Original Article

Evaluation of Efficacy of Four Disinfectants on Striated and Non-striated Orthodontic Instruments: An In Vitro Study

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ABSTRACT

Introduction: To achieve effective infection control only disinfecting instruments is not perfect when sterilization is an ideal method. Few chemical disinfection methods have disadvantage of not killing spores as cross infection is of great importance in dentistry; Standard sterilization and disinfection protocols must be followed by dental health care professionals for efficient infection control. Aim: The aim of this study was to evaluate the efficacy of undiluted concentrations of Durr Dental system, Bacillol, Savlon, and Dettol for disinfection of striated and nonstriated orthodontic instruments. Materials and Methods: Orthodontic instruments were divided into two groups. Each group of instrument was exposed to three microbes: Streptococcus mutans, Candida albicans, and Bacillus subtilis. Once the instruments were exposed to bacteria, they were immersed in four commercially available disinfectants: Durr Dental solution, Bacillol, Dettol, and Savlon. Culture streaks were taken at 5, 10, and 15 min of contact time and growth of organisms was observed on culture media. Results: All the four disinfectants showed no growth of bacteria and all were significantly effective. As per the immersion time factor, Durr system and Bacillol were more efficient than Dettol and Savlon. Conclusion: Study concluded that there was no growth of bacteria after disinfecting in all the four disinfectants. Dettol and Savlon were unable to eliminate B. subtilis at 5 min of contact time. All the disinfectants were effective in eliminating the microorganisms at 10 and 15 min postexposure.

Keywords: Disinfection, microbiological study, orthodontic instruments, sterilization

INTRODUCTION

Sterilization and disinfection play a vital role in medical and dental practice. Infection control is of the main concerns among dental health-care workers because of prevalence of blood-borne diseases. Dentists are prone to infection through direct contact of blood, saliva, and aerosol. Infection control is crucial for preventing cross contamination from one patient to other patient and from patient to dental personnel.[1]

Infection control measures have overtime become an essential and integral part of every orthodontic dental practice. Hepatitis B, HIV, and herpes virus complex along with various bacteria are some of the high-risk cross infectious agents that spread through saliva and blood. Instruments used in an orthodontic office are high-risk sources of infection. It is difficult to identify infected persons without proper blood investigations. So it is better to treat all patients with

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same precautions that would be taken while treating an infected person. [2]

It has been found that orthodontists are at high risk of transmitting cross infection compared to other dental specialist as they did not tend to adhere to strict infection control protocols. This was attributed of the presence of a larger volume of patients in an orthodontic office and use of multiple pliers on a single patient at short interval. [3] There was also a concern regarding deterioration of instrument quality and blunting of cutting edges because of repetitive exposure to high temperature while autoclaving. These problems undoubtedly contributed to questioning of the methods of sterilization of instruments in an orthodontic office. [4]

Cross contamination and risk of transmission of pathogens can be narrowed down by proper sterilization and disinfection; the correct protocol for effective chair side disinfection of contaminated orthodontic instruments remains a critical question. These disinfection methods are technique sensitive and must be performed meticulously. It is always preferred to sterilize whenever possible and disinfection should be used only when there is no other alternative.

It is necessary to improve the standard of chair side infection control protocol for an orthodontic office. Commercially many chemical disinfectants are available but their efficacy is questionable and these chemicals may not be suitable for orthodontic instruments so it is need of the hour to determine the effects of these commercial disinfectants on orthodontic instruments. [5]

The aim of this study was to throw light on efficacy of four commercial disinfectants in eliminating Streptococcus mutans, Bacillus subtilis, and Candida albicans from striated and nonstriated orthodontic instruments at three time intervals.

**Materials and Methods**

The sample consisted of 10 orthodontic instruments that were divided into two groups. Group 1 comprised striated instrument that included Weingart, straight hoe, curved hoe, bracket positioner, and Mathew needle holder. Group 2 consisted of nonstriated instruments that included debonding plier, band remover, ligature cutter, distal end cutter, and bird beak plier [Figure 1]. All the instruments were thoroughly cleaned in ultrasonic bath along with enzyme detergent and autoclaved before the commencement of the test procedure to make sure the instruments were sterile.

The following clinical isolate strains were acquired to be used in the study: *S. mutans* ATCC 0497, *C. albicans* ATCC 90028, and *B. subtilis* ATCC 0736. The disinfectants to be used were Durr Dental solution, Bacillol, Dettol, and Savlon [Figure 2].

These organisms were grown in nutrient broth to obtain required turbidity of 0.5 McFarland tube. Instruments from G1 and G2 were immersed in bacterial suspension for 60 minutes to allow adhesion of microorganisms to them. Instruments were then removed and were immersed in one of the four disinfectant solutions. After 15 minutes the instruments were removed from the disinfectant solution and were dipped in neutralizing agent for another 15 minutes. [Figure 3].

Finally, solutions of suspension, disinfection, and neutralizer were streaked at 5, 10, and 15 min interval and cultured on blood agar and MacConkey’s agar [Figure 4]. The same procedure was repeated by immersion of instruments into Bacillol, Dettol, and Savlon, respectively. The results of the disinfection of instruments were judged by the growth of bacteria. The results were tabulated and sent for statistical evaluation.

Statistical analysis was performed using descriptive statistics such as mean, standard deviation, and standard error to describe the mean scores. Kruskal–Wallis test was applied to compare four disinfectant groups and Mann–Whitney test was used for pairwise comparison.
To compare proportions between disinfectant groups, chi-square test was used.

RESULTS
Results of the study showed that no growth of all the three microorganism was seen in striated and nonstriated instruments after immersion with Durr Dental system and Bacillol at 5, 10, and 15 min of exposure. Both the groups of instruments disinfected using Dettol showed growth of *B. subtilis* in 5-min immersion time but it was destroyed when observed at 10 and 15 min postexposure.

Savlon showed growth of *B. subtilis* at 5-min immersion time and no growth was seen at 10- and 15-min time interval. This shows that Dettol and Savlon were not efficient against *B. subtilis* at 5-min interval but were able to disinfect the instruments at 10 and 15 min [Table 1 and Graph 1].

DISCUSSION
Cross infection control has taken the shape of a global problem and has international concerns. It is one of most important and pertinent topics of discussion and concern among health-care workers in the field of medicine. Dental practitioners are constantly exposed to an environment with infectious pathogens and unknowingly they also act as a carrier in transfer of these pathogens to healthy patients. Orthodontic instruments act as medium through which these microorganisms can be transmitted from one patient to other.

Conventional methods of disinfection include autoclaving, dry heat method, and use of Chemiclave. Conventional autoclave makes use of saturated water vapors at a temperature of 240°F, with 15 pounds of pressure for 15–40 min. It is the gold standard method but for orthodontists it is problematic as it requires long time duration to effectively sterilize. It is also likely to cause rusting of pliers resulting in blunting of cutting edges.[5]

Dry heat is a low-cost sterilization procedure but has its own drawbacks. The first drawback was the time required for a complete cycle is 1–2 h at 320°F, which is too long to be practical during a busy practice day. The second problem was the air gets stratified and causes uneven temperatures that caused improper sterilization. Unsaturated chemical vapor sterilization, also known as Chemiclave, was a suitable alternative for orthodontic instruments. Its working required 240°F temperature, with 20–40 pounds of pressure for a time period of 20 min. Use of unsaturated vapor resulted in absence of rusting. The main drawback was a residual chemical odor that required adequate drying in a ventilated area before usage of instruments.[6] To overcome these problems, the most practical and time efficient method available is use of chemical surface disinfectants.
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Surface disinfectants such as Durr Dental hygiene and Bacillol were found to be more efficient than Dettol and Savlon. Durr Dental and Bacillol significantly reduced the mean colony count at 5 min after immersion. Increase in immersion time resulted in enhanced antimicrobial activity. Savlon was found to have the least antimicrobial activity out of all the disinfectants.

In Ghanbarzadeh et al.’s study, alginate discs were immersed in disinfectant solutions. Glutaraldehyde component showed antimicrobial activity that was superior to alcohol-based component. The results were similar with our study. Instruments immersed in durr dental and Bacillol showed absence of bacterial growth after 5 minutes of contact time. At 15 minutes of contact time, all four disinfectants were able to eliminate Streptococcus Aureus, Bacillus subtilis and Candida Albicans from both atriated and non-striated instruments.

In standard sterilization procedure using autoclaves, corrosion is induced and there is decrease wear resistance of the cutting edges of ligature cutting pliers. Angelillo et al.’s study suggested that it is necessary to investigate every step of sterilization cycle to determine its effects on decreasing the life of orthodontic wire-cutting pliers.

Almeida et al. concluded that glutaraldehyde at 2% concentration was an efficient method to disinfectant orthodontic pliers as it was able to eliminate the microorganisms with a contact time of 30 min. Other disadvantage of glutaraldehyde was presence of unpleasant odor, toxic fumes that irritated eyes, skin, caused respiratory distress, and staining of instruments. These drawbacks were the main setbacks in regular usage of glutaraldehyde as disinfectant solution.

It must always be kept in mind that disinfection is temporary solution, which reduces the number of pathogens with the use of chemical agents. Saha et al. suggested that formalin was effective in eliminating various pathogens and Milhaud et al. reported that development of resistance to formaldehyde during sporulation was related to the concentration of formaldehyde used. He also reported that Gram negative bacteria were more resistant to be eliminated by antiseptics and disinfectants. Absolute alcohol is less effective than 70% aqueous solution of the same. Alcohol is bactericidal against vegetative forms but American Dental Association does not recommend use of alcohols, quaternary ammonium compounds (QACs), or phenolic compounds for sterilization in dentistry, because they are nonsporicidal and ineffective against hepatitis B virus. Dettol (alcohol-based component) was inefficient at 5-min immersion on B. subtilis but was efficient on 10- and 15-min immersion.

Immersion for 10 minutes in 2% chlorhexidine gluconate solution resulted in complete disinfection by elimination of Staphylococcus aureus at short and long exposures. These findings were in similar to other investigators, who showed the efficacy of chlorhexidine gluconate against C. albicans and S. mutans.

The protocol we used in our study was based on those of previous investigators who showed successful use of chlorhexidine gluconate solution as a disinfection agent. According to Smith, 24 h of immersion in a solution with 4% concentration of chlorhexidine gluconate was effective against methicillin-resistant S. aureus. Savlon that has chlorhexidine gluconate as a key ingredient was not efficient on B. subtilis at 5 min of immersion, whereas it was found significantly efficient in eliminating at 10 and 15 min.

Effectiveness of chemical agents in disinfection process is dependent on the morphology and surface characteristics of the instrument. It is well understood

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**Table 1: Growth of three microorganisms at different time intervals postexposure to various disinfectants**

|                      | Durr Dental baseline | 5 min | 10 min | 15 min | 5 min | 10 min | 15 min | 5 min | 10 min | 15 min |
|----------------------|----------------------|-------|--------|--------|-------|--------|--------|-------|--------|--------|
| Streptococcus mutans | 100                  | 0     | 0      | 0      | 100   | 0      | 0      | 100   | 0      | 0      |
| Bacillus subtilis    | 100                  | 0     | 0      | 0      | 100   | 0      | 0      | 100   | 0      | 0      |
| Candida albicans     | 100                  | 0     | 0      | 0      | 100   | 0      | 0      | 100   | 0      | 0      |

**Graph 1:** Graph showing growth of *Bacillus subtilis* in Dettol and Savlon group at 5 min and absence of growth of microbes at 10 and 15 min in all disinfectant groups
that the more roughness of surfaces, the less will be the contact of all surfaces with the disinfectant solution.[1]

However, as found in literatures, it should be noted that disinfection is not a substitute for sterilization.[2] Care should be taken so that instruments that can be sterilized must not be disinfected. Thus, this study proved that Durr Dental and Bacillol were efficient on 5-min immersion, whereas Dettol and Savlon showed efficiency on 10-min immersion. All four were efficient and effective on 15-min immersion. Dettol was not efficient on *B. subtilis* on 5-min immersion time and Savlon was not efficient on *B. subtilis* and *Escherichia coli* on 5-min immersion time, whereas Durr Dental and Bacillol were efficient and effective on six microorganisms.

It must be kept in mind that efficacy of disinfectants for eliminating pathogens is dependent on multiple factors such as chemical used, surface characteristics, and properties of the instrument.[8]

**Conclusion**

The sterilization method to be used is determined by the nature of material and the microorganisms that have to be eliminated. Autoclave still remains the gold standard for achieving efficient and predictable sterilization but there are times where faster methods of achieving asepsis are necessary. The study concluded that Durr Dental solution, Bacillol, Dettol, and Savlon in undiluted concentrations were able to effectively eliminate *S. mutans*, *C. albicans*, and *B. subtilis* from both striated and nonstriated instruments if adequate contact time was provided.

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**Conflicts of interest**

There are no conflicts of interest.

**REFERENCES**

1. Ghanbarzadeh M, Dehghani M, Ghazvini K, Movahhed T. Disinfection of orthodontic pliers using three different disinfectants. J Int Dent Med Res 2014;7:1-6.
2. Angelillo IF, Bianco A, Nobile CGA, Pavia M. Evaluation of the efficacy of glutaraldehyde and peroxygen disinfection of dental instruments. Microbio 1998;27:292-6.
3. Almeida CMF, Carvalho AS, Duarte DA. Evaluation of disinfection methods of orthodontic pliers. Dental Press J Orthod 2012;17:105-9.
4. Ganavadiya R, Chandra Shekar BR, Saxena V, Tomar P, Gupta R, Khandelwal G. Disinfecting efficacy of three chemical disinfectants on contaminated diagnostic instruments: a randomized trial. J Basic Clin Pharm 2014;5:98-104.
5. Payne GS. Sterilization and disinfection in the orthodontic office. Am J Orthod Dentofacial Orthop 1986;90:250-2.
6. Aksoy A, Kilic G, Hussein E, Aboukhalil D. Sterilization and disinfection in orthodontics. Principles in Contemporary Orthodontics. Chapter 6. InTech. Rijeka, Croatia: 2011. p. 113-28.
7. Saha AK, Haque MF, Karmaker S, Mohanta MK. Antibacterial effects of some antiseptics and disinfectants. J Life Earth Sci 2009;3:19-21.
8. Shanon TK, Robert KS, Mark IM, Cyrus MA. Sterilization in orthodontics. J Clin Orthod 1987;21:326-36.
9. Karen TA, Paula VS, Ana Lucia M, Eunice TG, Ana Claudia P, Carlos EV. Effectiveness of two disinfectant solutions and microwave irradiation in disinfecting complete dentures contaminated with methicillin-resistant Staphylococcus aureus. JADA 2012;143:270-7.
10. Mulick JF. Upgrading sterilization in the orthodontic practice. Am J Orthod 1986;89:346-51.
11. McDonnell G, Russell AD. Antiseptics and Disinfectants: Activity, Action, and Resistance. Clin Microbiol Rev 1999;12:147-79.
12. Smith EG. Glass bead sterilization of orthodontic bands. Am J Orthod Dentofacial Orthop 1986;90:243-9.