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Efficacy of Nanosil and Listerine Antiseptics for Infection Control in Dental Unit Waterline

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Objectives The aim of this study was to compare the antibacterial efficacy of two antiseptic agents namely Nanosil and Listerine for controlling water contamination.

Methods A In this experimental study, six dental units were divided into three groups of A, B, and C. First, sampling of the water from the turbines' water ducts and the dental air-water sprays was performed early in the morning during two consecutive weeks on Saturdays (the first working day) and Wednesdays (the last working day). The samples were sent to a laboratory in sterile containers for bacterial colony counting. Next, group A and B units underwent decontamination once a week by Nanosil (1% hydrogen peroxide + silver ion) and Listerine, respectively. Group C was the control group. Afterwards, sampling was conducted again as in stage 1 to determine the bacterial colony count.

Results The Wilcoxon test indicated a statistically significant difference in the mean bacterial count between the samples taken before and after decontamination in Nanosil and Listerine groups, and the mean bacterial count was lower in the Nanosil group than in the Listerine group (P<0.001). A statistically significant difference was also found in the mean bacterial count between samples taken on Saturdays and Wednesdays before decontamination, and the mean bacterial count was higher on Saturdays than on Wednesdays (P<0.001).

Conclusion Both Listerine and Nanosil were effective in decreasing the microbial colony count in the dental unit water lines (DUWLs). The mean bacterial count was lower in the Nanosil group than in the Listerine group.

Keywords Hydrogen Peroxide; Disinfection; Listerine

Introduction

In dental office setting, dental unit is an essential equipment for dental treatment. Dental unit has water input and sewage output. Air is used to set up the rotational devices, air/water syringes, ultrasonic scaler, suction, etc.[1-3] The activity of the rotational devices connected to the unit, including the high-speed handpiece, leads to heat generation, which can damage the tooth. Thus, the output water of dental unit waterlines (DUWLs) in dental unit is used as a coolant for hand-pieces, scalers, and air/water sprays.[4]

DUWLs contain various microorganisms such as environmental microorganisms (e.g. Moraxella sp. and Flavobacterium sp.) and opportunistic and true human pathogens (e.g. Pseudomonas aeruginosa, Legionella pneumophila, Mycobacterium sp., Candida sp., Actinomyces sp., Streptococcus sp., and Staphylococcus sp.).[5] This suggests that bacteria in the outlet water may originate from the incoming tap water, suck-back of oral fluids from a patient, formation of biofilm, and internal tube surfaces within the DUWL. [5] Therefore, DUWL is a potential source of infection that puts patients and office staff at risk of infection. This issue is specifically important in susceptible individuals such as the elderly and immunocompromised patients.[6] Various authors have evaluated chemical decontamination using different disinfectants such as peracetic acid, hydrogen peroxide, silver salts, chloramine, glutaraldehyde, chlorhexidine, chlorine dioxide, EDTA, and sodium hypochlorite.[7-9] However, only few studies have been conducted in a dental office setting in this respect.[10, 11] Newer methods include ozonation of water, anti-retraction devices in dental turbines, and auto-flushing dental units. Apart from all the methods introduced for prevention of cross-contamination by DUWLs, chemical disinfection is a well-accepted, practical, cost-effective, and evidence-based method for this purpose.[12]

Nanosil combined with hydrogen peroxide and silver ion is effective because of its antimicrobial effect on microorganisms and biofilms. The released oxygen species destroy the protective membranes of the bacteria and viruses and render Nanosil capable of penetration, a mechanism through which microorganisms are destroyed. The hydrogen peroxide and silver ions have synergistic effects. Silver ions also make bacteria inactive by forming strong covalent bonds with bacterial proteins. Silver ion improves the oxidation of hydrogen peroxide. Their products are less toxic and mutagenic than chlorine products.[13, 14]

Listerine, a mouthwash that contains phenolic compounds such as thymol, eucalyptol, menthol, and methyl salicylate, has antiplaque and anti-gingivitis effects similar to chlorhexidine but does not have the unwanted side effects of chlorhexidine; yet, there have been some complaints about its taste.[15]

Considering the advantages of using these two substances, especially Nanosil, in comparison with other usable chemicals, this study was conducted to compare the

efficacy of two available and cost-effective antiseptic agents, Nanosil and Listerine, in reducing the microbial colony count in water collected from DUWLs through high-speed hand piece and air-water syringe.

Materials and Methods

In this experimental study, six dental units with municipal water and reservoir water without any periodic disinfecting procedure were randomly chosen. The units were divided into three groups (A, B and C), two units in each group. These units were randomly selected from the Endodontics Department of Kermanshah Dental School. The Ethics Committee of Kermanshah University of Medical Sciences approved this study (No.IR.KUMS.1395.703).

In the beginning of a work day, after 1 minute of water flushing, 10 mL water sample from the high-speed handpiece and 10 mL water sample from the air/water syringe were collected in sterile Falcon tubes and sent to a microbiology lab. The tip of the water syringe did not contact the Falcon tube. Sampling was performed during a 2-week period, twice per week on Saturdays (the first day of work) and Wednesdays (end of working day). In the microbiology lab, the Mueller Hinton agar culture medium was prepared and added to 20-cc test tubes. Then, they were autoclave-sterilized. Next, 1:10 ,1:100, and 1:1000 dilutions were prepared from each sample in sterile tubes, and 0.5 cc from each dilution was put in a sterile plate with Mueller Hinton agar added to it. After adding Mueller Hinton agar, the samples were mixed with circular movements and placed in an incubator at 37℃ for 47 hours. Finally, the number of colonies was determined by a counter. In group A units, 250 mL of Nanosil (1% hydrogen peroxide containing silver ions; Kimiafam pharmaceutical Co., Tehran, Iran) was added to the reservoir water. After 2 min of flushing with high-speed handpiece and circulating Nanosil in the unit water tubes, the unit water system was shut down and the solution remained in the water lines overnight for 15 hours. The reservoir tank was disconnected, the remaining disinfectants were thrown away, and the reservoir tank was refilled with water and connected to the unit. The unit system water was turned on and the remaining disinfectants in the unit tubes were thrown away by flushing. Then, sampling was done as mentioned earlier before disinfection. The samples were sent to a lab in sterile tubes. Finally, the number of colonies was determined. It should be noted that the disinfection process was done once a week. The disinfection process, time of using the disinfectants, and sampling method in group A units were exactly similar to group B except that in group B Listerine Coolmint® mouthwash (Johnson & Johnson; NJ, USA) was used in the reservoir tank. The group C units were considered as the control group. In this group, the sampling procedure was similar to that in the other two groups. The data were analyzed by SPSS version 24 (SPSS Inc., IL, USA). $P<0.05$ was considered statistically significant.

Results

A total of 96 samples were evaluated in this study, 32 samples in each study group. The Kolmogorov-Smirnov test showed that the variables were not normally distributed ($P>0.001$).

The results of the Kruskal-Wallis test showed no statistically significant difference in the mean number of bacteria between the study groups before disinfection ($P=0.841$), but a significant difference was observed between the three groups after disinfection ($P<0.001$). The mean number of bacteria was lower in the Nanosil group than in the Listerine and control groups (Table 1).

The results of Wilcoxon test showed a statistically significant difference in the number of bacteria between Saturday and Wednesday samples before disinfection. The number of bacteria was higher in Saturday samples than in Wednesday samples ($P<0.001$). Moreover, the results of Wilcoxon test indicated no statistically significant difference in the number of bacteria between Saturday and Wednesday samples after disinfection ($P=0.097$,Table 2). In addition, the Wilcoxon test showed a statistically significant difference in the number of bacteria between the high-speed hand-piece and water syringe before and after disinfection ($P<0.001$, Table 3).

Table 1- Comparison of bacterial colony count before and after disinfection in the study groups

Time	Control		Listerine		Nanosil		P-value**
	Med	IQR	Med	IQR		Med	IQR
Before Disinfection	230000	850000	240000	610000	**Before Disinfection**	230000	850000
After Disinfection	200000	330000	4100	14200	**After Disinfection**	200000	330000
P-value*	0.091	<0.001	<0.001		**P-value***	0.091	<0.001

Table 2- Comparison of bacterial colony count before and after disinfection in Saturday and Wednesday samples

	Before Disinfection		After Disinfection		P-value[a]	P-value[b]	P-value[c]	P-value[d]
	Saturday	Wednesday	Saturday	Wednesday				
Med	440000	140000	3500	5600	<0.001	0.097	<0.001	0.005
IQR	525000	196000	179580	129580				

Med: Median; IQR: Interquartile Range
[a]Comparison between Saturday and Wednesday samples before disinfection
[b]Comparison between Saturday and Wednesday samples after disinfection
[c]Comparison between before and after disinfection samples on Saturdays
[d]Comparison between before and after disinfection samples on Wednesdays

Table 3- Comparison of bacterial colony count before and after disinfection in high-speed handpiece and water syringe samples

	Hand-piece		Air water syringe		P-value[a]	P-value[b]	P-value[c]	P-value[d]
	Before Disinfection	After Disinfection	Before Disinfection	After Disinfection				
Med	242000.00	63451.00	629333.33	101977.83	<0.001	<0.001	<0.001	<0.001
IQR	102000	139870	308000	168700				

Med: Median; IQR: Interquartile Range.
[a]Comparison between before and after disinfection samples of high-speed handpiece
[b]Comparison between before and after disinfection samples of water syringe
[c]Comparison between high-speed hand-piece and water syringe samples before disinfection
[d]Comparison between high-speed handpiece and water syringe samples after disinfection

Discussion

The aim of this study was to compare the efficacy of two antiseptic agents namely Nanosil and Listerine for water disinfection in dental units. Dental care providers use tap water in treatment of patients. Evidence shows that untreated dental waterlines are highly contaminated. Water transfers directly through the dental unit and then into the high-speed hand-piece, air-water syringe, and scaler and enters the oral cavity.[16]

Based on the results of this study, there was a statistically significant difference in the mean number of bacteria before and after disinfection among the Nanosil, Listerine, and control groups such that the number of bacteria was lower in the Nanosil group than in Listerine and control groups. Walker et al.[5] and Schel et al.[11] showed that 0.02% H202 appears to be effective in complete elimination of colony forming units in DUWLs after 2 weeks. These results were in accordance with the findings of the present study.

The results of the current study were in agreement with those of a study carried out by Petti et al.[17] who investigated the use of Nanosil in DUWLs to decrease the colonization and growth of heterotrophic bacteria using the same methodology. Nanosil was active against planktonic pathogens in the human saliva and those in microbial biofilms. Similar results were reported by Coleman et al.[18] and Tuttlebee et al.[19] Coleman et al.[18] reported that using appropriate mouthwashes such as 0.1% chlorine dioxide and H_2O_2 before treatment can help to achieve high quality water in dental units and biofilm removal. Tuttlebee et al.[19] reported that two H2O2-based disinfectants were effective in reducing the bacterial load below the standard level recommended by the American Dental Association (200 colony forming units/mL). Alwarid et al.[20] evaluated the effect of alcohol and hydrogen peroxide on reduction of bacterial contamination in DUWLs. They found that hydrogen peroxide was more effective than alcohol. The higher efficacy of Nanosil (H2O2/Ag+) for microbial infection reduction is because hydrogen peroxide has been shown to possess a wide spectrum of antimicrobial activities. The activity of H_2O_2 against microorganisms is due to the presence of hydroxyl radicals (OH+) in the solution. Hydroxyl radicals are believed to be the strongest oxidant known. They can attack the membrane lipids, DNA, and other essential cell components. Some of the biofilm-forming cells are killed by the internally produced H_2O_2.[21]

Nanosil mouthwash has been shown to highly decrease the number of developed colonies, especially in anaerobic environments.[22] The lower efficacy of Listerine in the present study might be due to the fact that this substance has a small antimicrobial spectrum.[15]

In this study, Saturday (the beginning of the working week) and Wednesday (the end of the working week) samples were selected for sampling. The results showed that the mean number of bacteria was significantly higher in Saturday than in Wednesday samples before disinfection. In a study by Memarian et al.[23] sampling was done on Saturdays and midweek. They showed that contamination was higher on Saturdays than in the middle of the week, possibly because the unit was turned off during the weekends and water was stagnated inside the unit pipes. Samples taken from the air/water syringe showed a significantly higher contamination rate than the high-speed hand-pieces.

One limitation of this study was that the type of bacteria was not identified and evaluation of the biofilm production was not within the scope of this study. Therefore, further in vivo or in vitro studies should be carried out in areas like identification of microorganisms and effect of disinfectants on the biofilms present in DUWLs. This would help in adoption of more efficient disinfection procedures to improve DUWLs.

Conclusion

Nanosil disinfectant was more effective than Listrine. A limitation of this study was that the type of bacteria was not specified and the biofilm production was not within the scope of this study. Therefore, further in vivo or in vitro studies should be carried out in areas like identification of microorganisms and effect of disinfectants on the biofilms present in DUWLs. This would help in production of more effective disinfection procedures to improve DUWLs.

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Conflict of Interest

Non Declared ■

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