Sterilization Of Gutta-Percha: A Review

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***Abstract*- Sterilization plays an important role in the success of endodontic therapy. Gutta-percha is the most commonly used root canal filling material. Hence, it requires meticulous sterilization to maintain its purity, thereby ensuring the success of the root canal therapy. Owing to its physical and chemical properties, gutta-percha cannot be sterilized by conventional methods such as autoclaves or hot air ovens. Various chairside disinfection methods with chemical agents and herbal extracts have been used recently. Among the various chemical agents used, sodium hypochlorite and chlorhexidine are found to be the most effective. Among herbal extracts, Aloe vera and amla have been found to be efficient sterilizing agents. The dental professional can provide effective and infection-free root canal therapy with confidence if they are aware of the intricacies of gutta percha sterilization, protecting their patients' entire oral health and wellbeing.**

Keywords: **Gutta-percha, Sterilization, sodium hypochlorite, chlorhexidine.**

INTRODUCTION:

Sterilization plays a pivotal role in ensuring the success of endodontic procedures, where eradication of microorganisms from the root canal system is critical. Gutta percha is a widely used root canal filling material [(1).] It requires meticulous sterilization to maintain its purity and prevent the introduction of harmful microbes during endodontic treatment. The success of root canal treatment heavily relies on the proper disinfection and obturation of root canal space with sterile gutta percha [(2)]. A lot of work is put into getting rid of any bacteria that are already in the root canal system and keeping others out. Contrary to the caution used in cleaning the canals, obturation is frequently carried out using gutta percha cones straight out of storage containers, regardless of their sterility. The like hood of attaining a favourable result could be lowered by this method because the majority of manufactures do not assert that their cones are sterile [(3)]. A contaminated obturating material might reinsert germs into the root canal system, prolonging illness by delaying or preventing recovery [(2)]. In addition to the endogenous oral microbial flora, the practitioner must be concerned with exogenous bacterial contamination [(4)]. According to studies, when gutta percha cones are taken out of their packing and placed in dental operatory, microorganisms such as cocci, rods and yeasts quickly contaminate the items. Decontaminating the obturating material is therefore necessary before inserting them into the root canal [(2)].

Due to their physical and chemical characteristics, gutta percha points cannot be physically sterilized using the standard techniques such as autoclave or hot air oven. so, in order to effectively sterilize the gutta percha points, chemical treatment is required [(5). In] this context, this article delves into the various methods employed to sterilize gutta-percha, highlighting the importance of maintaining aseptic technique to achieve optimal outcomes in endodontic procedures. Understanding the intricacies of gutta percha sterilization that ensures the dental practitioners can confidently deliver effective and infection free root canal treatments, safeguarding the overall oral health and well-being of their patients.

PROPERTIES OF GUTTA PERCHA:

The definitive and volumetric impermeability of the root canal system is the ultimate element of the endodontic triad. Gutta-percha (GP) has been the most enduring and closest material to meet this criterion. Numerous materials have been investigated and evaluated as endodontic filling materials, of which GP has been the most widely employed for decades and has established itself as the benchmark (6).

CHEMICAL PHASES OF GP:

Phases	Properties	Example
Alpha form	Brittle at room temperature Gluey, adhesive and highly flowable when heated (lower viscosity)	Thermoplasticised gutta-percha used for warm condensation obturation technique
Beta form	Stable and flexible at room temperature Less adhesive and flowable when heated (high viscosity)	Commercially available gutta-percha used for cold condensation obturation techniques

Gamma (γ) form Similar to α- form, unstable

PHYSICAL PROPERTIES OF GP:

Gutta-percha (GP) is a temperature-sensitive material that exhibits both thermoplastic and viscoelastic properties. At ambient room temperature, it exists in a rigid and solid state. Prolonged exposure to light and air can cause GP to become brittle due to oxidation. At 60°C, GP softens, and it melts around 95°C-100°C with partial degradation. As temperature decreases, the strength and resilience of GP increase, and vice versa, especially when temperatures exceed 30°C (6).

PHYSICAL FORMS OF GUTTA-PERCHA

1) Solid core gutta-percha (GP) points are available in both standardized and non-standardized forms (beta phase).

Standardized points are manufactured to correspond to specific instrument tapers and apical gauges. Non-standardized points have variable tapers and require the tip of the point to be adjusted after apical gauging to achieve an optimal fit and apical seal.

2)Thermomechanical compactable GP

3)Thermo plasticized GP:

Available in injectable form (alpha phase). Special heaters are provided in the systems to attain flowable temperature of GP. The apical seal is accomplished with the plugging of master cone and then the injectable GP is backfilled.

4)Cold flowable gutta-percha (GP):

An eugenol-free, self-polymerizing filling system in which powdered gutta-percha is combined with a resin sealer in a single capsule.

It exhibits the viscoelastic property of thixotropy, resulting in improved flow under shear stress, which in turn provides superior sealing ability [(6).]

METHODOLOGY:

S. No	YEAR	AUTHOR	INFERENCE	CONCLUSION
1	2005	Gomes et al	Chlorhexidine (CHX) was not effective in eliminating Bacillus subtilis spores on gutta-percha cones after 72 hours of exposure. In contrast, 5.25% sodium hypochlorite (NaOCl) eliminated spores from gutta-percha after just 1 minute of disinfection. Of the cones evaluated from their boxes, 94.5% were not contaminated. The microbial genus most frequently found after intentional contamination with gloves was Staphylococcus.[1]	5.25% sodium hypochlorite (NaOCl) is an efficacious agent for the rapid disinfection of gutta-percha cones.[1]
2	2006	Nurhan ozlap et al	In all the time intervals examined, the gutta-percha cones were effectively sterilized by 2.5% NaOCl. On the other hand, even after a quarter of an hour of exposure, glutaraldehyde failed to decontaminate the gutta-percha cones. Positive controls yielded expected results within the initial 24 hours. Monitoring of negative controls was carried out for 24 and 48 hours, and the absence of microbial growth in all tested groups validated the effectiveness of the prior sterilization process.[4]	This study found a 2.5% concentration of NaOCl to be an effective agent in disinfecting contaminated gutta-percha cones at no additional costs [4]
3	2013	Subha et al	The research revealed that 1% peracetic acid was the most effective disinfectant for both 1 and 5 minute	This study's results validated the effectiveness of both 1% peracetic acid and 2% chlorhexidine in swiftly

			intervals. 2% chlorhexidine came in second, although its performance was statistically equivalent to that of peracetic acid. The third place was occupied by 3% hypochlorite, which showed a statistically significant difference when compared to peracetic acid and chlorhexidine. Povidone-iodine had the least disinfection effect among all groups for both contact durations, however, a contact time of 5 minutes yielded better outcomes than a 1 minute contact time for gutta-percha.[2]	disinfecting Resilon and gutta-percha.[2]
4	2013	Pradeep et al	The study found all the disinfectant solutions to be successful in sterilizing gutta-percha points, although with varying disinfection times. A 1-minute immersion in either 5% Sodium hypochlorite or a mix of 1.5% Chlorhexidine and 15% Cetrimide was sufficient to disinfect the gutta-percha cones.[5]	The findings indicated that the most effective chemical disinfectants for sterilizing gutta-percha were Sodium hypochlorite (5%) and a combination of Chlorhexidine (1.5%) and Cetrimide (15%).[5]
5	2018	Singh Shailaja et al	The study's outcome revealed that CHX efficiently disinfected GP cones within a minute, followed by glutaraldehyde and sodium hypochlorite. Among the herbal extracts, Amla proved to be the most potent in disinfecting GP, with Aloe Vera and Neem trailing behind.[8]	CHX and glutaraldehyde have proven to be effective disinfectants. Herbal substances also show potential as disinfectants, with Amla demonstrating the most promising results in a brief time span.[8]
6	2020	Madhuri Agarwal et al	At both time points assessed, 2% chlorhexidine gluconate (G2) exhibited no bacterial growth. 5.25% sodium hypochlorite (G1) demonstrated bacterial growth after a 30-second immersion, but no growth was observed after 60 seconds. Propolis (G3) and Ozonated water (G4) yielded varied results after being immersed for 30 and 60 seconds.[16]	Immersing GP cones in 2% chlorhexidine gluconate for half a minute proved to be an efficient disinfection technique, whereas 5.25% sodium hypochlorite required a full minute to achieve the same effect. Ozonated water is also a viable option for disinfecting gutta-percha cones. However, Propolis was found to be less potent in disinfecting gutta-percha cones.[16]

7	2020	Jyothsna et al	turbidity was observed in the solutions of aloe vera and chlorhexidine, while it was not present in the sodium hypochlorite and the control group.[7]	Sodium hypochlorite was found to be more effective, followed by Chlorhexidine and Aloevera solution.[7]
8	2023	Divya Chowdary et al	The study's findings revealed that Chlorhexidine successfully disinfected gutta-percha cones within a minute, followed by glutaraldehyde and sodium hypochlorite. Among the herbal extracts, Amla was the most potent in disinfecting gutta-percha, with aloe vera and neem coming next.[9]	Chemical substances such as Chlorhexidine, Glutaraldehyde, and Sodium Hypochlorite are effective disinfectants. However, herbal compounds also show potential as future disinfection mediums.[9] .

DISCUSSION:

The sterilization of endodontic devices and materials is a crucial step in endodontic therapy. The regularly used gutta-percha cones for root canal filling have a number of benefits, including biocompatibility, radio-opacity, antibacterial activity, ease of removal from the canal, dimensional stability, and lack of staining of the tooth structure (5). Despite being produced in an aseptic environment, gutta-percha cones are rapidly contaminated by poor storage, aerosols, and physical handling. According to studies, 5–19% of freshly opened gutta-percha packs contain bacteria. Despite the relatively low amount of these organisms at the time of packaging, dentists frequently use gutta-percha points "straight out of the box" without knowing if they are sterile (7).

Gutta-percha cones cannot be sterilized using the traditional procedure that uses moist or dry heat because this could change the gutta-percha structure due to their thermoplastic nature. Therefore, a quick chemical disinfection at the chairside is required. Chemicals including polyvinylpyrrolidone-iodine, ethyl alcohol, sodium hypochlorite, hydrogen peroxide, quaternary ammonium, glutaraldehyde, and chlorhexidine liquid have all been studied for cold disinfection. These compounds can kill bacteria for brief periods of time or for extended periods of time (1).

Research by Sahinkese et al. revealed that 2% CHX and 5.25% NaOCl are both more efficient (11). Additionally, numerous investigations carried out by Cardoso, Brenda, and Nurban ozalp demonstrate that sodium hypochlorite was more successful at sterilizing gutta-percha when compared to Chlorhexidine and Glutaraldehyde (7).

SODIUM HYPOCHLORITE:

As an irrigant during the biomechanical preparation of the root canal, Naocl is a widely utilized gold standard. The concentration of NaOCl has a significant impact on its antibacterial effectiveness, which is mostly attributed to hypochlorous acid (HClO) in the solution, which has an oxidative effect on the sulphydryl groups of bacterial enzymes (5). It has a wide range of antibacterial effects. Numerous research have demonstrated the efficiency of 5.25% NaOCl in killing the majority of bacteria (10). A study came to the conclusion that the use of NaOCl and chlorhexidine in gutta-percha decontamination enhanced the surface free energy, promoting strong interaction between the utilized sealers and gutta-percha/resilon (7).

According to Gomes et al., the concentration of the solution used had an inverse relationship with the amount of time it required for sodium hypochlorite to kill the microorganisms (1). Candida albicans and E. faecalis can be completely eliminated by sodium hypochlorite (NaOCl) of 5.25% in under 45 seconds, as opposed to these bacteria being completely eliminated by 2.5% NaOCl in 10 minutes. Because of this, NaOCl can be used to efficiently disinfect GP cones (12). After disinfecting with sodium hypochlorite, it is essential to wipe the GP with a piece of gauze because concentrations of 5.25% NaOCl may result in a significant buildup of chloride crystals on the GP cone, as well as GP degradation and loss of elasticity, which may affect the effectiveness of the obturation and can impair the seal of root canal(13,8).

CHLORHEXIDINE:

CHX is a cationic bisbiguanide with extensive antibacterial activity. An irreversible loss of cytoplasmic components results from the CHX molecule's reaction (with negatively charged groups) on the surface of the bacterial cell (8). By compromising the integrity of the membrane and causing the cytoplasm to precipitate, chlorhexidine destroys vegetative bacteria. Broad-spectrum antibacterial action, substance, low toxicity, and water solubility are just a few of the characteristics of CHX that have generated interest in its application as an endodontic irrigant (1). CHX is employed as an irrigant in endodontic procedures due to its antibacterial, sporicidal, and substantial properties (7) Gomes et al. reported that it took less than 30 seconds for 2% chlorhexidine solutions to thoroughly remove E. faecalis from contaminated GP cones. It was discovered that a 2% CHX solution worked for 15 seconds to 2 hours in direct contact with gutta percha cones (9).

OTHER CHEMICAL AGENTS:

GLUTRALDEHYDE:

Glutaraldehyde has been utilized successfully as a high-level disinfectant or chemosterilizer. Aqueous 2% glutaraldehyde solutions exhibit a broad spectrum of activity and a quick rate of microbial death. In less than a minute after exposure, they can destroy microorganisms in the vegetative state. In 3 hours or less, spores can be eliminated [9].

PARAFORMALDEHYDE POWDER:

According to a study by James R. Higgins et al, sterilizing gutta percha cones contaminated with bacterial endospores with paraformaldehyde powder was ineffective the use of paraformaldehyde powder in the storage container prevented contamination of gutta-percha cones over a 60-day period. It is advised that the use of paraformaldehyde powder storage of gutta-percha cones cease because practical substitutes are available [3].

PERACETIC ACID:

Rapid broad-spectrum action is a hallmark of PAA acid. In 5 minutes or less, it will inactivate gram-positive and gram-negative bacteria, fungi, and yeasts. It produces no hazardous byproducts and leaves no traces behind. It has been employed in medicine to clean thermosensitive equipment like endoscopes. 1% peracetic acid produced the greatest outcomes for both 1 minute and 5 minutes of disinfection in the study by Shubha et al[14,2] .

HERBAL EXTRACTS:

ALOE GEL:

Since many years ago, aloe vera has been used to treat a variety of illnesses, from gastric ulcers to its use in cosmetics. The chemicals p-coumaric acid, ascorbic acid, pyrocatechol, and cinnamic acid have been particularly recognized as having a well-established antibacterial activity [15]. Another significant benefit is the discovery that aloe vera gel can effectively decontaminate GP cones in under a minute [9]. Aloe vera solution displays antimicrobial activity; the lesser disinfection action was due to lesser acidic content and a lower amount of total monomeric anthocyanins [7].

AMLA:

Emblica officinalis (Amla) is extensively used in the Indian system of medicine and also believed that it increases body's defense mechanism against many diseases. Amla can provide antioxidant protection while also defending cells from free radical damage caused by a variety of microbes. Amla has astringent and antibacterial qualities that make it more beneficial for ulcer healing and the prevention of several infections [8].

Triphala is an Indian herbal product that has lately been utilized in dentistry as one of the alternatives. Triphala means three (tri) fruits (phala). Its powder consists of a combination of three dried herbs (Terminalia bellirica, Emblica officinalis, and Terminalia chebula). Because of this material's antibacterial properties, it has several uses in dentistry. Triphala-containing oral rinses are utilized in periodontal treatments and to prevent tooth decay. Studies have revealed that because of its antibacterial and antioxidant properties, it can be used as a root canal irrigant [9].

Divya Chowdary et al in 2023 concluded that Amla was the most effective herbal extract in disinfecting gutta percha followed by aloe vera and neem.

CONCLUSION:

Though gutta-percha cones are usually sterile during storage, they can be easily contaminated if incorrectly manipulated. Various studies concluded that sterilization with sodium hypochlorite and chlorhexidine is effective means of chemical sterilization. Herbal compounds such as aloe vera and amla show potential as future disinfection mediums. However, further research is needed to determine the long-term efficacy of these herbal extracts.

CONFLICT OF INTEREST: The Author declares no conflict of interests.

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