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Original Research Article

Bacterial contamination of dental units before and after disinfection

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Abstract: Infection control plays an important role in dental treatment and to overcome the problem of bacterial contamination that confronts dentistry, we should examine the dental treatment environment, in general, and dental units, in particular. The aim of this study is to evaluate bacterial contamination prior and subsequent to disinfection by the cleaning crew in the dental faculty of Qazvin University of Medical Science. Samples were collected from 24 randomly-selected units, each of which was divided up into seven different parts vulnerable to contamination. Sterile swabs soaked in saline were used for gathering samples from units and were placed into two types of tubes, one with saline content and the other with BHI content. The tubes were sealed and transported to a laboratory for incubation. The bacterial load was measured, and the type of bacterial content was identified. The data were analyzed using Tukey-Kramer method and *t*-tests on SPSS 21 software ($\alpha = 0.05$). The results show that despite a significant reduction in the number of colonies after disinfection, no significant difference was found between pre- and post-disinfection in terms of infection rates and the type of organisms. Also before and after disinfection, Staphylococcus epidermidis was the most prevalent Species (51.9%) and Enterococcus was the least (3.7%). In addition, the process of disinfection adds new microorganisms in some cases.
Keywords: bacterial contamination, dental unit, indirect transmission, Staphylococcus epidermidis

INTRODUCTION

Infection control has garnered much attention in dentistry due to the contact with the patient's mucosa, blood, and contaminated surfaces, and the importance of providing a non-threating operational environment. Most dental procedures require special methods for preventing transmission of disease [1, 2]. Dental operational surfaces are exposed to microbial contamination from saliva, tissue, and blood aerosols. Aerosols are airborne contaminants which are capable of being created by high-speed handpiece from bacterial contaminants of saliva, tissues, blood, plaque, and fine debris cut of the carious teeth. They can suspend in the air for hours and transmit diseases. Most of these aerosols are gram-positive streptococci [3] .Bacteria can continue to live on solid surfaces around us. Although the interaction between bacteria suspended in the air and surfaces has not been studied well, microorganisms transmitted by air eventually rest on surfaces, many of these infectious agents are capable of survival on surfaces in different periods of time unless eliminated via disinfection or sterilization [4]. Infection occurs when microorganisms enter the body, rest in a proper place, and begin to reproduce [5]. in some cases, there is a greater concern about aerobic bacteria because of special conditions such as a history of rheumatic heart disease, mitral valve Prolapse, endocarditis or prosthetic joints [6]. One of the ways in which infection is transmitted is indirect contamination, in which contact with unprotected surfaces can potentially spread contamination [7]. Environmental surfaces and the gown of the dentist in dental offices are not directly in contact with the patient but can become contaminated during work and then act as a source of microbial contamination [8] .Despite numerous studies in different fields of dentistry on the role of microorganisms, there is a paucity of research on cross-infection through dental work and the exact increase in pollution levels during routine dental treatments. The aim of the present study was to investigate the contamination of surfaces of dental units before and

after routine dental work in all departments of Qazvin dental faculty in Iran 2016.

METHODS AND MATERIALS

A total of 24 dental units were randomly selected from the eight departments of the dental faculty of Qazvin University of Medical Science, three units from each department. Samples were obtained from 7 parts of each unit which were more vulnerable to contamination, (i.e., light switch, light handle, tray, tray handle, headrest, chair, and unit switches) (Figure 1).

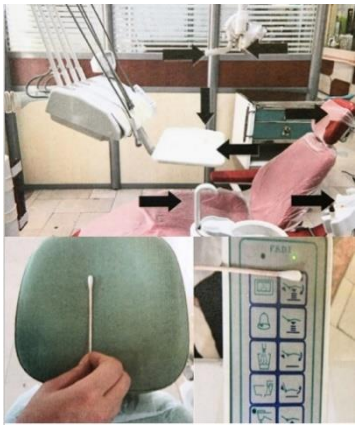

Fig-1: Samples were obtained from 7 parts of each unit

Before sampling began, two types of tubes were prepared: the tubes containing 1cc of saline (sterile water) and the tubes containing Brain Heart Infusion Broth (BHI). After daily work finished, two sets of samples were collected: one before and the other after the cleaning crew disinfected the units. Two samples were taken from each of the seven parts of each unit. For sampling purposes, first a sterile swab was soaked in saline. Then, it was rubbed gently against 1.1 cm of the mentioned unit surfaces and was rotated inside the saline tube to force out excess water. Afterward, the swab was removed from the tube, and the tubes were capped. These samples were used for counting the number of bacterial colonies (Figure 2).

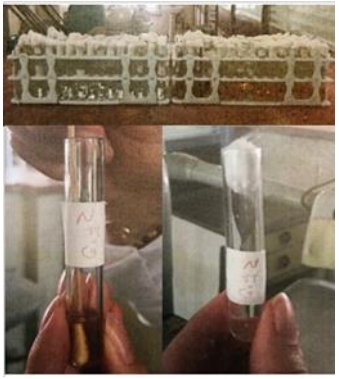

Fig-2: Tubes, before sending to the laboratory

The second round of sampling was performed in the same way as above, with the difference being that this time the swabs were placed into BHI tubes, and the tubes were capped. These latter groups of samples were used for identifying the type of microorganisms. All the tubes were sent to the laboratory, and BHI ones were incubated at 37 ºC for 4 hours. The pour-plate method was used for measuring the bacterial load. The tubes containing sterile water were poured into sterile plates, and then 9 cc of Trypticase Soy Agar (TSA) was poured onto the same plates. After the pour plates cooled and the Agar hardened, they were inverted and incubated at 37 ºC for 18-24 hours, and bacterial counting was done (Figure 3).

Fig-3: Preparation of pour plates samples

The BHI tubes were incubated for four hours before being spread onto Blood Agar and McConkey Agar plates. After cooling, the plates were incubated for 18-24 hours, and the number of bacterial colonies was measured (Figure 4).

Fig-4: Preparation of blood agar samples

After plate incubation, slides were prepared, and gram stain technique was performed. To identify the type of bacteria, the catalase, coagulase, DNA-as oxide, and Growth in NACL 9.5% tests were performed. Gram positive cocci and gram positive and gram negative bacilli were identified. The catalase test was performed for gram positive. Streptococci are catalase negative and staphylococci are catalase positive. Bile esculin was used for identifying streptococcus D, NACL 9.5% was used for enterococci, and MSAA, Coagulase, and DNA-as oxide were used for staphylococcus aureus. Novobiocin discs were

prepared for non-species staphylococcus. MacConkey's Agar (MAC), is specific for gram negative bacillus. To identify E. coli and other bacteria, Gallery media were used. The data were analyzed using Tukey-Kramer method and *t*-tests on SPSS 21 software ($\alpha = 0.05$).

RESULTS

Prior to disinfection, 27 (16%) of the samples were positive culture, and 141 (84%) were negative culture. However, after disinfection, 24 (14.2 %) were positive culture, and 144 (85.8%) were negative. In other words, bacterial contamination minimally decreased from 16% to 14.2%. Of a total of 336 samples that were taken from different parts of dental units in two stages, 51 (15.2%) were positive culture, and 285 (88.4%) were negative culture. This means that only 15.2% of the samples were contaminated with bacteria. Gram stain results are shown in Table 1.

Table-1: Bacterial contamination of units before and after disinfection By Gram stain

Gram stain	Before disinfection	After disinfection
Gram-positive bacilli	6 (22.2%)	3 (12.5%)
Gram-negative bacilli	5 (18.5%)	2 (8.3%)
Gram-positive cocci	16 (59.3%)	18 (75%)
Total	27 (100%)	24 (100%)
P-value	P-value: 0.35	

Based on laboratory results, before disinfection, Staphylococcus epidermidis was the most prevalent Species (51.9%), and Enterococcus and staphylococcus aureus were the least prevalent Species (3.7%). After disinfection, Staphylococcus Epidermis was the most prevalent Species (62.5%), and Enterococcus was the least prevalent at 4.2%. A series of new microorganisms such as fungi were added after disinfection (Table 2).

Table-2: Bacterial contamination of units before and after disinfection by Microorganisms

microorganism	Before disinfection	After disinfection
Aerobic gram-positive bacillus	6 (22.2%)	3 (12.5%)
Staphylococcus epidermidis	14 (51.9%)	15 (62.5%)
Staphylococcus aureus	1 (3.7%)	2 (8.3%)
E. coli	3 (11.1%)	0 (0%)
Enterococcus	1 (3.7%)	1 (4.2%)
Acinetobacter	2 (7.4%)	2 (8.3%)
Fungi	0 (0%)	1 (4.2%)
Total	27 (100%)	24 (100%)
P-Value	*P*-value: 0.51	

Before disinfection, the pediatric department had the highest contamination (22.2%), and the prosthodontics department had the lowest (3.7%). After disinfection, the orthodontics, operative, and endodontics department had the most contamination (20.8%), and the pediatrics and maxillofacial departments had the least (4.2%). This indicates that the pediatrics department was the most successful in implementing the disinfection procedure (Table 3).

Table-3: Bacterial contamination of units before and after disinfection by departments

department	Before disinfection	After disinfection
Oral and Maxillofacial Surgery	3 (11.1%)	3 (12.5%)
Periodontics	2 (7.4%)	2 (8.3%)
Prosthetic	1 (3.7%)	2 (8.3%)
Orthodontic	4 (14.8%)	5 (20.8%)
Pediatric	6 (22.2%)	1 (4.2%)
Restorative	3 (11.1%)	5 (20.8%)
Oral and maxillofacial medicine	3 (11.1%)	1 (4.2%)
Endodontics	5 (18.5%)	5 (20.8%)
Total	27 (100%)	24 (100%)
P-value	P-value: 0.61	

No significant difference was found between pre- and post-disinfection in terms of the amount of contamination and the types of microorganisms. However, the number of bacterial colonies significantly declined after disinfection (*P*-value:0.011) (Table 4).

Table-4: Comparison of the number of bacterial colonies before and after disinfection

Phase	Mean	Standard deviation	*P-value*
Before disinfection	15.9	9	0.011
After disinfection	10.8	2.8	

DISCUSSION

Despite numerous studies on the role of microorganisms in the field of dentistry, little research has been performed on microbial contamination and cross-infection through dental units. The current study found that bacterial contamination is the main factor contributing to contamination. Prior to the disinfection of dental units, Staphylococcus epidermidis was the most frequent bacterial contamination (51.9%). Staphylococci are not the normal flora of the mouth and live on mammalian skin. Thus, staphylococcus aureus resting on different surfaces of dental units is a consequence of the contact between the hands of staff and different parts of units. So, washing hands and wearing gloves is highly recommendable. In a study by Valian *et al.* [9], which was carried out with the aim of determining the type and amount of aerobic bacterial contamination of the gowns of dental students before and after treatment, it was found that upon completion of the treatment, contamination increased in of 86.7% of the samples. The greatest source of contamination was Gram-positive bacteria. The Staphylococcus aureus was the commonest species [9]. Also in our study, Gram-positive bacteria (Staphylococcus epidermis) were the most frequent bacterial contamination. Staphylococcus bacteria are a major cause of nosocomial infections, Staphylococcus aureus and Staphylococcus epidermidis are the most common Species that can be pathogenic. Sometimes staphylococcal infections, especially those that occur in hospitalized patients are resistant to most are resistant to most existing antibiotics and are referred to as MRSA [10]. Likewise, in the study by *Kim et al*. [11], most bacteria isolated from the nose and hands of dental personnel were staphylococcus aureus [11]. Rautemaa *et al*. [3] stated that, due to the contamination of the surfaces after dental work and despite various disinfection methods, there is no method that could free the environment from harmful bacteria [3]. Williams *et al*. [6] compared levels of bacterial surface contamination in a teaching clinic in 1976 and 1998 to see if renovation and more stringent infection control procedures made a difference. They found that in both studies, mean bacterial counts were higher at the end of the day than in the morning, but the differences were only significant in the 1976 study [6]. This finding accords with the result obtained in the present study. Enterococci are one of the most common causes of hospital infections, and their transmission is mainly through the hands of hospital staff members, some of whom are carriers of enterococci in their digestive tract. The most common site of infection is the urinary tract, scars, blood, and bile ducts. Isolating Enterococcus genus after disinfection indicates that the bacteria were transmitted from dental staff to the units. Saharkhizan *et al.* [12] compared the effectiveness of new disinfectants such as Sanocil, Alprocide, Bibfort, Javel-dose with that of Micro10 and Deconex in disinfecting organisms isolated from dentistry units. They reported that Deconex and Alprocide were very effective disinfectants, Sanosil and Javel-dose were relatively good, and Bibfort had mild effectiveness, but Micro 10 was relatively weak [12]. We can conclude from the results obtained in the current study that contamination of dental unit is inevitable and that it is important to disinfect different levels of dental units once a patient is treated and before another patient receives treatment. This can reduce transmission of infection from one patient to another. Moreover, since infection control is economical and cost-effective, it is important that dental staff be trained and patients be made aware in this regard. In general, there were no significant differences in infection rates before and after disinfection of units in different parts of the dental units and different departments and also in terms of the type of microorganisms. The fact that the disinfection process did not yield significant results can be attributed to the use of covers for different parts of dental units, which significantly reduce the microbial load on unit surfaces so that only 15.2% of the samples were contaminated with bacteria. The point of concern in this study is the addition of some microorganisms in the process of disinfection. This highlights the importance of providing continued education to the dental staff on how to perform disinfection with maximum accuracy. It is also important to form an infection control committee with trained and experienced members. Finally, this study shows that the current methods of cleaning and disinfecting dental units need to be reconsidered and improved. Taking precautionary measures and implementing clean-up procedures can reduce the load of microorganisms, and this shows that the level of bacterial load can be indicative of the effectiveness of the implemented infection control principles. Failure to follow infection control procedures and in particular insufficient disinfection of the surfaces can result in the addition of microorganisms in the office environment. Hence, high levels of bacterial contamination indicate that the principles of infection control are not properly observed. It is incumbent upon dental staff to ensure

that these principles are stringently followed so that cross-infection can be prevented and microorganisms can be controlled.

CONCLUSION

The present study produced the following major findings:

- The dental units in different departments were not significantly different from one another in terms of the amount of contamination before and after disinfection.
- There was no statistically significant difference between the dental units in terms of the type of microorganisms.
- In some cases, the process of disinfection adds new microorganisms, and this is indicative of the importance of continued education and training for dental staff.
- Before and after disinfection Staphylococcus epidermidis was the most frequent bacterial contamination.

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