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Review Article

Dentistry Section

Effect of Electromagnetic Field on Oral Tissues: A Narrative Review

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ABSTRACT

An emerging pattern in clinical practice involves patients presenting with unexplained systemic and neurological symptoms despite normal diagnostic workups, with metallic or dissimilar-metal dental restorations being a recurring feature. The present narrative review explores potential links between Electromagnetic Field (EMF) exposure, dental materials and systemic health effects, with a particular focus on neurological manifestations. Drawing on principles from quantum biology and physics, the review examines unique clinical cases that defy conventional medical explanations yet may be interpreted through interactions between EMFs and metal restorations at the quantum level. These cases suggest that the human body may act as a biological interface where classical and quantum physical phenomena intersect. While the review emphasises evidence-based findings, it also presents quantum-level hypotheses—such as spin dynamics and Radical-Pair Mechanisms (RPM)—for interdisciplinary consideration, underscoring the complexity of EMF-biological interactions and the need for further investigation.

Keywords: Anxiety, Autopsy, Dental amalgam, Hypertension

INTRODUCTION

Dental amalgam is by far the main source of human total mercury body burden. This is supported by autopsy studies, which found 2-12 times more mercury in body tissues of individuals with dental amalgam. Autopsy studies are among the most valuable and important investigations for examining amalgam-related mercury burden [1].

Electromagnetic waves are produced by the motion of electrically charged particles [2]. At lower frequencies, these waves generate alternating EMFs. The electric and magnetic fields are inherently linked and oscillate rapidly; the electric field changes direction as the magnetic field varies in tandem. Such quantum-level interactions underscore the potential for EMF to affect human biology, particularly in individuals with metallic components in the body. Alternating magnetic fields can induce electric currents in conductive materials, including dental metals [3,4]. When electromagnetic radiation interacts with nearby objects, it can alter their behaviour, especially in the case of metals. This includes dental amalgam, metal restorations, implants and prosthetic components [3]. It becomes imperative to examine potential underlying mechanisms that extend beyond conventional diagnostics. The present review investigates the possible influence of environmental EMFs on dental materials—particularly dissimilar-metal restorations—and to explore how these interactions may contribute to physiological disturbances, with a focus on neurological function.

To provide context for the case analyses that follow, the authors first present the fundamental physical principles relevant to this discussion, focusing on electromagnetism and emerging ideas from quantum biology. The present review focuses on EMF-induced alterations in oral tissues, supporting the plausibility of biological sensitivity to such fields. This broader context explores whether classical mechanisms (e.g., galvanism, corrosion) and speculative quantum-biological processes (e.g., radical-pair reactions, spin coherence) might together inform a more comprehensive understanding of patient-reported symptoms. Accordingly, the authors present a dual framework rooted in classical electromagnetism while remaining open to quantum hypotheses, as a basis for interpreting the cases that follow and guiding future interdisciplinary inquiry.

CASE REVIEWS

Case 1

A case reported by Balagopal S et al., (2015) describes a 50-year-old male, weighing 110 kg, who was physically active and had no significant medical co-morbidities such as diabetes or hypertension [4]. He had undergone surgical treatment after sustaining a road traffic accident more than 25 years earlier. He worked as a merchant navy engineer for two decades before transitioning to an Information Technology (IT)-based desk job in the shipping industry. Three months after relocating to a new workstation adjacent to a server room and an inverter room, the patient began experiencing symptoms, including feverish sensations, bodyaches and fatigue by the end of the day, intermittent tingling of the fillings in his tooth cavities, tension and anxiety and disturbed sleep. Initially these were attributed to stress until he experienced a brief spell of disorientation. The patient's blood pressure was checked and he underwent a number of investigations including blood tests (complete blood count, chemistry and enzymes), imaging and scans, all of which showed no significant deviations from normal reference ranges. He also visited a dentist for an opinion and was cleared of other medical and psychological issues. The patient then reported that, upon self-assessing changes in life and difficulty at the workstation, everything had changed. He searched the literature and visited the following pages: (1) Google Scholar search for "EMF radiation studies," (2) a forum thread on working server rooms and (3) a Google Scholar search for "effect of EMF on teeth fillings." The patient could relate to many of the symptoms described on these pages, such as electrohypersensitivity or radio-wave sickness. He informed the office of his symptoms and after moving away from the inverter and server room he was totally relieved of all symptoms. The present case highlights a potential link between EMF exposure and systemic symptoms in individuals with dental amalgam fillings, drawing attention to the possible role of quantum-level interactions. Dental amalgam, a commonly used material for fillings, contains metals such as mercury, silver, tin and copper—elements that can conduct electricity and interact with external EMFs. When an individual is exposed to strong or persistent EMFs, such as those emitted by servers, inverters, or other electronic equipment, these metallic fillings may act as miniature antennas, potentially absorbing

and re-emitting electromagnetic energy [5,6]. From a quantum-mechanical standpoint, dental materials—particularly metal alloys used in fillings and implants—can exhibit sensitivity to external EMFs due to the quantum behaviour of their conduction electrons. Electrons in these materials occupy discrete energy states and exposure to Radiofrequency (RF) or low-frequency Electromagnetic Radiation (EMR) can induce transitions between these states, altering local charge distributions and generating weak electric currents. Such effects may influence adjacent biological tissues, especially neural structures in the oral cavity, potentially leading to sensory disturbances in electrosensitive individuals. This phenomenon parallels mechanisms observed in radical-pair systems, such as the photoinduced electron-transfer reaction between chrysene and dicyanobenzene isomers, in which recombination yields are modulated by weak magnetic fields through spin-selective processes. These findings support the broader applicability of Quantum Electrodynamical (QED) principles in understanding how weak EMFs may interact with metal-containing dental materials, offering a framework for exploring potential biological responses at the subatomic level [7]. While such effects remain controversial and not fully understood in clinical medicine, the present case underscores the importance of interdisciplinary research—bridging dentistry, biophysics and quantum mechanics—to explore how EMFs may interact with restorative materials in the body. Understanding these mechanisms could lead to safer material choices and improved workplace guidelines for individuals exposed to high levels of EMFs.

Case 2

In a case-control study by Daroit NB et al., the effects of cell phone EMR exposure on the frequency of micronuclei, binucleated cells and karyorrhexis in epithelial cells of the oral mucosa were evaluated [8]. The study was conducted at the School of Dentistry, Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre, Brazil.

The sample comprised 60 cell phone users who were non-smokers, had no clinically visible oral lesions and were generally healthy. Cells were collected from anatomical sites with the highest incidence of oral cancer: the lower lip, the border of the tongue and the floor of the mouth. The inclusion criteria required owning a cell phone with a Specific Absorption Rate (SAR) of two watts per kilogram of body weight, which is the Brazilian limit adopted according to the International Commission on Non Ionising Radiation Protection (ICNIRP) guidelines. In addition, alcohol intake was limited to no more than two weekly doses (340 mL of beer, 113 mL of wine, or 28 mL of distilled spirits). Sample size calculations were performed according to Yadav and Sharma [9], using the mean (10.72) and standard deviation (8.194) reported by the authors for the "Total micronucleus" variable.

Participants were divided into two groups: those with 60 minutes or less of cell phone use per week and those with 60 minutes or more. The mean ages were 23.28 years in the first group and 23.35 years in the second group. The results showed a statistically significant increase in the number of micronuclei observed in the lower lip in the group that spoke for more than 60 minutes per week compared to those who spoke for less than 60 minutes per week. An increased number of binucleated cells was also observed on the floor of the mouth in these individuals.

The present report draws attention to the possibility that individuals using a cell phone for more than 60 minutes per week over eight years may have increased nuclear abnormalities with a possible rise in cancer risk. Micronuclei play a role in tumorigenesis, with micronuclei Deoxyribonucleic Acid (DNA) being a source of complex genome rearrangements (including chromothripsis) and promoting a cyclic Guanosine Monophosphate (GMP)-(GMP)-Adenosine Monophosphate (AMP) synthase {cyclic GMP-AMP (c-GAS)}-mediated cellular response that may contribute to cancer metastasis [10].

Emerging evidence suggests that quantum processes—particularly the RPM—play a pivotal role in mediating biological responses to weak EMFs. The RPM involves spin-dependent reactions of transient radical pairs, whose outcomes can be modulated by external magnetic fields, influencing key cellular pathways such as oxidative stress regulation, DNA repair and circadian signalling. These quantum-level interactions may underlie observed EMF-induced phenomena, including increased DNA fragmentation, micronuclei formation and altered cell signalling, with potential relevance to oral tissues frequently exposed to diagnostic EMFs. Additionally, processes such as quantum tunneling during base-pair proton transfer may contribute to spontaneous mutations or epigenetic instability in rapidly renewing oral epithelium. Together, these findings support the view that quantum biology offers a compelling framework to understand subtle, non thermal EMF effects on dental tissues and genomic integrity [11].

In summary, the present study highlights epidemiological evidence linking cell phone use with nuclear abnormalities and invites exploration into how quantum-level interactions influenced by EMFs may underlie genotoxic effects, thereby contributing to cancer risk with long-term exposure.

Case 3

An observational cross-sectional study by Singh K et al., aimed to determine the effect of EMRs on unstimulated and stimulated salivary flow rate and other health-related problems among the general population residing near to and far from mobile phone base stations [12].

A total of four mobile base stations were randomly selected from four zones of Jaipur, Rajasthan, India. A total of 20 individuals living within 1 km of the selected mobile phone towers were enrolled as the case group and a control group of 20 individuals living approximately 1 km away in the peripheral area was selected for salivary analysis.

Sleep disturbances were assessed using the Pittsburgh Sleep Quality Index (PSQI) and other health problems were included in the questionnaire. The Chi-square test was used for statistical analysis.

It was noted that a majority of the subjects residing near the mobile base stations complained of sleep disturbances, headache, dizziness, irritability, concentration difficulties and hypertension. A majority of the study subjects also had significantly reduced stimulated salivary secretion ($p<0.01$) compared to the control subjects.

The report concluded that the effects of prolonged exposure to EMRs from mobile phone base stations on the health of the general population cannot be ruled out. It also suggested that further studies are needed to evaluate the effects of EMFs on general health, with particular emphasis on oral health.

Emerging research suggests that the biological effects of EMF exposure—common in clinical dental settings—may be mediated through quantum processes, particularly the RPM. This quantum phenomenon, sensitive to weak EMFs, affects spin-dependent biochemical reactions involved in oxidative stress, melatonin synthesis and neuronal signalling. Jammoul M and Lawand N highlight melatonin's protective role as a potent antioxidant and free-radical scavenger, capable of modulating spin states and stabilising radical pairs, thereby reducing oxidative damage induced by EMFs. In the context of oral health, these findings have significant implications: oxidative stress and autonomic dysregulation are key contributors to periodontal inflammation, wound healing and neurogenic orofacial pain. Furthermore, quantum-level disruptions—such as altered ion channel function or redox imbalances—may influence pulp vitality, salivary gland function and circadian-related

oral tissue homeostasis. Thus, integrating quantum biology into dental research may offer novel insights into the prevention of EMF-related cellular damage, with melatonin emerging as a potential adjunctive therapeutic agent [13].

Case 4

A case report by Hyams BL and Ballon HC discussed two cases. The first case involved a 51-year-old female patient who was a known case of chronic arthritis and had a dental bridge inserted to replace her mandibular incisors [14]. Shortly after placement of the bridge, she complained of a metallic taste in her mouth, which was aggravated by coffee. She also had a full upper denture made of vulcanite (tellurium- and copper-based) and, on the mandibular left side, a fixed bridge from the first premolar to the second molar (copper with gold and zinc alloy). She was tested with a microammeter by the author, who disclosed that a constant current of 15 microamperes was present when there was contact between the two bridges.She was tested with a microammeter by the author who disclosed that a constant current of 15 microampere was present when there was contact between the two bridges.

It was then discovered that the posterior bridge was made of copper and zinc in a gold alloy, whereas the anterior bridge contained large quantities of nickel, silver, zinc and a small gold content. This shows the presence of electrogalvanic current flowing in the oral cavity due to contact between dissimilar metals. To break the contact between the two bridges, a space was ground (with drill) between the crown of the premolar and the inlay of the canine. The patient then reported the disappearance of the metallic taste the following day and there was no reported recurrence of symptoms. A test in an experimental cell, using coffee as an electrolyte and aluminium as the positive metal, gave a constant reading of 120 microamperes, further proving the presence of electrogalvanic current. When saliva was added, the reading rose to 300 microamperes, showing that dissolved salts in saliva act as an electrolytic solution in the oral cavity.

The second case was a 36-year-old male patient who was a waiter by profession. He presented with complaints of pain in the left groin, weight loss, diarrhoea, dyspnoea, borborygmi and a metallic taste in the mouth. He gave a history of urethritis, a bilateral herniotomy and an appendectomy. He also reported tobacco and alcohol consumption in moderation. The general physical examination, including fluoroscopic examination of the chest and a roentgen-ray examination of the gastrointestinal tract after administration of barium, was negative. The Wassermann test was negative and his blood work showed signs of moderate secondary anemia. On examination of the oral cavity, it was revealed that he had a large amalgam filling on the distal surface of the maxillary left third molar, a gold crown on the maxillary right premolar along with a replacement for the second premolar. On the left, there was a gold crown for the first molar along with a similar replacement for the second premolar. In the mandibular arch, he had a gold bridge from the second premolar to the second molar on each side and a gold crown on the right third molar. This crown made contact with the amalgam filling of the maxillary right third molar in occlusion. Dental radiographic examination showed all the teeth to be vital and free from disease. Microammeter readings of all possible contacts showed a constant current of 15 microamperes between the crown and the amalgam filling and a current of 1-2 microamperes between points of the gold bridges when the silver alloy amalgam filling was excluded. The silver filling was then ground out of contact. This resulted in the disappearance of all symptoms and the patient remained symptom-free for four months.

Two possible phenomena explaining these two cases are: One, the labelled-line principle, which states that when a nerve fibre is stimulated at any point on its path to the sensory cortex, the stimulus evokes symptoms exactly as if they were coming from the territory nourished by the nerve [15].

Two, subliminal fringe; subliminal fringe refers to the phenomenon when weak synaptic inputs that are individually insufficient to produce long-term potentiation in synaptic transmission can induce potentiation when they occur simultaneously [16].

In the present case, the electrical current induced by the two dissimilar alloys may have altered the membrane potentials of the pain- and taste-related neural fibres in the oral cavity, causing the neurons to be more excitable than normal. As the membrane potential was brought very close to the threshold potential, the addition of hot coffee was enough to push the potential over the threshold in these hyperexcitable neurons and induce the feeling of pain and the increased perception of bitterness of caffeine in their beverages. As the pain fibres and taste pathway neurons project to their sensory cortices, the same sensory modality would have been perceived by the cortex according to the labelled-line principle.

In the presence of modern EMF sources {(phones, Magnetic Resonance Imaging (MRI)}, dissimilar metals may not only cause galvanic currents but also absorb and emit electromagnetic energy at frequencies that can perturb quantum states of surrounding atoms or tissues [11].

DISCUSSION

Electromagnetic waves, generated by the movement of electrically charged particles, are increasingly present in our modern environment through the widespread use of electronic and wireless devices [2]. While advancements in communication technologies have undeniably improved convenience and connectivity, growing evidence suggests that EMR—particularly within the RF range—may also pose under-recognised health risks [2]. The biological effects of such exposure are especially relevant in dentistry, where the presence of metallic restorations introduces a potential site for EMF interaction.

Clinical reports add further weight to this concern. Balagopal S et al., described a patient with unexplained systemic symptoms—including nightly adrenaline surges and palpitations—resistant to conventional diagnosis [4]. Only after the removal of multiple metal-based dental restorations did the patient report a reduction in symptoms, suggesting a possible link between metallic dental work, EMF exposure and systemic dysregulation. While anecdotal, such cases illustrate the diagnostic challenge posed by EMF-related sensitivities and highlight the importance of interdisciplinary investigation.

Mortazavi G et al., observed significant mercury release from dental amalgam following exposure to EMFs emitted by mobile phones and MRI machines [6]. They highlighted that in susceptible populations such as children, individuals with EMF hypersensitivity, or those with chronic EMF exposure—these levels may reach toxic thresholds. Such findings underscore the need to revisit assumptions about the inertness of dental amalgams in electromagnetic environments [5,6]. Singh K et al., emphasised that potential health effects are not restricted to mobile phone base stations but may also result from everyday exposure to Wi-Fi networks and personal devices [12].

It is also important to consider the role of electrogalvanism—the generation of electrical currents between dissimilar metals in the oral cavity—which has been implicated in both local mucosal lesions and systemic symptoms [13]. The presence of multiple metal types in prosthetics, crowns and fillings may create microcurrents or amplify EMF interactions, particularly in high-field environments. One study demonstrated that EMFs can induce measurable changes in dental materials and surrounding tissues [17]. Another study associated mobile phone use with altered oral physiology: Mishra SK and Chowdhary R identified adverse effects on salivary

glands, oral mucosa and facial nerves following prolonged mobile phone exposure [18]. Daroit NB et al., noted increased micronuclear alterations in buccal cells among long-term mobile phone users, a change often linked to genotoxic stress [8].

From a mechanistic perspective, quantum biology offers a potential explanatory framework for some of these interactions. Theories involving spin dynamics, RPMs and electromagnetic sensitivity in biologically embedded metals remain speculative but are increasingly considered in fields such as magnetoreception and photobiology [19]. Although these ideas have not been definitively proven in human dental tissues, they offer a compelling direction for further inquiry into how low-level EMFs might influence biological function at the molecular level.

Despite these suggestive findings, this field faces several limitations. Many of the cited studies are observational or anecdotal and robust clinical trials are lacking. Confounding variables such as stress, environmental exposures and individual sensitivity are difficult to control. Moreover, the application of quantum mechanical theory to biological systems, while conceptually stimulating, remains largely theoretical at this stage.

In summary, emerging data and clinical observations suggest that EMF exposure may adversely affect patients with metallic dental restorations, potentially contributing to unexplained systemic symptoms. Although current evidence is preliminary, interdisciplinary exploration—bridging dentistry, physics and neurology—is essential. Further empirical research is necessary to clarify these mechanisms, quantify risks and develop guidelines for safer dental practice in increasingly EMF-saturated environments.

CONCLUSION(S)

In conclusion, the present review highlights the potential intersection between quantum mechanics, EMFs and dentistry, particularly focusing on their impact on systemic health. The cases presented, although unexplainable by conventional medical frameworks, reveal intriguing correlations that suggest a broader, more complex interaction between dental materials, their electromagnetic properties and the human body. These findings prompt a re-examination of how dissimilar metal restorations and their quantum-level behaviours may influence biological systems, possibly contributing to otherwise inexplicable systemic conditions. This exploration opens the door for future interdisciplinary research, bridging dentistry, physics and medicine to better understand these phenomena and improve diagnostic and treatment approaches for affected patients.

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