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FACULTY OF ELECTRICAL ENGINEERING

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FACULTY OF ELECTRICAL ENGINEERING

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PREFACE

The Third International Conference “Electrical Engineering, Technology, Informatics, Mechanical Engineering and Automation – Technical Sciences in the Service of the Economy, Education and Industry” (ETIMA’25), organized by the Faculty of Electrical Engineering at the “Goce Delchev” University – Shtip, represents a significant scientific event that enables interdisciplinary exchange of knowledge and experience among researchers, professors, and experts in the field of technical sciences. The conference was held in an online format and brought together 78 authors from five different countries.

The ETIMA conference aims to establish a forum for scientific communication, encouraging multidisciplinary collaboration and promoting technological innovations with direct impact on modern life. Through the presentation of scientific papers, participants shared the results of their research and development activities, contributing to the advancement of knowledge and practice in relevant fields.
The first ETIMA conference was organized four years ago, featuring 40 scientific papers. The second conference took place in 2023 and included over 30 papers. ETIMA’25 continued this scientific tradition, presenting more than 40 papers that reflect the latest achievements in electrical engineering, technology, informatics, mechanical engineering, and automation.

At ETIMA’25, papers were presented that addressed current topics in technical sciences, with particular emphasis on their application in industry, education, and the economy. The conference facilitated fruitful discussions among participants, encouraging new ideas and initiatives for future research and projects.

ETIMA’25 reaffirmed its role as an important platform for scientific exchange and international cooperation. The organizing committee extends sincere gratitude to all participants for their contribution to the successful realization of the conference and its scientific value.

We extend our sincerest gratitude to all colleagues who, through the presentation of their papers, ideas, and active engagement in discussions, contributed to the success and scientific significance of ETIMA’25.

The Organizing Committee of the Conference

ПРЕДГОВОР

Третата меѓународна конференција „Електротехника, Технологија, Информатика, Машинство и Автоматика – технички науки во служба на економијата, образованието и индустријата“ (ЕТИМА’25), организирана од Електротехничкиот факултет при Универзитетот „Гоце Делчев“ – Штип, претставува значаен научен настан кој овозможува интердисциплинарна размена на знаења и искуства меѓу истражувачи, професори и експерти од техничките науки. Конференцијата се одржа во онлајн формат и обедини 78 автори од пет различни земји.

Конференцијата ЕТИМА има за цел да создаде форум за научна комуникација, поттикнувајќи мултидисциплинарна соработка и промовирајќи технолошки иновации со директно влијание врз современото живеење. Преку презентација на научни трудови, учесниците ги споделуваат резултатите од своите истражувања и развојни активности, придонесувајќи кон унапредување на знаењето и практиката во релевантните области.

Првата конференција ЕТИМА беше организирана пред четири години, при што беа презентирани 40 научни трудови. Втората конференција се одржа во 2023 година и вклучи над 30 трудови. ЕТИМА’25 продолжи со истата научна традиција, презентирајќи повеќе од 40 трудови кои ги отсликуваат најновите достигнувања во областа на електротехниката, технологијата, информатиката, машинството и автоматиката.

На ЕТИМА’25 беа презентирани трудови кои обработуваат актуелни теми од техничките науки, со посебен акцент на нивната примена во индустријата, образованието и економијата. Конференцијата овозможи плодна дискусија меѓу учесниците, поттикнувајќи нови идеи и иницијативи за идни истражувања и проекти.

ЕТИМА’25 ја потврди својата улога како значајна платформа за научна размена и интернационална соработка. Организациониот одбор упатува искрена благодарност до сите учесници за нивниот придонес кон успешната реализација на конференцијата и нејзината научна вредност. Конференцијата се одржа онлајн и обедини седумдесет и осум автори од пет различни земји.

Изразуваме голема благодарност до сите колеги кои со презентирање на своите трудови, идеи и активна вклученост во дискусиите придонесоа за успехот на ЕТИМА’25 и нејзината научна вредност.

Организационен одбор на конференцијата

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ELECTROMAGNETIC INTERFERENCE OF ENDODONTIC EQUIPMENT WITH GASTRIC PACEMAKER

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Abstract

Electromagnetic interference (EMI) from endodontic equipment could potentially affect a gastric pacemaker. This article provides an overview of interaction risks, potential consequences, and precautions related to such interference. Certain electronic dental devices may interfere with the pacemaker's function, but the level of risk depends on the type of equipment and its proximity to the implanted device. A gastric pacemaker operates using small electrical impulses to stimulate stomach muscles. If an endodontic device induces unintended electrical currents in the body, these could be picked up by the pacemaker's leads, potentially disrupting its normal function. Electromagnetic interference between a gastric pacemaker (also called a gastric electrical stimulator, GES) and endodontic equipment is therefore a potential concern, especially in dental procedures involving electronic devices.

Endodontic devices commonly used in root canal therapy include apex locators, electric motors for rotary files, electrosurgery units, and ultrasonic devices—all of which generate electrical or electromagnetic fields. In summary, patients with a gastric pacemaker can generally be treated safely in the dental setting, provided that management involves collaboration with both the gastroenterology team and the device manufacturer. The processes of deactivation and reactivation (switching the pacemaker off before, and back on after, the procedure) are straightforward and help minimize risks to both patient and device. Furthermore, it is important to maintain a distance of at least 15–30 cm (6–12 inches) between the implanted pacemaker and electrical equipment—particularly ultrasonic and electrosurgical instruments—and to use modern apex locators and rotary motors designed with low electromagnetic emissions, in order to reduce the likelihood of interference.

Key words

Endodontic equipment, gastric pacemaker, electromagnetic interference

Introduction

A gastric pacemaker (GES) is used to manage gastroparesis and other motility disorders by delivering electrical impulses to the stomach to regulate digestion [1]. Endodontic equipment commonly used in root canal therapy includes apex locators, electric motors for rotary files, electrosurgery units, and ultrasonic devices—all of which generate electrical or electromagnetic fields [2].

Electromagnetic interference (EMI) from endodontic equipment can potentially affect a gastric pacemaker through several mechanisms. Many endodontic devices (e.g., electronic apex locators, ultrasonic scalers, electrocautery devices) generate electromagnetic fields that may interfere with implanted medical devices such as gastric pacemakers. The gastric pacemaker

operates using small electrical impulses to stimulate stomach muscles. If an endodontic device induces unintended electrical currents in the body, these could be detected by the pacemaker's leads, potentially disrupting its normal function [3].

Some dental devices, especially ultrasonic instruments and electrosurgery units, operate at radio frequencies (RF) [4]. If the pacemaker's sensing circuits misinterpret these signals as biological activity, it may inhibit or misfire impulses, leading to improper gastric stimulation. The closer the endodontic device is to the gastric pacemaker, the higher the risk of interference. For example, if an ultrasonic scaler or electronic apex locator is used near the chest or abdomen, where the pacemaker is implanted, the risk is greater than when working on lower teeth [5].

Potential signs of interference include nausea, stomach bloating, or irregular gastric movements if the pacemaker malfunctions. In rare cases, dizziness or unusual heart rhythms may occur, especially if the gastric pacemaker overlaps in function with a cardiac pacemaker [6].

Endodontic equipment poses varying levels of interference risk to gastric pacemakers. Electronic apex locators present a low to moderate risk, particularly if used near the stomach region [7]. Ultrasonic scalers carry a moderate risk, as their radio-frequency emissions may interfere with pacemaker sensing [8]. Electrocautery devices pose a high risk due to strong EMI that can disrupt pacemaker function. Cordless endodontic handpieces present a low to moderate risk, depending on their operating frequency [9].

Materials and methods

Study design

For this review article on the electromagnetic interference from endodontic equipment and gastric pacemaker, a thorough search of relevant literature was performed using electronic databases such as PubMed, PMC, Medline, Science Direct and Google Scholar. Keywords including endodontic equipment or gastric pacemaker or electromagnetic interference were used to locate pertinent articles published in peer-reviewed journals. The selection criteria focused on studies, clinical trials, and reviews published in English within the last ten years. Priority was given to articles that addressed the materials, methods, techniques, and recent advancements within the field of endodontics.

Inclusion Criteria

This review considered studies that met the following criteria: they were published within the past ten years, involved human participants, were written in English, and included data on adult patients with medically refractory gastroparesis who underwent gastric electrical stimulation therapy. Eligible publications included peer-reviewed articles, review papers, observational studies, and clinical trials.

Exclusion Criteria

Studies were excluded if they focused on pediatric populations, involved animal research, or were categorized as books or grey literature. The selected articles were carefully reviewed, and essential information was gathered and synthesized to create a comprehensive summary of the topic. Furthermore, textbooks and manufacturers' literature were reviewed to complement the

findings from the literature search. The goal of this review is to provide a well-rounded and informative discussion on electromagnetic interference and its prevention in clinical practice.

Assessment and outcomes

The articles reviewed consistently emphasized the common use of endodontics in a variety of electromagnetic interference, including soft endodontic equipment and gastric pacemaker. An apex locator works by measuring the electrical resistance or impedance between the tip of the endodontic file inside the canal and the surrounding tissues. As the file approaches the root tip (apex), the device detects changes in electrical conductivity, allowing the dentist to identify the precise endpoint of the canal. This helps ensure the canal is cleaned and filled properly, avoiding damage to surrounding tissues and improving the success of the treatment. (Fig. 1).

Fig. 1 Electronic apex locator
Source: www.endodonticsoralimplantology.blogspot.com

A gastric pacemaker, also known as a gastric electrical stimulator, is an implantable device designed to regulate stomach motility. It works by sending electrical pulses to the stomach muscles through electrode leads positioned in the abdominal region. The system includes a pulse generator implanted in the abdominal wall, leads that are attached to the stomach lining, and a battery-powered circuit board that controls the delivery of impulses. The device continuously monitors signals from the stomach and adjusts the stimulation patterns as needed to support proper digestive function.

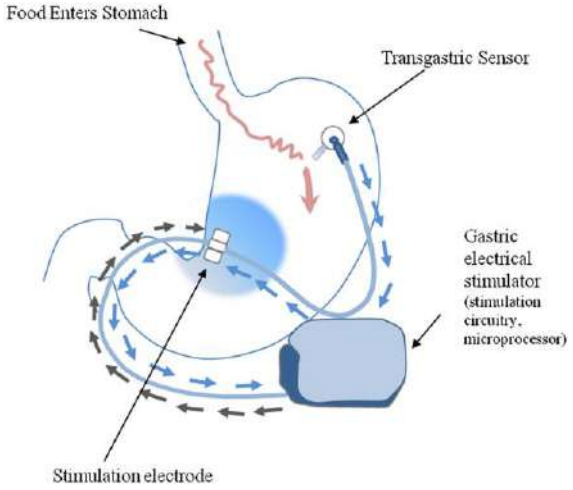

Fig. 2 View of gastric pacemaker and how it works
Source: www.mriquestions.com

Discussion

To minimize the risks associated with using dental equipment in patients with a gastric pacemaker, several precautions should be taken. First and foremost, it's essential to inform the dentist or endodontist about the presence of the gastric pacemaker prior to any procedure. Dental professionals should use shielded equipment that meets medical electromagnetic interference (EMI) safety standards. Whenever possible, endodontic tools should be kept at a safe distance from the area where the pacemaker is implanted. Special care should be taken to avoid the prolonged use of electrosurgical or ultrasonic devices near the stomach. If any unusual symptoms occur during treatment, the procedure should be halted immediately and the pacemaker function should be evaluated [10].

Also, to minimize the risk of electromagnetic interference (EMI) during dental procedures for patients with a gastric pacemaker, certain precautions should be followed before, during, and after treatment. Before starting any dental work, it is important to review the patient's medical history and inform the dentist about the presence of the gastric pacemaker. Consulting with the patient's physician or gastroenterologist can also provide valuable information regarding the specific device and any recommended precautions. Additionally, checking the guidelines provided by the manufacturers of both the pacemaker and the dental equipment can help identify potential risks related to EMI [11].

During the procedure, maintaining a safe distance between electrical dental devices—especially ultrasonic and electrosurgical tools—and the implanted pacemaker is crucial. Ideally, these devices should be kept at least 15 to 30 centimeters (6 to 12 inches) away from the pacemaker site. Using shielded or low-EMI equipment, such as modern apex locators and rotary motors designed to emit minimal electromagnetic signals, is recommended to reduce interference [12]. When electrosurgical devices are necessary, it is important to use the lowest effective power settings and ensure grounding pads are properly applied to minimize risks. Throughout the treatment, the patient should be closely monitored for any symptoms such as dizziness, palpitations, or discomfort, and the procedure should be stopped immediately if any of these occur [13], [14], [15].

After completing the dental procedure, it may be necessary to verify the proper functioning of the pacemaker, especially if any concerns arise during treatment. Patients should also be educated on the importance of reporting any unusual symptoms or changes they experience following the procedure to ensure prompt medical evaluation if needed [16].

Conclusion

Although the likelihood of electromagnetic interference (EMI) occurring between a gastric pacemaker and endodontic dental equipment is generally considered to be low, it is still important to take appropriate safety measures. This is particularly true when using high-frequency dental devices, which have a greater potential to interfere with the pacemaker's function. To ensure the patient's safety throughout the procedure, clear and thorough communication between the patient, the dentist or endodontist, and the broader medical team is essential. By working together and sharing relevant medical information in advance, the healthcare providers can make informed decisions, minimize any possible risks, and proceed with greater confidence that the pacemaker's performance will not be compromised during dental treatment. Patients with a gastric pacemaker can be safely treated in a dental setting,

provided there is collaboration with the gastroenterology team and the device manufacturer. A thorough risk assessment should take into account both the management of the pacemaker and any medical conditions related to gastroparesis. Temporarily turning the device off and then reactivating it is a straightforward process that helps minimize potential risks to both the device and the patient as much as reasonably possible.

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