

Gold foil restoration: a never-ending beauty

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Introduction.

Gold foil (direct gold restoration) is possibly the oldest and best-documented dental treatment for repairing cavities.

Giovanni Arcolani (Ioannis Herculani) published in 1483 his treaty 'Pratica Chirurgica' where first he described the use of gold to fill teeth. Stringfellow introduced in 1839 the technique of plugging metal in dental cavities¹, and Arthur² introduced in 1855 the cohesive gold foil for direct gold restorations.

So why is it rarely – if ever – part of the curricula at dental schools, and why have dentists almost abandoned it as a choice dental procedure for caries?

This article aims to explore the technique and to present a clinical case. The authors believe that gold foil restorations, even if not performed, should be well understood in their principles by general practitioners in order to improve the quality of their restorations of any kind.

Advantages and disadvantages

A gold foil restoration is a filling technique of decayed teeth that exploits the properties of gold of being welded in its cold state, due to its highly cohesive nature.

The resilience of dentine and the adaptability of gold allow an almost perfect seal between the tooth structure and gold. The malleability of gold, which is the property of being worked into very thin foils, make it possible to add gold in very small amounts that are building up the filling.

Gold is resistant to corrosion, shows no shrinkage or expansion, and therefore is an ideal dental filling material. The advantages of gold foils restorations are that they can last for a long time if correctly done.

The disadvantages are that these restorations are technique sensitive, and to achieve excellence great skill, patience and time is required. The consequences of an improper restoration finishing with a coarse or crystallised surface can affect the periodontal ligament. The welding technique, with or without a mallet, can generate a pulpar trauma that can lead to RCT.

Because of the high thermal conductivity of gold, larger restoration can enhance sensitivity, and a larger restoration is very complex to finish and polish.

Gold foil is more expensive than any other restoration material not only because of the gold (dental bonding is by far more expensive), but because it requires a lot of operative time and a full set of instruments requiring sterilisation and assistance. Multiple restorations are no faster, and each one requires at least a full hour

in the hands of a very expert dental surgeon to be completed to perfection. Last, but not least, gold restorations are out of fashion, especially when patient and operator-friendly procedures are a valid alternative.

Indication for direct gold restorations

Generally, gold foil restorations are used for incipient or early lesions, generating small cavities in non stress-bearing areas, and where aesthetic concern is limited. The technique is also used to repair of endodontic openings in gold crowns or for gold crown margins, onlays and inlays. They are not generally used in children and young adults. According to Stibbs³, the indications for direct gold follow the rules: the smaller the lesion, the greater the indication; the greater the need for conservative, permanent restorations, the greater the indication for foil.

The American Academy of Gold Foil Operators⁴ indicates class 1, class 2, class 3, class 5, and class 6 cavities. The dimensions illustrated in their guidelines are small, with the exception of class five cavities that can be of several millimetres.

Rex Ingram in his 'Atlas of Gold Foil and Rubber Dam Procedures'⁵ offers guidelines on class 1 pits and fissures restorations, class 5 restorations, maxillary class 3 restorations, labio-invisible class 3 restorations, mandibular class 3 restorations and class 2 restorations.

Do we need longer lasting restorations?

New dental materials like glass ionomers, composite resins, pit and fissure sealants and full ceramic restorations are reported in literature to perform quite well and last over several years. It is conceptually difficult to compare new materials, as the concept of cariology has evolved in the last decade.

The new paradigm in cariology holds that dental caries is a reversible process, and treatment takes place at a bio-molecular level at which remineralisation can be pharmacologically boosted. As a consequence, the need for longer lasting restorations is today less emphasised than it was in the past.

Concerning pits and fissures, it is today established that they form a system, and therefore the effective treatment requires the sealing of the whole occlusal surface in order to obtain a valid protection against caries.

Front teeth decays raise concern for their aesthetic implications, and it should not surprise that the public disfavours non-aesthetic fillings.

The assumption that a shorter lasting restoration will lead to

tooth destruction is all but demonstrated. Most composites are replaced simply because the increasing quality of the materials available today advise for a replacement of older and discoloured fillings.

Types of gold used

Gold used for conservative procedures is classified in crystalline and fibrous, according to its microscopic structure⁶. The former is produced by melting of pure gold into ingots that appear made up of intertwined fibres, giving great strength. The latter is produced by electrolytic precipitation, and appears granular under microscope magnification.

Gold foil is produced by fibrous gold ribbons which can be either flattened using round head mallets to produce five square inches foils, or by rolling mills to produce rolled gold foil.

Gold foils are classified in cohesive and not cohesive. Gold foils produced by 'beating' or 'rolling' are both non-cohesive, which means that the cohesive property has to be obtained by slow heating, the annealing process.

Non-cohesive gold foils are more flowable, and are used basically in the proximal portions of class 2 restorations and class 3 lingually. Its use prevents the possible damages to enamel rods involved in the use of the mallet necessary for cohesive gold foil. Cohesive gold is used for all surfaces subject to wear.

Crystallised gold is used as filler to build up in class 5 and class 1. It should not be used for external surfaces of restoration, because it shows a tendency to surface pitting.

Storage of gold foils

Exposure to air and dust can affect the cohesive properties of gold foils.

Cohesiveness properties are conveniently maintained storing gold foils in the presence of ammonia (an open bottle or sachets), in a drawer or in a box. They should never be handled directly with bare hands in order to avoid salts and moisture from the skin to contaminate the surface.

Annealing

The process of annealing is the heating of gold at certain temperatures in order to eliminate impurities and allow the full expression of cohesion properties showed by pure gold.

It is obtained by two methods, using the free flame from grain alcohol in the blue spectrum of the flame emerging from a wick of one inch in height, or with an electric annealer.



Figure 1:



Figure 2: Desirable depth and design can be achieved using a #34 inverted cone bur on the floor of the cavity



Figure 3: The final step of the preparation is to use a chisel to remove unsupported enamel

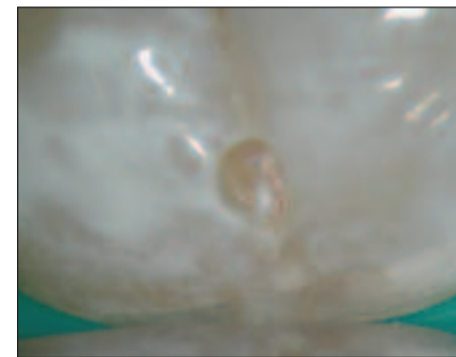


Figure 4: A nice smooth finish is produced when the excess of gold is polished away

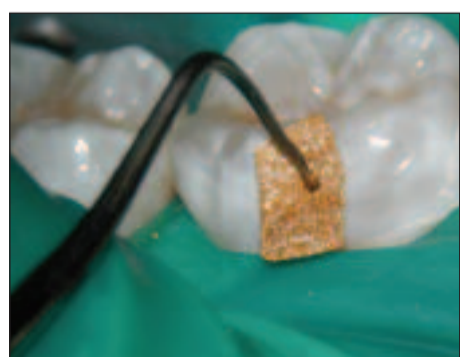


Figure 5: A crystalline mat gold is held in place with a probe



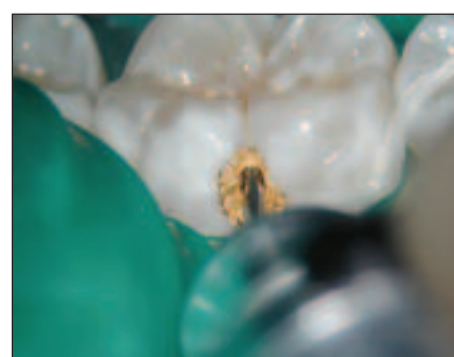
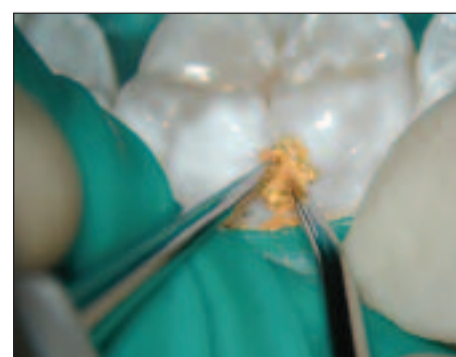
Figure 6: The probe is gently plugged into the cavity



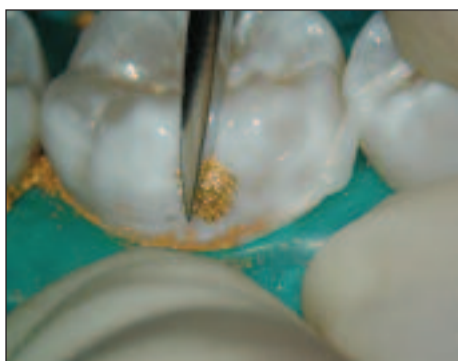
Figure 7: One of the methods for condensing gold is by using the pneumatic condenser



Figure 8:



Figures 9-12: The pellets are applied and compressed on the cavo-surface of the preparation until gold slightly exceed the margins



Figures 13-14: The burnisher should always be used following the direction from gold to the tooth

Figures 15-16: The restoration is polished using a rubber cup and polish

Cavity preparation

Pre-requisites for success in gold foil restorations related to cavity preparations are a proper design, and an absolutely dry field (rubber dam must be sealing the field from saliva). Due to the great perfection required, a pre-operative design of the preparation and fully efficient burs, chisels and motors can be the key of success as otherwise the first components of failure.

Cavity design should show mechanical retention, aesthetic outline form and adequate access for instrumentation. Particular concern is necessary for pulp protection.

When removing an existing restoration, attention should be paid in order to be as minimal as possible, and at the same time offer access to complete condensation.

Desirable depth and design can be achieved using a #34 inverted cone bur on the floor of the cavity (Figure 2). The final step of the preparation is to use a chisel to remove unsupported

enamel (Figure 3). Alternatively, a 7061 finishing bur can be used. Doing so, we can obtain a bevel and a desirable cavo-surface margin, which produces a nice smooth finish when the excess of gold is polished away (Figure 4).

The preferable depth of the cavity preparation is 2 to 3mm, from 1 to 2mm in dentin. The shape of the preparation has to attain to aesthetic criteria, and a harmonious design is important. If the depth of the cavity is deeper than 3mm, a protection for the pulp has to be considered. Whatever your choice, avoid the presence of trapped air using an amalgam condenser.

Methods of condensation

A crystalline mat gold (Williams Gold Refining Co., Fort Erie, ON) is held in place with a probe (Figure 5), and using a compressor, it is gently plugged into the cavity (Figure 6). Now the gold undergoes the condensation process.

There are several methods of condensing gold. The simplest is to use an amalgam condenser. It requires a good amount of pressure, in order to push out all the air in the mat.

Other methods of condensation that can be used are hand mallets, the electro mallet, and the pneumatic condenser (Figure 7).

Whatever the technique used, it is important to avoid contact between the condenser or the mallet and the margins of the cavity. Additional amounts of crystallised gold mat can be added and compressed until the cavity is completely filled.

The final layers could be placed using gold foil (Jensen Industries Incorporate, North Haven, CT).

Gold foil is rolled in tiny pellets that are annealed using a pure alcohol flame. The pellets are applied and compressed on the cavo-surface of the preparation (Figures 9, 10, 11) until gold slightly exceed the margins (Figure 12).

Once the superficial gold foil layer has been placed and compressed, a beavertail burnisher is applied to burnish and smooth the surface. The burnisher should always be used following the direction from gold to the tooth (Figures 13, 14). Finally, the restoration is polished using a rubber cup and polish (Figures 15, 16).

Conclusions

Whenever the indication for a gold foil is correctly set, this kind of restoration will last for decades persuaded by warm aesthetics.

References

1. Stringfellow, S. L. On Plugging Teeth. *Amer J Dent Science* 1 (1st ser): 111-112, 1839
2. Arthur R. A New Method of using Gold Foil. *Amer J Dent Science* 5 (2nd ser): 600-605, 1855
3. Stibbs, G.D., Direct Golds in Dental Restorative Therapy. *Oper Dent* 5: 107-114, Summer, 1980
4. <http://www.goldfoil.org/>
5. Ingram R et al. An Atlas of Gold Foil and Rubber dam procedures Los Angeles 1961
6. Turnbaugh Hodson J, Stibbs GD Structural Density of Compacted Gold Foil and Mat Gold *Journal of Dental Research* Vol. 41, No. 2, March-April 1962.

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Dr Liviu Steier will be one of the speakers at Private Dentistry 07, Westminster, on 30 November 2007. Other presenters include Kevin Lewis, Philip Newsome, Lina Craven and Komal Suri. For more information, or to book your place, call 0800 371 652, email seminars@fmc.co.uk or visit www.independentseminars.com/pd2007.

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