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Sterilization In Orthodontic Clinic

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ABSTRACT

Sterilization is defined as process by which an article surface or medium is freed of all micro-organisms including virus, bacteria, spores and fungi both pathogenic and non-pathogenic. A sterile object, in the microbiological sense, is free of living microorganisms. The objective of sterilization is to remove microorganisms or destroy them from materials or from areas since they cause contamination, infection and decay. The methods of sterilization employed depend on the purpose for which it is carried out, the material, which has to be sterilized, and the nature of the microorganisms that are to be removed or destroyed. Various physical and chemical agents are used in sterilization and disinfection of orthodontic materials and instruments such as sunlight, heat, filtration, radiation, ultrasonic vibrations, alcohols, halogens, dyes, aldehydes, gases, phenols etc. Specific issues in orthodontic office that needs to be addressed include increased handwashing, 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 minimum. However, further research is required to investigate occupational injuries and infection control in orthodontic office.

INTRODUCTION

It has been detected that bacteria are found in the ocean waters at all latitudes from 20 degrees south to 90 degrees north and at the bottom of the seas at hydrostatic pressures as great as 13,000 lbs/sq. inch. Some live in natural hot springs at temperature near boiling, others grow at temperatures near freezing. Perhaps one larger area that most closely approaches sterility is the surface of sandy desert. Although dry heat found there is destructive to most bacteria, the greatest sterilizing effect is exerted by the short wave rays from the sun in the near UV spectrum.

The objective of sterilization is to remove microorganisms or destroy them from materials or from areas since they cause contamination, infection and decay. The methods of sterilization employed depend on the purpose for which it is carried out, the material, which has to be sterilized, and the nature of the microorganisms that are to be removed or destroyed. Every health care speciality that involves contact with mucosa, blood or contaminated body fluids needs a special concern. The goal is to ensure compliance with universal barriers and other methods to minimize infection risk.

The increased risk of contracting and spreading major infections like tuberculosis, pneumonia, hepatitis B, and even AIDS through dental treatment procedures is a cause to contemplate. Adequate attention to prevention of cross-contamination in dental operatory has largely been ignored by orthodontist. This has occurred because orthodontic procedures are usually non tissue – invasive and the disease most identified in dentistry, hepatitis B, is thought to be transmitted only by contact with blood

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of an infected carrier. But with the discovery of HB surface antigen in saliva (1972) and later in body secretions (1983), it is time to take critical look at procedures used to protect our patients, assistants, and ourselves [1]. Orthodontists have been reported to have the second highest incidence of hepatitis B among dental professionals. Saliva is about half as infectious as blood, and most likely modes of transmission in dental office are through puncture wounds, skin abrasions etc. Dental aerosols, splattering and instrument contamination can also transmit viruses which can survive for several weeks at room temperature [2].

Orthodontists are becoming increasingly aware of the threat of communicable diseases that can be transmitted between patients and staff. Hepatitis B, herpes and AIDS are certainly the most serious diseases of many that can be contracted in orthodontic office. Even though orthodontic patients are considered low risk patients every patient should be treated as a possible Hepatitis B carrier.

As a minimum our goal should be to reduce the number of pathogenic organisms to a level at which our own body resistance may prevent infection and to break the circle of infection by eliminating cross contamination. To achieve our goals, we must have a clear definition of certain terms like sterilization, asepsis and disinfection.

The recommendation for universal precautions indicate that all patients should be treated as if they are infected with HBV and HIV because all infected persons can't be identified by medical history, physical examination, laboratory test. Hence, considering each patient to be a risk group full proof method of attire and barrier techniques should be employed.

TERMINOLOGY

1. Sterilization: The process of destroying all forms of microbial life. A sterile object, in the microbiological sense, is free of living microorganisms.

2. Disinfection : It is defined as a process of destruction and removal of organisms capable of giving rise to infection.

REVIEW OF LITERATURE

Leeuwenhock (1675) [3] first described bacteria and protozoa under microscope.

Pringle (1750) [3] observed relationship of putrefaction to disease, performed studies with agent's he called "antiseptics".

Jenner (1796) [3] introduced smallpox vaccination as effective and preventive method against disease outbreaks.

Lister (1860-1870) [3] was "father of clean and decent surgery". He introduced aseptic technique for surgery and care of wounds. Lister initially applied dilute carbolic acid (phenol) to contaminated wounds and then progressed to its application in all surgical wounds as well as in operating room by nebulisation of this solution.

Pasteur (1860-1880) [4] established microbiology as a science; developed the process of pasteurisation.

Koch (1870 -1880s) [4] isolated and demonstrated the infectivity of anthrax bacillus; discovered mycobacterium tuberculosis; formulated Koch's postulates for infectious disease investigation.

Mosley & White (1975) [5] found that greatest danger for orthodontist and members of the staff is from puncture of their skin with contaminated instruments or sharp edges of orthodontic appliances. Any small cuts or erosions on the orthodontists hands may allow the entry of minute amounts of serum which is sufficient to cause infection.

Starnbach & Biddle (1980) [6] established some initial guidelines for asepsis in orthodontic office. According to them, orthodontist and his staff, instrument and supplies, and operatory surfaces are links in cross contamination and these are the areas to which orthodontist must direct his attention. Hence, an orthodontist must know instrument to be sterilized because of blood and saliva contamination like bands, scalers, band removers, etc. and which instrument and supplies can be handled safely with disinfectants, like ligature and distal end cutters, mirrors, burs, stones etc.

Payne (1986) [1] evolved a pragmatic approach towards sterilization and disinfection in his office. Each orthodontic office needs would be different but he gave suggestions on how adequate inventory can be determined, according to which one should divide operations into various procedures, banding–bonding, appliance removal, archwire change and routine adjustments and then proceed accordingly. Bands and brackets should be removed from boxes with cotton forceps. Those that have been tried for fit and rejected should be sterilized in glutaraldehyde.

Nalini (2001) [7] conducted a study to find out efficacy of sterilization and infection control procedure followed by practicing orthodontists in Bangalore. Different methods commonly followed were tested for efficacy by carrying out culture tests on the used and autoclaved instruments. It was found that though orthodontists were using protective barrier like mouth masks and gloves but they were not particular about the quality and brand of barriers and did not change them after every patient.

STERILIZATION IN ORTHODONTIC OFFICE [1,8,9]

The keen awareness by both public & professionals of severe disease transmitted through cross – infection has resulted in

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closer examination of orthodontic sterilization & disinfection procedure. George S. Payne [1] recommended ways to maintain an adequate inventory, according to which operations should be divided into various procedures example:

1. Banding – Bonding
2. Appliance removal
3. Arch wire change
4. Routine adjustment

After that a list of instrument used for each procedure should be made and then average for each instrument used per day is determined. Allow 30 minutes to cycle a load & then determine how many of each instrument are needed depending on how they are cycled. Once, the instruments are sterilized there are 2 practical methods for storing sterilized instruments i.e. either to use tray setups or place instruments in paper bags. The instruments in drawers should not be touched & they are placed by assistant on operating tray. Other surfaces should not be touched until hands are washed. Band & brackets should be removed from boxes with cotton forceps. Those that have been tried for fit & rejected should be sterilized in glutaraldehyde. If there is a break in skin on hands, gloves or finger cot should be used. Protective eye glasses should be worn to prevent spattering from entering eyes. **(Figure 1)**

Figure 1. Sterilization Centre.

Instrument Supplies

One can decrease cross – contamination by the number of viable micro organisms on dental instrument at some stage b/w their use on different patients. The orthodontist must divide the instruments that need to be sterilized because of blood & saliva contamination and one which are handled satisfactorily by disinfection. In orthodontic office following instruments and supplies have been selected for sterilization example: bands, scalers, band removers, ligature directors & band forming pliers. These instruments are placed in an ultrasonic cleaner, rinsed in water, dried & placed in a dry heat sterilizer for 2 hrs at 2500 F. Indicator tape is used to determine that sterilization temperature has been reached **(Figure 2).**

Figure 2. Ultrasonic Cleaning.

The following instruments which come into contact with blood & saliva less frequently should be placed in a disinfectant solution: ligature distal end cutters, tying pliers, mirrors, burs & stones. These must be all cleaned with soap, rinsed & placed in a buffered glutaraldehyde solution (cidex) for at least 10 min. Instruments must rinsed before immersion in cidex.

Those instruments that rarely come in contact with mouth are washed, dried & then wiped with gauze pad soaked in 70% isopropyl alcohol example: arch forming pliers, torquing keys & cotton pliers.

Operator site: The treatment chairs, syringes, bracket tables, light handles & handpieces are wiped at noon & evening with guaze pads soaked in 70% isopropyl alcohol.

STERILIZATION OF PLIERS [10]

The most common sterilizers used are for orthodontic instruments are autoclaves, chemiclaves and dry heat units. A study by Paganlli and Morandini [11] in 1997showed the effects of these three methods on sterilization of pliers **(Figure 3).**

In autoclave units, the major problem is rusting and the corrosion of the orthodontic pliers joints and dulling of instrument

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

Figure 3. Storage Drawers for Miscellaneous Pliers.

Dry heat units require higher temperature to operate i.e. 320 – 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 reduce problems due to corrosion as well as those related to dulling of cutting edges.

Some manufacturers recommend, lubrication of the instrument hinges before sterilization but oils should be avoided as they interfere with heat conduction during sterilization. Studies by Carcao [11] showed that:

- The stainless steel used in instruments is formed at 1,800-2,000°F, cooled to 350°F, and tempered at 800-900°F.
- The metal could not be altered by hot air currents unless it reached at least 800°F.
- The carbide steel inserts in pliers are even more inert.

Malcolm Jones, Kelvin Pizzaro and Romolo Blunden [10] in their study found that surgical stainless steel pliers are the most appropriate for use in clinics where instruments are recycled by steam autoclave sterilization. The most important factor in maintaining the longevity of instruments relate to care in cleaning, lubrication and sterilization process.

STERILIZATION OF BRACKETS, BAND MATERIAL [12,13]

The orthodontic brackets and band materials can also be sterilized by standard steam, chemical vapour or dry heat sterilizing cycles. The contaminated brackets and bands must be cleaned, rinsed, dried and then subjected to sterilization cycles.

Studies have shown that all the three methods of sterilization are equally effective. The contaminated orthodontic instruments and bands can be sterilized within OMS-ASAP system cassettes. Buchman [14] in 1980 showed that direct bond metallic brackets can also be recycled. Removal of the acrylic bonding agent which is usually a type of thermosetting filled resin is the most critical part of recycling process and requires either long exposures to heat i.e. 450° C for 60min or use of a solvent. This temp can lead to the reduction of corrosion resistance and hardness of the stainless steel. But it has been shown that the hardness value for the recycled brackets is within 92% of the non-recycled one, thus it has little clinical relevance. Bands often have ink markings indicating their size and side. Heating these bands to high temperature. can cause the evaporation of ink making it difficult to recognize these bands. So some authors recommend chemical sterilization method rather than heat.

STERILIZATION OF NICKEL – TITANIUM ARCH WIRES [15,16]

Although Ni –Ti arch wires display excellent resilience and low load deflection, their high cost has hampered their universal appeal. As a consequence both the cost factor and the retention of elastic properties have lead to reuse these arch wires.

To minimize the potential health hazard to the patient who receives a recycled wire, accepted techniques of sterilization must be adopted.

Three approved sterilization methods are

- Dry heat
- Formaldehyde – alcohol vapor
- Steam autoclave

According to study conducted by Mayhew and Kusy [17] in 1988, no detrimental changes of clinical significance has been observed for the mechanical properties with these sterilization methods.Although, chemical sterilization is accepted it is considered better to sterilize these metal wires by heating.

Effects of Sterilization on Mechanical Properties and Surface Topography of Nickel – Titanium Arch Wires

MAYHEW & KUSY [17] determined the effects of sterilization on mechanical properties and surface topography of 0.017 x 0.025 –inch Nitinol and titanal arch wires. Three approved heat sterilization methods were used: dry heat, formaldehyde – alcohol vapor, and steam autoclave. Elastic moduli were obtained on 1-inch segments in 3 point bending. Laser scans of flatwise wire surfaces were conducted to detect surface alterations i.e. whether they were caused by tarnish, corrosion, or pitting. Tensile properties were determined on 7 inch lengths: the 0.1% yield strength, the ultimate tensile strength, and the percent elongation at break.

Neither the heat sterilization nor multiple cycling procedures had a deleterious effect on the elastic moduli, surface topography, or tensile properties of Nitinol or Titanal arch wires. Laser spectroscopy of nickel – titanium arch wire surfaces was established. Although Titanal is clearly smoother than Nitnol, the influence on sliding mechanics is uncertain at this time. The bending moduli and the tensile strength were approximately 10% greater for Nitinol than Titanal.

The Effects of Sterilization on the Tensile Strength of Orthodontic Wires [15]

Julia Ann Staggers and Dallas Margeson (1993) [15] in their study evaluated the effect of sterilization on tensile strength of 0.016" beta-titanium, nickel titanium and stainless steel wires. Three common methods of sterilization – autoclaving, dry heat and ethylene oxide – were evaluated in three test trials involving zero, one and five sterilization cycles. It was found that sterilization and reuse of orthodontic wires does not alter the ultimate tensile strength. A common reason given for not recycling wire is fear of reducing the wire's strength. The tensile strength of both TMA and Sentalloy increased after sterilization and for autoclave and ethylene oxide sterilization, five cycles, on 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.

Sterilization of stainless steel wire by any method can be expected to decrease the wire's tensile strength. TMA and stainless steel wires with bends are not candidates for recycling since the same bends will rarely fit in more than one patient. Nickel titanium wires are usually placed without orthodontic bends, and most brands of nickel titanium wire are incapable of retaining a bend, which makes this type of wire ideal for sterilization and reuse. Still, breakage and patient abuse of these wires may prevent some wires from being recycled.

Effect of Long-term Immersion Corrosion on the Flexural Properties of Nitinol

Schwaninger et al [18] studied the effects of long term in vitro corrosion on flexural properties of Nitinol, including the modulus of stiffness, flexural yield strength, and bend cycles to fatigue, were evaluated for Nitinol arch wire after periods of immersion in a 1 percent sodium chloride solution for up to 11 months. It was found that corrosion does not affect the physical properties of the wire.

A scanning electron microscopic examination of the surface fractured after repetitive 90-degree bending revealed similar modes of fracture for both corroded and control samples. Early failure of the wire is due to the presence of surface defects generated during manufacturing and not to the effects of corrosion. Improvement of the surface quality of the material by the manufacturer will help improve the clinical performance of Nitinol.

Disinfection of Elastomeric Ligatures [19]

Elastomeric ligatures are sold in strips, of which orthodontist may use from 1 to 10 modules in any one appointment. This leaves the task of disinfecting the remaining modules before they can be used for another patient. 2% glutaraldehyde has been used for disinfection of elastomeric ligatures. Immersion for 10 minutes is adequate for disinfection. However, repeated immersion may accelerate breakage to the cross links among the long chain molecules of polyurethane that lead to rapid relaxation of modules. For sterilization immersion for 10 hours is needed.

Avoiding Cross-Contamination of Elastomeric Ligatures [20]

Cross-contamination in handling elastomeric ligatures is serious concern in the orthodontic office, since cold sterilization can damage the elastomeric material. In addition, most manufacturers produce strips with enough ligatures for both arches of a single patient. If an entire strip is not used at once, the remaining ligatures are either wasted or re-exposed to potential cross-contamination. A clear tubing should be purchased with a lumen of about 5/16" at a hardware store, and cold sterilize the sections. Cut strips of elastomeric ligatures into section about ½" longer than the tubes. Insert the ligature sections into the tubes, leaving the ends of the ligature stick protruding.

During archwire placement, the operator contact only the outside tubing while removing ligatures. The used section of ligatures is cut off and discarded after ligation, and the remaining section is inserted into a clean and sterilized tube. The used tube is placed in a cold sterilizing solution.

The effects of 2% alkaline glutaraldehyde solution on the elastic properties of elastomeric chain

Jeffries & Fraunhofer [21] studied the effect of two proprietary alkaline gluteraldehyde solutions on the strength (failure load) and the required displacement or stretching to achieve a force of 500g of elastomeric chains. The effect of disinfection and sterilization as well as repeated immersion cycles on these parameters was determined. Its was found that cold disinfection /

sterilization via glutaraldehyde solution (sporicidin and cidex-7) may be an effective and convenient approach for elastomeric chain. The displacement required to produce a 500g force increase by 5 mm at most, following long term exposure to glutaraldehyde solution, the force to break chain only decreased by approximately 20-100g under same condition. Discoloration of some chain occurred in the sterilizing solution but this change appeared to have no effect on the chain properties.

The effectiveness of an Elastomeric Module Dispenser in Cross-infection Control [22]

Metal and elastomeric ligatures are potential agents in the transmission of infectious diseases. Mulick [4] recommended single-use dispensing of elastomeric materials to eliminate contact of canes or sticks with contaminated hands. More recently, dispensers have been introduced in the market, but the effectiveness of such dispensers in controlling cross infection has yet to be fully evaluated.

The Alastik dispenser proved to be efficient in limiting cross-infection through single-use dispensing, although it did not offer protection against handling and environmental factors, such as dust. Elastomeric materials should be handled only with surgical gloves. Partially used canes should not be returned to the general stock of elastomeric modules.

Infection Control for Curing Lights [23]

With the increasing popularity of light-cured adhesives, the curing light has become a standard item in many orthodontic offices. Several types of barrier covers have been introduced to prevent contact of the fiberoptic light curing tip with bodily fluids during bonding procedures. Such covers may attenuate the light transmission at the tip and thus affect polymerization of the adhesive. Jay Bowman & Maston [23] tested four type of curing tip covers:

- The Cure Sleeve Model 4500 Light - tip cover, a prepackaged translucent sleeve made of ethylene methacrylate copolymer.
- A translucent latex finger Cot that is rolled over the curing tip.
- Curelastic Cure Light Barrier, A translucent non-latex alternative to the finger cot.
- A 6" x 5" sheet of polyvinyl chloride (PVC) Perforated 920 Cling Film, tightly wrapped around the curing tip.

The PVC film, with no latex, is the least expensive of the four barriers tested. It can also be used as a barrier for the handle of the light-curing unit.

Although further investigation would be required to determine whether extra curing time would be necessary to maintain adequate bond strength when using any of these barrier devices. However, the PVC film warrants consideration as a curing-tip cover for orthodontic bonding procedures.

Orthodontic Marking Pencils as a source of Cross – contamination [24]

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

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

study by Fernando, Langcamp and Petrone [24] in 1998 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 removing infectious micro-organisms. A 20 minute drying interval was selected to represent as a time between patient in an orthodontic office, the pencil wiped with gauze actually increased in bacterial count over this time period. Soaking the pencil tips with disinfectant could be more effective. Even then grooves or pits on the pencil surface may protect some of the bacteria from drying or disinfection. Viral cross – contamination must also be taken into account. Alcohol containing permanent markers are a safe and effective alternative to pencils but it has been noted they become increasingly ineffective in eliminating bacteria the longer they are used.The only sure way to avoid potential cross contamination is to use the inexpensive, disposable markers.

Sterilization of Impressions

Impressions should be rinsed with 2% Gluteraldehyde. Iodoforms can also be used.

Casts and Models

Casts and models received from the laboratory or other dental clinics should be rinsed with5% sodium hypochlorite.

Table 1. Instruments and type of sterilization method.

Instruments	Sterilization Method
Impressions Trays	
Metal trays	Autoclave
Plastic trays	2% Gluteraldehyde

Hand Pieces	Steam autoclave, Chemiclave
Burs	Dry heat sterilization , Glass bead sterilizer
Fluoride gel trays	Autoclave
Heat resistant Plastic	Disposable
Non heat resistant plastic	Ethylene oxide
Mirrors	Dry heat
Suction tips	Disposable, Chemical disinfection
X-ray equipment holders	
Metal	Autoclave
Plastic	Chemical disinfection

CONCLUSION

Although no method of sterilization is complete in itself but we should at least try to achieve as high levels of sterilization as possible by employing techniques with less technical sensitivity and maximum effectiveness. Infection control procedures should be based on the fact with appreciation that risk of disease transmission in dental practice is related to procedures being performed.

There is room for improvement in knowledge related to sterilization procedures of both general dentist and orthodontist. Many fomites lurk in orthodontic office that must be eliminated. Specific issues in orthodontic office that needs to be addressed include increased hand washing, use of barrier techniques, puncture proof containers for disposal of sharps, HB vaccination for staff and heat sterilization of hand pieces and orthodontic instruments. This is of utmost importance to keep patient to patient and dentist to patient infection transmission at minimum. However, further research is required to investigate occupational injuries and infection control in orthodontic office.

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