Review Article

De-rigueur Protocol: Sterilization in Orthodontics

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Abstract

Orthodontist and his personnel are at risk of being exposed to a wide range of patients with blood-borne diseases such as HIV/AIDS, hepatitis B, hepatitis C, and airborne diseases such as tuberculosis and influenza. Infection can be directly transmitted by blood, oral fluids, contaminated instruments and surfaces, or through the respiratory system. Control of infection that spreads through various instruments and armamentarium, which are used in the field of orthodontics and dentistry in general, is an important measure to prevent cross infections which can be achieved by following universal precautions, including the imperative steps of disinfection and sterilization. The objective of sterilization is to remove microorganisms or destroy them from areas or from materials since they cause contamination, infection, and decay. Specific issues in orthodontic office that need to be addressed include increased hand washing, use of barrier techniques, puncture-proof containers for disposal of sharps, and heat sterilization of handpieces and orthodontic instruments. This is of utmost importance to keep patient-to-patient and dentist-to-patient infection transmission at a minimum. In the following article, authors have attempted to provide certain practical guidelines to be followed in practice for optimal infection control.

Keywords: Dental clinic, orthodontic office, sterilization

Introduction

Orthodontists often come in direct contact with blood and oral fluids of patients when placing or removing fixed appliances[1] and these patients may have tuberculosis or even HIV or they may be undetected hepatitis B carriers as these diseases have a long incubation period, and hence, it is difficult to identify the source of such infections.

Even though orthodontic patients are considered low-risk patients for hepatitis B still, every patient should be treated as a possible carrier because, according to a study, orthodontists have the second highest incidence of hepatitis B among dental professionals.[2]

According to Mosley and White,[3] the greatest danger for an orthodontist and his staff is from puncturing of the skin with contaminated instruments, sharp edges of an orthodontic appliance, as any cuts or abrasions will allow microorganisms to enter into the body, saliva is about half as infectious as blood [Figure 1]. Dental aerosols, splattering and contamination of instruments can also transmit viruses which can survive for several weeks at room temperature.[4]

Before beginning with the patient work, orthodontist should have clear primary goals of infection control in his/her mind.

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One must always remember that by reducing the levels of pathogens, the risk of cross-contamination should be lowered and any break in aseptic technique should be corrected immediately. Universal precautions should be used religiously with every patient, treating each patient and instrument as potentially infectious. The standards of universal precautions and infection control remain generally unchanged, but technological advancements, new products, new material, and new data require constant evaluation and adjustments of the techniques. It is mandatory to apply the most recent disinfection and sterilization practices to achieve the best results.

The first instructions for general infection control in dentistry were published by the Center for Disease Control and Prevention in 1986, and are being updated every year in this respect.[5]

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Figure 1: Contaminated instruments

Definitions

Sterilization

It destroys all forms of microorganisms including viruses and bacterial and mycotic spores. An instrument will be either sterile or not sterile. There is no in between.[6]

Disinfection

Disinfection is the process of destroying or inhibiting most pathogenic microorganisms and inactivating some viruses, hence, reducing microbial contamination to safety levels.[6]

Antisepsis

It involves the application of chemicals on living tissue to avoid infection.

Asepsis

It means an environment free of germs. That is the destruction of all disease-forming microorganisms in the working environment. Starnbach and Biddle[2] established some initial guidelines for asepsis in an orthodontic office. According to them, orthodontist and his staff, supplies and instrument, and operatory surfaces are links in cross-contamination, and these are the areas to which orthodontist must direct his/her attention. Hence, an orthodontist must know about the instrument to be sterilized because of blood and saliva contamination such as scalers, bands, and band removers.

Modalities of Protection, Prevention, and Control

Primary level

The protection level includes the protection of orthodontist, personnel, and operator site with the primary goal of infection control [Figure 2].

Secondary level

The prevention level includes prevention of orthodontist and his personnel from all kinds of infections while following all possible steps for infection control [Figure 3].

Tertiary level

Tertiary level includes the control level sterilization of armamentarium used during treatment as well as the disposal of contaminated wastes for infection control [Figure 4].

Figure 2: Primary level (protection level)

Primary Level: The Protection Level

Primary level includes the primary goals and the areas of infection control. To protect patients and personnel from occupational infections, to lower the risk of cross-contamination by reducing the levels of pathogens, to use universal precautions with every patient (treat every patient and instrument as potentially infectious), and to correct any break in aseptic technique should be the primary goals. The areas of infection control are orthodontist and staff, instruments, and the operator site.

Orthodontist and staff

- Good personal hygiene is the keystone of protection. The most important aspect of this is frequent hand washing. They should be washed at least for a minute in cold water with germicidal soap. Cold water is suggested because hot water may cause pores to open.[2] Then, the use of a hand disinfectant is administered. As far as the orthodontist is concerned, a reasonably complete medical history of his patient is important in determining who all are more likely carrying pathogenic organisms [Figure 5].

Instruments

- The orthodontist must decide for himself, which instruments need to be sterilized. Instruments can be of three categories according to Spaulding system:[7]
  a. Critical:- Instruments that penetrate the mucosa must be sterilized, for example, bands, band removers, ligature directors, orthodontic mini-implant placement kit, band-forming pliers
  b. Semi-Critical: Instruments that touches the mucosa should be sterilized whenever possible or treated with high-level disinfectants, for example, most of the orthodontic instruments, mirrors, retractors, dental handpieces
  c. Least Critical: Instruments that do not touch mucous membrane such as distal-end cutter, ligature cutter, torquing keys, arch forming pliers, V-bend forming plier, bracket positioning gauges should be disinfected.

Operator site

The orthodontist should have in mind that chair, table, spittoon, light handles three-way syringes, etc., all become contaminated. It should be wiped frequently with 70% isopropyl alcohol. It is

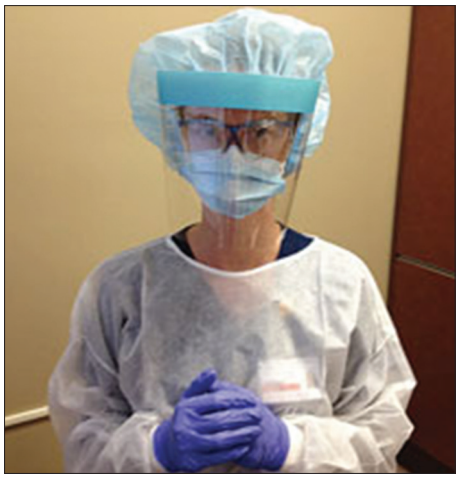

Figure 3: Secondary level

Figure 5: Protection barrier for orthodontist and staff

advisable to have straight tubing for the handpiece, three-way syringe, and handpieces should be fitted with a nonretraction valve. The number of tubing and wires which can accumulate dust should be minimized [Figure 6].

Secondary Level: The Prevention Level

This level includes all the steps necessary for infection control which leads to the prevention of orthodontist and personnel. It starts from patient screening and covers all aspect of personal protection, the first line of defense, that is, barrier method.

Patient Screening

A regular informative medical history of the patient can help to identify factors that assist in the diagnosis of systemic and oral disorders. Many patients often fail to provide the information. Every patient should be treated as potentially infectious. This important fundamental application of infection control is termed as UNIVERSAL PRECAUTIONS. The body fluid and blood precautions substantially reduce the clinical guesswork of a patient's infection status.

Figure 4: Tertiary level (control level)

Figure 6: Protection at operator site

Personal protection

Repeated exposure to blood and saliva during the dental treatment procedures may challenge the dentist's immune defense with a wide range of microbial agents. In this context, barrier protection and immunological protection are required.

Immunological protection

For immunological protection, the operator should be vaccinated with available vaccines of proven efficacy to prevent the onset of subclinical or clinical infection. The occupational risk of contacting hepatitis B, measles, rubella, influenza, and certain other microbial infections can be minimized by stimulating artificial active immunity.

Barrier control

Barrier protection should be against the range of potential pathogens encountered during patient treatment. The physical barriers such as disposable gloves, face masks, protective eyewear, head cap, and surgical gowns during treatment procedure will minimize the infectious exposure [Figure 7].

Protection of body using barrier method

Gloves

Abrasions and cuts, often found in fingers, will serve as roots of microbial infection entry into the system when ungloved hands are placed in patient's oral cavity – Wet-Fingered Dentistry. Hand washing is not a substitute for use of gloves, but the hands and nails should be cleaned with appropriate skin antiseptics both before wearing and after removing gloves[8] [Figure 8].

Figure 7: Barrier control

Four types of gloves can be identified for use in dentistry:[9]

A. Sterile surgical gloves: Best fitting and expensive disposable glove should be used when maximum protection is required. Ensure practitioner proper fit of a high-quality latex glove
B. Latex examination gloves: These are most commonly used gloves. Occasional hypersensitivity to latex has been reported. Inadequate drying before gloving can cause dermatitis
C. Vinyl examination gloves: Wear over gloves. Used when the intraoperative procedure is interrupted for a brief time, for example, to attend telephone
D. Nondisposable gloves/Heavy utility gloves: Used when handling contaminated supplies or instruments. They can be washed sterilized, disinfected, and reused. Pinholes are present in all gloves. It can lead to penetration and multiplication of microorganism.

Orthodontist's gloves orthodontists, repeatedly handle wire, bands, and ligatures which increase the risk of glove puncture. The orthodontist can use puncture-resistant gloves which are thicker at the palm region, a high-stress area for ligature placement, and thinner material at the fingertips. Improper fitting gloves, reuse of gloves, and washing of with antiseptics are not recommended. Washing gloves increase the size and number of pinholes.

Protective eyewear

Eyes are more susceptible to physical injury and microbial attack because of their diminished immune capacities and limited vascularity. Droplets containing microbial contaminants can result to conjunctivitis. The operator should have a protective eyewear during working. If protection eyewear is available for patients,[10] it is advisable because handpieces, sharp instruments, archwires, etc. are routinely passed over the patient's face. Removing a patient's glasses during dental treatment for the sake of comfort can no longer be recommended [Figure 9].

Masks

The best face masks can filter 95% of droplets of 3.0–3.2 microns in diameter and protect the operator from microbe-laden aerosolized droplets. Mask should fit around the entire periphery of the face, and it is advised to change the mask between each patient. Mask should be removed immediately after finishing by tearing it from the back and not left hanging around the neck [Figure 10].

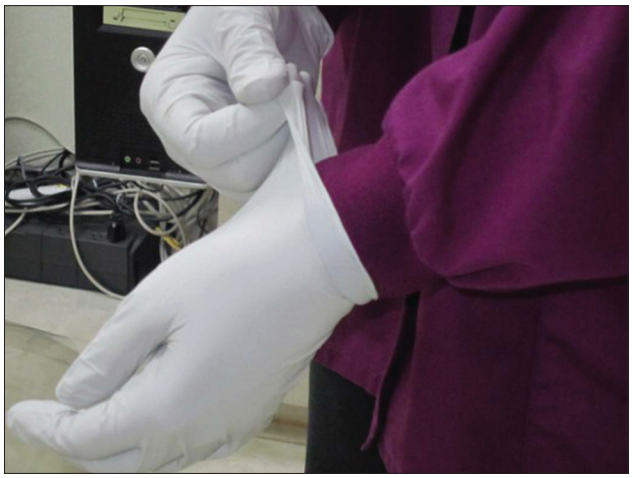

Figure 8: Gloves

Shoe Covers and Head Covers

A pair of smooth, slip-on shoes should be kept exclusively for use in the clinics. These should be cleaned at the end of each clinical session. Headcovers provide an effective barrier [Figure 11].

Proper clinical attire

Appropriate dental clinic attire is a misunderstood area as any practitioners place too much emphasis on the choice of attire and not enough emphasis on correct protocol. Although OSHA statement indicates that all exposed skin surfaces should be covered, the short-sleeved uniform may be acceptable. Intact skin is an adequate barrier against bloodborne pathogens. Gowns should be with fewer buckles and buttons. OSHA emphasizes that shoes and street clothes must not be worn during patient treatment. Personnel should not wear clinic attire to and from the workplace.

It is mandatory to use the aprons while examining patients or while working in the laboratory. These procedures will sow microorganisms into the fabric of the apron[11] [Figure 12].

Tertiary Level: The Control Level

After the damage has been done that is instruments or other objects in dental clinics have been exposed to infection-causing microorganisms, this level comes into play. The prime goal is decontamination, disinfection, and sterilization and disposal.

Disinfection

Disinfection procedures are advised only for those operatory surfaces and materials that cannot be routinely sterilized, such as dental chair, the table and working surfaces, and for certain orthodontic instruments.

Figure 9: Protective eyewear

Figure 10: Mouth mask

Figure 11: Head and shoe cover

Figure 12: Proper clinical attire

Surface disinfection

Surfaces that are likely to be contaminated by the handling or by the spatter or spill of oral contaminants should be disinfected. Surfaces touched by the dental surgeon are called touch surfaces, for example, unit handles, various controls, light cure unit, micromotor, ultrasonic handpiece, three-way syringe. The surfaces which are contaminated by contact with soiled instruments are called transfer surfaces, for example, instrument trays, tube and handpiece holders.[12] Surface disinfection can be done by scrubbing the surface with the iodophor-soaked gauze pads and allowed to dry. Then, 70% isopropyl alcohol should be used to remove the residue. Other materials such as sodium hypochlorite 5.25% (1:10 dilution), iodophors such as Biocide and combination synthetics (Phenolics, Multicide, and Omni II Vitaphine) and only 0.25% (w/v) glutaraldehyde can be used as surface disinfectants. However, they should be used with care, as repeated contact may damage the skin.

Instrument disinfection

Least critical instruments such as ligature tier and distal-end cutter, orthodontic brackets, tying pliers, arch forming pliers, torquing keys, elastomeric rings should be disinfected.

Disinfection of elastomeric ligatures

Polyurethane elastomers are frequently used in orthodontics as chain and ligature. The unused parts of elastomeric ligatures are generally sterilized through cold sterilization since they are not heat resistant. Disinfection of these materials in a 5% glutaraldehyde solution for 10 min is recommended.[13]

Based on two different disinfectants, glass transformation and tensile strength temperature of elastomeric ligatures that are not disinfected are found significantly different than those that are exposed to phenol and glutaraldehyde.[14] Schneeweiss[15] indicated a method of cutting elastomeric modules into smaller sections and covering them with clear tubing, which could then be cold sterilized.

Disinfection of orthodontic brackets

Chlorhexidine is an efficient disinfectant to be used on metal or ceramic brackets. Speer *et al*.[16] 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 bracket's adhesion ability. On the other hand, the attachment ability of ceramic brackets is significantly affected by this disinfecting solution, but the clinical effect does not reach levels below 6–8.[17]

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 springs and hooks, and on the smooth acrylic surfaces of the appliance.[18,19] Toothbrushes were not efficient enough to remove all the microorganisms on the retentive areas of the appliances. Hence, it is recommended to use antimicrobial agents to eliminate the bacterial biofilm.[20] Disinfection methods of acrylic orthodontic appliances should eradicate 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.[21] Oral safe is a germicide deodorant that is harmless if ingested. In a previous study, it was found to destroy 99% of microbes on removable appliances during 10 min of submersion.[22]

Orthodontic Marking Pencils

In practice, orthodontists focus their attention on sterilization of pliers, handpieces, and other instruments. Orthodontic marking pencils are usually not considered as a possible link in the chain of infection. Commonly used methods are:

- Wiping with a sterile gauze
- Soaking pencil tips in disinfectant.

A study by Ascencio *et al*.[23] showed that a single touch of a marking pencil tip was sufficient to pick up and retain as many as 350,000 bacteria. This study also showed that conventional wiping of orthodontic marking pencil is ineffective in eradicating infectious microorganisms. The only sure way to avoid potential cross-contamination is to use the inexpensive, disposable markers.

Disinfecting the alginate impression

Rinse the impression thoroughly under running tap water; remove the excess water from the impression.

Dip the impression in a 1:10 solution of sodium hypochlorite for required amount of seconds to ensure maximum contact of undercut with the disinfectant. Wrap the impression in gauze soaked in 1:10 sodium hypochlorite and seal it in a plastic bag for 10 min. Remove the impression and rinse thoroughly under running tap water [Figure 13].

Decontamination

Work against all kinds of germs to reduce the microbial source in amount for protection from unexpected contamination and infection is called decontamination.

Decontamination of orthodontic bands

Stainless steel bands of various sizes are frequently used on molars during fixed orthodontic treatment. Choosing the proper 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 blood and saliva, and autoclaved for future use.[24] Fulford *et al*.[25] suggested that bacterial multiplication is not observed on the bands that are washed with enzymatic disinfectant before autoclave sterilization.

Figure 13: Disinfection of alginate impressions

Sterilization

Some of the most common ways that are followed in orthodontic practice include steam autoclave sterilization, dry heat sterilization (DHS), chemical vapor sterilization, and ethylene oxide sterilization[26,27] [Table 1 and Figure 14].

Sterilization of orthodontic armamentarium

Orthodontic pliers

Mazzocchi *et al*.[28] showed the effects of different methods of sterilization of pliers.

In autoclave units, the major problem is rusting and the corrosion of the orthodontic plier's joints and dulling of instrument cutting edges.

Chemiclave units cause less corrosion of cutting edge, and it uses alcoholic solution with minimal water, but it emits irritating fumes.

Dry heat units require a higher temperature to operate, for example, 320°F–340°F, slower than the other two but they do not produce rust or fumes. The combination of higher grade stainless steel instruments with the use of a sodium nitrate solution dip can minimize the problems due to corrosion as well as those related to dulling of cutting edges.

Vendrell *et al*.[29] showed that orthodontic ligature-cutting pliers with stainless steel inserts showed insignificant difference in mean wear whether sterilized with a steam autoclave or dry heat. Steam autoclave sterilization can be used with no deleterious effects on pliers with stainless steel inserts.

Mazzocchi *et al*.[28] in their study found that surgical stainless steel pliers are the most suitable for use in clinics where instruments are recycled by steam autoclave sterilization. The most important factor in maintaining the longevity of instruments is to take care of them during cleaning, lubrication, and sterilization process.

Orthodontic wires

Although Ni-Ti archwires display low load deflection and excellent resilience, their high cost has hampered their

Figure 14: Sterilization equipment and method

universal appeal. As a consequence, both the retention and the cost factor of elastic properties have led to reuse these archwires. To minimize the potential health hazard to the patient who gets a recycled wire, accepted techniques of sterilization must be adopted.[30]

Pernier *et al*.[31] observed the sterilization of six different archwires by autoclaving them for 18 min in 134ºC through surface analysis techniques. No significant change was observed on the alloys surface characteristics that would effect their utilization.

Mayhew and Kusy[32] studied the effects of sterilization on the surface topography and the mechanical properties of 0.017″ × 0.025″ Nitinol and Titanal archwires. They concluded that neither multiple cycling procedures nor the heat sterilization had a deleterious effect on the elastic moduli, surface topography, or tensile properties of Nitinol or Titanol archwires.

Kapila *et al*.[33] determined the effects of *in vivo* recycling insinuated by DHS (together referred to as clinical recycling [CR]) on the load-deflection characteristics of nickel–titanium alloy wires (NiTi and Nitinol). The results indicated that both CR and DHS, as well as produced significant changes in the loading and unloading characteristics of Nitinol and NiTi wires.

Staggers and Margeson[34] in their study evaluated the effect of sterilization on the tensile strength of 0.016″ beta-titanium, nickel titanium, and stainless steel wires. The tensile strength of both TMA and Sentalloy increased after sterilization and for autoclave and ethylene oxide sterilization, five sterilization cycles, on an average, resulted in a greater increase in strength than one cycle. However, when TMA and Sentalloy wires were sterilized by dry heat, on an average, one cycle increased the tensile strength by more than five cycles.

Rubber items and saliva ejectors

The best method is to discard them after each use.

Other Items

Singh and Arora[35] proposed various methods of sterilization of instruments used in orthodontic office [Table 2 and Figure 15].

Table 1: Method of sterilization

Method of sterilization	Advantage	Disadvantage
Hot air oven	No corrosion	Longer sterilization time
	Large capacity per cost	Cannot sterilize liquids
	Items are dry after cycle	May damage plastic and rubber items
Autoclave	Good penetration	Nonstainless items may corrode
	Time efficient	Closed containers cannot be used
	Sterilize water-based liquids	May damage plastic or rubber items
Rapid heat sterilizer	No corrosion	Cannot sterilize liquids
	Short cycle	May damage plastic and rubber items
	Items are dry after cycle	Small capacity per cost
Unsaturated chemical vapor sterilization	Suitable method for orthodontic instruments	Drawback of this is the odor, even though not toxic requires adequate ventilation
Ethylene oxide sterilization	Suitable for large institutions	Slow procedure - 4 h at 54°C and 12 h at room temperature
		Costly
		If moisture is present, it reacts with ethylene oxide to form ethylene glycol coating.
		After sterilization articles should be aerated for 24 h for dissipation of gas

Table 2: Sterilization of different instruments

Instruments	Sterilization method
Impressions trays	
Metal trays	Autoclave
Plastic trays	2% glutaraldehyde
Handpieces	Steam autoclave, chemiclave
Burs	Dry heat sterilization, glass bead sterilizer
Fluoride gel trays	Autoclave
Heat-resistant plastic	Disposable
Nonheat-resistant plastic	Ethylene oxide
Suction tips	Disposable, chemical disinfection
X-ray equipment holders	
Metal	Autoclave
Plastic	Chemical disinfection
Mirrors	Dry heat

Waste and sharps disposal system

In dental health-care facilities, management of regulated medical waste is done by use of color-coded or labeled container[36] that prevents leakage (e.g., biohazard bag) to contain nonsharp-regulated medical waste [Table 3]. Handling, segregation, mutilation, disinfection, storage, transportation, and final disposal are vital steps for safe and scientific management of biomedical waste in any establishment.[37]

Figure 15: Sterilisation of orthodontic instruments

Table 3: Color coding and final waste disposal system

Color coding	Treatment options
Yellow - plastic bags	Incineration and deep burial
Red plastic bags	Chemical disinfection, autoclave
Blue/white/trans-plastic bags puncture proof	Chemical disinfection, shredding, autoclave
Black-plastic bag	Secured landfill

Table 4: Waste disposal protocol in an orthodontic office

Material	Disposal
Impression material (discarded/used)	Immerse 1% sodium hypochlorite solution bucket for 24 h and then dispose in black container
Dental casts (discarded/used)	Immerse 1% sodium hypochlorite solution bucket for 24 h and then dispose in black container
Removable appliances with wire component (used/broken not to be worn by patient anymore)	Sharps container containing 1% sodium hypochlorite
Wires, steel ligatures, orthodontic mini implants, needles after being burnt, sharps	Container containing 1% sodium hypochlorite
Wax bite registrations	Red container
Debonded brackets, buttons, and other attachments	Red container
E-chain, elastic ligatures, elastics	Red container
Infected cotton	Yellow container
Mouth mask, gloves	Red container
9 head cap, shoe covers	Black container
Syringe (after breaking at hub in needle destroyer)	Red container
LA bottles	Black container If broken, sharps container

LA: Local Anesthesia

The commonly used items in an orthodontic office and their disposal protocol are shown in Table 4.[27] A sharps container is a mandatory part of the overall waste disposal system within the dental office.[37] Sharps container must be rigid, puncture-proof, leak-resistant, and sterilizable[38-40] [Figure 16].

Conclusion

Always keep in mind that every patient is potentially infectious, so all the safety measures must be taken during dental practice. All the three steps that are primary secondary and tertiary should be employed. No method of sterilization is complete in itself, but we should at least try to achieve as high levels of sterilization as possible along with protection, prevention, and infection control. There is room for improvement in knowledge related to sterilization procedures for both general dentist and orthodontist.

Figure 16: Waste and sharp disposal system

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