Mashhad University of Medical Sciences (MUMS)

Reviews in Clinical Medicine

Clinical Research Development Center Ghaem Hospital

The role of diffusion-weighted MRI on the study of brain complications related to heroin abuse

Yasamin Davoudi (MD)[1], Leila Ameri (MD)[1], Bita Dadpour (MD)[2*]

[1]*Department of Radiology, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.*
[2]*Addiction Research Center, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.*

ARTICLE INFO

Article type
Review article

Article history
Received: 5 May 2014
Revised: 25 May 2014
Accepted: 17 Aug 2014

Keywords
Brain complication
Diffusion weighted images
Heroin abuse
Magnetic Resonance image

ABSTRACT

Heroin has physical effects on many parts of the body, for example, respiratory and digestive system, muscles, and nervous system. Neurologic complications include brain abscess, neuropathy, transverse myelitis, and leukoencephalopathy.
Magnetic resonance image is more sensitive in detecting lesions with low signal on T1W and high signal on T2W, and FLAIR images in the white matter and other areas of brain. Imaging findings are similar to other leukoencephalopathies (hereditary diseases, abnormal metabolic diseases, and intoxications).
In the course of finding ways to differentiate heroin-induced spongiform leukoencephalopathy from other leukoencephalopathies, attention has been changed to diffusion magnetic resonance imaging in recent years.
Nevertheless, studies do not verify that diffusion-weighted image is a valuable tool in establishing the diagnosis.

Please cite this paper as:
Davoudi Y, Ameri L,Dadpour B. The role of diffusion-weighted MRI on the study of brain complications related to heroin abuse. Rev Clin Med. 2015;2(3):144-146.

Introduction

Opiates abuse is one of the most serious human problems and challenging issues with an increasing rate in recent years. In recent years, there has been the increasing prevalence of opiates abuse. For example in Pakistan, every minute a person is addicted to heroin and 52,600 people per year are added to the camping consumers. In the meantime, our country is no exception to this rule (1,2).

Heroin is a material that comes from the poppy plant and action of natural chemicals called endorphins that are produced in response to pain and act on specific opioid receptors in the brain and spinal cord Heroin also has physical effects on other parts of the body for example respiratory and digestive system and muscles (3).

Neurologic complications of heroin possibly related to the drug or its method of use. addicted individuals experience complications such as brain abscess, neuropathy, transverse myelitis, rhabdomyolysis and myoglobinuria (4). The pathophysiology is probably secondary to ischemic-hypoxic damage, hypotension, cerebral edema, or infection. Heroin-related deaths may be associated with acute overdose of heroin or intravenous (IV) drug use complications such as hepatitis C virus (HCV) and human immunodeficiency virus (HIV) infections.

Toxin-related diseases in the brain are uncommon. When this toxin affects the white matter, the condition is known as toxin-dependent leukoencephalopathy which is a rare and reversible condition if the exposure to the toxic agent be stopped. This condition is rare but brain effects

***Corresponding author:** Bita Dadpour.*
Addiction Research Center, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.
***E-mail:** Dadpourb@mums.ac.ir*
***Tel:** 095138598973*

of toxin agents are reversible. Heroin is a drug that it was commonly used by people in the late 1960s and early in 1970s (5). Heroin-induced spongiform leukoencephalopathy was reported first time in 1982 in Amsterdam; until 2000, 100 cases were identified in Europe and USA (6). Heroin-induced spongiform leukoencephalopathy is associated with a mortality rate of approximately 23-25% (4). This complication is observed following inhalation of heroin, but it has been rarely reported in patients taking heroin intravenous. It is characterized by symptoms of neurological and clinical complications. Heroin-induced spongiform leukoencephalopathy has been detected at three clinical stages. At stage 1, patients often show the signs of cerebellar dysfunction. Patients at stage 2 show cerebellar and extrapyramidal symptoms. At stage 3, the patients suffer from spasmodic stretching and akinetic or hypotonic mutism, and may eventually lead to death (7).

Diagnosis

Computed tomography (CT) scan of the brain shows diffuse symmetrical hypodense lesions in the white matter of cerebral and cerebellum, brainstem, internal capsule, and septum pellucidum. Magnetic resonance imaging (MRI) is more sensitive in detecting lesions because these lesions have low signal on T1W and high signal on T2W. FLAIR images can be obtained from the white matter extending to centrum semiovale, corpus callosum, major forceps, corona radiate, posterior horn of the internal capsule, retrolenticular internal capsule, cerebral peduncle, lemniscus medialis, and pyramidal pathway. Subcortical U-fiber is preserved (8). Mass effect or enhancement is not seen after injection (7). They can be homogeneous or heterogeneous signal. Brain tissue swells and grooves and sulci become smooth. Ventricular system is dilated and midline shift is not observed (9).In MR spectroscopy some studies demonstrated a decreased N-acetylaspartate/creatinine (NAA/Cr) and an increase in lactate peak that supports the theory of mitochondrial dysfunction. Magnetic resonance (MR) angiography normally shows the proximal circulation (10). These findings are similar to other leukoencephalopathies mentioned below.

Differential diagnosis

Hereditary diseases, abnormal metabolic diseases, and intoxications can cause spongiform leukoencephalopathy for example:

-AIDS-induce leukoencephalopathy in addicts and intoxication with hexachlorophene, isonicotinic, must be differentiated.

- Alexander's disease is a degenerative disorder of the nervous system. In the early stages, lesions are located especially in frontal lobes and gradually extended posteriorly, later to the occipital white matter, thalamus, and caudate nucleus. Hydrocephalus can sometimes be found.

- Mitochondrial encephalopathy usually leads to focal or multifocal spongy white matter and the lesions are usually asymmetrical. Gray matter structures are often involved, for example, thalamus, putamen, caudate nucleus, globus pallidus and dentate nuclei, tectum and tegmentum of the mesencephalon, the tegmentum of pons and medulla oblongata.

- Spongy degeneration of white matter (Canavan disease) is an autosomal recessive disorder, which is predominantly found in infants of Eastern European Jewish ancestry, and mainly involves the basal ganglion and cerebellum.

- Congenital muscular dystrophy is seen in combination with demyelinating disorder. The white matter is affected almost symmetrically. The corpus callosum, internal and external capsules, brain stem, and cerebellum are rarely involved.

- L-2-hydroxyglutaric aciduria has multifocal lesions, especially in the subcortical white matter. The vermis of the cerebellum is severely atrophic. Dentate nuclei are usually involved (9).

Result

Scientists have been concerned to find a way to be able to differentiate between heroin-induced spongiform leukoencephalopathy and other types of leukoencephalopathies because early diagnosis can lead to early treatment, withdrawal, avoid complications, and even death that may not occur in other leukoencephalopathies. In the course of finding ways to differentiated heroin-induced spongiform leukoencephalopathy from other leukoencephalopathies, attention has been changed to diffusion MR imaging in recent years that first was used in 2000 by Dr. Chang et al. He showed areas of restricted diffusion in the white matter and claimed that these images might help in the differentiation of heroin-induced spongiform leukoencephalopathy from the two large groups of white matter diseases including brain edema and other demyelinating diseases with increased signal in T2W images. It can be highly sensitive to detect this type of leukoencephalopathy. They claimed that the decreased water diffusion of the white matter can be attributable to the underlying pathologic alternation of the myelin in response to heroin-produced neurotoxicity. The neuropathological findings of heroin-induced encephalopathy have detected spongiform degeneration of the white matter where vacuoles were formed between the

myelin lamellae by splitting of the intraperiod lines. The aggregation of restricted fluid between lamellae layers of myelin might cause increased isotropy of water diffusion of the white matter and responsible for the increased signal intensity on the diffusion-weighted images (DWI) (11).

However, other studies did not confirm their results. For example, in 2007, Dr. Offiah and Dr. Hall evaluated six patients with clinical or histopathological diagnosis of heroin-induced leukoencephalopathy and MRI examinations was done in all of them including DWI and single-voxel MRS. Cerebellar white matter was involved in all six cases demonstrating similar symmetrical white matter involvement with sparing of the dentate nuclei. Brain stem signal was altered in five of the six patient images. There was not any area of signal abnormality with restriction on DWI images (8).

Therefore, DWI and MRI roles are just suspected and other studies did not identify their diagnostic value.

Acknowledgement

We would like to thank Clinical Research Development Center of Ghaem Hospital for their assistant in this manuscript. This study was supported by a grant from the Vice Chancellor for Research of the Mashhad University of Medical Sciences for the research project as a medical student thesis with approval number of 920631.

Conflict of Interest

The authors declare no conflict of interest.

References

1. Shams Alizadeh N,Moghadam M, Mohsenpour B, Rostami Gooran N. Prevalence of substance abuse in medical students of Kurdistan University. Scientific Journal of Kurdistan University of Medical Sciences. 2008;13:18-26.
2. Ehsan Manesh M, Karimi Keisami I. A review of the history and several studies regarding substance abuse in Iran. Iranian Journal of Psychiatry and Clinical Psychology (Andeesheh Va Raftar) 2000; 5:78-62.
3. Akhtar S, South N. Hidden From Heroin's History: Heroin Use and Dealing within an English Asian Community-A Case Study. Crime Prevention Studies. 2000;11:153-178.
4. Siu J, Tsui E. Spongiform leukoencephalopathy after intravenous heroin use: evaluation by diffusion-weighted imaging.Hong Kong J Radiol. 2004;7:84-87.
5. Keogh CF, Andrews GT, Spacey SD, et al. Neuroimaging features of heroin inhalation toxicity:"chasing the dragon". Am J Roentgenol. 2003;180:847-850.
6. Hill MD, Cooper PW, Perry JR. Chasing the dragon-neurological toxicity associated with inhalation of heroin vapour: case report. Can Med Assoc J. 2000;162:236-238.
7. Au-Yeung K, Lai C. Toxic leucoencephalopathy after heroin inhalation. Australas Radiol. 2002;46:306-308.
8. Offiah C, Hall E. Heroin-induced leukoencephalopathy: characterization using MRI, diffusion-weighted imaging, and MR spectroscopy. Clin Radiol. 2008;63:146-152.
9. Zheng W, Zhang X. Characteristics of spongiform leukoencephalopathy induced by heroin: MRI detection. Chin Med J. 2001;114:1193-1195.
10. Bega DS, McDaniel LM, Jhaveri MD, et al. Diffusion weighted imaging in heroin-associated spongiform leukoencephalopathy. Neurocrit Care. 2009;10:352-354.
11. Chen C-Y, Lee K-W, Lee C-C, et al. Heroin-induced spongiform leukoencephalopathy: value of diffusion MR imaging. J Comput Assist Tomogr. 2000;24:735-737.