Sterilization Methods in Orthodontics - A Review

Abstract
Sterilization is a process by which an article, surface or medium is freed of all micro-organisms either in vegetative or spore state. 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. Considering the fact that the rate at which newer strains evolve with time and older strains develop resistance it has become a constant challenge through time and in the years to come. The article reviews the various methods of sterilization by focusing on the guidelines for an effective and efficient orthodontic practice.

Key Words: Orthodontic Pliers; Sterilization Methods

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Introduction
Sterilization in orthodontics has been discussed and stressed through times in the dental literature.(1-3) Both patients and practitioners produce a substantial risk of spread of infection like hepatitis B, pneumonia and HIV because of the nature of oral environment which is rich in diverse aerobic and anaerobic bacterial flora. In a survey conducted on the various specialty practitioners of the dental faculty, based on the risk of contracting hepatitis, the orthodontists were the second highest among the group in contracting hepatitis.(2) Sterilization, asepsis and universal precautions to prevent infectious disease transmission is often neglected in dental practice. Hence this article review the various sterilization protocols pertaining to orthodontic instruments apart from implementation of additional infection control measures required in general.

The advice sheet on infection control formulated by the department of health, United Kingdom proposed a three stage protocol to sterilization which includes pre-sterilization cleaning, sterilization and storage.

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. Depending on the instrument load this procedure lasts between 10-20 minutes. At the end of pre-sterilization procedure it is very important to eliminate any residual moisture on the instruments as it may lead to corrosion when certain types of sterilization procedures are employed in the next stage.

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.(4) 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.(5) 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.(6) The absence of moisture is of utmost importance for the longevity of the pliers.(7)

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. Materials may be dipped in a disinfectant before flaming. 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.(2)

**Hot air oven** is the most widely used method of sterilization by dry heat. A holding period of 160°C (320°F) 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 190°C for 6-12 minutes and is also called as Rapid dry-Heat Sterilization. It is suitable for dry powders and water free oily substance. This type of energy does not penetrate materials easily and thus long periods of exposure to high temperatures are necessary. It is an effective and safe method of sterilization for metal instruments such as pliers and mirrors as it does not cause corrosion of Carbon steel instruments and burs.(2)

**Glass bead sterilizer:** The glass bead sterilizer uses a metal cup with glass beads of 1.2-1.5mm in diameter. Larger beads are not effective in transferring heat to due to presence of large air spaces between the beads which reduces the efficiency of the sterilizer when operated at a temperature range of 218°C - 240°C for 3-5 seconds. The use of this method in orthodontics is limited to orthodontic bands. However it is theoretically possible to sterilize one or two pliers within 20-30 seconds. A longer sterilization time is required because larger the instrument longer the heat-up time. Similarly if more than one molar band at a time is placed in the well twice the amount of time is required. The recommended protocol for sterilization of single molar band to have a sporicidal effect is 220°C for 45 seconds. (9)

**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. As the water molecules in steam become more energized, their penetration also increases. It is used for heat resistant plastics, dental hand pieces, dental instruments, cotton rolls, gauze, anesthetic syringes, glass slab, towel packs. (8) The conventional method involves pressure in the range of 15 to 20 psi at a temperature of 121°C to 134°C (250°F). A holding time of 15-21 minutes at 121°C (conventional method) or 3 minutes at 134°C (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. (10) However, a study conducted by Vendrell(6) on orthodontic ligation-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. A lot of attention has been focused on sterilization of molar bands for both the tried-in bands as well as the new bands. (9) It is recommended to sterilize the tried-in molar bands separately without mixing them up with the new ones. If the tried-in molar bands cannot be sterilized immediately, it is advisable to process them through a pre-sterilization cleaning procedure with ultrasonic scaling and storing them separately. (11)

**Ethylene oxide sterilization:** Ethylene oxide is a gas at temperatures above 10.8°C. It has excellent penetration capacity and is sporicidal as well as virocidal. It is both toxic and highly explosive. The gas is released into tightly sealed chamber where it circulates for up to 4hrs which is carefully controlled with humidity and mixed with CO₂ and nitrogen to reduce concentration of up to 10% so that it is less explosive. The chamber then must be flushed with inert gas for 8-12 hours to ensure that all traces of ethylene oxide are removed. Otherwise, the chemical can cause “cold burns” on contact. It is used to sterilize paper, leather, wood, metal and rubber as well as plastic. The conventional orthodontic marking pencils cannot be autoclaved. Gas sterilization is effective in killing bacteria, but is also costly and difficult, making it impractical for orthodontic offices. (12)

**Chemical Immersion/Cold Sterilization:** This method is recommended only for heat sensitive non-surgical instruments and alginate impressions. One of the facts about cold sterilization is that there is no method to verify its effectiveness. 2% gluteraldehyde is the most popular high level disinfectants used in dentistry. It is a colorless liquid with a pungent odor. It is very effective method of inactivation of bacterial...
spores. Studies have shown that spore is permeable to gluteraldehyde regardless of pH and temperature and that chemical penetrates the spore at once. It is used as an as immersion solution for metallic instruments, face masks, heat sensitive plastic rubbers, and fiber optics. The duration of sterilization is about 6-10 hrs at room temperature. It is non-corrosive, nontoxic and can sterilize heat sensitive equipment. An added advantage is its low cost. Long immersion time, odor, irritating to mucous membrane (eyes), and monitoring is a relative disadvantage. 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.(13) 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.(14) 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. (15)

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. It is also a strong dehydrating agent. It is used to sterilize the skin prior to cutaneous injections. It is commonly used for disinfection of clinical thermometers. ‘Isopropyl alcohol’ has high bactericidal activity in concentration as high as 99% but is relatively inefficient in the presence of blood and saliva. It lacks sporicidal activity and also causes corrosion of metals. It has been used for sterilization of orthodontic arch wire materials for recycling. Studies 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.(16)

Surface active agents are substances which alter the energy relationships at interfaces producing a reduction of surface tension. They are widely used as wetting agents, detergents as they possesses both water attracting (hydrophilic), and water repelling (hydrophobic) properties. A classic example is an anionic surface active agent (soap). There is a greater compliance with sterilization recommendations including protective barriers among general dentists than orthodontists.(11)

Laser (Light Amplification by stimulated Emission of Radiation): Recent experiments indicate that laser beams can be used to sterilize instruments(17) and 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.

Discussion

One of the most important points to debate on as far as sterilization is concerned is the instrument damage caused in spite of proper sterilization protocol. The factors that influence instrument damage include the water quality, use of strong detergents, excessive heat exposure and presence of moisture after pre-sterilization cleaning, improper compositions and concentrations of chemicals used and last but not the least the quality of pliers. It may be more appropriate to categorize the materials used in orthodontics under the following headings and discuss the practical guidelines for an effective process of sterilization:

Orthodontic plier sterilization:

1. Ultrasonic scaling for 5-12 minutes.
2. Rinsing it with distilled water.
3. Remove the excess moisture
4. Lubricate the joints with silicon based lubricants.
5. Sterilize using dry heat or Autoclave (as recommended)

Molar bands:

1. Ultrasonic scaling for 5-12 minutes.
2. Rinsing it with distilled water.
3. Remove the excess moisture
4. Sterilize using dry heat or Autoclave (as recommended)
5. Chemical immersion protocols should be limited to bands without pre-welded attachments.
6. Glass bead sterilization is only an option.

Elastomeric ligatures and chains:

Chemical disinfection is not recommended for elastomeric chains and ligatures as they are known to destabilize their physical characteristics. (18) However, elastomeric modules can be sterilized by cutting them into smaller sections and covering them with clear tubing, which could then be cold sterilized.(10)

Alginate impression: Commonly used disinfecting solutions used for alginate impressions are 2% glutaraldehyde and 1%
sodium hypochlorite. The manufacturer’s prescription recommends immersing the alginate impression for not more than 10 minutes as it may cause alteration in the surface characteristics of the material. (11) Newer alginate impression materials are commercially available as self-disinfecting alginites. (19)

1. Rinse the impression under running water on removal from the oral cavity.
2. Immerse them in disinfecting solution for 7-8 minutes (not more than 10 minutes)
3. Clean under running water to remove the disinfecting solution.
4. Pour the model.

Conclusion

“Prevention is better than cure” a proverb well suited to sterilization. Thorough understanding of the application of sterilization will help ensure safety from the invisible but deadly world of microbial pathogens. Hence utilization of proper sterilization, disinfectants and aseptic procedures help us achieve the safety of our professional demands.

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