Evaluation the Effect of Chemical Disinfectants on Denture Base Resin and Testing of Their Effect in Hardness and Surface Ruoghness: An *In vitro* Study.

By

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This Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master in Dental Material

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Declaration

I declare that this study is an individual work in which there was no unethical behavior during all the stages from planning the thesis until its writing and all the information in this thesis was obtained according to academic and ethical rules.I declare that I have referenced all the interpretations not obtained in this study and that these sources are listed in the list of sources, there is no violation samples or working during this study and the writing of thesis.

Dedication

I dedicate this thesis to my mother soul Special feeling of gratitude to my family , who had taught me to work hard for the things that I aspire to achieve.

I would like to dedicate my work to my father who offered unwavering encouragement and support.

Acknowledgement

I am deeply thankful and grateful to ***ALLAH*** *by the grace of whom only this work was possible.*

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List of Abbreviation

Polymethylmethacrylate	PMM
Denture stomatitis	D.S
Atom transfer radical polymer	ATRP
Epoxy vinyl resin	EVR
Removable partial denture	RPD
Complete denture	C.D
Denture cleanser	D.C
Methylmethacrylate	MMA
Ultraviolet	UV
Hydrogen peroxide	H2O2
Yitria stabilized zerconia	YSZ
Aluminum tri oxide	AL2O3
Hydroxyapatite	HA
Zirconium dioxide	ZrO2
Thermogravimetric analysis	TGA
Scanning electronic microscope	SEM
Transmission electronic microscope	TEM
Sodium hypochlorite	NaCl
Hypochloric acid	HOCI
Part per million	PPM

Distilled water	DW
Chlorhexidine	CHX
Brinell hardness number	BHN
Meyer hardness test	MHT
Knoop hardness test	KHT
Vicker hardness number	VHN
National standard test	NIST
Analysis of variance	(ANOVA)
Standard deviation	(SD)
Probability	(p)

Evaluation the Effect of Chemical Disinfectants on Denture Base Resin and Testing of Their Effect in Hardness and Surface Roughness: An *In vitro* Study

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Abstract

Introduction; Acrylic resin (PMMA) is extensively used material in different branches of dentistry. Most dentures are made up from acrylic resins because of its ease of manipulation and low price, in spite of its benefits, PMMA is not an ideal material, with surface roughness, discoloration and hardness being three drawbacks.Accumulation of biofilm as a consequence of poor denture hygiene, which in turn leads to onset of several systemic and oral infections.Denture cleansing is necessary for removal of biofilm from dentures. Denture cleansing can be achieved mechanically by manual brushing, chemically involving wide varieties of chemical agents, and by combination of both. **Aims:**The current study aimed to evaluate the effect of three types of disinfectants (5% sodium hypochlorite, 00.12% chlorahexidine and 6% hydrogen peroxide) on elimination of (*C.albicans ,Staph, Aures and Strept. Mutans*) from heat-cure acrylic resin surface by 10 minutes immersion and in the same time study of their effect on hardness and roughness of denture surface.

Material and Method: The samples were prepared using a putty former filled with base plate wax, then invested with a dental stone in metallic dental flasks. The resin was manipulated according to the manufacturer's instructions. Polishing was done in one surface of the samples, and the other surface was left unpolished. The microorganism has been clinically isolated by swab from oral cavity and allowed to grow in their selected culture using incubator. Specimens were separately placed in petri-dishes with respective culture. The samples has been divided into three main groups according to types of disinfectant, all samples has been placed again into incubator for 24h to allowing the microorganism grow over the rough surface. Then, each group divided again into three subgroups. Each sub group contains six samples. Five samples for each sub-group were colonized in the laboratory by, *Staphylococcus aureus* , *Streptococcus Mutans* ,*and Candida Alibicans spp*. Respectively, the remained single sample will be considered as control sample. After colonization of microorganisms each group has been disinfected by corresponding disinfectant for 10 minutes, and then incubated again for 24 hours. After that the petri-dishes with samples were checked for re-colonization of microorganism as respect to disinfectant agent. The hardness test was also evaluated by Vicker test machine after 10 minutes of immersion in disinfectant. The roughness has been evaluated by surface profilometer. **Results:** The microbiological test had shown that all selected microorganisms have been eliminated by all disinfectants except strept., which shown a resistance to hydrogen peroxide. all disinfectants shown a significant difference in comparison to control samples which was immersed in distilled water, this was for both hardness and surface roughness. However, there was no significant difference between tested groups. **Conclusion:** From economic point of view the 5% sodium hypochlorite is cheaper than the other disinfectants and it is available in every market whereas, the other disinfectants (chlorahexidine and hydrogen peroxide) are more expensive and only found in certain places. Therefore, it can be recommended that the 5% sodium hypochlorite is most appropriate disinfected agent in prosthodontics to clean dentures; this finding was supported and approved by many researchers.

1. Introduction:

The dynamic development of new multidisciplinary areas has a direct impact over the possible treatments and the rehabilitation of the dental function. Teeth rehabilitation with removable denture prosthesis is an established form of treating both partial dentition and complete edentulous patients. The developments in recent decades with dental implants dominate the current dental research, not only medical contraindications but also a negative attitude toward implants and economic limitation are the major disadvantages for their universal applicability, so the rehabilitation with dental prostheses still makes up a significant portion of everyday clinical practice.[1]

The PMMA material revolutionized the preparation techniques used so far since Walter Wright introduced the acrylic resin as the denture base material in 1937.Polymethyl methacrylate\ (PMMA) is an acrylic resin usually used with a long tradition for prosthetic purposes. It can be classified as chemically or thermally polymerized material depending on the factors that initiate the reaction. For dental prosthesis, thermally polymerized materials are used and the heat can be generated by hot water bath or microwave energy.[1]

Accumulation ofbiofilm as a consequence of poor denture hygiene, which in turn leads to th onset of several systemic and oral infections.[2] The continuous presence of biofilm formed by fungi and bacteria in such denture wearer causes an inflammatory condition called as denture stomatitis (DS). Cultures and smears of denture plaque in such denture wearers validate higher concentration of *Candida* species, especially *Candidaalbicans.*[3,4]

The oral flora of denture wearers with healthy palatal mucosa primarily have microbial bacteria such as Streptococci, Staphylococci, *Actinomyces*, Lactobacilli, and Gram-negative *Cocci*, but very few Gram negative rods and yeast. [5]

Denture cleansing is necessary for the removal of biofilm from the dentures. Denture cleansing can be achieved mechanicallyby manual brushing, chemically involving wide varieties of chemical agents, and by combination of both. [2,3]

Studies have been done to evaluate the effect of cleansing dentureson individual microorganisms that form the biofilm on acrylicdentures, but oral cavity habitats various species behaving in a complex manner.[6,48]

It has been claimed that the correlation between insufficient cleanliness of the dentures and denture stomatitis is statistically significant. The prosthesis cleaning procedure is important since the removal of biofilm is clinically necessary to maintain the oral health of denture wearers.[7]

A previous study indicated that denture polishing is essential for cleaning procedures to minimize the adherence and colonization of microorganisms on the denture base. [8]Hence, this study was doneto evaluate colonization and population dynamics of mixedfungal and mixed bacterial microbial biofilms formation after subjecting to different denture cleansing methods for the heat cure acrylic denture base resin.

The denture base hardness whichis defined as the resistance of the material to plastic deformation under indentation is a property that is usually related to the surfacecharacteristics of acrylic resins, and hasbeen used to evaluate the changes resultingfrom many kinds of denture cleansers. [9]

However, a chemical denture cleanser may have a negative effect on the mechanical and physical properties of denture base including the hardness and surface properties.(10)

Therefore, it is a clinical importance to determine the effect of denture cleansers on the properties of acrylic resins. Irregularities and porosities present on denture surfaces alsooffer a favorable niche to retain stain and microbial plaque.(11)

The surface roughness is of particular clinical relevance since it can affect the biofilm formation or make its removal difficult. Microbial adherence capacity is influenced by differences in the surface of the denture.(12,13)

Previous studies reported that the roughness of surfaces of prosthesis might cause micro-traumas in oral tissues. These studies concluded that surface roughness favored colonization by the microorganisms, contributing indirectly to tissue injury. Furthermore state that the bacteria, once joined to irregular surfaces and other stagnation sites can survive for long periods of time.(14,61)However, few studies have investigated the influence of prosthodontics cleansers on acrylic resin surfaces. (15,85)

2. Literature review

Acrylic resin (Polymethylmethacrylate- PMMA) is extensively used material in different branches of dentistry.Internationally, most dentures are made up from acrylic resins because of its ease of manipulation and low price.(1)

Although of its benefits, PMMA is not anideal material, with surface roughness,discoloration and hardness being three drawbacks. (16)

Acrylic resin is an amorphous polymer formed by the polymerization of MMA monomer carried out using different mechanisms [free radical vinyl polymerization, anionic polymerization, group transfer polymerization (GTP), or atom transfer radical polymerization (ATRP)] . The bulk or solution (homogeneous polymerization) and emulsion or suspension (heterogeneous polymerization) techniques are used to obtain PMMA.(17,18,19)

Among them, suspension polymerization is a good route to produce PMMA with high molecular weight (36,100), high yield (83%), and a polydisparity.(1)

The PMMA material revolutionized the preparation techniques used so far since Walter Wright introduced the acrylic resin as the denture base material in 1937.(20)

The acrylic resin became the preferred material for making denture bases, due to its ability to overcome many of the deficiencies of the materials used at that time.(20)

2.1 Types of polymethyl methacrylate

Poly(methyl methacrylate) (PMMA) is an acrylic resin usually used with a long tradition for prosthetic purposes. It can be classified as chemically or thermally polymerized material depending on the factors that initiate the reaction. For dental prosthesis, thermally polymerized materials are used and the heat can be generated by hot water bath or microwave energy. It was suggested that residual monomer concentration is the most important parameter in the determination of the final properties of the PMMA for dental prosthesis. It was found that in the chemical structure of PMMA, the alpha methyl groups tend to remain in the outer layer surface, whereas the methylene groups are in the inner layer of the PMMA surface, which gives an idea of the arrangement of the polymer. In other words, PMMA has exhibited moderate cytotoxicity in bulk material and polymerized form.(1)

Alternative polymer systems to PMMA, such as polyamide, epoxy, polystyrene, or vinyl acrylic resins, have also been tried. However, the desired denture base material has not been developed yet.(19,21)

A removable partial denture without metal clasps has recently been used in dental practice. In recent years, injection-molded thermoplastic resins such as polycarbonate, polyamide, and polyester have been used as denture-base materials.(22,23)

Injection molded thermoplastic resins (polyamides, polyethylene terephthalate, and polycarbonate) are used for denture bases of RPDs without metal clasps because of their advantageous characteristics, such as a higher elasticity than heat polymerizing base resins, and the fact that they can facilitate denture retention by utilizing the undercuts of abutment teeth in the denture base design . Polyamides, known as “nylon” are thermoplastic polymers produced by condensation between a diamine and a dibasic acid.[20]

2.2 Advantages of PMMA

Include excellent esthetic properties,an adequate strength, low water sorption, lack of toxicity, facility of repair, and construction by a simple molding and processing technique.[20]

Conversely, removable dentures are used in critical conditions of the oral cavity. There are about 500 microorganisms in the mouth, which produce a biofilm in an acidic environment causing several diseases, such as denture stomatitis , deterioration of the periodontal status of the remaining teeth , or carious lesions in abutment teeth . Therefore, it is very important to choose a suitable material for dental prosthesis.[1]

2.3 Uses of polymethyl methacrylate

Acrylic polymers has been successfully used in various areas such as shutters, denture base materials, artificial teeth, denture repair materials, crowns and bridges face the vestibular prosthesis . Denture base polymers are usually supplied as a mixture of poly methyl methacrylate (PMMA) powder beads and methyl methacrylate (MMA) monomer liquid. MMA: Acrylic resin most commonly used in dentistry is metil methacrylate which is the methyl ester of methacrylic acid. The polymethyl methacrylate is formed by the polymerization of styrene. Since 1946, 98% of all denture base polymers MMA and copolymers began to be performed. Although polymerization could be made ultraviolet and visible light; chemical initiator is commonly used for polymerization in dentistry. During the polymerization of pure methyl methacrylate up to 21% ratio of a volume shrinkage occurs.

PMMA: pure form is a transparent resin. The 0.25 micrometer wavelength UV light can pass even through the acrylic and not be discolored by UV. to create similar colors with tissue, can be used together with many pigment.[1]

2.4 Properties of PMMA

Poly methyl methacrylate (PMMA) acrylic resin material is preferably used for prosthodontic applications this mainly for its adequate aesthetics and desirable characteristics. It has adequate strength, low water sorption, low solubility and low thermal conductivity and it is free from toxicity. [25]

Attention has been directed toward the incorporation of inorganic fillers into acrylic resin to improve its properties. It was noted that reinforcement of PMMA with 2.5% of Al_2O_3 significantly increases the flexural strength and surface hardness of the resin while the surface roughness not differ from the control group. Modification of heat-cured acrylic resins with certain amounts of metal oxides done by Neset et al.,[24] who added Al_2O_3,TiO_2 and ZrO_2 fillers in 1% and 2% by volume for each filler type resulted in significant increase in impact strength and fracture toughness and significant decrease in water sorption and solubility. The problem with reinforcement of acrylic denture base with fillers is the adhesion failure, so surface modification of an inorganic particle with an organic substance is a useful way to reduce its surface energy and increase its compatibility with polymer matrix and dispersion homogeneity and thus improve the properties of the polymer/ inorganic particles.[25]

2.4.1Biological Properties

Although dentistry has developed new materials and techniques used in rehabilitation of edentulous patients, polymethyl methacrylate (PMMA) resins have dominated the denture base market for over 80 years. However, PMMA resins have certain disadvantages, such as porosity, water sorption, and may deteriorate base materials and decrease their efficacy overtime. Alternative methods to reduce the adhesion of microorganisms have been tried by altering the surface charge of denture base resins. The adherence of *Candida albicans* to denture base surfaces in vitro has been associated closely with the hydrophobicity of the microorganism. *C. albicans* adheres more readily to hydrophobic surfaces than to hydrophilic surfaces.

C. albicans, such as other living cells, has a net negative surface charge, providing an environment of electrostatic repulsion through the negative-negative charge interactions with the polymer. Understanding the effect of electrostatic interactions in the adhesion of *C. albicans* to PMMA, it can be suggested that negatively charged denture base materials can prevent adhesion of *C. albicans* and reduce the development of denture-induced stomatitis.[26]

Chemical modification of the surface charge of denture resin is a novel approach in preventing adhesion of *C. albicans*. [26]

Another important limitation is the deposition and formation of biofilm on the surface of PMMA resins, which acts as a reservoir of microorganisms and contributes to oral diseases and tissue damage. The intaglio surface of the denture is not polished before insertion so that rough uneven imperfect areas in the denture may serve as a breeding ground for opportunistic oral fungi. Poor oral hygiene causes the adhesion of microbial cells; possible dissemination of pathogens from denture biofilm in immunosuppressed patients can cause severe systemic infections.[26]

The management of denture-associated lesions relies on denture cleaning and disinfection, appropriate denture-wearing habits, and prescription of topical or systemic antifungal agents. However, the relapse of the infection is still high. Due to the limited compliance of some edentulous patients after denture insertion, it would be convenient if denture base materials could prevent biofilm formation. Various attempts to change properties of denture base resin have included the incorporation of anti-infectious agents, which would undergo gradual release in the oral cavity. However, the use of releasing agents is not suitable for long-term use.(26)

Synthetic acrylic resins are susceptible to microbial adhesion. The adherence of microorganisms is an essential and necessary in successful colonization of microorganisms. After adherence, aggregation and growth of microorganisms occur in the absence ofappropriate denture hygiene, free salivary flow and mucosal cleansing by the tongue, thus forming the denture plaque. In the plaque, a variety of harmful products may be produced by both the yeasts and the bacteria, which may provoke mucosal inflammationand once the mucosa is inflamed its barrier function against microbial products is diminished. Oral bacteria may be risk factors for a number of prevalent systemic diseases also.

Dentures offer a reservoir for microorganisms associated with these infections. Therefore, attention should be paid to the bacterialpopulation in denture as a potential source of oral and systemic diseases. In addition to the significant Gram-positive and fungal isolates,the Gram-negative infections that become systemic are of particular concern because they possess lipopolysaccharides (endotoxin),which may initiate cascades of harmful cytokines such as tumor necrosis factor . The already difficult chemotherapy of these microorganismshas been further complicated in recent years by the well-documented overall increase in antimicrobial resistance. Therefore, it isessential that clinicians be cognizant of the importance of appropriate prosthesis hygiene so that denture-related diseases can be avoided.[27]

In patient mouth dentures as an indwelling medical device, prepare an optimal environment for adhesion and multiplication of both pathogenic and non-pathogenic organisms. The increasing use of removable dentures has caused increasing the denture related infections like stomatitis or other infections.Management of denture related infections is challenging and infected dentures generally need to be disinfected.[28,29]

The removal of biofilm deposited on denture surfaces is commonly accomplished by mechanical methods. Due to patient's lack of motor coordination, such methods may be ineffective, and thus demand alternative means such as chemical cleansing. The rate at which deposits accumulate on dentures may vary between individuals and can be affected by factors such as saliva composition, dietary intake, surface texture and porosity of the denture base material, duration for which the dentures are worn, and the denture-cleansing regimen adopted by the wearer. Several disinfectants have been suggested for the disinfection of dentures .The best disinfectant should fulfill most of the requirements of the ideal agent while not causing any alterations in the structure of the dentures.[30]

Sodium hypochlorite is inexpensive, presents a broad spectrum of activity, and requires a short period of disinfection. Chau et al.[31] observed that besides superficial disinfection of acrylic resin, 1% sodium hypochlorite was also effective in the elimination of microorganisms from the inner surface of the material after 10 minutes. Glutaraldehydebased disinfectants are often used in dentistry. Tabs of sodium perborate and alkaline peroxide based denture cleansers are commonly used for denture cleaning and for helping mechanical hygiene. Gornitsky et al.[32] verified the existence of antimicrobial activity of these solutions on microorganisms adhered to denture, but suggested that the use of denture cleaning agents might be controlled. McCabe et al.[33] stated that the denture cleaning agents are complementary to denture hygiene and must be employed in association with mechanical cleaning for more effective biofilm elimination.

It is of a clinical importance to determine the effect of denture cleansers on the properties of acrylic resins. Irregularities and porosities present on denture surfaces offer a favorable niche to retain stain and microbial plaque. [30]

Biofilm is a microbial community that has dense and complex structure and may represent multiple organisms. They are often encapsulated within a matrix of exopolymeric material that consists of intricate networks of cells attached to biotic surfaces. They resist antimicrobials and immune cell challenge and are deeply embedded into cracks and porosities of dental materials.[34]

Metallic and non-metallic medical devices like catheters, implants, dental materials are suitable sites for colonization of various types of microorganisms. This development can detoriorate the materials with the presence of biofilm.[34]

Three-dimensional structure of biofilm is known to provide a highly complex arrangement of microorganisms. Several studies regarding the developments and structures of biofilms on different dental materials including denture bases and their effects over oral health have been constituted. However the relationship between the biofilm related biocorrosion and crack and/or fracture formation still remains complicated even undefined.(34)

To count microbial colonization, several study methods have been designed in laboratory conditions. Radiolabelling, slot immunoblot assay,bacterial incubation and counting and scanning electron microscope (SEM) techniques were used to measure the bacterial colonization rates.(35)

2.4.1.1 Disinfectant agent

Disinfectants are chemical agents that inhibit or kill microorganisms (surgical apparatus, periphery of the patient, and the objects used by the patient).(36)

Disinfection is the process by which we can destroy most pathogenic organisms on inanimate surfaces, Can be accomplished by application of chemical agents, use of physical agents (ionizing radiation) dry or moist heat, superheated steam(autoclave, 120℃).(36)

Home care instructions provided to patients after insertionof complete dentures are important in maintaining oralmucosal health and the longevity of the prostheses.

Beyondthe concern for esthetics, poor oral hygiene can lead to biofilmformation and oral infections, especially in elderly patients. The most commonly used method for cleaningdenture is mechanical cleaning using detergent, soap, or tooth paste. Older patients often face a difficulty in mechanicalremoval of plaque because of reduced manual dexterityor impaired vision or physical limitations.(36)

Chemical cleanserare alternatives to mechanical cleaning for cleaningdentures should be immersed in the chemical solutions fora certain period of time.(36)

An ideal denture cleansershould reduce biofilm accumulation and be antibacterial,antifungal, non-toxic, short-acting, easy to use, and cost-effective also, an ideal denture cleanser should not haveany detrimental effect on the denture materials. However,long-term immersion or incorrect use of chemical denturecleansers may adversely alter the physical and mechanicalproperties of the artificial denture teeth and base materials.(36)

The need to disinfect prostheses has resulted in thewidespread search for disinfectant agents that areinnocuous to the prosthesis surface.

2.4.1.2Types of chemicalagents used for prosthesis disinfection.

They are many disinfectants used in prosthesis disinfection such as, chlorine, iodophors, and aldehyde compounds included immersion in 2% alkaline glutaraldehyde,5% and 1% sodium hypochlorite, 3%aqueous formaldehyde, hydrogen peroxide as alternativemethods of dental prosthesis disinfection. In addition, 4% chlorhexidine gluconate and 3.78% sodium perborate proved to beeffective in reducing the number of microorganisms on dental prostheses. Chlorine dioxide is effective in eliminating microorganisms from theinternal and external surface of acrylic resin.(37)

- **Sodium Hypochlorite**

Sodium hypochlorite (NaOCI) is the most widely used disinfectant despite the increasing availability of other disinfectants. Sodium hypochlorite fulfills many requirements as the ideal disinfectant and furthermore it has an excellent cleaning action. The effectiveness of sodium hypochlorite in the cleaning and disinfection processes depends on the concentration of available chlorine and the pH of the solution.

Hypochlorous acid (HOCI) is a weak acid and dissociates to the hypochlorite ion (OCI^-) and proton (H^+) depending on the solution pH. It is generally believed that HOCI is the active species in the germicidal action, whereas the concentration of -OCI is a key factor determining the cleaning efficiency.

This implies that the optimal pH region of the germicidal activity of sodium hypochlorite differs from that of its cleaning activity.(38)

Disinfection by sodium hypochlorite (NaOCl) is the oldest and most widely used of active chlorine compounds in chemical disinfection due to its powerful germicides, free of poisonous residuals, easy to handle, and most economical to use.

Sodium hypochlorite solutions range in concentration from 1% to 15%, with 1% to 5% available chlorine products employed for domestic use . Sodium hypochlorite solution is a clear liquid which can be fed through solution feed equipment without fear of clogging. It is normally diluted to 1% solution before application; it tends to lose strength if exposed to sunlight for long time before use.(39)

Sodium hypochlorite, on the other hand, is a disinfectant, bactericide, as well as fungicide, which can be also used as a soaking solution for denture, to remove stains, dissolve organic materials,

Substance that contains 0.2-2.0 ppm chloride is categorized as bactericide and viruside; whereas a minimum 100 ppm is needed to obtain a fungicide effect.

Sodium hypochlorite in a low concentration, about 0.5%, is usually used as a household sanitizer. It is affordable, easy to use, available almost everywhere, odourless, tasteless and no side effect on skin and other goods, thus can be used as a potential soaking solution for dentures.[40]

- **Hydrogen Peroxide**

Hydrogen peroxide, better known as H_2O_2, is an inorganic chemical, liquid, bluish clear, slightly acidic, dissolves well in water when it decomposes naturally it will produce water and oxygen. H_2O_2 is also an oxidiser because it can produce active oxygen which can kill bacteria and anaerobic germs by oxidising it. Some literature has discussed a lot about the use of H_2O_2 which among them is used in medical treatment as a disinfectant and cleanses wounds because it can kill bacteria and anaerobic germs and also functions to slow bleeding. However, if H_2O_2 is too long in contact with wounds and skin, it can damage healthy granulation. Therefore, the use of H_2O_2 in the wound must be done immediately and as quickly as possible. Also, H_2O_2 can be used as bleach for clothes, detoxification, defence of the body against poisons, bacteria, viruses and fungi. Whereas in the field of dentistry, H_2O_2 is used in periodontal treatments such as curettage, denture cleansers and mouthwash.[41]

Peroxide based disinfectant has been sold as denture soaking solution in a form of powder or fast-dissolving (effervescent) tablets with alkaline peroxide as the active material/compound. This commercial solution is intended to remove plaque and stain on dentures.[40]

- **Chlorhexidine**

Digluconate is a biguanide that was introduced into the United Kingdom in 1954 as a disinfectant and topical antiseptic. In the 1970s, its ability to inhibit the formation and development of bacterial plaque was demonstrated. It is the most effective and safest antiplaque agent that has been developed to date. Because of its usefulness in controlling bacterial plaque chemically, it is indicated for use in the general population and in high-risk groups of patients.

Chlorhexidine is characterized by being a strong base with cationic properties. It's mechanism of action is that the cationic molecule binds to the negatively-charged cell walls of the microbes, destabilising their osmotic balance. It acts bacteriostatically when administered at low concentrations, as it encourages the liberation of low molecular weight substances such as phosphorus and potassium. At higher concentrations it acts bactericidally, by causing a precipitation or coagulation of the cytoplasmic content that kills the cells. Its anti-bacterial spectrum covers Gram positive and Gram negative bacteria (the latter to a lesser extent), fungi and yeasts.[(42)]

. Denture cleansers also used in preventing the denture that related stomatitis by controlling the growth of microorganisms on the dentures when the dentures cleaned by these cleansers when they are out of the mouth.[(43)]

Chlorhexidine was developed in late 1940s as a result of search for antiviral agents. It was found that chlorhexidine does not possess antiviral activity but instead it possesses antibacterial activity. The use of chlorhexidine was begun as a general disinfectant with a broad antimicrobial spectrum. Its antimicrobial spectrum include most of the microbials such as Gram positive and Gram negative organism including bacterial spores, lipophilic viruses, yeasts and dermatophytesetc.

Chlorhexidine is extensively used in various medical fields such as gynecology, urology, ophthalmology and treatment of burns etc. [44]

The first use of chlorhexidine in dental practice was in washing operation site and disinfecting root canals, subsequently reports appeared in the literature on the plaque control, prevention of caries, as a denture disinfectant, in the treatment of dry socket, apthous ulcers etc. Chlorhexidine over a period of last 40 years has been thoroughly investigated and successfully used as plaque control agent in dental practice. [44]

A literature review, highlighting chlorhexidine as not only a plaque control agen tbut also as an effective antimicrobial agent and its wider application in variety of oral disorders in various formulations.[44]

2.4.2 Thermal properties

Thermal stability of dental base is relatively important, because temperature of food will direct affect the oral temperature. Thermal stability of denture base measures the ability of the materials to function properly under various temperature conditions.

Thermal stability of the composite is defined from the thermogravimetric analysis (TGA). In addition, the weight of the composite decreased with increasing temperature. The results showed that the mass loss of composite is lower than pure PMMA resin which indicates that PMMA composites are more stable than pure PMMA. Dynamic mechanical analysis is used to study viscoelastic behaviour of polymers. A sinusoidal stress is applied and the strain in the material is measured. Complex modulus is measured by varying temperature and frequency of stress. Normally reduction of storage modulus is attributed to the increase of polymer chain mobility when the temperature arises.(45)

This phenomenon reflects that polymer chains are more mobile at high temperature which responsible for the reduction of low interaction between filler and matrix of the composites material hence resistance to deformation is reduced.

According to Richeton et al.(46), the breakage of secondary bonds will cause transition in the polymer. This is due to the termination of the attractive interaction between specific atoms involved in the molecular motion corresponding to specific relaxation. Commonly, incorporation of filler into resins is able to change the mechanical and thermal properties of composites. This is due to some factors which consists of variation in the mobility of macromolecules in boundary layers, the orienting influence of filler surface and different types of filler-matrix interaction.(46)

2.4.3 Water absorption

Water absorption is used to identify the amount of water being absorbed under specified condition. There are some factors which will affect the amount of water being absorbed, for example type of plastic, the additives used and the period expose.

Acrylic resin has several desirable features, but water absorption is one of its drawbacks which cause the dimension change for denture base. In addition, high water absorption of a material will decrease the mechanical properties of the material.(47)

Munoz and Manrique, (48) reported that, the flexural strength of water immersed samples decreased compared to the dry samples. This is due to the increase in the percentage of water absorption which will lead to the formation of higher number microcrack. Moreover, research carried out by Beyari, [49] reported that, adding silver filler at certain amount able to decrease the water absorption of PMMA resin significantly.

2.4.4 MechanicalProperties of PMMA

The drawback properties of PMMA resins create opportunity for more researches to be carried out in order to improve the properties of PMMA resin. First is by substitute other polymer in PMMA resin. However, this method is not so suitable to be used due to high cost.

Second, modification of PMMA, however this method does not show significant improvement in the strength of PMMA. Third, incorporation of filler with PMMA resin, this method is reported to show significant improvement of composite properties. [47]

In reinforcing method, there are various factors which may causes PMMA reinforced composites to perform in different ways. For example, types of fillers, size of fillers, amount of fillers, shape of fillers, fabrication processes, mixing, curing temperature, curing period and sequence of fabrication process. Many researches had been carried to identify different parameters that govern PMMA composites properties.[47]

There are several reasons caused fracture happened on denture base. For example, improper fitting, anatomical notches and lack of adequate design. The reasons of fracture occur is due to the load applying excess the maximum limit of flexure fatigue limit of the denture base. Hence flexural strength is one of the most important mechanical properties required for denture base resin materials.[47]

The flexural strength of a material is defined as its ability to resist deformation. In addition, it had been reported that acrylic resin with incomplete polymerization which will have lower mechanical properties compare to those with complete polymerization.[50]

Previous work by Calabrese et al. on PMMA/HA composite reported that the maximum flexural properties is reported at 20 wt% of HA, after which the flexural properties decreased.[51]

Besides, the interfacial interaction between filler and matrix becomes the driving force in strengthening and toughening effects on the composites.[52]

In order to further improve the mechanical properties of PMMA/HA composites, surface treatment of HA filler was carried to enhance the surface interaction between filler and resin. Tham et al.[53] reported surface of HA fillers was treated by silane coupling agent which show significant improvement in flexural properties compared with untreated HA fillers. This is due to better HA dispersion and better interaction between PMMA resins and HA fillers.[53]

Fracture toughness is an indication of the amount of stress required to propagate a pre-existing flaw. It is also a very important property to every material include denture bases.

Purietet al.,[54] statedthat the fundamental requirement of a good performance of denture based resin is its adequate impact strength and fracture toughness. However, one of the major shortcomings of PMMA resins is low fracture toughness. This shortage can be improved by adding fillers in PMMA resins. Based on the previous research by Wei et al.[55] the fracture toughness of PMMA resin was increased after adding ZrO_2 as filler and maximized at 2wt% of ZrO_2 filler content. With 2 wt% of ZrO_2, the fracture toughness of PMMA composite improved from 0.549 to 1.057 KJ/m2. In addition, the whisker structure of HA fillers show better improvement toward the fracture toughness compared to spherical nano-particle. Moreover, the fracture toughness value of whisker HA with PMMA composites increased as the volume fracture of filler increased. [56]

Fracture is one of the frequent problem that faced by removable denture base. Fracture occurs may be due to accident dropping, repeated masticatory forces and areas of stress concentration around the notches.[57]

Impact strength is the capability of the material to withstand a suddenly applied load and is expressed in term of energy. Hence impact strength of polymers used for production of denture bases is very important. It was reported that incorporation of PMMA resin and filler, results in impact strength improvement. For example, Merin et al.[58]reported that the impact strength of PMMA reinforced by polypropylene fibres increased with increasing weight percentage of polypropylene. Besides based on their research, 10 wt% with 12 mm long polypropylene fibres reinforced PMMA resins showed the highest impact strength which was 4.81 KJ/m2 compared to other tested groups.[58]

2.4.4.1 Roughness

The roughness of the acrylic resin surfaces is important since the adhesion of microorganisms to a surface is a prerequisite for the colonization of that surface.[59]

It is a clinical importance to determine the effect of denture cleansers on the properties of acrylic resins. Irregularities and porosities(roughness) present on denture surfaces offer a favorable niche to retain stain and microbial plaque. The surface roughness is of particular clinical relevance since it can affect the biofilm formation or make its removal difficult.

Microbial adherence capacity is influenced by differences in the surface of denture. A previous studyreported that the roughness in prostheses' surfaces might cause micro traumas in oral tissues. Williams and Lewis[60], concluded that surface roughness favored colonization by the microorganisms, contributing indirectly to tissue injury.

Furthermore, there are not enough studies about the effects of denture cleansers on denture base materials as acrylic resins and metals together.[61,62]

Appropriate cleaning of dentures is crucial for keeping a healthy mucosa of the oral cavity. Microbial biofilm on oral tissues and surface of acrylic resin denture base is a significant part in the development of denture stomatitis. Denture cleansing is essential part in preventing cross contamination and improves oral health of the patients, longevity of the dentures and quality of life. Several products are designated for removal of denture biofilm and categorized into chemical and mechanical products.

Cleaning using chemical products consists of keeping the denture in liquids with solvent, antifungal, detergent, and antibacterial activities with or without use of brushing or ultrasonic devices. The efficacy of denture cleansers is well known; nevertheless, it is critical that continuing use for long time should not cause any negative effect on the acrylic resin denture base and their mechanical and physical properties should remain unchanged. [16]

Roughness of the denture base acrylic resin after immersion in denture cleansers has been extensively reported. Studies of the surface roughness of acrylic resins have reported no changes in the roughness after immersion in denture cleansers. Other studies showed that surface roughness might add to the increased rate of colonization, adhesion, and maturation of microbial biofilm on surfaces.(16)

The roughness of the surfaces of acrylic resin is an imperative aspect, since the adhesion of microorganisms to a surface is a precondition for the colonization of that surface. Irregularities of the surface intensify the probability of microorganisms staying on the surface of the denture after has been cleaned.(16)

The surface roughness is of particular clinical relevance since it can affect the biofilm formation or make its removal difficult. Microbial adherence capacity is influenced by differences in the surface of denture. A previous study reported that the roughness in prostheses' surfaces might cause micro traumas in oral tissues, Williams and Lewis concluded that surface roughness favored colonization by the microorganisms, contributing indirectly to tissue injury. (49)

The efficacy of chemical denture cleansers dislodging food debris, biofilm, and tobacco stains from prosthodontics surface has been previously reported. However, few studies have investigated the influence of prosthodontics cleansers on acrylic resin surfaces. Furthermore, there are not enough studies about the effects of denture cleansers on denture base materials as acrylic resins and metals together.(30)

2.4.4.2 Hardness

The denture base hardness is used to evaluate the changes in the surface characteristics of acrylic resins and that result from denture cleansers, thermal cycling toothbrush/dentifrice abrasion and different systems of denture base polymerisation. Literature showed that different acrylic resins present significantly lower hardness after being submitted to 3.78% sodium perborate solutions of 1% sodium hypochlorite and 4% chlorhexidinegluconate solutions.(63)

Previous studies have shown that the hardness of a denture base is not significantly decreased by decontaminating in 4% chlorhexidine solutions or 1% sodium hypochlorite for 1 minute and in sodium perborate for 10 minutes. Conversely, the hardness of acrylic resins is reported to be changed by solutions of 4% chlorhexidine, 2% glutaraldehyde or 1% sodium hypochlorite. It is possible that due to cleaning and disinfecting treatments, surface hardness of acrylic resins can be decreased which will result in micro-organism adherence and formation of biofilm on the dentures.(63)

Indentation Hardness is an important physical property of a material indicating its resistance to plastic deformation under scratching forces. It is also mechanical property most frequent used to characterize the wear resistance of the material that mean the material with higher surface hardness considered to be more wear.(59)

The Brinell, Knoob, Vickers, Rockwell, Shore hardness are the most common methods used for testing the hardness of the restorative materials.(64)Hardness of denture base resin is indicative of the ease of finishing off a material, as well as its resistance to in-service scratching during cleaning procedures.(60)

Different type of filler added will direct influence the hardness of PMMA composites. For example, based on the research done by Alhareb et al.(65), they reinforced PMMA resin with mixture of Al_2O_3 with YSZ fillers. When increased the amount of Al_2O_3, the Vickers hardness value of PMMA composite dropped but when the amount of YSZ increased, the Vickers hardness value of PMMA composite increased.(65)

2.4.4.3 Micro-structure analysis

Electron microscopy, such as scanning electron microscopy (SEM) and transmission electron microscopy (TEM) are powerful imaging tools used to study the morphological and micro-structure analysis of the denture base sample. For example in dental base application, SEM or TEM are usually used to investigate the cause of fracture happened on denture base materials. In SEM technique, a focused electron beam is scanned over the sample in parallel lines. For SEM sample preparation, the samples for imaging were mounted on the specimen stub with double-side tape.(47)

TEM image on the other hand obtain as a result of electron and sample interaction as the electron beam passing through. The samples for imaging were cut thin in order for the electron beams able to pass through the sample. For filler samples, they are usually dispersed in ethanol and the solution was placed onto mesh copper grid. Next, the grid was dried and ready to be imaging in the TEM. (53)

Tham et al.(53) used SEM to observe the micrographs of the fractured surfaces of PMMA and HA composites in their control state and after being subjected to water absorption. It can be seen that there is noticeable gap between PMMA and HA for the untreated composite. However, for the treated HA composites, there is a better interfacial interaction between PMMA and HA. This fracture morphology can support the excellent recovery and retention properties of PMMA composites after being subjected to water absorption. Previous work by Hamizah et al.[66] reported that based on the SEM observation it was found that filler agglomeration in PMMA matrix caused reduction in flexural strength and modulus of the PMMA composites.

Previous research works on PMMA for denture application works on PMMA reinforced with different fillers have been investigated by many researchers. As reported by Them et al., their research, mechanical properties for the PMMA composites were measured and analyzed.[53]

From the results reported on PMMA resin reinforced by different fillers, Hamizah et al.[66] obtained maximum flexural strength (85.8 MPa) by reinforced PMMA resin with 4 wt% of glass ceramic by vacuum mixer. However, PMMA resin reinforced by 4 wt% of glass ceramic showed lower fracture toughness compared to PMMA resin reinforced with HA.

Study review about poly methyl methacrylate reported that PMMA resin reinforced by 5 wt% (40 % Al_2O_3/60 % YSZ) filler/7.5 achieved the highest fracture toughness which is about 2.61 MPa.m1/2. While for impact strength, PMMA reinforced by 1 wt% (50% Al_2O_3 / 50% YSZ) filler showed the highest value which is about 10.86 KJ/m^2. [47]

2.5 Evolution of Surface Properties

2.5.1 Hardness

The hardness of a solid material can be defined as a measure of its resistance to a permanent shape change when a constant compressive force is applied.[67]

The deformation can be produced by different mechanisms, like indentation, scratching, cutting, mechanical wear, or bending. In metals, ceramics, and most of polymers, the hardness is related to the plastic deformation of the surface.(67)

Hardness has also a close relation to other mechanical properties like strength, ductility, and fatigue resistance, and therefore, hardness testing can be used in the industry as a simple, fast, and relatively cheap material quality control method. Since the Austrian mineralogist Friedrich Mohs devised in 1812 the first methodical test to measure the hardness, a large variety of methods have been established for determining the hardness of a substance. (67)

The first report of a machine to measure indentation hardness was done by William Wade in 1856, where a specified load was applied to a pyramid-shaped hardened tool, and the hardness value was evaluated from the size of the deformed cavity on the surface.

At the beginning of the twentieth century, there were already commercially available machines for measuring indentation hardness because of the increasing demand for testing steels and rubbers. Mass production of parts in the new aeronautic, automotive, and machine tool industries required every item produced to be quality tested.(67)

During World War I and World War II, macro-indentation and later micro-indentation tests had a big role for controlling gun production. However, it was only in 1951 when the scientific basis for the indentation hardness tests was settled in the seminal work of Professor Tabor (father of the science of tribology). It represented a revolutionary model based on theoretical developments and careful experiments which provided the physical insight for the understanding of the indentation phenomena.(67)

Hardness has been used toassess the mechanical properties of materials, ease of finishingand polishing, resistance to scratching, and wearresistance of many restorative materials, including artificialdenture teeth.[63)]

2.5.1.1Typesof hardness test

- **Brinell Test**

Proposed by Johan A. Brinell in 1900, this is from the historic point of view the first standardized indentation hardness test devised for engineering and metallurgy applications. In this test, a ball of diameter D (mm) is used to indent the material through the application of a load L. The diameter D (mm) of the indentation deformation on the surface is measured with an optical microscope, and the Brinell hardness number (BHN) is then calculated as the load divided by the actual area Ac of the curved surface of the impression.[(67)]

- **Vickers Test**

The Vickers hardness test is calculated from the size of an impression produced under load by a pyramid-shaped diamond indenter. Devised in the 1920s by engineers at Vickers, Ltd. (UK), the indenter is a square-based pyramid whose opposite sides meet at the apex with an angle of 136, the edges at 148, and faces at 68. In designing the new indenter, they chose a geometry that would produce hardness numbers nearly identical to Brinell numbers within the range of both tests. The Vickers diamond hardness number, HV, is calculated using the indenter load L and the actual surface area of the impression.[(67)]

- **Meyer Test**

Devised by Prof. Eugene Meyer in Germany in 1908, thetest is based on the same Brinell test principle,butthe Meyer hardness number (MHN) is expressed as thendentation load L divided by the projected area Ap of the indentation .An advantage of the Meyer test is that it is less sensitiveto the applied load, especially compared to the Brinellhardness test.[65]

- **Rockwell Test**

The Rockwell test determines the hardness by measuringthe depth of penetration of an indenter under a large loadcompared to the penetration made by a smaller preload.The differential-depth hardness measurement used in themethod was conceived in 1908 by the Austrian professorPaulLudwik in his book Die Kegelprobe.[68]

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- **Knoop Test**

Developed in 1939 at the USA National Bureau of Standards(nowadays NIST) by Frederick Knoop, the indenteris a rhombic-based pyramidal diamond that produces an elongated diamond shaped indent.[65]

2.5.2 Measurement of surface roughness

Numerous measurement techniques have been used for roughness study in enormous quantity of works over a large periods of time, which itself speaks for the importance of this research area. Important types of contact, non-optical, and optical instrumentation for surface metrology are reviewed in.[68]Among non-contact methods, most used are optical white light and laser ones. Apart from all known microscopes for direct surface examination, for surface topology study almost all known optical measurement techniques with relevant digital hardware facilities and image processing software are used.(68)

A lot of measurement techniques rely on a pattern projection and its modulation, caused by the surface's roughness, structure of the generated speckle pattern, and the intensity of the scattered light. To mention some of them briefly citing exemplary publications:

Three-dimensional profiles of surface roughness are well revealed by the fringe projection technique,(69) ,as well as by fringe projection moir´e.(70)

Recently, a comparison between three optical methods for characterizing surface roughness on nanoscale via two scatterometers (laboratory and commercial), and a confocal optical profiler have been performed.(71)

Contrast, correlation, energy, and homogeneity features are studied with respect to surface roughness of paper through gray-level co-occurrence matrix of the produced speckle patterns.(72)

profilometer technique was first constructed by Abbott and Firestone's in 1933.(73) It is known that modern software allows computing of approximately 300 parameters of roughness profile and dozens of topography parameters. Roughness of any surface can be measured up to 200 mm length and 100 mm width with the deviation of guide being equal to fractions of micrometers, and further software support of accuracy can be applied.(74)

Research objectives

This study aimed to evaluate the effects of different denture cleanser agents on microorganisms' attachment, the surface roughness and surface hardness of denture base materials (conventional denture base material).

Specific objectives

1-Evaluation the effect of using 5% sodium hypochlorite immersion for 10 min, on hardnessroughness, and microorganism attachment on denture base heat cure acrylic resin.

2. Evaluation the effect of using 0.12%chlorhexidinegluconate immersion for 10 min, on hardness, roughness, and microorganism attachment on denture base heat-cure acrylic resin.

3. Evaluation the effect of using 6% hydrogen peroxide immersion for 10 min, on hardness,roughness, and microorganism attachment of denture base heat cure acrylic resin.

3. Materials and methods

3.1 Materials

The local available of heat cure acrylic resin materialswas used in this study to prepare the tested samples (Figure3.1 (PYRAX-Germany).The method of disinfection was sub immersion method for 10 minutes. Three types of disinfectants agents were used in this study (sodium hypochlorite 5% - chlorhexidinegluconate 0.12% and hydrogen peroxide 6%**)**(Figure 3.2)**.**(15 mm-diameter and 4 mm-height).[16]

3.1.2 Samples preparation

Total of seventy eight samples were prepared (15 mm-diameter and 4 mm-height)[16] using a putty former (Figure 3.3) filled with base plate wax. All the wax patterns were invested with a dental stone in metallic dental flasks (Figure 3.4). After the setting of stone the flask helves were separated, the wax was eliminated, and the stone mold was cleaned with hot water to remove remaining wax. The resin was manipulated packed and pressed into the mold according to the manufacturer's instructions. The heat polymerization method carried out in water bath at 73 °C for 90 min, followed by 94 °C for 30 min. All flasks were allowed to cool at room temperature before opening.Polishing was done only on one surface of the samples, and the other surface was left unpolished to presenting the fitting surfaceof denture base.

Then, the seventy eight samples had been divided in three major groups:

Group 1: Consist of fifty four samples prepared for biological part of study.

Group 2: Consist of twelve samples prepared for roughness test of study.

Group3: Consist of twelve samples prepared for hardness test of study.

Figure 3.1: Conventional heat cure acrylic resin.

Figure3.2: Disinfectant agents used in this study

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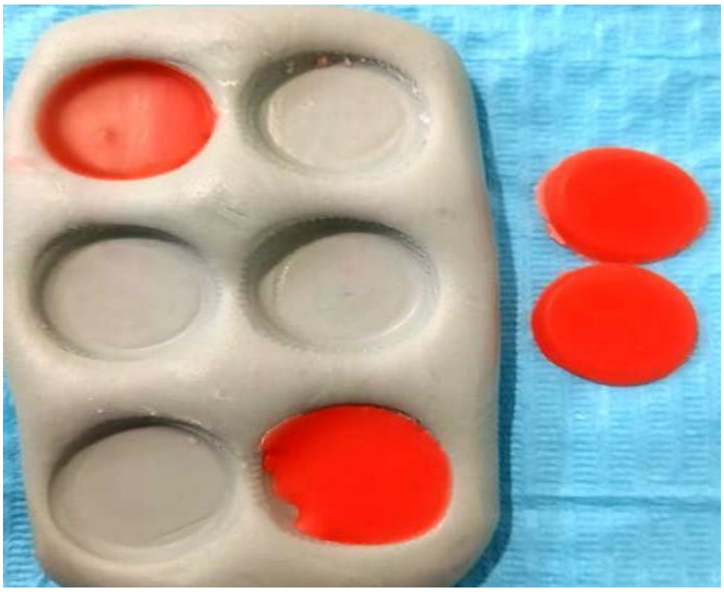

Figure3.3: Putty former filled with base plate wax.

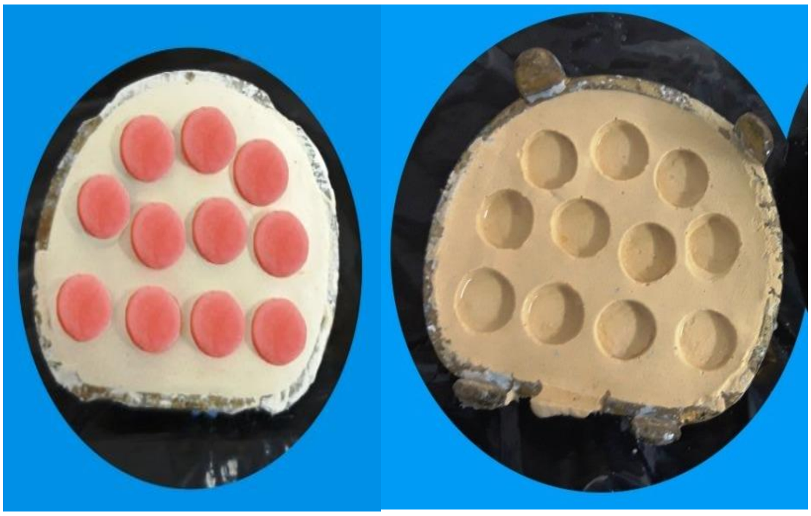

Figure 3.4: Metallic Dental flask filled with acrylic resin.

3.2 Method

3.2.1 Microorganisms preparation and disinfectant procedures

Total of fifty four samples was used for this part of study.The microorganism has been clinically isolated by swab from oral cavity and allowed to grow in their selected culture using incubator. Specimens for bacteria and other for fungal contamination were prepared and selected from Microorganism Analysis lab of Benghazi University .Then, the sapeciments separately placed inpetri-dishes with respective culture. The brainheart infusion (BHI) culture media was used in Petri plates torecover/count *Staphylococcus Aureus*, chocolate agar for *Streptococcus Mutans* and sabourauds dextrose agar (SDA) for *CandidaSpp*.Thesamples has been divided into three main groups according to three different types of disinfectants,each group of sample has been placed in petri dishes while the inteligo surface contact the microorganism (Figure 3.5). Then , all samples has been placed again into incubator for 24h to allowing the microorganism grow over the rough side of samples.

The 54 samples were divided into three main groups according to type of disinfectants.All groups were disinfected by immersion in disinfectant for 10 minutes.Eachgroup was containingeighteen samples.

Group1: Aconsists of eighteen samples were disinfected by 5% Sodium Hypochlorite disinfectant.

Group1: Bconsists of eighteen sampleswere disinfected by 6% Hydrogen peroxide disinfectant.

Group1:C consistsof eighteen sampleswere disinfected by 0.12% chlorahexidine disinfectant.Then, each group divided again into three subgroups asfollowing:

Group1 A: divided into three subgroups **G1A1** , **G1A2** , and**G1A3.**

Group1 B: divided into three subgroups **G1B1**, **G1B2** , and **G1B3.**

Group1 C: divided into three subgroups **G1C1** , **G1C2** ,and **G1C3.**

Each sub group contains six samples. Five of six samples for each sub-group were colonized in the laboratory by *Staphylococcus Aureus* , *Streptococcus Mutans ,and Candida Albicans spp*. respectively. The remained single sample will be considered as control sample (Figure 3.6).After colonization of microorganisms each group has been disinfected by corresponding disinfectant for 10 minutes, then the samples were placed in their respective culture in the Petri-dishes and then, incubated for 24 hours (Figure 3.7).After one day in incubator the petri-dishes with samples were checked for re-colonization of microorganism as respect to disinfectant agent.

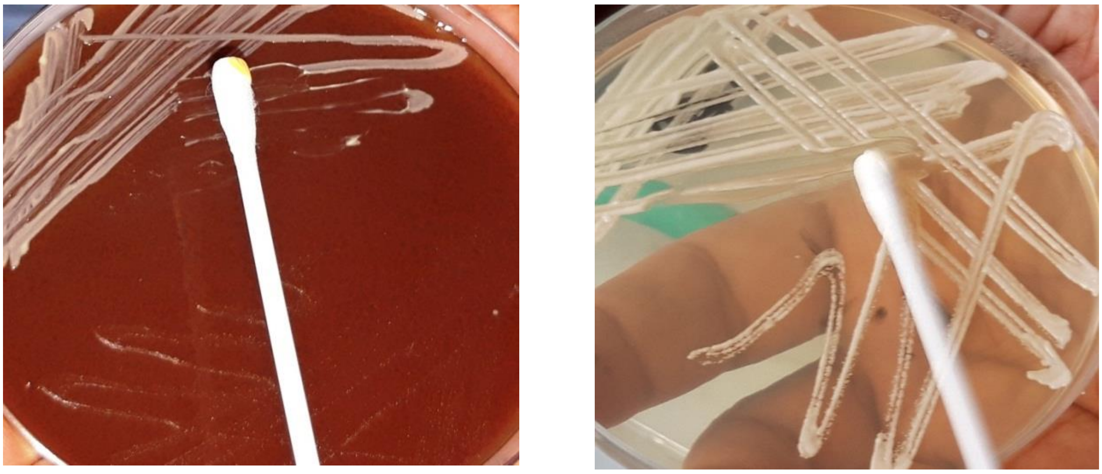

Figure 3.5: Placing of clinically isolated microorganisms by swab in culture.

Figure 3.6: Tested samples in petri-dish incubated with microorganisms for colonization.

Figure 3.7: Tested samples in petri-dish incubated with microorganisms after disinfected.

3.2.2 Specimensfor roughness and hardness

3.2.2.1 Roughness

Total of twelve samples of heat cure acrylic were prepared divided in to four groups, each group consist of three samples.

Group2 A: disinfected by 10 minutes immersion in Sodium hypochlorite.
Group2B: disinfected by 10 minutes immersion inH_2O_2.
Group2C: disinfected by 10 minutes immersion in Chlorhexidine.
Group2 D: immersed in distilled water for 10 minutes.

The average number of roughnessof each group was calculated. Roughness test carried out to evaluate and compare the changes resultingfrom disinfection procedure. The specimens were submitted to the surface roughness using profilometer device (Figure 3.8) and the result had been confirmed by using computerized microscope (Figure 3.9).

The surface roughness (in μm) was analyzed with a surface roughness profilometer (Mitutoyo SJ-210, Mitutoyo Corporation, Tokyo, Japan) having a diamond stylus (tip radius 5 μm) (Figure 3.8). The surface roughness is the average of the absolute values of the measured profile height of surface irregularities and measured from a mean line within a preset length of the specimen. The profilometer was set to move the diamond stylus across the specimen surface under a constant force of 4 m/N. A measurement was obtained from the stylus passing across a length of 4 mm at 0.5 mm/s to the nearest of 0.01 μm. The cut-off length was 0.8 mm. An orientation jig was fabricated to position the stylus of the profilometer in the same location on the specimen for repeated measurements.

Three measurements of surface roughness were performed for each sample at the same position, and the mean value was calculated. The samples were tested in their surface roughness after immersion of specimens in respective to disinfectantsused. The surface morphology also evaluated used a microscope at 100 magnification power to confirm the results.

3.2.2.2 Hardness

Total of twelve samples of heat cure acrylic were prepared divided in to four groups, each group consist of thee samples as following:

Group3 A disinfected by10 minutes immersion in Sodium hypochlorite.
Group3 B disinfected by 10 minutes immersion H_2O_2.
Group3 C disinfected by 10 minutes immersion in Chlorhexidine.
Group3 D immersed in distilled water for 10 minutes.

The average number of hardness of each group was calculated. Hardness testcarried out to evaluate and compare the changes resultingfrom disinfection procedure.The specimenswere submitted to the surface hardness test using a Vickersindenter device (with an indentation load for 5-10 sec (Figure 3.10).

Figure3.8: Surface roughness testing device(surface profilometer)

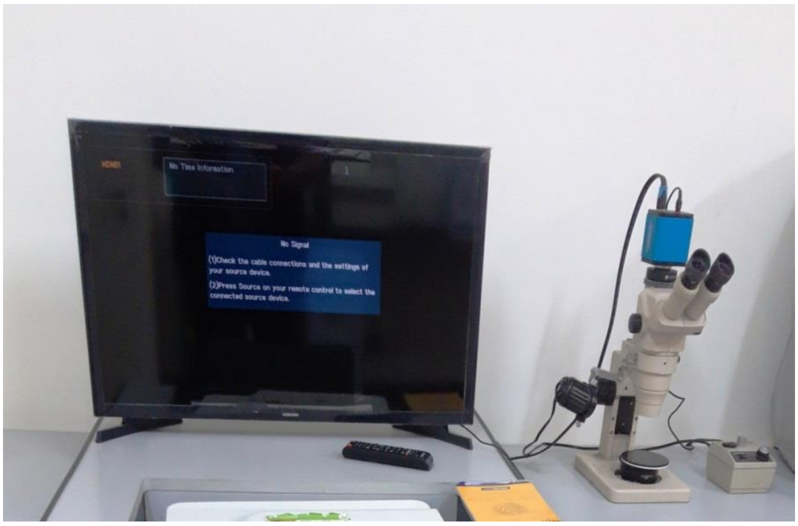

Figure 3.9: Computerized microscope used to scan the samples

Figure3.10: Vickers Hardness machine

3.3 Data collection:

The data was captured in an excel spread sheet. The spreadsheet was designed to reflect the effect of disinfect agent on surface roughness and hardness, the mean value of the 3 measurements for each samples were calculated.

3.4 Data analysis:

The mean of the three measurements obtained from each disinfectant agentwere compared to control samples (distilled water). Data were analyzed with an analysis of variance (ANOVA). All data analysis was carried on SPSS IBM22. The results were graphically illustrated.

4. Results

4.1 Microbiology evaluation (G1)

4.1.1 Effect of sodium hypochlorite(G1A)

Figure 4.1.shows effect of using sodium hypochlorite as disinfectant agent on growth of microorganisms. It can be seen that there is no signs of microorganism growth (*Strept.Mutans* - *Ataph.Aures* - *Candida Albicans*) when using of sodium hypochlorite as disinfectant solution to cleans denture base compared to sample being immersed in distilled water which showed a growth of microorganisms.

4.1.2 Effect of Hydrogen peroxide (G1B)

Figure 4.2.shows effect of using hydrogen peroxide as disinfectant agent. It can be seen that there is signs of *Strept.Mutans* growth furthermore there is no signs of *C. Albicans* and *Staph.Aures* grow thwhen using of hydrogen peroxide as disinfectant solution to cleans denture base compared to sample being immersed in distilled water which showed a growth of microorganisms.

4.1.3 Effect of chlorhexidine(G1C)

Figure 4.3.shows effect of using chlorhexidine as disinfectant agent. It can be seen that there is no signs of microorganism growth (Strept.Mutans - Staph.Aures - Candida. Albicans) when using of chlorhexidine as disinfectant solution to cleans denture base compared to sample being immersed in distilled water which showed a growth of microorganisms.

Figure 4.1: Group1 A: Effect of sodium hypochlorite on microorganism growth. (A_1: Strepto.M -. A_2: Candida –Alb. A_3: Staph. Aures Arrow – distilled water control sample)

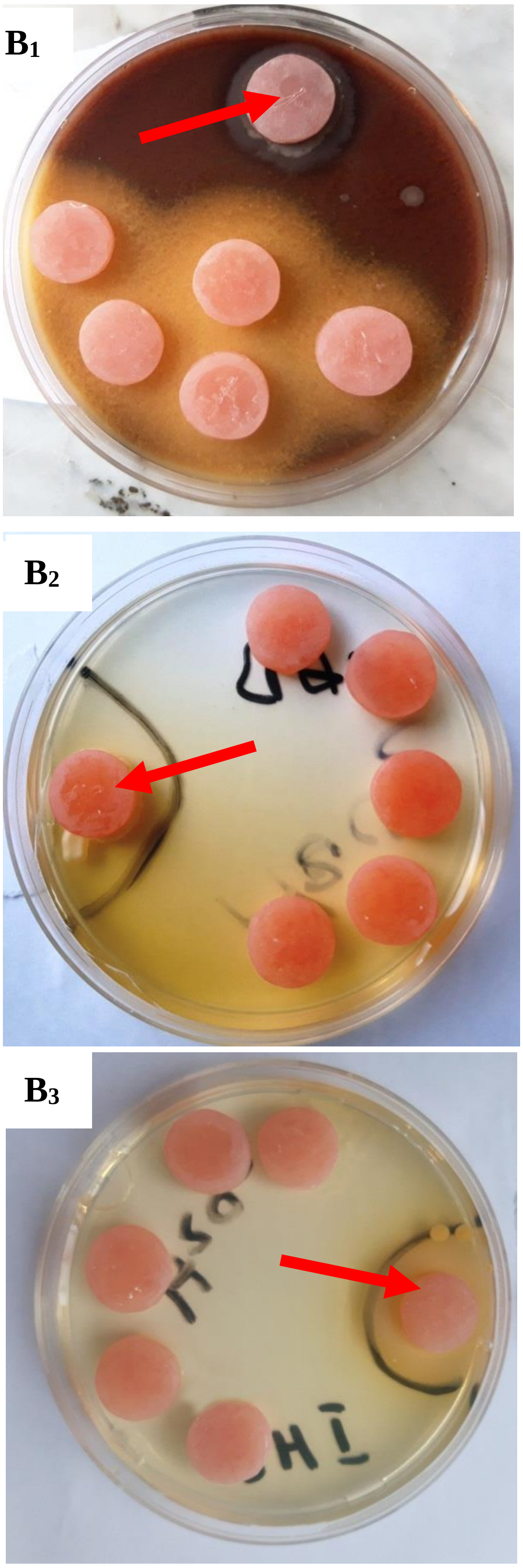

Figure 4.2: Group1 B: Effect of hydrogen peroxide on microorganism growth.(B_1: Strepto.M – B_2:Candida Alb. – B_3:Staph.Aures Arrow – distilled water control sample).

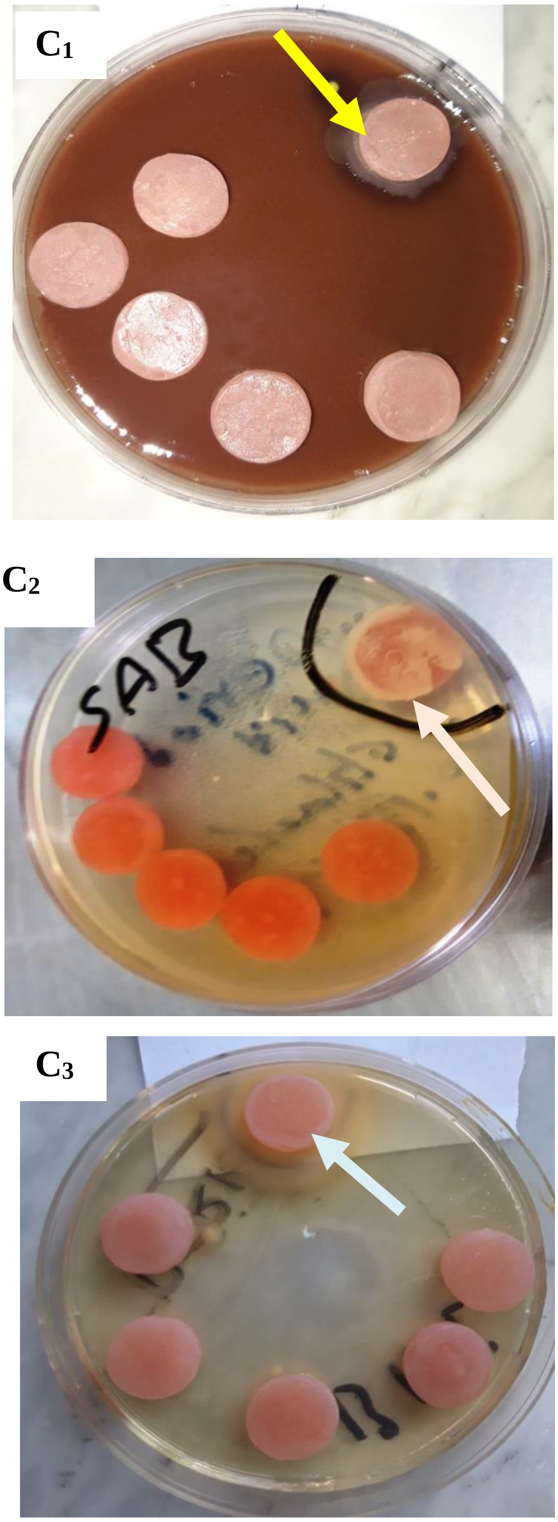

Figure 4.3:Group1C: Effect of chlorhexidine on microorganism growth.(.C1-.Strepto.M - C2-Candida.Alb. C2 – Staph.Aures- C. Arrow – distilled water control sample)

4.2SurfaceRoughness Evaluation

4.2.1 Effect of sodium hypochlorite(G2A)

Figure 4.4 shows effect of using sodium hypochlorite (SHC) as cleansing solution compared to distilled water (DW) and none immersed samples (Dry)on the surface roughness of denture base material. Statistically there was a significant difference between SHC and two tested groups (DW and Dry), ($P<0.013$). However, the samples disinfected by sodium hypochlorite showed slightly lower surface roughness compared to two other tested groups [hydrogen peroxide (HPO) and chlorhexidine (CHX)] (Figure 4.5), statically there was no significant difference between tested groups ($P<0.998$ and $P<0.144$, for HPO and CHX respectively).

Furthermore, as directed in (Figure 4.9), which show the effect of SHC sample under microscopic scan at 100 magnifications in comparison to control sample (Figure 4.8). It can be seen that there was no clear differences between two groups.

4.2.2 Effect of Hydrogen peroxide (G2 B)

Figure 4.6 shows the effect of using hydrogen peroxide as disinfectant agent on surface roughness of denture base material compared to distilled water and dry samples. It can be seen that hydrogen peroxide displayed higher surface roughness with significant differences ($P<0.008$) between tested groups (DW and Dry samples). However, hydrogen peroxide (HPO) was none significantly different with two other tested groups (Fig. 4.5) ($P<0.998$ and $P<0.226$ for SHC and CHX respectively).

Furthermore, as depicted in Figure (4.10), which show the effect of H_2O_2 on the surface roughness of sample under microscopic scan at 100 magnifications. It can be seen that there was an effect on surface roughness as compared to control sample (Figure 4.8).

4.2.3 Effect of chlorhexidine(G2C)

Figure 4.7 shows effect of using chlorhexidine(CHX) as disinfectant agenton surface roughness of denture base material. CHX showed higher surface roughness compared to DW and Dry samples, there was a high significant difference between them (P<0.000). But there were no significant differences between CHX and two other tested groups SHC and PHO groups (Fig. 4.5) (P<0.144 and P<0.226 for SHC and CHX respectively).

Furthermore, Figure 4.11 shows the effect of CHX on one of sample under microscopic scan at100 mgnification. It can be seen that there is a clear effect in surface roughness as compared to control sample (Figure 4.8).

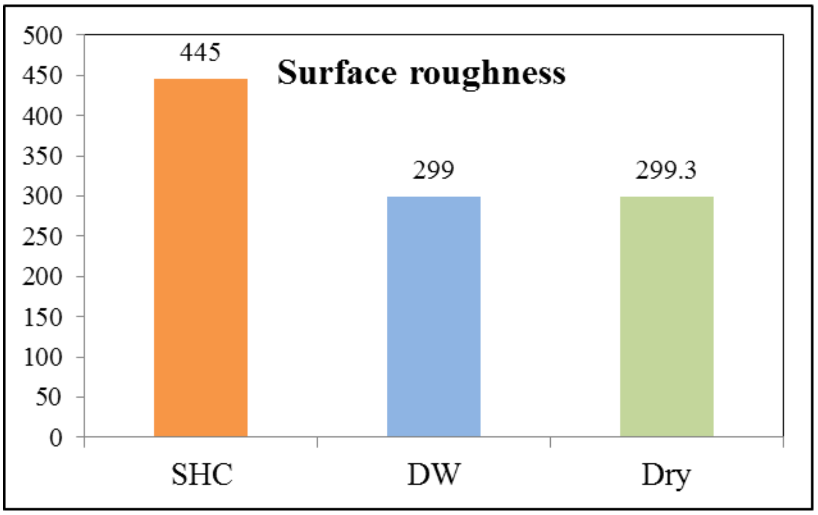

Figure 4.4: Surface roughness of denture base after using sodium hypochlorite compared to DW and Dry condition.

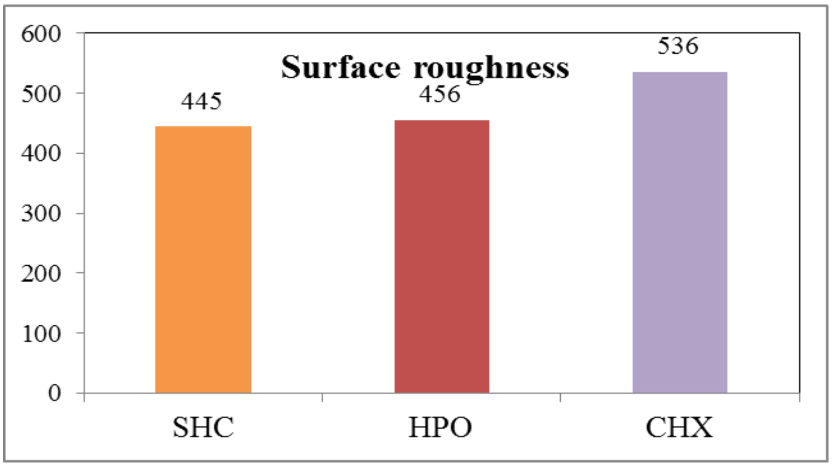

Figure 4.5: Surface roughness of denture base after using sodium hypochlorite compared to HPO and CHX.

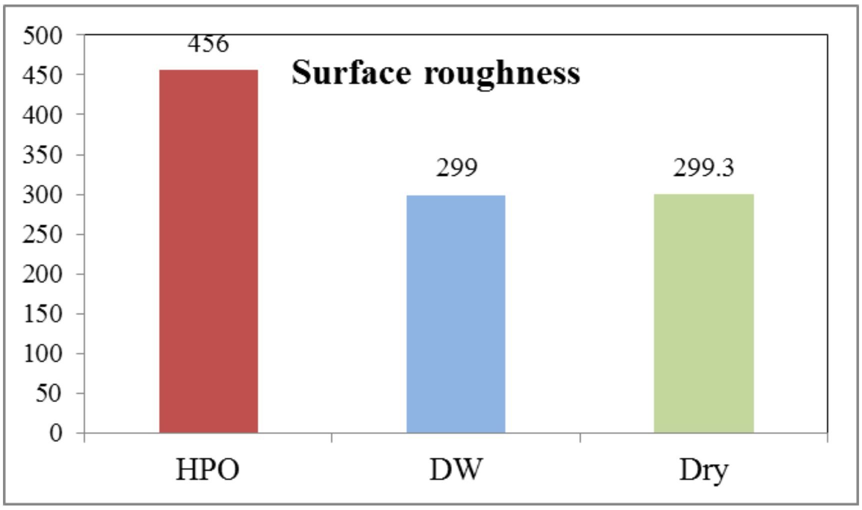

Figure 4.6: Surface roughness of denture base after using Hydrogenperoxide compared to DW and Dry condition.

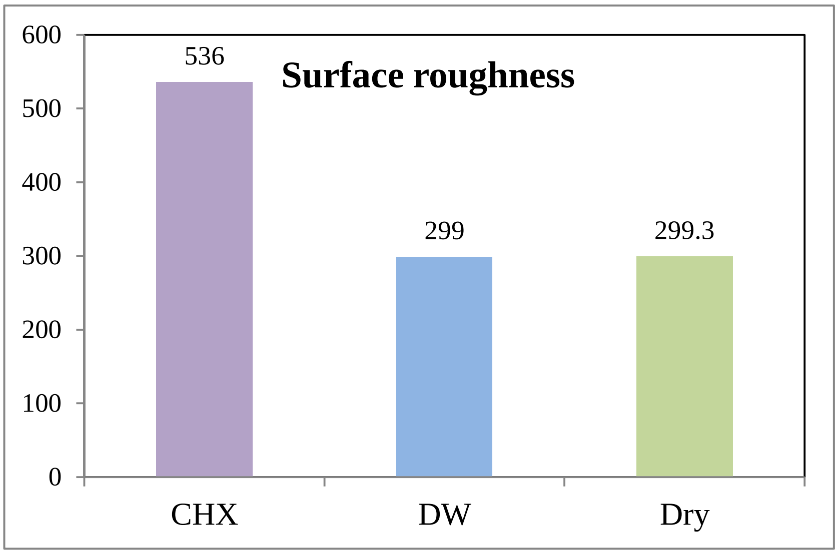

Figure 4.7: Surface roughness of denture base after using chlorhexidine compared to DW and Dry condition.

Figure 4.8 Microscopic photo 100 magnification of control sample.

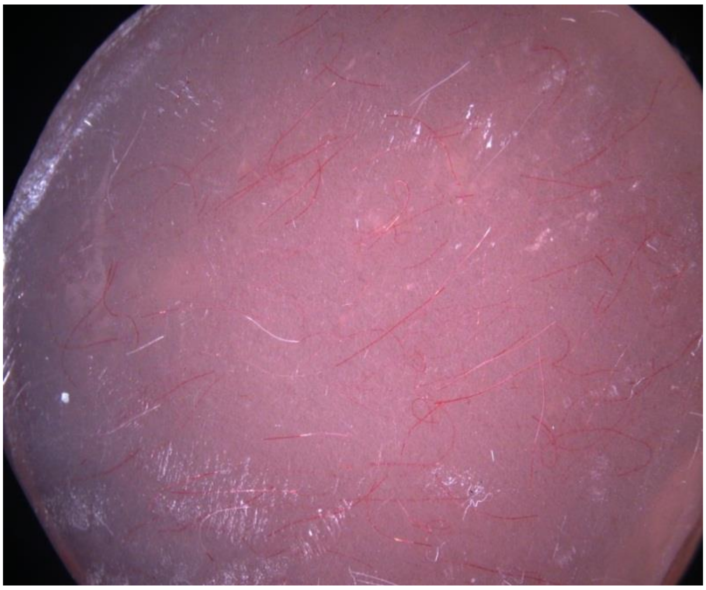

Figure 4.9: Microscopic graph at 100 magnificationsof sample immersed in SHC.

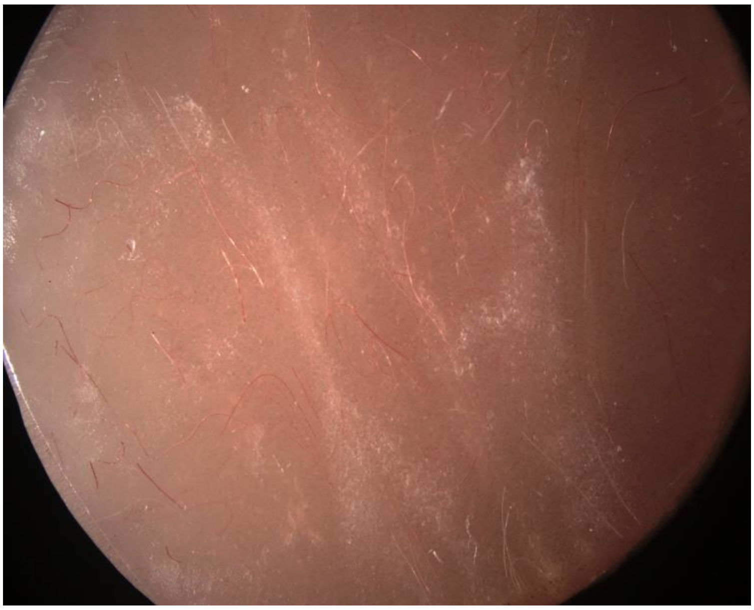

Figure 4.10: Microscopic graph at 100 magnification of sample immersed in H_2O_2.

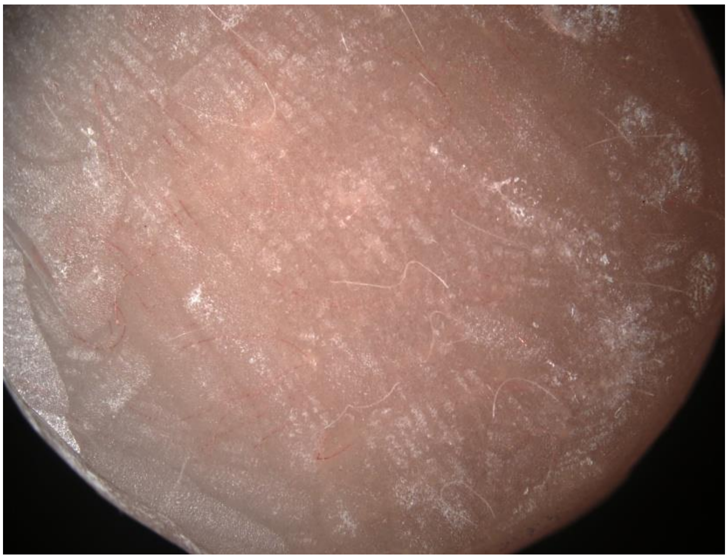

Figure 4.11: Microscopic graph at 100 magnification of sample immersed in CHX.

4.3Micro-hardness evaluation (Group3 of 12 samples)

4.3.1 Effect of sodium hypochlorite (Group3 A)

Figure 4.12 shows the effect of using sodium hypochlorite as cleansing solution on micro-hardness of denture base. It can be seen that surface hardness of there was a significant difference between sodium hypochlorite and distilled water samples ($P<0.036$), however, there was no difference between sodium hypochlorite, hydrogen peroxide and chlorhexidine samples (Fig. 4.13) ($P<0.427$ and $P<0.068$ for HPO and CHX respectively).

4.3.2 Effect of Hydrogen peroxide (Group3 B)

Figure 4.14 shows effect of using hydrogen peroxide as disinfectant agent on micro-hardness. It can be seen that surface hardness of there was a significant difference between hydrogen peroxide and distilled water samples ($P<0.004$), however, there was no difference between hydrogen peroxide, sodium hypochlorite and chlorhexidine samples (Fig. 4.13) ($P<0.427$ and $P<0.546$ for CHC and CHX respectively).

4.3.3 Effect of chlorhexidine (Group3 C)

Figure 4.15 shows effect of using chlorhexidine as disinfectant agenton micro-hardness. It can be seen that surface hardness of there was a significant difference between hydrogen peroxide and distilled water samples ($P<0.001$), however, there was no difference between chlorhexidine, sodium hypochlorite, and hydrogen peroxide samples (Fig. 4.13) ($P<0.068$ and $P<0.546$ for CHC and CHX respectively).

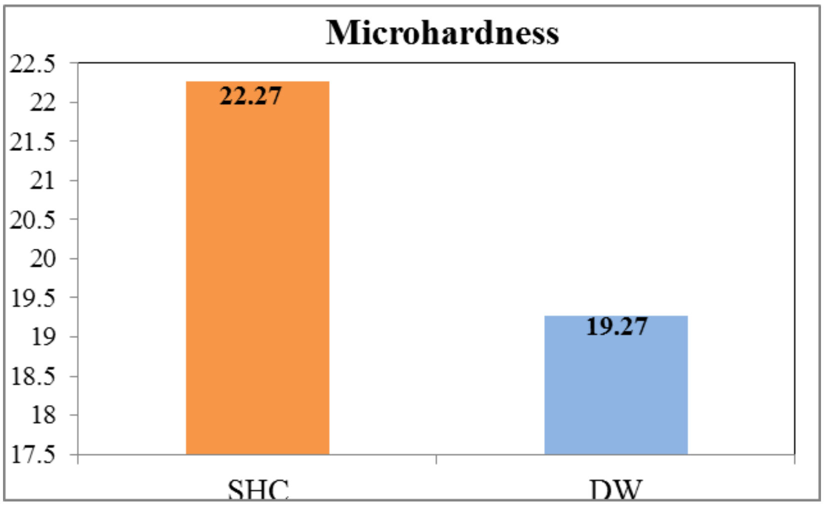

Figure 4.12: Microhardness of denture base after using sodium hypochlorite compared to DW samples.

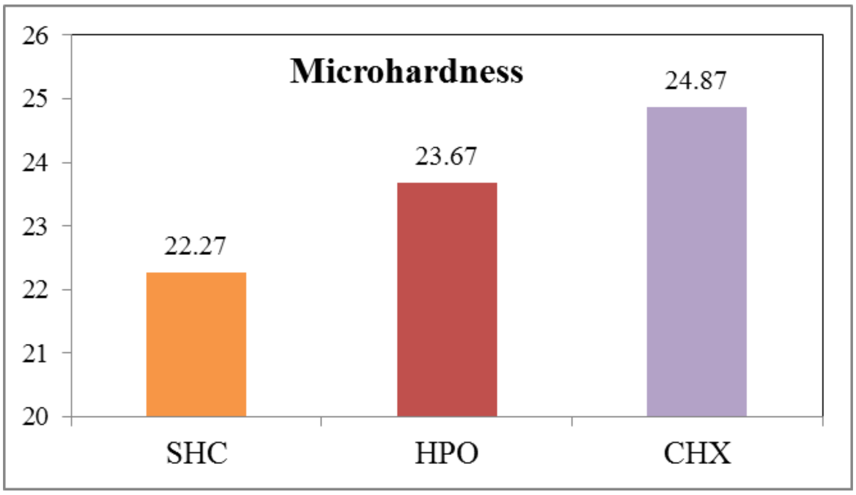

Figure 4.13: Microhardness of denture base after using sodium hypochlorite compared to HPO and CHX.

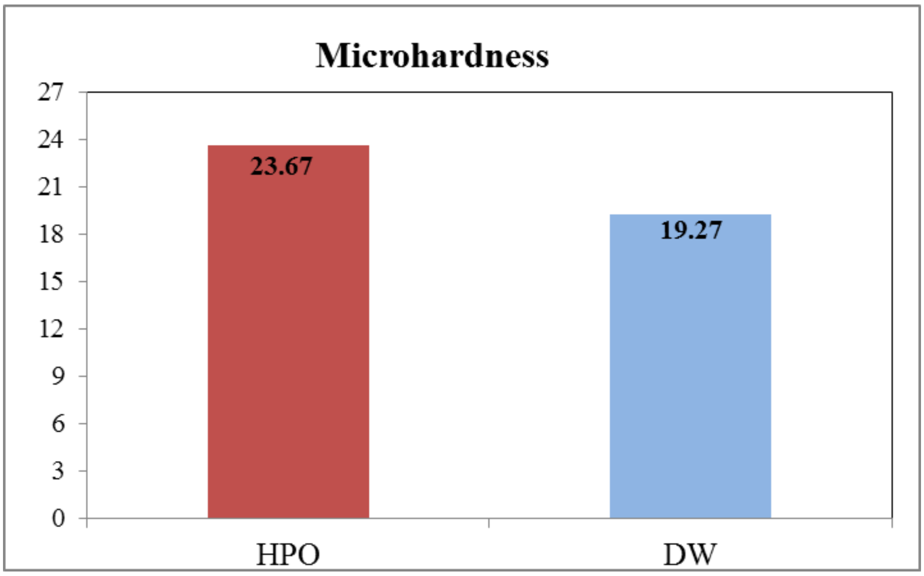

Figure 4.14: Microhardness of denture base after using hydrogen peroxide compared to DW samples.

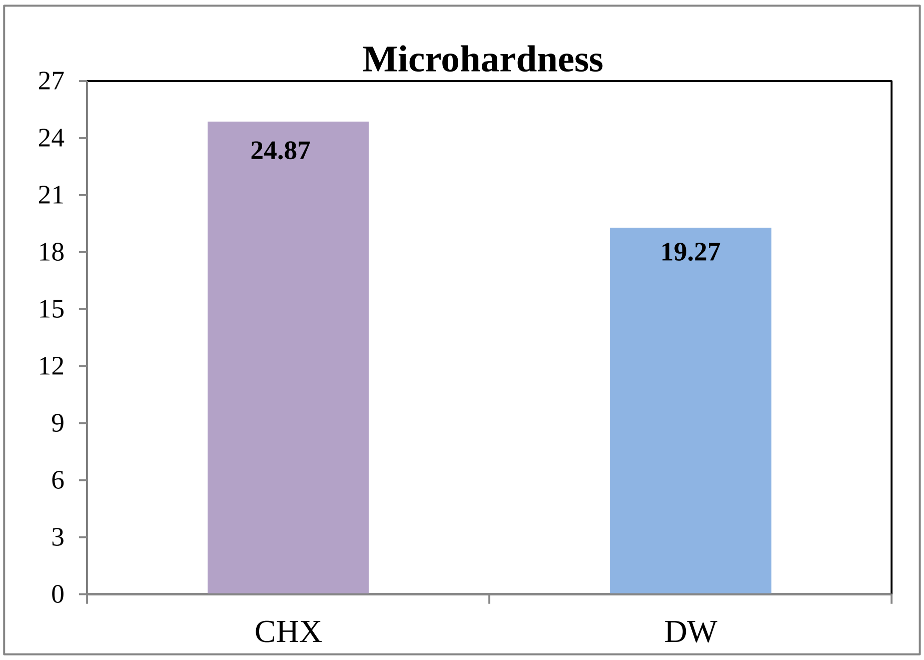

Figure 4.15: Microhardness of denture base after using chlorhexidine compared to DW samples.

5.Discussion

The acrylic resin became the preferred material for making denture bases, due to its ability to overcome many of the deficiencies of the materials used.Poly(methyl methacrylate) (PMMA) is an acrylic resin usually used with a long tradition for prosthetic purposes. Conversely, removable dentures are used in critical conditions of the oral cavity.

There are about 500 microorganisms in the mouth, which produce a biofilm in an acidic environment causing several diseases, such as denture stomatitis, deterioration of the periodontal status of the remaining teeth, or carious lesions in abutment teeth. Therefore, it is very important to choose a suitable material for dental prosthesis.Appropriate cleaning of dentures is crucial for keeping a healthy mucosa of the oral cavity.

Microbial biofilm on oral tissues and surface of acrylic resin denture base is a significant part in the development of denture stomatitis. Denture cleansing is essential part in preventing cross contamination and improve oral health of the patients, longevity of the dentures and quality of life. Several products are designated for removal of denture biofilm and categorized into chemical and mechanical products. Cleaning using chemical products consists of placing the denture in liquids with solvent, antifungal, detergent, and antibacterial activities with or without use of brushing or ultrasonic devices. The efficacy of denture cleansers is well known; nevertheless, it is critical that continuing use for long time should not cause any negative effect on the acrylic resin denture base and their mechanical and physical properties should remain unchanged.[50]

The microbial flora of the oral cavity is extremely diverse due to abundant nutrients, moisture, hospitable temperature and availability of surfaces to develop. The majority of these organisms pose no risk;

however, a number of them cause serious infections. The most frequently identified microorganisms in the oral cavity are *Streptococcus species*, *Staphylococcus species, Actinomyces species, Preptostreptococcus species, Pseudomonas species, ,Klebsiella pneumonia, and Candida species*.[42]

Denture associated stomatitis is a common infection which affects most denture wearers. However, there have been relatively few studies on such mixed bacterial-fungal biofilms generated in vitro. Different microbial species have frequently been reported and associated with DAS and interactions between bacteria and yeast in the oral cavity have been recognized for several years. [70]

Denture and oral cleaning should be quick and easy to perform by patients and/or their care givers. The cleaning procedures should also be efficient, economical, and comprise of regular oral care, denture hygiene, and removal of the dentures at night. These procedures can be combined with the administration of antifungal and antimicrobial agents in the case of severe and persistent mucosal infection. [70]

The present study evaluated the effect of various denture cleansers on microorganism growing, surface roughness and surface hardness of heat cure denture base material. We chosen the most common disinfectant material used in this field sodium hypochlorite, hydrogen peroxide and chlorahexidin solution. There are controversial opinions in the literature related to the effects of denture cleansers on surface roughness and hardness of denture materials. Differing compositions of cleansing solutions and materials, and different testing methods may be responsible for the controversy. The surface roughness of dental materials has been shown to be of particular importance for adhesion of oral bacteria; hence, smoother surfaces will result in denture longevity.[20]

Profilometry and its numerical data has been shown to be useful in the evaluation of the roughness of dental materials. Bollen et al.found a threshold value of 0.2 µm, suggesting that low roughness levels do not influence adhesion.[75]

This study compared the efficacy of denture cleaners on contaminated specimens. Among all the agents evaluated against selected microorganisms, 5% sodium hypochlorite solution demonstrated the best cleaning effect on denture base material. No colonization was found in any of the specimens. While, the 6% hydrogen peroxide has no effect on streptococcus mutan.

Moreover the 0.12% chlorhexidne has eliminate all selected microorganism but it had a strong effect on surface roughness it was the highest among the other disinfectants.

Pavarina e*t al*[76], also noted the effectiveness of chlorhexidine as a denture cleanser, though they used the chlorhexidine in a different concentration. In their study, the effectiveness of chemical agents (4.0% chlorhexidinegluconate, 1.0% sodium hypochlorite, and iodophors.) for cleansing and disinfecting of removable dental prostheses was evaluated, and it was concluded that the 4.0% chlorhexidinegluconate and 1.0% sodium hypochlorite solutions were effective in reducing the growth of the microorganisms in the 10-minute immersion period. [77]

Hydrogen peroxide is widely used to treat cuts and scrapes, but some sources warn that it doesn't reliably kill all bacteria and can even harm healing tissue. The hydrogen peroxide molecule has one more oxygen atom than a water molecule, so it acts as an oxidizer. Some bacteria can defend themselves against this, and some cannot.Hydrogen peroxide is an oxidizing agent, but it does not damage the cell as much as the superoxide anion and tends to diffuse out of the cell. Hydrogen peroxide would not be an effective choice for disinfecting linens, rooms, carpets, etc. because it is not effective enough on *Streptococcus Species* .[77]

Several studies have investigated the effects of chemical denture cleaning solutions on the properties of acrylic denture base resins[78,79]. Peracini et al.[80] demonstrated that commercially available alkaline peroxide denture cleansers altered the color, increased the surface roughness, and reduced the flexural strength of heat-polymerized acrylic denture base resin. Among the plethora of over-the-counter denture cleansers, peroxide-based solutions are the most widely used because they generate H_2O_2 to kill microorganisms in denture plaque. Thus, the generated H_2O_2 might contribute to the degradative change in the acrylic resin because H_2O_2 is a well-known oxidant. [80]

In the present study the valid tool used for determining the hardness of rigid polymers was Vickers microhardness test, which is based upon the ability of the surface of a material to resist point penetration under a certain load.

The findings of the current study suggest that the immersion of tested denture base resin in various denture cleansers can affect the hardness of the resin in comparison with distilled water (control group) which showed no effect. This is may be due to the chemical nature of the denture cleansers. The findings indicate that the hardness of all PMMA resins tested was decreased following immersion regardless of the immersion solution type or immersion time. This may be due to leaching out of the monomer from the PMMA matrix and/or the diffusion of molecules from the cleansing solution and into the PMMA resin through the formation of side group chains. Both of the above would result in the softening of the resin. The polymerization process of conventional PMMA resins occurs by free addition thus resulting in the presence of free radicals as well as partial cross linked polymer chains containing high levels of residual monomer.[41]

This is believed to have an adverse effect on some of the mechanical properties of the resin including the hardness due to diffusion of the monomer from the polymer and simultaneous water sorption by diffusion into the resin, a plasticizing effect which reduces the inter-chain forces allowing easy deformation and significant reduction in the hardness of PMMA acrylic resins under load during hardness tests.[(81)]

Reports in the literature using experimental testing protocols that would allow a comparison with this study. The purpose of immersing dental prostheses in a disinfectant solution isto inactivate infectious viruses and bacteria without damaging the dental prostheses. In this study, the disinfectant protocol was similar to othersthat exposed resin acrylic samples to disinfectant solutions: 5% sodium hypochlorite, 0.12% chlorhexidine and 6% hydrogen peroxide. Similarly to this study, othersevaluated the effects of disinfectant solutions on physical and mechanical properties of acrylic denture base resins, i.e. roughness, hardness and surface morphology. Roughness affects the patient’s comfort and prosthesis longevity. A smoother surface leads to better esthetic results and less biofilm retention.[(63)]

Srinivasan and Gulabani[(82)] reported that the use of chemical-based denture cleansers reduced the microbial numbers as compared to plain manual cleansing methods in complete dentures. An immersion-type or chemical-based cleanser was found to be the most suitable cleanser because of its low abrasivity and effective removal of organic debris.

Chemical-based denture cleansers do not contain abrasive particles. One of the main cleansing agents in this category is effervescent peroxide or sodium hypochlorite. The oxygen released effectively dislodges debris and creates a surface free of plaque. [83]

Duyck et al. [84]did a crossover randomized clinical trial and concluded that the use of cleansing tablets during overnight denture storage reduced the total bacterial count on acrylic removable dentures as compared to overnight storage in water. This type of cleansers is good in their cleansing efficiency but can lead to deterioration of the denture base material such as bleaching of acrylic resin, corrosion of metal, and deterioration of soft lining materials if used incorrectly.[84]

The research work of Pinto et al. stated significant increase in surface roughness after repeated cycles of chemical disinfection. [85]

In this study, roughness values increased in the samples that were disinfected with all disinfectants in comparison to the control group, but the chlorhexidine has more effect on roughness than the other disinfectants.

Disinfectant agents may alter the surface of acrylic resins. The microhardness of the acrylic resins used as denture base immersed in disinfectant solutions was also evaluated in the present study, similarly to other studies. [9,36]

Hardness is the property of a material that gives it the ability to resist permanent deformation (bending, breaking or shape changes), when a load is applied . The effect of disinfectant solutions on the microhardness of denture base after 10 minutes of immersion was observed.[76]

The same results were obtained when the acrylic resins used for denture base were disinfected in solutions such as chlorhexidine 4%, sodium hypochlorite 1% and sodium perborate for 10 minutes . In addition, some studies reported the immersion of denture base in 2% alkaline glutaraldehyde for 1 hour, which resulted in no significant effect on hardness values .[59,26]

Carvalho, et al.[26] reveal that , after twelve-hour immersion in disinfections Surface morphology analyses showed changes in all the groups that were immersed in disinfectant solutions, mainly in samples immersed in sodium hypochlorite. Pore formation was observed in keeping with a study that used two glutaraldehyde disinfectant solutions, i.e. an alkaline solution and another alkaline solution with a phenolic buffer, and reported surface pitting and the formation of polymer beads after 10 minutes of exposure. When exposure time increased, the matrix phase seemed to dissolve slowly and more polymer beads were exposed..[37]

Evaluation of mass loss of the acrylic resins following immersion for 1 hour in the disinfectant solutions glutaraldehyde 2%, chlorhexidine 4% and sodium hypochlorite 1%, for 1 hour revealed no statistically significant difference between the experimental and control groups. Nevertheless, samples immersed in glutaraldehyde solutions showed greater mass loss. Previous studies have reported mass loss following exposure of acrylic resins to disinfectant solutions.

A decrease in weight would occur by water sorption. Signs of chemical attack were observed on the surface. These findings suggest that components of the disinfectant solution penetrate the resin base material and cause partial dissolution and softening of the surface. [19]

Further studies will be necessary to examine how to minimize the damage of some kinds of disinfectant solutions on denture base acrylic resins.[37]

6. Conclusion

The current study was carried out to evaluate the effect of chemical disinfectants material on heat curing acrylic resin, which is widely used as a denture base material in dentistry due to it is favourable properties, low cost and easy handle. However, there some harmful effect associated with using of chemical cleanser especially on hardness and roughness.

In this study, the ability of three types of disinfectants on microorganism was tested as well as the effect of these cleansers on hardness and roughness of acrylic resin denture base material.

Three most common available disinfectants in domestic market which are 5% sodium hypochlorite, 0.12% chlorahexidine and 6% hydrogen peroxide were selected to be the disinfectant agent used.

The results revealed that the 5% sodium hypochlorite and 0.12% chlorhexidine have great ability to eliminate all selected microorganisms from the samples after 10 minutes of immersion, while the hydrogen peroxide has no ability to eliminate the *Streptococcus Mutans* from all samples. The *Streptococcus.M* considered as an important effective factors of Denture Stomatitis. In addition, although 5% sodium hypochlorite had the significant effect on roughness and hardness in comparison to control samples but it had the least effect in comparison to other disinfectants (0.12% chlorahexidine and 6% hydrogen peroxide). Where the 12% chlorahexidine had eliminated all microorganisms from sample surfaces but it had a significant effect on roughness and hardness in comparison to other disinfectants.

From a financial point of view the 5% sodium hypochlorite is cheaper than the other disinfectants and it is available in demostic markets.

Whereas, the other disinfectants (0.12% chlorahexidine and 6% hydrogen peroxide) are more expensive and they are only found in certain places. Therefore, from the results of current study can be recommended that the 5% sodium hypochlorite is most appropriate disinfected agent in prosthodontics to clean dentures; this finding was supported and approved by many researchers.

6.2. Recommendations for further works

The following recommendations can be carried out in future works;

1. Test different concentration from disinfectant agents and compare their effect on hardness and roughness as well as on microorganisms count.
2. Test least concentration available of disinfectants with mechanical cleaning to compare their effect on mechanical properties of heat cure acrylic resin.
3. Test water absorption and the amount of water uptake during denture immersion.
4. Test other surface properties such as color stability of denture base as a function of remaining disinfectant particles which may change the color of denture surface after disinfectant procedures.
5. Using different denture base materials with different disinfectants.

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اختبار تأثير المنظفات على قواعد اطقم الأسنان واختبار تأثيرها على الصلابة وخشونة السطح : دراسة معملية

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الملخص العربي

المقدمة: راتنجات الأكريليك) PMMA (مادة مستخدمة على نطاق واسع في مختلف فروع طب الأسنان وتصنع معظم أطقم الأسنان من راتنجات الأكريليك نظرًا لسهولة استخدمها وسعرها المنخفض ، على الرغم من فوائدها ، فإن PMMA ليست مادة مثالية ، ومن عيوبها خشونة السطح وتغير اللون والصلابة وتراكم البيوفيلم نتيجة لسوء نظافة طقم الأسنان ، والذي بدوره يؤدي إلى ظهور العديد من الالتهابات الجهازية والفموية .تطهير الأسنان ضروري لإزالة البيوفيلم من أطقم الأسنان .يمكن تنظيف طقم الأسنان ميكانيكيًا عن طريق الفرشاة اليدوية ، باستخدام أنواع مختلفة من المواد الكيميائية كيميائيًا ، وبالجمع بين الاثنين معًا.

الأهداف :هدفت الدراسة الحالية إلى تقييم تأثير ثلاثة أنواع من المطهرات 5 (٪ هيبوكلوريت الصوديوم ، 12.00٪ كلوراهيكسيدين و 6 ٪ بيروكسيد الهيدروجين)على التخلص من (Staphylococcus aureus و Streptococcus و) Candida spp والتي تنمو على سطح راتنجات الأكريليك بغمرها لمدة 10 دقائق وفي نفس الوقت دراسة تأثيرهذه المنظفات على صلابة وخشونة سطح طقم الأسنان.

المواد وطريقة العمل : تم تحضير العينات باستخدام عجينة السليكون وملؤها بالشمع ، ثم وضعها في قالب جبسي .وتم وضع الاكريلك وفقًا لتعليمات الشركة المصنعة .وتم التلميع على

سطح واحد من العينات ، وترك السطح الآخر غير مصقولة .تم عزل الكائنات الحية الدقيقة سريريًا عن طريق مسحة من تجويف الفم وتم السماح لها بالنمو في الوسط المختار ووضعها في الحاضنة .تم وضع العينات بشكل منفصل في أطباق بتري كلا في وسط خاص حسب نوع الكائنات الدقيقة .وتم تقسيم العينات إلى ثلاث مجموعات رئيسية وفقًا لنوع المطهر المستخدم ، تم وضع جميع العينات مرة أخرى في الحاضنة لمدة 24 ساعة للسماح للكائنات الحية الدقيقة بالنمو فوق السطح الخشن .ثم تم تقسيم كل مجموعة مرة أخرى إلى ثلاث مجموعات فرعية . تحتوي كل مجموعة فرعية على ست عينات .وتم إنماء خمس عينات من كل مجموعة فرعية في المختبر بواسطة Staphylococcus aureusو Streptococcus و . Candida spp على التوالي، سيتم اعتبار العينة المفردة المتبقية كعينة تحكم .بعد نمو الكائنات الحية الدقيقة ، تم تطهير كل مجموعة حسب المطهر المستخدم لمدة 10 دقائق ، ثم حضنت مرة أخرى لمدة 24 ساعة .بعد ذلك تم فحص أطباق بتري مع العينات لإعادة تقييم نمو الكائنات الحية الدقيقة فيما يتعلق بنوع المطهر .تم تقييم اختبار الصلابة أيضًا بواسطة جهاز اختبار فِيكر بعد 10 دقائق من الغمر في المطهر .وكذلك تم تقييم الخشونة بواسطة مقياس خشونة السطح.

النتائج :أظهر الاختبار الميكروبيولوجي أن جميع الكائنات الحية الدقيقة المختارة قد تم القضاء عليها بواسطة جميع المطهرات باستثناء Strept ، والتي أظهرت مقاومة لبيروكسيد الهيدروجين . أظهرت جميع المطهرات فرقًا معنويًا مقارنةً بعينات التحكم المغمورة في الماء المقطر ، وذلك لكل من الصلابة وخشونة السطح .ومع ذلك ، لم يكن هناك فرق كبير بين المجموعات المختبرة .

الخلاصة : من وجهة نظر اقتصادية ، يعتبر هيبوكلوريت الصوديوم بنسبة 5 ٪ أرخص من المطهرات الأخرى وهو متوفر في كل الأسواق بينما المطهرات الأخرى(الكلورهيكسيدين وبيروكسيد الهيدروجين)أغلى ثمنا ولا توجد إلا في أماكن معينة .لذلك ، يمكن التوصية بأن

يكون هيبوكلوريت الصوديوم بنسبة 5 ٪ هو العامل الأكثر تطهيرًا في التركيبات السنية لتنظيف أطقم الأسنان ؛ توافقت هذه النتيجة مع نتائج العديد من الباحثين.

اختبار تأثير المنظفات على الكائنات الدقيقة في قواعد اطقم الأسنان واختبار تأثيرها على الصلابة وخشونة السطح

" دراسة معملية"

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قدمت هذه الرسالة استكمالا لمتطلبات الحصول على درجة الماجستير في خواص المواد

جامعة بنغازي

كلية طب وجراحة الفم والاسنان

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