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The Effect of Radiation Exposure from Smartphone to Fetus Mice.

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ABSTRACT

A study on the effect of radiation exposure in pregnant mice against fetal anomalies have been done. A number of 20 pregnant mice were divided into four groups. The first group was the control group which did not expose to smartphone radiation. Groups 2-4 were expose to smartphone radiation for 15, 30 and 60 minute. Radiation exposure were given on day 6th to 18th of pregnancy. After the 18th day of pregnancy, animals were laparotomy. The observation parameters were body weight of the parent, number of viable fetuses, the number of dead fetuses, observation of defects in the fetus, and the observation results of fixation. The data were analyzed by analysis of variance (ANOVA) with significance level of 5%. The result showed that pregnant mice were exposed smartphone radiation for 15, 30 and 60 minutes had low body weight compared to control group. The mice exposed for 15 and 30 minutes consist slower growth compared to 60 minutes exposure. Fetus disability cleft palate, and treads haemorrhagic resorption in radiation exposure for 60 minutes. It can be concluded that exposure of smartphone radiation to pregnant mice would affected growth of pregnancy and produced visceral defect fetus

Keywords:

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INTRODUCTION

Smartphone is a mobile device that is more than just making and receiving phone calls, text messages, and voice messages. The basic features of a Smartphone that can access to the internet[1]. This device can also access digital media such as pictures, music and video. Smartphone is said to be a high end mobile phone equipped with mobile computing capabilities. With these capabilities, the smartphone has the ability that can not be compared to regular cell phones that only have the facility to make calls and send text messages only[2]. Smartphones, which first appeared a combination of functions of a personal digital assistant (PDA) with a mobile phone or a camera phone. Along with its development, now the smartphone also has a function as a portable media player, the low-end digital compact cameras, pocket video cameras and GPS. Modern smartphone is also equipped with a high-resolution touch screen display, a browser capable of displaying full web like on a PC, as well as data access wifi and broadband internet[3].

The growth of smartphones is indeed remarkable in the world, including in Indonesia. According to Roy Morgan research institute, period March 2012-2013, smartphone ownership in Indonesia more than doubled, from 12% to 24% of the total population of Indonesia. Meanwhile, mobile phone users increase by 10% to reach 84% of the total population of Indonesia in March 2013. Based on these data it appears that the use of smartphones has increased each year. The rapid use of smartphones last few years has raised concerns about the health risks caused by radiation of the smartphone.

Radiation is the process of transmitting or distribution of energy in the form of electromagnetic waves. An electromagnetic wave is a radiation field produced by electric currents and magnetic fields. If someone using a smartphone then he will be exposed to radiation of electromagnetic waves from the device. Electromagnetic fields (EMF) emitted by the smartphone has a frequency of 900-1200 MHz[3]. In everyday life, without realizing our bodies often interacted with the radiation. Although the electromagnetic wave radiation that is emitted by the smartphone is basically a small, but the old user interaction is able to potentially cause health problems and even damage to the tissue or cell[4].

Electromagnetic field radiation from a smartphone could change the cell structure. The damage starts from the plasma membrane and receptors also to biomolecules in cells that can lead to genotoxic. Genotoxic properties are defined as compounds that can cause genetic instability until damage to DNA that can change the body's biological systems and functional. These changes have an effect on the proliferation of cells that play an important role during early embryonic development[5]. This is in accordance with one of the definitions teratogen that environmental agents that cause permanent abnormalities in the structure or function of organs, inhibiting the development or cause the death of the embryo or fetus[6]. So for pregnant women and fetuses, are both susceptible to radiation electromagnetic waves generated from a smartphone because it can affect embryo development and cell. Microwave radiation can damage the placenta membrane that serves to protect the placenta of toxic agents that go through the mother. This has been proved in a study conducted by[3], that found an effect teratology fetal exposure to radiation produced by mobile phone mother used during pregnancy and is expected to lead to greater effects such as spontaneous abortions, congenital defects and problems behavior[3].

Animal studies conducted by[7] grouped into two groups of chicken embryos and incubated at temperature of 37.5 ° C. The group was given the radiation exposure of the active smartphone (900MHz-1800MHz) and incubated. The smartphone rang four times a day for 15 minutes. Congenital defects that are visible in the embryo is an embryo size larger, subcutaneous bleeding, and malformations of the brain and then compared with the controls. Also the increased growth of the eye at day 7-10, the thickening of the neural retina at an early age. From this research at the conclusion that the results was smartphone with electromagnetic waves (900MHz- 1800MHz) can cause eye growth until day 10 embryos during the incubation period, and looks likely to cause brain abnormalities.

Other studies have been done on animals show that exposure to radiation of electromagnetic fields on parent mice had a damaging effect and cause abnormalities or malformation of the fetus mice cranium. From the measurement of fetal mice cranium, known that the influence of electromagnetic waves on a mobile phone mother mice to mice fetal malformations cranium, where the size of the cranium animal treatment groups smaller than the control group cranium[8].

Results of research on the effects of radiation on the smartphone skull malformations in the fetus that has been done before does not elaborate on the type of treatment that is used in pregnant mice that cause teratogenic effects. One type of treatment are incoming calls from the smartphone itself is also suspected of teratogenic effects because these devices also emit radiation when making a call. Based on this, the researchers wanted to examine the effects of radiation resulting from incoming calls by smartphone.

MATERIALS AND METHODS

Materials

The materials used in this research are: Aqua dset, solutions Alizarin, Solution Bouin's, Cages, coats, masks, and gloves, scalpels, surgical scissors, a petri dish, and toilet paper, watch glass, an analytical balance, a magnifying glass and tweezers, digital cameras, smartphones

Preparation of Animal

Animals used in these experiments are female mice (*Mus musculus*), approximately 2 months old, healthy, *nullipara*, has a regular estrus cycle is 4-5 days and weigh around 20-30 grams

Acclimatization Animal Experiments and Recycling Determination Estrus

Acclimatization conducted for 10 days to habituate the animals that are in the experimental environment. Food and drink are given *ad libitum*, weight loss were weighed daily and observed behavior. During the acclimatization conducted to determine the estrous cycle by means of visual observation of the vagina of mice, mice in estrus period marked by red-colored mice vagina and gummy. Animals used if the still considered healthy body weight is not more than 10%, visually showed normal behavior and have the estrous cycle is 4-5 days[9].

Use of Animal Experiments

At the time of estrus animal mixed males and females with a ratio of 1: 4. Male mice inserted into female mice cages at four o'clock in the afternoon and separated again tomorrow morning. On the morning of the examination of vaginal plugs. Corks vagina indicates mice have experienced copulation and are on day 0 of pregnancy. Mice who had been pregnant separated and unmixed again with male mice[9].

Grouping Animals

Animals were randomized. Giving treatment to each group on day 6 to day 15 of pregnancy[9].

Table 1: Group of treatment

Group	Treatment of the radiation from smartphone
I	Animals are not given radiation by mobile phone
II	Animals are given radiation by mobile phone for 15 min/day
III	Animals are given radiation by mobile phone for 30 min/day
IV	Animals are given radiation by mobile phone for 60 min/day

Methods

Exposure of Radiation

This study uses radiation exposure incoming calls android mobile phone as a form of treatment of the research object. As for how such exposure as follows: pregnant female mice placed in cages and cellular phone placed at a distance of 1.5 cm from the mice, then twenty pregnant female mice were divided into four groups each consisting of five dogs. The treatment is given by giving a call from a smartphone (Samsung) 900-1800 Mhz frequency (SIM 1 and 2) with SAR 2.0 W/kg which is placed at a distance of 1.5 cm from the mice. On days 6-15 of pregnancy by exposure to radiation incoming calls from mobile phones android.

Observations During Pregnancy

Every day the body weight was observed, if the weight loss and is accompanied by bleeding around the vagina, the possibility of abortion animal then the animal must be sacrificed and examined. During exposure was also observed in mice who are sick due to treatment or illness it can not continue their treatment[10].

Observations of Fetuses

Laparotomy

Laparotomy performed on the 18th day of pregnancy. Mice were sacrificed by means of cervical dislocation, then do laparotomy to remove the fetuses of mice. Mice were dissected at the abdomen upward until it looks uterus containing a fetus. Fetus removed by cutting the uterus and placenta. Furthermore, the observed presence or absence of resorption site marked by a red blob as a fetus implantation. Total fetus is calculated on each portion of the uterus, either survive fetuses and fetuses who have died. Once the fetus is dried with a tissue, the weight of each fetus weighed to determine the weight of an average birth. Then observation whether there is any visual abnormalities the tail, earlobes, eyelids, the number of front and rear legs[10].

Fixation and observation of morphological defects

Having observed visually, one third of the fetus from the mother in fixation with Bouin's solution for 14 days, until the yellow fetus issued and dried. The outside of the fetus were examined ears, eyes, feet and tail. Furthermore, the observed presence or absence of a cleft palate by slipping a scalpel with molars, slice his head right under the plane of the middle ear leaf[11].

The remaining two thirds of the more soaked with Alizarin red solution, allow two to three days, while occasionally shaken until the fetus becomes transparant and will look red bone, bone abnormalities observe and count them. Observations were made on the sternum, feet, and toes[11].

RESULT AND DISCUSION

In this study used smartphone type of Samsung as a media presenter electromagnetic wave radiation to the fetus mice. Radiation is a teratogen agents produced by environmental factors. Smartphone can emit radiation in the form of electromagnetic waves with a frequency of 900-1200 MHz[12]. Besides the rapid use of smartphones last few years has raised concerns about the health risks caused by radiation of the smartphone. This is evidenced by the increasing number of studies on the dangers of smartphones and some of its produce defects in laboratory animals.

In pregnant women radiation teratogen is an agent that can injure the developing embryo and can cause cell death or injury of chromosomes. The severity and damage to the embryo depends on exposure and stage of development). In the phase of organogenesis is the most vulnerable period of disability. This period witnessed a very intensive differentiation cells forming organs, so that the fetus is very sensitive to teratogenic substances[9].

Observations of weight gain during pregnancy performed parent to see the state of nutrition and general health of the mother. In this period the weighing is done from the time of administration of the compound to *laparotomi*, which aims to see how the influence of the parent compound to mice. From the graph changes in body weight of mice its seen on day 6 to day 8 of pregnancy, weight gain has not happened yet large enough parent mice. The weight gain seen tend to increase parent mice on day 9 until day 18 of pregnancy. The increase is due to the development of fetal mice and increased volume of amniotic fluid, placenta, and amniotic membranes[13]. Total fetus also affect weight gain parent mice. Generally, the greater the weight gain, the parent, the more chances that the fetus will be born.

The observation of the parent mice performed during administration of radiation exposure up time will be *laparotomi*. The average weight gain during pregnancy the parent of mice in the control group, 15

minutes, 30 minutes and 60 minutes respectively was 39.9 ± 5.78 grams; 40.4 ± 4.66 grams; 41.1 ± 4.37 grams; 42.9 ± 5.47 grams. From these data no significant differences seen after administration of radiation exposure compared with the control group ($P > 0.05$). This means that the treatment accorded not toxic to the parent mice.

Based on statistics obtained from the percentage difference between the parent body weight of mice during pregnancy in a group of 15 and 30 minutes look parent mice experienced a pregnancy progresses slower than the control group and the group 60 minutes experienced a fast development during pregnancy. This is certainly a question of why the low-dose radiation exposure led to the slow development compared radiation exposure with higher doses. This is due to the effects of radiation which can occur in non-target cells are cells that do not receive direct radiation exposure.

Radiation interacts with cells directly and transferring energy in the cell to cause a response or effect. It turned out that cells are not exposed to radiation able to respond as well as cells exposed to radiation and the effect is called the bystander effect. In the range of low-dose exposure bystander effect can be a mutation, chromosomal damage and cell transformation. Bystander effect occurs in non-target cells located around the cell which was exposed by radiation. Clearly, no bystander cells in said radiation or alpha particles crossed but receives a signal or factors secreted by cells in irradiation so as to cause a response in by stander cells. So, this effect could potentially improve the effectiveness of radiation biology at low dose by increasing the number of damaged cells in excess of cells that are directly exposed to radiation.

Based on the data obtained in the group 60 minutes are known to experience rapid development during pregnancy that this is due to the adaptive response of cells to radiation exposure or obtain any response radio adaptive. Adaptive response is a biological phenomenon that describes their resistance to high doses of radiation exposure after a single or multiple radiation exposure to the lowest dose. But did not rule on a higher dose of radiation exposure that is given will cause interference with the development of the pregnancy and the fetus effect is called the defect.

Observations on granting the group exposure to radiation for 15 minutes and 30 minutes of not finding teratogenic effects on the fetus were born either weight or the number of dead fetuses. Whereas in the group giving exposure to radiation for 60 minutes found a footprint resorption on one parent mice. Resorption their footprint in the form of a red blob that is embedded in the uterus allegedly caused by the effect of radiation exposure during organogenesis. At this time there are no longer totipotention nature that it can not repair damage to the network and there is no further developments. As a result of fetal death and formed a red blob. Still in the experimental group 60 minutes, found two tails fetuses who have died on two different parent of mice. Death of fetal mice were thought to be caused by the presence of a genetic vulnerability factor (sensitivity) of the fetus as an individual against exposure to radiation emitted by smartphone.

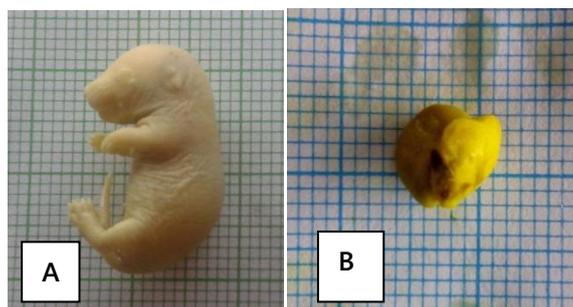


Figure 1: Tread resorption in fetal mice were given exposure to radiation for 60 minutes

In the treatment of the provision of radiation exposure for 60 minutes also found teratogenic effects in the form of cleft palate that is not the discovery of cracks in the ceiling 3 heads fetus from different mice. Observations cleft palate is done by cutting the head from the mouth area to the rear right mid earlobe until his head was separated into two parts. Having disposed of the fetus tongue found the ceilings are not able to close. Cleft palate occurs because of interference during the process of closing tissues in the ceiling caused by exposure to radiation by smartphone.

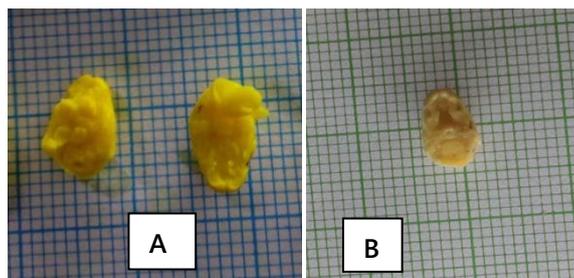


Figure 2: Fetal cleft palate (the presence of a crack in the ceiling)

It is also found on the legs haemorrhagic fetus distinct from the parent of mice given radiation exposure for 60 minutes. This is caused by blood circulation disorders. The system has a normal blood vessel endothelial lining is soft and slippery, platelets and fibrin are not easily attached. Endothelium intact non-genetic thrombus because endothelial cells produce some substances such as prostaglandin (PG12), proteoglycans, plasminogen activator and trombo-modulin, which can prevent the formation of thrombin. When endothelial damage when spurred by exposure to radiation, then the sub-endothelial tissue will be exposed. This situation will cause the clotting system is activated and platelets will be attached to the sub-endothelial tissue, especially collagen fibers, the basement membrane and micro-fibrils. Platelets are attached will release adenosine diphosphate and thromboxane A2 which will stimulate others still circulating platelets to change shape and stick together. Damage to the endothelial cells themselves will also activate the clotting system, forming thrombus.

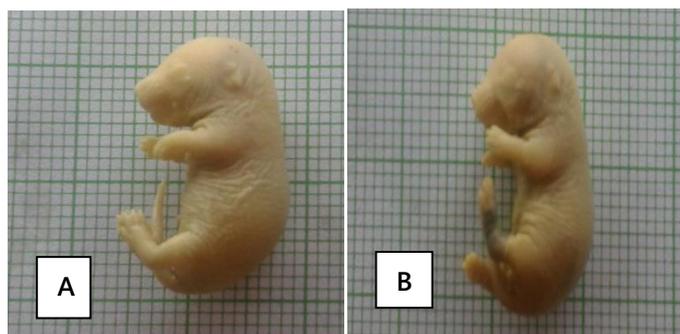


Figure 3: Haemorrhagic fetal mice

Periods of these vulnerabilities can be concluded that the administration of radiation exposure for 15 minutes and 30 minutes did not cause defects in the fetus. however led to the slow development of the mother mice during pregnancy. While the administration of radiation exposure for 60 minutes led to the increasing development of the mother mice during pregnancy, but in giving exposure to longer potentially cause defects in the fetus that is in the group of giving exposure to radiation for 60 minutes on days susceptible. In the treatment group 60 minutes also found two dead fetuses tail of a different parent. Stillborn characterized by the absence of fetal movement when removed from the uterus[9]. Fetal death does not occur in every parent because different abilities of each parent to metabolize the drug. Embryotoxic effect of a substance can occur if it accumulates in the embryo that is genetically susceptible [14].

From this teratogenicity test results shows that there are a number of fetal abnormalities [15],[16]. However, the potential teratogen of radiation smartphone is still uncertain because of the nature of susceptibility between individuals although derived from the same parent. In this study, environmental factors such as infections, vitamin deficiencies are also potentially teratogenic to a fetus is not observed. Therefore, they need to do similar research using other species.

CONCLUSION

From test teratogenicity Award radiation exposure by smartphones in vivo can be concluded that: Provision of exposure to radiation from the smartphone for 15 minutes and 30 minutes led to slower

development on the weight of parent bodies of mice during pregnancy but at giving exposure to radiation for 60 minutes led to the development faster on the parent body weight of mice during pregnancy. Exposure to radiation for 60 minutes by smartphone teratogenic effects and the potential to cause defects in the form of footprint resorption, cleft palate and haemorrhagic fetuses.

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