International Journal of Allied Medical Sciences and Clinical Research (IJAMSCR)

ISSN:2347-6567

IJAMSCR |Volume 9 | Issue 3 | Jul - Sep - 2021
www.ijamscr.com

Research Study *Medical research*

Association between exposure to gadolinium-based contrast agents and neurotoxicity in patients who have undergone contrast MRI in a tertiary care hospital

Arul.S*, Dr.Ilangovan Gurubharath[1], Dr.Alex Daniel Prabhu[2], Dr.E.A.Parthasarathy[3], Dr.Deepak Pathiran

**Chettinad Academy of Research and Education.*
[1]*Prof&HOD, department of radiology, Chettinad Academy of Research and Education.*
[2]*Prof&HOD, department of radiology, Chettinad Academy of Research and Education.*
[3]*Associate professor, department of radiology, Chettinad Academy of Research and Education.*

***Corresponding Author**: **Arul.S**
Email id: arulsai2@gmail.com

ABSTRACT

Background
Magnetic resonance imaging (MRI) is the wildest emerging non invasive diagnostic modalities in medicine. It hires ground-breaking techniques and the latest discoveries, which are harmless actual, but even so it is tough to evade drawbacks particularly concerning lasting significances. The protection of gadolinium is now the most regularly deliberated.

Objectives
1. To see if there's a link between gadolinium contrast and neurotoxicity
2. Identification of newly developed neurotoxicity symptoms following the use of an MRI contrast agent
3. Identifying changes in frequency and magnitude of pre-existing neurotoxicity symptoms that are linked to pre- and post-contrast medical history.
4. To see if a single or many doses of intravenous gadolinium contrast are linked to new neurotoxicity symptoms and maybe additional side effects

Materials and Methods
The present study is a Retrospective study conducted among 45 patients selected by convenience sampling who undergo MRI brain contrast examination in the Department of Radiology for a period of one year.

Results
Majority of the study population were in the age group of 41-60 years (38%) Mean age is 48.76 and standard deviation is 7.86. There is no association between age and neurotoxicity. About 58% were males and 42% were females. About 78% of study participants were alive. Headache is the most common symptom (22%) followed by vision loss (18%). About 9% had memory loss and 7% had paralysis .About 4% had numbness and 4% had altered sensation. Among 10 patients with headache,2 developed it in the same day,6 within a week, and 2 within a month. Among numbness 1 developed in the same day and 1 in a week. Among vision loss 2 within a week and 6 developed within a month. Symptoms of neurotoxicity were present in 29% of study participants.

Conclusion

There are some associations between exposure to gadolinium based contrast agents and neurotoxicity. These neurotoxicity symptoms frequency and magnitude varying from number of time patients undergone MRI contrast study. Which may leading to gadolinium retention, gadolinium deposition disease and nephrogenic systemic fibrosis.

Keywords: MRI, Gadolinium, Neurotoxicity

INTRODUCTION

Magnetic resonance imaging (MRI) is the wildest emerging noninvasive diagnostic modalities in medicine. It hires ground-breaking techniques and the latest discoveries, which are harmless actual, but even so it is tough to evade drawbacks particularly concerning lasting significances. The protection of gadolinium is now the most regularly deliberated topic.[1] This infrequent paramagnetic metal is extensively used in diagnostic imaging due to its high magnetic moment and comparatively extended magnetic lessening time. In view of the fact that the finding of X-rays in 1895, which noticeable the effectual birth of diagnostic medical imaging, there have been frequent modification of imaging techniques and the advance of entire new modalities, together with ultrasound, computed tomography, MRI and positron emission tomography[2]

Gadolinium has a thermal neutron capture cross-section of 49,000 barns, the highest of any known element. In dry air, the metal is reasonably stable; however, in moist air, it tarnishes and creates a loosely adhering oxide film that breaks off, exposing additional surface to oxidation.[3] Gadolinium based contrast agents (GBCAs) are extensively used in medicine since 1988, after Magnevist (Bayer Healthcare Pharmaceuticals) expanded the U.S. Food and Drug Administration approval. In 2014 Inappropriately, Kanda et al. observed assembly among preceding gadolinium managements and high signal intensity in the dentate nucleus and globus pallidus in the human brain autonomous of renal function. [4]

This detection has strained consideration to the safety of contrast enhanced MRI. The influence of gadolinium on human health remnants unidentified, although exertions are made to comprehend the mechanisms of gadolinium toxicity which can help to find therapeutic and preventive solutions for patients presenting signs and symptoms of gadolinium accretion.[5]

Objectives

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4. To see if a single or many doses of intravenous gadolinium contrast are linked to new neurotoxicity symptoms and maybe additional side effects.

MATERIALS AND METHODS

Study design: Retrospective study
Sample size: 45
Study period: 1 year (2019-2020)
Study place: Department of Radiology and Imaging Sciences, Chettinad Hospital and Research Institute, Kelambakkam.

Criteria for sample selection

Patients who have undergone MRI brain contrast studies.

Inclusion criteria

All patients irrespective of their gender are included

Exclusive criteria

Patients with gadolinium sensitivity, pregnancy and the present elevated value of renal function parameters.

Sampling technique: Convenience sampling

Sample: Patients who undergo MRI brain contrast examination are taken.

The Institutional Human Ethics Committee provided ethical approval and authorization for this investigation. Proposal No. 119/IHEC/Jan 2021 (CHETTINAD ACADEMY OF RESEARCH AND EDUCATION). Patients' information was gathered by phone using standardized closed-ended questionnaires. The demographic information on the patients was gathered from hospital medical records, radiology information systems, and hospital information systems.

Data entry and analysis

Data collected was entered in Microsoft excel and analysed using SPSS version 20.0. Qualitative variables expressed in proportions and quantitative variables expressed in Means and Standard deviation.

Table 1: Age wise distribution of study participants

Age in years	Frequency	Percentage
1-20 years	8	17.78
21-40 years	11	24.44
41-60 years	17	37.77
61-80 years	7	15.56
≥81 years	2	4.45
Total	45	100

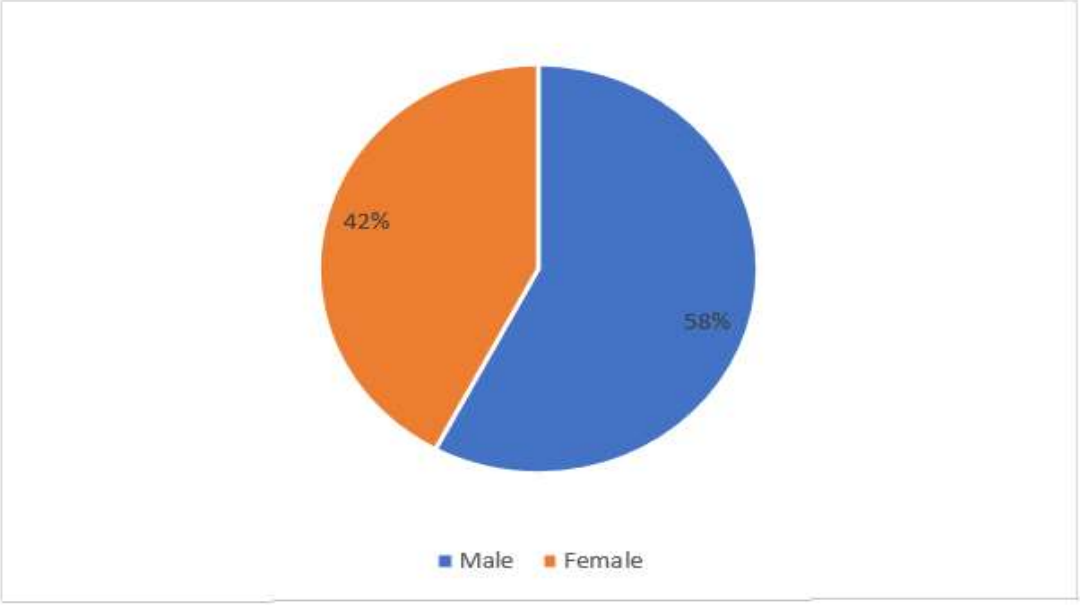

Figure 1: Sexwise distribution of study participants

Table 2: Distribution of symptoms among study participants

Symptoms	Frequency	Percentage
Headache	10	22.22
Tingling	0	0
Numbness	2	4.44
Paralysis	3	6.67
Behaviour changes	0	0
Vision loss	8	17.78
Memory loss	4	8.89
Altered sensation	2	4.44
Sexual dysfunction	0	0

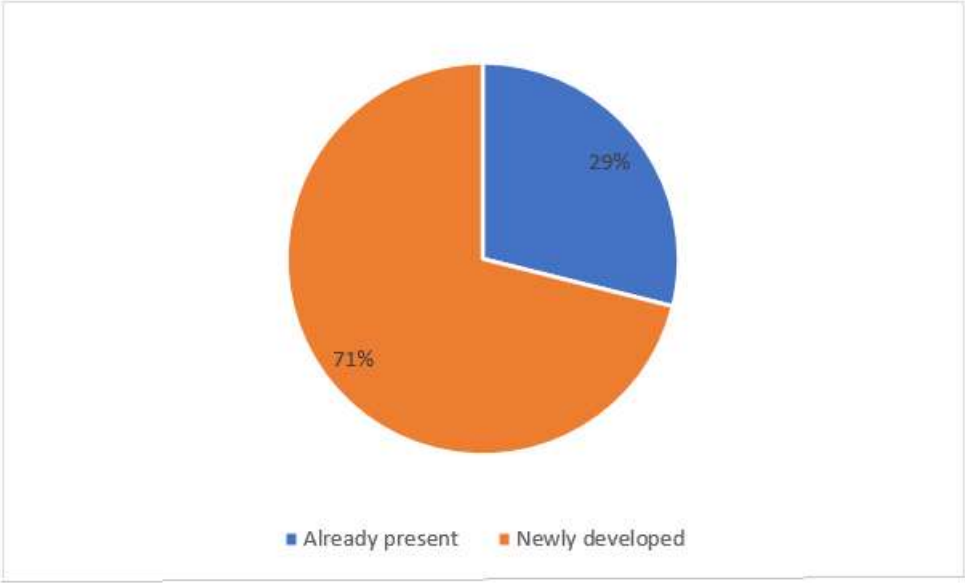

Figure 2: Neurotoxicity status among study participants

Table 3: Association between age and headache

Age in years	Headache	No headache	CHI SQUARE	P value
≤40	4	15		
>40 years	6	20	0.04	0.81
Total	**10**	**35**		

RESULTS

The present study is a hospital based retrospective study for which the data was collected from 45 patients presenting to the Radiology department with various complaints. Majority of the study population were in the age group of 41-60 years (38%). About 24% were in the age group of 21-40 years. About 18% of study population belonged to age group of less than 20 years. About 15% were in the age group of 61-80 years and only less than 5% were in the age group of more than 81 years. Mean age is 48.76 and standard deviation is 7.86. there is no association between age and neurotoxicity. About 58% were males and 42% were females. About 78% of study participants were alive. Headache is the most common symptom (22%) followed by vision loss(18%).About 9% had memory loss and 7% had paralysis .About 4% had numbness and 4% had altered sensation. Among 10 patients with headache,2 developed it in the same day,6 within a week, and 2 within a month. Among numbness 1 developed in the same day and 1 in a week. Among vision loss 2 within a week and 6 developed within a month. Symptoms of neurotoxicity were present in 29% of study participants.

DISCUSSION

Since the late 1980s, gadolinium-based contrast agents (GBCA) have been approved for parenteral usage. Chelate chemistry, stability, viscosity, osmolality, and, in certain circumstances, efficacy for certain applications can all be used to distinguish these substances. Gadolinium-based contrast agents (GBCAs) have been used for diagnosis and therapy guidance in far more than 300 million patients globally since they were approved by the US Food and Drug Administration (FDA) in 1988.GBCAs make dysfunctional tissues more noticeable. All GBCAs have the same organic ligand structure, which securely binds to the core gadolinium heavy metal ion and increases its stability, solubility, and safety. The chelate is largely removed through the kidneys in most people, with some evidence of liver excretion for a few of the drugs. NSF is a systematic illness that is uncommon yet dangerous.[6]

In renally compromised people, this condition is marked by fibrosis of the skin and other tissues all over the body. As a consequence of the prudent use of GBCAs in patients with impaired renal function and a reduction in GBCAs that are more strongly linked to NSF should be used. Patients who got

numerous doses of GBCAs during their lifespan have leftover gadolinium in their neural tissue.[7] Gadolinium deposition appears to develop predominantly in particular regions of the brain, even in the absence of clinically diagnosed illness and in the presence of an intact blood brain barrier, for causes that are unknown. Although there are no known negative clinical effects of gadolinium deposition in the brain, more research is needed to understand the mechanisms of deposition, the chelation condition of these deposits, the connection to GBCA stability and ligands, and the conceptual toxic possibilities, which may vary depending on the GBCA.[8]

CONCLUSION

There are some associations between exposure to gadolinium based contrast agents and neurotoxicity. These neurotoxicity symptoms frequency and magnitude varying from number of time patients undergone MRI contrast study. Which may leading to gadolinium retention, gadolinium deposition disease and nephrogenic systemic fibrosis.

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