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REVIEW ARTICLE

Is magnetic resonance imaging teratogenic during pregnancy? Literature review

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KEYWORDS
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Abstract Magnetic resonance imaging is a diagnostic tool used for obtaining an image through the combination of electromagnetic fields and radiofrequency. Given its properties and safety, it is the imaging modality of choice in pregnant women. However, little is known about the effects of MRI on the developing foetus.
Objectives: To identify the effects of the use of magnetic resonance imaging on the foetus when used as a diagnostic tool during pregnancy.
Materials and methods: A literature search was performed in PubMed, Embase, and LILACS. Clinical guidelines and the grey literature were also reviewed. An analysis was made based on the findings.
Results: Four potentially adverse effects where found: (1) The impact on the auditory development due to the acoustic sound made by the resonator. (2) Teratogenic effects on DNA. (3) Physical deformities secondary to temperature increase. (4) Teratogenic effects due to the use of gadolinium as a contrast agent.
Conclusion: The risk assessment on the use of magnetic resonance imaging on the foetus is complex, owing to the multiple differences in field strength, force gradients, and radiofrequency pulses used. Although the adverse effects of using this method are not very clear, there are studies that describe the possible outcomes that can result from the use of this imaging modality. It is recommended to use MRI with caution, as long as the benefits outweigh the risk in pregnant patients.

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PALABRAS CLAVE
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Embarazo;
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Daño de ADN;
Anomalías congénitas

¿Es teratogénica la resonancia magnética durante el embarazo? Revisión de la literatura

Resumen La resonancia magnética nuclear es una herramienta diagnóstica que actúa mediante la obtención de imágenes por campos electromagnéticos en combinación con radiofrecuencia. Dadas sus propiedades y seguridad es el estudio de elección en mujeres en estado de embarazo. Sin embargo, poco se sabe acerca de las consecuencias que la exposición a la resonancia magnética nuclear tiene sobre los fetos en gestación.
Objetivos: Identificar los efectos que tiene la resonancia magnética sobre el feto cuando se utiliza como método diagnóstico durante el embarazo.
Materiales y métodos: Se realizó una búsqueda de la literatura en PubMed, Embase y LILACS. Se revisaron además guías de práctica clínica, literatura gris y se hizo un análisis en función de los hallazgos.
Resultados: Se encontraron 4 efectos potencialmente adversos: 1) El impacto en el desarrollo auditivo por el sonido acústico que genera el resonador, 2) Efectos teratogénicos sobre el ADN, 3) Deformaciones físicas por aumento de temperatura, y 4) Efectos teratogénicos por el uso de gadolinio como medio de contraste.
Conclusión: La evaluación del riesgo que genera el uso de resonancia magnética nuclear sobre el feto es compleja debido a las múltiples diferencias entre las fuerzas de los campos, gradientes de fuerza y pulsos de radiofrecuencia utilizados. Consecuentemente los efectos adversos del uso de este método no son muy claros, sin embargo sí hay estudios que describen los posibles desenlaces que puede tener su utilización por lo que se sugiere usar este método con cautela, siempre y cuando los beneficios sobrepasen los riesgos en las pacientes embarazadas.

Introduction

All living things are constantly exposed to natural electromagnetic fields; these are, however, weak and non-ionizing fields, so most people are unaware of their existence.[1] Magnetic resonance imaging (MRI) has been established as an essential tool in the study of various diseases. Its use during pregnancy has increased and it is even used to diagnose alterations of prenatal development that cannot be properly studied with ultrasound.[2–7] Little is known, however, about the consequences of exposure to magnetic fields on the developing fetus.[8] It is difficult to assess the risks due to the many variables involved.[3,9] Nevertheless, there are guidelines that aim to limit the use of this method despite the lack of information. The main objective of this systematic review is to find basic information about the effects of MRI on the fetus.

Materials and methods

A systematic literature review was carried out on the teratogenic effects of magnetic resonance imaging in the Embase and PubMed databases, as well as in clinical practice guidelines. The following MeSH terms and their respective cross-references were used: ''magnetic resonance imaging,'' ''pregnancy,'' ''teratogen,'' ''DNA damage,'' and ''congenital abnormalities.'' The filters used were: observational study, clinical study, systematic reviews, humans, other animals. No language restriction was established. A total of 597 articles were found, 42 of which were selected: one prospective cohort study, 9 narrative reviews, 15 experimental studies in animals, 2 experimental studies *in vitro*, 5 experimental studies in humans, and 10 clinical practice guidelines.

Gray literature was searched using the ''open grey'' portal, looking for papers presented at important international conferences; this search gave only one result, which was not useful for our study, since magnetic resonance was not used.

For Latin American studies, the LILACS database was searched without obtaining any results.

Only those studies were included that related magnetic resonance imaging, either positively or negatively, with teratogenic effects; these were narrative-type, observational, and clinical studies, as well as systematic literature reviews. Articles were discarded if they did not evaluate the outcomes of interest, comparing the implementation of the proposed interventions. After an initial selection based on a review of titles and abstracts, the remaining articles were read in their totality and an analysis of the findings was carried out. This process was completed by multiple investigators (Fig. 1 and Table 1, Appendix 1).

Magnetic resonance imaging as a diagnostic method

Generalities

Magnetic resonance images are generated by manipulating the polarity of the protons in the tissues, using electromagnetic fields and radio frequency.[1,9,10] The image is projected after the body is exposed to a static magnetic field stimulated by an oscillating field, which results in the emission of