Received 5 February 2008; Accepted 5 April 2008

Comparing the Disinfecting Efficacies of Micro 10, Deconex, Alprocid and Microzid AF on the Microorganisms on Radiographic Equipments

Fatemeh Ezoddini Ardakani [1] • Hengameh Zandi [2] • Zahed Mohammadi[3]* • Jamshid Ayatollahi [4] • Fatemeh Ayatollahi [5] • Behnaz Behniafar[5]

1. Associate Professor, Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Yazd University of Medical Sciences, Iran
2. Assistant Professor, Department of Microbiology, Faculty of Medicine, Yazd University of Medical Sciences, Iran
3. Assistant Professor, Department of Endodontics, Faculty of Dentistry, Yazd University of Medical Sciences, Iran
4. Associate Professor, Department of Infectious Diseases, Faculty of Medicine, Yazd University of Medical Sciences, Iran
5. Undergraduate Dental Student, Yazd University of Medical Sciences, Iran
** Corresponding Author, E-mail: mohammadi_zahed@yahoo.com*

Abstract

Background and aims. The exposure and processing of dental radiographs are not routinely associated with the spatter of blood or saliva; however, infection control is still an issue resulting from contaminated equipment, supplies, film packets or cassettes. This study aimed at comparing the efficacy of four commercially available disinfectants on microorganisms present on the equipment of radiology department.

Materials and methods. Samples from twelve sites of the radiology department were collected using a sterile swab smeared with normal saline, which was then dipped in a test tube. Experimental surfaces were then disinfected by the spray-wipe-spray method using one of Micro 10, Deconex, Alprocid or Microzid AF disinfectants, followed by resampling. The samples were subsequently cultured on blood agar and EMB plates and the colonies were counted. Isolates were identified by biochemical tests. For statistical analysis, Wilcoxon signed ranks test, Kruskal-Wallis, Chi-square and Fisher exact tests were used.

Results. *Staphylococcus aureus* and coagulase-negative staphylococci had the highest and *Lactobacillus* spp. had the lowest prevalence before disinfection. There were significant differences between the cfu/mL of bacteria before and after disinfection with any of the four disinfectant solutions. There was a significant difference between efficacy of Deconex and Alprocid (P = 0.014), Deconex and Microzid AF (P = 0.001), and Deconex and Micro 10 (P = 0.001).

Conclusion. According to the results, Deconex has the highest disinfectant efficacy compared to other solutions.

Key words: **Disinfectant solutions, infection control, radiological equipment.**

Introduction

The primary goal of infection control procedures is to prevent cross contamination between patients as well as between patients and health care providers.[1,2] In an oral radiology clinic, the operator's hands may become contaminated by contact with a patient's mouth and saliva-contaminated films and film holders. Cross contamination also may occur when operators open film packets to process the films in the darkroom.[3] Each dental office on practice should have a written policy describing its infection control practices. It is the best if one individual in a practice, usually the dentist, assumes responsibility for implement-

ing this procedure.[4]

In the case of an infectious disease, a cycle of three factors, namely microorganism, host and the method of transmission, should be considered.[5] Cross-infection control aims at breaking this cycle by taking measures to prevent subsequent person-to-person transmission of infection. In dentistry, the patient and the dentist are at a high risk of cross-infection, since human mouth secretions contain the broadest range of microorganisms in a normal flora. Infection control in dentistry should focus on common ways to block cross contamination.[6,7] The followings are among the common ways of infection transmission: Direct contact with pathogens existing in the saliva, blood, respiratory secretions and wastes; direct contact with microorganisms existing in the air and mouth aerosols; and indirect contact with materials and instruments contaminated with microorganisms. The latter is of importance in a radiology clinic setting, and procedures must be applied to prevent cross contamination in this area.

The use of disinfectants is one of the procedures applicable as an infection control method for prevention of indirect transmission.[8] In this research, we attempted to compare the efficacy of four different commercially available disinfectants in order to suggest a reliable method for disinfection of surfaces in a radiology department.

Materials and Methods

In this study, twelve various sites of the radiology department at Shahid Sadoughi University of Medical Sciences Dental School, Yazd, Iran, which were likely to have been contaminated with patients' saliva underwent sampling: X-ray tube head, exposure button, door handle of cabin, cabin door's surface, outside handle of darkroom door, inside handle of darkroom door, the surface of darkroom bench, the processor on-off key, entrance and exit spots of the film processor, reception table, and refrigerator door surface. At the end of the working day, sampling was performed using a sterile swab smeared with normal saline (pre-disinfection sampling). The test area was chosen randomly for each sampling. The swab was then dipped into the test tube containing 3 mL Triptic Soy Broth (TSB) liquid culture medium under a sterile hood and each tube was labeled.

Disinfectant solutions used included:

1. 2% Micro 10 (Unident, Genev, Switzerland; Contact time 2 min)
2. 2% Deconex (Borer Chemic, Genev, Switzerland; Contact time 2 min)
3. 4% Alprocid (Alpro, Schwarzwald, Germany; Contact time 2 min)
4. 6% Microzid AF (Inhalt Losung, Freiburg, Germany; Contact time 60 s)

Only one disinfectant solution was used in each sampling day. The disinfectant solution was sprayed on a limited area and re-sprayed after rubbing and wiping by gauze smeared with normal saline. Manufacture's instructions for each disinfectant regarding contact time were followed. At the end of the contact time, a sterile swab smeared with normal saline was rubbed on the disinfected surface covering the whole area. The swab was then dipped in the tube containing TSB close to spirit lamp and the tubes were labeled. 12 samples were taken after using normal saline as a positive control group. The test tubes (12 pre- and 12 post-disinfection samples for each disinfectant) were transferred to the laboratory immediately after sampling on each day. The tubes were incubated at 37°C for 24 h. 100 µl of each sample tube was separately dropped on a blood agar and Eosin Methylene Blue (EMB) culture medium using a repetitive pipette, and then drops were dispersed on culture media using sterile loops. Colony counting (cfu/mL) was performed after incubation at 37°C for 24 h. Isolated strains were identified by gram staining and biochemical tests.[9]

Kruskal-Wallis tests were used to compare mean values. Fisher Exact test was used to evaluate the relationship between two qualitative variables when sample size was less than five. Chi-Square and Wilcoxon tests were used to evaluate the relationship between two quantitative variables.

Results

In this study, the efficacies of four disinfectant solutions, commonly used in dental radiology clinics, were assessed on different sites of radiology department. Frequency of isolated bacterial species from four pre-disinfection samplings of the twelve sites of radiology department is shown in Table 1.

The average cfu/mL of isolated bacterial species from different sites and equipments of radiology department before and after disinfection according to disinfectant solution used is shown in Table 2.

Table 1. Frequency of isolated bacterial species from different sites of radiology department at four stages of sampling before disinfection

Microorganisms / Sites and Equipments	*Staphylococcus aureus*	Coagulase-negative staphylococci	*Bacillus* spp.	Diphtheroids	*Lactobacillus*.spp.	*Escherichia coli*	*Pseudomonas aeruginosa*	*Klebsiella*.spp.	Non-hemolytic streptococci	Candida	Total
X-ray tube head	1	3	1	0	0	0	0	0	1	0	6
door handle of cabin	2	3	3	1	0	0	0	0	0	0	9
cabin door's surface	2	2	3	0	1	1	0	0	0	0	9
Exposure button	1	2	2	1	0	0	0	0	0	1	7
Outside handle of darkroom door	4	1	2	1	0	2	0	0	0	0	10
Inside handle of Darkroom door	3	2	1	0	0	0	0	1	1	0	8
Surface of darkroom bench	0	2	3	1	0	1	0	1	0	0	8
On-off key of processor	2	2	2	0	0	0	0	0	1	0	7
Processor (film entry)	1	3	1	1	0	1	0	0	0	1	8
Processor (film exit)	2	1	1	2	0	0	0	0	1	0	7
Reception table	4	3	1	1	0	1	0	1	0	2	13
Refrigerator door	1	3	1	0	0	1	1	0	0	0	7
Total	23	27	21	8	1	7	2	3	3	4	99

Over a million of colonies were counted in control sampling group with normal saline. Using Wilcoxon signed ranks test, there were significant differences between the cfu/mL of bacteria before and after disinfection with any of the four disinfectant solutions; however, the efficacies of the four solutions were different (P = 0.004). The highest decrease in cfu/mL of bacteria was seen after disinfection with Deconex and the lowest decrease was seen after using Micro 10. Because of the contamination of all of the 12 sites assessed, the number of disinfected sites with different disinfectants used was compared (Table 3).

Using Fisher-Exact test, there were no significant differences between efficacies of four disinfectant solutions on coagulase-negative Staphylococci (P = 0.069). However, there were significant differences between efficacies of four disinfectants on *Staphylococcus aureus*. Deconex had the highest and Microzid AF had the lowest antibacterial effect. In

Table 2. Average of cfu/mL of isolated bacteria from different sites of radiology department before and after disinfection according to disinfectant solutions

Disinfectant solution	Time of sampling	Number of sites	Average of colony counting	SD	Min	Max	P-value
Microzid AF	B.D*	12	188,833	38,092	100,000	100,000	0.001
	A.D**	12	100,000	0	0	100,000	
Deconex	B.D	12	98,333	5,773	80,000	100,000	0.000
	A.D	12	0	0	0	0	
Alprocid	B.D	12	211,033	31,327	50,000	100,000	0.000
	A.D	12	95,833	14,434	0	80,000	
Micro 10	B.D	12	88,182	36,604	20,000	100,000	0.001
	A.D	12	30,954	27,136	0	100,000	

* Before disinfection
** After disinfection

Table 3. Status of disinfected sites according to disinfectant solutions

Disinfectant solution	Total number of sites	Number (percent) of disinfected sites
Microzid AF	12	3 (25)
Deconex*	12	12 (100)
Alprocid	12	6 (50)
Micro 10	12	2 (16.7)

* P-Value = 0.000

this study, all of the studied disinfectant solutions had 100% efficacy on Gram-negative bacteria (*Escherichia coli*, *Pseudomonas aeruginosa*, and *Klebsiella* spp.) with no significant differences between their efficacies.

The efficacy of Microzid AF, Deconex and Alprocid on *Lactobacillus* spp. and *diphtheroids* was 100%, but 66.7% for Micro 10. There were no significant difference between efficacies of the four solutions on *Bacillus* spp. and *diphtheroids* (P = 0.15). There was no significant difference between efficacy of the used solutions on non-hemolytic Streptococci and Candida (P > 0.05).

Discussion

The present study compared the efficacy of four disinfectant solutions on 12 sites of the radiology department which underwent sampling and bacterial culture of sites before and after disinfection were prepared for each disinfectant solution. The results of the study showed that Deconex disinfectant had the highest efficacy (the highest mean rank difference among four disinfectants tested). According to the results, the highest decrease in cfu/mL of bacteria was seen after disinfection with Deconex and the lowest decrease was seen after using Micro 10. Chi-Square statistical tests showed significant difference between efficacy of these disinfectant solution (P = 0.000). Using Fisher Exact statistical test, the efficacy of any of the four disinfectant solutions was compared two by two. The results showed a significant difference between efficacy of Deconex and Alprocid (P = 0.04), Deconex and Microzid AF (P = 0.001) and Deconex and Micro 10 (P = 0.001). However, there were no significant differences between efficacies of other three disinfectant solutions in two by two comparisons (P > 0.05).

Frequency of disinfected sites previously contaminated with different types of bacteria according to four disinfectant solutions is shown in Table 4. Based on our results, the existing colonies on different surfaces of the radiology department is in accordance with the amount of work in the department. This is in line with Greenlee's study[10] in which colonies in the air, liquids and surfaces of the dark room had been identified at high-work and low-work times.

Sheikhi & Soltani[9] reported that 2% Micro 10 disinfection efficacy was 81.5% in 15 min and 83.3% in 60 min using Micro 10, sodium hypochlorite, Betadine and Savlon disinfectant solutions. The results of the present study showed that with Deconex, all tested sites were disinfected (100%) and with Micro 10, only 16.7% of sites were disinfected. The difference in the results can be attributed to the different disinfectant solutions used.

Yilmaz et al[11] showed that soaking in 5.25% sodium hypochlorite reduced the number of viable adherent microorganisms significantly compared to soaking in 2% sodium hypochlorite, which led to greater reduction than soaking in either 5% Deconex or 3.5% Savlex. The use of 5.25% sodium hypochlorite in all groups was sta-

Table 4. Status of disinfected sites according to disinfectant solutions and the type of bacteria

Disinfectant	Coagulase-negative staphylococci		Percent of disinfected sites	*Staphylococcus aureus*		Percent of disinfected sites	*Bacillus* spp.		Percent of disinfected sites
	BD*	AD**		BD	AD		BD	AD	
Microzid AF	4	2	50%	10	9	10%	4	1	75%
Deconex	7	0	100%	3	0	100%	7	0	100%
Alprocid	6	2	66.7%	7	4	42.9%	5	1	80%
Micro 10	10	6	40%	3	1	66.7%	5	4	20%
			P = 0.069			P = 0.018			P = 0.015

* Before disinfection
** After disinfection

tistically significant.

In another study, Haratian[6] found that the disinfectant efficacy of 53 plus Deconex in 65% and that of Deconex spray is 15%. In this study, there was a significant difference between efficacy of Deconex and Alprocid (P = 0.014) with Deconex exhibiting a better performance.

Comparing the results of this research with similar studies shows that Deconex is superior to other disinfectant solutions, since it reduces the highest amount of colonies. Alprocid, Microzid AF and Micro10 follow Deconex regarding the disinfection efficacy, respectively.

References

1. White SC, Pharaoh MJ. *Oral Radiology: Principles and Interpretation*, 5th ed. St. Louis: Mosby; 2004:115.
2. Hubar JS, Gardiner DM. Infection control procedures used in conjunction with computed dental radiography. *Int J Comput Dent* 2000; 3:259-67.
3. Wyche CJ. Infection control protocols for exposing and processing radiographs. *J Dent Hyg* 1996; 70:122-6.
4. Infection control recommendations for the dental office and the dental laboratory. ADA Council on Scientific Affairs and ADA Council on Dental Practice. *J Am Dent Assoc* 1996; 127:672-680.
5. Jawetz E, Melnick J, Adelberg EA. *Medical Microbiology*, 22nd ed. New York: Prentic Hall; 2001:180-214.
6. Haring JJ. Jansen L. *Dental Radiography: Principles and Techniques*, 2nd ed. Philadelphia: W.B. Saunders; 2000:195,198-202.
7. American Academy of Oral and Maxillofacial Radiology infection control guidelines for dental radiographic procedures. *Oral Surg Oral Med Oral Pathol* 1992; 73:248-9.
8. Bachman CE, White JM, Goodis HE, Rosenquist JW. American Academy of Oral and Maxillofacial Radiology infection control guidelines for dental radiographic procedures. *Oral Surg Oral Med Oral Pathol* 1992; 73:248-9.
9. Sheikhi M, Soltani B. Comparsion of disinfectant efficacy of Micro 10, Sodium Hypochlorite, Betadine and Savlon on the equipment of Radiology Department, School of Dentistry, Isfahan University of Medical Science. *Dental Research Journal* 2005; 2: 26-31.
10. Greenlee JS. Review of currently recommended aseptic procedure. III. Radiographic equipment and dental professional preparation. *Dent Hyg (Chic)* 1984; 58:74-7.
11. Yilmaz H, Aydin C, Bal BT, Ozçelik B. Effects of disinfectants on resilient denture-lining materials contaminated with Staphylococcus aureus, Streptococcus sobrinus, and Candida albicans. *Quintessence Int.* 2005;36:373-81.