# Ultrastructural Analysis of the Effects of Electromagnetic Field on Fetal Cardiac Muscle^

## *ELEKTROMANYETİK ALANIN FÖTAL KALP KASI ÜZERİNE ETKİSİNİN İNCE YAPI DÜZEYİNDE İNCELENMESİ*

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**Summary**

*The aim of this study was to analyze the effects of an electromagnetic field that could be exposed during our daily life on developing cardiac muscle in fetus. Pregnant mice with similar age and body weight were randomly divided into two groups as "control" and "electromagnetic field". Mice in the study group were exposed to 120 microtesla , 7 hrs/day and 7 days/week. On the 18 th day of pregnancy, mice were sacrified after taking their fetuses out by cesarean section and electron microscopic examination of the cardiac muscles of fetuses were made. It was found that an electromagnetic field that could be exposed during our daily life effected development of fetal cardiac muscle by leading degeneration in the striae of cardiac muscle and loss of cristae in mitochondria.*

Key Words: Fetal cardiac muscle, Electromagnetic field, Ultrastructure

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**Özet**

*Bu çalışmanın amacı, günlük yaşamda etkisi altında kalabileceğimiz ortalama bir ele/ctromanyetik alanın, fötusta kalp kasının gelişimi üzerine olan etkisini incelemekti. Bu amaçla yaşları ve vücut ağırlıkları birbirine yakın olan gebe fareler "Kontrol" ve "Elektromanyetik alan" olmak üzere iki gruba ayrıldılar. Elektromanyetik alan grubundaki fareler günde 7 saat 120 mikroteslalık bir elektromanyetik alana konuldular. Farelerden gebeliklerinin 18. gününde sezeryanla fötusları çıkarıldı ve stereomikroskop altında fötusların kalp kasları çıkarılarak rutin elektron mikroskobu takip işlemine alındı. Sonuç olarak günlük yaşamda etkisi altında kalabileceğimiz ortalama bir elektromanyetik alanın, fötusun kalp kasında çizgilennıeyi bozarak ve kalp kası mitokondriyonlarında krista kaybına yol açarak fötustaki kalp kası gelişimini etkilediği gözlemlendi.*

Anahtar Kelimeler: Fötal kalp kası, Elektromanyetik alan, İnce yapı

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Several electromagnetic fields effect us during our daily life. Source of electromagnetic field is natural or artificial. Electrical house equipment, computers, mobile phones which play hnportant roles in our daily life and energy terminals are estimated in this group of sources. These sources which give rise to electromagnetic field interact with each other also.

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The aim of this study was to analyze the effects of an electromagnetic field that could be exposed during our daily life on developing cardiac muscle in fetus.

### Materials and Methods

In this study, 48 mice (36 female and 12 male) were used. Three female and one male rats with similar age and body weight were put into the same cage for one night. Twenty mice with vaginal plagues were considered pregnant and randomly divided into two groups as "control" (CG) and "study" (MFG).

The mice were housed in an octagonal wooden cage with a side length of 25 cm. The magnetic fields was generated by horizontally arranged coils

of 10 turns. The diameter of the coil system was 75 cm, and the distance between two adjacent coils was 0.5 cm. Magnetic coils were fixed to the wooden cage from various parts using thermoresistive cords. M F G mice were exposed with 120 microtesla, 7 hr./day (9 a.m-4 p.m) and 7 days/week. Temperature and humidity was 230°C±2 and 45%±5, respectively. Animals had continual access to food and drink. On the 18th day of pregnancy, mice were sacrificed after taking their fetuses out by cesarean section (1-5).

Hearts of fetuses were extirpated and cut into pieces of 1 x 1 x 1 mm. They were fixed for 24 hours in 2.5% phosphate buffered glutaraldehite. After this, the specimens were postfixed in 1% osmium tetroxide, dehydrated in serial ethyl alcohol and embedded in a mixture of Araldit CY 212 and Dodesenilsuccinic acid. The thin sections were stained Lead citrate and Uranyl acetate. They examined under Zeiss EM 900 microscope.

## Results

### Control Group

Cardiac muscle cells were seen as oval shaped. Shape of nuclei were in harmony with shape of cells. Heterochromatin was rarely seen in nucleus and localized under cytoplasmic membrane. There was numerous nucleoli in nucleus. Two or three nucleoli were present in some of the cells. Mitochondria in the cytoplasm were oval or spherical shaped. Cristae of mitochondria were specific for fetal tissue and less developed and short shelf shaped. Mitochondrial matrix had a larger field. Rough and smooth endoplasmic reticulums in the cytoplasm were short and narrow. Miyofibers were rarely observed and were between nuclear and cytoplasmic membranes. Transverse lining? were usually prominent. Some muscle fibers were considered underdeveloped and were connected with each other by discus intcrcalaris (Figures 1 and 2).

### Study Group

When compared with the control group, mitochondria of cardiac muscle cells were considered severely degenerated. Miyofibers were underdeveloped and atrophic alterations were occasionally seen. Transverse lines were not marked as the ones of control group. (Figures 3 and 4)

## Discussion

It is recently attempted to compose safety standards by making discussions about biological effects of electromagnetic fields and their border values that surround us. Most of the population are come down with the effects of electromagnetic fields continuously. The cables that distribute energy, electrical motors and all electrical equipment that are essential for modern life, surround our living environment. It has been reported that a sixty Hertz field can produce an electromagnetic field

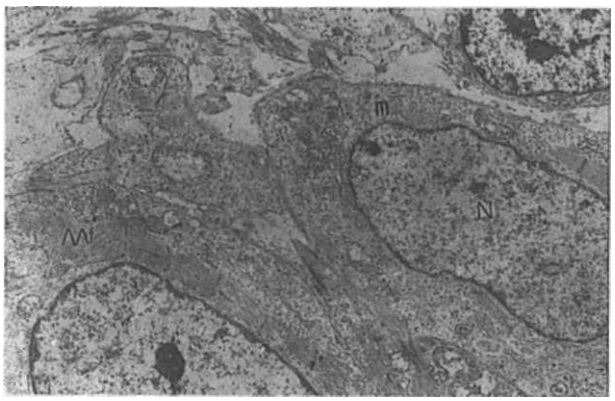


Figure 1. Electron microscopic examination of the control group shows the oval shaped cardiac muscle cells. Nucleus (N) has adapted the shape of the cell. Also miyofibers (Mf), transverse striation (⟶) and mitochondria (m) are seen. (Lead citrate-uranyl acetate x 8800)


Figure 2. Miyofibers (Mf), discus intercalaris (di) and mitochondria (m) with a matrix that has shelf shaped cristae are seen. (Lead citrate-uranyl acetate x 14000)

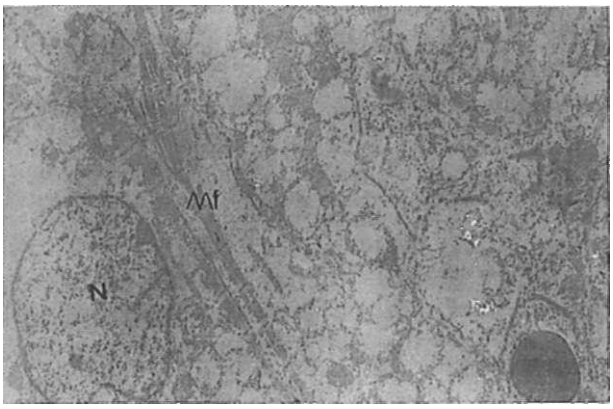


Figure 3. Nucleus (N), less developed miyofibcrs (Mf) and degenerated mitochondriae (m) are seen in the electron microscopic examination of the cardiac muscle. (Lead citrate-uranyl acetate x 6000)

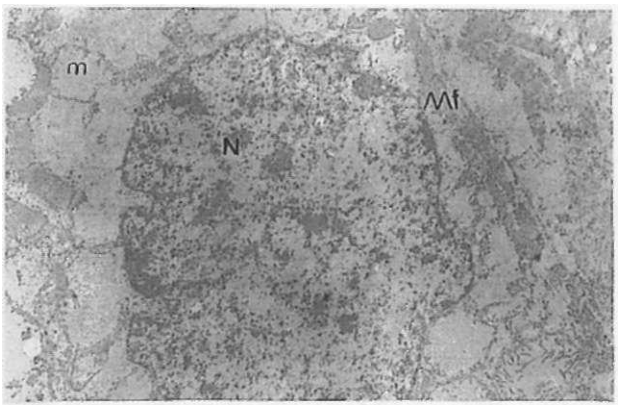


Figure 4. Nucleus (N), less developed miyofibers (Mf) and large degenerated mitochondriae (m) with loss of cristae are seen in the electron microscopic examination of the cardiac muscle. (Lead citrate-uranyl acetate x 8800)

between 1 and 20 v/m in an ordinary house. This value reaches to a value of 250 V/m near to the electrical house equipment (6). In the literature, there has been many studies about the reproductive and teratologic effects of electromagnetic fields. Various factors like severity, formation and duration of electromagnetic field and species of mammal can effect the outcome. (7)

Huuskonen et al., reported minor abnormalities in the skeletal system and visceral organs in their study about the effects of low frequent magnetic fields on fetal development in rats. These abnormalities were; extrathoracic rib, wavy rib, displaced rib, partially thick rib in the skeletal system and uretery dilatation, renal pelvic dilation and large kidney in visceral organs (1).

On the other hand, there are differences among the mammalian species in the sensitivity to environmental factors and formation of malformation. Schardein et al., reported that low frequency electromagnetic field effected skeletal system in rats and caused eye defects, exencephaly, polydactily and cleft palate in mice (7).

Stuchly et al., found that there were only minor skeletal anomalies in female mice which were left in three different type of electromagnetic fields (5.7 microtesla, 23 microtesla and 66 microtesla) for 7 hours/day for two weeks (8).

Some studies have revealed that on the potential for cancer promotion, co-promotion and progression, as well as possible synergistic, genotoxic, immunological and carcinogenic effects associate with chronic low level RF exposure (9).

In our study, we observed that an electromagnetic field of 120 microtesla led degeneration in the striae of cardiac muscle and loss of cristae in mitochondria more than control group.

In conclusion, we believe that advanced studies are needed for understanding the effects of electromagnetic fields on human health and fetal development exactly.

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