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An update on gutta percha from senescent to recent: A comprehensive review

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Abstract

Access preparation, cleaning and shaping and obturation forms the endodontic triad which are the three key steps to be meticulously followed for a successful root canal therapy. The goals of root canal therapy are elimination of infected tissue from the pulp chamber and root canal space by cleaning, shaping and obturation to prevent reinfection. Obturation which is defined as filling the complete root canal space from orifice to root apex i.e cementodentinal junction (CDJ) is a crucial step of endodontic treatment that aims at providing hermetic seal, thus preventing reinfection of the root canal space. Many obturating materials are available of which gutta percha (GP) with sealer is the most established material for its versatility. GP was proved to be successful with different techniques of obturation, but certain limitations like lack of rigidity, length control, poor adhesive quality, easy displacement by pressure have paved path for its modifications and innovations.This review article deals with evolution of GP, its chemistry, phases, properties and advances.

Keywords: Gutta percha, Obturation.

Introduction

The success of root canal treatment depends upon factors like proper diagnosis and treatment planning, knowledge of canal anatomy and morphology, canal debridement, sterilization of canal and obturation for its success. Obturation is defined as the three-dimensional filling of the entire root canal system as close to the CDJ as possible. Its main objective is to achieve a fluid tight seal at apical, lateral and coronal sections of root canal system.[1] In the past various root canal filling materials like gold foil, amalgam, silver points and tin foil are tried. But none of these can be used as ideal obturating materials.[2] Sundqvist and Fidgor assigned three primary functions to the root filling (1998): sealing against ingrowth of bacteria from oral cavity, entombment of remaining microorganisms and complete obturation at a microscopic level to prevent stagnant fluid from accumulating and serving as nutrients for bacteria from any source.[3]

The search for ideal root canal filling material was ended with the discovery of GP which exhibits numerous benefits such as its biocompatibility, cost effectiveness, ease of removal during retreatment proving to be a gold standard material for obturation when retained in root canal system. Hence for obturation, GP is preferred as solid, core filling material. The major challenge with GP is lack of bonding with root canal wall, voids and leakage over a period of time leading to reinfection of tooth. These issues were resolved by certain modifications of conventional GP which improved the properties of material. This article reviews about evolution of GP and its innovations.

Source

GP is a dry coagulated extract of plants from palaquim and Blanco genus of Sapotaceae family which are abundant in the Malay Peninsula (South East Asia). These trees are mainly found in Malay Archipelago, Indonesia, Sumatra, Philippines, Brazil, South America, Singapore, and other tropical countries. These trees are medium to tall (approximately 30 m) in height and up to 1 m in trunk diameter.[4]

The name Gutta Percha springs from two words, "GETAH" - meaning gum; "PERTJA" - name of the tree in Malay language.[2]

Chemical Nature and Phases OF GP:

GP is a form of natural latex, chemically a trans-isomer of polyisoprene having approximately 60% crystalline form, whereas natural rubber has cis-isomer form, which is amorphous in nature. Crystalline GP has 2 phases i.e alpha and beta phase (C.W Bunn in the year 1942). Both of these are trans- isomer forms which differ in single bond configuration and molecular repeat distance. Thus, they are interconvertible.

Alpha form	Beta form
1. This phase is tacky, adhesive, noncompactible, and non elongatible. Brittle at room temperature. 2. At temperature of >65^{0}C, alpha phase is formed which is amorphous, adhesive and highly flowable. (lower viscosity) 3. Eg: thermoplasticised GP for warm condensation technique.	1. Stable and flexible at room temperature. 2. If the alpha phase is cooled rapidly, beta phase is formed. Becomes less adhesive and flowable when heated. (high viscosity) 3. Available in commercial GPs, unheated tree form.

Gamma form is similar to alpha form and is unstable.[4]

If the natural "alpha" form is heated above 65^0 C, it becomes amorphous and melts. The "alpha" form recrystallizes, if this amorphous material is cooled extremely slowly (0.5^O C per hour). On the other hand, recrystallisation of the "beta" form occurs if the amorphous melt is cooled routinely. The most commercial gutta-percha, including dental gutta-percha exists in this form. If the "beta" form is now reheated, the polymer becomes amorphous at 56^O C, i.e 9 degrees lower than the melting point for the "alpha" form. Therefore, it is apparent that the factor determining the melting point of "alpha" and "beta" gutta-percha is the rate of cooling. It in turn controls the extent and character of crystallinity in the congealed material.In addition, the purity of a sample as well as its average molecular weight and molecular weight distribution affects these melting points.[4]

The significance of these phases are changes in physical properties and the expansion of material occurs when heated from the beta to the alpha or gamma phases from less than 1% to almost 3%. When cooled down to the beta phase, similar percentiles of shrinkage can take place, but the degree of shrinkage almost always is greater than the degree of expansion and may differ by as much as 2%. That means if gutta-percha is heated above 42^0 to 49^0 C and then inserted into a prepared canal, a condensation procedure should be applied or some method is used to lessen the problems of shrinkage.[1]

Composition of Commercial Gutta-Percha: (Friedmann et al)

Gutta-percha 18-22 % (matrix), Zinc oxide 59-76%(Filler), Waxes/resins 1-4% (Plasticizer), Metal sulfates 1-18% (Radiopacifier).[2]

Availability of GP

1. **Guttapercha points**: They have size and shape similar to ISO standardization (2% taper from sizes No. 15 to 140).
2. **Greater taper Guttapercha**: They have taper other than 2%. They are available in 4%,6%,8% and 10% sizes.
3. **Variable taper Guttapercha**: They have points suiting the taper of variable taper shaping instruments like protaper F1, F2 and F3.
4. **Auxiliary points**: They are non-standardized gutta cones. They perceive the shape of root canal.
5. **Precoated guttapercha**: Metallic carriers are coated with gutta percha. Carriers used are stainless steel, titanium or plastic materials, eg: Thermafil.
6. **Gutta flow**: In this powdered gutta percha is incorporated in resin-based sealer.
7. **Syringe system**: Low viscosity gutta-percha is used, eg: Successfil.
8. **Guttapercha pellets/bars**: Availability in small pellets which are used for thermoplasticized gutta percha obturation, eg: Obtura system.
9. **Guttapercha sealers**: Gutta percha is dissolved in chloroform or eucalyptol to be used in the canal.
10. **Medicated guttapercha**: Calcium hydroxide, iodoform or chlorhexidine containing gutta-percha points.[2]

Properties of Gutta Percha

Thermal Properties: GP is a thermoplastic and viscoelastic material and is temperature sensitive. There is apparently no difference in the mechanical properties of "alpha" and "beta" gutta-percha, but there are thermal and volumetric differences.GP undergoes internal structural conversions or crystalline phase changes with respect to its "alpha" and "beta" forms at specific transition points during heating and cooling cycles. This results in molecules with different repeat units producing different crystallographic structures, the variations of which are reflected in volume changes induced in gutta-percha by heating and cooling. At room temperature, it exists in a stiff and solid state. On prolonged exposure to light and air, it becomes brittle due to oxidation. It becomes soft at 60°C. Melting occurs around 95°C–100°C with partial degradation.[4]

Mechanical Properties

Compared to elastomers such as cis-polyisoprene, GP is a tough, hard polymer which displays high elastic modulus, yield point and tensile strength. An inverse relationship was found to exist between the zinc oxide concentration and percentage elongation. However, the relationship is not significant if zinc oxide and barium sulfate are considered together to behave as an inert filler. The authors believe this is an indication that zinc oxide is functioning as a vulcanizing agent and not simply as an extender or filler. The deformation occurring in GP is plastic in nature. Elastomers such as elastomeric polyurethane undergo elongation of approximately 400%. However, this is essentially an elastic deformation.[5]

Decrease in temperature increase the strength and resilience and vice versa, especially when temperature exceeds 30°C. The physical properties such as tensile strength, stiffness, brittleness, and radiopacity depends on the organic components i.e GP polymer, wax/resins, inorganic components i.e zinc oxide and metal sulfates. Zinc oxide alters the properties of GP like it increases brittleness, decreases percentage elongation and ultimate tensile strength. Tensile strength of GP gives a reliable measure of its properties than compressive tests. Materials with the predominant property of ductility do not exhibit repeatable values for compression on account of resulting complicated stress patterns.[4]

The property of viscoelasticity is important during condensation of GP in obturation procedures which permits plastic deformation of the material under continuous load causing the material to flow. The transformation temperatures required for β to the α-phase transition is 48.6°C–55.7°C and 59.9°C–62.3°C for the α- to the amorphous phase transition, depending on the specific compound; heating dental GP to 130°C causes physical changes or degradation.[4]

Biological Properties

GP and gutta balata are derivatives of the same botanical family as the rubber tree, and related to latex. Occasionally when GP is in short supply, the manufacturers add some gutta balata or synthetic trans-polyisoprene to the GP cones. The synthetic trans-polyisoprene wouldn't be expected to contain any Hevea latex cross-reactive proteins. But problem arises when gutta balata is added as it releases proteins that cross react with hevea latex. Use of a balata containing product could potentially place a highly latex allergic patient in danger for an allergic reaction even when proper instrumentation and obturation techniques are used to confine the material within the root canal system. It may even be a specific problem for the dentist who treats an asymptomatic individual who is within the early stages of their sensitization and thus provides a negative history of latex allergy despite having detectable latex specific IgE antibody in their skin or blood. The percentage of gutta balata in relation to the total mass of other components in the commercially available cones is reportedly very low (1% of total mass). Hence, the practical risk of using GP products with gutta balata additive may therefore be considered minor.[6]

Despite of many advantages of GP certain drawbacks such as lack of rigidity, lack of length control, easy displacement by pressure, lack of adhesive quality have led to its modifications.

Modifications in Guttapercha

Surface Modified GP	Medicated GP	Nanoparticle Enriched GP	Expandible GP	Others
1. Resin coated 2. Glass ionomer coated	1.Iodoform 2.Chlorhexidine 3.Calcium hydroxide	1.Nanodiamond coated gutta-percha composites biomaterials 2.Silver nanoparticles coated gp	1. Gutta flow	1.Thermafil 2.Biogutta

3. Bio ceramic coated 4. Non-thermal plasma 5. Chitosan modified	4.Tetracycline 5.Cetylpyridinium chloride			

Surface Modified GP:

Resin Coated GP: It involves use of hydrophilic methacrylate resin monomers incorporated into root canal sealers. This facilitates better resin penetration into dentinal tubules after removal of the endodontic smear layer. But this bonding concept is hampered by the lack of a chemical union between the polyisoprene component of gutta-percha and methacrylate-based resins.[6] This poor adhesive quality of GP is improvised by resin coating on its surface.

Endorez Points /Resin Coated Guttapercha

It is manufactured by first reacting one of the isocyanato groups of a diisocyanate with the hydroxyl group of a hydroxyl terminated polybutadiene, as the latter is bondable to hydrophobic polyisoprene. This is followed by the grafting of a hydrophilic methacrylate functional group to the opposite isocyanato group of the diisocyanate, producing a gutta percha resin coating that's bondable to a methacrylate-based resin sealer.[7]

Available as EndoREZ Points which are standard ISO-sized gutta percha points coated with a thin resin coating.[7]

Endorez Sealer: EndoREZ points are used along with endoREZ sealer which consists of base and catalyst components. Endorez sealer is second generation methacrylate-based resin sealer and does not depend on separate dentin conditioning. It uses non-acidic, hydrophilic resin monomers to reinforce sealer penetration into dentinal tubules after the removal of the smear layer to facilitate resin tag formation for retention. It is a hydrophilic, two-component (base and catalysts), dual-curing self-priming sealer.

Advantages are it helps in resin tag formation for retention by enhancing sealer penetration into tubules, resulting in monobloc formation.

Disadvantages are if excess water is present during polymerisation process, it causes entrapment of water droplets in the sealer resulting in bond disruption and increase in leakage. Indicated in wide or narrow canals as it provides good adaptation to intricacies of dentin walls.[8]

Monoblock Concept

The term monoblock means a single unit. A monoblock obturation system is the unit which consists of the core material, sealing agent and the root canal dentine forming a single cohesive unit. Two properties are simultaneously required for a monoblock to function successfully as a mechanically homogenous unit. First, the materials that form a monoblock should have the ability to bond strongly and mutually to at least one another, also on the substrate that the monoblock is intended to reinforce. Second, the modulus of elasticity of these materials should be similar to that of the substrate. Tay and Pashley classified monoblocks created in the root canal space as primary, secondary or tertiary depending on the number of interfaces present between the bonding substrate and the bulk material core.[9]

GIC Coated GP: ActivGP is a first generation biocompatible bonded obturation system. It is based on improved glass ionomer technology which is combined with advanced material science to result in a technique that provides both hermetic seal and superior bonding ability.[10] Another method applies adhesive layer of particles to the surface of GP which resulted in highly active surface and this adheres chemically to activeGP glass ionomer sealer. These are designed to be used with active GP sealer. The result is a highly active surface prepared to chemically adhere to the activGP glass ionomer sealer.[11]

The sealer accompanied with this technique is glass ionomer sealer. It has been developed with an extended working time (12 min). This sealer does not need an extended rinsing of the canal to ensure set or adhesion. It forms ionic bond to dentin meaning there is no need for a bonding agent and the correlated application technique challenges. Chemical and micromechanical adhesion between the canal walls, the Activ GP sealer, and therefore the Activ GP Gutta percha cones leads to a monoblock. The sizes of Activ GP Gutta percha cones are consistently accurate. They are verified by laser measurement to match any constant taper .04 or .06 file system. This system is ISO sized and colored and is available in two types: traditional design and enhanced version (active GP plus). ActivGp in traditional type uses traditional GP design where as Activ GP Plus, uses calibration rings for easy depth measurement and a unique barrel handle, which when placed with placement instrument facilitates easy placement into the canal.

Advantages are it results in true single cone obturation, creates ionic bond with dentin, it is non-resorbable and not affected by presence of residual sodium hypochlorite, there is no need for application of bonding agent, has minimal shrinkage, high biocompatibility and fast setting time.[11]

Disadvantages are it takes more time to remove a GIC sealer than a conventional sealer during retreatment procedures. But when GIC sealer is used in combination with GP, it can be dissolved and then the GIC can be removed ultrasonically from the canal without leaving excessive amounts of residue on the canal walls.[12]

Bioceramic Coated GP: The term bioceramics refers to biocompatible ceramic materials coated and incorporated onto GP points which are available in specific sizes. These includes calcium phosphate silicates in the form of nanoparticles. They bring better sealing ability by taking advantage of natural moisture in dentin.[4] They increase quality of obturation along with specific hydrophilic bioceramic sealers. The bond between dentin and bioceramics is still under investigation. Studies reported that it has micromechanical anchorage and chemical adherence to the dentin. Available as endo sequence bio ceramic points.

Advantages are having slight expansion which is useful to seal the canal, has exceptional dimensional stability, do not shrink upon setting, remain nonresorbable inside the root canal, has potent anti-bacterial effect because of high ph, hydrophilic nature and its active calcium hydroxide diffusion.[13]

Non-Thermal Plasma: Non-thermal plasma treatment is one of the methods to improve the adhesive characteristics of gutta-percha. It is an effective and clean technology, in which the bulk properties of the materials remain unchanged or well-maintained after the treatment.Non-thermal gas plasmas are partially ionized gases. They contain highly reactive particles, including electronically excited atoms, molecules, ionic and radical species at room temperature. Depending on the plasma chemistry or gas composition, these highly reactive plasma species can react with clean and etched material surfaces, bond to varied substrates, or combine to make a thin layer of plasma coating. They consequently alter the surface characteristics. GP is sprayed with argon and oxygen plasma.

Argon plasma causes chemical modification and surface etching.Argon plasma caused only chemical changes.

Oxygen plasma increased surface roughness. Oxygen plasma led to both topographic and chemical changes within the gutta-percha surface.It chemically etches the surface, removing free molecules and creating reactive species (excited Oxygen), ready to link and create new components. The etching procedure increases the surface roughness [14]

Advantages are increased the surface free energy of GP equally, (Oxygen plasma favored both the polar and dispersive components, Argon plasma treatment favored the polar component). It favoured the wettability of sealers (Argon plasma, these results can be attributed to the chemical modifications associated with the improvement in surface free energy. Regarding the Oxygen plasma, the higher wettability can also be associated with the roughness) and influenced positively in the adhesion and leakage.Both plasma treatments on gutta-percha favoured the bond strength to dentin.[14]

Chitosan Impregnated GP: Chitosan is a natural and non-toxic polymer. Produced by deacetylation of chitin. Composition was previously described by Gurgel-Filho et al. as follows: 14.5% (w/w) gutta-percha, 1.2% (w/w) resin, 28.0% (w/w) metal sulphates, 2.8% (w/w) zinc chloride, and 56.3% (w/w) ZnO. Chitosan (Low molecular weight (LMW), Sigma-Aldrich, St. Louis, MO) were impregnated on to the commercial gutta-percha points.

Preparation of chitosan solution: chitosan (1.4–2%) was dissolved in 1% acetic acid (v/v) and mixed with a plasticizer, specifically with 40% (v/v) of sorbitol solution. Then, the pH was adjusted to 5.8 to ensure that the antimicrobial effect caused by chitosan was not due to the low pH or the acid effect brought about by the acetic acid solution. The mixture was placed in a petri plate and were dried at 37^0C until a dense solution was obtained, which was then used to coat the commercial gutta-percha points. After manual coating, the points were left to dry to get a film around the gutta-percha points and were stored in the dark until further analysis.

Has wide range of applications due to its biological properties like antimicrobial, bio adhesive, biocompatible, binding agent. It has similar mechanism to chlorhexidine i.e by disrupting bacterial cell membrane.Effective against C. albicans which supressed formation of hyphal structures causing severe cell wall alterations. Impregnation of chitosan onto GP improves drawbacks of mechanical properties like lack of rigidity, adhesiveness and increase in tensile strength and also more elastic and resistant than GP points.[15]

Medicated Gutta Percha: These are site Specific, Surface acting antimicrobial gutta percha points. The antimicrobial chemicals, iodoform or tetracycline, that are utilized within the gutta percha point are incorporated into the shape by a special warming process, so as to be evenly distributed throughout the medicated gutta percha point.[4]

Tetracycline Coated GP: It is bound within the gutta percha points. They act as a reservoir of antimicrobial that is capable of diffusing onto the Surface of the gutta percha thereby inhibiting the colonization of bacteria on the gutta percha points and within the root canal System. Tetracycline is capable of coalescing within the dentinal tubules to inhibit long term microbial growth.[4]

Iodoform Coated GP: Iodoform of 99.5% purity must be used. All impurities are removed in creating the triodomethane.[4]

Bodrumlu et al (2006) evaluated Antimicrobial and Antifungal Effects of Iodoform-Integrating Gutta-Percha and regular GP cones and concluded that Regardless of time and bacterial strain, MGP was more effective than regular gutta-percha. MGP were effective against C. albicans for up to 72 hours, but regular gutta-percha exhibited no antifungal activity. [16]

Calcium Hydroxide GP Points

Calcium hydroxide has been utilised in dentistry from the 1930s. It combines efficacy of calcium hydroxide and GP.

Its action is based on ph which depends on rate of release and concentration of hydroxyl ions. It can be used as temporary intracanal medicament. It is activated by moisture in canal and the ph is raised to 12+ within minutes. Its antimicrobial action is evident upto 1-4 weeks.It is composed of 52% calcium hydroxide, 42% gutta-percha, sodium chloride, surfactant, and coloring agents. Pure calcium hydroxide is uniformly distributed throughout the gutta-percha matrix.Sodium chloride and the surfactant increases the solubility of calcium hydroxide and the mobility of the ions. Commercially available as calcium hydroxide plus points.[17]

Chlorhexidine GP Points: Chlorhexidine has been utilised in dentistry from the 1950s. It has broad spectrum antimicrobial action and relative absence of toxicity. Its action is related to cationic bisguanide molecular structure. Acts by adsorption onto cell wall of microorganism and causing leakage of intracellular components. These are available as chlorhexidine active points which are able to use, firm, and yet are flexible for straightforward introduction into canals. It consists of chlorhexidine diacetate 5%, gutta-percha, zinc oxide, barium sulfate and colouring agents. The chlorhexidine diacetate is distributed homogeneously throughout the gutta-percha matrix. Chlorhexidine diacetate is released when it comes in contact with moisture which is cationic in nature. this combines with anionic surface of cell wall of bacteria causing osmosis to malfunction.

Alagarswamy etal (2013) compared effectiveness of calcium hydroxide plus points and chlorhexidine activ points against Enterococcus *faecalis* by agar diffusion test and concluded thatchlorhexidine activ points show the maximum inhibition against E. faecalis. Calcium hydroxide points alone and when combined with chlorhexidine shows the minimal antibacterial efficacy.[17]

Guttapercha Enriched With Nanoparticles:

Nanotechnology is gaining importance and expertise in every area of medicine. Nano is derived from the Greek word υαυος meaning dwarf, by definition one nanometer (10^{-9}) or one-billionth of a meter.Nano particulates show higher antibacterial action on account of their polycationic or polyanionic nature, which expands their applications in various fields.[4]

Nanodiamond Coated Guttapercha

Disadvantages of GP like Inability to provide adequate seal to prevent bacterial percolation may be a challenge in endodontics, Inadequate rootcanal seal due absence of bond between GP and dentinal surface results in formation of voids, this establishes reinfection of rootcanal, which causes treatment failures.

In order to overcome these treatment failures, the sector of nanomedicine incorporated broad spectrum powerful nanoparticles i.e nanodiamond amoxycillin (ND-AMC) which is embedded onto a composite called as nanodiamond GP (NDGP). This reduced the likelihood of reinfection and enhanced treatment outcomes. NDs are carbon particles of approximately 46nm diameter. Its properties are possessing surface chemistries which are suitable for electrostatic adsorption and covalent conjugation of varied compounds, demonstrated antimicrobial activity, increase is toughness due to homogenous dispersion of NDs throughout the GP matrix. Advantages are simultaneously sequestering and localise activity of amoxycillin, enhances mechanical properties of GP, facilitates eradication of residual bacterial within the root canal system after obturation, also kills the bacteria that are entering through lateral canals on contacting with NDGP.[18]

Silver nano particle Coated GP

Silver (Ag) ions or salts are known to possess a good antimicrobial effect and that they are used for years, in several fields in medicine.[19] At nanoscale, AgNP has small size in order that they exhibit significantly unusual physical, chemical and biological properties. Due to their strong antibacterial activity, nanosilver coatings are widely used on various textiles, bandages, wound dressings, ointments also as coating on certain surfaces like implants, catheters, prostheses and even washing machines. Depending on this wide range of applications, nanosilver coated gutta-percha was introduced in 2008 for the first time by Iranian researchers to prevent bacterial colonization in root canal space.[20] Advantages are Small particle size and enormous area provides antibacterial effect at low filler level, thus avoiding negative influence on mechanical properties and Due to small size, can penetrate cell membranes of bacteria more easily which is particularly important since microorganisms in biofilms are more resistant to antimicrobial agents than planktonic pathogens. Its mechanism remains unclear. It seems that silver ions interact with the peptidoglycan cell wall causing structural changes, increased membrane permeability and, finally, necrobiosis. Also, interact with the exposed sulfhydryl groups in bacterial proteins, avoiding DNA replication.[19]

Expandible GP System

Gutta flow: It was developed by coltene/whaledent using modern expertise in silicone polymer technology.

It comprises of finely ground GP, roekoseal root canal sealer (polydimethylsiloxane), and nanosilver. Thus, it is a mixture of filling material and sealer which is easily dispensed and provides excellent 3-dimensional filling of root canal. Sealer portion of guttaflow is highly thixotropic. It has a grain size of (9 micrometer). It provides the dentist a simplified obturation technique that is fast, efficient and east to learn and use. It is flowable at room temperature. Does not require expensive equipment needed for heating. Only requires triturator usually found in offices. It is a straightforward backfill process. It has a working time of 15 minutes and will completely set in 25 to 30 minutes. Advantages are providing 3-dimensional filling of canal, as sealer is thixotropic in nature, it can penetrate well under slight pressure into lateral canals, it expands slightly (0.2%) when sets.[21]

GuttaFlow bioseal is a recently developed, silicone-based, cold filling sealer containing GP powder and bioactive glass. GP along with bioactive glass can form hydroxyapatite crystals. It consists of Gutta-percha powder, polydimethylsiloxane, platinum catalyst, zirconium dioxide, silver (preservative), coloring, and bioactive glass ceramic.

Available as gutta flow capsule and syringe form(The New Gutta Flow Generation).

Advantages are lesser leakage which could be attributed to the volumetric changes that occur during the setting of sealers i.e it has high water sorption ability. No gaps are seen due to the formation of precipitate (bioactive glass) or mineralisation product formed during setting process.

According to Tanomaru-Filho et al., GuttaFlow bioseal undergoes 0.14% expansion after storage in distilled water for 7 days, and 0.68% volume contraction after 30 days of storage

Camargo et al. reported that the dimensional change in GuttaFlow bioseal after storage in distilled water for 30 days was 2.1% expansion.[7]

Prithviraj KJ etal (2020) made comparison of the microbial leakage of obturation systems: Epiphany with resilon, guttaflow, and ah plus with gutta percha and concluded that Resilon/Epiphany and Guttaflow groups demonstrated less microbial leakage than Gutta-percha/AH Plus group.[22]

Others

Thermafil: Thermafil technique was initiated by Ben Johnson in 1978 and came into the market in the early 1990s as a K-File covered by gutta-percha that was inserted into the canal after bunsen flame heating. The current configuration of Thermafil includes a central radiopaque plastic core (carrier) surrounded by a gutta-percha layer which will be heated in an electric oven to make sure thermoplasticization. Thermafil obturators are manufactured in 17 sizes, from 0.20 to 1.40 mm of tip diameter, with carrier taper of about 4%. Thermafil gutta-percha envelops the carrier for about 16 mm. For the selection of the correct obturator, Ni-Ti verifiers are used having a diameter of 0.20 to 0.90 mm. Some authors propose to use Thermafil plastic carrier from which the gutta percha has been removed (denudate carrier) instead of Ni-Ti verifiers, as the carrier reproduces the conditions occurring during filling operations better than the Ni-Ti verifier, so it is suggested that the clinicians to denudate a series of carriers that are used only as "verifiers", and then choose a corresponding obturator to seal the canal. Gold standard in case of severe curves, double curves, narrow canals and long canals. Advantages are Simple and fast technique and only thermoplasticized GP technique in which apex is closed for sure.[23]

Priyank H etal (2017) compared apical microleakage in root canals obturated with gutta flow, thermafil and regular GP with lateral condensation and concluded that all three groups showed microleakage and none of the methods was able to achieve perfect apical seal. The result in the present study showed that gutta flow provides a similar consistent seal as compared to either cold lateral compaction or thermafil technique.[24]

Bio gutta: It consists of GP mixed with bioglass (45S5). Advantages are bond to dentin walls and does not require any sealer, has high degree of biocompatibility comparable to GP, provides tight seal, increases the ph, provides antimicrobial action.

Mechanism of Action: Under moist conditions, there is formation of calcium phosphate that would precipitate on the surface and provide self-adhesiveness and tight seal.

Bioglass 45S5 were mixed with Polyisoprene (PI) and polycaprolactone (PCL) up to 30 weight % separately to develop root canal filling materials with high sealing ability making the need for a sealer obsolete.Both BAG+PCL and BAG+PI showed hydroxyapatite precipitation and improved immediate sealing ability with no noticeable leakage in vitro when compared to control samples. Thus, Bio-Gutta, PCL, and PI with BAG may serve as clinical alternatives to conventional GP.[25]

Marending et al (2012) compared Pushout bond strength and adherence of biogutta and conventional GP and concluded that both materials under investigation had similar initial pushout bond strength values ($P > 0.05$). The adherence of Bio-Gutta increased from day 1 to 8 and was significantly higher than that of conventional GP at 8 and 30 days ($P < 0.05$).[26]

Conclusion

For successful endodontic therapy, selection of appropriate obturating material is crucial. The complete seal of root canal is achieved by proper root canal filling technique along with suitable obturating material and sealer. Gutta-percha has a unique property of inertness, easy retreivability from canals, and better sealing ability. Thus, it can be concluded that modifications of GP, along with its ease of availability, manipulation, ease to adapt in clinical use have made this material indispensable in the field of endodontics.

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