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Brain Ultrasound Exposure Finding in Albino Rat Fetuses at Late Gestation Stage

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Abstract: ***In spite of ultrasound important role in human imaging especially to obestrics examination, power of ultrasound increased exponential with development of equipment their boost dose to fetuses and raise the probability of biological damage. This experimental study is to evaluate the brain histopathology of albino rat fetuses after being exposed to ultrasound in utero at late gestation period of (17, 18, 19, 20, 21) day. Control against exposed groups is used in this study with fixed ultrasound exposure parameter for 40 minutes. Result from this study found that exposed group show multiple differentiation between two groups like disorganization of cortical and medulla, edema, hemorrhage and dis arrangement of white and grey matter of brain tissue. From this experiment results ultrasound may cause deleterious effect of brain tissue of developing fetuses during late gestation period.***

Keywords: Ultrasound Exposure, Histopathology Effect, Brain Hemorrhage, Late Pregnancy

1. Introduction

Medical diagnostic ultrasound has been use for over 40 years, having found widespread application in anatomic imaging and blood flow velocity measurement in medicine. particularly in Obestrics ,where is radiography is not generally used ,ultrasound has provided an important means for fetal dating ,evaluation of fetal development , and diagnosis of fetal , uterine and placental abnormalities . (Merritt, Kremkau et al. 1992).

The physical effects of sound can be divided into two principal groups: thermal and non-thermal. Most medical professionals recognize the thermal effects of elevated temperature on tissue, and the effects caused by ultrasound are similar to those of any localized heat source.

Animal studies were designed to address questions concerning possible deleterious effects of exposure to ultrasound during pregnancy. Use of animal models is of importance since various possible confounding factors could be controlled in such investigations. (Jensh and Brent 1999)
The developing brain and nervous system seem particularly sensitive to the effect of the heat, but elevated maternal or fetal temperature can result in spectrum of adverse outcomes that effect many developing tissue. (Swerdlow 2010).

A large body of literature have investigated and reviewed the embryos of many mammals and found it to be susceptible to heat damage. Embryonic development consists of highly ordered sequences of cell proliferation, cell differentiation, cell migration and apoptosis (programmed cell death). (Zaiki and Dom 2014)

The aim of this study to describe histological finding results of ultrasound exposure to brain of Albino Rat fetuses at late gestation stage.

2. Material and Methods

A. Ultrasound:

New calibrated portable ultrasonic Diagnostic system A6 ultrasound machine from –sonoscape Co., Ltd. Transducer of linear array L 8-12 MHz used. Focal distance kept constant at 4.5 cm. The TI value was 0.5 and MI value was 0.8 of output display throughout the experiment, exposure duration was 40 minutes

B. Animal:

Nulliparous female albino rats weighing between 170 to 190 g and male albino rats weighing between 200 to 220 g were obtained from Khartoum University -pharmacology college animal house. all experimental procedure was conducted with guide for instituitional animal care. The exposures were carried out during gestational day (16, 17, 18, 19, 20). Gestational period of albino Rats usually varies between 21-22 days (MASON BARR 1973). For control group, no ultrasound exposure was given.

C. Experiment design:

Pregnant was captive next day of exposure and Fetuses were taken out. A total of fifty-five fetuses was obtained for histopathology processing, in specialized laboratory by senior technologist and interpreted by veterinary histopathologist.

D. Histology processing:

Starting with fixation using buffer formalin 10% for 48 hours. Then grossing for brain selection is from the occipital bone to the frontal bone. Eliminating all the

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occipital, parietal, frontal bone of the skull, start removing the brain from the frontal lobe backwards, cutting each cranial nerve from. Entire dissection was performed carefully. And then put into cassette for fixation. after fixation it processed using automatic processing machine and embedding before cutting into 4mm slice using rotary microtome and staining by routine hematoxylin and eosin (H&E).

3. Result

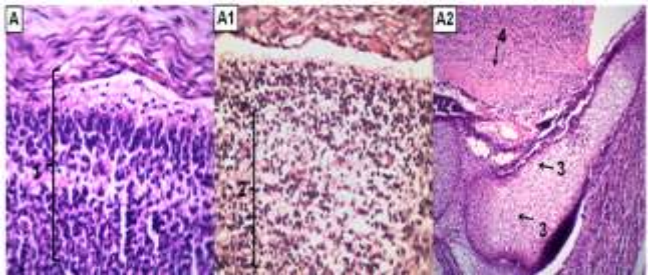


Figure 1: Microphotograph of day 17. A 40x control group show normal, intact cerebral cortex and medulla A1 40x -A2 10x exposed group showing disorganization of cortex with numerous of supporting cells (2) swelling of chondrocytes lacunae (3) loss of arrangement of white matter (4).

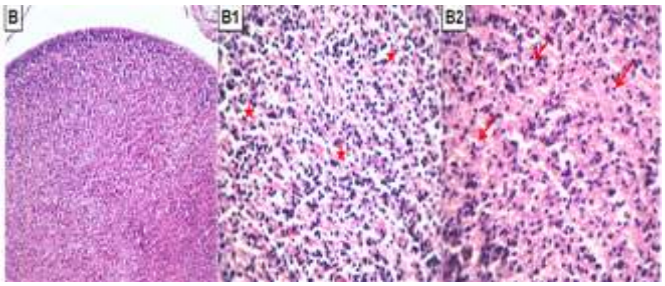


Figure 2: Microphotograph of day 18. B 10x control group show normal, intact cerebral cortex and medulla B1 40x -B2 40x exposed group showing neuronal spongiosis, with disorganization of neural cell, with vacuoles around glia cell increased sized (red arrows)

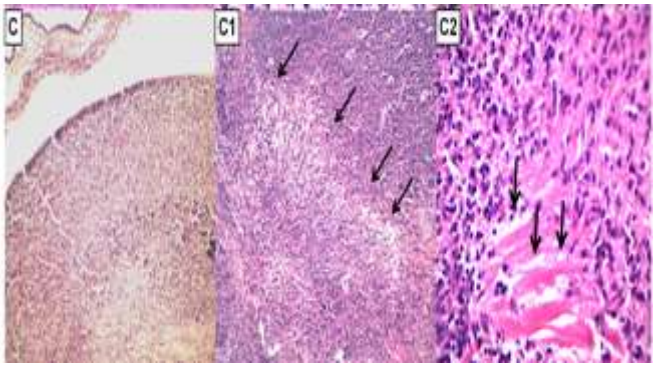


Figure 3: Microphotograph of day 19. C 10x control group show normal, intact cerebral cortex and medulla C1 10x -C2 40x exposed group showing slightly vacillations in brain tissues were recognized specially within the white matter with slight edema (black arrows).

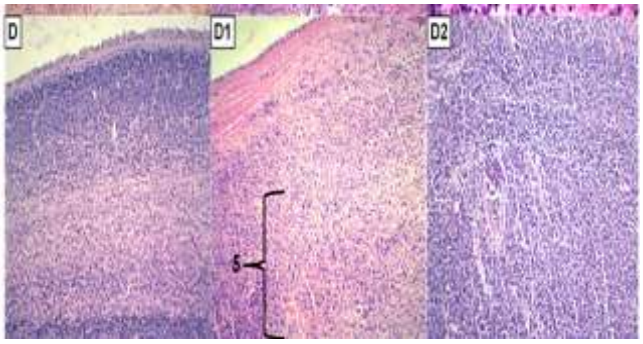


Figure 41: Microphotograph of day 20 D 10x control group show normal, intact cerebral cortex and medulla D1 10x -D2 10x exposed group showing loss of organization of cerebral layers (5)

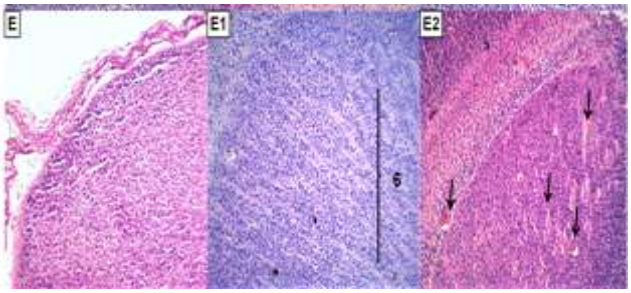


Figure 5: Microphotograph of day 21. E 10x control group show normal, intact cerebral cortex and medulla E1 10x -E2 10x exposed group showing multiple change disarrangement of white mater with slight oedema (6) and dilated congested blood vessels different sized of vacuoles between cells (black arrows).

4. Discussion

Regarding to histological evaluation of this study ,examined exposed brain tissue showed changes in histological levels in multiple brain regions ,these observations showed different findings dependent to gestations day , most obvious was disorganizations and arrangement of white matter figure (1), (3), and (5), with other confounding findings including disorganizations of neural cell ,vacuoles, loss organization of cerebral layer figure (2) and (4) previous studies shows sensitivity of developing central nervous and brain to effect of heat ,in addition elevated maternal or fetal temperature can resulted spectrum of adverse outcome (Abramowicz 2005)

Karagoz et al (2007) study the effect of B-mode and Doppler ultrasound on activities of three antioxidant enzymes and lipid peroxidantion end product in fetal rat brain and resulted of evidence that B-mode ultrasound and Doppler potential to cause harmful effects possibly increase of radical by high temperature (Karagöz, Biri et al. 2007), which may cause significant cytotoxiciy of tissues (Jensh and Brent 1999) and cause consequential destruction and loss of organization of tissue pattern which it may equivalent to our study findings of loss of tissue disorganizations or differentiation from normal.

Hemorrhage near fetal Rat bone exposed to pulsed ultrasound was investigated by Timothy et al., (2006) and founded is increased occurrence but not correlated to

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exposure parameter (Bigelow, Miller et al. 2007), in our study we noted separate ventricular hemorrhage on day 17 which may endorse from ultrasound exposure.

Ange et al 2006 suggest exposure to diagnostic ultrasound is capable of altering neuronal migration in the developing mouse cortex with more effect with long exposure (Ang, Gluncic et al. 2006), process of migration is high sensitive to exposure from external factor and its deleterious outcome as our conducted study show loss of cortex and medulla organizations that may impact in process of neuronal migration. vis-à-vis to human although it might differ in developing from animal but the same basic developmental stages of brain development and sequencing occurs (Goldman 1976). however, increased of none right-handedness in male fetuses was suggested to ultrasound induced in utero by Salvesen Ka and Eik-Nes (1999) (Salvesen and EikNes 1999), which is possibly will be due to an increased susceptibility of male fetal brains to ultrasound induced disturbances in neuronal migration and development of synapses (Joy, Cooke et al. 2006) which extension of exposure effect to behavioural and cognitive process from alteration of brain tissue.

5. Conclusion

Ultrasound exposure to brain tissue show numerous pattern change in tissue structures in this study, which may affect offspring, cognitive behavioral and adulthood as developmental disturbance from ultrasound. Therefore, prudent use and apply ultrasound is recommended to avoid such harmful result.

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