Original Article

Neurotoxiclogy

Histomorphological Evidences of *Moringa oleifera's* Ameliorative Effects against Lead Toxicity in Cerebral Cortex

Joshua OWOLABI [1,*], Felicia WILLIAM [2], John OLANREWAJU [3], Temitope ETIBOR [3], Oluseyi FABIYI [1]

ABSTRACT [ENGLISH/ANGLAIS]

Lead toxicity has been a global health challenge due to the seriously deleterious effects produced on most body tissues by lead poisoning. The primary objective of this research was to investigate and evaluate the possibility, nature and extent of Moringa oleifera leaf extract on the frontal lobe of the cerebral cortex of experimental animal models modulated into conditions relatively similar to those of the human body. Thirty male rats (n=30) were used and divided into five groups, with six in each group (n=6), labeled Groups A–E. Group A served as the control, Group B was administered moringa only, Group C was administered Lead only, Group D was administered lead and moringa concurrently and Group E, lead for the first half of the treatment period and thereafter moringa extract. All administrations lasted 30 days; employing dosages of 50mg/kg body weight of lead and 100mg/kg body weight of moringa. The animals were sacrificed and histological preparations were made from the cerebral cortex tissues for histological analysis. Lead produced significant neuronal loss in the treated groups as observable in the numerous vacoulations in the photomicrographs. Moringa leaf administration, whether concurrently or after lead treatment produced observable ameliorative effects. Moringa oleifera leaf extract produced ameliorative effects against lead toxicity in the cerebral cortex.

Keywords: Histology, morphology, toxicity, cerebral cortex, *Moringa oleifera*, lead toxicity

RÉSUMÉ [FRANÇAIS/FRENCH]

La toxicité du plomb est un problème de santé mondial en raison des effets délétères sérieux produites sur la plupart des tissus de l'organisme par un empoisonnement au plomb . L'objectif principal de cette recherche était d'étudier et d'évaluer la possibilité, la nature et l'étendue de Moringa oleifera extrait de feuilles sur le lobe frontal du cortex cérébral de modèles animaux expérimentaux modulé en conditions relativement similaires à celles du corps humain . Trente rats mâles (n = 30) ont été utilisés et répartis en cinq groupes , dont six dans chaque groupe (n = 6) , marquée Groupes A- E . Groupe A a servi de contrôle , le groupe B a été administrée seule moringa , Groupe C a été administrée plomb seulement , Groupe D a été administré en même temps que le plomb et le moringa et le Groupe E , conduit pour la première moitié de la période de traitement et par la suite extrait de moringa . Toutes les administrations ont duré 30 jours; utilisant des doses de 50mg/kg de poids corporel du plomb et du poids corporel de 100mg/kg de moringa. Les animaux ont été sacrifiés et les préparations histologiques ont été effectuées à partir des tissus de cortex cérébral pour l'analyse histologique. Le plomb produit une perte neuronale importante dans les groupes traités comme observable dans les nombreux vacoulations dans les microphotographies. Administration de feuilles de Moringa, que ce soit simultanément ou après le traitement principal produit des effets améliorateurs observables. Extrait de Moringa oleifera feuilles produit des effets améliorateurs contre la toxicité du plomb dans le cortex cérébral.

Mots-clés: Histologie, de la morphologie, la toxicité, le cortex cérébral, le Moringa oleifera, la toxicité du plomb

Affiliations:

[1] Anatomy Department, Ben Carson Sr. School of Medicine, Babcock University, NIGERIA

[2] Department of Clinical Pharmacy and Pharmacy Practice, Faculty of Pharmaceutical Sciences, University of Ilorin, NIGERIA

[3] Anatomy Department, College of Health Sciences, University of Ilorin, NIGERIA

* Email Address for Correspondence/ Adresse de courriel pour la correspondance: olaowolabi001@yahoo.com

Accepted/Accepté: February 2014

Full Citation: Owolabi J, William F, Olanrewaju J, Etibor T, Fabiyi O, Histomorphological Evidences of Moringa oleifera's Ameliorative Effects against Lead Toxicity in Cerebral Cortex. World Journal of Life Sciences and Medical Research 2014;3(2):53-8.

INTRODUCTION

Lead toxicity has been a global health challenge due to the seriously deleterious effects produced on most body tissues by lead poisoning coupled with the several means by which lead can be accidentally ingested into the body systems. It is therefore important to explore the possibility of natural interventions that can either serve the purpose of therapy or prophylaxis. The primary objective of this research was to investigate and evaluate the possibility, nature and extent of Moringa oleifera leaf extract on the frontal lobe of the cerebral cortex of experimental animal models modulated into conditions relatively similar to those of the human body.

In our previous articles, we have successfully established that *Moringa oleifera* due to its ability to reduce the oxidative stress induced by lead toxicity; ability to serve

the purpose of a metallic ion absorbent and its high nutritional value could ameliorate and rejuvenate tissues damages as caused by lead poisoning in several tissues including the lung [1], testis [2], liver [3] and bone marrow elements [4].

The cerebrum is the rostralmost part of the mammalian brain also referred to as the telencephalon. Its cortex consists of the grey matter which basically has cell bodies as its content. Cerebral cortex cells include neurons as the basic functional cells as well as glia including astrocytes, oligodendrocytes and microglia. Other cells may include the endothelial cells of the blood vessels. From histological perspective, the cerebral cortex has six layers; though the six layers are not well defined in all cortical areas. The six layers, beginning form the most superficial to the deepest include the molecular Layer I; the external granular Layer II; the external pyramidal Layer III; the internal granular Layer IV; the internal pyramidal Layer V and the multiform Layer VI.

Lead is a shiny, blue-white soft metal, when its surface is fresh. Otherwise, lead would react rapidly with the oxygen and carbon dioxide in the air. Acute lead poisoning results from ingesting soluble lead compounds. The damage appears to be mainly to the nervous system and the effects not as acute, as those of mercury poisoning. Lead is an accumulative poison, building up until it reaches a toxic level. Lead is stored in the body mainly by compartments like blood, soft tissues and bone. Other tissues that store lead include brain, liver, spleen, kidneys and lungs. Half-life of lead in blood is measured in weeks, while that of soft tissues, in months and for bone, in years. In the brain, toxic effects include apoptosis of cells and other disorders of neurons and glia [5]. Mechanisms involved include alteration of calcium homeostasis [6], disruption of neurotransmitters systems and mechanism of action [5] and excito-toxicity [5]. Other mechanisms of actions include opening of mitochondrial transition pore, mitochondrial damage, inhibition of anti-oxidative enzymes, alteration of lipid metabolism, and proliferation of the astrocyte [5]. Wang *et al.*, [7] in another report suggested that the damage of cerebral cortex may be caused by lead toxicity that results from the changes of NOS activity, NO level, SOD activity and MDA content in cerebral cortex

Moringa is rich in antioxidants, amino acids, carbohydrates and several phytochemicals of pharmacological importance [8]. These properties have been suggested for why its leaf extracts have been used for treating nervous system related disorders including headache, epilepsy and hysteria [9].

MATERIALS AND METHODS

Thirty male Wistar rats (n=30), six months old on the average, were used and divided into five groups, with six in each group (n=6), labeled Groups A–E. Group A served as the control, Group B was administered moringa only, Group C was administered lead only, Group D was administered lead and moringa concurrently and Group E, lead for the first half of the treatment period and thereafter moringa extract. All administrations lasted 30 days; employing dosages of 50mg/kg body weight of lead and 100mg/kg body weight of moringa. The animals were sacrificed and histological preparations were made from the cerebral cortex tissues for histological analysis using the routine haematoxyline and eosin staining technique (Baker, 1962). Histological and cytological analyses were done with reference to the work of Garman [10}.

RESULTS AND DISCUSSION

In the control Group A illustrated in Figure A; At the magnification of 160; neurons and glia are observable as they are distributed in a somewhat particulate pattern across the layers of the cerebral cortex. Large pyramidal neurons are relatively prominent. At the x640 magnification neurons appear morphologically normal and healthy as they are predominantly monomorphic within layers and/or regions. Glia- astrocytes especially, population also support the above observation as astrocyte population and morphology appear normal. Oligodendrocyte and microglia morphology also appear normal. These observations also rule out any possibility of gliosis- an important indication or neuronal damage or 'ill health'. There is no vacoulation in the neuropil- ruling out neuronal loss or myelin or cell processes damage. The control group therefore presents a healthy and histomorphologically normal cerebral cortex.

When the animals were treated with moringa extract only as illustrated by photomicrographs in Figure B, neurons at lower magnification are adequately distributed across the cerebral cortex. Relative to the control, a few neurons, mostly pyramidal appear quite large and distinct within the cerebral cortex. Most other neurons however have morphology similar to the control. The astrocytes appear more prominent than in the control group. Glia population and general morphology however appear normal. The Group cerebral cortex does not have any

observable histomorphological disruption. The few aforementioned observed variations indicate that moringa's administration on its own could influence brain cells morphology; most evidences however show that such effects in this study were not deleterious or histo and cytologically disruptive. The cortex in this group is thereby considered healthy.

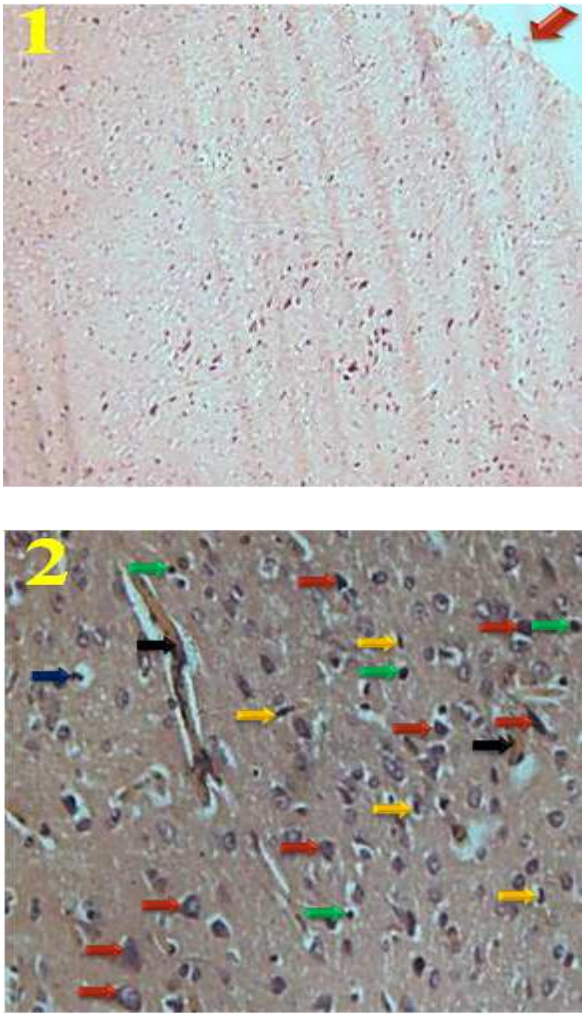


Figure A: Photomicrographs of the cerebral cortex of the control Group A animals 1- X160 and 2-640. Photomicrograph 1 shows normal histological architecture while 2 shows neurons, mainly granular (indicated by red arrows) and glia (yellow, blue and green arrows) integrity appearing normal and clearly defined

In the Group C , that has animals exposed to lead poisoning throughout the duration of experiment (Figure C) neurons are barely distinct and observable at the lower magnification- a sign of cytological disruption. A feature that is peculiar to the histology of this cortex include numerous vacoulations. At the higher magnification, it is clear that the vacoulations are due to extensive damage

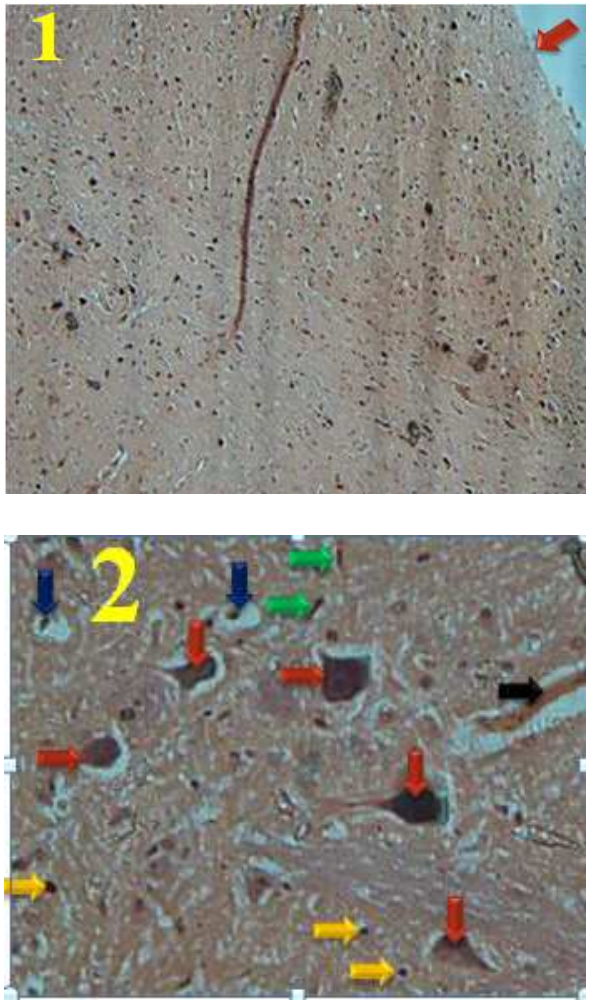
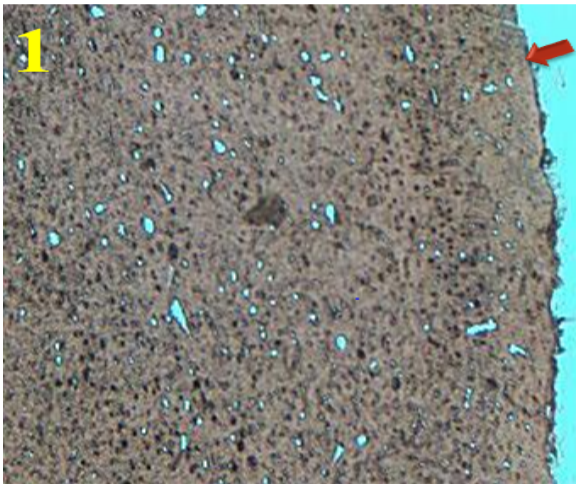


Figure B: Photomicrograph of the cerebral cortex of the Group B animals 1- X160 and 2-640; administered moringa leaf extract only throughout the period of treatment. Photomicrograph 1 shows normal histological architecture while 2 show neurons, mainly pyramidal (indicated by red arrows) and glia (yellow, blue and green arrows) integrity appearing normal and clearly defined

not only to neurons but also to the glia and the extensive processes of the cells. Individually, the neurons appear to be undergoing degeneration as cell bodies are poorly stained, with distorted morphology exhibiting features of acute eosinophilic neuron degeneration [10]. Neuronal population exhibit polymorphic features. Glial astrocyte population appears to have increased in reactions to

neuronal damage. Oligodendrocytes are almost not distinguishable; a sign that suggest axonal degeneration. Microglia too are barely distinguishable. The observed vacoulations are therefore due to extensive loss of adjacent neurons, their processes and surrounding supportive glia cells. This is a clear indication of lead toxicity deleterious effects.



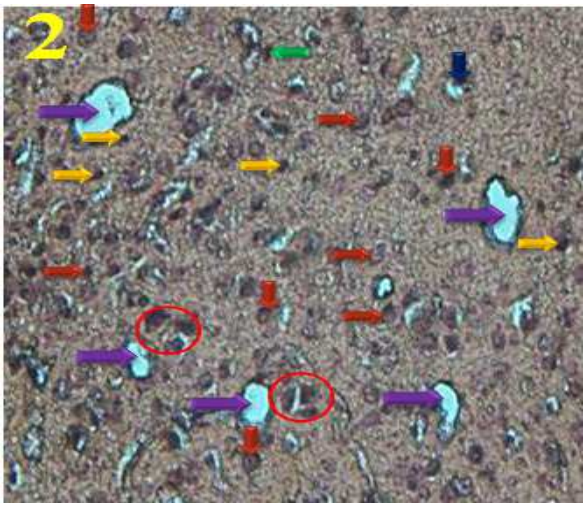
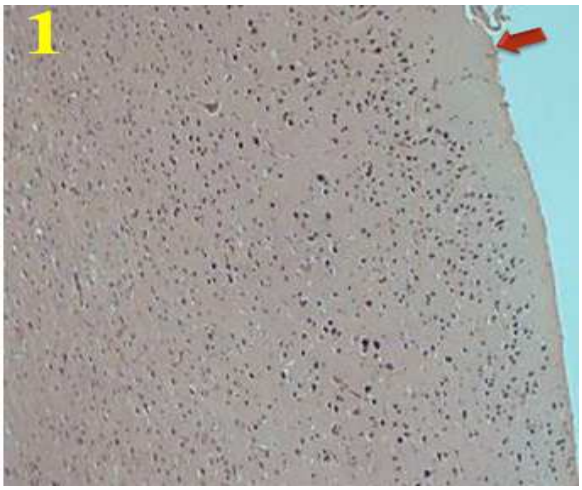


Figure C: Photomicrograph of the cerebral cortex of the Group C animals 1- X160 and 2-640; administered lead only throughout the period of treatment. Photomicrographs at both magnifications show large vacoulations indicated by the purple arrows with neurons (indicated by red arrows) and glia (yellow and green arrows) integrity much distorted and not clearly defined

Group D animals which were treated with lead and moringa leaf extract concurrently have their cerebral cortex represented as Figure D. The neurons are adequately distributed across the cerebral cortex. Neurons are prominent with well-defined morphology; the glia also appears normal. There are no observable cytological and histological damages. It is clear that that moringa extract has a higher level of effectiveness in its prophylactic - when used concurrently to cancel the deleterious effects of lead poisoning, than its therapeutic effects- when used to treat damages caused by lead poisoning deleterious effects.



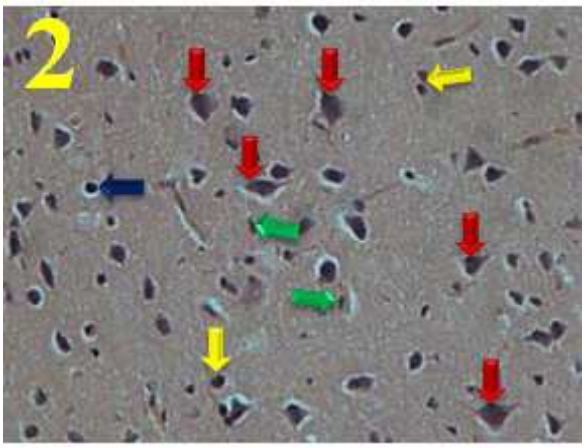


Figure D: Photomicrograph of the cerebral cortex of the Group D animals 1- X160 and 2-640; administered lead and moringa leaf extract concurrently throughout the period of treatment. Photomicrograph 1 shows no sign of general histological disruption; neurons and glia in 2 are also observable, however less populated than in the control

In the Group E treated with lead first and thereafter, moringa leaf extract (Figure E) neurons are clearly observable at the every chosen magnification. Vacoulations are not observed in this Group. Oligodendrocytes are more compared to Group C, even A and B. Microglia are also clearly distinguishable. Neurons however still appear polymorphic in some parts. A few neurons show signs of karyorrhexis (fragmentation of the

nucleus as a sign of impending cell death) (10). The therapeutic effects of the administered moringa extract in this group produced observable positive effects by preserving the general histoarchitecture and preventing excessive cell morphology distortion.

These results share similarities with the previous work of Engin [11], and that of Amal and Mona [12] who all reported the nature of lead deleterious effects on the cerebral cortex. The latter also reported that antioxidants could ameliorate such effects.

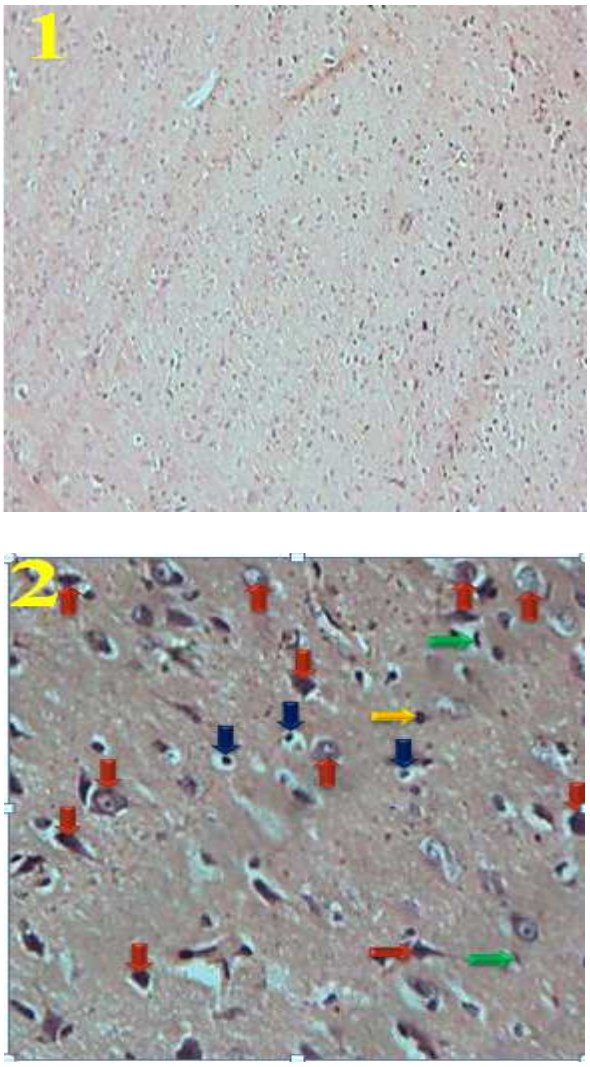


Figure E: Photomicrograph of the cerebral cortex of the Group E animals 1- X160 and 2-640; administered lead for the first half and moringa leaf extract fir the second half of experiment duration. Photomicrograph 2 shows polymorphic neurons and abundant and prominent glia.

CONCLUSION

Lead exposure in adult Wistar rat brains produced deleterious effects that are histologically observable in forms of cell death, histological disruption and vacoulations. Moringa leaf extract administration, whether concurrently or after lead treatment produced ameliorative effects.

REFERENCES

[1] Owolabi J, Ghazal O, Dare M, Olanrewaju J, Caxton-Martins A, Williams F. Prophylactic and regenerative effects of alcoholic extract of Moringa oleifera on rat lung tissue following lead-induced damage. European Journal of Anatomy 2013; 17(2):115-122.

[2] Owolabi JO, Ghazal OK, Williams FE, Ayodele EO. Effects of Moringa Oleifera (Drumstick) Leaf Extracts on Lead-Induced Testicular Toxicity In Adult Wistar Rat (Rattus Novergicus). International Journal of Biotechnology and Biomedical Research 2012; 2(1).

[3] Ghazal OK, Owolabi JO, William FE, Lambe E. Effects of Ethanolic Extract of Moringa Oleifera Leaves On Lead Acetate Induced Liver Damage In Adult Wistar Rats. International Journal of Biotechnology and Biomedical Research, 2012; 2(1).

[4] Owolabi JO, Opoola E2 and Caxton-Martins EA. Healing and Prophylactic Effects of Moringa oleifera Leaf Extract on Lead Induced Damage to Haematological and Bone Marrow Elements in Adult Wistar Rat Models. Open Access Scientific Reports, 2012; (1) 8.

[5] Lidsky TI and Schneider JS. Lead Neurotoxicity in children: basic mechanism and clinical correlates Brain 2003; 126, 5-9.

[6] Bressler TI and Goldtserin GW. Meahnism of lead neurotoxicity. (review). Biochem Pharamcol 1991; 41: 479-84.

[7] Wang S, Zhou W, Wei M, Zhang G. Effects of lead on NO, NOS, SOD, MDA in rat cerebral cortex. Wei Sheng Yan Jiu (Article in chinese), 2002; 31(4):226-8..

[8] Fahey JW. Moringa Oleifera: A Review of the Medical Evidence for its Nutritional, Therapeutic, and Prophylactic Properties. Part 1. Trees for Life Journal, 2005; (1)5.

[9] Fuglie LJ . The Miracle Tree: Moringa oleifera: Natural Nutrition for the Tropics. Church World Service, Dakar 2001; 68; revised in and published as The Miracle Tree: The Multiple Attributes of Moringa, p 172.

[10] Garman RH. Histology of the Central Nervous System. Toxicol Pathol 2011;39(1):22-35 .

[11] Engin D. Ultrastructural effects of lead acetate on brain of rats. Toxicology and Industrial Health 2006; 22(10): 419 – 422.

[12] Amal EA and Mona HM. Protective effect of some antioxidants on the brain of adult male albino rats, Rattus rattus , exposed to heavy metals. Bioscience Research, 2009; 6(1): 12-19.

ACKNOWLEDGEMENT / SOURCE(S) OF SUPPORT

Nil.

CONFLICT OF INTEREST

No conflicts of interests were declared by authors.