Innovations

A Study of the Effectiveness of Methods Used to Disinfect Dental Unit Water Lines

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Abstract
Contamination of dental water lines is a cause of concern in dentistry due to rapid development of biofilms within them. Through the years there have been reports regarding the involvement of water from dental chairs to be the suspected cause of afflictions in patients. This study was conducted to compare the disinfection of DUWL using 0.5% of Sodium Hypochlorite, 0.12 % Chlorhexidine Gluconate, Flushing with Distilled Water and Plain tap water. Their effect on bacterial load in DUWL was assessed by evaluating the Total colony count in the water lines. Disinfection with Sodium Hypochlorite proved to be the most effective method of all those analyzed in the present study. The data obtained by the study can be utilized to tailor make disinfection solutions of Dental unit water lines taking into consideration the local factors.
Keywords: *Dental unit water lines, Flushing, Disinfection, Sodium hypochlorite, Chlorhexidine*

Introduction

Infection control's primary goal is to lower the possibility that patients will come into contact with potential pathogens, resulting in a safe and healthy workplace. Dental professionals must establish, analyse, continuously Due to concerns over the possible spread of blood-borne infections and the effects of newly emerging, highly contagious respiratory and other illnesses, organisations update and monitor their infection prevention and control policies.

During dental procedures, the mouth cavity is irrigated and fluids are evacuated via dental unit water lines. Literature has demonstrated over time that the water delivered by these devices is not sterile and contains a lot of bacteria[1,2,3,4]. Dentistry is quite concerned about dental water line contamination because biofilms there are developing quickly. Microbial communities called biofilms form on solid surfaces when there is enough moisture. The majority of biofilms have a variety of species and morphologies. They are encased in a glycocalyx, a coating of polysaccharide slime.The glycocalyx shields the organisms inside against immune system attacks from both plants and animals as well as desiccation, chemical injury, and predation. Additionally, biofilms offer a setting that is favourable for the growth of numerous different types of microscopic life. Bacteria, fungi, and protozoa are among the microorganisms recovered from dental unit waterlines, according to Pankhurst et al[3].

Laminar flow of water through dental unit waterlines causes maximal flow at the lumen's centre and minimal flow at its edges, which promotes the deposition of organisms on the tubing's surface. Dental lines that are used seldom cause the entire water column to stagnate for long stretches of time during the day, which encourages additional unchecked bacterial growth. [2,4]

The water from the dental lines was originally observed to be contaminated by microbes by Blake [1]. [5] Smith et al. described pervasive microbial contamination of dental unit water lines that appeared unrelated to unit age and make, and they advised using sterile irrigants for surgical procedures[6].There have been instances, reported in literature and media, of unsafe practices in dental clinics raising worries about dental infection control procedures.[7, 8] James T. Walker et al[2]DUWL tube befouling and the microbiological load of water from DUWL in conventional dentistry clinics were examined. They came to the conclusion that decontamination techniques greatly decreased biofilm coverage [1].Introduction of patients to potentially contaminated water is not acceptable by the high standards of care in dental practice today and allowing this to happen is contradictory to the accepted principles of infection control. We critically need improved, scientifically supported, and workable strategies for reducing DUWL's microbial contamination. It has been advised to use a range of techniques to clean the DUWL, including flushing with water and chemical disinfection. [3,5]

Dental water treatment currently makes use of commercially available equipment and methods that incorporate chemical processing and microfiltration. Some of these proprietary equipment and solutions may not be ideal for all setups due to their expensive overhead, particularly the Developing countries must have affordable community-based clinics. Three of the practical and economical methods of disinfection were examined in this study the DUWL have been compared, and the suitability of the local tap water for the same purpose has also been examined.

The cleaning of Dental Unit Water Lines (DUWL) with 0.5% Sodium Hypochlorite, 0.12% Chlorhexidine Gluconate, Flushing with Distilled Water, and Regular Tap Water were contrasted in this study. To determine their effect on the amount of bacteria in DUWL, the total colony count discovered in the water lines was examined.

Materials and Methods

This study was carried out at the Manipal College of Dental Sciences in Mangalore's Department of Conservative Dentistry and Department of Pedodontics. The Institutional Ethics Committee of the Manipal College of Dental Sciences in Mangalore granted ethical permission for the project.

Water samples were taken from 21 dental units with closed circuit water systems' high speed handpiece and air/water syringe lines for each group. (Confident India, Model Chamundi). Using the various solutions, water samples were taken at baseline and after flushing. The study only included dental chairs with a closed circuit water supply. The study excluded dental chairs that use an external water source. The obtained samples were then examined by a microbiologist to determine the number of bacteria present.

For three minutes, tap water was flushed through the mouth rinse source, hand piece, and air/water syringe lines in Group 1. For three minutes, distilled water was used to flush the air/water syringe lines, handpiece, and oral rinse source in Group 2. For five seconds, the 0.12% Chlorhexidine Gluconate solution

was flushed through the air/water syringe lines, handpiece, and mouth rinse source in Group 3. Following an overnight soak in the lines, the solution was flushed for two minutes with distilled water.For five seconds, the 0.5% Sodium Hypochlorite Solution was flushed through the air/water syringe lines, handpiece, and mouth rinse source in Group 4. After the solution had been in the lines for 10 minutes, it was flushed for 2 minutes with distilled water.
The water containers were tagged and labelled so that the evaluators couldn't see what was inside. To calculate CFU/mL values, microbial culture was used.

Microbiological analysis:
The process used to decide how The treated water samples included large numbers of live, culturable heterotrophic bacteria, according to the heterotrophic plate count (HPC), formerly known as the standard plate count. All types of water contain heterotrophs, which include bacteria, moulds, and yeasts and utilise organic carbon sources to flourish. All types of water, food, soil, plant life, and air include these bacteria. Coliforms and primary and secondary bacterial illnesses are examples of heterotrophic bacteria. Serratia, Enterobacter, Klebsiella, Escherichia coli, and Citrobacter.Thus, the HPC test may be used to gauge the overall bacteriological quality of drinking water in semi-public, private, and public water systems. The HPC is useful for examining the finished water quality in a distribution system as well as for assessing the efficacy of various drinking water treatment methods.The samples were grown on nutritional agar medium (HIMEDIA). 0.1 ml of the purified water samples were plated using the spread plate method on Hi-Veg Agar culture media (HiMedia Laboratories, Mumbai, India). For 78 hours, the infected medium were incubated at 370C. The following formula was used to determine the colony forming units per millilitre (CFU/ml) of the water sample:

$$\text{CFU/ml} = \frac{\text{Number of colonies counted}}{\text{Volume of sample plated}}$$

Results
The tables 1 provide the comparative outcomes for all categories.An analysis of the colony counts in all the viewable groups revealed that the group using tap water had the highest colony count, followed by the groups using distilled water and chlorhexidine solution. In the group utilising sodium hypochlorite, the count was lowest. The maximum value for sodium hypochlorite was 22 CFU/ml and the maximum value for tap water was 338 CFU/ml, showing a significant difference in the values between the two groups.
The tap water group greatly outperformed all other study groups in terms of CFU/ml, as seen in table 2 by comparing the separate groups to one another. In comparison to the groups utilizing Chlorhexidine Gluconate and Sodium Hypochlorite, the group using distilled water demonstrated considerably higher CFU/ml. Comparing the Chlorhexidine Gluconate group to the Sodium Hypochlorite group, the former group displayed noticeably greater CFU/ml.
Kruskal Wallis one way analysis of variance was used to analyse the data in order to determine whether there was a significant difference between each group. The Mann Whitney 'U'test was used to examine how much the values in each group differed from one another. P value was established at 0.001.
The findings of the DUWL disinfection performed in this study show that 0.5% Sodium Hypochlorite, 0.12% Chlorhexidine Gluconate, and flushing with distilled water are the most effective treatments. It was discovered that flushing with tap water had no effect.

Discussion
One of the most widely used biocides in water treatment facilities is chlorine, specifically sodium hypochlorite[2]. It has demonstrated its effectiveness, particularly for reducing Legionella Proliferation, in cold water hospital systems [9,6]. Sodium hypochlorite is a strong disinfectant and antimicrobial. Its chlorination action has the potential to be a germ killer. As a result, sodium hypochlorite is always used to disinfect dental water units. Because it is affordable and widely available, sodium hypochlorite is

appropriate for routine usage in dental settings.The water used in dental units was examined microbiologically in a study by CinthiaRegianeKotaka et al. [7]. The researchers identified Gram-negative non-fermentative rods (GNNR) and tested their capacity to stick to polystyrene as well as the antimicrobial activity of disinfectants on the identified strains. They came to the conclusion that DUWL can be disinfected using sodium hypochlorite at 0.25%. [10]
Chlorhexidine is a crucial antibacterial, antiseptic, disinfectant, and preservative in clinical settings. It is an effective membrane-active agent against bacteria and suppresses bacterial spore outgrowth but not germination, making it non-sporicidal. The molecule's cationic character encourages interaction with an anionic component at the bacterial surface (phospholipids from lipopolysaccharide in Gram-negative bacteria and phosphate groups from teichoic acid in Gram-positive bacteria) and is capable of changing the integrity of that compound[11]. This substance is reasonably priced and easily accessible on the market. It has excellent substantivity and is a broad spectrum disinfectant. Chlorhexidine can be thought of as a substitute for Sodium Hypochlorite in order to avoid its caustic effects when used to disinfect dental water lines. Chlorhexidine alone and distilled water with Chlorhexidine were found to be the most successful in meeting the ADA guidelines when Kettering et al examined the performance of tap water and distilled water in combination with Chlorhexidine and bleach for sanitising dental water lines[12].By using time-dependent flushing (1 minute, 2 minutes), 0.12% Chlorhexidine Gluconate, distilled water, and tap water as water sources, Vatsala Singh et al. examined the impact of disinfecting dental unit waterlines on bacterial load. The best solution was discovered to be 0.12% chlorhexidine gluconate. [13]
One of the suggestions for cleaning the water pipes in dental units of germs was flushing. The CDC advises flushing water pipes for several minutes at the beginning of each clinic day to significantly reduce bacteria accumulation brought on by overnight stagnation in the waterline. Dental operations should be flushed for 2 minutes in the morning and for 20–30 seconds in between patients, according CDC recommendations from 1993 [8]. Despite the fact that several published infection control guidelines advise flushing with plain, clean water, investigations have shown that biofilms cannot be eliminated by flushing alone and that biofilm bacteria can quickly recontaminate treatment water.According to Rice et alassessment .'s of microbial contamination in clean water dental units, flushing handpieces with water to reduce bacterial counts is the most widely employed method of disinfection. When Santiago JI et al.[16] evaluated the immediate and long-term effects of flushing, they came to the conclusion that two minutes of flushing typically lowered the microbial concentrations in DUW. However, in some instances, concentrations increased while in others, the decreases were barely noticeable. As a result, additional preventative measures to reduce bacterial contamination in DUW should be put into place in accordance with the same general principles as other medical fluid delivery systems.
The group that used the local tap water had the most colonies, followed by the groups that used distilled water and 0.12% chlorhexidine solution, according to the study's findings. The lowest count was achieved by the 0.5% Sodium Hypochlorite group.The American Dental Association (ADA) and the Centers for Disease Control and Prevention (CDC) both consider levels within the 200 CFU/ml range to be acceptable14. All groups except the one utilising tap water displayed values within this range [9]. In this study, there was a very highly significant rise in the colony counts when comparing the tap water group to the distilled water group, demonstrating that the quality of the water in the public water lines may not always be suitable for flushing.

Conclusion:

In addition, it was found that cleaning the DUWL with water before use may not be a reliable method of disinfection. Of all the methods examined in the current investigation, disinfection with 0.5% sodium hypochlorite was shown to be the most effective.

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Table 1: Represents bacterial count in Colony Forming Units per ml from 21 samples for the four groups.

Tap Water	Distilled Water	Chlorhexidine Gluconate	Sodium Hypochlorite
68	45	5	4
78	11	2	4
180	28	6	2
62	42	8	6
70	28	18	2
65	15	25	11
111	3	7	3
117	38	17	2
87	31	8	0
42	42	2	5
59	36	17	8
180	33	37	0
338	54	13	0
120	94	4	1
56	73	13	4
94	22	12	22
60	66	52	1
108	31	34	10
70	48	43	5
83	44	27	13
102	70	55	2

Table 2: Shows Maximum values, Minimum values, Mean and Standard deviation for the four groups.
Descriptive analysis of the Colony counts

	N	Mean	Std. Deviation	Minimum	Maximum
Tap water	21	102.381	65.289	42.00	338.00
Distilled water	21	40.666	21.861	3.00	94.00
Chlorhexidine gluconate	21	19.285	16.266	2.00	55.00
Sodium hypochlorite	21	5.000	5.357	.00	22.00

H=61.88 p<0.001 vhs

Table 3: Represents the comparison between each group with the other**.**

Comparisons	**Z**	**P**
Tap water Vs Distilled water	4.53	<0.001 vhs
Tap water vs Chlorhexidine gluconate	5.473	<0.001 vhs
Tap water vs Sodium hypochlorite	5.552	<0.001 vhs
Distilled water vs Chlorhexidine gluconate	3.183	<0.001 vhs
Distilled water vs Sodium hypochlorite	5.162	<0.001 vhs
Chlorhexidine gluconate vs Sodium hypochlorite	3.745	<0.001 vhs