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Sterilization and Disinfection in Orthodontics

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*Devoted for the memory of my beloved father Okay Aksoy
 who passed away suddenly on 25th of March*

1. Introduction

On a daily basis, the practicing dentist 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 Influenza and Tuberculosis (Değer, 2004; Ozer, 2005). Infection can be directly transmitted by oral fluids, blood, contaminated instruments and surfaces or via the respiratory system (Toroglu et al., 2001; Shah et al., 2009). 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 (Değer, 2004; Akcam and Ozdiler, 1999).

Orthodontists do not perform oral surgery, but come in direct contact with blood and oral fluids of healthy patients or infectious diseases patients when placing or removing fixed appliances (Toroglu et al., 2001). Some orthodontic instruments used regularly have hinges and cutting edges, and this makes disinfection prior to sterilization a sensitive procedure (Holht et al., 1998). Instruments have to be cleaned and dried prior to sterilization in order to minimize damage and corrosion when applicable, and to increase lifespan.

Various dental supplies and instruments that are used every day make specific studies about infection control necessary, as their components and/or their maintenance procedures might differ. The standards of infection control and universal precautions remain generally unchanged, but technologic advancements, new products, new material and new data require constant evaluation and adjustments of the techniques accordingly (Deger, 2004). It is therefore our obligation to apply the most recent disinfection and sterilization practices to achieve the best results (Akcam and Ozdiler, 1999; Ozer, 2005, Haydar, 2000).

The first general infection control instructions for dentistry were published by Center for Disease Control and Prevention (CDC) in 1986 and are being updated every year in this respect. The main principle is to consider each patient as being infected because many infectious diseases can be present in one individual without any signs and symptoms, especially at an early stage (Külekçi, 2000b). The American Dentist Association recommends to all staff part of the dental team to apply the universal precautions prevent infection and cross-contamination. The universal precautions suggest standard application of infection control and sterilization techniques for each patient. (Külekçi, 2000a; Acar, 2007).

1.1 Flora of the human body

In normal conditions, microorganisms are living inside our body, in different regions and different cavities, and on our skin. The external microorganisms are in continuous contact with living things whereas microbial flora interacts with organisms in our body. Most of the time, the interaction of body flora with organisms continues throughout the person's lifetime without causing any damage. (Değer, 2004)

One of the easiest ways for a microorganism to enter the body is via the oral cavity during respiration and/or eating. (Değer, 2004)

1.1.1 Normal microbial flora

The microorganisms living in harmony in the human body are called "normal microbial flora". Human body flora is part of the normal resistance mechanism of the body, hence it begins to establish as early as birth. Most of its microorganisms are bacteria, although viruses, fungi and protozoa can be present in minority. (Değer, 2004)

1.1.2 Permanent flora

Microorganisms are stabilizing in specific regions at different times. They can be modified for a short period but are reestablished not too long afterwards via the permanent flora. (Değer, 2004)

1.1.3 Oral and upper airway normal flora

Mouth flora is established between six and eight hours after birth. The development of oral flora happens throughout the following stages: birth, childhood and adulthood. Oral hygiene and nutrition play an important role as well. Virulent Streptococcus is present in large numbers in the permanent flora, between four to twelve hours after birth. Aerobic and anaerobic staphylococcus, gram (-) diplococci and diphtheroids manifest during infancy before the eruption of the primary teeth. After eruption, Streptococcus Viridans takes over. (Değer 2004)

The microorganisms in the oral flora can be listed as:

- Streptococci
- Anaerobics (Bacteroides, Porphyromonas, Prevotella, Fusobacterium, Capnocytophaga, Peptostreptococcus, Salmonella, Leptotrichia, Eubacterium, Veillonella, Helicobacter, Spirochetes)
- Actinobacilli
- Gram negative bacteria
- Staphylococci (Külekçi, 2000a)

1.1.4 Pathogenesis in oral flora

Pathogenesis of bacteria depends on various factors. Microorganisms spread out vigorously when changes in the mucosal barrier occur, when systemic and local factors might impair tissue congestion and when there is a lack of tissue oxygenation.

Normal oral flora is usually the cause of dental, gingival and bone infections. Frequently, anaerobic bacteria (Bacteroides, Porphyromonas, Prevotella, Fusobacterium, Capnocytophaga, Peptostreptococcus, Salmonella, Leptotrichia, Eubacterium, Veillonella, Helicobacter, Spirochetes) are involved. (Külekçi, 2000a, Değer, 2004)

1.2 Infection and contamination

Infection is the settlement of microorganisms in any of the tissues of a living body for living and proliferation. Disease is the reaction of the tissues exposed to these harmful agents that are called microbes (Georgescu, 2002).

The transfer of pathogens materializes by the way of direct and indirect contact, inhalation and inoculation. Microorganisms that participate in contamination and cross infection during dental procedures, affected areas in the body and associated illnesses are summarized in table 1 (Georgescu, 2002).

For infection to occur four factors are needed and they define the “infection chain”. These factors are:

1. Organism that is sensitive to infection
2. Microorganism that is virulent and pathogenic enough to cause infection
3. Infection carrier
4. Port of entry to the organism

No sickness will take place if not all four are present. An effective infection control strategy aims to break any of the rings of this chain in order to avoid disease (Georgescu, 2002; ADA, 2003).

1.3 Cross-infection in dentistry

Microorganisms are easily transferred between patients, dentists and dental staff in private offices. Infection involving these people is called cross-infection (Mutlu et al., 1996)

Oral cavity harbors the microorganisms that carry the risk of infection by contamination. Infection control is the most common subject that is discussed. Infection risk encloses wide range of area from patient to patient, patient to doctor, patient to dental staff and to laboratory technicians. All employers are responsible to protect their staff and patients from cross infection by applying high standard sterilization and disinfection precautions. (Mutlu et al., 1996, Georgescu, 2002)

1.3.1 Infectious microorganisms in dentistry

1.3.1.1 Hepatitis viruses

Hepatitis Virus is highly important in the field of dentistry. Six hepatitis viruses have been found in the last 35 years. They are identified as A, B, C, D, E and G. B, C, D and G carry heavy importance in dentistry as far as cross-infection is concerned (Bulut, 2009).

Hepatitis B Virus: Infection with Hepatitis B virus (HBV) usually occurs via the parenteral route but also through skin or mucosal cracks. Probability of infection following an injury with a contaminated needle stick or sharp instrument lies between 25 and 30%. Contaminated blood and secretions are the main sources for transmission of infection. In the same order of ideas, saliva on its own is not a problem but since it generally carries blood or blood products it has the potential to infect. Moreover, there is no evidence to prove virus transmission via inhalation or aerosols. It is also known that blood spatter in the eyes, although should not be occurring often, may cause infection. The incubation period for HBV is 45-160 days. Infection begins after the incubation period and lasts during the acute phase. Nevertheless, the acute disease is not always obvious; 50% of the HBV infection is subclinical and the infected people are not always aware of their illnesses (Kocabaş, 2004).

Hepatitis C Virus: Hepatitis C virus (HCV) has been defined in 1988 by modern colonization techniques. This virus is an RNA virus that has 6 types and 40 subtypes. HCV infection is transmitted by the parenteral route. No sexual transmission has been proven up to date. HCV can be found in many of the body fluids. Its ratio in the saliva is generally low and

Herpes Simplex Virus Type I (HSV I)	Nasopharynx	Direct contact	Oral Herpetic lesions Conjunctivitis
Hepatitis B Hepatitis C Hepatitis D Hepatitis G	Liver	Inoculation	Hepatitis B Hepatitis C Hepatitis D Hepatitis G
Human Immunodeficiency Virus (HIV)	T4 lymphocytes (CD4+ lymphocytes)	Blood and body fluids	HIV infection Acquired Immunodeficiency Syndrome (AIDS)
Mycobacterium Tuberculosis	Pharynx	Inhalation of droplets and aerosols born from oropharyngeal secretions	Tuberculosis
Pseudomonas Aeruginosa	Dental chair water	Aerosol inhalation and swallowing of contaminated water	Pneumonia Wound infection Dental abscess
Methicillin-resistant Staphylococcus aureus (MRSA)	Mouth, skin, nasopharynx	Direct contact with hand/ skin	Dental abscess
Candida Albicans	Mouth and skin	Saliva or direct contact with nasopharyngial secretions	Candidiasis Cutaneous infections
Escherichia coli	Gastrointestinal Tract	Aspiration of droplets originating from Oropharyngeal secretions	Wound infection Sinusitis Upper Airway infections
Epstein Barr Virus (EBV)	Lymphoid nodules Nasopharynx		Infectious Mononucleosis, Burkitt Lymphoma

Table 1. Microorganisms that participate in contamination and cross infection during dental procedures, affected areas in the body and associated illnesses (Değer, 2004)

shows correlation with hepatic functions. No HCV transmission is reported in vivo. Incubation period is 15-150 days after viral contact. Many infected persons cannot realize it because of the slow clinical course of development. People having acute infection are 70-80% asymptomatic. After one has been wounded by an HCV contaminated instrument, there is no specific treatment. Immunoglobulin treatment or short term Interferon treatment can be recommended. Retrospective studies show the HCV incidence in healthcare personnel is as high as 4.1% (Dolar, 2006).

Hepatitis D virus or Delta Agent: Hepatitis D virus (HDV) was discovered in 1977. This RNA virus needs HBV for existence, replication and infection. Therefore HDV is found in individuals having either acute Hepatitis B infection or are chronic Hepatitis B carriers. The incubation period after contact is 15-150 days. Hepatitis B vaccination includes immunization for Hepatitis B and D (Kocabaş, 2004).

Hepatitis G Virus: Hepatitis G virus (HGV) discovered lately is a highly infective virus affecting the liver. The ratio of positivity is high in opiate users and in patients who receive

dialysis and/or are hemophilic. Studies on the effect of this virus for chronic hepatitis are still going on. Nevertheless it has been proposed that it does not have a highly toxic effect on the liver depending on the studies conducted so far. HGV from the flavi virus is a type of RNA virus. HGV can be transmitted by blood and blood products. Prevention of HGV is possible and highly successful by effective sterilization techniques (Erensoy, 2001).

1.3.1.2 Herpes Simplex Virus (HSV)

Herpes Simplex virus (HSV), having two antigenic types, is responsible for oral or genital infections. HSV-1 is responsible for oral mucosal infections, whereas HSV-2 is responsible for genital herpetic lesions. HSV infections are generally asymptomatic. Antibodies are found in most of the adults. Prevalence of HSV antibodies is related with the socio-economical state and age of the infected patients. Contamination by HSV occurs by mucosal contact, thus not spreading by air. Agent enters from small skin and mucosal wounds in oropharynx, cervixes and conjunctiva and begins to reproduce. As a result of this proliferation, focal necrosis, epithelial cell degeneration and multiple vesicular eruptions develop (Bulut, 2009).

Avoiding direct contact with the ulcerated tissue is the most effective protection.

1.3.1.3 Epstein - Barr virus (EBV)

The first infection by Epstein-Barr virus (EBV) is generally asymptomatic. It may cause nonspecific illness during infancy. Fever, weakness, exudative angina and regional or general lymphadenopathy are seen in symptomatic (infective Mononucleosis) adults.

Viral diffusion and contamination occurs by the way of saliva and oropharyngeal secretions. EBV exists in lymphoid nodules primarily but also can be colonized on pharyngeal epithelial tissue where it can be hidden (Denizci and Çankal, 2006)

Standard precautions are sufficient to prevent contamination from EBV.

1.3.1.4 Human Immunodeficiency Virus (HIV)

Human Immunodeficiency Virus (HIV) is a member of Retroviridae that contain two identical RNA in a single spiral carrying interesting virology characteristic. Virus attaches to its receptor on the surface of the CD4 lymphocyte. HIV can be contracted via the parenteral route, mucosal contact or contact with broken skin. Viral load can also be found in other body secretions. Therefore, it can be transmitted via sexual contact with an infected partner. In spite of some available data, HIV is a fairly weak virus that can be inactivated at 56°C for 10 minutes using appropriate disinfectants and its spread is not as easy as expected. Thus the risk of HIV transmission following a needle stick is 0.3% (0.2-0.5%). HIV can also be transmitted from an infected mother giving birth to her child (Bakır ve Babayiğit, 2004). The risk of mortality in dentistry is 1.7 times greater for HBV than it is for HIV. If HIV penetrates broken skin, it can be held by the macrophages up to 24 hours in a human body and up to 36 hours in animals. This time interval is of utmost importance and can be favorably used by health officials. Immediately following contamination, the area in question needs to be cleaned and washed with warm water and soap; the use of antiseptics in such cases is still controversial. Mucosal membranes, if contaminated, are also to be washed. And so, antiretroviral therapy is to be initiated within two hours following exposure for optimal effect (Bulut, 2009).

1.3.1.5 Influenza Virus

Influenza virus causes flu, the most common epidemic worldwide. It is transmitted via body droplets. The incubation period for the illness varies between one and four days, but

symptoms usually display after two days. Fever, fatigue, headache, diffuse muscle pain and characteristic spasmodic cough and sore throat are the main signs and symptoms of the illness. Symptoms usually last for four days whereas fatigue can last longer. Three antigenic types of Influenza virus are classified as A, B and C. The most variable antigenic type that causes pandemic is the A type. Vaccination can help in preventing Influenza infection. Moreover, in-office precautions must be taken to prevent the spread of the flu virus.

Chlorine, hydrogen peroxide, antiseptics with iodine and alcohol are to be used in addition to standard cleaning procedures.

Coughing and sneezing to be done in a paper tissue that will be discarded after use and the hands washed.

Eyes, nose and mouth must not be touched when hands are unclean.

During illness, one must stay away from others.

The location must be air-conditioned frequently.

Hands must be washed with water and soap for 15-20 seconds and alcohol-based hand rub can be used in inaccessible areas of water and soap or if hands are not soiled (Ergönül, 2009).

1.4 Infection control in dentistry

1.4.1 Medical anamnesis

During the initial appointment, a detailed and complete medical history has to be taken from the patient, and in subsequent visits, updated accordingly. Although general health problems will affect the nature of the dental treatment, medical anamnesis is not the reliable way of determining individuals who are asymptomatic carriers and are unaware of their illness (Mutlu et al.1996). Hence, a social history is often useful.

1.4.2 Vaccination

Dentists and dental staff are always recommended to be vaccinated against tuberculosis, rubella, diphtheria, tetanus and most importantly, against HBV (Değer, 2004).

Hepatitis B vaccine consists of 3 injections to the deltoid muscle. Side effects are minimal and not common. Some people do not have sufficient level of antibodies (anti-HBs Ag) after the third injection. This is mostly seen in immunosuppressive patients, the elderly and overweight individuals. Five years after vaccination, immunity remains only in 7% of the individuals. Therefore, booster doses are required. Booster doses are given at 3-5 year intervals after vaccination. (Kocabaş, 2004)

1.4.3 Personnel protective equipment

Dental personnel should wear gloves during cleaning and touching contaminated instruments and surfaces. Hands should be washed after removal of gloves after each patient. Changing or washing the gloves will disturb the structure of the gloves as a barrier and is not an accepted practice (Külekçi, 2000b).

Surgical masks, protective glasses and plastic face masks should be worn during oral procedures that are likely to splash blood, saliva and oral fluids. When there is a risk of contamination of blood or saliva disposable gowns or laboratory clothing should be worn. Such aprons should be changed when contaminated with blood (ADA, 2003; Değer 2004)

Plastic stretch, single use waterproof coatings such as aluminum foil can be used to coat surfaces that are difficult to clean. Coatings should be removed without removing the gloves and contaminated gloves must be disposed of together with (Mutlu et al, 1996, Chris 1996).

1.4.4 Protection of hands and skin

Skin care and protection is required to keep the risk of viral cross-infection to a minimum level. Hand and finger infections occur frequently and can cause cross-infection with other patients. Wearing gloves reduces the possibility of transmission of viral infections from dentists to patients and accumulation of blood and microorganisms in finger nails. Latex and vinyl non-sterile gloves prevent blood and saliva-borne micro-organisms entering from cuts, abrasions and wounds in hand. But the hands and nails should be cleaned with appropriate skin antiseptics both before wearing and after removing gloves (Mutlu et al., 1996; ADA 2003).

1.4.5 Clinical and laboratory coats

Daily clothes can be protected from contamination by wearing uniforms or clothes on them. Clothes contaminated with blood, saliva and oral secretions should be washed with water and chlorine if possible. Normal washing and drying system appropriate to manufacturers recommendations is sufficient to eliminate harmful microorganisms including the viruses (Mutlu et al., 1996; ADA 2003).

1.4.6 Protection of eyes

Protective apparatus are utilized to protect eyes and mucous membranes from macroscopic particles, chemical injury and from losses caused by microbial infections. Goggles might be used for the patients as well to protect eyes in addition to physicians and ancillary staff (Mutlu et al., 1996, Chris 1996).

The eyes can be protected by different types of glasses but ideally they should be plastic and both sides must have protective properties. They can be used alone but also can be used on-grade goggles. These glasses can easily be cleaned and disinfected without deformation if necessary (Mutlu et al., 1996, Chris 1996).

Plastic masks completely covering the face can also be used instead of glasses (viewfinder). Glutaraldehyde can be used for cleaning glasses. Iodoforms were reported to cause coloration. There is currently no information on the effects of hypochlorite solutions. Autoclaving of plastics was reported to impair the optical properties of these kinds of glasses (Georgescu 2002, ADA 2003).

1.4.7 Hand Instruments

The hand instruments must be sterilized by heat, and water channels must be cleaned with the help of pressurized water at the beginning and end of each day in between each patient because the instruments used in dentistry are in contact with mucous membranes and their complex structures limit cleaning, disinfection and sterilization of the internal and external surfaces. Hand tools should be sterilized between patients by appropriate methods. Sterilization, lubricating and storing recommendations of manufacturers should be strongly followed so that the tools to be durable. Today all high-speed and low-speed hand tools are said to be heat-resistant by the manufacturers. Surface deletion or disinfection by using chemical antiseptics of the hand instruments on the dental units which are in contact with air and waterways are not the proposed methods of cleaning for using the instrument again. These instruments have replaceable parts and therefore after each patient, disposable parts are recommended to be changed after each use (Chris 1996, ADA 2003).

1.4.8 Removal of sharp Instruments and infectious wastes

The patient's blood and saliva-contaminated sharp instruments should be considered as infected and necessary precautions should be taken for preventing injuries. To avoid needle accident the use of disposable syringes should be preferred and sharp tools must be placed in boxes that are puncture-resistant and this box should be left to an area nearby (Chris 1996, ADA, 2003; Değer 2004).

Precautions that should be taken when using sharp instruments are as follows:

All of the personel must wear protective clothing during clinical operations and cleaning.

Whole staff that contact with body fluids should be vaccinated.

Sharp instruments should not be left around and should not be passed from hand to hand.

Needles should be placed in their cover with the help of a suitable tool and they should be discarded immediately after usage.

Sharp instrument boxes must be sufficient amount and when 3/4 of the boxes are full, waste should be discarded.

There must be someone responsible to change the full boxes with the empty ones.

All staff should have a detailed knowledge with the use and the getting rid of sharp tools.

Gauze, cotton rolls, disposable waste, that are contaminated with blood, must be placed in waterproof plastic bags and removed.

It is a low probability of any kind of transfer of microorganisms by clothes. Therefore, normal washing and drying of dirty clothes is a good method for cleaning and is sufficient.

Gloves should be worn during processing with blood, saliva-absorbing tube fluid and other liquid waste. Liquids must be poured to a channel connected to sewage with care. (Chris 1996, ADA 2003, Değer 2004)

1.5 Sterilization and disinfection procedures in orthodontics: Definitions

Sterilization: Sterilization 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 (Saniç, 2003).

Disinfection: Disinfection is the process of destroying or inhibiting most pathogenic microorganisms and inactivating some viruses, hence reducing microbial contamination to safety levels (Saniç, 2003).

Antisepsis: Application of chemicals on living tissue to avoid infection.

Asepsi: It means an environment free of germs. That is the destruction of all disease-forming microorganisms in the working environment.

Dekontamination: work against all kinds of germs to reduce the microbial source in number for protection from, unexpected contamination and infection is called decontamination. (Miller 1991; Değer 2004).

The tools used in the hospital varies according to the risk of infection. The method of disinfection is selected according to the level of risk of infection. (Mullick, 1986; ADA, 2003).

Sterilization of all tools and equipment used in dentistry is extremely important, but it is not always possible to apply the most effective method. In such cases, any proper method of disinfection should be used (Mutlu, 1996; ADA, 2003).

1.5.1 Sterilization techniques

Foundations of modern medicine were laid on the possibility of contamination of the wound or physician by microorganisms.

This process began with the description of Pasteur 'the presence of the microorganism germs on the surfaces of all the items commonly found in hospitals' in the French Academy of Medicine on April 30, 1878.

One of the oldest records of sterilization is the work of a physicist in 1832, from Manchester named William Henry about the effect of heated water pressure in a container on infectious bacteria (Akcam and Özdiler, 1999)

1.5.1.1 Sterilization stages

- a. Cleaning
- b. Packaging- loading
- c. Sterilization
- d. Unloading- registration
- e. Storage- distribution

1.6 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 are important today because of the professional, ethical and legal aspects. Although it is not possible to obtain a complete sterilization in orthodontics clinics, it is possible to approach ideal sterilization by using new techniques (Akcam and Ozdiler, 1999).

A study conducted by Starnbach have shown that in the fields of dentistry the orthodontists are in second raw fort he incidence of having hepatitis B. HTLV-III (AIDS) virus is weaker and less infectious. Orthodontists became more conscious of the need of surface decontamination of the tools they are using with the increase of the incidence of AIDS, like hepatitis B (Kirchoff, 1987; Mc Carthy et al.1997).

1.6.1 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 (Ozer, 2005). Corrosion of these instruments is one of the few sterilization consequences that orthodontists face. Corrosion is an electrochemical event that metals undergo when reacting with an oxidant as a result of oxidation and reduction reactions (Uzel and Haydar 1989).

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 (Haydar, 2000). 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. Unsaturated chemical vapor sterilization of pliers is appropriate to minimize corrosion, but this method requires a well ventilated area to eliminate noxious odors (Haydar, 2000).

In a study, Mazzocchi et al. evaluated the effects of autoclaving, dry-heat and chemical sterilization for 500 cycle's usage, on hardness, degradation and nitrification in the surface color. The maximum increase in hardness was observed when the autoclave was used, and the least amount when dry-heat sterilization was used. Degradation in the surface color was observed in each group but mostly when the chemical sterilization was used. Briefly, clinical and metallurgical modifications in every group in this study, after 500 cycle sterilization, are really minimal. Hence, they can be omitted (Mazzochi, 1996).

Glass bead sterilization is another viable method in which pliers are left inside the sterilizer at 218°C (450°F) for 15 seconds only. Note that large instruments can not be sterilized with this method (Deger, 2004).

In another study, Wichelhaus et al. evaluated corrosion resistances of orthodontic pliers after chemical sterilization with surface disinfectants. According to their findings, dry-heat sterilization does not corrode the instruments as much as chemical sterilization (Wichelhaus et al., 2004). Once the orthodontic pliers have been used clinically and thus contaminated with oral fluids and plaque, the efficiency of different disinfection methods were evaluated. Thus, spray disinfection such as (Incidur or Iso - Septol) was found to be insufficient for reducing the amount of the microorganisms. For this reason, disinfecting orthodontic pliers with spray disinfectants is proscribed. Soaking the instruments in a disinfecting solution was also found to be insufficient for decreasing the amount of the microorganisms. A successful high level disinfection can be obtained by using an ultrasonic bath (Sekusept 5%). Successful results can be achieved from thermal disinfection; the amount of microorganisms is hence decreased (Wichelhaus et al., 2004).

1.6.2 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 (Speera et al., 2005). 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 (Wichelhaus et al., 2006).

1.6.3 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 and Douglas, 2007).

There is currently little information about the contamination level and the disinfection procedure's success of the bands that are to be reused. Fulford et al, (2003) suggested that bacterial multiplication is not observed on the bands that are exposed to enzymatic disinfectant prior to autoclave sterilization (Fulford et al., 2003).

1.6.4 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 et al., 1986).

Pernier et al (2005) observed the sterilization of 6 different arch wires by autoclaving them for 18 minutes in 134°C via surface analysis techniques. No significant change was observed on the alloys surface characteristics that would effect their utilization.

1.6.5 Disinfection of elastomeric ligatures

Polyurethane elastomers are frequently used in orthodontics as ligature and chain. The unused parts of elastomeric ligatures are generally sterilized via cold sterilization since they are not heat-resistant. Disinfection of these materials in a 5% gluteraldehyde solution for a

period of 10 minutes is recommended. 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°C does not lead to permanent deformations or to increased shrinkage whereas in the case of dry-heat, their manipulation becomes more difficult (Mayberry et al., 1996).

Based on two different disinfectants, tensile strength and glass transformation temperature of elastomeric ligatures that are not disinfected are found significantly different than those that are exposed to phenol and glutaraldehyde (Evangelista et al., 2007).

A parallel observation was detected between the decrease in tensile strength as a result of exposure to disinfectants in Evangelista et al's study and the decrease in tensile strength in Jeffries and Fraunhofer's study. Breakage of intermolecular links and glass transformation temperatures are decreased as a result of prolonged contact with disinfectants. Polyurethanes are not inert materials, and when they are exposed to enzymes, water, moisture and heat, they will absorb water and get destroyed. As a result of the plasticizer effect of disinfection solutions on polymer ligatures, decrease in tensile force and glass transformation temperature will occur (Mayberry et al., 1996; Evangelista et al., 2007).

1.6.6 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 (Uzel and Haydar; 1989; Lessa et al., 2007).

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 (Amitha ve Munshi, 1995).

In Lessa et al's study, 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 (Lessa et al., 2007).

1.6.7 Surface disinfection

Surfaces that can not be sterilized must be disinfected effectively. These surfaces include the air-water sprayers, aspirator heads, reflector arms, cuspidors, drawers, head rest and arms. Suitable clinic and instrument setting will reduce the surfaces to be disinfected. If the chair's positions can be controlled using a pedal and cuspidors controlled by buttons at the level of the elbow or the knee, hand contact is therefore minimized (Uzel, 1989).

Sodium hypochlorite 1% or solutions including 70% alcohol are used for surface disinfection in orthodontic clinics. Iodine solutions used for disinfection are cheap, easily stored and

highly effective. The only disadvantage is the staining characteristic of iodine. There are types that can be diluted in water or in 70% isopropyl alcohol (Özer, 2005).

1.7 Antibacterial agents in orthodontics

In a healthy oral cavity, microbial flora is in equilibrium with its surroundings. This equilibrium could be disrupted by application of orthodontic appliances which can then result in disease. The most common adverse effects of fixed orthodontic appliances are periodontal disease and decalcifications caused by bacteria. The surface features and designs of orthodontic appliances and bonding materials affect the formation of the biofilm layer (Maruo et al., 2008).

Inside the oral cavity, an increase in the levels of *Streptococcus mutans* and *Lactobacillus* strains is detected once the orthodontic appliances have been bonded. In many studies, a correlation existed between this bacterial growth and tooth decay. When carious activity increases, increasing the frequency of teeth brushing or high level topical fluoride application is not enough to arrest the demineralization process. Thus, individuals that are treated with orthodontic therapy and individuals that are at high risk need not only to improve their oral hygiene habits but also use chemotherapeutic agents that will act as caries suppressors. Chlorhexidine is an antimicrobial agent that is very efficient against *Streptococcus mutans*. Many applications are recommended to maximize caries prevention. In patients receiving fixed orthodontic therapy, there are a number of studies suggesting that the use of chlorhexidine solution significantly decreases *Streptococcus mutans* levels and bacterial levels in dental plaque and saliva (Dogan et al., 2009; Kuvvetli and Sadalli, 2006).

In a two group study, the effect of 0.2% chlorhexidine and fluoride toothpaste on plaque development is compared clinically and microbiologically in orthodontic patients. In the 0.2% chlorhexidine group, a decrease of the bacterial content is detected and it is shown that majority of *Streptococcus mutans* are eliminated. During fixed orthodontic treatment, 0.2% chlorhexidine mouth rinse can be used to reduce plaque accumulation, thus increasing the efficiency of oral hygiene. For an improved oral health, patient education and regular professional recalls are mandatory (Kuvvetli and Sadalli, 2006).

Sterling Winthrop Research Institute has developed a topical antimicrobial agent: Octenidine di hydrochloride. In early studies, it was shown that this solution prevented formation of biofilm in experimental animal and human models (Tazegül et al., 2006). Octenidine di hydrochloride is an antimicrobial effective against bacterial plaque formation (Dogan, 2008). Rosin et al (2002) evaluated the antibacterial and antiplaque efficiency of using polyhexamethylen biguanid hydrochloride, chlorhexidine gluconate and Listerine after teeth brushing. 0.12% biguanid hydrochloride was found to be more effective than Listerine, however, after 5 days, chlorhexidine was found to be more effective than polyhexamethylen biguanid hydrochloride (Decker et al., 2003).

2. Conclusion

Dentists face with many kinds and amount of micro-organisms because of their professions that require intimate contact with their patients. These microorganisms may lead either a simple illness such as influenza or a serious one such as hepatitis infection or AIDS. For this reason, Keeping in mind that every patient is potentially infectious, all the measures must be taken during dental practice. Sterilization and disinfection methods should be implemented meticulously and their effectiveness carry crucial importance for the physician and the patient's health.

Although orthodontists usually do not work on tissues and treat infectious diseases patients may still carry germs that infect other people. Thus today, the use of proper sterilization techniques are important because of professional, ethical and legal aspects. Although it is not possible to obtain a complete sterilization in orthodontic clinics, it may be approachable by using new techniques.

In the orthodontic practice, providing full range sterilization requires serious effort. 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.

Sterilization of instruments used in orthodontics brings some special problems together, because of the hinge regions and cutting edges that are difficult to clean and sterilize. In addition, there is a need to avoid damage during cleaning operations, because the repair or renewal of the equipments are expensive.

Orthodontic clinics running with a limited number of instruments and appliances, prefers fast methods for sterilization for effective working. To ensure this, in addition to planning the sterilization area in ortodontic clinics, new sterilization-disinfection techniques and solutions must be learned.

As a result in the orthodontic practice, providing full range sterilization requires serious effort. 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.

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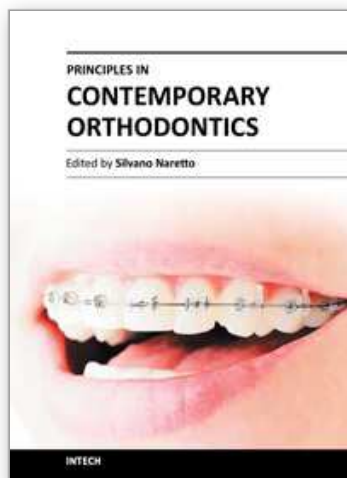
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Orthodontics is a fast developing science as well as the field of medicine in general. The attempt of this book is to propose new possibilities and new ways of thinking about Orthodontics beside the ones presented in established and outstanding publications available elsewhere. Some of the presented chapters transmit basic information, other clinical experiences and further offer even a window to the future. In the hands of the reader this book could provide an useful tool for the exploration of the application of information, knowledge and belief to some orthodontic topics and questions.

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