Historically, the most common material used to replace missing teeth and to fill decaying teeth has been gold and its alloys. But with ever increasing gold prices, dental experts started looking for possible substitutes. Initially, these too were metallic. Later with cosmetic dentistry coming into the limelight, search for newer materials to fill and replace missing teeth with tooth-colored substitutes was initiated. This is when the concept of ‘metal-free practice’ originated.

However, despite recent advances, metal-free dental practice appears practically unfeasible, since the dentist who truly maintains a practice free from use of all metals and metal alloys, would deny patients some of the best restorative materials known to dentistry today.

Metals and Metallic Alloys in Dentistry

Etruscans (or civilization of ancient Italy sometime in the 7th century) are believed to have been the first to use gold in dentistry. During those days, tooth of an animal such as a cow or a calf properly fastened with gold wiring was used to replace a lost tooth. Later, metals were used in the fabrication of crowns, bridges and dentures. High purity (99.7%) gold was perhaps the oldest metal used in this field. Today, however, a wide range of metallic alloys find application in almost all processes of dentistry. These include (a) precious metallic alloys such as gold-platinum alloy, gold-palladium alloy, gold-copper-silver alloy, (b) semi-precious metallic alloys such as silver-palladium alloy, palladium-copper alloy, silver-gold-copper alloy, (c) base metallic alloys such as cobalt-chromium alloy, nickel-chromium alloy, and (d) titanium based alloys such as nickel-titanium alloy.

Pertinently, minor composition changes in base metal alloys are known to cause significant beneficial effect in their ease of casting, bonding, hardness and strength. This takes care of the sag of alloys at elevated temperatures (also known as the high temperature creep) that can markedly affect fit of the castings. For example, nickel-chromium alloys possess lower sag values than gold alloys.

Dental Crowns

A dental crown is a dental restoration that completely encloses or caps a tooth or a dental implant. Crowns are generally required to improve strength and appearance of a tooth that is so badly damaged that its repair or restoration with conventional filling materials becomes practically impossible. Crowns have been made from a variety of materials such as:

All-/Full-metal crowns

Full-metal crowns (Fig. 1A) are mostly cast from jewelry grade (~18 carat) gold, but may also be cast from certain alloys including high-noble or jewelry-gold (made from gold mixed with platinum or palladium), noble (made from gold, palladium and silver) or base metal (made mostly from nickel and beryllium) alloys.

All-metal crowns are stable and nearly indestructible, since they have no porcelain veneer that could chip or break. They also require less tooth reduction and their bevel makes them more stable and less likely to leak.

Figure 1.
A: Full-/all-metal dental crown in situ (arrow),
B: diagrammatic representation of a full-/all-metal crown vis-à-vis the underlying tooth core
The only major disadvantage of this type of crown is its poor aesthetic value. It is because of this reason that they are almost exclusively used on rear chewing teeth.

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Porcelain-fused-to-metal (PFM) crowns are simple, thin, tooth-shaped shells commercially available in a variety of materials and graduated sizes as metal-free alternatives. These include porcelain, alumina, ceramic, zirconia and polycarbonate crowns (Fig. 3A,B). However, due to imperfect fitting, such prefabricated crowns if worn for long durations may cause gum problems at the margins where the crown meets the tooth. Moreover, the contact that such crowns make with adjacent teeth may be poor allowing for food impaction between the teeth.

These crowns also make excessive contact with the opposing teeth causing difficulties in biting. Adjustments to correct excessive vertical height may weaken the finished prefabricated crown. Their life expectancy depends upon how much the dentist has to modify them from their original state to make them fit and how careful the patient is with them. Generally, prefabricated crown is considered a practical temporary alternative to an extraction.

Fixed Partial Denture (FPD) or Bridge

A fixed partial denture or a bridge is a restoration that is used to replace a missing tooth by permanently joining adjacent teeth or dental implants (Fig. 4A). The materials used for making bridges include gold, metal alloys, porcelain-fused-to-metal, porcelain-fused-to-zirconia or porcelain or ceramic alone (Fig. 4B-D). The extent and type of reduction...
done to the adjoining teeth varies according to the material used.

Removable Partial Dentures
Removable partial dentures (RPD) having cast metal frameworks were initially made from wrought (hammered) silver (Fig. 5A-B). The metal framework did not come in direct contact with the gums. Thus, as the gums resorbed with ageing, these partial dentures did not sink with them and rarely required adjustments. Modern frameworks are made from chrome-cobalt alloy, which is extremely strong and can be cast very thin. In addition, these are lighter, corrosion resistant, are much less perceptible to the tongue, and do not affect taste during eating because of minimal metal framework coverage over transpalatal area. Sore spots are almost never an issue since neither framework nor plastic extensions contact soft oral tissues with any force. They can be easily modified in future including adding new teeth and clasps.

Dental Implants
Dental implants are anchors surgically embedded in the jaw bone (Fig. 6A-C). They are usually made from titanium or titanium alloys and are meant to support dental restorations (such as a crown or a bridge) that are used to replace missing teeth. Implant placement is a minimally invasive technique administered under local anesthesia. Successful replacement of implants is also conveniently achievable. Long-term studies observing implant solutions for over 15 years confirm their high safety and success rate of >96%. Failure of implants is due primarily to inadvertent loading or risk factors such as poor bone quality and smoking and/or surgical factors. Zirconia implants have also been used in Europe for past many years. They are believed to be highly bio-compatible. Besides, being ceramic, they do not corrode.

Modern orthodontists offer many varieties of braces. These include:
(a) Traditional metal-wired braces made from stainless steel and/or titanium. These may be conventional braces that require ties to hold the archwire in place or the newer self-tying brackets that reduce friction between the wire and the slot of the bracket and may also provide therapeutic benefit. Titanium braces are lighter and are recommended for persons with allergies to nickel (a basic and important component of stainless steel),
(b) Gold-plated stainless steel braces are also employed for patients allergic to nickel in steel,
(c) Clear braces that serve as cosmetic alternative to traditional metal braces by blending in more with the natural colour of the teeth or having less conspicuous or hidden appearance. Typically, these are made of ceramic or plastic, but due to higher component of friction, these tend to be more brittle than metal braces and can make their removing difficult and time consuming at the end of treatment and
(d) Lingual or Incognito braces are custom made fixed braces bonded to backside of the teeth making them invisible to people and serve as cosmetic alternative to all other types of braces.
The major advantage of braces is that one can continue to eat and drink while wearing braces. But they have to be periodically tightened by the orthodontist causing increasing amounts of discomfort. Besides, one must give up certain foods and habits such as chewing gum while wearing them.

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Dental braces are used to align and straighten teeth, position them with regard to the person’s bite and improve overall dental health.

Dental filling or Dental restoration
Dental filling or dental restoration is the material used to restore morphology and functional integrity of the missing tooth structure due to caries or external trauma. Metals mostly used for making crowns, bridges and dentures have been used for dental filling. Efforts have been made to develop new safe and effective dental materials. But current alternatives such as composite resins have not been as effective as dental amalgam in providing durable restorations especially in case of larger fillings.

Gold dental filling: It was as early as 15th century that the first dental textbook published in Leipzig, Germany had recommended use of gold leaf for dental filling. Like the solid gold teeth and gold crown, gold fillings (Fig. 8A) have shown remarkable strength against opposing teeth while being in continuous use.

Amalgam dental filling: Amalgam filling, commonly known as silver or mercury filling (Fig. 8B), is an excellent and versatile restorative material in extensive use for over 150 years in dental health care. It is a mixture of almost equal parts of elemental liquid mercury (43-54%) and an alloy powder (57-46%) composed of silver, tin, copper and sometimes smaller amounts of zinc, palladium or indium. It is inexpensive, relatively easy to use and manipulate since it remains soft for a short interval and can be conveniently packed to fill any irregular volume in a single appointment. Used primarily to fill posterior cavities, it is also used extensively for crowns, bridges and dentures.
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to the components of amalgam in dental literature. According to the American Dental Association, given their solid track record, amalgam fillings are still the best bet. The Report of FDA's Dental Products Panel of 1991, too, states that there was no convincing reason to believe that avoiding amalgams or having them removed will have beneficial effect on health. In fact, it is not advisable to have amalgam removed unnecessarily, as this might cause structural damage to the otherwise healthy teeth. Claims that removal of amalgam leads to recovery from multiple sclerosis or that use of amalgam leads to arthritis or Alzheimer’s disease remain unsubstantiated.

Pertinently, the dentists, too, are now much less exposed to mercury due primarily to their increased awareness and adherence to precautions as they create and apply dental amalgam. This is based on the observed decreasing levels of mercury concentration during urinary screening in about 1.700 dentists.

According to reports, the least amount of nickel and chromium is released from arch wires composed of an alloy containing 54% nickel and 46% titanium in corrosion tests. Titanium is highly corrosion resistant and alloying with nickel results in a corrosion resistant alloy. The localized potentiodynamic corrosion resistance of nickel-titanium alloy is much lower than that for stainless steel. In corrosion tests using 1% sodium chloride (slightly higher than that of saliva), it has also been shown that nickel component of the alloys may have a selectively higher dissolution rate from the corrosion pit.

It is believed that people are exposed to much less mercury due to improved amalgam fillings. Till date there is no scientific evidence to support that exposure to mercury from amalgam restorations poses any serious health risk in humans, except for few allergic reactions.

According to US Public Health Service report of 1993, in 50 years of continuous use, there have only been about 100 documented cases of allergic reactions.