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THE INFLUENCE OF DIFFERENT TYPES OF BRACKETS AND EFFICACY OF TWO CHLORHEXIDINE MOUTHWASHES ON ORAL HYGIENE AND THE INCIDENCE OF WHITE SPOT LESIONS IN ADOLESCENTS DURING THE ORTHODONTIC THERAPY

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SUMMARY

Background: *To detect the effect of two different types of brackets (ceramic and stainless steel) and investigate the effectiveness of two chlorhexidine mouthwashes 0.2% (CHX) on oral hygiene status and incidence of white spot lesions (WSLs) in adolescents wearing fixed orthodontic appliance.*

Subjects and methods: *One hundred and twenty subjects (aged 11 to 18 years, mean age 14.5 years) were divided into six equal groups according to brackets type and to different mouthwashes: Group 1: metal brackets and conventional CHX, Group 2: metal brackets and CHX with anti-discoloration system (CHX-ADS), Group 3: ceramic brackets and conventional CHX, Group 4: ceramic brackets and CHX-ADS, Group 5: metal brackets and water correction flavors mouthwash (placebo), Group 6: ceramic brackets and placebo. Four weeks after the placement of fixed orthodontic appliance the subjects were provided with three different mouthwashes for use during the next two weeks. Assessment was carried out according to oral hygiene index-simplified (OHI-S) and WSL index performed: prior to placement of the appliance (baseline), four weeks, six weeks, eighteen weeks, and thirty weeks after the placement. The data were then subjected to statistical analysis.*

Results: *Group 4 showed reduction in the OHI-S scores when compared to the Group 5 (in the 6th week), and Group 6 (in the 6th and 18th week), which was statistically significant, P<0.05. Group 4 showed decrease in the WSLs scores when compared to the Group 1 (in the 4th, 6th, 18th and 30th week), Group 5 (in the 18thand 30th week) and Group 6 (in the 6th, 18th and 30th week), which was statistically significant, P<0.05.*

Conclusion: *The ceramic brackets and the usage of CHX-ADS resulted in better oral hygiene status and lower incidence of WSLs.*

Key words: *chlorhexidine – mouthwash - orthodontic bracket - oral hygiene - white spot lesion*

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INTRODUCTION

Plaque accumulation is increased in orthodontic treatment with fixed appliances (Alves et al. 2008, Toroglu et al. 2003). Compound form of fixed orthodontic appliances contributes to retention of supragingival plaque due to reduced effectiveness in self-cleaning and oral measures of hygiene (Smiech-Slomkowska et al. 2007). Deficient removal of supragingival plaque can possibly cause development of initial caries lesions in area around bands and brackets, white spot lesions (WSLs) (Chadwick et al. 2005). WSLs have been described as "subsurface porosity of enamel from carious demineralization" that is placed on smooth surfaces, presenting as "a milky white opacity" as a result of significant changes in the optical enamel properties (Bishara & Ostby 2008). After the therapy with fixed orthodontic appliances demineralization of enamel can appear in up to 50% of patients (Årtun & Brobakken 1986). The potency of WSLs is to develop in a period of 4 weeks of inception of the orthodontic treatment, however development of the initial process of demineralization to a carious lesion mainly lasts about 6 months (Livas et al. 2008). WSL seem to accompany the interaction of quite a few factors including inadequate dental plaque elimination due to intrabuccal appliances that restrict the self-cleansing mechanism (Hadler-Olsen et al. 2012). During the last few years the popularity of ceramic brackets has evolved due to increased request for greater esthetics during the orthodontic treatment. It is of great interest to recognize possible variations in dental plaque retention on different bracket materials, in favor of decreasing the risk of side effects appearance of such therapy (Jurela et al. 2013). An impact of used bracket material affects the formation of the intraoral biofilm as well as properties of the surface brackets used in clinical practice (Anhoury et al. 2002). Consideration of adolescents following orthodontic treatment as high-risk patients implies the fact that they need more motivation and

hygiene control (Chaussain et al. 2010). It has been shown that useful adjuncts in controlling of the plaque for orthodontic patient were chemical agents such as chlorhexidine (CHX) (Sekino et al. 2003). CHX mouthwash is considered as the gold standard (Zanatta et al. 2010). It has side effects such as brownish teeth, discoloration dorsum of the tongue and taste perturbation (Prasad et al. 2015). Recently, in dental clinical practice the advanced version of CHX with anti discoloration system (CHX-ADS) is present. CHX-ADS avoids the side effect of staining aside from maintenance of its antiseptic qualities (Bernardi et al. 2004).

The aim of this clinical study was to detect the effect of two different types of brackets (ceramic and stainless steel) and investigate the effectiveness of two chlorhexidine mouthwashes on oral hygiene status and incidence of WSLs in adolescents wearing fixed orthodontic appliance. The first null hypothesis was that stainless steel and ceramic brackets show no influence on oral hygiene status and incidence of WSLs. The second null hypothesis of the study was that two different CHX mouthwashes show no differences in the effectiveness of reducing the incidence of WSLs and improving oral hygiene in adolescents undergoing fixed orthodontic treatment.

SUBJECTS AND METHODS

One hundred and twenty subjects (aged 11 to 18 years, mean age 14.5 years) were included in this prospective clinical study. The subjects had to satisfy the following inclusion criteria: indication for fixed orthodontic treatment, no antibiotic intake or use of antibacterial mouthwashes in previous three months, good general health and nonsmoking. Prior to beginning of orthodontic treatment, the patients were given oral hygiene instructions. They were instructed to maintain regular oral hygiene, which include daily tooth brushing in addition to interdental cleaning aids (dental floss or interdental tooth brushes). The ethics committee approved the study, and a written informed consent was obtained from the participants and their parents. The subjects were divided into 6 equal groups according to brackets type and to different mouthwashes:

Group 1: Metal brackets and conventional CHX;

Group 2: Metal brackets and CHX –ADS;

Group 3: Ceramic brackets and conventional CHX;

Group 4: Ceramic brackets and CHX –ADS;

Group 5: Metal brackets and placebo;

Group 6: Ceramic brackets and placebo.

There were used: metal - stainless steel brackets (Ortho Classic; Mini Twin, Oregon, USA), received ceramic brackets (3M Unitec; Clarity, Monrovia, USA). All arch wires were ligated using stainless steel ligatures (Dentaurum, Ispringen, Germany).

Four weeks after the placement of fixed orthodontic appliance the subjects were provided with two different CHX mouthwashes and placebo for use during the next two weeks. Ten mL of each mouthwash were used twice daily. Mouthwashes were supplied in coded bottles containing 125 ml. The placebo, water correction flavors mouthwash, was identically supplied. The subjects were blinded to the used mouthwash. They were instructed to avoid drinking and eating for 30 minutes after rinsing (Kulkarni & Damle 2003).

The following parameters were measured:

- oral hygiene status - by using the oral Hygiene Index - Simplified (OHI-S) (Greene & Vermillion 1964),
- the incidence of WSLs- by using the WSL index (Gorelick et al.1982).

The mean scores for OHI-s and WSL index were calculated.

All clinical measurements were performed by the same examiner at five time points: prior to the placement of the fixed orthodontic appliance (baseline), four weeks after the placement of the fixed orthodontic appliance (the subjects were given a mouthwash), six weeks after the placement (after two weeks of rinsing), eighteen weeks after the placement and thirty weeks after the placement of the fixed orthodontic appliance.

The data were analyzed by SPSS 17.0 software (SPSS Inc, Chicago, Ill). The multivariate analysis of variance (MANOVA) was conducted to assess differences on mean the OHI-S and WSL index scores across the two types of orthodontic brackets and the three types of mouthwashes. Tukey HSD test and Games-Howell test were used for post hoc analyses.

RESULTS

One hundred and twenty subjects (aged 11 to 18 years, mean age 14.5 years) participated in this study. The mean OHI-S and WSL index scores among the groups of adolescents with different types of orthodontic brackets and used types of mouthwashes was compared at baseline, 4 weeks, 6 weeks, 18 weeks and 30 weeks after the placement of the appliance are presented in Table 1. and Table 2.

The MANOVA analysis confirmed that we have a significant multivariate effect for combined dependent variables of OHI-S and WSL index scores in respect of Groups: $\lambda_{OHI\text{-}S}=0.612$, $F_{OHI\text{-}S}$ $(25,410)=2.317$, $p<0.001$; $\lambda_{WSL}=0.680$, F_{WSL} $(20,369)=2.279$, $p<0.05$. Partial Eta Squared for OHI-S scores is 0.093, which, according to generally accepted criteria is considered as a medium effect. This represents 9.3 percent of variance in OHI-S scores explained by Groups. Partial Eta Squared for WSL index scores is 0.093, which, according to generally accepted criteria is considered as a medium effect. This represents 9.2 percent of variance in WSL scores explained by Groups.

Table 1. OHI (S) score at baseline (B), 4 weeks, 6 weeks, 18 weeks and 30 weeks after the placement of the appliance

OHI-S	n	Mean					Std. Deviation				
		B	4 weeks	6 weeks	18 weeks	30 weeks	B	4 weeks	6 weeks	18 weeks	30 weeks
Group 1	20	0.51	0.89	0.69	0.75	0.91	0.24	0.24	0.36	0.42	0.39
Group 2	20	0.52	0.87	0.64	0.71	0.86	0.22	0.33	0.37	0.07	0.32
Group 3	20	0.50	0.80	0.63	0.68	0.71	0.25	0.59	0.46	0.50	0.27
Group 4	20	0.47	0.73	0.43	0.51	0.63	0.20	0.58	0.35	0.55	0.43
Group 5	20	0.51	0.77	0.90	0.94	0.95	0.30	0.42	0.37	0.37	0.45
Group 6	20	0.58	0.78	0.90	0.96	0.96	0.43	0.40	0.34	0.36	0.45
Total	120	0.52	0.81	0.70	0.76	0.84	0.28	0.44	0.40	0.43	0.41

Table 2. WSL score at baseline (B), 4 weeks, 6 weeks, 18 weeks and 30 weeks after the placement of the appliance

WSL	n	Mean					Std. Deviation				
		B	4 weeks	6 weeks	18 weeks	30 weeks	B	4 weeks	6 weeks	18 weeks	30 weeks
Group 1	20	0.00	0.22	0.23	0.25	0.25	0.00	0.12	0.11	0.14	0.14
Group 2	20	0.00	0.20	0.19	0.20	0.22	0.00	0.20	0.20	0.21	0.22
Group 3	20	0.00	0.17	0.17	0.18	0.18	0.00	0.09	0.10	0.10	0.10
Group 4	20	0.00	0.10	0.11	0.11	0.12	0.00	0.08	0.08	0.08	0.07
Group 5	20	0.00	0.16	0.26	0.29	0.30	0.00	0.15	0.21	0.22	0.22
Group 6	20	0.00	0.18	0.27	0.29	0.29	0.00	0.17	0.19	0.20	0.20
Total	120	0.00	0.17	0.20	0.22	0.23	0.00	0.14	0.16	0.18	0.18

Table 3. The statistically significant difference between groups on the mean OHI-S index score

Dependent Variable	Group	Group	Mean Difference	Std. Error	p
6 weeks	5	4	0.4680	0.11937	0.002
	6	4	0.4720	0.11937	0.002
18 weeks	6	4	0.4540	0.14800	0.045

Table 4. The statistically significant difference between groups on the mean WSL index score

Dependent Variable	Group	Group	Mean Difference	Std. Error	p
4 weeks	1	4	0.1200	0.03171	0.008
6 weeks	1	4	0.1195	0.03047	0.005
	6	4	0.1560	0.04659	0.028
18 weeks	1	4	0.1380	0.03623	0.008
	5	4	0.1815	0.05124	0.018
	6	4	0.1780	0.04883	0.014
30 weeks	1	4	0.1300	0.03569	0.013
	5	4	0.1765	0.05071	0.022
	6	4	0.1715	0.04828	0.018

Univariate independent one-way ANOVAs showed OHI-S scores in the 6th and 18th week after the placement of the appliance differed significantly in respect of Groups: OHI-S (in 6thweek): $F(5,114)=4.540$, $p=0.001$ ($p<0.01$); OHI-S (18 week): $F(5,114)=3.507$, $p=0.005$ ($p<0.01$). There was a minor violation in homogeneity of variance for OHI-S scores in the 18th week after the placement of the appliance. We examined those OHI-S scores in the 18th week scores again, using independent one-way ANOVA with Brown-Forsythe F and Welch's F adjustments. There is still a highly significant difference in OHI-S scores in the 18th week across Groups, Welch $(5,46.388)=3.633$, $p=0.007$ ($p<0.01$). The violation of homogeneity of variance poses no threat to the validity of our results.

Univariate independent one-way ANOVAs showed WSL index scores in the 18th and 30th week after the placement of the appliance differed significantly in respect of Groups: WSL (in 18th week): $F(5,114)=3.619$, $p=0.004$ ($p<0.01$); WSL (in 30th week): $F(5,114)=3.507$, $p=0.005$ ($p<0.01$). There was a minor violation in homogeneity of variance for WSL (in 18th week) and WSL (in 30th week) scores across groups. We examined those WSL scores again, using independent one-way ANOVA with Brown-Forsythe F and Welch's F adjustments. There is still a highly significant difference in

WSL (in 18thweek) scores across Groups, Welch (5,51.78)=5.929, p=0.000 (p<0.01). The violation of homogeneity of variance poses no threat to the validity of our results. There is still a highly significant difference in WSL (in 30th week) scores across Groups, Welch (5,51.47)=5.871, p=0.000 (p<0.01). The violation of homogeneity of variance poses no threat to the validity of our results.

Tukey post hoc analyses suggest that Group 5 (p=0.002) and Group 6 (p=0.002) had significantly higher OHI-S scores in the 6th week than Group 4; Group 6 (p=0.045) had significantly higher OHI-S scores in the 18th week than Group 4 (Table 3). Games-Howell post hot analyses suggest that Group 1 (in 4th week, p=0.008; in 6th week, p=0.005; in 18th week, p=0.008; in 30th week, p=0.013), Group 5 (in 18th week, p=0.018; in 30th week, p=0.022) and Group 6 (in 6th week, p=0.028; in 18th week, p=0.014; in 30th week, p=0.018) had significantly higher WSL score than Group 4 (Table 4).

DISCUSSION

The presence of fixed appliances on surfaces of teeth such as bands and brackets make cleaning of teeth more difficult and lead to the build-up of plaque and incidence of WSLs (Khalaf 2014). Upon completion of orthodontic therapy, detraction from greater esthetics is caused by presence of WSLs (Cai et al. 2003). During the orthodontic treatment precise evaluation of demineralized WSLs is of crucial interest for clinician to induce an early preventive regimen (Maxfield et al. 2012). In prevention of dental caries, the most effective documented antimicrobial agent is CHX (Catalbas et al. 2009). Problems regarding attitudes and habits in dental hygiene in orthodontic subjects have been previously mentioned (Rafe et al. 2006). The important fact in our investigation was that the format followed was that of our study, which was constructed for orthodontic patients, wearing their appliances for a long period of time and using a mouthwash during the testing period. We decided to measure OHI-Sand WSL index at five time points. The first, baseline, measurement was taken prior to the placement of the fixed orthodontic appliance. The second measurement was taken 4 weeks after the appliance placement. After the measurement the subjects were given a mouthwash. The third sets of measurements were taken 2 weeks after the using mouthwash or 6 weeks after the appliance placement. The fourth measurement was taken 18 weeks after the appliance placement, and the fifth measurement was taken 30 weeks after the appliance placement to assess the overall influence of the brackets and effect mouthwashes on oral hygiene and on incidence WSLs**.** OHI-S scores increased from baseline to the 4th week, decreased from 4th to 6th week, and increased to the last measurement. The results of our study revealed significantly lower OHI-S scores in the Group with ceramic brackets and using CHX–ADS when compared to the Group with metal brackets and using placebo (P<0.05) and the Group with ceramic brackets and using placebo (P<0.05). WSLs scores increased from baseline (it was 0) to the 4th week, after that increased all the time. Group with ceramic brackets and using CHX-ADS when compared to the Group with metal brackets and using conventional CHX showed a marked decreased in the WSLs score measured in the 4th, 6th, 18th and 30th week; when compared to the Group with metal brackets and using placebo showed a marked decreased in the 18th and 30th week, when compared to the Group with ceramic brackets and using placebo showed a marked decreased in the WSLs score measured in the 6th, 18th and 30th week was statistically significant (P<0.05). In results of our study it has been shown that plaque accumulation and WSLs are problem during the orthodontic treatment. Our results are in accordance with Øgaard et al. reveling that WSLs could become visible around the brackets in a period of 4 weeks of bonding (Øgaard et al. 1988). In this study all brackets were ligated using metal- stainless steel ligatures in order to avoid the influence of different ligation methods (Alves et al. 2008). Our findings are in accordance with some studies that discovered a higher plaque affinity to stainless steel brackets. Lin et al. indicated on corrosion of stainless steel brackets proving that surface of bracket change its characteristics over a period of time due to the wear from drink and food (Lin et al. 2006). Lindel at al. revealed that ceramic brackets appear to show advantageous material properties with regard to long-term bio-film formation (Lindel et al. 2011). The first null hypothesis about no influence of metal – stainless steel or ceramic brackets on oral hygiene status and incidence of WSLs was rejected because we found lower OHI-S and WSLs scores in subjects wearing ceramic brackets. Ristic et al. revealed that a period with the highest prevalence of oral microbiota in orthodontic patients was the period of 3 months after the appliance placement, which followed by decrease in the next 3 months (Ristic et al. 2007). So, during that period we were determined to use two different CHX mouthwashes and placebo to see if they can prevent the dental plaque formation and the incidence of WSLs. We found higher OHI-S and WSLs scores in subjects using placebo. The results of our study are in accordance with the findings of Zabokova-Bilbilova et al. who assess the effectiveness of a mouth rinse containing CHX. They suggested that the CHX mouth rinse showed superior effects than the normal home care for improving the appearance of WSLs (Zabokova-Bilbilova et al. 2015). And so, our crucial interest was to compare the efficiency of conventional CHX and CHX-ADS. The previous studies show different conclusions. No superior effects on oral hygiene in subjects using CHX-ADS were proved in

results of Li et al. (Li et al. 2014). Arweiler et al. revealed that conventional CHX showed superiority in inhibiting plaque re-growth and reducing vitality of bacteria in comparison with CHX-ADS (Arweiler et al. 2006). Addy et al. showed that CHX-ADS has the same anti-plaque effectiveness as the CHX rinse product (Addy et al. 2005). Our findings showed superiority of CHX-ADS in comparison with conventional CHX. Considering that CHX-ADS contains ascorbic acid and sodium metabisulfite, future research should be based on examination of their effects. The results of our study revealed lower OHI-S and WSLs scores in the subjects using CHX-ADS mouthwash. Therefore, the second null hypothesis was also rejected.

There were several limitations to this study. The lack of specific bacterial counts and different orthodontics appliances could be included in further study. Cooperation of subjects (in relation to maintenance of oral hygiene and use of mouthwashes) should be determined by questionnaire in future research. Also, esthetic satisfaction during wearing of fixed orthodontic appliances (ceramic-esthetic and stainless steel brackets) could have influenced the cooperation of subjects, so parameter from a psychological standpoint should be included in further research.

CONCLUSION

The ceramic orthodontic brackets as well as usage of CHX-ADS resulted with better oral hygiene status and reduced the incidence of white spot lesions.

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Conflict of interest : None to declare.

Contribution of individual authors:

All the authors contributed to the conception and writing of the article. Sanja Jurišić gave is definition of intellectual content, made design of the study and wrote the first draft. Davorin Kozomara gave part in statistical analysis and took part in interpretation and formatting of data. Hrvoje Jurić reviewed the manuscript drafts. Željko Verzak was included in literature searches and contributed in designing of the study. Gordan Jurišić participated in literature searches and interpretation of data.

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