



GUTTA PERCHA – A GOLD STANDARD FOR OBTURATION IN DENTISTRY

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ABSTRACT

Obturation of the cleaned and shaped root canal space has been performed for many years using a core of gutta-percha rubber cones combined with various formulations of sealer cements. The gutta-percha and sealer filling material has been the most popular and most tested filling material throughout the history of nonsurgical endodontic procedures.

Gutta-percha has over the years have been modified in several ways to accommodate the growing trends in endodontics and achieve its mission by simplifying the techniques, achieving optimal seal with a better adaptation to the dentinal walls and a less time consuming process. So, this article deals briefly with the historical background, source, chemical composition, manufacturing and its evolution till now and the future in dentistry.

Key Words: Gutta Percha, Alpha and Beta phase, Obturation

Introduction

The major objective of root canal treatment is to prevent or cure apical periodontitis by cleaning, shaping and filling the root canal space. Obturation of the root canal system is an integral component in promoting periapical healing and preventing disease progression. The effectiveness of a material to adequately seal the root canal space is established by its physical properties and handling characteristics.

Before 1800, root canal fillings were done using gold. It was then followed with various other metals, oxychloride of zinc, paraffin, and amalgam, etc. But none of them meet the requirements of ideal obturating materials. This search ended with the discovery of gutta percha.

For decades, Gutta percha is the most popular core material used for obturation, because it possesses many favourable properties, which include biological compatibility, dimensional stability, pliability, easy placement and removal, and radiopacity¹. However, little is known about the Origin, Evolution and manufacturing of Gutta percha.

Discovery of Gutta –Percha:-

Gutta-percha is often employed in insulating marine and underground cables, since it is an excellent non conductor. It was also used for golf-ball coverings, surgical appliances, and adhesives. The honour of discovering gutta-percha goes to John Tradescant, who brought this material from Far East in 1656 and named it – “Mazer-wood”. However, Dr William Montogmerie, a British surgeon was the one who appreciated the potential of this material in medicine and introduced the western world to gutta percha in 1843. He first noticed this material in Singapore in 1822 and learned its malay name ‘Gutta percha’. Later, in 1843 he was awarded Gold Medal from the Royal Society of Arts in London for his work related to Gutta percha².

The three properties of gutta percha which laid the foundation were its hard “plasticity”, its electrical insulating properties and its extremely low coefficient of thermal expansion/contraction. These were exploited in quite different ways; the first in the manufacture of golf balls, the second in the manufacture of telegraph cables and the third in the making of moulds, dies and castings³.

The discovery of a form of rubber called gutta-percha in 1843 led to the manufacture of a suitable insulation by 1847. In 1845, the S. W. Silver & Co. of Stratford, East London, invented a

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means of extruding gutta-percha to cover wire. Gutta-percha was used to insulate the telegraph lines along the Great Western Railroad in 1843. Once the technology was understood, things moved rapidly and later that year Hancock & Bewley formed The Gutta-Percha Company in the UK. The first gutta-percha patent - taken out by Alexander, Cabriol & Duclos for a laminate consisting of three layers: gutta-fabric-gutta. In 1858 CW Field, used the ship "The Faraday" to lay the first transatlantic telegraph cable. This was both insulated and coated with gutta-percha^{3,4}.

The first gutta-percha golf ball, known as a "guttie" was hand moulded by J Patterson in Scotland in 1845 and was just a smooth ball. The gutta percha golf ball period lasted from around 1848 well into the 1900s. The guttie replaced the feathery because of less cost and better quality. When the rubber core golf ball replaced the guttie it was due to superior driving and playing qualities even though it costs more than twice as much when first introduced⁵.

Gutta-percha serves several useful ends in medicine, surgery, and pharmacy, and is likewise used for ornamental and various other purposes. Splints, etc., have been made of it, and employed in cases of fractures, diseased joints, and other cases where it is desired to keep the parts in a permanent position. Gutta percha was also used to control the haemorrhage after extraction. It has been extolled by dermatologists as an efficient application in certain skin infections. It has thus been employed in smallpox, in erysipelas, psoriasis, herpes tonsurans, prurigo, and certain eczemas³.

Evolution of Gutta Percha in Dentistry

Edwin Truman first introduced Gutta Percha to dentistry as a temporary filling material. In 1847, Hill Developed "Hill's-stopping" a restorative material, a mixture of bleached Guttapercha

with carbonate of lime and quartz.⁶ However it was not until 1867 when Bowma, for the first time used Gutta percha for root canal filling. S.S White Company in 1887 was first to start the commercial manufacturing of Gutta-percha points. Gutta percha was then used in different ways, Rollins (1893) used Gutta-percha with pure oxide of mercury into root canal filling and Callahan(1914) introduced softening and dissolution of Gutta-percha with the use of rosins in obturation.⁷

Finally in 1959, Ingle and Levine were the first persons to propose standardization of root canal instruments and filling materials and at their behest, standardized Gutta-percha was introduced

to the profession in 1959 after 2nd International Conference of Endodontics at Philadelphia. In 1976 a group evolved into the present day International standards organization (ISO) for approval of specification of root canal instruments and filling materials. ADA specification for obturating Guttapercha points is No.78.⁸

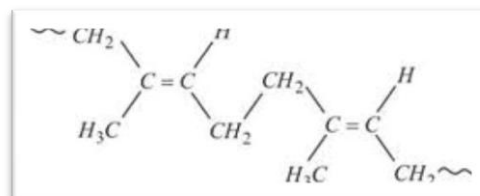
Fig. 1 :



Source

The term Gutta-Percha is derived from the word 'Getah Pertja' meaning 'gum' and name of the tree respectively in Malay language. Gutta Percha is the dried coagulated extract of plants of Palaquim, Blanco, Genus of Sapotaceae family, most important being Dichopsis Gutta or Isonandra Gutta, (fig 1) also known as Palaquium Gutta. These trees are natural in habitant of South East Asia, Malaysian and Indonesian Archipelago. Gutta percha trees often attain a height of 70 to 100 ft. and the trunk has a diameter of from 2 to 3 ft. The leaves are obovate-lanceolate usually about 6 inch. long³.

Fig. 2 :



Gutta Percha is usually imported from Central South America for its use in dentistry, which is one of the reasons for its high cost. In India few species are found like, Palaquium Obavatum, Palaquium Polyanthum, Palaquium Ellipticum and Palaquium Gutta trees mainly in Assam and Western Ghats. However, they are very scanty.

Palaquium gutta was recently introduced and planted in Botanical gardens, Bangalore.⁹

Gutta-balata or Surinam Gutta – percha, obtained from *Mimusops globosa* (Bullet tree), South America can be considered as an substitute to Gutta percha. It contains more resin proportion than true Gutta percha. However, the use of a gutta-balata-containing product could potentially place a highly latex allergic patient at risk for an allergic reaction.¹⁰

Commercial Manufacturing

Collection method

The tree was cut down or the bark was stripped off altogether or rings were cut at intervals of about a foot (fig 2). The latex that oozed from the cut was collected into small cups/bowls attached to the tree. Another method was to collect the fresh leaves, which were then chopped and crushed.

Fig. 3 :



Method of coagulation

The sap that oozed out was collected, put into a pot and boiled with a little water, which prevented its hardening afterwards when exposed to air. It is then boiled and then kneaded under running water and rolled sheets to expel the air and to enable it to dry quickly. It is afterwards put into a masticator, which is heated and revolved until it is fit for use. The chemical method of coagulation is by the addition of alcohol and creosote mixture (20:1), ammonia, limewater or caustic soda⁹.

Obach's technique

The obtained pulp is mixed with water and heated to 75°C to release the Gutta-percha threads and then cooled to 45°C. The flocculated

Guttapercha called “yellow Gutta” contains 60% poly isoprene and 40% contaminants (resin, protein, dirt and water). Yellow Gutta is mixed with cold industrial gasoline at below 0°C temperature. This treatment not only flocculates the Gutta-percha but also dissolves resins and denatures any residual proteins. After removal of cold gasoline, de-resinated Gutta threads are dissolved in warm water at 75°C and dirt particulate is allowed to precipitate. Residual greenish yellow solution is bleached with activated clay, filtered to remove any particulate and then steam distilled to remove the gasoline¹¹. “Final ultra pure” Gutta-percha has gasoline scent, before it is modified with fillers into its final commercial product formulation.

Fig. 4 :



Chemical Composition

Gutta-percha is a Trans- isomer of poly isoprene. Its chemical structure is 1, 4, trans-poly isoprene¹¹ (fig 3). The molecular structure of Gutta Percha is close to that of natural rubber from *Hevea brasiliensis*, which is a cis-isomer of poly isoprene. The Trans isomer is more linear and crystallizes more easily than the cis – isomer

(natural rubber). The gutta percha polymer is harder, more brittle and less elastic than natural rubber.⁷

In crude form its composition is:-

GUTTA----- 75-82%

ALBAN----- 14-16%

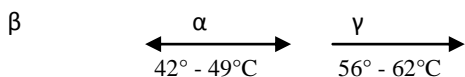
FLUAVIL----- 4-6% and also contains tannin, salts and saccharine substance.²

Gutta determines the elasticity of gutta-percha, and its plasticity at elevated temperatures. Alban does not seem to have any harmful effect upon the technical properties of gutta-percha. *Fluavil* is a lemon-yellow, amorphous body, having the composition (C₁₀H₁₆O). When it occurs in gutta in larger quantities it renders this material brittle.³

Modern Gutta percha cones are composed of organic (gutta-percha polymer and wax/resins) approximately 18-22% and inorganic components (zinc oxide, ZnO; barium sulphate, BaSO₄) 37% - 75%. Small Percentage of coloring agents and antioxidants could also be present.¹³

Phases of Gutta Percha

Chemically pure gutta-percha exists in two distinctly different crystalline forms (alpha and beta) that can be converted into each other). Thus, the phase transitions in gutta-percha are reversible and cyclic phenomenon¹⁴. It is known that natural gutta-percha occurs naturally as the α -form. The β -form results if this is cooled at a rate of more than 0.5° C/h. When β gutta-percha is thermally analysed, two endothermic peaks occurs. The first (between 42° C and 49 ° C) corresponds to the transformation from β to α . The second peak (between 53° C and 59 ° C) accompanies the conversion of the α -material to amorphous gutta-percha (gamma phase)¹⁵.



There are differences in the physical properties of these two phases. The α phase of gutta percha is brittle at room temperature. It becomes gluey, adhesive and highly flowable when heated (lower viscosity). The β phase of gutta percha is stable and flexible at room temperature. And becomes less adhesive and flowable when heated (high viscosity). The thermoplasticised gutta percha used for warm condensation obturation technique are in alpha form whereas, commercially available gutta percha used for cold condensation obturation techniques are in beta form¹⁶.

Materials expand, when heated from β to α or γ phases (1-3%). When cooled down, shrinkage also takes place and it is greater than degree of expansion and differs by 2%¹².

Current Perspectives

Gutta percha over the years has undergone many modifications. Various new techniques have been introduced to achieve the three dimensional filling of the root canal systems. Thus, depending upon the technique employed the form of gutta percha used differs. The current forms of Gutta percha are:-

- ❖ Solid core Gutta-percha points
 - Standardized
 - Non standardized
- ❖ Thermo mechanical compactable Gutta-percha
- ❖ Thermo plasticized Gutta-percha
 - Solid core system
 - Injectable form
- ❖ Medicated Gutta-percha
- ❖ Coated Gutta Percha
 - Resin coated
 - Glass ionomer coated
 - Bioceramic coated

Traditionally β form of Gutta-percha was used for improved stability, hardness and reduced

stickiness. But α phase Gutta-percha with low viscosity will flow with less pressure or stress and create a more homogenous filling. Now, various manufacturers have introduced products to take advantage of these properties. This includes Thermafill (Tulsa Dental Corp), Ultrafill – regular, firm set, endoset (Hygienic Corp).⁷

Recently, the concept of “Monoblock”, which literally means creating mechanically homogenous unit with root dentin¹⁷, is in forefront. To achieve this gutta percha are being coated with the materials which render them adhesive to the root canals sealer, thus forming a chemical bond between the sealer and the gutta percha. Until now Resilon and Epiphany system and the ActiV GP system have been introduced based on this concept. But Recently a new horizon have been opened with the introduction of Bioceramic sealer and Bioceramic coated gutta percha. Ghonein G. A, et al has said that the innovative bioceramic – based sealer used in conjunction with glass ionomer – coated GP cones (Active GP), may have potentiality to strengthen endodontically treated teeth to a level comparable to that of intact tooth¹⁸. However, currently more research work is going now and results are been awaited to see the

vertical fracture resistance of teeth obturated with Bioceramic sealer and cones.

CONCLUSION

The rapid strides taking place in dental materials science has led to the introduction of newer materials and techniques with improved physical and mechanical properties. This surge in newer alternatives has led to the phasing out of older obsolete materials. Ever since its introduction as an obturative material for obliterating the root canal space, gutta percha, in its various forms, has proven to be extremely versatile.

Gutta-percha's unique property of inertness, better sealing ability and the ability to do re-treatment in case of failure, make it an indispensable obturating material currently. Since its established use in endodontics gutta percha has been a material of choice for obturating root canals. Achieving three dimensional apical seal is essential for success of root canal treatment. Gutta percha has passed the test of time, to have been able to achieve apical seal. Host acceptance is also an important parameter that determines the success of therapy. Currently researchers are on the look for materials that may replace gutta percha in future. Till then however, gutta percha remains steadfast as a golden standard in obturation.

In future, for Gutta-percha to remain indispensable certain property modifications are required such as increased stability, better flow properties, better intra-canal adaptation with reduced shrinkage and an inherent antibacterial efficacy without dissolution.

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