored as described by Saxton and Vander Ouderaa[26] upon probing the buccal sulcus of the Ramfjord teeth (upper right first molar, upper left central incisor, upper left first premolar, lower left first molar, lower right central incisor, lower right first premolar) as Score 0 : Absence of bleeding after 30 seconds, Score 1 : Bleeding observed after 30 seconds, and Score 2 : Immediate bleeding. The MGI (**Fig 3**) was scored according to the MGI on the buccal marginal gingiva of the Ramfjord teeth as :Score 0: Absence of inflammation, Score 1: Mild inflammation (either marginal or papillary gingival unit), Score 2: Mild inflammation (entire marginal and papillary gingival unit), Score 3: Moderate inflammation, and Score 4: Severe inflammation. The PI (**Fig 4**) was scored according to the Turesky modification on the Quigley-Hein PI[36] on the buccal surface of Ramfjord teeth using disclosing agent as : Score 0: No plaque; Score 1: Discontinuous band of plaque at the gingival margin, Score 2: Up to 1 mm continuous band of plaque at the gingival margin, Score 3: Band of plaque wider than 1 mm but less than one-third of the surface, Score 4: Plaque covering one-third or more of the surface, but less than two-thirds of the surface, Score 5: Plaque covering two-thirds or more of the surface.

Figure 1(a): Representative patient of Group I (Control group).

Figure 1(b): Representative patient of Group II (Rinse group)

Figure 2: Recording of Bleeding Index (BI).

Figure 3: Recording of Modified Gingival Index (MGI)

Figure 4: Recording of Plaque Index (PI).

3. Results

All the data was collected and analysed by a single operator.

4. Statistical Analysis

The statistical software SPSS 16.0 was used for analysis of data. The descriptive statistics like mean, median, S.D and frequency distribution of data were calculated.

The statistical tests used were as follows: The normality of data was tested by Shapiro Wilk test and found the data was not normally distributed**,** therefore the significance of data was tested by non-parametric test. The inter group comparison of parameters between groups was tested by Mann Whitney U-TestIntra group comparison i.e., the difference within group between two time intervals was tested by Wilcoxon sign rank test. The 95% C.I. and 5% level of significance was used for analysis of data.
(*Significant p<0.05, ** Highly significant p<0.01 *** Very highly significant p<0.001,^{NS} not significant p>0.05)

Table 1 Shows frequency distribution of samples in two groups with 20 patients in group I and 20 patients in group II (**Graph 1**).

Table 2 Shows frequency distribution of males and females with 16 (40%) males and 24 (60%) females (**Graph 2**).

Inter group comparison of BI, MGI and PI between two groups at three time intervals were done by Mann-Whitney U-Test (**Table 4**). The measurements at (T1) were not significantly different between the two groups (P >.05). At (T2) subjects in Group II had statistically significantly lower mean BI (P < 0.001), MGI (P<0.001), and PI (P <0.001) scores than the subjects in Group I.

Comparison of BI (**Graph 3**) MGI (**Graph 4**) and PI (**Graph 5**) between two groups at different time intervals were done. It shows with increase in time intervals the BI, MGI and PI reduced in Group II (Rinse group) and increased in Group I (Control group).

Intra group comparison of BI, MGI and PI between three time intervals within a group were done by Wilcoxon Signed Rank Test **(Table 5).**

Group I (**Graph 6**) The BI, MGI and PI scores increased from (T0) to (T1) but were not statistically significant (p>0.05).The BI, MGI and PI scores increased between (T0) to (T2) and were significant statistically (p<0.05).The BI and MGI scores between (T1) and (T2) were significant but the difference in PI scores was not statistically significant (P=0.083).

Group II (**Graph 7**) The difference of BI, MGI and PI between (T0) and (T1) and between (T0) and (T2) in Group II were statistically significant (p<0.05). The scores of BI and MGI between (T1) and (T2) were significant but the difference in PI scores was not statistically significant (P=0.008).

Intra group comparison of BI, MGI and PI between males and females of Group I at three time intervals were done by Mann-Whitney U- Test (**Table 6**). It shows BI, MGI, and PI scores of Group I in males and females at three time intervals (T0), (T1) and (T2) were not significantly different in Group I (P >.05).

Intra group comparison of BI, MGI and PI between males and females of Group II at three time intervals were done by Mann-Whitney U- Test (**Table 7).**It shows BI, MGI, and PI scores of Group II in males and females at three time intervals (T0), (T1) and (T2) were not significantly different in Group II (P >.05).

Tables

Table 1: Frequency distribution of samples in two groups

	Frequency	Percent
Group I	20	50
Group II	20	50
Total	40	100

Table 2: Frequency distribution of males and females

	Frequency	Percent
Male	16	40
Female	24	60
Total	40	100

Table 3: Tests of Normality

	Group	Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	P value
BI T0	Group I	0.223	20	0.01	0.809	20	0.001
	Group II	0.335	20	0	0.641	20	0
BI T1	Group I	0.45	20	0	0.545	20	0
	Group II	0.438	20	0	0.611	20	0
BI T2	Group I	0.335	20	0	0.641	20	0
	Group II	0.487	20	0	0.495	20	0
MGI T0	Group I	0.255	20	0.001	0.787	20	0.001
	Group II	0.509	20	0	0.433	20	0
MGI T1	Group I	0.375	20	0	0.72	20	0
	Group II	0.45	20	0	0.448	20	0
MGI T2	Group I	0.311	20	0	0.76	20	0
	Group II	0.487	20	0	0.495	20	0
PI T0	Group I	0.274	20	0	0.856	20	0.007
	Group II	0.333	20	0	0.768	20	0
PI T1	Group I	0.322	20	0	0.817	20	0.002
	Group II	0.42	20	0	0.66	20	0
PI T2	Group I	0.438	20	0	0.58	20	0
	Group II	0.487	20	0	0.495	20	0
. Lilliefors Significance Correction							

Table 4: Inter group comparison of BI, MGI and PI between two groups at three time intervals by Mann-Whitney U- Test

	Group	N	Mean±Std. Deviation	Median	Significance by Mann Whiney U-test	
					'z' value	p value
BIT0	Group I	20	.90±0.788	1	-2.492	0.013*
	Group II	20	1.50±0.513	1.5		
BIT1	Group I	20	1.05±0.394	1	-1.125	0.261^{NS}
	Group II	20	.90±0.447	1		
BIT2	Group I	20	1.50±0.513	1.5	-5.196	0.000**
	Group II	20	.20±0.410	0		
MGIT0	Group I	20	.90±0.852	1	-3.711	0.000**
	Group II	20	1.85±0.366	2		
MGIT1	Group I	20	1.25±0.550	1	-1.766	0.077^{NS}
	Group II	20	1.00±0.324	1		
MGIT2	Group I	20	1.60±0.681	1.5	-5.174	0.000**
	Group II	20	.20±0.410	0		
PIT0	Group I	20	1.05±0.826	1	-3.45	0.001**
	Group II	20	1.95±0.605	2		
PIT1	Group I	20	1.40±0.681	1	-1.289	0.197^{NS}
	Group II	20	1.15±0.489	1		
PIT2	Group I	20	1.70±0.470	2	-4.625	0.001**
	Group II	20	.80±0.410	1		

*Significant p<0.05, ** Highly significant p<0.01, *** Very highly significant p<0.001, ^{NS} not significant p>0.05

Table 5: Intra group comparison of BI, MGI and PI between three time intervals within a group by Wilcoxon Signed Rank Test

Group		BI T1 – BI T0	BI T2 – BI T0	BI T2 – BI T1	MGI T1 – MGI T0	MGI T2 – MGI T0	MGI T2 – MGI T1	PI T1 – PI T0	PI T2 – PI T0	PI T2 – PI T1
Group I	"z" value	-.775	-2.358	-3.000	-1.606	-2.568	-2.333	-1.698	-2.372	-1.732
	p value	.439^{NS}	.018*	.003**	.108^{NS}	.010*	.020*	.090^{NS}	.018*	.083^{NS}
Group II	"z" value	-3.464	-3.963	-3.742	-4.123	-4.072	-4.000	-4.000	-3.758	-2.646
	p value	.001**	.000**	.000**	.000**	.000**	.000**	.000**	.000*8	.008^{NS}

*Significant p<0.05, ** Highly significant p<0.01, *** Very highly significant p<0.001, ^{NS} not significant p>0.05

Table 6: Intra group comparison of BI, MGI and PI between males and females of Group I at three time intervals by Mann-Whitney U- Test

	Group	N	Mean±Std. Deviation	Median	Significance by Mann Whiney U-test	
					'z' value	p value
BIT0	Male	9	1.05±0.601	1	-1.175	0.295^{NS}
	Female	11	1.95±0.905	0		
BIT1	Male	9	1.0±0.500	1	-0.489	0.625^{NS}
	Female	11	1.09±0.302	1		
BIT2	Male	9	1.67±0.500	2	-1.134	0.189^{NS}
	Female	11	1.36±0.55	1		
MGIT0	Male	9	1.22±0.833	1	-1.535	0.125^{NS}
	Female	11	0.64±0.809	0		
MGIT1	Male	9	1.33±0.707	1	-0.772	0.440^{NS}
	Female	11	1.18±0.405	1		
MGIT2	Male	9	1.67±0.707	2	-0.422	0.673^{NS}
	Female	11	1.55±0.688	1		
PIT0	Male	9	1.33±0.866	1	-1.316	0.188^{NS}
	Female	11	0.82±0.751	1		
PIT1	Male	9	1.44±0.882	1	-0.213	0.831^{NS}
	Female	11	1.36±0.505	1		
PIT2	Male	9	1.56±0.527	2	-1.243	0.214^{NS}
	Female	11	1.82±0.405	2		

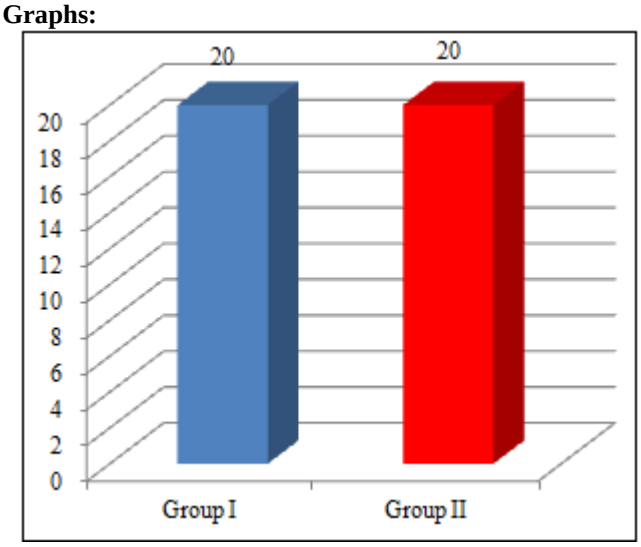
*Significant p<0.05, ** Highly significant p<0.01, *** Very highly significant p<0.001, ^{NS} not significant p>0.05

Table 7: Intra group comparison of BI, MGI and PI between males and females of Group II at three time intervals by Mann-Whitney U- Test

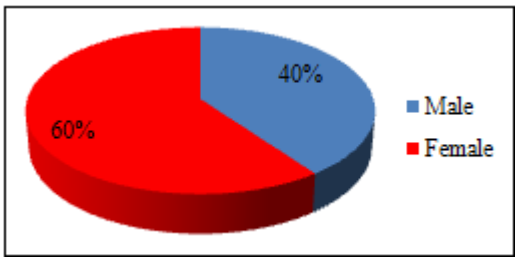
	Group	N	Mean ±Std. Deviation	Median	Significance by Mann Whiney U-test	
					'z' value	p value
BIT0	Male	7	1.71±0.488	2	-1.371	0.170 NS
	Female	13	1.38±0.506	1		
BIT1	Male	7	1.14±0.378	1	-1.762	0.078NS
	Female	13	.77±0.439	1		
BIT2	Male	7	0.29±0.488	0	-0.685	0.493 NS
	Female	13	0.15±0.376	0		
MGIT0	Male	7	1.86±0.378	2	-0.064	0.949 NS
	Female	13	1.85±0.376	2		
MGIT1	Male	7	1.00±0.577	1	0	1.000NS
	Female	13	1.00±0.000	1		
MGIT2	Male	7	0.43±0.535	0	-1.828	0.068 NS
	Female	13	0.08 ±0.277	0		
PIT0	Male	7	1.86±0.690	2	-0.515	0.606 NS
	Female	13	2.00±0.577	2		
PIT1	Male	7	1.29±0.488	1	-0.891	0.373NS
	Female	13	1.08±0.494	1		
PIT2	Male	7	0.86±0.378	1	-0.457	0.648 NS
	Female	13	0.77±0.439	1		

*Significant p<0.05, ** Highly significant p<0.01, *** Very highly significant p<0.001, NS not significant p>0.05

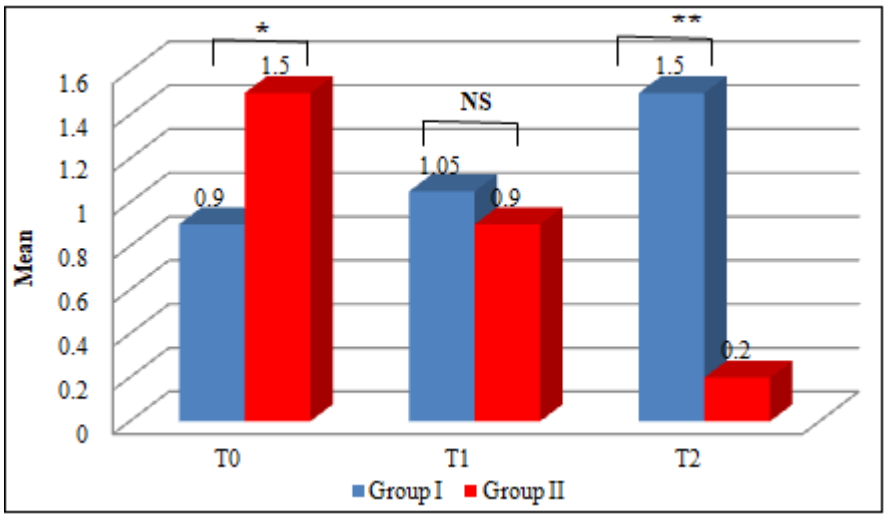
Graphs:



Graph 1: Frequency distribution of samples in two groups

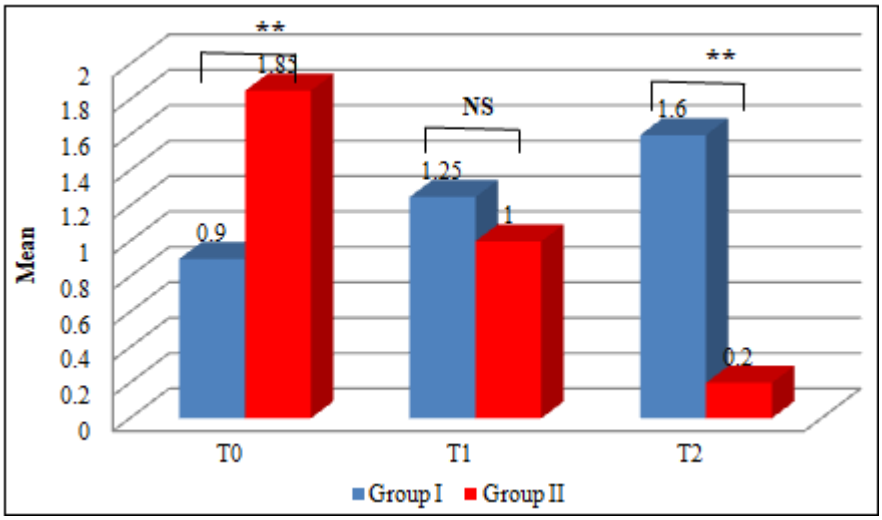


Graph 2: Frequency distribution of males and females

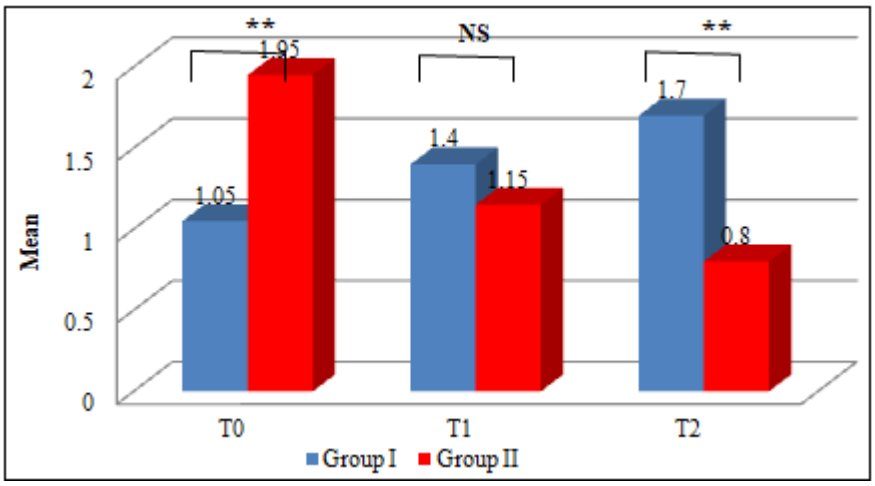


Graph 3: Comparison of BI between two groups at different time intervals

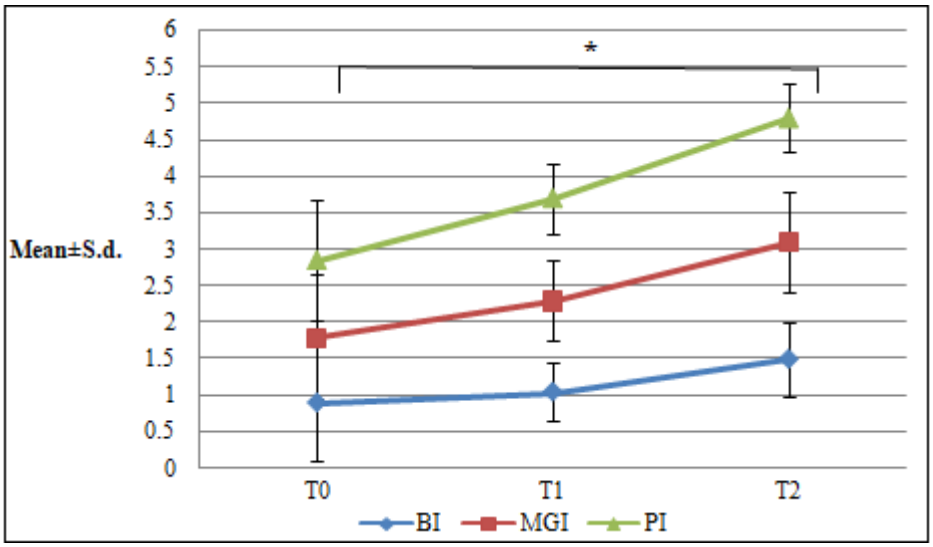
*Significant p<0.05, ** Highly significant p<0.01, *** Very highly significant p<0.001, NS not significant p>0.05



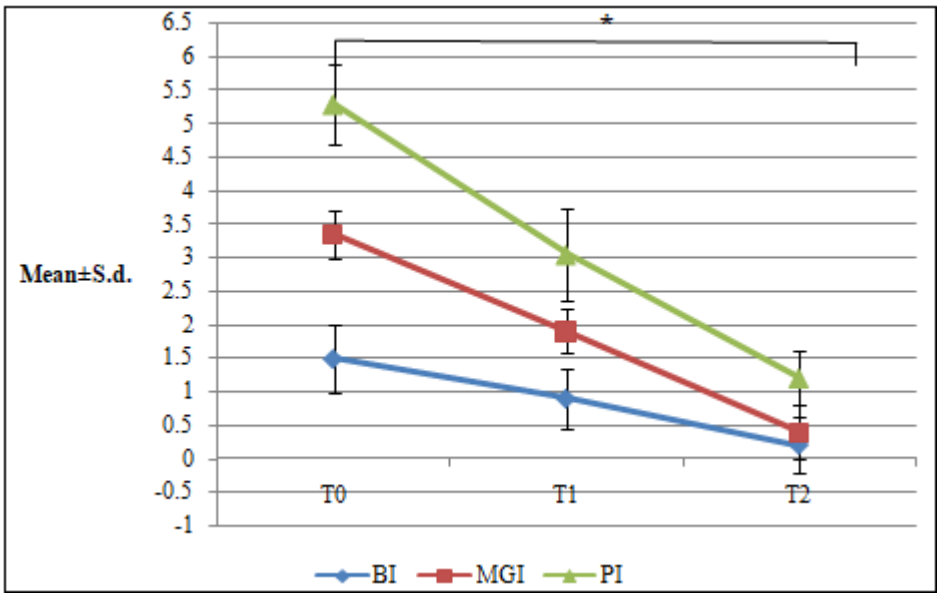
Graph 4: Comparison of MGI between two groups at different time intervals
*Significant p<0.05, ** Highly significant p<0.01, *** Very highly significant p<0.001, NS not significant p>0.05



Graph 5: Comparison of PI between two groups at different time intervals
*Significant p<0.05, ** Highly significant p<0.01, *** Very highly significant p<0.001, NS not significant p>0.05



Graph 6: Intra group comparison of BI, MGI and PI between different time intervals of Group I
*Significant p<0.05, ** Highly significant p<0.01, *** Very highly significant p<0.001, NS not significant p>0.05



Graph 7: Intra group comparison of BI, MGI and PI between different time intervals of Group II
*Significant p<0.05, **Highly significant p<0.01, *** Very highly significant p<0.001, ^{NS} not significant p>0.05

5. Discussion

Patients undergoing fixed orthodontic treatment are more prone to gingival inflammation because fixed orthodontic appliances are bulky and create a favorable environment for plaque accumulation.[34] Mechanical plaque removal poses a challenge for orthodontic patients and different strategies have been implemented in order to control plaque formation, prevent the development of gingivitis and maintain oral health.[34]Santos A[35] in his study on control of plaque and gingivitis concluded that oral hygiene status significantly improved when antibacterial mouthrinses were added to the daily oral hygiene regimen compared with tooth brushing alone. More specifically, chemotherapeutic agents with antimicrobial properties, such as 0.12% chlorhexidine (CHX), have been proposed as an adjunct to the standard oral hygiene protocol.[38] However, prolonged use of these agents has been associated with side effects, such as hypersensitivity reactions, burning sensation and changes in taste and cause extrinsic tooth stains.[12] Another potential approach for the management of oral health in orthodontic patients is the use of essential-oil containing mouthwashes due to their antimicrobial and anti-inflammatory properties.[20]

The bactericidal efficacy of Listerine, an essential oil-containing mouthrinse, has long been recognized. The clinical benefits associated with the bactericidal activity of Listerine include prevention and reduction of supragingival plaque and gingivitis, and decreased intrinsic oral malodor, without an increase in extrinsic tooth staining.[14,17,18,31] Although rinsing with Listerine should not replace standard oral hygiene regimen, it could be an efficient adjunct to brushing in orthodontic patients who struggle to maintain their oral hygiene in the presence of fixed appliances.[7,10,11]

It has been shown that oral hygiene deteriorates in as little as 2 to 3 weeks after plaque accumulation and significantly improves when Listerine mouthrinse is added to daily oral hygiene regimen.[38] Akbulut Y[2] described that the short term effect (3 weeks) of Listerine mouthrinse on plaque demonstrated that additional rinsing helped in reducing plaque and gingivitis.Similarly long term studies by Gordon JM et al[21] concluded that Listerine mouthrinse significantly reduced the development of plaque at 1, 3, 6 and 9 months and the development of gingivitis at 9 months.

Our study evaluated the effect of Listerine mouthrinse in orthodontic patients when added to their routine oral hygiene regimen (brushing) over a 6-month period.

The sample was equally divided into 2 groups of 20 subjects each. (**Table 1; Graph 1**) The patients were allocated to the 2 groups in an alternate manner.

The distribution of male: female ratio in Group I was 40% : 60% and in Group II was 30% : 70 % (**Table 2; Graph 2**). There was more percentage of females in both the groups because generally more females opt for orthodontic treatment. Although many epidemiologic surveys have shown that gingivitis is more prevalent in males than in females, few studies have clearly explained what causes this difference. FurutaM et al[19] concluded sex-based differences in gingivitis in young people can be explained by oral health behaviors and hygiene status, which are influenced by lifestyle, knowledge and attitude. Females have greater knowledge, a more positive attitude, a healthier lifestyle, and higher level of oral health behaviors than males. The BI, MGI, and PI scores (**Table 6, Table 7**) in Group I and Group II between males and females at (T0), (T1) and (T2) were not significantly different in our study. (P >.05).

In our study in Group I (45% patients were in age range of 13-15 and 55% in age range of 17-23) and in Group II (30% patients were in age range of 13-15 and 70% were in age range of 17-30). In both the groups percentage of younger patients was less than older ones, and Group II had lower scores of BI, MGI and PI which tended to have more adults than Group I. Wiess J and Eiser HM[40] have shown that young patients were more compliant and cooperative than older ones. Albino JE et al[3] and Bartsch A et al[6] found no correlation with age. Studies by Mehra T et al[26] on

predicting patient compliance reported that cooperation levels varied considerably depending on the patient's age and sex, perception of malocclusion, influence of parents on the child, personality type, and socioeconomic factors.

In our study Group II (Rinse group) showed significant improvement in oral hygiene which is possibly the result of greater compliance and not the age factor because this group was inadvertently more closely monitored. Intra group comparison between younger and older patients did not show any significant differences in the BI, MGI and PI scores. Compliance with rinsing in the Group II (Rinse group) was monitored and reinforced by having participants return back empty bottles on a monthly basis and suggested that the patients were compliant with the given instructions.

In our study BI, MGI, and PI scores for each oral hygiene regimen protocol was measured at three time points (**Table 4**). The measurements at (T0) were significantly different between the two groups BI ($P < 0.05$), MGI ($P<0.01$), PI ($P <0.01$) the scores being more for Group II (Rinse group). This was not intentional and it may have been just by chance. The measurements at (T1) were not significantly different between the two groups. ($P >.05$) This was to be expected as suggested by Gorelick L et al[22] and Alexander SA[4] that tooth brushing becomes more challenging in the presence of the orthodontic appliances. At T2, subjects in the rinse group had statistically significantly lower mean BI ($P < 0.001$), MGI ($P<0.001$), and PI ($P <0.001$) scores than the subjects in the Control group. Mean BI, MGI, and PI scores remained significantly different between the groups ($P<0.001$) at (T2). Tufekci E et al[38] reported similar reduction of scores at T2 in rinse group.

The intra group comparison of scores between two time intervals were measured (**Table 5**). The difference of BI, MGI and PI between (T0) and (T1) of Group I (Control group) were not significant, ($p>0.05$) and between (T0) and (T2) and between (T1) and (T2) were significant, ($p<0.05$) The scores of BI, MGI and PI significantly increased from (T0) to (T2) (**Graph 6**). The increased scores of BI, MGI and PI in Group I indicate worsening of oral hygiene due to difficulty in brushing because of the presence of brackets, bands, wires, and elastomeric ligatures.[4,22]This may be indicative of the fact that the patients are generally more compliant in the beginning of treatment and gradually the degree of compliance to maintenance of oral hygiene wanes with passage of time and needs to be reinforced at every visit.

The difference of BI, MGI and PI in Group II (Rinse group) (**Table 5**) between (T0) and (T1), (T0) and (T2), (T1) and (T2) were significant, $p<0.001$. The scores of BI, MGI and PI significantly decreased from (T0) to (T2) (**Graph 7**). All patients were given specific instructions on oral hygiene at the beginning of treatment, and all patients were also provided with oral-B toothbrushes, but since the Group II had an additional regimen of Listerine mouthwash twice daily, it may have had a positive reinforcement on their oral hygiene maintenance.

Intra group comparison of BI, MGI and PI between males and females of Group I and Group II at three time intervals was measured (**Table 6, Table 7**). It shows BI, MGI, and PI scores in Group I and Group II between males and females at (T0), (T1) and (T2) were not significantly different ($P >.05$).

In our study, there was a continuous increase in the BI, MGI, and PI scores for Group I (**Graph 6**), and continuous decrease in the BI, MGI, and PI scores for Group II (**Graph 7**). Tufekci E et al,[38]Alves et al,[5] Chen et al[12] and Akbulut[2] in their studies evaluating use of Listerine in orthodontic patients also showed BI, MGI and PI scores were significantly higher in the group that did not use a mouthwash compared with the group that used Listerine mouthrinse.

Furthermore, Charles CH et al, [11]Bauroth K et al[7] and Charles CA et al[10] in their studies evaluating the use of Listerine in non-orthodontic subjects, showed BI, MGI, and PI scores were significantly improved compared with baseline values.

Although the evidences by Charles CH et al[11] suggests that use of Listerine reduces plaque and gingivitis, it is possible that the reduced plaque and gingivitis in Group II (Rinse group) was attributable to ''enhanced hygiene awareness'' because of the added step of rinsing with Listerine. Patients who rinsed with Listerine in addition to their standard oral regimen might have been motivated to care for their teeth more meticulously than the patients who used only brushing. The lower mean scores in BI, MGI, and PI measurements may also have been attributable to the mechanical effect of rinsing alone. However, results from previous studies by Charles CH et al,[11]Bauroth K et al,[7] and Charles CH et al[10] that used a placebo mouthrinse for control-group patients support bactericidal efficacy rather than any mechanical effect as the source of reduction in scores in experimental subjects.

The results of our study demonstrated that the use of Listerine mouthrinse provided significant reductions in the amount of plaque and gingivitis compared with the control group. Use of Listerine in addition to the standard oral hygiene regimen was found to be beneficial for orthodontic patients in maintaining proper oral health.

The limitations of the study are that the methods of measuring the indices are subjective and may vary with the expertise of the operator. An involvement of a periodontist for evaluating the indices would have improved the reliability. Another limitation of the study is that one group was more closely monitored than the other group which may have led to better oral hygiene rather than the effect of Listerine alone.

Further studies need to be done where the samples are closely matched for the oral hygiene status, age, sex and attitude towards orthodontic treatment. Further studies should also be conducted to assess whether Listerine mouthwash can be continued over a longer durations as the orthodontic treatment can typically last upto two years.

List of Abbreviations

BI: Bleeding Index.
MGI: Modified Gingival Index.
PI: Plaque Index.
SPSS: Statistical Package for Social Sciences.
SD: Standard Deviation.
C. I: Confidence Interval.
Group I: Control Group
Group II: Rinse Group.

Trade name

Listerine (Johnson & Johnson pvt ltd India)

References

[1] **Ainamo J**. Control of plaque by chemical agents. Journal of Clinical Periodontology. 1977 Dec;4(5):23-35.
[2] **Akbulut Y**. The effects of different antiseptic mouthwash on microbiota around orthodontic mini-screw. Nigerian journal of clinical practice. 2020 Nov;23(11):1507-13.
[3] **Albino JE, Lawrence SD, Lopes CE, Nash LB, Tedesco LA**. Cooperation of adolescents in orthodontic treatment. Journal of behavioral medicine. 1991 Feb 1;14(1):53-70.
[4] **Alexander SA**. The effect of fixed and functional appliances on enamel decalcifications in early Class II treatment. American Journal of Orthodontics and Dentofacial Orthopedics. 1993 Jan 1;103(1):45-7.
[5] **Alves KM, Goursand D, Zenobio EG, Cruz RA.** Effectiveness of procedures for the chemical-mechanical control of dental biofilm in orthodontic patients. J Contemp Dent Pract. 2010 Mar 1;11(2):41-8.
[6] **Bartsch A, Witt E, Sahm G, Schneider S**. Correlates of objective patient compliance with removable appliance wear. American Journal of Orthodontics and Dentofacial Orthopedics. 1993 Oct 1;104(4):378-86.
[7] **Bauroth K, Charles CH, Mankodi SM, Simmons K, Zhao Q, Kumar LD**. The efficacy of an essential oil antiseptic mouthrinse vs. dental floss in controlling interproximal gingivitis: A comparative study. The Journal of the American Dental Association. 2003 Mar 1;134(3):359-65.
[8] **Beyth N, Redlich M, Harari D, Friedman M, Steinberg D**. Effect of sustained-release chlorhexidine varnish on Streptococcus mutans and Actinomycesviscosus in orthodontic patients. American journal of orthodontics and dentofacial orthopedics. 2003 Mar 1;123(3):345-8.
[9] **Bloom RH, Brown LR**. A study of the effects of orthodontic appliances on the oral microbial flora. Oral Surgery, Oral Medicine, Oral Pathology. 1964 May 1;17(5):658-67.
[10] **Charles CA, McGuire JA, Sharma NC, Qaqish J**. Comparative efficacy of two daily use mouthrinses: randomized clinical trial using an experimental gingivitis model. Brazilian oral research. 2011;25:338-44.
[11] **Charles CH, Sharma NC, Galustians HJ, Qaqish J, McGuire JA, Vincent JW**. Comparative efficacy of an antiseptic mouthrinse and an antiplaque/antigingivitis dentifrice: A six-month clinical trial. The Journal of the American Dental Association. 2001 May 1;132(5):670-5.
[12] **Chen Y, Wong RW, Seneviratne CJ, Hagg U, McGrath C, Samaranayake LP.** The effects of natural compounds-containing mouthrinses on patients with fixed orthodontic appliance treatment: clinical and microbiological outcomes. International journal of paediatric dentistry. 2013 Nov;23(6):452-9.
[13] **Dagli N, Dagli R, Mahmoud RS, Baroudi K.** Essential oils, their therapeutic properties, and implication in dentistry: A review. Journal of International Society of Preventive & Community Dentistry. 2015 Sep;5(5):335.
[14] **DePaola LG, Overholser CD, Meiller TF, Minah GE, Niehaus C**. Chemotherapeutic inhibition of supragingival dental plaque and gingivitis development. Journal of clinical periodontology. 1989 May;16(5):311-5.
[15] **Dolinska E, Stokowska W**. Short time effect of elmex and Listerine mouthrinses on plaque in 12-year-old children. Advances in medical sciences. 2006 Jan 1;51:73-6.
[16] **Faria TR, Furletti-Goes VF, Franzini CM, De Aro AA, De Andrade TA, Sartoratto A, De Menezes CC**. Anti-inflammatory and antimicrobial effects of Zingiberofficinale mouthwash on patients with fixed orthodontic appliances. American Journal of Orthodontics and Dentofacial Orthopedics. 2021 Jan 1;159(1):21-9.
[17] **Fine DH, Mendieta C, Barnett ML, Furgang D, Meyers R, Olshan A, Vincent J**. Efficacy of preprocedural rinsing with an antiseptic in reducing viable bacteria in dental aerosols. Journal of periodontology. 1992 Oct;63(10):821-4.
[18] **Fine DH, Yip J, Furgang D, Barnett ML, Olshan AM, Vincent J.** Reducing bacteria in dental aerosols: Pre-procedural use of an antiseptic mouthrinse. Journal of the American Dental Association (1939). 1993 May 1;124(5):56-8.
[19] **Furuta M, Ekuni D, Irie K, Azuma T, Tomofuji T, Ogura T, Morita M**. Sex differences in gingivitis relate to interaction of oral health behaviors in young people. Journal of periodontology. 2011 Apr;82(4):558-65.
[20] **Goes P, Dutra CS, Lisboa MR, Gondim DV, Leitao R, Brito GA, Rego RO**. Clinical efficacy of a 1% Matricaria chamomile L. mouthwash and 0.12% chlorhexidine for gingivitis control in patients undergoing orthodontic treatment with fixed appliances. Journal of oral science. 2016;58(4):569-74.
[21] **Gordon JM, Lamster IB, Seiger MC**. Efficacy of Listerine antiseptic in inhibiting the development of plaque and gingivitis. Journal of clinical periodontology. 1985 Sep;12(8):697-704.
[22] **Gorelick L, Geiger AM, Gwinnett AJ**. Incidence of white spot formation after bonding and banding. American journal of orthodontics. 1982 Feb 1;81(2):93-8.

[23] **Hildebrandt GH, PapeJr HR, Syed SA, Gregory WA, Friedman M**. Effect of slow-release chlorhexidinemouthguards on the levels of selected salivary bacteria. Caries research. 1992;26(4):268-74.
[24] **Lundstrom F, Krasse BO**. Caries incidence in orthodontic patients with high levels of Streptococcus mutans. The European Journal of Orthodontics. 1987 Jan 1;9(1):117-21.
[25] **Mandel ID**. Chemotherapeutic agents for controlling plaque and gingivitis. Journal of clinical periodontology. 1988 Sep;15(8):488-98.
[26] **Mehra T, Nanda RS, Sinha PK**. Orthodontists assessment and management of patient compliance. The Angle Orthodontist. 1998 Apr;68(2):115-22.
[27] **Mitchell L**. Decalcification during orthodontic treatment with fixed appliances—An overview. British Journal of Orthodontics. 1992 Aug 1;19(3):199-205.
[28] **Mizrahi E**. Enamel demineralization following orthodontic treatment. American journal of orthodontics. 1982 Jul 1;82(1):62-7.
[29] **O'reilly MM, Featherstone JD**. Demineralization and remineralization around orthodontic appliances: an in vivo study. American Journal of Orthodontics and Dentofacial Orthopedics. 1987 Jul 1;92(1):33-40.
[30] **Ogaard B**. Prevalence of white spot lesions in 19-year-olds: A study on untreated and orthodontically treated persons 5 years after treatment. American Journal of Orthodontics and Dentofacial Orthopedics. 1989 Nov 1;96(5):423-7.
[31] **Quigley GA, Hein JW**. Comparative cleansing efficiency of manual and power brushing. The Journal of the American Dental Association. 1962 Jul 1;65(1):26-9.
[32] **Sakamaki ST, Bahn AN**. Effect of orthodontic banding on localized oral lactobacilli. Journal of dental research. 1968 Mar;47(2):275-9.
[33] **Saloum FS, Sondhi A**. Preventing enamel decalcification after orthodontic treatment. The Journal of the American Dental Association. 1987 Aug 1;115(2):257-61.
[34] **Santamaria M, Petermann KD, Vedovello SA, Degan V, Lucato A, Franzini CM.** Antimicrobial effect of Melaleucaalternifolia dental gel in orthodontic patients. American Journal of Orthodontics and Dentofacial Orthopedics. 2014 Feb 1;145(2):198-202.
[35] **Santos A**. Evidence-based control of plaque and gingivitis. Journal of clinical periodontology. 2003 Jun;30:13-6.
[36] **Saxton CA, Van der Ouderaa FJ**. The effect of a dentifrice containing zinc citrate and triclosan on developing gingivitis. Journal of Periodontal Research. 1989 Jan;24(1):75-80.
[37] **Scheie AA, Arneberg P, Krogstad O**. Effect of orthodontic treatment on prevalence of Streptococcus mutans in plaque and saliva. European Journal of oral Sciences. 1984 Jun;92(3):211-7.
[38] **Tufekci E, Casagrande ZA, Lindauer SJ, Fowler CE, Williams KT.** Effectiveness of an essential oil mouthrinse in improving oral health in orthodontic patients. The Angle Orthodontist. 2008 Mar;78(2):294-8.
[39] **Von der Fehr FR, Loe H, Theilade E**. Experimental caries in man. Caries Res. 1970;4:131-48.
[40] **Weiss J, Eiser HM**. Psychological timing of orthodontic treatment. American Journal of Orthodontics. 1977 Aug 1;72(2):198-204.
[41] **Williams P, Fenwick A, Schou L, Adams W**. A clinical trial of an orthodontic toothbrush. The European Journal of Orthodontics. 1987 Jan 1;9(1):295-304.
[42] **Winska, K, Maczka W, Lyczko J, Grabarczyk M, Czubaszek A, Szumny A**. Essential Oils as Antimicrobial Agents - Myth or Real Alternative? Molecules 2019 Jan; 24(11):2130.
[43] **Zabirunnisa M, Gadagi JS, Gadde P, Myla N, Koneru J, Thatimatla C.** Dental patient anxiety: Possible deal with Lavender fragrance. Journal of research in pharmacy practice. 2014 Jul;3(3):100.
[44] **Zachrisson BU, Zachrisson S**. Caries incidence and orthodontic treatment with fixed appliances. European Journal of Oral Sciences. 1971 Apr;79(2):183-92.