Health Sciences & Disease
The Journal of Medicine and Biomedical Sciences

Case Report

Parkinsonism in an Adult Following Delayed Carbon Monoxide Exposure: A Case Report

Syndrome Parkinsonien chez un Adulte Post Exposition Tardif au Monoxyde de Carbone

Leonard Ngarka[1,2], Faustin N. Yepnjio[1,2], Paul C Mbonda[2,3], Michel K Mengnjo[1,2], Eric S Chokote[1,2], Leonard N Nfor[1,2,4], Aurelien S Tele[1,2], Alfred K Njamnshi[1,2,5*]

Affiliations
1. Neurology Department, Yaoundé Central Hospital, Cameroon
2. Neuroscience Lab, Faculty of Medicine and Biomedical Sciences, The University of Yaoundé I, Cameroon
3. Neurology Department, General Hospital Yaoundé, Cameroon
4. Neurology Department, CHU Brugman, Belgium
5. Brain Research Africa Initiative (BRAIN), Yaoundé, Cameroon
6.

*__Corresponding author__: Alfred Njamnshi. Email: alfred.njamnshi@brainafrica.com

Key words: Carbon monoxide, MRI findings, Oxygen
Mots clés : monoxyde de carbone, résultats d'IRM, oxygène

ABSTRACT

Exposure to carbon monoxide (CO) over long periods is associated with delayed clinical manifestations in exposed subjects. These manifestations include parkinsonian signs which could be mistaken for idiopathic Parkinson's disease if a thorough medical history is not taken. We present a 55-year-old woman who was hospitalised at 2 weeks following CO exposure with altered behavioural patterns, bilateral pyramidal signs, parkinsonism and abnormal neuro-imaging findings. This case is an example of delayed central nervous system dysfunction secondary to CO exposure highlighting the importance of the clinical observation and raising the issue of brain health and environmental pollution.

RÉSUMÉ

L'exposition au monoxyde de carbone (CO) sur de longues périodes est associée à des manifestations cliniques retardées chez les sujets exposés. Ces manifestations comprennent des signes parkinsoniens qui pourraient être confondus avec la maladie de Parkinson idiopathique si des antécédents médicaux complets ne sont pas pris. Nous présentons une femme de 55 ans qui a été hospitalisée deux semaines après l'exposition au CO avec les troubles de comportement, des signes pyramidaux bilatéraux, syndrome parkinsonien et des signes de neuro-imagerie anormaux. Ce cas est un exemple de manifestations neurologiques retardées du système nerveux central secondaires à l'exposition au CO, soulignant l'importance de l'observation clinique et soulevant la question de la santé du cerveau et de la pollution de l'environnement.

INTRODUCTION

Exposure to carbon monoxide (CO) over long periods is associated with delayed clinical manifestations in exposed subjects. These manifestations include parkinsonian signs which could be mistaken for idiopathic Parkinson's disease if a thorough medical history is not taken. We present a 55-year-old woman who was hospitalised at 2 weeks following CO exposure with altered behavioural patterns, bilateral pyramidal signs, parkinsonism and abnormal neuro-imaging findings. This case is an example of delayed central nervous system dysfunction secondary to CO exposure highlighting the importance of the clinical observation and raising the issue of brain health and environmental pollution.

CASE PRESENTATION

A 55-year-old married and right-handed woman with a remarkable past history of CO exposure 2 weeks before presentation, following an all-night exposure to burning charcoal within a closed room during the month of August(wet season), was found unconscious with foamy saliva-filled mouth, unresponsive and unconscious for 24 hours and brought into the Emergency Room of our medical facility. After 2 days of observational care, she regained consciousness and was discharged after an uneventful evolution.

She was later admitted in the Neurology department about 2 weeks after discharge for a progressively altered behavioural pattern marked by incoherent speech, agitation, confusion and memory impairment, gradually evolving to mutism, drowsiness unresponsiveness and inability to recognize her family entourage. On admission, her clinical examination revealed a blood pressure of 106/96 mmHg, temperature = 38°C, SaO_2 = 88%. She was less responsive, poorly mobile and drowsy with a Glasgow coma scale of 10 /15 (E4, V1, M5). On neurologic examination, the patient had tetraparesis with muscle strength medical research council (MRC) 4/5, bilateral extensor plantar response and Hoffman's sign and Parkinsonian signs (bradykinesia, marked extrapyramidal rigidity requiring help with clean-up,

feeding, mobilization and poor facial expression). **T**here was no evidence of autonomic instability after evaluating clinically, cardiovascular reflexes, pupillary changes and casual sweating patterns and neuropsychological could not be properly assessed. A working diagnosis of CO-related encephalopathy was made.

A series of ancillary clinical tests were carried out including a non-enhanced head CT revealing bilateral pallidal hypodensities associated with bilateral white matter hypodensities (Figure 1) while a brain MRI revealed bi-pallidal T1 hyperintense signals, T2 hypointense signals and DWI images showing marked bipallidal hypointense signals with diffuse white matter hyperintense signals consistent with predominantly frontal bilateral subcortical and periventricular demyelination (Figures 2-5). Other tests including a full blood count with Hb = 11.4g/dl; serum electrolytes as well as kidney function tests and transaminases were within normal limits. An inflammatory assay (CRP and ESR) as well as an infectious screen (urinalysis, serum TPHA/VDRL, CSF analysis) were all normal. An EEG revealed moderate to severe generalized slowing with diffuse intermixed sharp waves, suggestive of moderate to severe cortical dysfunction; no epileptic activity was observed (Figure 6), Serum carboxyhaemoglobin and oxyhaemoglobin could not be measured.

The management plan consisted of normobaric oxygen through a face mask at 8L per day for the first 7days, in the absence of hyperbaric oxygen. This treatment resulted in an oxygen saturation ranging from 89% to 91%, and all vital parameters were within normal limits except for the stagnant oxygen saturation.

The evolution over a period of n days/weeks was characterized by the stagnant altered consciousness, persistent parkinsonian rigidity and SaO2 at 93%. Financial difficulties and challenges with oygen availability are some of the reasons for the inconistsent administration of oxygen administration and consequently stationary evolution. The patient died after 1 month of hospitalisation.

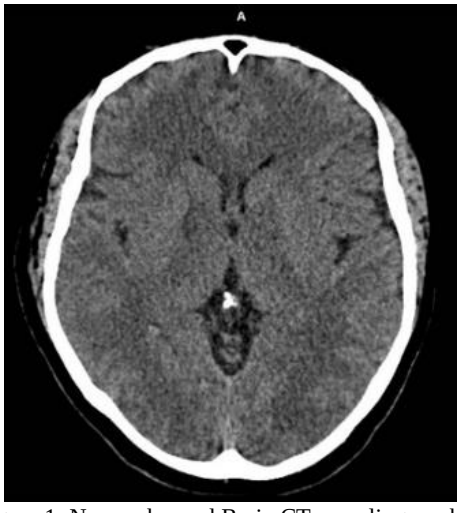

Figure 1: Non- enhanced Brain CT revealing marked bilateral pallidal hypodensities associated with diffuse white matter hypodensities

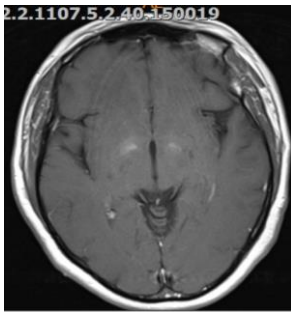

Figure 2: T1 Brain MRI revealing bipallidal hyperintense signals in the same patient

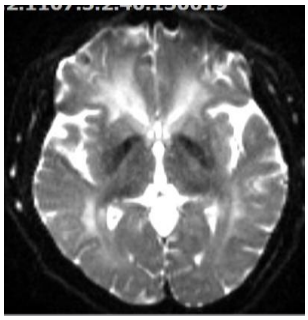

Figure 3: Brain MRI-DWI revealing marked pallidal hypointense signals with frontal white matter hyperintense signals

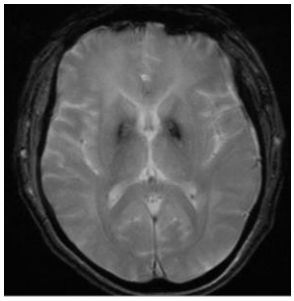

Figure 4: T2 MRI sequence revealing bipallidal hypointense signals

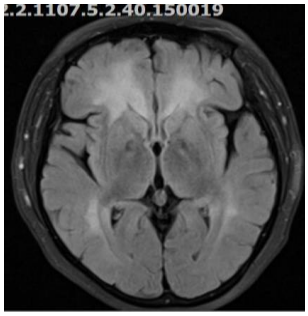

Figure 5: T2 FLAIR image sequence revealing bipallidal hypointense signals

DISCUSSION

CO is produced from of incomplete combustion organic material as a tasteless, odourless non-irritating but highly toxic gas and is present in minimal proportions in the atmosphere (1,2). CO exposure is often frequent in conditions of closed home fires, faulty combustion heating systems, contained exhaust from internal combustion engines, and heating gases other than natural gas (3). In our patient, the CO exposure was due to the incomplete combustion of coal, with closed doors in order to keep the room warm during the cold rainy season.

With an affinity of approximately 200 to 250 times that oxygen for binding to haemoglobin when inhaled, CO binds avidly to haemoglobin (Hb) compared to oxygen, forming a carboxyhemoglobin (COHb) complex, thus impairing tissue oxygen delivery, inhibiting mitochondrial oxidative phosphorylation and inactivating cytochrome oxidase which will lead to cellular dysfunction and demyelination (4–6).

CO poisoning diagnosis is difficult as the symptoms are subtle (features ranging from headache, nausea, and flu-like symptoms) or the subject may be asymptomatic for several days to several weeks, and then relapse with neurologic and/or psychiatric symptoms (7). A study reported that more than one-tenth of those exposed to CO developed delayed neurologic sequelae after a symptom-free period for 2–40 days (8). The patient featured in our case-report abruptly developed neuropsychological impairment approximately 2 weeks after CO poisoning.

The clinical diagnosis of acute CO poisoning is confirmed paraclinically with an elevated COHb level (5,9) but this could not be done in our setting. A second physical marker sometimes used to evaluate CO exposure is CO in exhaled air (10) and this can be exploited in cases where a blood sample cannot be obtained. In our patient, the plasma COHb level as well as arterial gases could not be measured. Though not specific, the oxygen saturation on pulse oximetry was 88% and served as an indirect indicator of hypoxia probably due to the high plasma COHb levels. The delay of onset of neurologic and neuropsychological symptoms is thought to be due to a progressive white matter demyelination (11), as showing on neuroimaging of our patient.

Approximately one-third of delayed CO-related encephalopathy patients may present with mild cognitive decline, ranging from changes detectable only on neuropsychological testing to a severely altered intellectual function with dementia. Findings frequently reported include disorientation, attention deficits, lack of concentration, executive dysfunction, altered visuospatial skills, verbal fluency and speed of information processing (12) . Furthermore, delayed-onset parkinsonian symptoms (bradykinesia, masked facies, reduced facial expression, rigidity, and shuffling gait) have been observed in about 72% of cases of delayed CO exposure (8). In the current case, the patient exhibited marked cognitive changes, decreased verbal expression, and an inability to care for herself and had parkinsonian signs. A third physical marker of CO encephalopathy involves neuroimaging but there are no pathognomonic signs on computed tomography, MRI, magnetic resonance spectroscopy, or single photon emission computed tomography. The severity of the lesions vary depending on the dose of exposure of CO. (13,14).The most frequent abnormal findings on MRI for patients with CO exposure include bilateral hypointensities consistent with necrosis in the globus pallidus and bilateral hyperintensities in periventricular white matter (13). Our patient presented with a non-enhanced head CT revealing bilateral pallidal hypodensities associated with bilateral white matter hypodensities, while a brain MRI revealed bi-pallidal T1 hyperintense signals, marked bipallidal hypointense T2 and DWI signals with diffuse white matter hyperintense signals consistent with predominantly frontal bilateral subcortical and periventricular demyelinisation. The white matter changes could signify reversible demyelination and axonal damage (11), although some studies reported that the white matter changes were more predictive of outcome than the globus pallidus changes (14). Although most reported lesions occur in the globus pallidus and white matter, some studies have identified lesions in other vulnerable brain areas such as the hippocampus, thalamus, cerebral cortex and cerebellum (3,15,16).

The best available estimates of the yearly incidence of carbon monoxide (CO) poisoning in the United States, based on emergency department visits, are 50,000 (16.0 cases per 100,000 population). Recent studies show declining numbers of CO death, most recently found to be 1,319 in 2014, from estimates of 2,700 in the mid-2000s (17). There are approximately 15,000 intentional CO poisonings annually, accounting for over two-thirds of reported deaths (18,19)

The main treatment goal of CO poisoning involves the rapid oxygenation of body organs by way of Hyperbaric Oxygen (HBO), defined as the administration of 100% oxygen in a pressurized chamber (5). By restoring tissue oxygenation, this treatment improves mitochondrial function, alters CO-induced inflammatory responses, and limits post-ischemic brain damage in subjects exposed to CO Carbon monoxide poisoning can trigger an inflammatory response in the body. HBO has been shown to have anti-inflammatory effects by reducing the production of pro-inflammatory substances and promoting the release of anti-inflammatory factors. This can help to minimize tissue damage and improve the overall healing proces (20,21). Very few studies report that dopaminergic agents (e.g. levodopa), anticholinergics, and electroconvulsive therapy (ECT) do not improve CO toxicity-associated parkinsonian symptoms (8,22). The prognosis after treatment is good with excellent improvement of motor symptoms, with parkinsonism resolving in 75% of patients 1 year after onset(8). Given that Hyperbaric oxygen (HBO) is relatively unavailable and unaffordable, a number of comparison studies to assess the efficacy of HBO compared with that of normobaric oxygen (NBO) had significant methodological limitations that make conclusions about the efficacy of HBO difficult (23,24). However studies have showed mortality rate ranging between 1 and 30%. It's important to interpret these figures with caution, as they can be influenced by factors such as the study population, the severity of cases included, and the quality of medical care provide.(18,19)

CONCLUSION

Although CO poisoning has subtle and non-specific neuropathologic, neurologic, and neuropsychological manifestations, delayed CO exposure can manifest as pyramidal and extrapyramidal syndromes and MRI findings revealbilateral basal ganglia necrosis and bilateral periventricular white matter hyperintensities. This case provides further evidence that a thorough history taking and a full neurologic examination remains a vital tool in the early diagnosis and management of delayed CO poisoning. If management is done on time as it should it may lead to unfavourable outcomes.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

This case report and discussion was written and jointly approved by all authors.

REFERENCES

1. Lane TR, Williamson WJ, Brostoff JM. Carbon monoxide poisoning in a patient with carbon dioxide retention: a therapeutic challenge. Cases J. 2008 Aug 18;1:102.

2. Penney D, Benignus V, Kephalopoulos S, Kotzias D, Kleinman M, Verrier A. Carbon monoxide [Internet]. World Health Organization; 2010 [cited 2018 Jan 16]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK138710/

3. Bruno A, Wagner W, Orrison WW. Clinical outcome and brain MRI four years after carbon monoxide intoxication. Acta Neurol Scand. 1993;87(3):205–9.
4. Laties VG, Merigan WH. Behavioral effects of carbon monoxide on animals and man. Annu Rev Pharmacol Toxicol. 1979;19(1):357–92.
5. Quinn DK, McGahee SM, Politte LC, Duncan GN, Cusin C, Hopwood CJ, et al. Complications of carbon monoxide poisoning: a case discussion and review of the literature. Prim Care Companion J Clin Psychiatry. 2009;11(2):74.
6. Hardy KR, Thom SR. Pathophysiology and treatment of carbon monoxide poisoning. J Toxicol Clin Toxicol. 1994;32(6):613–29.
7. Devine SA, Kirkley SM, Palumbo CL, White RF. MRI and neuropsychological correlates of carbon monoxide exposure: a case report. Environ Health Perspect. 2002 Oct;110(10):1051–5.
8. Choi IS. Delayed neurologic sequelae in carbon monoxide intoxication. Arch Neurol. 1983 Jul;40(7):433–5.
9. Hampson NB, Piantadosi CA, Thom SR, Weaver LK. Practice recommendations in the diagnosis, management, and prevention of carbon monoxide poisoning. Am J Respir Crit Care Med. 2012 Dec 1;186(11):1095–101.
10. Lee MS, Marsden CD. Neurological sequelae following carbon monoxide poisoning clinical course and outcome according to the clinical types and brain computed tomography scan findings. Mov Disord. 1994;9(5):550–8.
11. Chang KH, Han MH, Kim HS, Wie BA, Han MC. Delayed encephalopathy after acute carbon monoxide intoxication: MR imaging features and distribution of cerebral white matter lesions. Radiology. 1992;184(1):117–22.
12. Betterman K, Patel S. Neurologic complications of carbon monoxide intoxication. Handb Clin Neurol. 2014;120:971–9.
13. Weaver LK. Carbon monoxide poisoning. N Engl J Med. 2009;360(12):1217–25.
14. Vieregge P, Klostermann W, Blümm RG, Borgis KJ. Carbon monoxide poisoning: clinical, neurophysiological, and brain imaging observations in acute disease and follow-up. J Neurol. 1989;236(8):478–81.
15. Zagami AS, Lethlean AK, Mellick R. Delayed neurological deterioration following carbon monoxide poisoning: MRI findings. J Neurol. 1993;240(2):113–6.
16. Uchino A, Hasuo K, Shida K, Matsumoto S, Yasumori K, Masuda K. MRI of the brain in chronic carbon monoxide poisoning. Neuroradiology. 1994;36(5):399–401.
17. Hampson NB. Emergency department visits for carbon monoxide poisoning in the Pacific Northwest. J Emerg Med. 1998;16(5):695–8.
18. Hampson NB. U.S. Mortality Due to Carbon Monoxide Poisoning, 1999-2014. Accidental and Intentional Deaths. Ann Am Thorac Soc. 2016 Oct;13(10):1768–74.
19. Mott JA, Wolfe MI, Alverson CJ, Macdonald SC, Bailey CR, Ball LB, et al. National vehicle emissions policies and practices and declining US carbon monoxide-related mortality. JAMA. 2002 Aug 28;288(8):988–95.
20. Weaver LK, Hopkins RO, Chan KJ, Churchill S, Elliott CG, Clemmer TP, et al. Hyperbaric oxygen for acute carbon monoxide poisoning. N Engl J Med. 2002;347(14):1057–67.
21. Olson KR. Carbon monoxide. Poisoning Drug Overdose Fifth Ed N Y NY McGraw-Hill. 2007;
22. Ginsburg R, Romano J. Carbon monoxide encephalopathy: need for appropriate treatment. Am J Psychiatry. 1976;
23. Wolf SJ, Lavonas EJ, Sloan EP, Jagoda AS. Clinical policy: critical issues in the management of adult patients presenting to the emergency department with acute carbon monoxide poisoning. J Emerg Nurs. 2008;34(2):e19–32.
24. Juurlink DN, Buckley NA, Stanbrook MB, Isbister GK, Bennett M, McGuigan MA. Hyperbaric oxygen for carbon monoxide poisoning. Cochrane Database Syst Rev. 2005;1.

Fig 6. Electroencephalographic recording showing diffused brain slowing