

PD240CH

Hand-Held Metal Detector

Localization in the human body of ferromagnetic materials and prostheses which are dangerous in MRI scans: use of the CEIA PD240CH hand-held metal detector



Introduction

Magnetic Resonance Imaging (MRI) generates a strong magnetic field, at present in the order of 3-4 T (Tesla), far in excess of the earth's magnetic field, which reaches a maximum of about 70 μ T at the poles. This strong field can cause serious damage to patients that have ferromagnetic metal devices or implants. The damage is proportional to the field generated, the mass of the object and its degree of magnetic susceptibility. ▶



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The potential problems that can arise are dislocation or torsion, overheating or induction of electrical current. It has been demonstrated that the latter two effects, due to the high-frequency component of the electromagnetic field, are negligible [1, 2, 3, 4]. On the other hand, the static magnetic field generates a force on ferromagnetic materials: if these objects are present inside the human body they can damage the surrounding tissue, while in the case of objects inadvertently carried in the within the area subjected to the magnetic field, they can be violently attracted towards the magnet with a "bullet" type effect.

Many studies have been carried out to establish whether certain devices, prostheses or implants commonly used in medicine are dangerous during MRI scans. The results show that the majority of the devices or metal parts inside the human body are not dangerous during this type of analysis, but that a small percentage of them are.

Most of the devices or implants are made of non-ferromagnetic materials [e.g. titanium, titanium alloys, stainless steel, tantalum or ceramics], and so are not influenced by the static field. Examples of such devices are some haemostatic clips, dental implants [except the wires of the braces] and orthopaedic implants.

Some devices are made of materials which are slightly ferromagnetic [e.g. stainless steel¹, chromium alloys], which are attracted by the magnetostatic field in proportion to its intensity. Examples of these devices are cardiac valves and the wiring of dental braces. In both cases the force of attraction is less than that exerted by the binding of the device to the human body, and so the risk of damage is low.

1: Depending on the type of alloy and processing this may or may not have weak ferromagnetic properties.

Other devices, such as some haemostatic clips or contraceptive diaphragms, are ferromagnetic, and so their use during MRI scans is advised against.

Despite the existence of problems linked to the use of MRI, adequate pre-MRI scanning procedures are not that widespread [5]. Generally the patient is presented with a questionnaire regarding any surgical operations or accidents at work that might then indicate the presence of metal objects inside the body. Very often, however, patients might not be aware of the type of metal inside their bodies, or might not interpret the questions correctly. Direct analysis procedures such as radiography is invasive and costly.

The use of magnetometers and metal detectors is often overlooked or omitted. A pre-MRI inspection could help the doctor in assessing the risks and preventing accidents. Detractors of the use of magnetometers and metal detectors complain about the low sensitivity of the former and the ineffectiveness of the latter due to the lack of discrimination between ferromagnetic and non-ferromagnetic metals [5].



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To resolve these problems CEIA has designed the PD240CH portable metal detector which combines high sensitivity to ferromagnetic metals with immunity to non-ferromagnetic metals. Additionally, by quickly changing the operational mode it can become a complete metal detector capable of detecting any type of metal material.

The PD240CH has **3 analysis modes** selectable via a keypad interface:

- **HEAD:** high sensitivity to very small ferromagnetic objects. Total immunity to non-ferromagnetic objects of average dimensions. Designed to analyse the head, this setting allows discrimination of, for example, non-ferromagnetic dental implants. At the same time, it can detect, at a distance of some cm, ferromagnetic spheres with a diameter of a few mm.
- **BODY:** high sensitivity to small ferromagnetic objects. Total immunity to non-ferromagnetic objects of large dimensions. Designed to analyse the whole body, this setting allows discrimination of, for example, non-ferromagnetic metal prostheses. At the same time, it can detect, at a distance of some cm, ferromagnetic spheres with a diameter of a few mm.
- **ALL-METALS:** high sensitivity to all types of materials. This setting allows detection of any ferromagnetic or non-ferromagnetic metal object, for example pacemakers, prostheses and vital support devices, and also any other object carried by the patient which should not be taken into the strong magnetic field area. This mode can also be used in the A&E environment, where there is a need to identify, for example, the presence of metal slivers in a patient following an accident or swallowing metal objects.

To ensure optimum operating conditions for the PD240CH metal detector, the patient should be lying on a metal-free bed. This, especially in the “All-metals” mode, will ensure maximum effectiveness and reliability, avoiding the influence of metal reinforcement in the floors.



The speed of operational mode changes in the PD240CH allows doctors to carry out a complete examination of the patient. By using all three modes, they can obtain an indication of any metals inside the patient and of their magnetic susceptibility. Together with written and verbal questionnaires, the doctor can thus get a clear picture of the risk situation and make the most appropriate decision.

The control interface allows selection of the type of alarm wanted, acoustic and/or vibration. The visual signalling, together with the audio, provide feedback on the extent of the alarm by giving an indication, depending on the operational mode, of the size of the object in combination with its ferromagnetic characteristics. Alarm analysis is of the static type, and does not require movement of the detector relative to the object. It thus allows pinpointing of the object by searching for the point of maximum alarm signal.

The PD240CH can also be configured using the “HHMD Setup” graphic interface, which allows personalization of the interface, of the energy-saving mode and of the sensitivity of the three operational modes. In this way it is possible to refine the analysis capabilities based on the specific needs encountered during use, increasing or reducing sensitivity to prioritize sensitivity to or discrimination of the devices and prostheses that may be in the patients.

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Summary

The growing awareness of the dangers in MRI scans requires an increase in preventive inspections so as to ensure the safety of patients and the operators around them. A written questionnaire filled in by the patient can be prone to errors due to misinterpretation or ignorance of the typology of any implants or prostheses inside the body. A preventive inspection by metal detector would eliminate banal mistakes and allow the doctor to better assess the situation.

The PD240CH hand-held metal detector incorporates the benefits of magnetometers and metal detectors, allowing a rapid analysis of the patient in the search for any ferromagnetic metal objects while discriminating all the objects, prostheses and implants that are not dangerous in MRI. In addition, the PD240CH can be used in environments where the use of a complete metal detector is required to search for any type of metal.

References

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