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RESEARCH ARTICLE

DENTAL HANDPIECE – MAINTENANCE, CONTAMINATION CONTROL AND STERILIZATION

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ABSTRACT

Dental handpiece is one of the indispensible instruments in dental office required for the efficient accomplishment of a multitude of dental procedures like cavity preparation, tooth preparation for esthetic and prosthodontic procedures, polishing and prophylaxis, implant site preparation and placement. Adherence of dentist to the maintenance and sterilization protocols of handpieces has become inevitable not only to ensure their efficient functioning and longevity but also to prevent cross-infection and cross contamination amongst dentists and patients. This paper discusses principles of handpiece maintenance and methods available for effective sterilization in general dental practice.

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INTRODUCTION

Dental hand pieces, one of the most commonly used dentist's armamentarium were first introduced in the nineteenth century as primitive hand-operated devices and evolved significantly into sophisticated, engineered precision instruments over the years. They remain a vital part of dentistry. Maintenance and contamination control of handpiece is essential to preserve the life span of the handpiece, to prevent cross-contamination and spread of infectious diseases between dentists, dental assistants and patients. Appropriate maintenance procedures can keep the handpieces functioning smoothly longer, and maximize their efficiency. Concerns over hand piece contamination relate to the accumulation of particulate matter (débris from restorative materials and dental hard tissues), microorganisms from the oral cavity (bacteria, fungi and viruses), microorganisms from the water and airlines and collection of human tissue (blood, saliva) within the hand piece chamber, turbine blades, gearing, air and water lines. Dental hand pieces are extremely difficult to clean, inspect and sterilize due to the small size and length of lumens, intricate working parts (which require lubrication) and their inability to be readily dismantled (Smith, 2009). This review emphasizes on (A) Methods of contamination control and (B) Sterilization protocol that should be mandatorily followed in general dental practice.

Methods of Contamination Control: Dental hand piece asepsis includes surface contamination control, turbine contamination control, water retraction system correction, inherent water system contamination and control of contamination from spatter and aerosol.

Surface contamination control: External surface of the hand piece are mainly contaminated by blood and saliva. Center for Disease Control and Prevention (CDC) guidelines recommends flushing water through the handpiece in the operatory for 30 seconds followed by removing the bur and scrubbing the handpiece under running water with a sponge to remove external debris. The handpiece has to be held upright to reduce the amount of water entering the head of the handpiece (http://www.cdc.gov/ncidod/dhqp/pdf/guidelines/Disinfection_Nov_2008.pdf.). Brief wipe with disinfectant soaked sponge does not completely clean the irregular surfaces and crevices around the bur chuck.

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Application of disinfectant and scrubbing reduce the number of bacteria but does not completely eliminate them. Chemicals should not be used for cleaning as they can have a detrimental effect on the sterilizer and the handpiece during sterilization cycle. Complete infection control of handpiece surfaces can be accomplished only by sterilization[3].

Turbine Contamination Control: Contaminated oral fluids may be drawn back into the turbine chamber by any one of the following ways:

- By negative pressure created by a Venturi effect during operation
- When turbine continues to spin whenever the drive air is stopped

The Venturi effect is the fluid pressure that results when an incompressible fluid flows through a constricted section of pipe. The fluid velocity must increase through the constriction to satisfy the equation of continuity, while its pressure must decrease due to conservation of energy. The gain in kinetic energy is supplied by a drop in pressure or a pressure gradient force.[4] Contaminated oral fluids may enter into the worn bearing seals. They may also get aspirated into the vent holes in the top of older hand-chuck operated handpieces or into the air-water spray orifice that communicates with the turbine chamber in some handpieces.[3]

Water retraction system correction: Anti-retraction valves were originally used to prevent fluid retraction into DUWLs, but most of them substantially fail after a few months of use. These devices tend to become clogged and worn, and they have to be periodically maintained to prevent the retraction of oral fluids and to avoid contamination of the waterlines or possible cross-contamination to subsequent patients.[2,5]

It has been shown that autoclaving of handpieces after use combined with 30 s of flushing between each patient and 2.5 min at the end of the day would help to eliminate the sucked fluids (Beierle, 1993; Vanessa Barbot *et al*., 2012). High-speed air handpieces operate when compressed air, controlled by the rheostat in the foot pedal, is released into the head where the air spins the blades of the turbine. Coolant water is carried by separate tubing and is also discharged at the same time. The air is released from the top and bottom of the head as the turbine rotates. However, when the air pressure is released, the handpiece shuts down, creating a vacuum that can aspirate oral microorganisms, blood, saliva, and other debris into the turbine and dental unit waterlines (DUWLs) (http://www.cdc.gov/ mmwr/preview/ mmwrhtml/rr5217a1.ht). Electric handpieces operate by the introduction of direct-current (DC) into an electric motor sealed in the housing of handpiece [Figure 3]. These motors do not use compressed air, and when the current driving the motor is stopped by releasing the foot pedal, the motor stops. Because there is no air to create a vacuum, there is little or no retraction of oral fluid back into the waterline or turbine—an important infection control factor.

Contamination control of biofilm in Dental Unit Water Lines (DUWL): Dental unit waterlines are an essential part of dental surgery equipment, supplying water as a coolant, primarily for air turbine and ultrasonic scalers. The hydrophobic surface of waterline plastic promotes the attachment and colonization of biofilm organisms.

Active biofilm is the primary reservoir for continued contamination within the water supply system. Biofilms are adherent colonies of bacteria, fungi, and protozoa that form along the inner surface of DUWLs. The initial biofilm layer thickens through replication of the organisms that make up the biofilm, as well as through adherence of free-floating microorganisms from the water source. Donlan and Costerton propose a new definition of biofilm as a microbially-derived sessile community characterized by cells that are irreversibly attached to a substrate or to each other, are embedded in a matrix of extracellular polymeric substances that they have produced, and exhibit an altered phenotype with respect to growth rate and gene transcription (Donlan, 2002). Biofilm provides microbial cells with: (1) easier exchange of genetic material; (2) easier accumulation of nutritive substances from the water phase; (3) protection against an excess of nutritive substances and against drying (Donlan, 2002). Three mechanisms are responsible for the biofilm resistance: (1) Slow-growing or non-growing cells are not very susceptible to many antimicrobial agents. (2) Production of exopolymers - exopolysaccharides, prevent various agents to penetrate the full depth of the biofilm. (3) At least some cells in a biofilm adopt a distinct and protected biofilm phenotype. This phenotype is a biologically programmed response growth on a surface. They can deactivate some disinfectants or provide a diffusion barrier based on the anionic and hydrophobic nature. Biofilm bacteria are substantially resistant to surfactants, biocides and antibiotics (Costerton *et al*., 1999). Microorganisms in dental lines can be free-floating or in sessile form. This sessile form, known as biofilm produce a polysaccharide matrix that provides a mechanism for surface attachment and retention of microorganisms to the water line. The main inhabitants are opportunistic, gram-negative, aquaphilic bacteria. The bacteria may include atypical Mycobacteria, Pseudomonas and possibly Legionella bacteria. [3]

The most frequently isolated oral microorganisms from DUWLs belong to the genera Lactobacillus, Streptococcus, Actinomyces, Staphylococcus, Bacteroides, Veillonella and Candida (Martin, 1987; Pankhurst, 1998) Some microbial species found in DUWLs are known to be opportunistic pathogens for humans: Acinetobacter calcoaceticus, Aeromonas hydrophila, Aeromonas sorbia, Burkhlderiacepacia, Brevundimonasvesicularis, Methyobacteriummesophilicum, Pseudomonas aeruginosa, Pseudomonas fluorescens, Pseudomonas putida, Sphingomonaspaucimobilis and Staphylococcus cohnii.[13,14,15]

The individual microorganisms, as well as pieces of biofilm, can dislodge and pass out of waterlines. It is at this point that the biofilm becomes a potential problem for the dental patient or dental healthcare worker. The nature of DUWLs is such that they will develop a biofilm, and water flowing down the biofilm-coated waterlines will contribute to microbial load in the water as it exits the tubing. Frequent periods of water stagnation in DUWLs and the properties of the plastics used in DUWLsconstruction can promote the attachment and colonization of biofilm-forming microorganisms (Jolanta Szymanska, 2007). The physics of laminar flow of water passing through the DUWLs results in maximum flow at the centre of the lumen and minimal flow at the periphery, encouraging deposition of organisms onto the surface of the tubing thus promoting further undisturbed bacterial proliferation (Whitehouse, 1991; Williams, 1996).

In addition, bacteria adhere more readily to hydrophic polymeric plastic tubing (polyvinyl chloride, polyuretane) than to tubing composed of glass or steel (Williams *et al*., 1996). Different methods may contribute to combat microorganisms associated with water, upstream from, on the entrance and inside the DUWL. These methods may involve chemical or nonchemical approaches. Chemical approaches mainly involve the use of disinfectants that have been developed for DUWL maintenance. Most of them are based on sodium hypochlorite (NaOCl), hydrogen peroxide (H2O2) – with or without silver ions – and TAED (tetra-acetylethylenediamine) formulation of peracetic acid; this formulation has fewer side effects than peracetic acid (Montebugnoli *et al*., 2004). Ideally, a treatment process should prevent both initial contamination of DUWLs and biofilm development, be easily performed by staff, and offer continuous protection (and during periods of nonuse). .

Non-chemical approaches (Vanessa Barbot, 2012) for disinfection of DUWL includes

- Pretreatment of tap water by filtration (Dayoub *et al*., 1978; Monarca *et al*., 2002), the use of gloves, masks, protective eyewear and rubberdam-like barriers are all relevant approaches to prevent microbial contamination both at the entrance and at the output of the unit (Cochran *et al*., 1989).
- Surface of tubing is modified to inhibit microbial accumulation; polyvinylidene fluoride-coated tubes have been demonstrated to significantly reduce biofilm formation and maintain water quality over 1 year (Yabune *et al*., 2005).
- Incorporation ofantiretraction valves to reduce suck-back of fluids from the oral cavity.
- Flushing of waterlines would reduce the microbial load in DUWLs.

The CDC recommendation stating that dental unit treatment water should contain less than 500 colony forming units (CFU) per milliliter of bacteria can be accomplished by use of microbial point-of-use filters and independent water systems. [3] Precautions to be taken while disinfecting the water system contamination are

- Disinfectants such as iodophore or diluted sodium hypochlorite, used for disinfection must be flushed out of the system with clean, boiled, or sterile water before use.
- 0.5% sodium hypochlorite and other strong chemicals can damage the handpiece; hence handpiece must be removed before disinfecting the system.
- Very dilute biocides that are used continuously in the treatment water must be researched thoroughly because some of them can decrease composite bond strengths to enamel and dentin.

Dental Bioaerosol-potential occupational hazard: Dental handpieces produce aerosol which is a mixture of air coming from a handpiece, water flowing from Dental Unit Water Lines and a patient's saliva, and is always accompanied by splatter. [16]Micik and colleagues in their pioneering work on aerobiology defined aerosols as particles less than 50 µm in diameter and splatter as airborne particles larger than 50 µm in diameter. Aerosols have the potential to penetrate and lodge in the smaller passages of the lungs and are thought to carry greatest potential for transmitting infections (Micik *et al*., 1969; Miller *et al*., 1971; Micik *et al*., 1971; Abel, 1971; Miller, 1978). Aerosols include patient's saliva, nasal and throat secretions, dental plaque, gum secretion, blood, tooth tissues and materials used for dental treatment. Splatter is described as mixture of air, water and/or solid substances, such as fragments of dental fillings, carious tissues and sandblasting powder (Jolanta Szymanska, 2007). Aerosolization of microorganisms especially mycobacterium that may cause pulmonary tuberculosis has always been a concern. Contamination from aerosol and splatter can be reduced by use of rubber dam, high volume evacuation and universal use of personal barriers, drapes or effective clean up procedure. [3]

Sterilization: The lumen and crevices in handpieces that lodges infective patient materials makes cleaning and disinfection challenging. Sterilization of instruments ensures that they are free of all microbial life including microbial spores which are the most difficult of micro-organisms to kill. [24] Sterilization is defined as the complete destruction or elimination of all living micro-organisms, accomplished by physical methods (dry or moist heat), chemical agents (ethylene oxide, formaldehyde, alcohol), radiation, or mechanical methods (filtration) (Dorland's Medical Dictionary). Sterilization ensures that the handpieces are free of all microbial life including microbial spores which are most difficult of microorganisms to kill.

According to Spaudling's Classification, patient care items are classified as critical, semi-critical and non-critical items. Dental handpieces (inclusive of high speed motors, low speed motors, contra/prophy angles and ultrasonics) are semi-critical instrumentsrequiring sterilization (instruments that do not penetrate the soft tissues or bone but contact mucous membranes or non-intact skin). The Centers for Disease Control (CDC) and the American Dental Association (ADA) utilizes this classification and gives the following recommendations (Centers for Disease Control and Prevention, 2003; American Dental Association, 1996; American Dental Association, 2005):

- Semi-critical items be heat sterilized between uses and not heavily disinfected.
- Dental handpieces can be contaminated internally with patient material and should be sterilized after each patient
- Handpieces that cannot be heat sterilized should not be used

Sterilization of handpieces must be monitored and documented. The motor end of the attached low-speed handpiece can be covered by pulling a disposable, single-use, slender plastic bag up over it and pushing (popping) the handpiece through the sealed end of the bag so that the bag covers the motor end and part of the hose. Cleaning, disinfection and lubrication before sterilization is essential for safe use of high-speed dental turbines. Due to internal contamination, it is necessary to clean the handpieces internally before sterilization. Disinfection is defined as the removal or killing of all pathogens, but not spores. Ideally, all vegetative microbes should be killed, but a reduction in the number of pathogens to a level that is unlikely to cause infection is acceptable. The CDC and ADA have suggested that the external surfaces of handpieces be wiped thoroughly with absorbent materials saturated with a chemical germicide if they cannot be sterilized. Methods of disinfection include heating (Pasteurization or boiling in water), ultrasonics, or chemical solutions (2).

The disinfectants commonly used in dentistry includes iodophors, aldehydes (glutaraldehyde and formaldehyde), alcohol (ethanol and isopropanol), Alcohol ammonium, Quaternary ammonium compounds (benzalkonium chloride, alkyldimethylbenzyl ammonium chloride, and didecyldimethylammonium chloride), and peroxygenated compounds. Cleaning followed by disinfection is generally practiced, whereas cleaning followed by sterilization is to be preferred (Polat *et al*., 2006). The choice of lubricant is also very important for proper maintenance of the rotating instruments. The lubricant should have a good wetting capacity in order to cover all internal moving parts, but at the same time not being able to leak out. Lubricating oil should be applied before sterilization, but has been proved to be both an impediment to and favorable for the sterilization process. Petroleum-based lubricants are not easily removed by washing with aqueous cleaners. Contamination from patient bacteria in dental devices may be hindered by lubricants. The use of non-water-soluble, oil-based lubricant could prevent steam from killing bacterial endospores, especially if there is an excess use of lubricant (Zimmerman). Proper steps in sterilization must be performed after every patient. Remove any bur present in the handpiece before beginning a handpiece maintenance and sterilization cycle. Handpieces should never be sterilized with a bur in the chuck. Use of a steam heat autoclave or chemical vapor sterilizer is required, at a maximum temperature of 135 degrees C or 275 degrees F per sterilizer manufacturer's recommendations.

When using a chemical sterilizer, the handpiece must be completely dry. Excess water will cause oxidation of the hand piece in the chamber resulting in corrosion. If using a plastic/ paper bag be sure the paper is facing up to ensure complete sterilization. Steam heat autoclave is the most widely recommended form of sterilization. Autoclaves should be tested weekly with a biologic indicator to ensure proper sterilization is achieved with each cycle. A properly working autoclave will ensure all of your instruments are free of infectious and contaminated material. The autoclave should always run through the complete cycle. Never use a handpiece that has not cooled off. Running a handpiece under cool water can warp the turbine. Using the handpiece while still warm will cause stress to the turbine. Allow the handpiece to completely cool down prior to use. Sterilization between patients using acceptable methods that ensure internal and external sterility is recommended. Acceptable sterilization methods include steam under pressure (autoclave), dry heat, or chemical vapor. Ethylene oxide sterilization is not recommended for high-speed dental handpieces, low-speed handpiece components used intraorally, or prophy angles. Disposable prophy angles are available and must be discarded after one use. Autoclave sterilization is one of the most rapid methods of sterilization of handpieces. Fiber optics should be cleaned with detergent solution and ends of optics should be wiped with alcohol or other suitable organic solvents before factory servicing. The clinician should scrub metal-bearing, high-speed handpieces and the sheath or cone of the low-speed straight handpiece at the sink with running water and detergent. The handpiece should be bagged, sheathed, and autoclaved. The manufacturer's directions should be followed for cleaning high-speed handpieces with a lubrication-free, ceramic-bearing turbine. Chemical vapor pressure sterilization works well with ceramic-bearing handpieces. Chemical that would damage the internal parts of the handpiece should be avoided. Attention to directions on cleaning fiberoptics at both ends of the handpiece prolongs service life. ETOX gas sterilization is the gentlest method of sterilization used for handpieces. Internal and external cleaning is important. The handpieces should be out of circulation for several hours or overnight during ETOX processing. [3]

Conclusion

Dental handpiece are an essential part of any dental practice. It is imperative for every practicing dentist to understand the importance of maintenance and sterilization of dental handpiece and their components in order to preserve the lifespan of the instrument with good functionality and longevity, to minimize the risk for cross-infection and to ensure optimal performance in the dental office.

REFERENCES

Abel LC., Miller RL., Micik RE., Ryge G. 1971. Studies on dental aerobiology, IV: Bacterial contamination of water delivered by dental units. *J Dent Res.,* 50:1567-9.

Abichandani SJ. and Nadiger R. 2013. Cross-contamination in dentistry: A comprehensive overview. Chronicles of Young Scientists 4(1): 51-58.

American Dental Association (ADA) Sterilization and disinfection of dental instruments, Downloadable December 1, 2005 at: http://www.ada.org/members/ resources/topics/cdc/cdc_sterilization.pdf

Centers for Disease Control and Prevention (CDC). Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008. http://www.cdc.gov/ncidod/dhqp/pdf/ guidelines/ Disinfection_Nov_2008.pdf.

Centers for Disease Control and Prevention (CDC). Guidelines for infection control in dental health care settings, 2003. MMWR Morb Mortal Wkly Rep.2003, Dec. 19, 2003, Vol. 52, No. RR-17, 1-68. http://www.cdc.gov/mmwr/ preview/mmwrhtml/rr5217a1.htm.

Costerton JW., Stewart PS., Greenberg EP. 1999. Bacterial biofilm: a common cause of persistent infections. *Science*, 284, 1318-1322.

Donlan RM., 2002. Biofilms: microbial life on surfaces. *Emerging Infectious Diseases*, 8, 881-890.

Donlan RM., Costerton JW. 2002. Biofilms: survival mechanisms of clinically relevant microorganisms. *Clin Microbiol Rev.,* 15, 167-193.

Dorland's Medical Dictionary. American Dental Association (ADA) Council on Scientific Affairs, Council on Dental Practice. Infection control recommendations for the dental office and dental laboratory. *J Amer Dent Asso*, 1996; 127 (5):672-80.

Jolanta Szymanska. Dental Bioaerosols as an occupational hazard in dentist's workplace. *Ann Agric Environ Med* 2007; 14: 203-207.

Korvick JA., Rihs JD., Gilardi G.L and Yu VL. 1989. A pink pigmented, oxidative, non-motile bacterium as a cause of opportunistic infections. Arch Intern Med 149: 1449–1452.

Martin MV. 1987. The significance of the bacterial contamination of dental unit water systems. *Br Dent J* 163: 152–154.

Micik RE., Miller RL., Leong AC. 1971. Studies on dental aerobiology, 3: Efficacy of surgical masks in protecting dental personnel from airborne bacterial particles. *J Dent Res.,* 50:626-30.

Micik RE., Miller RL., Mazzarella MA., Ryge G. 1969. Studies on dental aerobiology, I: Bacterial aerosols generated during dental procedures. *J Dent Res.,* 48:49-56.

Miller RL., Micik RE. 1978. Air pollution and its control in the dental office. *Dent Clin North Am.,* 22:453-76.

Miller RL., Micik RE., Abel C. and Ryge G. 1971. Studies of dental aerobiology, II: Microbial splatter discharged from the oral cavity of dental patients. *J Dent Res.,* 50:621-5.

O'Donnell MJ., Shore AC. and Coleman DC. 2006. A novel automated water-line cleaning system that facilitates effective and consistent control of microbial biofilm contamination of dental chair unit waterlines: a one year study. *J Dent*., 34: 648–661.

Pankhurst CL., Johnson NW. and Woods RG. 1998. Microbial contamination of dental unit waterlines: the scientific argument. Int Dent J 48: 359–368.

Polat, Z., Tacir, İ., Değer Y. and Özekinci. T. 2006. Microbiological Evaluation of Dental Air-Turbine Handpieces after Different Disinfection Procedures. Biotechnol. and Biotechnol. Eq.

Prashanth Kumar Kattta, Sridhar S, Malthesh B. Savakkanavar, Kiran Murthy D. 2014. Handpieces in dentistry. *Journal of dental sciences and research*, 5(1): 1-9.

Smith, G.W.G., Smith, A. J., Creanor, S., Hurrell, D., J. Bagg and D. F. 2009. Lappin. Survey of the decontamination and maintenance of dental handpieces in general dental practice. *British Dental Journal.,* 207: E7

Reference: H. Lamb, 1953. *Hydrodynamics*, 6th ed., Cambridge: Cambridge Univ. Press.

The Richmond Institute. The Dental Handpiece: Maintenance and Infection Control.

Tuttlebee CM., O'Donnell MJ., Kean CT., Russell RJ., Sullivan DJ., Falkiner F. and Coleman DC. 2002. Effective control of dental chair unit waterline biofilm and marked reduction of bacterial contamination of output water using two peroxide-based disinfectants. *J Hosp Infect.,* 52: 192–205.

Vanessa Barbot, Ame´ lie Robert, Marie-He´ le`neRodier and Christine Imbert. Minireview. Update on infectious risks associated with dental unit waterlines. FEMS Immunol Med Microbiol 65 (2012) 196–204.

Whitehouse RLS., Peters G., Lizotte J., Lilge C. 1991. Influence of biofilms microbial contamination in dental unit water. *J Dent.,* 19, 290-295.

Williams JF., Molinari JA., Andrews N. 1996. Microbial contamination of dental unit waterlines: origin and characteristics. *Compend Contin Educ Dent.,* 17, 538-540, 542 passim; quiz 558.

Zimmerman M. Dental handpiece asepsis and the risk of cross-infection. A review of existing scientific literature. Journal????

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