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Original Article

Dentistry Section

Comparison of the Effectiveness of Pre-procedural Rinse and Ultrasonic Coolant using Chlorhexidine Gluconate and Povidone-iodine in Reducing Aerosol Contamination: A Randomised Clinical Trial

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ABSTRACT

Introduction: The production of airborne particles with embedded microorganisms poses a high risk to dental professionals. Antimicrobials, when used in various forms such as pre-procedural rinse or ultrasonic coolant agents, could reduce the aerosol load.

Aim: To compare the effectiveness of ultrasonic coolant, pre-procedural rinse using 0.2% Chlorhexidine (CHX) gluconate, and 2% Povidone-iodine (PVI) in reducing aerosol contamination.

Materials and Methods: A prospective single-centre, triple-blind, randomised clinical trial was conducted in the Department of Periodontology at Sree Sai Dental College and Research Institute, Srikakulam, India. The study duration was four months, from November 2021 to February 2022. A total of 75 patients diagnosed with gingivitis, aged 20 to 30 years, systemically healthy, with probing depths of <3 mm were included and randomly assigned to one of two groups: pre-procedural rinse or ultrasonic cooling agent. They were then divided into five subgroups: Subgroup I- CHX pre-procedural rinse, Subgroup II- PVI pre-procedural rinse, Subgroup III- ultrasonic cooling agent CHX, Subgroup IV- ultrasonic cooling agent PVI, and Subgroup V- control (distilled water). Agar plates were placed at three different locations, followed by a 20-minute ultrasonic scaling procedure. The agar plates were then incubated at 37°C for 48 hours, and the Colony Forming Units (CFU) were counted using a digital colony counter. Multiple measures Analysis of Variance (ANOVA) was performed for group-wise comparisons, and Tukey's post-hoc test was performed for intergroup comparison of CFU.

Results: All the groups reported statistically significant differences. The control group had higher CFU (616.85, 871.77, 342.23 for the operator, patient, and back of the patient's head, respectively) compared to the rinse and coolant groups. However, the CHX coolant group showed lower CFU (186.31±41.508 at the operator's chest area, 415.38±59.219 at the patient's chest area, 71.69±10.323 at the back of the patient's head) compared to the other subgroups. The patient's chest area had higher CFUs (415.38±59.219 for CHX coolant, 545.85±38.105 for PVI coolant group, 580.38±48.290 for CHX rinse group, 752.46±41.667 for PVI rinse group, 871.77±98.826 for the control group) compared to the blood agar plates placed at other locations.

Conclusion: The results of the study clearly indicate that CHX coolant can be considered a promising alternative in reducing aerosol contamination produced during ultrasonic scaling procedures.

Keywords: Aerosolised droplets, Cross infection, Dental scaling, Microbiota, Mouthwashes

INTRODUCTION

Aerosols are defined as particles with a diameter of less than 50 µm [1]. These particles remain suspended in the air for extended periods of time before settling on surfaces or entering the respiratory system. Aerosols of smaller diameter have the ability to enter and reside in the smaller passageways of the lungs, posing the highest risk of infection. Splatter, on the other hand, refers to airborne particles larger than 50 µm in diameter that are propelled from the operation site in a ballistic manner [2]. These larger particles quickly fall to the ground or collide with surfaces. Unlike aerosols, splatter particles are not suspended in the air for long periods.

It has been reported that aerosolised microorganisms can reach high concentrations, up to a million germs per cubic foot of air, and can travel up to six feet [3]. The oral cavity harbors various microorganisms, including pathogenic bacteria and viruses. Dental procedures such as ultrasonic scaling and air polishing generate aerosols, posing a risk of airborne infections for dental professionals. To combat contamination from viable bacteria in aerosols, different methods have been proposed, including the use of pre-procedural rinses and ultrasonic coolant agents [4].

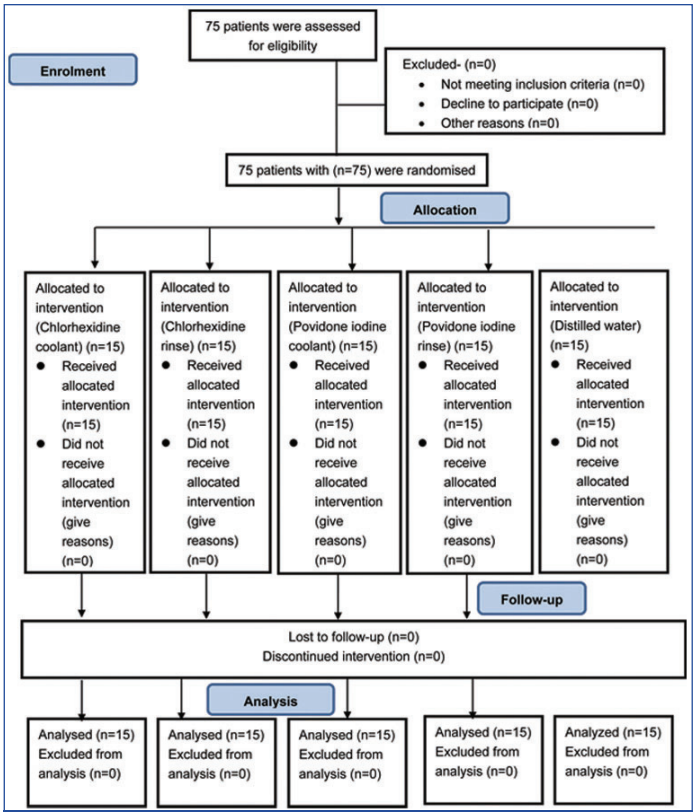
Chlorhexidine (CHX) gluconate is a commonly used rinse due to its broad-spectrum antimicrobial activity and high substantivity [3]. On the other hand, Povidone Iodine (PVI) has strong sterilising effects. It is a mixture of polyvinyl pyridine and iodine, and it exhibits antibacterial action with a low potential for resistance. PVI irrigation, particularly 10% PVI, used as an adjunct to scaling and root planing, has been shown to favour non-surgical periodontal therapy due to its broad-spectrum antimicrobial activity [5].

CHX and PVI mouthwashes have been extensively studied and have been found to effectively reduce the number of oral bacteria when rinsed for one minute. Therefore, the present study aimed to evaluate the effectiveness of ultrasonic coolant and pre-procedural rinse using CHX gluconate and PVI in reducing aerosol contamination produced during ultrasonic scaling.

MATERIALS AND METHODS

A prospective single-centre, triple-blind, randomised clinical trial was conducted in the Department of Periodontology at Sree Sai Dental College and Research Institute, Srikakulam, India. The study duration was four months, from November 2021 to February 2022.

The study was approved by the Institutional Ethical Committee (IRB/IEC/21-22/409/8), and the trial was registered in ClinicalTrials.gov (CTRI/2022/06/043520) before the study commenced. The trial was conducted in accordance with the principles of the Helsinki Declaration of 1975, modified in 2008. The nature and process of the study were explained to the participants, and written consent forms were obtained [Table/Fig-1].



[Table/Fig-1]: Consolidated Standards of Reporting Trials (CONSORT) flowchart depicting screening, enrolment, allocation, follow-up and analysis.

Inclusion criteria: The study included patients aged 20 to 30 years who were systemically healthy, had 20 sound natural teeth, and had probing depths of less than 3 mm.

Exclusion criteria: Patients who were allergic to CHX/PVI, had thyroid dysfunction, were smokers, had undergone periodontal treatment in the past six months, were pregnant or lactating, were immunocompromised, had used antibiotics in the past six months, had untreated carious or grossly decayed teeth, or had undergone professional cleaning three months prior were excluded from the study.

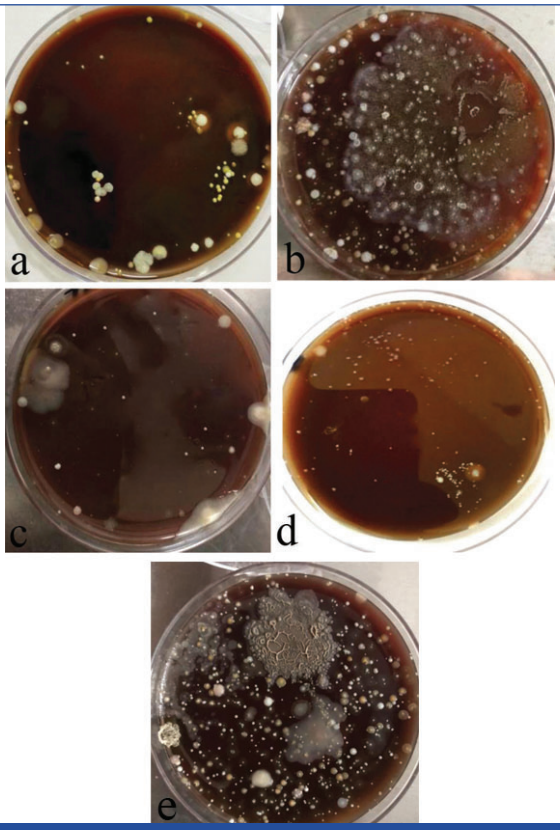
Sample size calculation: A total of 75 participants, consisting of 36 males and 39 females, who were diagnosed with gingivitis, were included in the study. Power analysis was used to determine the group sample sizes, using G*Power software version 3.1.9.5, with an effect size of 0.6, an α error of 0.05, 95% power, and a significance threshold of 0.05.

Study Procedure

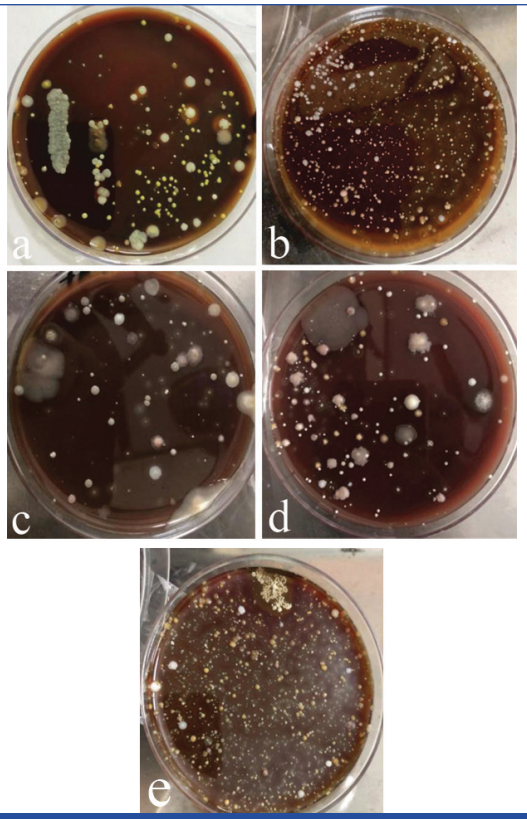
The patients who met the inclusion criteria were selected and randomised into five subgroups using sealed envelope randomisation. Subgroup I received a CHX pre-procedural rinse, subgroup II received a PVI pre-procedural rinse, subgroup III received a CHX ultrasonic cooling agent, subgroup IV received a PVI ultrasonic cooling agent, and subgroup V served as the control group and used distilled water. Full mouth plaque scores were recorded prior to the treatment procedure. Two commercially available solutions, 0.2% CHX (Rexidin 0.2%) and 2% PVI (Povident Germicide Gargle 2%), were selected for the study.

The same operatory room was used throughout the study, and the room was fumigated every 24 hours and prior to each treatment procedure to eliminate aerosols. The operator was blinded, and only one patient was treated per day. The treatment duration was 20 minutes, and the patient was the first patient of the day, ensuring that the operatory room remained unused for 18 hours. Pre-fabricated sheep blood agar plates (Allied Biotechnology India Pvt. Ltd., Mumbai, India) were coded and placed at three different positions: on the patient's chest area, the clinician's chest area, and behind the patient's head [Table/Fig-2]. Standardisation was achieved by marking reference points, and the agar plates were placed at a distance of six inches on the patients' and clinicians' chest area and nine inches from the back of the patient's head [6]. The operator was blinded, and the pre-procedural rinse was performed for one minute before oral prophylaxis and repeated every five minutes. Ultrasonic scaling was performed for 20 minutes with a water flow rate of 20 mL/minute [7]. Oral prophylaxis was performed by the same right-handed operator using a piezoelectric ultrasonic scaler with motorised suction. After the procedure was completed, the agar plates were collected and incubated at 37°C for 48 hours, and Colony-forming Units (CFU) were counted by a blinded clinician using a digital colony counter (©Labtronics) [Table/Fig-3-5a-e].

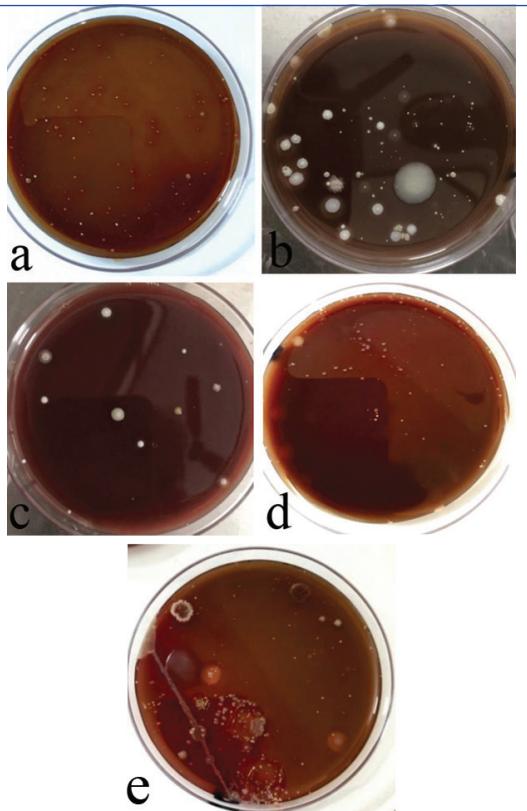
[Table/Fig-2]: Position of blood agar plates.



[Table/Fig-3]: Operator chest area agar plates shows Colony Forming Units (CFUs) a) CHX rinse b) PVI rinse c) CHX coolant d) PVI coolant.



[Table/Fig-4]: Patient chest area agar plates shows Colony Forming Units (CFUs) a) CHX rinse b) PVI rinse c) CHX coolant d) PVI coolant. e) Control.



[Table/Fig-5]: Back of the patients head agar plates shows Colony Forming Units (CFUs) a) CHX rinse b) PVI rinse c) CHX coolant d) PVI coolant e) Control.

STATISTICAL ANALYSIS

The statistician was blinded, and all the data were entered into a Microsoft Excel spreadsheet for statistical analysis using the Statistical Package for the Social Sciences (SPSS) version 25.0 (IBM SPSS Corp., Armonk, NY, USA). The data were expressed as mean and Standard Deviation (SD). Group-wise comparisons were performed using multiple measures ANOVA, and for intergroup comparison of CFU, Tukey's post-hoc test was performed. Statistical significance was defined as $p<0.05$.

RESULTS

The CHX coolant group showed the least number of CFU, with mean±SD values of 186.31±41.508, 415.38±59.219, and 71.69±10.323 at the operator area, patient's chest area, and back of the patient's head, respectively. In the CHX rinse group, the mean±SD of CFU was 325.23±49.878, 580.38±48.290, and 163.15±30.610 at the operator's chest area, patient's chest area, and back of the patient's head, respectively. In the PVI coolant group, the mean±SD of CFU was 290.00±37.743, 545.85±38.105, and 103.54±21.368 at the operator's chest area, patient's chest area, and back of the patient's head, respectively. In the PVI pre-procedural rinse group, the mean±SD of CFU was 451.46±50.204, 752.46±41.667, and 222.31±27.533 at the operator's chest area, patient's chest area, and back of the patient's head, respectively. The control group reported the highest CFU at all three locations, with mean±SD values of 616.85±110.369, 871.77±98.826, and 342.23±73.975 at the operator and patient's chest area, and back of the patient's head, respectively [Table/Fig-6].

Subgroups	n	Mean±SD	SE	95% CI Upper	95% CI Lower
Control-operator	15	616.85±110.369	30.611	683.54	550.15
Control-patient	15	871.77±98.826	27.409	931.49	812.05
Control-back of patient	15	342.23±73.975	20.517	386.93	297.53
ChxR-operator	15	325.23±49.878	13.834	355.37	295.09
ChxR-patient	15	580.38±48.290	13.393	609.57	551.20
ChxR-back of patient	15	163.15±30.610	8.490	181.65	144.66
PviR-operator	15	451.46±50.204	13.924	481.80	421.12
PviR-patient	15	752.46±41.667	11.556	777.64	727.28
PviR-back of patient	15	222.31±27.533	7.636	238.95	205.67
ChxC-operator	15	186.31±41.508	11.512	211.39	161.22
ChxC-patient	15	415.38±59.219	16.424	451.17	379.60
ChxC-back of patient	15	71.69±10.323	2.863	77.93	65.45
PviC-operator	15	290.00±37.743	10.468	312.81	267.19
PviC-patient	15	545.85±38.105	10.568	683.54	522.82
PviC-back of patient	15	103.54±21.368	5.926	931.49	90.63

[Table/Fig-6]: Mean CFU in all groups at different locations.
SE: Standard error; CI: Confidence interval; ChxR: Chrolhexidine rinse; PviR: Povidone-iodine rinse; ChxC: Chlorhexidine coolant; PviC: Povidone-iodine coolant

A total of 75 patients, consisting of 36 males and 39 females who were diagnosed with gingivitis, were enrolled [Table/Fig-7]. The mean plaque index scores of 5 subgroups were depicted in [Table/Fig-8]. Subgroup I control i.e., distilled water, subgroup II: CHX rinse, subgroup III: povidone-iodine rinse, subgroup IV: CHX coolant, and subgroup V: povidone-iodine coolant groups; each group consisted of 15 subjects. The mean colony counts at three standardised locations for the five subgroups were depicted in [Table/Fig-6]. The CHX coolant group showed a statistically significant ($p<0.01$) reduction in CFU, followed by the PVI coolant group, CHX rinse group, and PVI rinse group [Table/Fig-9]. The mean±SD at the back of the patient's head were 71.69±10.323, 103.54±21.368, 163.15±30.610, 222.31±27.533, and 342.23±73.975 for the CHX coolant, PVI coolant, CHX rinse, PVI rinse, and control group, respectively. The agar plates placed behind the patient's head showed the least number of CFUs in all the groups, but the CHX coolant group had the lowest CFU count.

Gender	Frequency (n)	Mean±SD	SE
Male age	36	26.39±2.44	0.41
Female age	39	26.92±1.68	0.27

[Table/Fig-7]: Demographic data.
SE: Standard error

	CHX coolant	CHX rinse	PVI coolant	PVI rinse	Control (distilled water)
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Plaque index	1.78±0.33	1.72±0.35	1.74±0.39	1.75±0.40	1.78±0.37

[Table/Fig-8]: Plaque index mean±SD of all five groups.

Groups	Parameters	Mean difference	SE	p-value	95% CI lower bound	95% CI upper bound
Control-operator	Control-patient	-254.923*	21.923	0.01	-330.32	-179.52
	Control-back of patient	274.615*	21.923	0.01	199.22	350.01
	ChxR-operator	291.615*	21.923	0.01	216.22	367.01
	ChxR-patient	36.462	21.923	0.94	-38.94	111.86
	ChxR-back of patient	453.692*	21.923	0.01	378.29	529.09
	PviR-operator	165.385*	21.923	0.01	89.99	240.78
	PviR-patient	-135.615*	21.923	0.01	-211.01	-60.22
	PviR-back of patient	394.538*	21.923	0.01	319.14	469.94
	ChxC-operator	430.538*	21.923	0.01	355.14	505.94
	ChxC-patient	201.462*	21.923	0.01	126.06	276.86
	ChxC-back of patient	545.154*	21.923	0.01	469.76	620.55
	PviC-operator	326.846*	21.923	0.01	251.45	402.24
	PviC-patient	71.000	21.923	0.09	-4.40	146.40
	PviC-back of patient	513.308*	21.923	0.01	437.91	588.71
Control-patient	Control-operator	-274.615*	21.923	0.01	-350.01	330.32
	Control-patient	-529.538*	21.923	0.01	-604.94	604.94
	ChxR-operator	17.000	21.923	1.00	-58.40	621.94
	ChxR-patient	-238.154*	21.923	0.01	-313.55	366.78
	ChxR-back of patient	179.077*	21.923	0.01	103.68	784.01
	PviR-operator	-109.231*	21.923	0.01	-184.63	495.71
	PviR-patient	-410.231*	21.923	0.01	-485.63	194.71
	PviR-back of patient	119.923*	21.923	0.01	44.52	724.86
	ChxC-operator	155.923*	21.923	0.01	80.52	760.86
	ChxC-patient	-73.154	21.923	0.07	-148.55	531.78
	ChxC-back of patient	270.538*	21.923	0.01	195.14	875.48
	PviC-operator	52.231	21.923	0.53	-23.17	657.17
	PviC-patient	-203.615*	21.923	0.01	-279.01	401.32
	PviC-back of patient	238.692*	21.923	0.01	163.29	843.63
Control-back of patient	Control-operator	-291.615*	21.923	0.01	-367.01	-199.22
	Control-patient	-546.538*	21.923	0.01	-621.94	-454.14
	Control-back of patient	-17.000	21.923	1.00	-92.40	92.40
	ChxR-patient	-255.154*	21.923	0.01	-330.55	-162.76
	ChxR-back of patient	162.077*	21.923	0.01	86.68	254.48
	PviR-operator	-126.231*	21.923	0.01	-201.63	-33.83
	PviR-patient	-427.231*	21.923	0.01	-502.63	-334.83
	PviR-back of pt	102.923*	21.923	0.001	27.52	195.32
	ChxC-operator	138.923*	21.923	0.01	63.52	231.32
	ChxC-patient	-90.154*	21.923	0.01	-165.55	2.24
	ChxC-back of patient	253.538*	21.923	0.01	178.14	345.94
	PviC-operator	35.231	21.923	0.95	-40.17	127.63
	PviC-patient	-220.615*	21.923	0.01	-296.01	-128.22
	PviC-back of patient	221.692*	21.923	0.01	146.29	314.09
ChxR-operator	Control-operator	-36.462	21.923	0.94	-111.86	-216.22
	Control-patient	-291.385*	21.923	0.01	-366.78	-471.14
	Control-back of patient	238.154*	21.923	0.01	162.76	58.40
	ChxR-operator	255.154*	21.923	0.01	179.76	-179.76
	ChxR-back of patient	417.231*	21.923	0.01	341.83	237.48
	PviR-operator	128.923*	21.923	0.01	53.52	-50.83
	PviR-patient	-172.077*	21.923	0.01	-247.48	-351.83
	PviR-back of patient	358.077*	21.923	0.01	282.68	178.32
	ChxC-operator	394.077*	21.923	0.01	318.68	214.32
	ChxC-patient	165.000*	21.923	0.01	89.60	-14.76
	ChxC-back of patient	508.692*	21.923	0.01	433.29	328.94
	PviC-operator	290.385*	21.923	0.01	214.99	110.63
	PviC-patient	34.538	21.923	0.96	-40.86	-145.22
	PviC-back of patient	476.846*	21.923	0.01	401.45	297.09
ChxR-back of patient	Control-operator	-453.692*	21.923	0.01	-529.09	38.94
	Control-patient	-708.615*	21.923	0.01	-784.01	-215.99
	Control-back of patient	-179.077*	21.923	0.01	-254.48	313.55
	ChxR-operator	-162.077*	21.923	0.01	-237.48	330.55
	ChxR-patient	-417.231*	21.923	0.01	-492.63	492.63
	PviR-operator	-288.308*	21.923	0.01	-363.71	204.32
	PviR-patient	-589.308*	21.923	0.01	-664.71	-96.68
	PviR-back of patient	-59.154	21.923	0.32	-134.55	433.48
	ChxC-operator	-23.154	21.923	1.00	-98.55	469.48
	ChxC-patient	-252.231*	21.923	0.001	-327.63	240.40
	ChxC-back of patient	91.462*	21.923	0.004	16.06	584.09
	PviC-operator	-126.846*	21.923	0.01	-202.24	365.78
	PviC-patient	-382.692*	21.923	0.01	-458.09	109.94
	PviC-back of patient	59.615	21.923	0.30	-15.78	552.24
PviR-operator	Control-operator	-165.385*	21.923	0.01	-240.78	-378.29
	Control-patient	-420.308*	21.923	0.01	-495.71	-633.22
	Control-back of patient	109.231*	21.923	0.01	33.83	-103.68
	ChxR-operator	126.231*	21.923	0.01	50.83	-86.68
	ChxR-patient	-128.923*	21.923	0.01	-204.32	-341.83
	ChxR-back of patient	288.308*	21.923	0.01	212.91	-212.91
	PviR-patient	-301.000*	21.923	0.01	-376.40	-513.91
	PviR-back of patient	229.154*	21.923	0.01	153.76	16.24
	ChxC-operator	265.154*	21.923	0.01	189.76	52.24
	ChxC-patient	36.077	21.923	0.95	-39.32	-176.83
	ChxC-back of patient	379.769*	21.923	0.01	304.37	166.86
	PviC-operator	161.462*	21.923	0.01	86.06	-51.45
	PviC-patient	-94.385*	21.923	0.002	-169.78	-307.29
	PviC-back of patient	347.923*	21.923	0.01	272.52	135.01
PviR-patient	Control-operator	135.615*	21.923	0.01	60.22	-89.99
	Control-patient	-119.308*	21.923	0.01	-194.71	-344.91
	Control-back of patient	410.231*	21.923	0.01	334.83	184.63
	ChxR-operator	427.231*	21.923	0.01	351.83	201.63
	ChxR-patient	172.077*	21.923	0.01	96.68	-53.52
	ChxR-back of patient	589.308*	21.923	0.01	513.91	363.71
	PviR-operator	301.000*	21.923	0.01	225.60	-225.60
	PviR-back of patient	530.154*	21.923	0.01	454.76	304.55
	ChxC-operator	566.154*	21.923	0.01	490.76	340.55
	ChxC-patient	337.077*	21.923	0.01	261.68	111.48
	ChxC-back of patient	680.769*	21.923	0.01	605.37	455.17
	PviC-operator	462.462*	21.923	0.01	387.06	236.86
	PviC-patient	206.615*	21.923	0.01	131.22	-18.99
	PviC-back of patient	648.923*	21.923	0.01	573.52	423.32
PviR-back of patient	Control-operator	-394.538*	21.923	0.01	-469.94	211.01
	Control-patient	-649.462*	21.923	0.01	-724.86	-43.91
	Control-back of patient	-119.923*	21.923	0.01	-195.32	485.63
	ChxR-operator	-102.923*	21.923	0.001	-178.32	502.63
	ChxR-patient	-358.077*	21.923	0.01	-433.48	247.48

	ChxR-back of patient	59.154	21.923	0.32	-16.24	664.71
	PviR-operator	-229.154*	21.923	0.01	-304.55	376.40
	PviR-patient	-530.154*	21.923	0.01	-605.55	605.55
	ChxC-operator	36.000	21.923	0.95	-39.40	641.55
	ChxC-patient	-193.077*	21.923	0.01	-268.48	412.48
	ChxC-back of patient	150.615*	21.923	0.01	75.22	756.17
	PviC-operator	-67.692	21.923	0.13	-143.09	537.86
	PviC-patient	-323.538*	21.923	0.01	-398.94	282.01
	PviC-back of patient	118.769*	21.923	0.01	43.37	724.32
ChxC-operator	Control-operator	-430.538*	21.923	0.01	-505.94	-319.14
	Control-patient	-685.462*	21.923	0.01	-760.86	-574.06
	Control-back of patient	-155.923*	21.923	0.01	-231.32	-44.52
	ChxR-operator	-138.923*	21.923	0.01	-214.32	-27.52
	ChxR-patient	-394.077*	21.923	0.01	-469.48	-282.68
	ChxR-back of patient	23.154	21.923	1.00	-52.24	134.55
	PviR-operator	-265.154*	21.923	0.01	-340.55	-153.76
	PviR-patient	-566.154*	21.923	0.01	-641.55	-454.76
	PviR-back of patient	-36.000	21.923	0.95	-111.40	111.40
	ChxC-patient	-229.077*	21.923	0.01	-304.48	-117.68
	ChxC-back of patient	114.615*	21.923	0.01	39.22	226.01
	PviC-operator	-103.692*	21.923	0.01	-179.09	7.71
	PviC-patient	-359.538*	21.923	0.01	-434.94	-248.14
	PviC-back of patient	82.769*	21.923	0.02	7.37	194.17
ChxC-patient	Control-operator	-201.462*	21.923	0.01	-276.86	-355.14
	Control-patient	-456.385*	21.923	0.01	-531.78	-610.06
	Control-back of patient	73.154	21.923	0.070	-2.24	-80.52
	ChxR-operator	90.154*	21.923	0.01	14.76	-63.52
	ChxR-patient	-165.000*	21.923	0.01	-240.40	-318.68
	ChxR-back of patient	252.231*	21.923	0.01	176.83	98.55
	PviR-operator	-36.077	21.923	0.95	-111.48	-189.76
	PviR-patient	-337.077*	21.923	0.01	-412.48	-490.76
	PviR-back of patient	193.077*	21.923	0.01	117.68	39.40
	ChxC-operator	229.077*	21.923	0.01	153.68	-153.68
	ChxC-back of patient	343.692*	21.923	0.01	268.29	190.01
	PviC-operator	125.385*	21.923	0.01	49.99	-28.29
	PviC-patient	-130.462*	21.923	0.01	-205.86	-284.14
	PviC-back of patient	311.846*	21.923	0.01	236.45	158.17
ChxC-back of patient	Control-operator	-545.154*	21.923	0.01	-620.55	-126.06
	Control-patient	-800.077*	21.923	0.01	-875.48	-380.99
	Control-back of patient	-270.538*	21.923	0.01	-345.94	148.55
	ChxR-operator	-253.538*	21.923	0.01	-328.94	165.55
	ChxR-patient	-508.692*	21.923	0.01	-584.09	-89.60
	ChxR-back of patient	-91.462*	21.923	0.004	-166.86	327.63
	PviR-operator	-379.769*	21.923	0.01	-455.17	39.32
	PviR-patient	-680.769*	21.923	0.01	-756.17	-261.68
	PviR-back of patient	-150.615*	21.923	0.01	-226.01	268.48
	ChxC-operator	-114.615*	21.923	0.01	-190.01	304.48
	ChxC-patient	-343.692*	21.923	0.01	-419.09	419.09
	PviC-operator	-218.308*	21.923	0.01	-293.71	200.78
	PviC-patient	-474.154*	21.923	0.01	-549.55	-55.06
	PviC-back of patient	-31.846	21.923	0.98	-107.24	387.24
ChxC-back of patient	Control-operator	-545.154*	21.923	0.01	-620.55	-469.76
	Control-patient	-800.077*	21.923	0.01	-875.48	-724.68
	Control-back of patient	-270.538*	21.923	0.01	-345.94	-195.14
	ChxR-operator	-253.538*	21.923	0.01	-328.94	-178.14
	ChxR-patient	-508.692*	21.923	0.01	-584.09	-433.29
	ChxR-back of patient	-91.462*	21.923	0.004	-166.86	-16.06
	PviR-operator	-379.769*	21.923	0.01	-455.17	-304.37
	PviR-patient	-680.769*	21.923	0.01	-756.17	-605.37
	PviR-back of patient	-150.615*	21.923	0.01	-226.01	-75.22
	ChxC-operator	-114.615*	21.923	0.01	-190.01	-39.22
	ChxC-patient	-343.692*	21.923	0.01	-419.09	-268.29
	PviC-operator	-218.308*	21.923	0.01	-293.71	-142.91
	PviC-patient	-474.154*	21.923	0.01	-549.55	-398.76
PviC-operator	Control-operator	-326.846*	21.923	0.01	-402.24	-251.45
	Control-patient	-581.769*	21.923	0.01	-657.17	-506.37
	Control-back of patient	-52.231	21.923	0.53	-127.63	23.17
	ChxR-operator	-35.231	21.923	0.96	-110.63	40.17
	ChxR-patient	-290.385*	21.923	0.01	-365.78	-214.99
	ChxR-back of patient	126.846*	21.923	0.01	51.45	202.24
	PviR-operator	-161.462*	21.923	0.01	-236.86	-86.06
	PviR-patient	-462.462*	21.923	0.01	-537.86	-387.06
	PviR-back of patient	67.692	21.923	0.13	-7.71	143.09
	ChxC-operator	103.692*	21.923	0.01	28.29	179.09
	ChxC-patient	-125.385*	21.923	0.01	-200.78	-49.99
	ChxC-back of patient	218.308*	21.923	0.01	142.91	293.71
	PviC-patient	-255.846*	21.923	0.01	-331.24	-180.45
	PviC-back of patient	186.462*	21.923	0.01	111.06	261.86
PviC-patient	Control-operator	-71.000	21.923	0.09	-146.40	4.40
	Control-patient	-325.923*	21.923	0.01	-401.32	-250.52
	Control-back of patient	203.615*	21.923	0.01	128.22	279.01
	ChxR-operator	220.615*	21.923	0.01	145.22	296.01
	ChxR-patient	-34.538	21.923	0.96	-109.94	40.86
	ChxR-back of patient	382.692*	21.923	0.01	307.29	458.09
	PviR-operator	94.385*	21.923	0.002	18.99	169.78
	PviR-patient	-206.615*	21.923	0.01	-282.01	-131.22
	PviR-back of patient	323.538*	21.923	0.01	248.14	398.94
	ChxC-operator	359.538*	21.923	0.01	284.14	434.94
	ChxC-patient	130.462*	21.923	0.01	55.06	205.86
	ChxC-back of patient	474.154*	21.923	0.01	398.76	549.55
	PviC-operator	255.846*	21.923	0.01	180.45	331.24
	PviC-back of patient	442.308*	21.923	0.01	366.91	517.71
PviC-back of patient	Control-operator	-513.308*	21.923	0.01	-588.71	-437.91
	Control-patient	-768.231*	21.923	0.01	-843.63	-692.83
	Control-back of patient	-238.692*	21.923	0.01	-314.09	-163.29
	ChxR-operator	-221.692*	21.923	0.01	-297.09	-146.29
	ChxR-patient	-476.846*	21.923	0.01	-552.24	-401.45
	ChxR-back of patient	-59.615	21.923	0.30	-135.01	15.78
	PviR-operator	-347.923*	21.923	0.01	-423.32	-272.52
	PviR-patient	-648.923*	21.923	0.01	-724.32	-573.52
	PviR-back of patient	-118.769*	21.923	0.01	-194.17	-43.37
	ChxC-operator	-82.769*	21.923	0.02	-158.17	-7.37
	ChxC-patient	-311.846*	21.923	0.01	-387.24	-236.45
	ChxC-back of patient	31.846	21.923	0.98	-43.55	107.24
	PviC-operator	-186.462*	21.923	0.01	-261.86	-111.06
	PviC-patient	-442.308*	21.923	0.01	-517.71	-366.91

[Table/Fig-9]: Intra and intergroup comparisons of mean±SD by Tukey's post-hoc test.
SE: Standard error; CI: Confidence interval; ChxR: Chrolhexidine rinse; PviR: Povidone-iodine rinse; ChxC: Chlorhexidine coolant; PviC: Povidone-iodine coolant

DISCUSSION

The present study is the first study to compare the effectiveness of pre-procedural rinse and ultrasonic coolant using CHX gluconate

and PVI in reducing aerosol contamination. In this study, a higher number of CFUs were observed in the patient's chest area. This finding is consistent with the study by Joshi AA et al., who reported that the amount of viable bacteria in aerosols is highest at the patient's chest area, followed by the operator and assistant in a descending manner [8]. Other studies by Kaur R et al., and Gupta G et al., also reported higher CFUs on agar plates placed on the patient's chest area, followed by the operator's chest area [9,10]. Bentley C and Nancy W and Sethi KS et al., found that large salivary droplets produced during dental treatments settle quickly from the air, leading to significant contamination, with higher CFUs observed on the patient's chest area [11,12].

Puljich A et al., stated that among aerosol-producing procedures, ultrasonic scaling can generate aerosols and droplet particles that can travel up to at least 1.2 meters from the source [13]. Larato DC et al., reported that particles containing organisms can be redirected to the dentist's face, eyes, and lips when using a high-speed drill, posing a major health risk [14]. Harrel SK and Molinari J suggested various defense methods such as the use of high-volume evacuation, personal protection barriers, and masks [2]. The Centers for Disease Control and Prevention (CDC) recommends the appropriate use of rubber dams, high-velocity air evacuation, and proper patient positioning to reduce the development of droplets, splatter, and aerosol contamination during treatment [15]. Among the methods of reducing aerosol contamination, pre-procedural rinse and ultrasonic liquid coolant have been preferred [2]. Marui VC et al., stated that the use of pre-procedural rinse significantly reduces the microorganisms produced in dentistry [1]. Veksler AE et al., found that rinsing with 0.12% CHX gluconate significantly reduced the amount of facultative and aerobic flora in the oral cavity [16].

The antibacterial properties of CHX are attributed to its effect on the inner cytoplasmic membrane. It is considered the gold standard for plaque control due to its broad-spectrum antibacterial activity and high substantivity. CHX has a relatively long-lasting effect on oral and mucosal surfaces. Approximately 30% of the drug is retained in the mouth after rinsing with a 10 mL solution of 0.2% aqueous CHX, and its antibacterial action can persist in saliva for up to five hours. The antibacterial effects on oral mucosal surfaces can last for more than 12 hours [11].

Pre-procedural mouth rinsing with a bis-biguanide like CHX gluconate 0.2%, along with the use of a high-volume evacuator, can result in a reduced quantity of viable bacteria in aerosols generated during ultrasonic scaling. These results can be attributed to the antiseptic action and antimicrobial efficacy of CHX. The CHX coolant group showed better reduction in CFUs compared to the control and rinse groups, which may be due to the flushing action of the coolant on the microbiota.

PVI at a concentration of 10% was selected as an antiseptic agent by Rahn R et al., because it has been reported to have a faster and more pronounced bactericidal impact than 0.2% CHX, making it a preferred solution for eliminating oral infections through rinsing. Based on these findings, the authors of the present study chose to use ultrasonic liquid coolants and mouth rinses with CHX and PVI [17]. Jawade R et al., concluded that CHX gluconate is more efficient than PVI in decreasing dental aerosols [18]. PVI showed better CFU reduction compared to distilled water. Iodine is a non-metallic necessary nutrient that has strong microbicidal effects against various microorganisms, including bacteria, fungus, viruses, and protozoa. The properties of iodine help maintain long-lasting antimicrobial efficacy with reduced toxicity, as povidone gradually and continuously releases free iodine into solution. Kaur R et al., reported that CHX showed the highest percentage of reduction at the chest level (43%) when compared to PVI and ozone rinse [9]. Sawhney A et al., found that 0.2% CHX had superior results in reducing aerobic bacterial counts compared to Listerine and water [6]. Mehta R et al., compared ultrasonic liquids and found that CHX gluconate effectively reduced CFUs compared to distilled water and PVI [8]. Logothetis DD and Martinez-Welles JM found that a two-minute pre-rinse with CHX significantly reduced aerosols produced by an ultrasonic scaler [19].

Limitation(s)

In the present study, CFU estimation was only performed on anaerobic bacteria, and no attempt was made to differentiate these bacteria. A limitation of the study was that only quantitative analysis was conducted, and a qualitative estimation of bacterial aerosols could have been included. Another limitation was that the contact time of the ultrasonic liquid coolant differed from that of the rinsing procedure. However, the results clearly indicated that the use of ultrasonic coolant or pre-procedural rinse led to a reduction in viable bacterial contamination caused by aerosols. Further studies with larger sample sizes are needed to confirm these findings.

CONCLUSION(S)

Within the limitations of the present study, it was found that CHX, when used as an ultrasonic liquid coolant, was more effective than PVI in both rinse and coolant forms in reducing the microbial load. This study concludes that CHX can be considered the gold standard for reducing oral microbiota, which helps prevent cross-contamination and could be a better modality for reducing the risk to dental professionals.

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