Journal of Forensic Radiology and Imaging 2 (2014) 60–63

Contents lists available at ScienceDirect

Journal of Forensic Radiology and Imaging

journal homepage: www.elsevier.com/locate/jofri

Demystifying the fog – CT and MRI confirming the diagnosis of carbon monoxide poisoning by gas geysers

Rahat Brar *, Abhishek Prasad [1], Shaleen Rana [2]

Department of Radiology, Fortis Hospital, Sector 62, Phase VIII, Mohali 160062, Punjab, India

ARTICLE INFO

Article history:
Received 12 May 2013
Received in revised form
12 February 2014
Accepted 26 February 2014
Available online 6 March 2014

Keywords:
Gas geyser
Computed tomography
Magnetic resonance imaging
Carbon monoxide poisoning
Brain
Liquefied petroleum gas

ABSTRACT

Objective: Unexplained loss of consciousness was observed in many people while taking bath in small sized, ill ventilated bathrooms equipped with liquefied petroleum gas (LPG) based water heaters (also known as gas geysers). This led many investigators to hypothesize that the gases produced during incomplete combustion of LPG, especially carbon monoxide was the cause behind these neurological events. The objective of this study was to observe the brain computed tomography (CT) and magnetic resonance imaging (MRI) findings of such patients and correlate these findings with brain imaging in carbon monoxide (CO) poisoning.

Material and methods: A total of 10 patients who were admitted to our hospital with a history of loss of consciousness in the bathroom fitted with LPG based water heaters were retrospectively included in our study. The brain CT was performed on 64 slice scanner. MRI studies were done on a 1.5 T MR scanner using routine brain sequences, including T1 weighted, T2 weighted Fluid Attenuated Inversion Recovery (FLAIR) and gradient echo in the axial sequences. T2 weighted images were acquired in coronal and also in sagittal planes. CT and MRI images of such patients were analyzed by two radiologists having 11 years of experience in neuroimaging and the findings were tabulated. The radiologists specifically observed the areas of brain involvement and commented whether the imaging pattern in gas geyser poisoning correlated with those observed in imaging of carbon monoxide poisoning.

Results: Globus pallidus was the most frequent site of involvement, which was seen in 50% of the patients ($n=5$). This was followed by putamen ($n=3$) and caudate nucleus ($n=2$). Cerebral edema was observed in two patients. Cerebellar lesions were seen in one of the patients ($n=1$). The areas of brain affected by gas geyser poisoning on CT and MRI were similar to that observed in carbon monoxide poisoning.

Conclusion: The distribution of brain lesions produced by "gas geyser poisoning", very closely correlated with that of brain involvement in carbon monoxide intoxication. Thus, we conclude that it is the CO produced by incomplete combustion of LPG in poorly ventilated washrooms that leads to various neurological symptoms in these patients. The purpose of this paper is to create awareness among radiologists, emergency medicine physicians, neurologists, general physicians and the public about the existence of gas geyser poisoning and to further elaborate the imaging findings in these patients.

1. Introduction

Sudden loss of consciousness is a common indication for which brain imaging is frequently done in order to find out the underlying cause. There are a number of conditions that can cause such a neurological event. Patient's history, clinical examination and brain imaging help in reaching the final diagnosis. We came across many patients who experienced such neurological symptoms while bathing in poorly ventilated bathrooms fitted with LPG based water heaters. In our literature search, we came across many case reports which described this entity. Few of these studies had postulated that emission of harmful gases, especially carbon monoxide, from the gas geysers was responsible for these neurological episodes. However, a large case series describing the imaging feature of brain in patients with gas geyser poisoning is lacking. We describe CT and MRI imaging findings in 10 patients with gas geyser poisoning and evaluate whether these

* Corresponding author. Tel.: +91 9878817737.
E-mail addresses: dr_rahatbrar@yahoo.com (R. Brar), drabhishekprasad@gmail.com (A. Prasad), ashleen78@gmail.com (S. Rana).
[1] Tel.: +91 9888904214.
[2] Tel.: +91 9780029904.

http://dx.doi.org/10.1016/j.jofri.2014.02.038
2212-4780

correlate with findings observed in imaging of carbon monoxide poisoning.

2. Materials and methods

In a period of around two years (November 2010 to December 2012) 10 patients were referred to our department for brain imaging with one similar history that they were found unconscious or comatose while having hot water bath in winter season in a closed bathroom. All of these patients were brought out by their relatives after breaking open the bathroom door latch. Further questioning confirmed that all these patients had LPG based water heater fitted in their small sized ill ventilated bathrooms. There were eight females and two males. A vast majority (about 70%) of the patients were between 20 and 35 years of age. Eight of these patients were brought in a delirious state. Two of them had regained consciousness before they reached the hospital and vaguely remembered a feeling of suffocation and dizziness before losing consciousness. The vitals of all the patients were within the normal range. None of them had any significant previous neurological history. Oxygen saturation was between 94% and 100%. Arterial blood gas, hemogram, metabolites, electrolytes were within the normal limits.

Six of these patients underwent MRI of brain while three got CT brain done. In one patient both MRI and CT scan of the brain were done and in one of the patients follow up MRI brain scan after six months was also done.

The brain CT was performed on 64 slice scanner (Siemens Sensation 64, Erlangen, Germany), using a collimation of $64 \times 0.6\ mm^2$, 100 kVp, 130 mA s and scan duration was 8 s. MRI studies were done on a 1.5 T MR scanner (Siemens Essenza 1.5 T, Erlangen, Germany) using routine brain sequences, including T1 weighted (TE=11 ms, TR=820 ms), T2 weighted (TE=109 ms, TR=3500 ms), Fluid Attenuated Inversion Recovery (FLAIR) and gradient echo in the axial sequences. T2 weighted images were also acquired in coronal and sagittal planes. CT and MRI images of such patients were analyzed by two radiologists having 11 years of experience in neuroimaging and the findings were tabulated. We retrospectively analyzed the CT and MRI findings of these patients and tabulated the findings.

As this study required the participation of human respondents, certain ethical issues were addressed. The consideration of these ethical issues was necessary for the purpose of ensuring the privacy as well as the safety of the participants. The significant ethical issues that were considered in the research process included consent and confidentiality. Informed signed consent was taken from the patients for all CT and MRI scans done. The confidentiality of the participants was ensured by not disclosing their names or personal information in the research. Only relevant details that helped in answering the research questions were included. The management of the patients was not altered in any way for the purpose of this research.

3. Results

We found that bilateral symmetrical T2 weighted hyperintense lesions in globus pallidi were the most frequent finding in these patients. This was found in five of the patients (50%). Three patients (30%) had hyperintense T2 weighted–FLAIR signal in caudate nucleus and putamen, one patient (10%) showed lesions in cerebellum and two patients (20%) showed features of hypoxic–ischemic encephalopathy (diffuse cerebral edema and cortical lesions). Follow up scanning after six months in one patient with pallidal lesions showed hyperintensity on T1 weighted images in the globus pallidi – suggesting necrosis with dystrophic calcifications. The findings of the imaging in the patients are summarized in Table 1 and Figs. 1–3.

Table 1
Clinical data and regions of brain involvement on imaging in patients with gas geyser poisoning.

Patient	Age	Sex	Approximate duration of stay in bathroom (min)	Approximate time elapsed since LOC (h)	Area of brain involved	Final outcome
1	58	F	30	8	Cn, Pu	Fully recovered
2	41	F	30	2	GP	Fully recovered
3	42	M	20	4	Pu, GP, CS	Recovered with deficit
4	21	F	30	4	Pu, Cu, Hp	Recovered fully
5	32	F	45	4	Cerebral edema	Recovered with deficit
6	28	F	30	8	GP	Fully recovered
7	26	F	30	6	GP	Fully recovered
8	32	M	20	6	Cerebellum	Fully recovered
9	30	F	30	4	GP	Recovered with deficit
10	33	F	45	8	BG, diffuse cerebral edema	Recovered with deficit

Cu: caudate nucleus; Pu: putamen; GP: globus pallidus; CS: centrum semiovale; Hp: hippocampus; BG: basal ganglia.

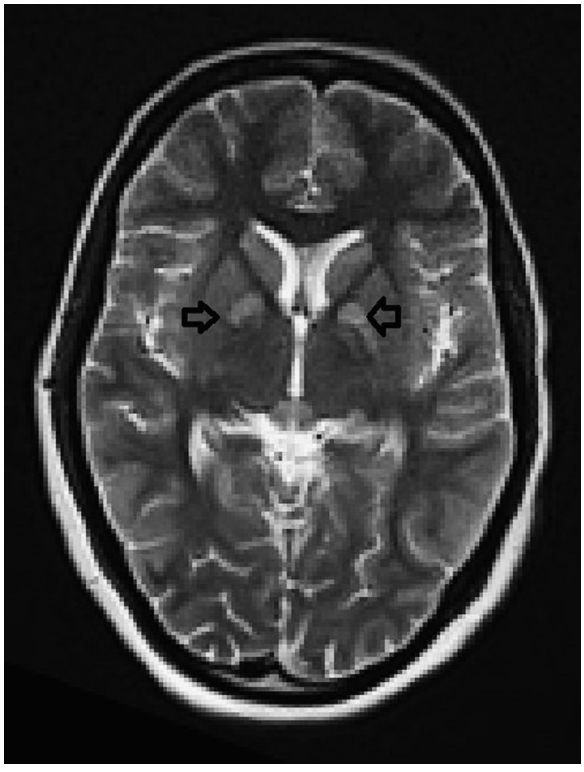

Fig. 1. MRI brain axial T2 weighted image of 35 year old female showing bilateral symmetrical hyperintensity in globus pallidi (arrows).