LITERATURE REVIEW: AMALGAM AND MERCURY (Hg) POISONING

Executive summary: The data from numerous studies show that amalgam used in fillings are leeching mercury vapour and that these amalgams remain the primary source of mercury burden in the human body. The mounting experimental evidence shows that this mercury vapour is absorbed fully by the blood stream and results in the accumulation of mercury in various organs of the body, including the brain. The result of this accumulation is the malfunction of these cells or organs. There exists real alternatives to the use of mercury amalgam, and although the experimental evidence is as yet incomplete on the effects of mercury amalgam, it would be far better to make use of these alternatives. The old precautionary principal by which all health-care professional live is very much prudent in this instance-“First, do no harm” In an effort to prolong the life of teeth, dentists have been cleaning out decay and filling teeth for centuries. Materials used as dental fillings were quite varied and have included stone chips, resin, cork, turpentine, gum, lead and gold leaf. The first true standard filling was mercury amalgams though [1] introduced to the western world by the French Crawcour brothers in 1831, mercury amalgam was first used in early China. Known as “silver paste”, amalgam is mentioned in the writing of Su Kung, dated 659 A.D. [2]. The modern mercury amalgam has remained virtually unchanged for the past 150 years and is still being used today. Amalgam is typically composed of 50% elemental mercury and a mixture of silver (35%), tin (13%), copper (2%) and zinc (trace amounts) [3].

Mercury is considered one of the most toxic substances known to man and is considered substantially more toxic than lead, cadmium or arsenic [4]. Although a known toxin, each tooth filling is comprised of about 750-1000 mg of mercury [3, 5]. For this reason, the use of mercury amalgam has been a bone of contention from the very beginning as many dentists object to the obvious disadvantage of using such a dangerous material in people’s mouths [5]. The continued use of these fillings is due to the fact that they are quickly and easily produced, inexpensive, and, as a tooth filling material, displays excellent material properties and durability [3]. Proponents for the use of amalgam also site the fact that dentists have not observed nor reported any adverse side effects in patients. Together with the continued long-term use and popularity of amalgam, these points are offered as evidence safety [6].

The American Dental Association (ADA), the chief champion of mercury amalgams, contend that the mercury in amalgam combines with other metals to render it stable and safe for use in filling teeth [7]. This statement however, is being challenged under the ever-mounting body of evidence to the contrary. Numerous studies have shown that the mercury from amalgams are not inert and that mercury vapour is continuously being released from these fillings, the rate of release into human mouth air increasing immediately after chewing or tooth brushing [8-10]. This fact is not contested by the ADA, stating on their website that 1-3 µg of mercury (a number in itself contested), may be released daily under the pressure of chewing or grinding [11]. Studies show further that mouth air levels of mercury correlate significantly with the number of occlusal (biting) amalgam surfaces in molar teeth and that continuous chewing for 10-30 minutes results in a sustained elevation of the mouth mercury level, which eventually declines to a baseline level 90 minutes after chewing cessation [12].

Blood mercury levels also display a positive correlation with the number and total surface area of amalgam fillings. A single amalgam filling with an average surface area of only 0.4 is estimated to release as much as 15 µg Hg/day primarily through mechanical wear and evaporation, as well as dissolution into saliva [13]. Recent electron microscopy images and electrochemistry data shows that direct evidence exits of amalgam mercury corrosion and leakage into saliva as free ions [14]. Thus, for an average individual with eight occlusal amalgam fillings, a total of 120 µg mercury could be released daily into the mouth with a significant portion of this amount being inhaled or swallowed. These estimations are consistent with a recent report showing that human subjects with an average number of amalgam fillings excrete approximately 60 µg Hg/day in feces, a portion of which are microparticles of amalgam. Various laboratories have estimated that the average daily body absorption of amalgam mercury in humans ranges between 1.2 and 2.7 µg, with levels for some individual subjects being as high as 100 µg/day [15]. The World Health Organization concluded that persons with mercury fillings absorb 3-17 µg of mercury per day, reflecting the consensus average of 10 µg’s absorbed per day [16]. Considering that the tolerable intake for mercury is 1.4 µg /day, it is clear that these levels are unacceptable [17].

It is clear, therefore, that amalgams are leeching toxic mercury into the body. The question remains then, what effects it has on the human body once absorbed. The mercury vapor released from the amalgam is absorbed 100% through nasal and oral mucous membranes and alveolar surfaces (net absorption is 80% due to dead-air space). After absorption into the blood, 50% of the Hg vapor is dissolved in plasma and only 50% remains bound to red blood cells. Together with its highly lipophilic nature, this means that Hg-vapor can be transported relatively quickly by the blood to the organs and even through the blood-brain barrier (BBB) into the brain [5]. The Hg bound to the erythrocytes are only freed at the end of the cells lifespan. The amount of mercury absorbed after exposure has been demonstrated in a number of studies. Human autopsy studies reveal significantly higher mercury concentrations in the brain and kidney of subjects with aged amalgam fillings compared to subjects who had none [15]. In another experiment, amalgam fillings containing a radioactive Hg
The accumulation of Hg into the tissues of organs results in a multitude of adverse physiological effects on the organs involved. The overt clinical effects resulting from toxic exposure to Hg have long been described. Various animal and human experiments over the past several years have addressed the possibility of more subtle pathophysiological effects of amalgam Hg upon the function of several organ systems or cell types, including the immune system, renal system, oral and intestinal bacteria, reproductive system, and central nervous system [2, 5, 11, 15]. A number of murine studies have shown that ionic Hg has been antigenic and capable of inducing autoimmunity in rats. A recent study implanted gelatin-encapsulated dental amalgam pieces intraperitoneally in an inbred strain of mice known to be genetically susceptible to Hg-induced immune pathology. Within 10 weeks to 6 months the animals displayed hyperimmunoglobulinemia, serum auto-antibodies that targeted nucleolar proteins, and systemic immune complex deposits. Similar changes were observed when only dental alloy i.e. not containing Hg was implanted, and these immune aberrations were attributed to the silver component of the alloy. This study concluded that both Hg and silver dissolution from dental amalgam can chronically stimulate the mouse immune system with subsequent induction of systemic autoimmunity [21]. In humans, fecal excretion of silver is also correlated with the number of amalgam filled teeth of their mothers [20]. This latter finding is consistent with previous animal studies that show greater Hg concentration in rat fetal tissues and less placental retention [15].

Numerous animal and human studies have shown increased renal Hg concentrations after exposure to dental amalgam. These studies have indicated that mercury derived from mercury fillings may impair kidney function. Sheep with amalgam tooth filling implants show a reduced filtration rate of inulin, increased urinary excretion of sodium, and a decrease in urinary albumin. As amalgam Hg collects in the proximal tubule of the kidney of the monkey, where the majority of sodium is normally reabsorbed, increased excretion of sodium after placement of amalgam fillings in sheep may reflect a reduced tubular capacity to conserve sodium selectively. Urinary albumin levels increased 1 year after removal of amalgam fillings in humans, whereas urine albumin levels fell in sheep after amalgam placement. It is uncertain whether these differences in albumin excretion patterns may reflect an Hg-induced reduction in renal blood flow due to the presence of amalgam fillings [5, 23].

It is well known that some human intestinal bacteria carry plasmids encoding resistance to both Hg and antibiotics. In a population subgroup of 356 persons who had no recent antibiotic exposure, those individuals with a high prevalence of Hg resistant bacteria in their intestinal flora were significantly more likely to display multiple antibiotic resistance in these same bacteria. A parallel investigation in monkeys demonstrated a marked increase in the proportion of Hg-resistant bacteria in the flora of the intestine and oral cavity soon after installation of dental amalgam tooth fillings, an increase that persisted until the amalgam fillings were removed. The majority of these primate Hg resistant bacteria were also resistant to one or more commonly used antibiotics. Results show that Hg released from dental amalgam can enhance the prevalence of resistance to multiple antibiotics in the bacteria of the primate normal flora [5, 18, 23].

It has long been established that long-term exposure to Hg ion alters reproductive cyclicity in the murine model and this has lead to studies examining the relationship of occupational exposure to Hg vapour and infertility of female dental assistants. Epidemiological screening by questionnaire of 7000 dental assistants showed that within an eligible subgroup of 418 women who were interviewed, fertility was reduced to only 63% that of control women not occupationally exposed to Hg vapour. While open to the criticism of all data that rely upon subject observation and opinion, it was concluded that dental assistants who prepared 30 or more amalgam fillings per week, and who also had poor Hg hygiene habits, were at risk of lowered fecundity [23]. Due to its lipophilicity,
mercury is known to cross the blood brain barrier. It is now common knowledge that uptake and accumulation of amalgam Hg occurs in both monkey and human brain tissues [24, 25]. Studies have demonstrated that Hg is selectively concentrated in human brain regions (medial basal nucleus, amygdala, and hippocampus) involved with memory function, and have suggested that Hg may be implicated in the etiology of Alzheimer’s disease (AD) [26, 27]. Abnormal microtubule formation in AD brains has been associated with a defect in the tubulin polymerization cycle, which may increase the density of neurofibrillary tangles[28]. A similar tubulin defect can be induced in the brain of HgC12 treated rats suggesting a connection between exposure to inorganic Hg and AD [29, 30]. It is a proven fact that Hg interacts with tubulin resulting in disassembly of microtubules. Without microtubules neurite structure cannot be maintained [15]. In a recent investigation, rats were exposed to Hg vapour four hours daily for a period up to 14 consecutive days. Vapor exposure was maintained at 300 µg Hg/ms air, a level which is detectable in the mouths of some human subjects with large numbers of amalgam fillings. Average brain Hg concentrations increased significantly with duration of Hg vapour exposure. Photoaffinity labeling of the β-subunit of the tubulin dimer with GTP in brain homogenates was diminished by 75% after 14 days of Hg vapour exposure. An identical neurochemical lesion of similar magnitude was seen in human AD brain homogenates, but no direct evidence exists to prove that this lesion is the result of human exposure specifically to amalgam Hg. Because the rate of tubulin polymerization is dependent on binding of tubulin dimers to GTP, it was concluded that chronic inhalation of low-level Hg vapour in rats can inhibit the polymerization of tubulin essential for formation of microtubules [15]. Another recent study demonstrates subclinical neuropsychological and motor control effects from an occupational exposure to Hg vapour over a 1 year period in a subpopulation of dentists with high urinary Hg levels [15]. A more extensive report, evaluating dental technicians and dentists who received occupational exposure to Hg vapour compared to non-dental personnel controls, demonstrated that urinary Hg levels were 16-fold higher in technicians and 6-fold higher in dentists compared to control subjects. Baseline urinary porphyrin levels measured before DMPS treatment were associated with urinary Hg levels obtained after the DMPS challenge. Urinary Hg was also adversely associated with several neurobehavioral changes in Hg-exposed subjects including impairment of attention tasks and motor perceptual tasks [15].

The safety of mercury amalgam fillings has not been proven by any clinical trial and should therefore not be considered safe.

References