



# Protective Effects of Vitamin E on Mobile Phone Induced Injury in The Brain of Rats

Sibghatullah Muhammad Ali Sangi<sup>1\*</sup>, Abdulhakim Bawadekji<sup>2</sup>, Nawaf M Alotaibi<sup>1</sup>,  
Ahmed M. Aljameeli<sup>1</sup>, Samreen Soomro<sup>1</sup>

<sup>1</sup> Faculty of Pharmacy, Northern Border University, P.O.Box840, Rafha-91911, Saudi Arabia.

<sup>2</sup> College of Science, Northern Border University, P.O.Box 1321, Arar 91431, Saudi Arabia.

## ABSTRACT

**Aim:** With increase in use of cell phone and exposure to radiation emission from Wi-Fi, cell damage in all the body systems is found. It is necessary to find ways and means to prevent that cell damage that may affect normal functioning of the organs etc. The objective of this study was to assess the damage to brain caused by exposure to cell phones connected with Wi-Fi and prevention of that damage with Vitamin E. **Methods:** Thirty male Wistar Albino rats were used in the study, rats were divided in different groups, they were exposed to cell phones and Wi-Fi for 8 weeks. The rats were treated with Vit. E 50 IU/kg of bodyweight for 4 weeks. **Results:** Histopathological examination of the rat brain revealed that, exposure of rats to cell phones and Wi-Fi caused significant damage to the neurons in different areas of rat brain. The rats treated with Vit. E showed less damage in comparison to untreated rat groups. **Conclusion:** In the brain of rats, treated with Vit. E intact neuronal architecture was found along with less inflammation.

**Key Words:** Cell phone, Wi-Fi, Brain, Vitamin E, Antioxidant

eIJPPR 2020; 10(1):97-104

**HOW TO CITE THIS ARTICLE:** Sibghatullah Muhammad Ali Sangi, Abdulhakim Bawadekji, Nawaf M Alotaibi, Ahmed M. Aljameeli, Samreen Soomro (2020). "Protective Effects of Vitamin E on Mobile Phone induced injury in the Brain of rats", International Journal of Pharmaceutical and Phytopharmacological Research, 10(1), pp.97-104.

## INTRODUCTION

The brain is an organ that's comprise a large mass of nerve tissue that's enclosed by within the skull. Major functions include sensory information processing, blood pressure regulation, breathing, and releasing hormones [1].

Brain damage is any harm that causes the destruction or impairment of brain cells. It occurs as a result of a wide range of internal and external factors. Brain damage can be defined as significant, indiscriminating trauma-induced damage, while neurotoxicity typically attributed to selective, chemically induced neuron damage [2].

Brain damage may occur via a wide range of conditions, illnesses, or injuries. Possible causes may include prolonged hypoxia (shortage of oxygen), poisoning, infection, and neurological illness. trauma; multiple

traumatic injuries can lead to chronic traumatic encephalopathy [3, 4].

Oxidative stress is recognized as a main mediating process in the pathogenesis of cell damage and associated complications in different body systems, due to increased production of free radicals and abnormal antioxidant defense [5, 6]. It has also been found in previous studies that use of antioxidants (natural as well as synthetic) prevent cell damage into different organs due to diseases which enhance the oxidative stress or the direct insulting factors to the cells [7-9].

The brain damage caused by radiation depends on where the brain tumor is found, the quantity of radiation used, and the duration of the treatment. Radiosurgery can also lead to tissue damage that results in about 1 in 20 patients requiring a second operation to remove the damaged tissue [10, 11]. A study conducted by [12, 13], stated that there

**Corresponding author:** Dr. Sibghatullah Sangi

**Address:** Faculty of Pharmacy, Northern Borders University, Rafha, kingdom of Saudi Arabi.

**E-mail:** doctor\_sangi@yahoo.com

**Relevant conflicts of interest/financial disclosures:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

**Received:** 22 September 2019; **Revised:** 11 January 2020; **Accepted:** 20 January 2020



were no relationship between locations or regions of the brain exposed to radiations and brain tumor . It has also been concluded that there is a risk of acoustic neuroma as well as glioma [14-16], and it increases with the increase in the cell phone use duration.

Mobile or cell phones now a days became an important part of current telecommunications in every individual life. In numerous countries, over half of the population use mobile phones. although mobile phones are used by billions of individuals globally, a little increase within the incidence of adverse effects on health could have major public health implications on long term basis. Moreover, the number of cell phone calls every day, the length of each call and the amount of time people use phones are important factors which increase the health related hazard [17].

Biological effects of electromagnetic radiation (EMR) emitted by a mobile phone have become a subject of an intense argument. A summary of the studies' results was published lately by Kesari *et al.* [18] on which the authors conclude that the "regular and long term use of microwave devices, especially mobile phones, can have a negative impact upon biological system, especially on brain, because the electromagnetic force source is held very close to the user's head".

Vitamin E is a potent antioxidant, soluble in lipids, preventing the propagation of free radicals and subsequent changes in membranes as well as plasma lipoproteins [19]. The antioxidant effect of Vitamin E, which suppresses the free radical production and assist the neuroprotective effect have been reported by several studies [20-23].

## MATERIALS AND METHODS:

### Animals:

Thirty Male Wistar Albino rats were obtained from the animal unit in faculty of pharmacy, Northern Border University and used in the study, each weighing 240-260 g and 8 weeks old at the beginning of the experiment. They were housed in polycarbonate cages. They were kept in an environment of controlled temperature (25-26 °C), humidity (55-60%), and controlled light and dark period for 5 days before the start of the experiment. A standard balanced diet and tap water were provided.

### Experimental Design:

The rats were randomized, based on body weight into 5 groups, prior to test item administration, the animals were randomized into groups as follows:

G1 (Vehicle control), whereas G2 was a treatment control exposed to mobile phone for 8 weeks. Groups, G3 and G4 were administered with Vitamin E 50 IU/kg of body weight for 4 weeks. These groups were exposed to mobile phones connected with Wi-Fi, daily 24 hours for 8 weeks. G5, were exposed to mobile phones daily 24 hours for 8 weeks.

Whereas, groups, G6 were administered with Vitamin E 50 IU/kg of body weight for 4 weeks.

All the animals were observed daily twice for signs of morbidity and mortality during the experimental period. Mobile phones were given calls after every 2 hours for 2 minutes.

### Histopathological examination:

After removing the brain from skull, brain was sectioned sagittally. Right hemispheres were removed and fixed with a buffered 10% formalin solution for 24 h and embedded in paraffin. Tissues were then sectioned, stained with hematoxylin and eosin (H&E) and examined for histopathological changes using light microscope.

## RESULTS:

### Cerebellum:

#### Group – 1 Normal Filtered water (ad libitum)

Section from cerebellum shows partially distorted architecture consisting of focally intact molecular layer, granular layer [Fig.1, Arrow] and white matter [Fig.2, Arrow].

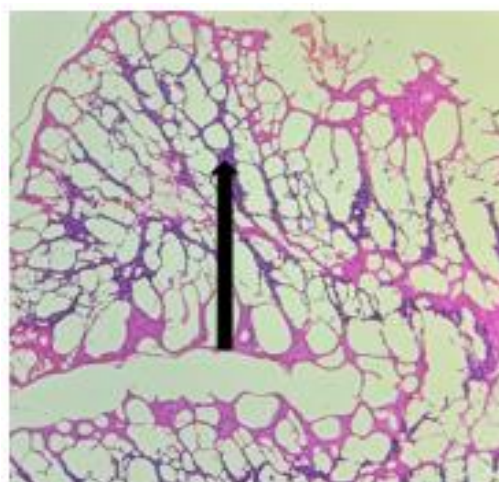


Figure 1. H&E x50

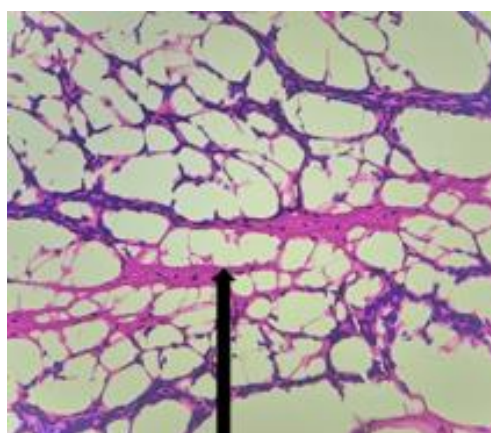
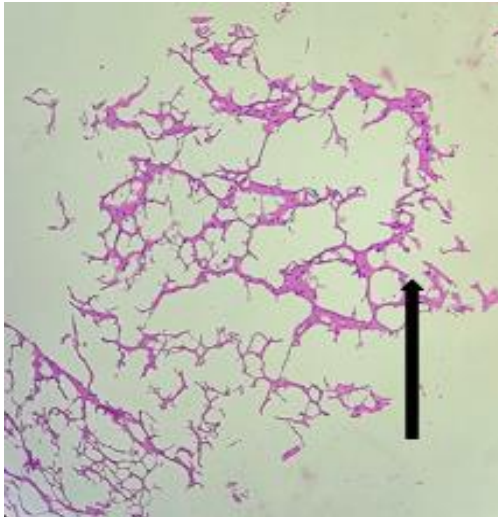


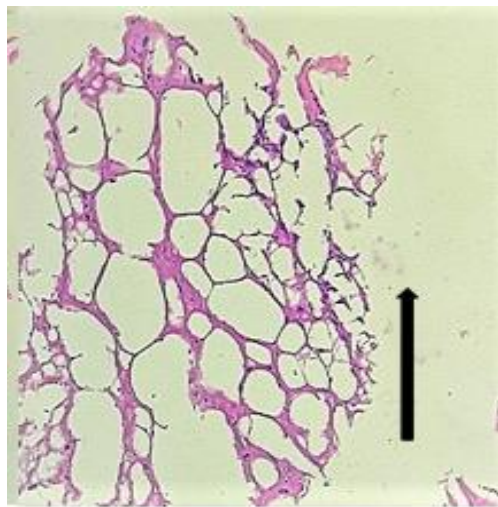
Figure 2. H&E x200 Group – 3

**Group – 3 EMR 900MHz (1hr/day) + Vit E**

Section from cerebellum shows completely distorted architecture consisting of scanty molecular layer [Fig.3, Arrow]. The compact granular layer appears completely disrupted [Fig.4, Arrow]. The white matter cannot be assessed.



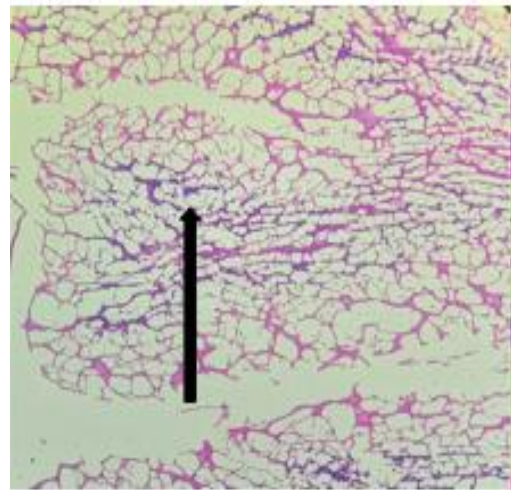
**Figure 3. H&E x50**



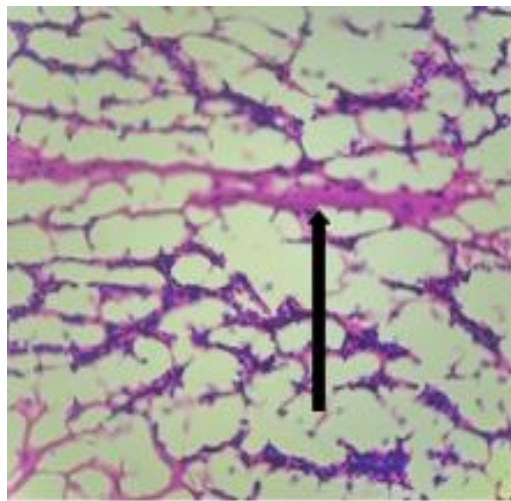
**Figure 4. H&E x200**

**Group – 6 (Vit E)**

Section from cerebellum shows partially distorted architecture consisting of focally intact molecular layer. The compact granular layer appears disrupted at places [Fig.5, Arrow] along with white matter [Fig.6, Arrow].



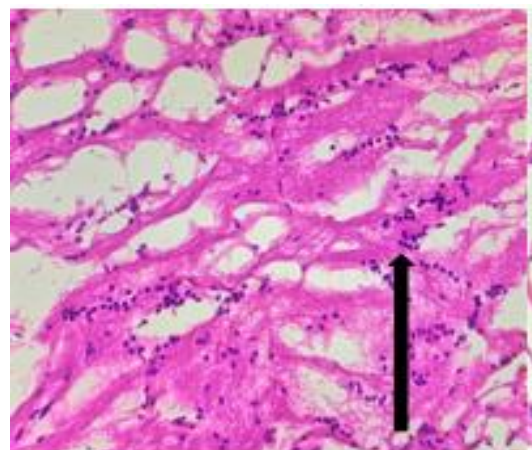
**Figure 5. H&E x50**



**Figure 6. H&E x2**

**Group – 3 EMR 900MHz (1hr/day) + Vit E**

Section studied from the brain parenchyma shows partially preserved intact architecture. The pyramidal cells and neuroglial cells appear within normal limits [Fig.7, Arrow] with dense patchy inflammatory cell infiltration [Fig.8, Arrow]. The blood vessels appear unremarkable.



**Figure 7. H&E x50**

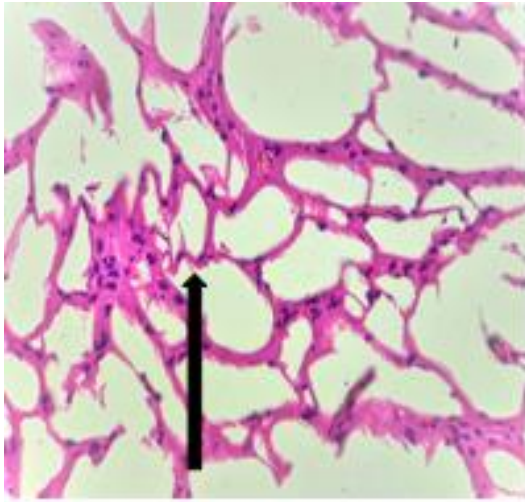


Figure 8. H&E x200

**Group – 4EMR 900MHz (1hr/day) + Vit E**

Section studied from the brain parenchyma shows scanty preserved intact architecture. Some of the pyramidal cells and neuroglial cells show degenerative changes [Fig.9, Arrow] with sparse inflammatory infiltration [Fig.10, Arrow]. The blood vessels appear unremarkable.

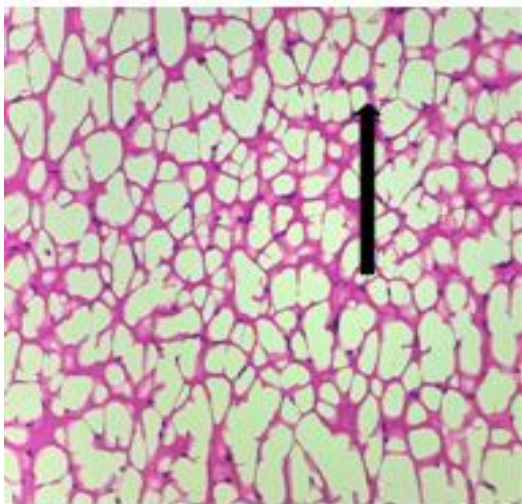


Figure 9. H&E x50

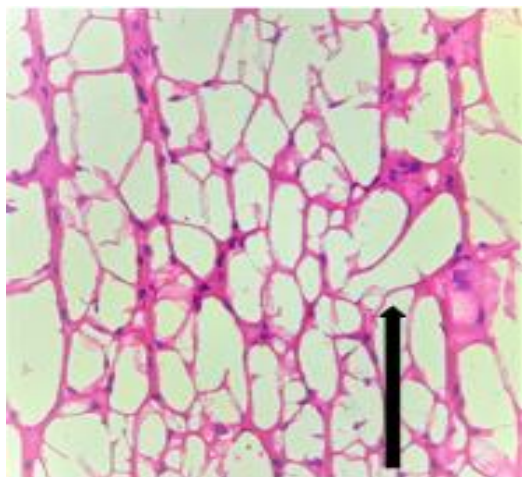


Figure 10. H&E x200

**Hippocampus**

**Group – 2 EMR 900MHz (1hr/day) only**

Sections from Hippocampus [Fig11., Arrow] shows distorted architecture consisting of cornuammonis [CA] and dentate gyrus. Stratum moleculare, Stratum pyramidale, Stratum radiatum, Granular cell layer and Fascia dentata appear distorted partially [Fig.12, Arrow]. Areas containing distorted cells are seen.

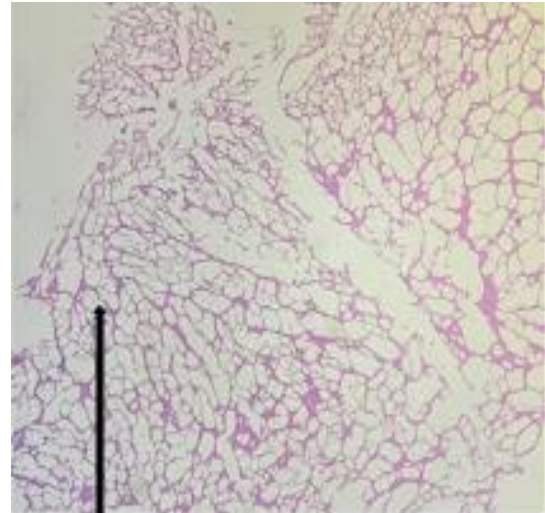


Figure 11. H&E x50

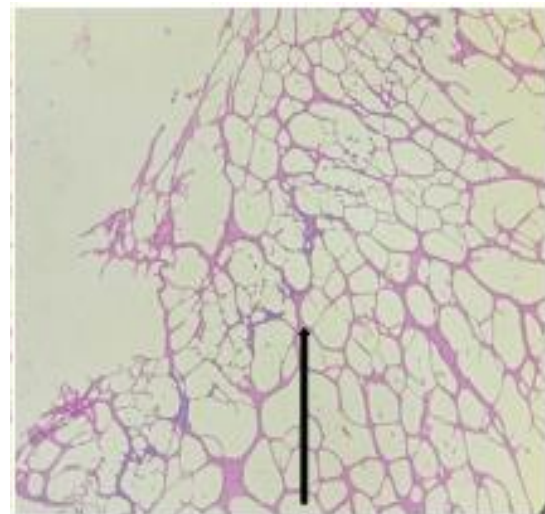


Figure 12. H&E x200

**Group – 3 EMR 900MHz (1hr/day) + Vit E**

Sections from Hippocampus [Fig.13, Arrow] shows intact architecture consisting of cornuammonis [CA]and dentate gyrus. Stratum moleculare, Stratum pyramidale, Stratum radiatum, Granular cell layer and Fascia dentata appear within normal limits [Fig.14, Arrow].

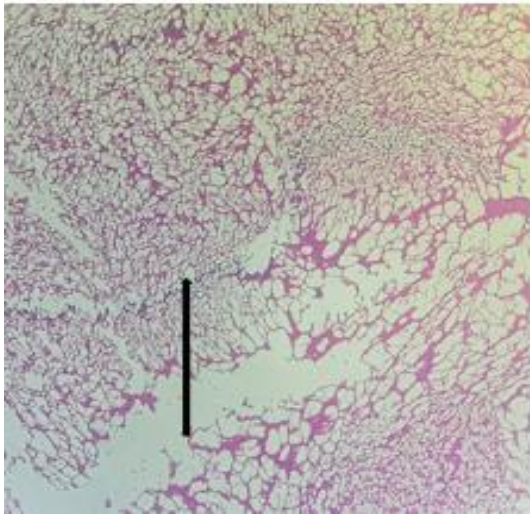


Figure 13. H&E x50

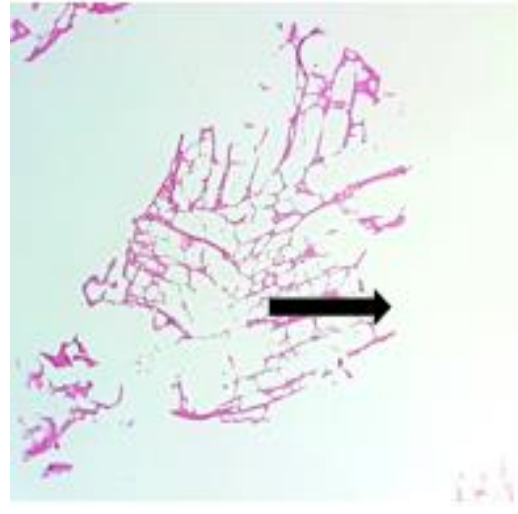


Figure 16. H&E x200

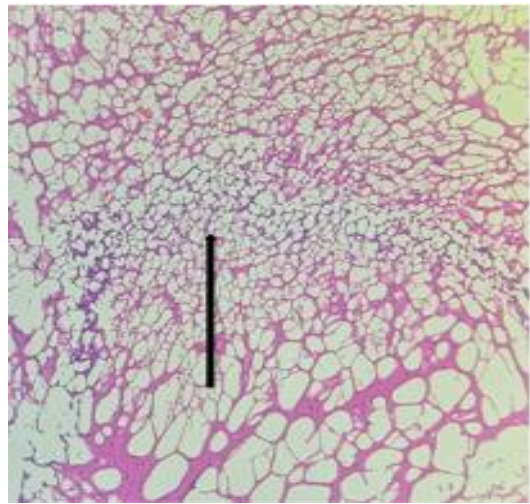


Figure 14. H&E x200

**Group-5: EMR 900MHz (1hr/day) + Vit. E (50 IU/kg)**  
Section from putamen shows partially distorted architecture consisting of focally preserved white bundle matter containing good number of deep nuclei [Fig.17, Arrow] interspersed in neuropilfibers [Fig.18, Arrow].

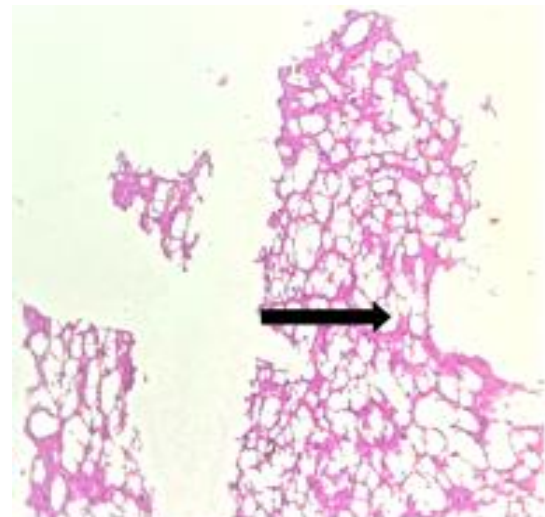


Figure 17. H&E x50

#### Caudate Putamen

##### Group-4: EMR 900MHz (1hr/day) + Vit E

Section from putamen shows completely distorted architecture with areas of disrupted white bundle matter containing few nuclei [Fig.15, Arrow] interspersed in completely disrupted neuropilfibers [Fig.16, Arrow].

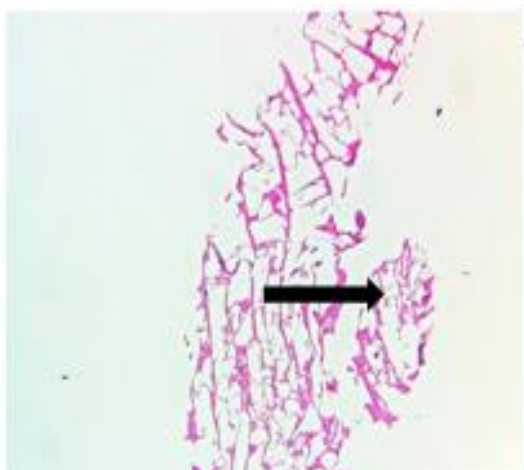


Figure 15. H&E

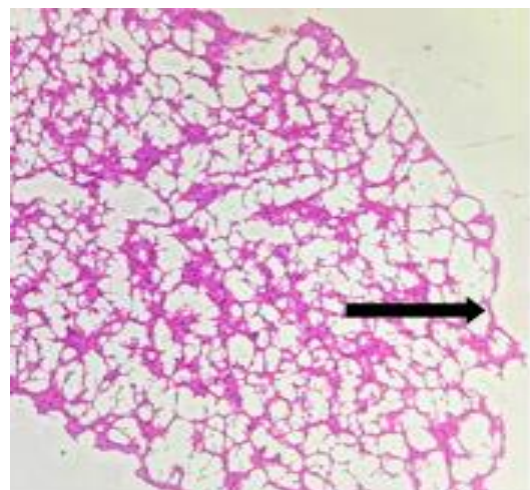


Figure 18. H&E x200

## DISCUSSION

The use of mobile phones is currently one of the most growing technological developments. The effect of radiation transmitted from mobile phones and other wireless electronic devices on human health is a subject of interest and study around the world, as a result of the enormous increase in mobile phone usage throughout the world [24]. The close proximity of the antenna of a phone to the abdominal organs has increased the concerns about the biological interactions between electromagnetic radiation and body organs [25].

Although the WHO stated that "A large number of studies have been performed over the last two decades to assess whether mobile phones pose a potential health risk. To date, no evidence of adverse effects on health have been established as being caused by mobile phone use." [26] Hardelet *al.*, and Lonnet *al.* [27, 28], concluded that exposure to mobile phone radiation depending on duration time of mobile phone use, will result in increased possibility of incidence of brain tumors and acoustic neurinoma.

From the histopathological results of our study it is evident that exposure to cell phones and Wi-Fi, produce significant inflammatory process in the different areas of brain these findings are similar to researches conducted by [29, 30]. Although the duration of the study was not very long even then the damaging effects were observed. Continuous exposure may lead to prolonged inflammation in the brain leading to the cerebral edema, loss or impairment into the function of the organs and systems which are being controlled by the area in which damage occurs and increased risk of cancer due to repeated mutations in the area [31-33]. In this research it was observed that standard antioxidant Vit E, when used simultaneously with exposure to Wi-Fi and mobile phone, prevented the damage to brain cells and decreased inflammation was seen, these findings in the present study are consistent with the findings of [34] which concluded that vitamin E, seem to be highly promising agents for protecting endometrium tissue from oxidative damage and improving histopathologic changes caused by 900MHz EMR exposure which may alter the antioxidant capacity and catalase in rat brain [35]. The decrease in inflammation and damage to the nervous tissue can be attributed to a decrease in oxidative stress by Vitamin E which enhance nerve tissues protection by the removal of the free radicals and stabilizing the cell membranes [36, 37].

It can be concluded that use of mobile phones and Wi-Fi cause inflammation and brain damage partly by increasing the free radical formation and partly by direct damage to the cells.

### Conflict of interest:

The authors declare that there is no conflict of interest.

## ACKNOWLEDGEMENT:

The author wishes to acknowledge the approval and the support of this research study by the grant No (7725-PHM-2018-39-F) from the Deanship of Scientific Research in Northern Border University (N.B.U.), Arar, KSA.

## REFERENCES

- [1] Retrieved from <https://www.healthline.com> medically reviewed by Seunggu Han, MD on March 13, 2018 — Written by Jill Seladi-Schulman, PhD.
- [2] Retrieved from [https://en.wikipedia.org/wiki/Brain\\_damage](https://en.wikipedia.org/wiki/Brain_damage) accessed on 26/1/2020.
- [3] "Birth Hypoxia and Brain Damage to Newborns". Michael E. Duffy. Archived from the original on 2013-08-05. Retrieved 2013-07-27.
- [4] "Overview of Brain Dysfunction – Brain, Spinal Cord, and Nerve Disorders – Merck Manuals Consumer Version". Merck Manuals Consumer Version. Retrieved 2016-12-09.
- [5] Ceriello, A. New insights on oxidative stress and diabetic complications may lead to a "causal" antioxidant therapy. *Diabetes care*, 2003; 26(5), 1589-1596.
- [6] Oswald, M.C., Garnham, N., Sweeney, S.T. and Landgraf, M. Regulation of neuronal development and function by ROS. *FEBS letters*, 2018; 592(5), 679-691.
- [7] Sangi, Sibghatullah Muhammad Ali, Nora Abdulaziz Al Jalaud.. Prevention and Treatment of Brain Damage in Streptozotocin Induced Diabetic Rats with Metformin, Nigella Sativa, Zingiber Officinale, and Punica Granatum. *Biomedical Research and Therapy*, 2019; 6(7), 3274–3285.
- [8] Sangi, S.M.A., Sulaiman, M.I., El-Wahab, M.F.A., Ahmedani, E.I., Ali, S.S. Antihyperglycemic effect of thymoquinone and oleuropein, on streptozotocin-induced diabetes mellitus in experimental animals. *Pharmacognosy magazine*, 2015; 11(Suppl 2), p.S251.
- [9] Sangi, S., El-feky, S.A., Ali, S.S., Ahmedani, E.I., Tashtoush, M. Hepatoprotective effects of oleuropein, thymoquinone and fruit of phoenix dactylifera on CCl<sub>4</sub> induced hepatotoxicity in rats. *World J Pharm PharmaceutSci*, 2014; 3, p.3475e3486.
- [10] Frei, P., Poulsen, A.H., Johansen, C., Olsen, J.H., Steding-Jessen, M., Schüz, J. Use of mobile phones and risk of brain tumours: update of Danish cohort study. *Bmj*, 2011; 343.
- [11] Little, M.P., Rajaraman, P., Curtis, R.E., Devesa, S.S., Inskip, P.D., Check, D.P., Linet, M.S. Mobile phone use and glioma risk: comparison of

- epidemiological study results with incidence trends in the United States. *Bmj*, 2012; 344, p.e1147.
- [12] Hardell, L., CARLBERG, M.I.C.H.A.E.L., Hansson Mild, K. Pooled analysis of case-control studies on malignant brain tumours and the use of mobile and cordless phones including living and deceased subjects. *International journal of oncology*, 2011; 38(5), 1465-1474.
- [13] Howlader, N., Noone, A.M., Krapcho, M., Garshell, J., Neyman, N., Altekruse, S.F., Kosary, C.L., Yu, M., Ruhl, J., Tatalovich, Z., Cho, H. SEER Cancer Statistics Review. Bethesda, MD: National Cancer Institute; 2013; 1975–2010.
- [14] Hardell, L., Carlberg, M., Mild, K.H. Use of mobile phones and cordless phones is associated with increased risk for glioma and acoustic neuroma. *Pathophysiology*, 2013; 20(2), 85-110.
- [15] Baan, R., Grosse, Y., Lauby-Secretan, B., El Ghissassi, F., Bouvard, V., Benbrahim-Tallaa, L., Guha, N., Islami, F., Galichet, L., Straif, K., 2011. Carcinogenicity of radiofrequency electromagnetic fields. *The lancet oncology*, 2011; 12(7), 624-626.
- [16] Prevention, Cancer Resources from OncoLink Treatment, Research, Coping, Clinical Trials. "Possible Side Effects of Radiation Treatment for Brain Tumors OncoLink". [www.oncolink.org](http://www.oncolink.org). reviewed November 25, 2019. Retrieved 22 september 2019.
- [17] Johannesen, T.B., Lien, H.H., Hole, K.H., Lote, K. Radiological and clinical assessment of long-term brain tumour survivors after radiotherapy. *Radiotherapy and Oncology*, 2003; 69(2), 169-176.
- [18] Kesari, K.K., Siddiqui, M., Meena, R., Verma, H.N., Kumar, S. Cell phone radiation exposure on brain and associated biological systems. *Indian Journal of Experimental Biology*, 2013; 51(3), 187-200.
- [19] Dobrovolny, J., Smrcka, M. and Bienertova-Vasku, J. Therapeutic potential of vitamin E and its derivatives in traumatic brain injury-associated dementia. *Neurological Sciences*, 2018; 39(6), 989-998.
- [20] Hoshida, S., Hatano, M., Furukawa, M., Ito, M. Neuroprotective effects of vitamin E on adult rat motor neurones following facial nerve avulsion. *Actaoto-laryngologica*, 2009; 129(3), 330-336.
- [21] Al-Malki, A.L., Moselhy, S.S. Protective effect of vitamin E and epicatechin against nicotine-induced oxidative stress in rats. *Toxicology and industrial health*, 2013; 29(2), 202-208.
- [22] Yargıçođlu, P., Yaraş, N., Ađar, A., Gümüşlü, S., Bilmen, S., Özkaya, G. The effect of vitamin E on stress-induced changes in visual evoked potentials (VEPs) in rats exposed to different experimental stress models. *ActaOphthalmologicaScandinavica*, 2003; 81(2), 181-187.
- [23] Galal, M.K., Khalaf, A.A.A., Ogaly, H.A. and Ibrahim, M.A. Vitamin E attenuates neurotoxicity induced by deltamethrin in rats. *BMC complementary and alternative medicine*, 2014; 14(1), 458.
- [24] Awad, S.M., Hassan, N.S. Health Risks of electromagnetic radiation from mobile phone on brain of rats. *J. Appl. Sci. Res*, 2008; 4(12), 1994-2000.
- [25] Deniz, Ö.G., Kıvrak, E.G., Kaplan, A.A. Altunkaynak, B.Z. Effects of folic acid on rat kidney exposed to 900 MHz electromagnetic radiation. *Journal of microscopy and ultrastructure*, 2017; 5(4), 198-205.
- [26] "Electromagnetic fields and public health: mobile phones". WHO. 8 October 2014. Retrieved 19 January 2018.
- [27] Hardell, L., Mild, K.H. and Carlberg, M. Further aspects on cellular and cordless telephones and brain tumours. *International journal of oncology*, 2003; 22(2), 399-407.
- [28] Hardell, L., Eriksson, M., Carlberg, M., Sundström, C. and Mild, K.H. Use of cellular or cordless telephones and the risk for non-Hodgkin's lymphoma. *International archives of occupational and environmental health*, 2005; 78(8), 625-632.
- [29] Lönn, S., Ahlbom, A., Hall, P. Feychting, M., Mobile phone use and the risk of acoustic neuroma. *Epidemiology*, 2004; 653-659.
- [30] Motawi, T.K., Darwish, H.A., Moustafa, Y.M. and Labib, M.M. Biochemical modifications and neuronal damage in brain of young and adult rats after long-term exposure to mobile phone radiations. *Cell biochemistry and biophysics*, 2014; 70(2), 845-855.
- [31] Frei, P., Poulsen, A.H., Johansen, C., Olsen, J.H., Steding-Jessen, M. and Schüz, J. Use of mobile phones and risk of brain tumours: update of Danish cohort study. *Bmj*, 2011; 343.
- [32] INTERPHONE Study Group. Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *International journal of epidemiology*, 2010; 39(3), 675-694.
- [33] Hardell, L., Carlberg, M.I.C.H.A.E.L Hansson Mild, K. Pooled analysis of case-control studies on malignant brain tumours and the use of mobile and cordless phones including living and deceased subjects. *International journal of oncology*, 2011; 38(5), pp.1465-1474.
- [34] Guney, M., Ozguner, F., Oral, B., Karahan, N. and Mungan, T. 900 MHz radiofrequency-induced

histopathologic changes and oxidative stress in rat endometrium: protection by vitamins E and C. Toxicology and industrial health, 2007; 23(7), 411-420.

- [35] Dasdag, S., Akdag, M.Z., Ulukaya, E., Uzunlar, A.K. and Ocak, A.R. Effect of mobile phone exposure on apoptotic glial cells and status of oxidative stress in rat brain. Electromagnetic biology and medicine, 2009; 28(4), 342-354.
- [36] Baydas, G., Nedzvetskii, V.S., Tuzcu, M., Yasar, A., Kirichenko, S.V. Increase of glial fibrillary acidic protein and S-100B in hippocampus and cortex of diabetic rats: effects of vitamin E. European journal of pharmacology, 2003; 462(1-3), 67-71.
- [37] Badgujar, P.C., Pawar, N.N., Chandratre, G.A., Telang, A.G., Sharma, A.K. Fipronil induced oxidative stress in kidney and brain of mice: protective effect of vitamin E and vitamin C. Pesticide biochemistry and physiology, 2015; 118, 10-18.