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RESEARCH ARTICLE

STERILIZATION IN ORTHODONTICS – A REVIEW

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ABSTRACT

On a daily basis, the practicing dentist and his personal are at risk of being exposed to a wide range of patients with blood borne diseases such as HIV/AIDS, hepatitis B, C and air borne diseases such as tuberculosis. Infection can be directly transmitted by oral fluids, blood, contaminated instruments and surfaces or via the respiratory system.Control of infection that spreads through various instruments and armamentarium used in the field of orthodontics and dentistry in general is of utmost importance as a preventive measure for cross infection. So, this article reviews the various methods of sterilization by focusing on the guidelines for an effective and efficient orthodontic practice.

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INTRODUCTION

Sterilization is a process by which an article, surface or medium is freed of all micro-organisms either in vegetative or spore state. Considering the enormity of challenge that infectious agents pose against us, as well as their nature to continuously evolve in real time; the implementation and execution of effective infection control protocols among all health care communities including our own is vital. Against this backdrop; an appraisal of the current sterilization protocols from an orthodontic prespective is outlined so that it would facilitate the discerning orthodontist in us to make an informed decision towards their implementation. To accomplish infection control accurately and to reduce the risk of cross contamination, all patients have to be treated while practicing universal precautions, the latter including the imperative steps of disinfection and sterilization. According to Starnbach in 1988, orthodontists have the second highest incidence of Hepatitis B among dental workers (Starnbach, 1988). Saliva, is the most common modes of transmission in dental offices through puncture wounds, skin abrasions, or lesions. Dental aerosols, splattering, and instrument contamination can also transmit the virus, which can survive for several weeks at room temperature.

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Some orthodontic instruments used regularly have hinges and cutting edges, and this makes disinfection prior to sterilization a sensitive procedure (Holht, 1998). Considering the enormity of the challenge that infectious agents pose against us, as well as their nature to continuously evolve in real time; the implementation and execution of effective infection control protocols among all health care communities is vital.

Sterilization techniques

Pre-Sterilization Cleaning: The process involves debridement of all instruments contaminated with blood, saliva and other impurities prior to undergoing a sterilization process. It is generally done by hand washing the instruments using detergents and brushes. However, in recent times ultrasonic baths and instrument washer equipment have also been employed.

Dry Heat Sterilization: Dry heat causes destructive oxidation of constituents, denaturation of bacterial protein, and oxidative damage and toxic effects on bacterial cell. *Moist Heat sterilization* causes denaturation and coagulation of bacterial enzyme protein. The dry heat sterilization (DHS) and clinical recycling (CR) produces significant changes in the loading and unloading characteristics of NiTi wires. Clinical recycling reduces the "pseudo plasticity" of NiTi wires and increases its stiffness (Kapila, 1992). A study conducted to compare the

nickel ion concentrations released from recycled NiTi wires after sterilization by either dry heat or steam autoclave showed no significant differences in the nickel ion concentrations released into the saliva (Poosti *et al*., 2009). Similarly another study conducted to compare the wear of orthodontic ligature-cutting pliers after multiple cycles of cutting stainless steel ligature wire (.025 mm) and sterilizing with dry heat or steam autoclave showed no significant difference in the mean wear at the tip of the pliers concluding that there is no need to maintain both sterilization systems, dry heat and steam autoclave, in the orthodontic office. Steam autoclave sterilization can be used with no deleterious effects on the pliers if they are manufactured with good quality stainless steel inserts.[5]The absence of moisture is of utmost importance for the longevity of the pliers (Rapisarda *et al*., 1999). Hot air oven is the most widely used method of sterilization by dry heat. A holding period of 160ºC(320ºF) for 1 hr is used to sterilize glassware, forceps, scissors, scalpels, all glass syringes, swabs, liquid paraffin, dusting powder, fats and grease. Present day hot air sterilization involves cycles at 190ºc for 6-12 minutes and is also called as Rapid dry-Heat Sterilization. Studies have concluded that neither the heat sterilization nor multiple cycling procedures had a deleterious effect on the elastic moduli, surface topography, or tensile properties of Nitinol or Titanium arch wire (Mayhew, 1988).

Flaming: Tips of the instruments are held in a Bunsen flame till they become red-hot. These include inoculating loop of wires, points of forceps, searing spatulas etc. Articles are passed for a few seconds without letting them get red hot which include scalpels, needles, mouth of culture tubes, glass slides and cover slips (Matlack *et al*., 1979).

***Glass bead sterilizer*:** The glass bead sterilizer uses a metal cup with glass beads of 1.2-1.5mm in diameter. The use of this method in orthodontics is limited to orthodontic bands. The recommended protocol for sterilization of single molar band to have a sporicidal effect is 220ºC for 45 seconds (Smith, 1986).

***Autoclaving*:** Autoclaving is the most popular method of sterilization and is considered as a gold standard for sterilization procedures. The basic principle is that when the pressure inside a closed chamber increases, the temperature at which water boils also increases. It liberates 518 calories of heat. Bacillus stearothermophilus is used for testing the efficiency.

The conventional method involves pressure in the range of 15 to 20 psi at a temperature of 121°C to 134ºC (250°F). A holding time of 15-21 minutes at 121ºc (conventional method) or 3 minutes at 134ºC (rapid cycle) is required for proper sterilization. The complete cycle from the start of sterilization to subsequent cooling requires 45 minutes to one hour. Although it is the most popular method of sterilization the presence of steam vapor during the process of heating has detrimental effect on the orthodontic pliers in the form of rusting and corrosion (Jones, 1993). However, a study conducted by Vendrell[5] on orthodontic ligature-cutting pliers with stainless steel inserts showed no significant difference in mean wear whether sterilized with steam autoclave or dry heat. Steam autoclave sterilization can be used with no significant deleterious effects on pliers with stainless steel inserts. The sterilization procedures which included steam autoclave, dry heat, or cold solution sterilization showed no clinically significant differences between new and used arch wires.

***Ethylene oxide sterilization*:** Ethylene oxide is a gas at temperatures above 10.8ºC. It has excellent penetration capacity and is sporicidal as well as virocidal. Gas sterilization is effective in killing bacteria, but is also costly and difficult, making it impractical for orthodontic offices (Ascencio *et al*., 1998).

***Chemical Immersion/Cold Sterilization*:** This method is recommended only for heat sensitive non-surgical instruments and alginate impressions. 2% gluteraldehyde is the most popular high level disinfectants used in dentistry. It is very effective method of inactivation of bacterial spores. It is used as an as immersion solution for metallic instruments, face masks, heat sensitive plastic rubbers, and fiber optics. This method can be employed on elastomeric materials such as elastomeric modules by cutting them into smaller sections and covering them with clear tubing, which could then be cold sterilized. Studies comparing the various sterilization protocols have revealed that cold sterilization causes a pitting type of corrosion of orthodontic instruments as against surface corrosion caused by other methods (Wichelhaus, 2004). A method to sterilize plastic items and heat sterilizable cheek retractors by immersing them in procide (sterilization solution which turns milky) after autoclaving and there by optimizing the sterilization technique has been followed (Drake *et al*., 1997). Alcohol is an effective skin antiseptic and valuable disinfectant for medical instruments. Ethyl and isopropyl alcohol are most frequently used. Isopropyl alcohol is preferred to ethyl alcohol as it is a better fat solvent, more bactericidal and less volatile. It is active at a conc. of 50-70%. It denatures proteins and lipids and leads to cell membrane disintegration.

Laser (Light Amplification by stimulated Emission of Radiation): Recent experiments indicate that laser beams cannot only sterilize instruments[14] but also the air in operating rooms, as well as wound surfaces. Various types of lasers used include CO2, Argon, and NdYAG lasers etc. The cost factor has been the primary reason for its uncommon use.

Sterilization and disinfection of orthodontic instruments and material

Orthodontists generally do not make very intensive operations on tissues and they do not treat infectious diseases. Despite this, however, patients can carry germs that may infect other people. The use of proper sterilization techniques is important today because of the professional, ethical and legal aspects.

Sterilization of orthodontic pliers

Prior to dry-heat sterilization, if water drops or excess disinfectant is left on the pliers they can be severely damaged. Corrosion of these instruments is one of the few sterilization consequences that orthodontists face. To prevent corrosion, orthodontic pliers should be dried with pressured air prior to sterilization. If they are not dried well, ions' reaction will create a loose layer of rust. Corrosion can also be prevented by oiling the joint surfaces with appropriate solutions.

Autoclaving will negatively affect orthodontic instruments causing blunting and corrosion of their sharp cutting edges. And one of its major disadvantages is that it is time consuming. Hence, soaking in 1% sodium nitrate can be recommended as an alternative. Glass bead sterilization is another viable method in which pliers are left inside the sterilizer at 218^{o}C (450^{o}F) for 15 seconds only. Note that large instruments cannot be sterilized with this method. A successful high level disinfection can be obtained by using an ultrasonic bath (Sekusept 5%).

Disinfection of orthodontic brackets

Chlorhexidine is an appropriate disinfectant to be used on metal or ceramic brackets. In a study that evaluated the effect of 0.01 % chlorhexidine solution on metal and ceramic brackets, it was found that chlorhexidine does not have a significant effect on the metal brackets' adhesion ability (Kapila, 1995). On the other hand, the attachment ability of ceramic brackets is significantly affected from this disinfecting solution, but the clinical effect does not reach levels below 6-8 Mpa (Speera, 2005).

Decontamination of orthodontic bands

Stainless steel bands of various sizes are frequently used on molars during fixed orthodontic treatment. Choosing the appropriate size requires often several trials. If trying of the bands is attempted inside the patient's mouth and determined that the size is not appropriate, the band should be decontaminated from saliva and blood, and autoclaved for future use (Benson, 2007).

Sterilization of orthodontic wires

Studies on the effect of sterilization on orthodontic wires have been going on since the 1980's. The results are in contradiction with one another. Some of the studies report mechanical alterations whereas the others defend the opposite (Buckthal, 1986). Pernier *et al* (2005) observed the sterilization of 6 different arch wires by autoclaving them for 18 minutes in 134ºC via surface analysis techniques. No significant change was observed on the alloys surface characteristics that would affect their utilization.

Disinfection of elastomeric ligatures

Polyurethane elastomers are frequently used in orthodontics as ligature and chains. The unused parts of elastomeric ligatures are generally sterilized via cold sterilization since they are not heat resistant. Various studies showed that repeated disinfection of the same elastic can accelerate the destruction of the cross links available in the long chain molecules of polyurethane polyesters. Sterilization of elastomeric ligatures inside the autoclave at 121^{o}C does not lead to permanent deformations or to increased shrinkage whereas in the case of dry-heat, their manipulation becomes more difficult (Mayberry, 1996).

Bacterial contamination and disinfection of removable acrylic appliances

When using removable appliances, there is an excessive formation of a biofilm layer that is observed on the retentive areas of hooks and springs, and on the smooth acrylic surfaces of the appliance. Studies showed that Lactobacillus and Streptococcus mutans levels are increased inside dental biofilm as a result of changing oral micro flora during orthodontic therapy with active removable appliances. Toothbrushes were not efficient enough to remove the microorganisms on the retentive areas of the appliances. Hence, it is recommended to use antimicrobial agents to eliminate the bacterial biofilm. Disinfection methods of acrylic orthodontic appliances should inactivate pathogenic microorganisms immediately, without damaging the composition of the appliance. Soaking the appliance in a chemical solution could cause decomposition of the acrylic resin molecules. In Lessa *et al*'s study, (Lessa, 2007), chlorhexidine gluconate, cetilpyridinium chloridine and sterile water were compared in terms of their eliminating action on Streptococcus mutans. Antimicrobial solutions in spray form were used, and they were examined for causing any changes in the composition of acrylic or not. The results of this study suggested that both of the previously mentioned antimicrobial agents reduced contamination compared to sterile water, but chlorhexidine gluconate was found to be significantly more effective than cetilpyridinium chloridine.

Conclusion

It is incumbent upon each orthodontist to conduct their practice in a manner that restricts the spread of infection and cross contamination. The presence of transmissible diseases like HIV/AIDS and Hepatitis B & C make it an absolute necessity to protect clinic staff and patients from cross contamination, by using effective disinfection and sterilization techniques. As the age old saying *"Prevention is better than cure"* goes, thorough understanding of the application of the sterilization will help ensure safety from the invisible but deadly world of microbial pathogens. Hence utilization of proper sterilization, disinfectants and aseptic procedures will help us achieve the safety of our professional demands.

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