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GUTTA-PERCHA – AN UNTOLD STORY

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ABSTRACT

"GUTTA-PERCHA" was first introduced as a restorative material and later developed into an indispensable endodontic filling material. It has become the "soul" of endodontics, in its development as a specialty.

Many articles have dealt about the various techniques of usage of Gutta-percha, but the present article deals briefly with its history, sources, chemistry, commercial manufacture, its evolution and future in dentistry. This article is an attempt to present comprehensively about a material, which we use commonly, yet we know very little about it.

INTRODUCTION

The primary objectives of operative endodontics are total debridement of the pulpal space, development of a fluid–tight seal at the apical foramen and total obturation of the root canal. Earlier, root canals have been reported to be filled with Amalgam, Asbestos, Balsam, Bamboo, Cement, Copper, Gold Foil, Iron, Lead, Oxy-Chloride of Zinc, Paraffin, Pastes, Plaster of Paris, Resin, Rubber, Silverpoints, Tin foil etc., Among all these materials tried, none of them met the requirements of an ideal obturating material. The search for a suitable Root canal filling material ended with the discovery of "Gutta-percha".

DISCOVERY AND ITS HISTORICAL USES

Gutta-percha is a name derived from two words.

"GETAH"- meaning gum
"PERTJA"- name of the tree in Malay language

Even long before Gutta-percha was introduced into the western world, it was used in crude form by the natives of Malaysian archipelago for making knife handles, walking sticks and for various other purposes. As we go through the history of Gutta-percha, there is an interesting story about its discovery. The first person to discover this material was John Tradescant, who brought this material after his travels from far-east in 1656, he named this material as "Mazer wood". But the honour of introduction of this material goes to Dr. William Montogmerie, who was a medical officer in Indian service. He was the first to appreciate the potential of this material in medicine and for which he was awarded the gold medal by the Royal society of arts, London in 1843[1].

As soon as it was introduced, it found use as an insulating medium in the laying of underground seawater cables[2]. The first Gutta-percha patent was taken by Alexander, Cabriol and Duclos for a laminate consisting of three

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layers called "Gutta-percha fabric". In 1845 Hancock and Bewley formed the Gutta-percha company in United Kingdom.

There were jewels and ornaments made of it as they were considered to be precious materials at that time. Its introduction simplified the manufacture of golf balls. Earlier they were made of wood, leather and feathers and the procedure was cumbersome. It was introduced as hand moulded one by James Patterson in 1845. This change was instrumental in seeing the game grow immensely. The era of Gutta-percha golf balls lasted from 1845-1900[3], till the introduction of natural rubber in its manufacture.

In medicine, they were used as splints for holding fractured joints and manufacture of handles of forceps, catheters etc., It was earlier used to control hemorrhage in extracted socket wounds. They were also used for skin diseases by the dermatologists, particularly against Small pox, Erysipelas, Psoriasis and Eczema[1].

SOURCES

Gutta-percha is a dried coagulated extract of plants of Palaquium, Blanco genus of Sapotaceae family[4]. These trees are natural inhabitants of South East Asia, particularly Malaysian and Indonesian archipelago.

The concrete juices of Isonandra gutta, Palaquium gutta and Dichopsis gutta are the main trees from where, we obtain Gutta-percha material. These Gutta-percha yielding trees are medium to tall trees, in which a series of cuts (concentric or v- shaped cuts) are made to obtain the juice. The leaves of these trees also contribute to a minimal extent in Gutta-percha production.

Indigenous sources

In India the species of this genus is very scanty. The species found are Palaquium obavatum, Palaquium polyanthum, Palaquium ellipticum and palaquium gutta trees in Assam and Western ghats[5]. Palaquium gutta was recently introduced and planted in Botanical gardens, Bangalore. Indigenous plantation of these trees can be done like rubber gardening and there is an encouraging prospect. Among the various trees, Palaquium oblongifolium is suited for plantations, but yield low amount of Gutta.

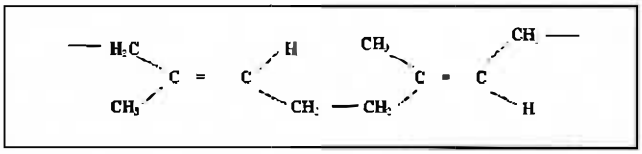
Other substitutes

Among them, the important one is Gutta-balata or Surinam Gutta-percha, obtained from Mimusops globsa (Bullet tree), South America[6]. It contains more resin proportions than true Gutta. The other substitutes are from Butyrospermum park (Sheabutter tree of West Africa), Dyera costulata (of Malaya and Borneo), Maytenus phyllanthoides (Mexico), Calatropis giganlea (Madar tree of India) and Manilkara species (inferior balata-South America)[6].

CHEMISTRY

Gutta-percha is a Trans- isomer of poly isoprene. Its chemical structure is 1, 4, trans–poly isoprene[7].

(FIG – I): Chemical Structure



Since its molecular structure is close to that of natural rubber, which is a cis-isomer of poly isoprene, it has a number of similarities but a difference in form makes its mechanical properties

to behave more like crystalline polymers. In crude form its composition is

GUTTA——— 75-82%
ALBAN--------- 14-16%
FLUAVIL——- 4-6% and also contains tannin, salts and saccharine substance[1].

DIFFERENT PHASES OF GUTTA-PERCHA

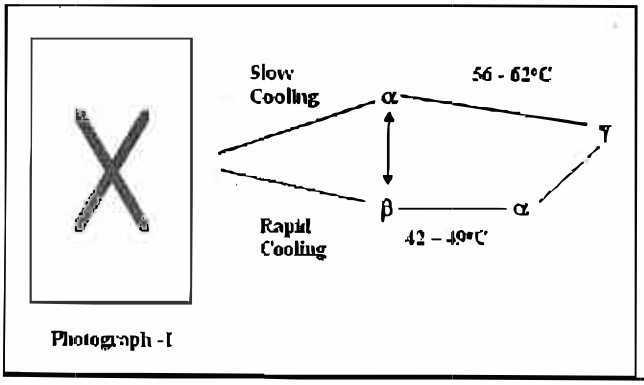
Chemically pure Gutta-percha exists in two distinctly different crystalline forms (a and b), that can be interconvertible. Natural Gutta-percha coming directly from the tree is in a form[8]. However the most commercial available product is in b form.

During the process of manufacture, if the cooling is done rapidly, 'b' form results. If it is cooled slowly, less than 0.5°c/hr, 'a' form results[8]. Another unstable form (g) exists, which is amorphous in nature.

α ---- runny, tacky and sticky (lower viscosity)
β ---- solid, compactible and elongatible (higher viscosity)
γ ---- similar to a (unstable)

Transistions between low and high melting polymorphs of Gutta-percha are reversible, cyclic phenomena[9]. Transistions can be represented in a schematic diagram as follows,

Fig (II): Transition Phase Schematic Diagram



Photograph -I

Materials expand, when heated from b to a or g phases (1-3%). When cooled down, shrinkage also takes place and it is greater than degree of expansion and differs by as much as 2%[7].

Aging of Gutta-Percha cones results in brittleness. The encylopedia brittanica[10] states that oxidation of Gutta-percha cones causes brittleness. Aged brittle cones can be made re-usable by a rejuvenation process of heating – quenching treatment. The cones are immersed in hot tap water (>55° C) for one or two seconds and then immediately immersed in cold tap water (< 20° C) for several seconds[11].

COMMERCIAL MANUFACTURE OF GUTTA-PERCHA

Coagulation

The sap that oozes out is collected and put into a pot and boiled with little water. It is boiled and then kneaded under running water. Chemical method of coagulation is by addition of alcohol and creosote mixture (20:1), ammonia, limewater or caustic soda[5].

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 Gutta-percha 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[12]. 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 gasoline. "Final ultra pure" Gutta-percha has gasoline scent, before it is modified with fillers into its final commercial product formulation.

EVOLUTION INTO DENTISTRY

Gutta-percha was first introduced to dentistry as a temporary filling material by Edwin Truman.

1847 - Hill Developed "Hill's-stopping" a restorative material, a mixture of bleached Gutta-percha and carbonate of lime and quartz[13].

1867 - Bowman was the first to use Gutta-percha for root canal filling.

1883 - Perry used pointed gold wire wrapped with soft Gutta-percha, rolled and packed it into the canal.

1887 - S.S White Company was the first to start the commercial manufacture of Gutta-percha points.

1893 - Rollins used Gutta-percha with pure oxide of mercury into root canal filling.

1914 - Callahan introduced softening and dissolution of Gutta-percha with the use of rosins in obturation.

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[14].

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 Gutta-percha points is No.78.

From then onwards, there was a great surge in the development of root canal therapy as a speciality. Although various cleaning and shaping methods have since been introduced, Gutta-percha remains to be the main core material used for root canal fillings.

CURRENT FORMS OF GUTTA-PERCHA AVAILABLE

Over the years, numerous methods have been advocated to obturate the root canal with Gutta-percha and sealer. Hence various forms of Gutta-percha are available for usage and the current forms are,

- Solid core Gutta-percha points
  - Standardized
  - Non standardized
- Thermo mechanical compactible Gutta-percha
- Thermo plasticized Gutta-percha
  - Solid core system
  - Injectable form
- Medicated Gutta-percha

Traditionally b form of Gutta-percha was used for improved stability, hardness and reduced stickiness. But a phase Gutta-percha with low viscosity will flow with less pressure or stress and create a more homogenous filling.

Various manufacturers have introduced products to take advantage of these properties[8].

Table (I): Products of α Phase Gutta-percha

PRODUCT	MANUFACTURER
Thermafill	Tulsa Dental Corp.,
Ultrafill – regular, firm set, endoset	Hygienic Corp.,

Thus various forms of Gutta-percha available in the market are a reflection of technologic advancement and sophistication, which help in ease of work and improved efficiency in root canal obturation.

FUTURE

The rapid strides taking place in dental materials science has lead to the introduction of newer materials and techniques with improved physical and mechanical properties. This surge in newer alternatives has lead to the phasing out of older obsolete materials. This brings to the question whether Gutta-percha is indispensable? However 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.

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. In this continual process, newer products like self-lengthed marked Gutta-percha have been developed and are in line for clearance of patency.

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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