Sterilization, Disinfection and Associated Corrosion in Orthodontics

*Dr Ashish Agrawal**

Abstract

Sterilization and disinfection are the two integral processes for maintaining asepsis. A cut or puncture wound provides a patent pathway for infection. Any blood observed in the mouth or in an impression would increase the risk of infection. Orthodontists have the second highest incidence of Hepatitis B among dental professionals. Thus, proper steps in sterilization in compliance with the ADA or CDC guidelines should be followed. Various methods of sterilization and disinfection in orthodontic practice have been vividly enumerated. Use of masks, gloves, protective eye wear and reusable or disposable gowns or laboratory coats should be brought into day to day practice in order to avoid cross contamination. Surfaces that cannot be sterilized should be effectively disinfected with any of the available means. A common problem arising with these methods is the associated corrosion. The corrosion resistance of orthodontic grade steel is directly proportional to its chromium content and inversely proportional to its carbon content. Recommendations by the instrument manufacturers must be followed in order to reduce any unwanted corrosion of the orthodontic instruments from steam autoclaving. A thorough understanding of application of sterilization along with properly followed techniques will ensure safety from deadly organisms along with appropriate care of the delicate instruments.

Keywords: **Sterilization, Disinfection, ADA guild lines, Corrosion.**

Introduction

The process of sterilization finds application in all medical fields for prevention of contamination by extraneous organisms, for maintenance of asepsis. The methods of sterilization employed depend on the purpose for which sterilization is carried out, the material, which has to be sterilized, and the nature of the microorganisms that are to be removed or destroyed. Microorganisms are ubiquitous. Since they cause contamination, infection and decay, it becomes necessary to remove or destroy them from materials or from areas. This is the object of sterilization.

A recent study[1] found that orthodontists have the second highest incidence of hepatitis B among dental professionals. Saliva is about half as infectious as blood, and the most likely modes of transmission in dental offices are 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.

Cross Contamination: is one of the ways by which infection spreads in a dental clinic/ hospital. There are 3 possible ways of cross contamination:

1. **Critical:** These include instruments that penetrate mucosa and must be sterilized.
2. **Semi critical:** Instruments that touch the mucosa but don't penetrate should also be sterilized.
3. **Least critical:** This includes the surface that is touched during treatment.

Risk Factors for Orthodontists and Staff

A cut or puncture wound provides a patent pathway for infection. If an orthodontist receives an average of one wound per week then a new cut or puncture wound would occur before the previous one had healed. Those who did not wear gloves would therefore be constantly exposed to infection.

Any blood observed in the mouth or in an impression would also increase the risk of infection, and this apparently occurs at least four times per day in the average office. Blood, in amount as small as 0.00000001ml, has been shown to be capable of transmitting HBV.[2] Blood is potentially infective for HBV for as many as

*Assistant Professor, Faculty of Dental Sciences, IMS BHU. ***E-Mail Id:*** ashishdoc2000@yahoo.com

seven days after drying, and for AIDS for as many as three days after drying.

Steps in Sterilization

1. **Rinsing:** All instruments should be rinsed and washed thoroughly which will remove all the non-sticky debris.

2. **Dibridment with ultrasonic scalers:** This will remove the sticky materials and dried blood from the instruments. The cycle will last for 2-15 min as per the kind of material that is sticking or the kind of ultrasonic cleaner.

3. **Dry thoroughly:** This can be done under hot air. This is essentially to avoid any damage to the instrument during next stage.

Compliance with ADA/ CDC Guidelines[3]

1. Masks are worn to protect oral and nasal mucosa from splatter of blood and saliva.
2. Gloves should be worn while treating all patients.
3. Eyes should be protected with some type of covering to protect from splatter of blood and saliva.
4. Reusable and disposable gowns, laboratory coats, or uniforms must be worn when clothing may be soiled with blood or other body fluids.
5. Sterilization methods known to kill all life forms should be used on dental instruments.
6. Instruments that are not intended to penetrate soft tissues or bone but may come into contact with oral tissues should also be sterilized.
7. CDC guidelines indicate that alcohol is an unacceptable choice for surface decontamination regimens.
8. Routine sterilization of hand pieces between patients is desirable; however, not all hand pieces can be sterilized.
9. Materials, impressions, and intraoral appliances should be cleaned and disinfected before being handled, adjusted, or sent to a dental laboratory.

Physical Agents	Chemicals
Sunlight	Alcohol: Ethyl, Isopropyl, Trichlorobutanol
Drying	Aldehydes: Formaldehyde, Glutaraldehyde
Dry Heat: Flamming, Inceration, Hot Air	Halogens
Moist Heat Boiling, (Steam Under Normal Pressure, Steam under Pressure)	Phenol
Radiation	Surface – Active Agents
Ultrasonic and Sonic Vibrations	Metallic Salts and Gasses (Ethyleneoxide, Fomaldehyde, Betapropiolactone)

Table 1.Various agents used in sterilization

Various Methods of Sterilization and Disinfection in Orthodontic Practice[2,3,4,5]

Sterilization

a. Ultrasonic cleaning

b. Steam pressure: 250 degree at 15 psi for 15 min, 270 degree at 30 psi for 3 min

c. Chemical vapor: (HCHO,-OH ,water)

   Instruments are wrapped and kept in the chamber at 270 degree at 20-40 psi for 20 min. However, when the chamber is opened the toxic fumes are allowed to escape.

d. Dry heat: 320 –340 degree for 1 hour

e. Heat transfer media: (Salt or Glass bead Sterilizer) effective against all organisms and spores, mainly used for smaller instruments.

f. Hyperbaric gas: (Ethylene oxide): Sterilization is recommended for instruments that are prone to corrosion or heat damage. However, the process is slow and costly, and the effluent gas is highly toxic. Another disadvantage is that materials retain varying amounts of ethylene oxide gas after removal from the sterilizer, and this must be allowed to dissipate before use. The standard treatment varies with temperature: 12 hours are required at room temperature, and four hours at 56°C for effective sterilization.

Disinfection Methods

Disinfection refers to the destruction of pathogenic microorganisms. It is a procedure which is incapable to destroy the spore and certain resistant microorganisms such as tubercle bacilli and hepatitis viruses.

- **a. Quaternary Ammonium Compound** (QAC or "quat") reduces the surface tension between bacteria and an object, thus disrupting the bacterial cell wall. Concentration, degree of contamination, level and extent of contact, and presence of other compounds all play a role in QAC effectiveness. Combining several disinfectants-for example, a QAC with a phenolic compound containing an anionic detergent-can cause them to neutralize each other.

- **b. Phenol** is not itself used as a disinfectant, but many disinfectants have been derived from it. At high concentrations, phenol is a rapid protoplasmic poison that penetrates the cell wall and precipitates the cell protein. The effectiveness of phenolic compounds depends on contact with the bacterial cell. These compounds are effective against vegetative bacteria, lipophilic viruses, and tuberculosis, but not against bacterial spores or hydrophilic viruses.

- **c. Alcoho**l is a moderate disinfectant that behaves similarly to a QAC. Absolute alcohol is less effective than a 70 percent aqueous solution. Alcohol is generally bactericidal against vegetative forms. However, the ADA does not recommend alcohols, QACs, or phenolic compounds for use in dentistry, because they are nonsporicidal and ineffective against hepatitis B virus.

- **d. Chlorine** in aqueous solutions, even in minute amounts, is rapidly bactericidal. The exact mechanism of this activity is not known, but theories range from cell wall damage and enzyme system blockage to protoplasmic poisoning. Chlorine disinfectant should be prepared with distilled water and used on objects that have been cleaned of all gross soil, tissue, and contaminants. It is effective against a wide spectrum of bacteria, enteroviruses, and spores, but chlorine solutions are unstable and must be made daily. Chlorine can corrode metals and soften plastics; it has a persistent odor and is irritating to eyes and skin. These disadvantages usually rule out routine use of chlorine solutions.

- **e. Iodine** is a faster disinfectant than a QAC or chlorine. The free iodine forms salts with the bacterial protein, thus killing the cell. It is effective against vegetative bacteria, spores, fungi, and certain viruses. Iodophors make effective surface disinfectants and are easily prepared by mixing iodine concentrate with softened or distilled water (hard water and some concentrations of alcohol will inactivate the iodine).

Contamination Vehicles

There are three main contamination vehicles that must be effectively sterilized:

- ✓ Instruments contaminated with blood or saliva,
- ✓ Surfaces contaminated with blood or saliva,
- ✓ Staff members' hands.

Instruments that are commonly used in Orthodontic Department

Instruments requiring sterilization include mirrors, pliers, scalers, banding and bonding instruments, bands, impression trays, cotton pliers, and ligature directors. Some, including plastic band seating instruments, cheek retractors, mirrors, and bite planes, cannot withstand heat sterilization. If ethylene oxide is not being used and the instrument would be damaged by heat sterilization, it should be thoroughly derided and submerged in a fresh solution of glutaraldehyde or formaldehyde for one to 10 hours.[6] The length of time depends on the sterilant used and the temperature of the solution.

Surfaces that are commonly used in Orthodontic Department

Surfaces that cannot be sterilized should be effectively disinfected. These surfaces include bracket trays, air/ water syringes, saliva ejector handles, chair control buttons, operatory light handles, sink handles, supply drawers, and chair armrests and headrests. Contaminated surfaces can be scrubbed with iodophor-soaked 4" ´ 4" gauze pads and allowed to dry. Gauze soaked with 70 percent alcohol can be used to remove the residue after drying. The iodine solution has a built-in antimicrobial activity indicator— when it turns from amber to clear, it should be replaced. Iodophors have a slight allergenic reaction with skin and can stain light-colored surfaces after repeated use. Vitawipes are disposable disinfectant cloths containing polyhydrochloride (3.2 percent), alkyl dimethyl, benzyl ammonium chloride (7.1 percent), and inert ingredients (89.7 percent). The cloth is dampened with water and used to wipe contaminated surfaces. It does not kill bacterial spores, mycobacterium tuberculosis, or hepatitis B virus on contact, but disinfects by physically removing the potential pathogens. The cloth is disposed of after an indicator strip changes color or after wiping a surface contaminated with hepatitis B virus.

Corrosion associated with Sterilization of Orthodontic Instruments

Corrosion is an electrolytic process in which the contact of two dissimilar metals (or dissimilar areas within a single metal) sets up a potential difference resulting in an electron flow. This electron flow leaves behind reactive ions that readily combine with atmospheric oxygen to form oxides (rust).

There are five types of electrolytic corrosion:

1. **Solution corrosion**: Strong solutions such as blood or saliva form the electrolyte and cause corrosion as either an acid or a strong base.
2. **Debris (interface) corrosion**: Debris such as cement or dried blood sets up a potential difference, resulting in electron flow and rust at the edges.
3. **Heat** itself will not cause corrosion, but it accelerates the process by increasing the rate of molecular reaction.
4. **Stress corrosion** involves lattice distortions at the point of stress in metals, producing an area of preferential electrochemical attack that may lead to breakage and corrosion.
5. **Pit corrosion:** A surface can be invaginated from scratches, hinge wear, or previous corrosion. This small corrosion cell then produces pit corrosion.

The corrosion resistance of orthodontic grade steel is directly proportional to its chromium content and inversely proportional to its carbon content.

Steps that can be taken to reduce Corrosion of Orthodontic Instrument from Steam Autoclaving

1. Instruments must first be cleaned thoroughly and rinsed with distilled water to ensure there are no deposits on the surface. Do not allow blood, saliva, or other contaminants to dry on instruments. An ultrasonic cleaner can be used before autoclaving to remove debris.
2. Tap water contains minute quantities of dissolved alkali and metallic ions that may be deposited on the metal surface. Rinsing with distilled water leaves the surface at a neutral pH, and alkaline or metallic deposits will not attach to a surface in the neutral range.
3. The steam used in the autoclave cycle should be deionized and of good quality. Bicarbonate alkalinity breakdown + carbon dioxide can cause the formation of carbonic acid. If the pH of the steam falls below 6.4, pitting and corrosion will occur.
4. Chrome-plated instruments should be autoclaved separately from stainless steel ones. Electrolytic action can carry carbon particles from the exposed metal of a plated instrument and deposit them on the stainless steel. In addition, instruments should not be laid on each other or directly on the rack during the steam cycle.
5. Detergents with chloride bases should not be used, because chloride residue unites with steam to form hydrochloric acid.
6. Detergents with a pH greater than 8.5 may disrupt the chromium oxide layer.

Light or dark spots on instruments usually result from minerals in the water, especially sodium, calcium, and magnesium. Purple or black staining is caused by exposure to ammonia. This can be prevented by thorough rinsing and by avoiding detergents containing amines.

The Effect of Sterilization on the Tensile Strength Orthodontic Wire[7]

As over head cost increases, orthodontists are continually searching for the way to reduce the cost, e.g. the reuse of Niti and Beta titanium are approximately 3 times more expensive than stainless steel wires, while Niti wires 2 times as expensive. Therefore the challenge is to make more cost effective use of these wires. Sterilization and re use of more expensive orthodontic wires is one option. Different methods that were used for sterilization included autoclaving, dry heat and ethelene oxide. Dry heat sterilization significantly increases the tensile strength of TMA wire after 1 cycle but not after 5 cycles. Autoclaving and ethelene oxide sterilization did not significantly alter the tensile strength of TMA wires. Dry heat and autoclaving sterilization also significantly increase the tensile strength of Sent Alloy Wires but the mean strength after 5 cycles was not significantly different from 1 cycle. Ethelene oxide sterilization of sent alloy wires did not significantly alter the tensile strength of that wire.

Conclusion

Sterilization of instruments is a multi process that begins with washing off debris after use, and then specific steps are required for effective completion of sterilization and disinfection. Thorough understanding of the application of sterilization will help ensure safety from the invisible but deadly world of microbial pathogens. Sterilization/ disinfection procedures should be adapted to the chemical profile of the metal alloys present. Recommendations for use published by instrument manufacturers must be followed**.**

References

1. Kirchhoff ST, Sekijima RK, Masunaga MI et al. Sterilization in Orthodontics. *JCO* May 1987: 326-36.
2. Campbell PM, Phenix N. Sterilization in the Orthodontic Office. *JCO* Oct 1986: 684-86.
3. Cash RG. Trends in Sterilization and Disinfection Procedures. *AJODO* Oct 1990: 292-99.
4. Cash RG. Sterilization and Disinfection Procedures: A Survey of Georgia Orthodontists. *JCO* Jan 1988: 22-28.
5. Buckthal JE, Mayhew MJ, Kusy RP. Survey of Sterilization and Disinfection Procedures. *JCO* Nov 1986: 759-65.
6. Matalak RE. Instrument sterilization in Orthodontic office. *Angle Orthodontics* 1980; 49(3): 205-10.
7. Straggers JA, Margeson D. The effect of sterilization on the tensile strength of orthodontic wire. *Angle Orthodontics* 1993: 63(2): 141-44.