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THE DANGERS OF EXPOSURE OF PREGNANT WOMEN AND THE EFFECTS OF IONIZING RADIATION ON FETUS'S HEALTH

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ABSTRACT

Introduction: The discovery of X-rays by Rontgen in 1895 and the useful results obtained from this radiation to see the inner side of body's tissue and diagnosing the diseases causes the increased use of these radiation in medical centers; however, the high numbers of medical experiments and lack of observing the protection principles is led to the ocular discomfort and severe and progressive dermatitis in medicine's hands are significantly increased only after some months of discovery of X-ray which is led to the death of many early radiologists. On the other hand, the delayed effects resulted from these radiation has been clarified after 20 years and national and international agencies tried to devise the protection principles and the radiologist's education to protect the radiologists and patients against the harmful effects of these radiation. **Background:** According to the performed studies, the ionizing radiation are potentially dangerous for the growing of the fetus and the pregnant women should be prevented from the unnecessary radiation except from when there are strong clinical reasons and even the conditions at which these radiation are had to be used for the pregnant women, all the protection principles should be observed to minimize the fetus's dose as much as possible. Therefore, observing the standard protection principles such as justification, optimization and dose limit are necessary to prevent the occurrence of radiation effects, especially for the protection of fetus. **Results and Discussion:** Regarding the genetic and somatic effects of X-rays, it is essential that the newest ways of radiation protection to reduce the patients and personnel's dose be acquired, and due to the fact that the fetus is highly sensitive to ionized radiation, the pregnant women should be prevented from being exposed to radiation unless a strong indication has been provided for.

Keywords: fetus's dose, Pregnant Women, radiography, exposure

INTRODUCTION

Shortly after the discovery of X-ray by Rontgen, these rays was used for imaging of various parts of the body in such a way that today, the medical radiation is considered as the most significant part of artificial radiation in the world. For instance, more than 90% of the artificial

radiation in England is resulted from performing the medical experiments (1). On the other hand, by developing the imaging technology and use of new imaging ways such as CT, the medical radiation of the general public are increasing so that many of these radiation methods is associated with high exposure of the patient. For example, the radiation of an elderly man for performing the abdomen CT scan experiment is 200-250 times more

than radiography experiments of chest (2,3).

Review of Literature

Russell established a 10-day rule in 1984 to prevent the unwanted effects of exposure being occurred for the women who are in pregnancy age. In this rule, it has been stipulated that the radiographic experiments of abdomen and pelvis for the women who are in pregnancy should be limited to the first 10 days after the starting of monthly period (4), and this rule is so significant for the medical radiation which have high attracting dose, because the possibility for the pregnancy of women in the first 10 days of monthly period is zero. On the other hand, by proposing the rule of all or none, the authority of the rule was questioned and this rule was then modified to 28 days, that is there is no ovum in the first 14 days of the monthly period, then there is no embryo to be damaged due to the exposure and the embryo monthly period is subjected to the rule of all or nothing in the second 14 days, that is whether the radiation makes no harm the embryo and is naturally grow up or it is gotten aborted because of the harm made by radiation and is wasted away. As is mentioned, this is why some restrictions are imposed for the women who are in pregnancy age without having any scientific justification and hereby the 10-day rule is modified to 28-day rule. Finally, by starting the next monthly period, women become familiar whether they are pregnant or not, and if it is observed that the person is pregnant, she is allowed to be under the radiography examination only when there is strong clinical indication for the patient's radiography (5,6).

DISCUSSION

There are three significant stages in the fetus's development in which the fetus has different rates of sensitivity to radiation:

1. The Pre-Implantation Stage (0-15 days after fertilization):

In this stage, the sensitivity of embryo is low against the radiation and the embryo comprises some of undifferentiated cells which is not able to restore the effects resulted from radiation; therefore, even if the radiation make destructive effects on some cells, these damaged cells are replaced by new mitosis and the embryo naturally continues its development.

In this stage, it is possible that the embryo to be died only if the embryo is affected to high exposure, but no specific risks can be observed in terms of malformation in this period. Therefore, if the embryo is faced with 10 rad dose, there is only 2% that it is died.

2. Stage of limb regeneration (15-50 days after fertilization):

In this stage, the cells are fully differentiated and the fetus is highly sensitive to radiation, because the cells damaged is differentiated from other cells. Therefore, there are many defects related to growing and malformations are occurred in this stage in such a way that the low dose of radiation (10rad) can be led to innate malformations. Finally, threshold radiation dose in this period is between 2.5-5rad for occurring innate defects such as brain damage, lips malformations, teeth or outside reproductive organs which is much higher than the ordinary doses in medical imaging methods.

3. The Embryonic Stage (50-270 days after fertilization):

The embryo is less affected to the radiation due to the differentiated cells and the danger of innate malformations is lower after the 10th week, but the danger of microcephaly still exists. In this stage, the most biggest undesirable effect of exposure, that is mental retardation and reduced development, can be observed

after the 17th week and the radiation with high dose is required for being occurred which are more higher than the medical radiation. Therefore, in most imaging methods, there is no significant increase in

the number of major malformations in the pregnant women who are undergone exposure accidentally (7-11).

Table1 compares the radiation from many sources between adult people and fetus.

Table1: the comparison between fetus's exposure and adult people from ionized radiation in diagnostic imaging methods (12).

| source of radiation | | adult exposure | fetus exposure | effect on fetus |
|----------------------|------------------------------------|---|-----------------------|---|
| Background radiation | Beach | annually 300 mrad | annually 300 mrad | No |
| | 5000 feet height | annually 1000 mrad | annually 1000 mrad | - |
| | 7 hours flight | 5 mrad | - | - |
| Medical exposure | Chest radiography, Skull, tooth | 4 mrad | Less than 1 mrad | No |
| | Skull CT scan | 200 mrad | Less than 10 mrad | No |
| | Chest CT scan | 800-1000 mrad | Less than 10 mrad | No |
| | Upper gastrointestinal radiography | 300 mrad | 4 mrad | No |
| | Pelvis X-ray of hip joint | 240 mrad | 240 mrad | No |
| | Sodium iodine (1 mCi) | 470 mrad (whole body), 780000 mrad (thyroid) | 1000 mrad whole body) | After the 10th week of fertilization in the time of thyroid growth, the radiation dose of embryo is much more than mother's and it can disturb the thyroid's growth |
| | Abdomen or pelvis CT scan | 1000 mrad | 2000 mrad | It increases the Leukemia risk with 1.5-2 factor. |
| | Accidental exposure | - | 2500-5000 mrad | The threshold dose to increase the innate malformations in the embryonic period (3-10 weeks after fertilization). |

Due to the risk of potential ionizing radiation in the fetus's development, preventing from unnecessary exposures in pregnant women is necessary in radiation medicine centers, and ultrasound and MRI (without injecting the contrast material) are the replacement imaging methods that their dangers have not yet been realized in these condition . On the other hand, other than

some of nuclear medicine methods which uses radioisotope of the iodine (due to vulnerability of thyroid gland) and also the radioisotopes such as iron and selenium which have long physical and biological half-life, performing most medical imaging methods in pregnancy are allowable (13,14,15).

Although the exposure with ionizing radiation in pregnancy are associated with some concerns, the dangers caused by them are really low and naturally the doses resulted from the doing diagnostic experiments is much lower than the doses led to the death of the cell (16,17). On the other hand, considering the cancers resulted from exposure, innate malformations and types of mutations observed in the Hiroshima and Nakazaki atomic explosions remainders for receiving high doses, the risks related to the medical exposure in pregnancy cannot be overlooked (18,19). For this reason, to prevent from the unwanted radiation of the fetus in pregnant women, the 10-day or 28-day rule has been devised by International Organization of Radiation Protection which stipulates that doing radiography in the women who are in pregnancy is limited to the first 10 days or 28 days after the initiation of monthly period (20-23).

Generally, the women who are in pregnancy age should be questioned for doing diagnostic radiological experiments in pelvis which is undergone the initial radiation and if the patient was pregnant, doing radiography experiments should be justifiable (24-26).

On the other hand, the 10-day or 28-day rule will be applied about the techniques with high dose and the radiologist pregnant women should avoid from doing interventional or fluoroscopic radiographies which causes a high dose (27-29).

Finally, the International Commission on Radiological Protection proposed the current standards on radiation protection as the three principles below:

1. Justification: according to this principle, no radiation is allowed unless useful results are achieved compared to the damaging effects of exposure.

2. Optimization: applying the "As Low As Reasonably Achievable" (ALARA) is necessary, so that the most diagnostic information should be provided by the least exposure.
3. Dose Limit : according to this principle, the radiation of people, embryo and fetus and also occupational radiation should be limited to a specific amount which using techniques such as shielding, increasing the distance to the source of radiation and reducing the time of radiation are so significant in this regard (30,31).

CONCLUSION

According to the somatic and genetic outcomes of ionizing radiation, radiation protection should be taken into consideration not only as a scientific issue, but a rational and ethical issue (32). According to the sensitivity of the fetus against ionizing radiation, unnecessary radiation for the pregnant women should be avoided unless there is a strong clinical indication (33). Being assured about the pregnancy or non-pregnancy in women before doing radiological experiments are necessary and if signs of pregnancy are observed, it must be attempted that the diagnostic information be achieved with the least exposure to the patient. On the other hand, doing some diagnostic experiments, such as chest, skull and parts of body radiography is applicable in each period of pregnancy if the fetus is completely shielded (34).

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