Uses of Gold in Dentistry – A Review

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ABSTRACT

Gold has been used in dentistry since ancient times. It has been used both in pure form as well as alloys. The non-tarnishing and non-corrosive quality has popularized its usage. In modern dentistry as well, the use of gold as a fashion statement has been well-accepted. They are primarily used as restorations, crowns and bridges, inlays and onlays. In recent days, gold oral jewellery or studs and orthodontic brackets, gold implants etc. have also been popular. Gold, due to its noble metal characteristics can be material of choice for screw posts, implants and in surgical instrument. Thus, Gold due to its chemical properties and social acceptance is a good choice in various procedures of restorative and aesthetic dentistry.

Keywords: Dental restoration; gold alloy; gold foil; gold wire; history; pure gold.

INTRODUCTION

Gold is always in and is thought to be a prized and steemed possession in the form jewellery or ornament. It has always been proudly displayed as a matter of beauty enhancement or financial prosperity.

Gold as a noble and malleable metal has been used in dentistry from the prehistoric era.1 It is the oldest dental restorative material.[2] Use of gold in dentistry has been associated with social and cultural characteristics. They are primarily used for restorations, crown and bridge, inlays, and onlays. In the past, gold has been used for splinting of the teeth and for decorations of teeth. Gold is used in dentistry either in its pure form or in the form of gold alloys.[2] Pure gold is very soft (HV 25) and its use is limited to direct filling of small occlusal cavities. However, no standard exists for the application and properties of direct filling gold.[2] The alloys contain gold, copper and other metals that result in a strong restoration. It is a common technique in conservative dentistry to cement investment cast gold alloy inlays and onlays into cavities.[2] Most commonly used alloys are based on 65-75% gold.[2] The properties which make high quality gold alloys so popular for dental work are their non-tarnishing and non-corrosive qualities.[2, 3] They have no injurious effect on gums and oral cavity. They take a high polish, are malleable and can easily be shaped without breaking. Such quality also ensures a tight fit around the edges of the cavity, sealing perfectly. Full cast or partially veneered crowns are mostly used for posterior teeth because of aesthetic reasons.[2] Inlays, onlays and partial crowns from high gold alloys can be precisely fabricated in the dental laboratory with an excellent marginal fit and longevity of many years.[2]

Additionally, gold alloys do not fracture under the pressures of mastication. And of course, gold is everlasting. Due to increasingly available dental materials alternative to gold, it is appropriate to review the current scenario of gold usage in dentistry.

History

Historically gold has been used for more than 4000 years in dental practice. In the early days, dental applications of gold was mainly for aesthetics rather than function.[2] The Phoenicians and Etruscans used

to wire loose teeth together with strips of gold; some samples consist of several gold bands fastened to natural teeth which supported artificial teeth.[1, 2] During 6th-4th century BC, dental prosthetics of Etruscans were found in the archaeological record, from where around 20 samples were found to consist of bands of gold into which false teeth were riveted, with empty lateral rings which were anchored around sound teeth.

Ancient Greeks and Romans used gold in their crude prostheses. It was Romans who introduced the art of making fix bridges from gold strips.[2] The splinting of teeth was also practiced by Egyptians; as evidenced by a specimen from Cizeh, 2500 B.C., which shows loose molars fastened with gold wires. The early evidence of dentistry among the Jews is found in a collection of books known as Talmud (352-407 A.D.), which stated that, the artificial tooth restorations were made with gold, silver and wood, especially by the women.

Marco Polo in 1280 A.D. stated that the Chinese used to cover teeth with thin gold leafs mainly as decorations. Spanish-Arabian physician Albucasis or Abul-Qasim (936-1013 A.D.) in his great surgical treatises Dechirurgia illustrated surgical and dental instruments with detailed description, many of them made of gold. He described a method of transplanting teeth and the use of gold wire to ligate loose ones.

Among the European literatures, one such text, Chirurgia Magna, written by the famous French surgeon Guy de Chauliac in 1386 A.D. devoted some space to pathology and therapeutics of the teeth. Chauliac was the first to coin the term "dentator" and "dentist." He was also the first to mention the filling of teeth with gold. Publication of Giovanni da Vigo's work in 1514 A.D. revealed the earliest printed record of the filling of teeth with gold foil. Pierre Fauchard in 1728 used gold for tooth restorations and denture bases.

As derived from the "history of dentistry," F. M. Bourdet, the Italian dentist in mid eighteenth century described the use of gold for base plates of the dentures. In 1798, John Greenwood made denture with gold base and ivory teeth for America's first President George Washington. In 1907, William Taggart demonstrated the cast gold inlay. Gold in olden days have been used for traditional belief and culture. Freed slaves of Africa used to put gold crown to show that they were free. In Ghana, once a Muslim made Al'Hajj, he used to get a gold tooth to signify his pilgrimage.

Mayans, a Mexican tribal community can often be identified by gold caps on upper or lower four front teeth. This tradition has been in practice for thousands of years.[1,4-6]

In Nepalese culture too, it is not uncommon to find an elderly person with gold crown in upper anterior segment, which is usually considered aesthetic and are usually made by goldsmiths. There is a tradition of keeping gold or gold coin in mouth of a dying person because gold is considered to be divine, thus elderly people prefer gold crown or gold stud in tooth or at least place a piece in the oral cavity. In rural parts of Nepal, there is to tradition to make a gold pit in front teeth to mask the hypocalcified spots. In Sherpa community, many individuals in porter profession wear gold crown so as to detect poisonous herbs during their feeding.

Gold Uses

At modern times again, the use of gold as the fashion statement has been once again popularised. They have been used in the form of crowns, oral jewellery or studs, orthodontic brackets, gold implants etc. Besides, gold due to its noble metal characteristics is still a good material of choice for screw posts, implants and as surgical instruments.

Four types of alloys are defined[2] covering a wide range of uses in conservative and restorative dentistry and orthodontics. The most widely used is the Type 4 alloy, which is suitable for all kinds of extra-high strength crown- and bridgework as full cast and/or polymer veneered. Orthodontic and clasp wires, attachments, partial denture framework, plates, bars, saddles and splints can be cast or prefabricated from Type 4 alloys. In addition, telescopic crowns and milling work are appropriate uses of this alloy.[2]

Gold alloys with special properties, including high sag resistance and compatible coefficients of thermal expansion to porcelains have been developed to fulfill the necessary requirements for fixed crowns and long span bridges with porcelain veneers.[2]

One further application for gold in dentistry is in plating or gilding other metallic components. If gilding is used, the thickness of the layer is only 0.1 to 0.2 µm, and therefore the durability may not be acceptable because of abrasion occurring during use. Gold plating with layers of 5 µm thickness and greater are therefore recommended. Plated layers are relatively hard.[2]

Biocompatibility

Biocompatibility is another important characteristic of all dental materials. Functional performance or efficiency of gold is of no value if it isn't compatible with oral tissues. Both in cases of pure gold or gold alloys, the phenomena of corrosion and any untoward reaction with tissues must be reduced to a minimum. Different ions are released at different rates from the alloy. To predict the biocompatible properties of a material, it is necessary to understand the properties of dissolution, cytotoxicity and, with regard to metals and alloys, about electrochemical potentials in saliva.[2, 4] Alloys containing 92-93% gold, 3-4% palladium and additional quantities of platinum, silver and tin release ions the least and don't corrode easily.

Electroforming

The electroforming process with pure gold was first used in conservative dentistry for inlays in 1961.[2, 4] In the electroplating industry for the production of jewelry, watch fabrication and decorative items the process has been used for more than 150 years. In the conservative dentistry, its use has only been few decades. The major advantage is the production of precise coping of pure gold which does not change its dimensions during firing on porcelain without any further need of wax modelling, investing, preheating of moulds and casting.[2, 4]

Dental applications of electroformed pure gold is wide in crowns and bridgeworks. Electroformed copings used in telescopic prosthesis have good strength. In long span bridges, copings are positioned onto the prepared stumps and cemented to the framework within the mouth. This technique is especially helpful in implant cases which may become detached if exposed to lateral stresses.[2, 4]

Gold Restorations

1. Direct Filling Gold

Historically Giovanni di Arcoli in 15th century first described direct filling of tooth cavity with gold leaf. In 1812, a manufacturer in Hartford, Connecticut specialized in beaten gold leaf for dental purposes. In 1855, Dr. Arthur described a technique for using cohesive gold foil. The procedure involves passing of gold foil through a flame which removes impurities and causes it to adhere to each other. An important condition for perfect cohesiveness is that the cavity has to be free of saliva. The dental dam plus the dental engine helped gold foil achieve a high degree of perfection.

Indications of direct filling gold are Class I small cavities or pit, small V cavity, Class III, Class VI, Class II small cavities where marginal ridges are not subjected to heavy occlusal forces. Contraindications are teeth with large pulp chambers, periodontally weakened teeth, handicapped patients who are not able to sit for longer appointments.

2. Casting Gold Restorations

Dr. William H. Taggart in 1907 introduced a new and accurate indirect method of casting gold inlays. This technique was called the "disappearing wax technique." He patented this technique but lost his patents. Later, it was discovered by the Dr. Philbrook of Dennison, Iowa. Dr. Philbrook had written article concerning the procedure of gold inlay castings 25 years earlier, which can be found at the library of the University of Iowa.

For casting gold alloys, the melting range should be as low as possible.

Gold Casting Procedure: In this technique, a crown or inlay is first shaped from wax and then surrounded by a heat resistant plaster. After the plaster has hardened, it is heated so that the wax melts and runs out. Molten gold alloy is then poured into resulting cavity. On cooling, the plaster is broken open, leaving an exact duplicate of gold alloy of the model wax restoration. Gold crowns, inlays, onlays and other dental restorations may be prepared in this manner.

The properties of the gold are modified to suit the various applications by alloying it with other metals. Today's standardized gold casting alloys come in different hardness's, melting points and expansions. The operator has therefore a variety of materials with which to work. And, although the price of gold itself is usually high, the main costs in dentistry are labour and services, not the metal. In an average crown, one twentieth of an ounce or less is gold.[3, 5-12]

Advantages of casting gold restorations are their good accuracy and durability, fine marginal detail, resistance to tarnish and corrosion, good fracture and wear resistance, biocompatible and non-toxic to oral structures, and as gold can have porcelain bonded to it may be used for fabrication of cosmetic crowns. Whereas disadvantages include it expensive cost, non-tooth coloured, and usually require multiple appointments with the dentist.

Indication of Cast Restorations

1. Extensive tooth involvement
2. Restoration of endodontically treated tooth
3. Correction of occlusion
4. Partial subgingival restoration
5. Retainers for fixed prosthesis

Contraindication of Case Restorations

1. Developing and deciduous teeth
2. High plaque and caries indices
3. Occlusal disharmony
4. Dissimilar metals

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