
HISTORY OF AMALGAM IN DENTISTRY

A história do amálgama em Odontologia

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The amalgam is a homogeneous alloy mixture of two or more elements, at least one of which is a metal. Most metals are soluble in mercury, but some (such as iron) are not. Amalgam also may be a solution of metal-like ion complexes, such as ammonium. Amalgams are commonly used in dental fillings. Mercury was a well-known metal in the ancient time in China, India, and was found in Egyptian tombs that date from 1500 BC. It was used to prolong life, heal fractures, and maintain generally good health.

China's first emperor, Qin Shi Huang Di - who unified China from 247 BCE to 221 BCE made some gigantic projects: Great Wall of China, a city-sized mausoleum guarded by a life-sized Terracotta Army, and a massive national road system. He was killed by mercury pills (failing liver, poison, brain death) intended to give him eternal life. The "theory" was that if mercury could even absorb gold, then if eaten, it would give that person its own powers, making him immortal. Mercury compounds were mixed with some food so as to make it edible.

The mythology of Mercury begins back in **Babylonia**, times where Mercury was known as **Nebo (Nebu)**, the son of **Marduk** gods. Marduk became the king by slaying the sea monster **Tiamat**, thus establishing order in the universe. (Figure 1). Nebo became the scribe of the gods. It was his job to write down the laws and edicts of Marduk and to communicate them to men. Marduk later became the *Greek Zeus* and then the *Roman Jupiter*. Nebo became the Greek **Hermes** (Figure 2) and then the Roman **Mercury**.



FIGURE 1 - Nebo



FIGURE 2 - Hermes

The ancient Greeks used mercury in ointments; the ancient Egyptians and the Romans used it in cosmetics. By 500 BC mercury was used to make amalgams with other metals. Hg is the modern chemical symbol for mercury. It comes from *hydrargyrum*, a Latinized form of the Greek word *ὤϊνᾱνᾱδῶνιῶ* (*hydrargyros*, which is a compound word meaning “water” and “silver” — since it is liquid, like water, and yet has a silvery metallic sheen. The element was named after the Roman god Mercury, known for speed and mobility. It is associated with the planet Mercury (Figure 3). The astrological symbol for the planet is also one of the alchemical symbols for the metal. Mercury is the only metal for which the alchemical planetary name became the common name. In the 4th century B.C., Aristotle discussed the use of ‘fluid silver’ for religious ceremonies. Hippocrates was said to have used mercury for medicinal purposes.



FIGURE 3 - Mercury planet

The Romans used vermillion (the red-colored sulfur salt of mercury) extracted from the Almadén Cinnabar mines as a cosmetic and decorative (Figure 4). Other early writers also recognized the association between certain disorders and occupations. The Roman scholar *Pliny*, in the 1st century AD, described mercury poisoning as a disease of slaves because mines contaminated by mercury vapour were considered too unhealthy for Roman citizens and thus were worked. Although the toxicity of elemental Hg had been reported already by *Pliny the Elder* or *Caius Plinius Secundus*.



FIGURE 4 - Cinnabar's sulphur salt of mercury

In the Middle Age even alchemists (the Indian word for alchemy is *Rasavâtam* which means “the way of mercury”) thought that mercury could be turned into gold by mixing mercury with some missing ingredients. Alchemy - an ancient science that combines astrology on one level and early chemistry on the other (Figure 5).



FIGURE 5 - David Tenier – “The Alchemist”

The alchemist's goal - to change or "transmutate" one element into another. This change wasn't necessarily chemical. Alchemists also sought ways to prolong life, not to mention discover the elusive "fountain of youth". Alchemy reached its heyday during the Medieval and Renaissance ages when alchemists major aim was to turn base metals like mercury, copper, silver and lead into gold (Figure 6) Aristotle was the first to believe that everything that is physical is based on four elements: water, earth, air and fire and that by altering that mix one element could be transformed into another. The Egyptians, the Arabs, the Romans, the Chinese and the Hindus all transcribed to Aristotle's basic theory and experimented with many elements, particularly mercury, in their quest to mass produce gold.



FIGURE 6 - Alchemist's symbol of mercury

The European alchemists refined Aristotle's theory to 3 basic elements: sulphur, which represents the male soul, mercury, the female spirit, and salt, the body. Before transmutation occurred, however, the alchemists made sure all their astrological calculations were correct. Discovering the recipe for gold soon became an obsession for many practising alchemists. Monarchs in every realm in Europe began financing these quests in the remote hope they would become richer than they already were. Alchemists also began experimenting with highly corrosive or volatile substances like nitric and sulphuric acid, which tended to blow up if handled or mixed incorrectly.

One of the greatest alchemists the Renaissance age produced was named *Philippus Aureolus Theophrastus Bombast von Hohenheim*. (1493-1541), otherwise known as *Paracelsus* after the Roman doctor, Celsus. He believed in experience, observation and experiment. As a result, he was the first to record that inhaled dust, and not subterranean spirits, was the cause of miners' diseases. He also realised that problems

with drinking water were responsible for goitre. He developed treatments using antimony, sulphur, mercury and potassium salts.

Mercury is a very strange metal. It is a liquid at room temperature, but it is so dense that cannon balls float in it. Mined as the ore Cinnabar, mostly from the Quavos mine at Almadén. With the invention of mercury amalgamation to treat silver ore, mercury became essential to the silver mines of the New World. The Spanish Empire transported mercury from Almadén across the Atlantic to supply the silver mines of Zacatecas (Mexico) and Potosi (Bolivia). Another source for mercury in the Spanish Empire was the mine of Huancavelica in Peru, discovered in 1563. In 1648, the Viceroy of Peru declared that Potosí and Huancavelica were "the two pillars that support this kingdom and that of Spain." Mercury amalgam was first applied to silver ores with the invention of the patio process in Mexico in 1557. Other amalgamation processes were invented for processing silver ores, including pan amalgamation and the Washoe process (a variation of pan amalgamation - the copper pans were replaced by iron).

Over 100,000 tons of mercury were mined from the region of Huancavelica, Peru, over the course of three centuries following the discovery of deposits there in 1563; mercury from Huancavelica was crucial in the production of silver in colonial Spanish America. Many former ores in Italy, the United States and Mexico which once produced a large proportion of the world's supply have now been completely mined out or in the case of Slovenia and Spain shut down due to the fall of the price of mercury in the international markets. The metal is extracted by heating cinnabar in a current of air and condensing the vapor.

Cavities (areas of decay) in teeth have been filled since earliest times with a variety of materials, including stone chips, turpentine resin (an organic plant substance), gum, and metals. Dentistry saw a huge boom in the 16th century. Dental technology was now more advanced than ever. People such as *Benvenuto Cellini* and *Giovanni d'Arcoli* were making huge strides toward improving the quality of dentistry in Italy. Cellini invented a method for casting gold inlays which were able to be used in dental practice. Giovanni of Arcoli, often better known by his Latin name, *Jobanus Arculanus*, who was a

professor of medicine and surgery at Bologna and afterwards at Padua, just before and after the middle of the fifteenth century, and who died in 1484. He is famous principally for being the first we know who mentions and is credited as being one of the first people to develop what is known as a dental filling. He did this by filling the teeth with a soft gold. Oddly enough, not until the 15th century were patients placed in the sitting position while having dental work done in their mouth. Giovanni d'Arcoli recommended gold-leaf (gold beaten into very thin sheets) fillings.

The most influential person in the 16th century was *Ambroise Pare*, suggested many things such as the treatment of cavities.

In France *Pierre Fauchard* (1678-1761); often referred to as “the father of modern dentistry”) favoured tin foil or lead cylinders. Fauchard also suggested that instead of pulling a tooth, it would be better to scrape the diseased cavity clean and then fill it with lead or gold leaf. His text contained detailed procedures for filling and treating cavities. Fauchard disdained the still-prevalent idea that worms caused decay, suggesting instead that sugary foods were to be avoided. He provided recipes for mixtures to treat infections of the mouth, which used items commonly available from apothecaries, such as oil of cloves and cinnamon.

Philip Pfaff (1715-1767), the Prussian great dentist used gold foil to cap teeth. After the French Revolution many well educated dentist leave their country to immigrate to America. But the possibility of the New World was a magnetic for the people to be in luck.

The amalgam wars

Aguste Taveau of Paris developed what was probably the first dental amalgam in 1816. He used filings from silver coins mixed with mercury. When the French *Crawcour* brothers immigrated to the United States in 1833, they introduced Taveau's amalgam. The *Crawcour* brothers opened for business in New York. To anyone with tooth troubles, the brothers' advertisements were irresistible: “Why pay a fortune to have your cavities plugged with gold when two brilliant dentists from Europe could fix them with a miraculous new sort of filling?”

With their amazing Royal Mineral Succedaneum, they could make a tooth as good as new—cheaply, painlessly and in just two minutes”. People flocked to the *Crawcours* for treatment. There was no need to spend hours in the dentist's chair, mouth clamped uncomfortably open while the dentist hammered gold foil into the hole tooth. New York's dentists watched in dismay as their surgeries emptied. In 1844 it was reported that 50% of all dental restorations placed in upstate New York consisted of amalgam.

The poor quality of the amalgam led to its condemnation by many dentists, kicking off the so-called “amalgam war,” a 10 -year period from 1840 to 1850 of bitter controversy about the merits and deficiencies of mercury amalgam. Numerous experiments were made from the 1860s through the 1890s to develop improved amalgam filings materials.

The Chicago, Illinois, dentist **G. V. Black** (1836-1915) finally standardized both cavity preparation and amalgam manufacture in 1895. After truly effective dental cement was developed, baked porcelain inlays came into use for filling large cavities. These were first described by **B. Wood** in 1862. In 1897 an Iowa dentist, **B. F. Philbrook**, described his method of casting metallic fillings from a wax impression that matched the shape of the cavity perfectly. Dr. **William H. Taggart** of Chicago described a similar method for casting fold inlays in 1907. This techniques made possible the modern era of accurate filling and inlay fitting.

Many American Dental Associations excommunicated unanimously the use of amalgam and in 1848 eleven dentists were excluded from the Dental Association in New York because they had neglected their patients by using amalgam. The “silver fillings” were actually a very valuable material. Some research was started to ascertain the technical qualities in the different amalgams that were available at the time. All research was concentrated only on the local qualities which then resulted in that the problems with mercurial poisoning due to tooth amalgam.

Alfred Stock, the German inorganic chemist, did pioneering research on the hydrides of boron and silicon, coordination chemistry, mercury, and mercury poisoning. In 1926 he called out with his own warnings about using mercurial amalgam (Figure 7). Stock mentioned his own

experiences about mercurial poisoning. Stock was himself ill from a slowly insidious mercurial poisoning. He published over 50 papers on different aspects of mercury and mercury poisoning.



FIGURE 7 - By Alfred Stock

He also introduced sensitive tests and devised improved laboratory techniques for dealing with mercury which minimized poisoning risk, possibly initiated by his chronic mercury poisoning in 1923. He became more vocal on protesting the mercury usage after realizing the toxicity of its organic derivatives. German dentists abandoned his warning in 1928 against copper amalgam usage. Nevertheless a paper from Fleischmann, in which removal of mercury in amalgam-related illness had led to complete recovery, supported his idea. This is a summary of all the symptoms he had three stages:

- Mental disturbances, tiredness, reduced capacity to work, irritation, swelling in the mucous membrane in the upper area of the nose cavity.
- Very high tiredness, reduced concentration, bad memory for numbers and names, irritation, capricious, the feeling of being “stupid”, stopped nose with dryness, nose secretion viscous and at times bloody, singing in ears, headache (often in forehead), bleeding gums

when brushing teeth, Irregular heart activity, periodical diarrhoea, had to go often to the toilet, slight trembling.

- Headache (very troublesome), dizziness, giddiness, inability to act, depression, backaches, urinating often, intestine catarrh, diarrhoea, Doge catarrh, bleeding gums, the sense of sullen galle, paradentosis, dental caries, decreased saliva excrete, laryngitis.

Gradually after moving to “Hg-free” laboratory facilities and also removing his mercurial fillings to friendlier materials, Stock was able to recover from his severe mercurial poisoning and also contribute with new important findings to research. Unfortunately now came the Second World War over Europe and under the rug where swept all trivial discussions about “capricious” people, mentally aberrated politicians and statesmen, changing from fury to deep depression all probably caused by mercurial poisoning and all while” the second amalgam war” fell in forgetfulness.

Since the beginning of 1980 discussions have been held in Sweden about the amalgams to be or not to be. Thanks to this many mercurial poisoned persons in Finland probably have been saved from an early death. It was the neurobiologist *Mats Hanson*, associate professor in physiology at Lund University in Sweden, who in 1981 started the fight against the authorities. Hanson made the following statement: “*Tooth amalgam is probably the material witch has caused the largest poison catastrophe*” in our decade.

Gradually he became “uncomfortable” and got sacked from his appointment, when he presented more research results about amalgam and mercurial side effects.

The Norwegian professor *Dag Brune* at the Joined Nordic Institute for Odontological Board of Examiners, NIOM, in Oslo Norway was forced to quit his appointment after being “uncomfortable” due to his research about the side effects from amalgam.

The symptoms of amalgam infections are many. The most common are disorders related to nerve cells, vegetative nerve cells and higher brain functions, which lead to problems with concentration, coordination, memory, or vision.

Further symptoms might be nervousness, sleeping disorders or heartbeat irregularities. Mercury can also cause various disorders of the mucus membranes, such as oral and intestinal infections, or increased overall susceptibility to infections. A very typical symptom is repeated bladder infections. When these disorders occur, especially in youth, amalgams should always be considered as a possible cause. Sensitivity to mercury varies from patient to patient and is further influenced by other factors, which must be taken into consideration during therapy: high acidity of the patient's mucus or the entire organism contribute to high mercury sensitivity. Zinc and selenium insufficiency can have the same effect. These factors must be corrected during therapy.

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