

TOPIC HIGHLIGHT

Hyperpolarization vs. Gadolinium Retention in the Brain: Topic Highlight

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ABSTRACT

Recent findings and reports came to the conclusion that gadolinium retained in the brain and in the human body in general after undertaking an MRI scan with contrast. Many governmental institutions claim that gadolinium is retained in the brain, but has no effect on human health. This paper will show both sides of the conversation regarding gadolinium retention in the brain and gadolinium replacement like hyperpolarization as a promising technique instead of using the gadolinium.

Key words: MRI; Gadolinium; Hyperpolarization; 13 carbon; Pyruvate

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INTRODUCTION

In recent years, the radiologic community came to a shocking finding that gadolinium-based contrast agents (GBCAs) can retain in the brain see (Figure 1). The European Medicine Agency (EMA's) released a statement of suspension to four linear intravenous GBCAs which are gadobenic acid, gadodiamide, gadopentetic acid, and gadoversetamide^[1]. After that, the FDA published a report claiming that there is no effect of gadolinium and the benefit outweigh risks^[2]. As well, GBCAs has an effect on other systems like the urinary system^[3]. Furthermore, in a stroke patient who underwent an MRI scan with contrast (gadolinium) showed the gadolinium leaked into the ocular structure which surround the patient's eyes^[4]. All the previous raises -among medical professionals and patients- the need for a safe replacement of the contrast media like hyperpolarization.

Hyperpolarization is an imaging technique that depends on an intravenous bolus (for the vascular and metabolism scan) of pyruvate which is a hyperpolarized 13 carbon-labeled probe see (Figure 2). The technique uses MRI spectroscopy to detect human metabolism in vivo and in real-time images. Signal to noise ratio is an important factor that allows the feasibility of exchanging the hyperpolarized 13 carbon between pyruvate and endogenous lactate pool on MRI spectroscopy. This exchange is called the chemical shift. Hyperpolarization technique can be applied by using three methods: dynamic nuclear polarization (DNP), parahydrogen-induced polarization (PHIP), or hyperpolarization of noble gases (for lungs scan)^[5].

LIMITATIONS OF THE HYPERPOLARIZATION

The natural existence of the 13 carbon is 1.1% which required an isotopic enrichment to the targeted molecule to increase the signal to noise ratio^[5]. While the hyperpolarized molecules spin, it will be the recording time of hyperpolarized molecules which is a very short time (in seconds). The short hyperpolarization period needs more studying to increase the lifetime of the hyperpolarized molecule to allow the MRI machine to record the hyperpolarization activities for a long time which will reflect on increasing the scan's signal to noise ratio^[5]. The ability of MRI spectroscopy to achieve spatial and

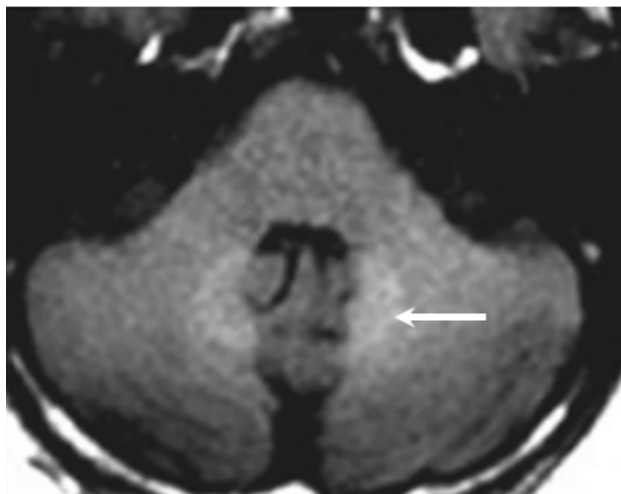


Figure 1 Gadolinium retention in the dentate nucleus of the cerebellum (white arrow).

spectral localizations in a short time is a challenging issue as well^[5]. Hyperpolarization required dedicated coils because it used with non-proton nuclei like 15 nitrogen and 13 carbon^[5]. Another issue is, every molecule (that will be hyperbolized) has its own relaxation and polarization properties^[5].

CONCLUSION

Hyperpolarization is a promising technique and it faces many challenges, but it is still a better replacement for gadolinium. Gadolinium maybe with time will not be in use anymore. There is a urgency in finding another safe replacement which is required by medical professionals and patients as well.

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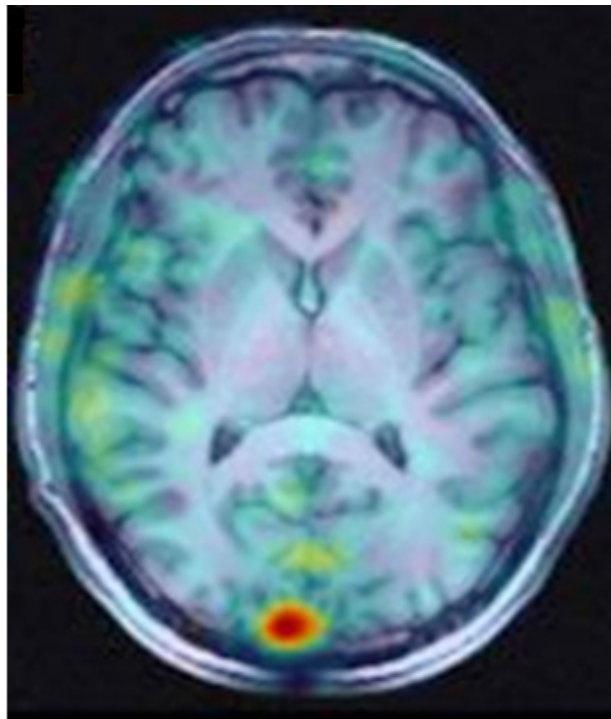


Figure 2 An MRI hyperpolarization scan of a healthy brain.

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