Original Article

Evaluation of the Clinical Efficacy of Quaternary Ammonium Components (QAC) As Surface Disinfectant

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Abstract:

Statement of problem: Surface disinfection is an important aspect of infection control in dentistry. A new generation of quaternary ammonium components (QACs) is gaining popularity as high-level disinfectants. Two types of QAC sprays, UniseptaQuick and SolarSept, are being widely used by Iranian dentists.

Purpose: The aim of this study was to evaluate the clinical efficiency of Unisepta quick and Deconex Solarsept sprays against a number of selected microorganisms.

Materials and Methods: In this experimental single-blind study, Unisepta quick and Solarsept sprays were examined using 15 specimens for standard and resistant pseudomonas aeruginosa, staphylococcus aureous, salmonella typhimurium, bacillus subtilis, mycobacterium bovis and trichophyton mentagrophytes. Test surfaces consisted of high-speed handpieces which were contaminated with suspensions of the microorganisms. Cultivation and incubation were performed and bacterial counts (Colony Forming Unit) were obtained. Data were analyzed using Fisher's exact, chi-square and Mann–Whitney U-tests.

Results: Unisepta quick and deconex solarsept showed bactericidal effects on pseudomonas aeruginosa, staphylococcus aureous, mycobacterium, and salmonella typhimurium and demonstrated fungicidal effects on trichophyton mentagrophytes. However, neither of them had a significant effect on bacillus subtilis and resistant-pseudomonas aeruginosa**.**

Conclusion: Deconex solarsept and unisepta quick are effective against all tested microorganisms, except bacillus subtilis and resistant pseudomonas aeruginosa; therefore they can be classified as intermediate-level disinfectants**.**

Key Words: QAC; Unisepta quick; Deconex solarsept

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INTRODUCTION

One of the most important aspects of infection control in dental clinics is surface disinfection between two visits [1]. Disinfectants are divided into high-, intermediate- and low-level according to their efficacy. Phenolics, alcohol and chlorine are considered as intermediate-level and glutaraldehyde, hydrogen peroxide and formaldehyde as high-level disinfectants [2].

According to the American Dental Association (ADA) acceptable chemical disinfectants must be effective in killing vegetative forms of pathogenic organisms including Mycobacterium tuberculosis (MT) and entroviruses within 30 minutes [3]. Accordingly, in 1978 ADA

announced that Quaternary Ammonium Compounds (QACs) are not acceptable for disinfection of instruments and environmental surfaces. A new generation of QACs have been produced and presented since 1990 and have gained approval as a disinfectant agent by AOAC (Association of official agricultural chemists, USA), Afnore (Association France de normalization, France), DGHM (Deustche Gesellschaft fur Hygiene and Microbiologie, Germany), BSI (British standards institution, UK) and Pasteur Institute of Iran.

Christensen et al [4] showed bactericidal activity of QAC on Psudomonas, Salmonella and Staphilococ-ci, but not on Mycobacterium and Polyviruses. Best et al [5] studied the efficacies of selected disinfectants against MT and found an old-generation QAC to be ineffective on both MT-contaminated suspendsions and stainless steel surfaces. On the other hand, the American Echo Cardiologist Association suggested the use of Deconex 53 Plus for disinfecting Transoesophageal echocardiographic (TEE) probes which are semi-critical instruments [6].

Several investigations regarding the efficacy of QAC have also been conducted in Iran. High and persistent microbicidal effects of micro 10 on surgical surfaces and contaminated gauze has been previously demonstrated [7]. Shakeri et al [8] reported %2 micro10 to be an intermediate- to high-level disinfectant agent. Uniseptic Quick and Deconex Solarsept are two new-generation QACs which have been recently presented to Iranian dentists in the form of sprays and have been widely accepted.

Previous studies on QACs were mostly in vitro and used long contact times. The aim of the present investigation was to determine and compare the clinical efficacy of Unisepta Quick and Deconex Solarsept sprays on contaminated surfaces by selected microorganisms according to the manufacturers' potency claims for disinfection.

MATERIALS AND METHODS

In this experimental single-blind study, Unisepta quick and Solarsept sprays (Unident and Borer Chime, Switzerland) with the same batch numbers were examined using 15 specimens for 7 microorganisms. Therefore a total of 105 plates were employed for each spray. High-speed handpieces were selected as test surfaces.

Bacterial/fungal suspensions of Pseudomonas aeruginosa (PA), staphylococcus aureus (SA), trichophyton mentagrophytes (TM), bacillus subtilis (BS), salmonella typhimurium (ST) and mycobacterium bovis (MB) were adjusted to 0.5 McFarland based on AOAC (Association of official agricultural chemists, USA) standards. By use of a sampler, the test surfaces (air-turbines) were contaminated with an equivalent of 1.5×10^7 colonies of each of the selected microorganisms. All air-turbine surfaces were sprayed with 2 puffs of two sprays according the manufacturers' recommenddations, in order to reduce the number of microorganisms. The test surfaces were then left to dry for 10 minutes and using a swab and sterile normal saline, samples were obtained and transferred to culture plates.

Control plates were prepared for each sample using Unisepta Quick or Solarsept sprays without contamination for the positive controls and bacterial or fungal species with no added antimicrobial agents for the negative controls.

Blood agar was used for BS, ST, PA and SA at a 36±1°C temperature, and the results were read after 24 hours. TM and MB were plated onto SDA agar (Sabouraud dextrose agar) and LJm (Lowenstein-Jensen medium), respecttively. TM fungi were cultured in a dark room and the results were recorded after 14 days. Culturing of MB was performed by sampling swab in 0.5 mL sterilized pure water and transferring this solution to non-sealed LJm culture tubes for 2 weeks. The tubes were then sealed and the results were read after a 2 month incubation period.

Diagnostic tests were used for positive plates. Antimicrobial activity and efficacy of the sprays were assessed as follows:

- No sterilization: even minimal contamination ($< 10^2$ CFU) was considered as "not sterile".
- Severe contamination: a contamination of at least 10^2 CFU in each plate was considered as severe.

The colony number in each plate was considered as a dependent variable and was used to compare the quantity of contamination between the two sprays, regardless of the number of contaminated plates. There was no need to specify a definite cut-off point.

Fisher's exact and χ^2 (chi squared) tests were used to analyze data regarding the number of contaminated plates and Mann-Whitney U-test was employed for comparison of the number of colonies between the two groups.

RESULTS

Results has been recorded about 6 bacteria and one fungi species separately for each solarsept and unisepta quick sprays totally on 105 plates and we report them according each species separately as following:

Standard pseudomonas aeruginosa: No positive plates were observed in the Solarsept (SS) group but there were 3 contaminated plates in the Unisepta Quick (UQ) group with less than 10 CFU in 2 plates and 50-99 CFU in one plate so the difference between the two groups was not significant (Table I).

Bacillus subtilis: Six SS plates were positive with counts of less than 10 CFU in 4 plates and 10-49 CFU in 2 plates. Contamination was seen in 7 UQ plates in which CFU was less than 10 in 2 plates, between 10 and 50 in one plate, 50-99 in 2 plates and more than 100 in the other 2 plates. No significant difference was found between the two test products.

Salmonella typhimurium: Only one plate in the SS group showed contamination of more than 100 CFU, therefore the two groups did not reveal significantly different efficacies.

Staphylococus aureus: Contamination was found in 3 of the SS plates with less than 10 CFU in one plate and 10-49 CFU in the other one. Only one plate in each group had more than 100 CFU. A significant difference was not observed between the 2 sprays (Table I).

Mycobacterium bovis: The SS spray was able to eliminate MB in all plates, but contamination remained in 2 of the UQ plates. The difference between the two sprays was not significan.

Trichophyton mentagrophytes: Less than 10 CFU of the fungal colonies remained in a total of 4 plates: 1 plate in the SS and 3 plates in the Uq group. No significant difference was identified between the 2 groups.

Resistant pseudomonas aeruginosa: There were 4 positive plates in each group. The SS group had less than 10 CFU in one and 10-49 CFU in the other 3 plates and the UQ group revealed less than 10 CFU in 3 and more than

Table I: Comparison of contamination frequency between solarsept Deconex and micro10 regarding bacteria species and remained colony count (CFU/ml).

Bacteria species	Comparison of contamination remained cases						Comparison of remained colony count	
	Remained bacteria			Remained colony> 100			Mann–Whitney	
	Test	χ^2	P-value	Test	χ^2	P-value	Z	P-value
Staphylococcus aures	Fisher	1.034	1.00	-	-	-	1.00	0.317
Salmonella typhimurium	Fisher	1.034	1.00	Fisher	1.034	1.00	1.00	0.317
Bacillus subtilis	Chi square	0.186	0.666	-	-	-	0.448	0.654
Pseudomonas aeruginosa standard	Fisher	0.240	0.624	Fisher	1.034	1.00	0.319	0.749
Pseudomonas aeruginosa resistant	Chi square	1.22	0.269	-	-	-	0.806	0.420
Trichophyton Mentagrophytes	Fisher	0.186	0.666	-	-	-		
Mycobacterium bovis	Chi square	30.00	20.001					

100 CFU in one plate. The difference between the 2 groups was not significant.

As a whole, the disinfecting ability of Solarsept and Unisepta Quick sprays were similar against all examined species except BS (Table II).

DISCUSSION

Considering that environmental surfaces and various semi-critical and non-critical instruments used in dentistry are not autoclavable, introducing a substitute for disinfection is necessary in order to prevent cross-contamination in dental clinics.

New generations of QAC [9] including Unisepta Quick and Solarsept Deconex sprays are being used by dentists in Iran (standard code:2814/20 BP or USP, Food and Drug Department of Ministry of Health and Medical Education, Islamic Republic of Iran), but in 1978 ADA has considered old generation QACs as detergents and not disinfectants [3]. In spite of extensive investigations on the properties of disinfectants and antiseptics, the clinical efficacy of SS and UQ has not been explained in detail.

In the present study, Unisepta Quick and SolarSept were shown to be effective against staphylococcus aureus, salmonella typhimurium, pseudomonas aeruginosa, mycobacterium bovis and trichophyton mentagrophytes when used according to the manufacturers' instructtions. However, neither of them was able to prevent the overgrowth of bacillus subtilis.

In a similar investigation, Shakeri and Soltanpoor [8], showed that %2 micro10 (unisepta quick) eliminated the same bacteria and fungi examined in the present study in addition to BS and concluded that micro10 was a powerful disinfectant. The difference between this report and the current investigation regarding the elimination of bacillus subtilis may be due to the longer contact time employed in their study.

In an in vitro investigation, Sabouri and Fallah [7] showed bactericidal effects of micro10 on pseudomonas aeruginosa. This was compareable to the results obtained in the current study except that when using antibiotic resistant species of pseudomonas aeruginosa, 4 of the plates were contaminated and one of them revealed CFU counts of more than 100.

According to the Pasteur Institute of Iran [7], Deconex products like SolarSept have an extensive range of mycobactericidal activities. Similarly, in the present investigation no mycobacterial contamination was observed after using SolarSept. Therefore SolarSept could be considered to be clinically effective against mycobacterium.

Christensen et al [4], and Best et al [5] claimed less or no effectiveness of QAC on mycobacterium bovis, pseudomonas aeruginosa, salmonella, staphylococcus aureus, trichophyton mentagrophytes and type I polyviruses. This may be due to the fact that they used an old-generation QAC.

Due to the antimicrobial activity of SolarSept and Unisepta Quick on different species (except bacillus subtilis), they may be considered as intermediate-level disinfectants.

Bacillus subtilis is used as an index for the evaluation of sterilization in autoclaves. This microorganism rarely causes disease in humans and is not orally transmitted [10]. Therefore solarsept and unisept quick are suggested for use as enivironmental surface disinfectants in clinical dental settings.

Table II: Comparison of solarsept Deconex and Unisept quick effect on scaled species.

	Pseudomonas aeruginosa	**Staphylococcus aures**	**Salmonella typhimurium**	**Bacillus subtilis**	**Mycobacterium bovis**	**Trichophyton Mentagrophytes**
Solarsept Deconex	+	+	+	–	+	+
Unisept quick	+	+	+	–	+	+

CONCLUSION

Within the limitations of this study it can be concluded that Deconex Solarsept and Uni-septa quick can be considered as inter-mediate level disinfectants.

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