Effects of Intensive Cell Phone (Philips Genic 900) Use on the Rat Kidney Tissue

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Purpose: To investigate effects of electromagnetic radiation (EMR) emitted by cell phones on the rat kidney tissue.

Materials and Methods: Twenty-one male Albino rats were divided into 3 groups, each comprising 7 rats. Group 1 was exposed to a cell phone in speech mode for 8 hours/day for 20 days and their kidneys were removed. Group 2 was exposed to EMR for 20 days and then their kidneys were removed after an interval of 20 days. Cell phone used in the present study was Philips Genie 900, which has the highest specific absorption rate on the market.

Results: Light microscopic examination of the kidney tissues obtained from the first group of rats revealed glomerular damage, dilatation of Bowman's capsule, formation of large spaces between the tubules, tubular damage, perivascular edema, and inflammatory cell infiltration. The mean severity score was 4.64 ± 1.7 in group 1, 4.50 ± 0.8 in group 2, and 0 in group 3. While there was no significant difference between group 1 and group 2 ($P > .05$), the mean severity scores of groups 1 and 2 were significantly higher than that of the control group ($P = .001$ for each).

Conclusion: Considering the damage in rat kidney tissue caused by EMR-emitting cell phones, high-risk individuals should take protective measures.

Keywords: kidney, cellular phone, electromagnetic radiation

INTRODUCTION

Advances in technology have introduced many new devices to the benefit of mankind. Some of these devices emit electromagnetic radiation (EMR). These devices include radars, cell phones, radio and television transmitters, certain devices used in medical and industrial practice, high-voltage transmission lines, microwave ovens, and household electrical appliances. Cell phones that have an increasing use in our daily life also emit varying degrees of EMR. Various studies have shown that radiation emitted by cell phones or base stations have a negative impact on human health.[(1)] There are publications in which cancer development, negative effects on reproduction, and development of neurological disorders associated with cell phone use have been reported.[(2,3)] Furthermore, there are studies suggesting elevated tissue levels of free radicals associated with the cell phone use.[(4)]

The kidneys filtrate 20% of the body blood in every minute and are thereby at high risk of being affected by harmful substances.[(5)] Generally, radiation emitted by the cell phones operating at 900 MHz that are mostly carried on the belts is mostly absorbed by the kidneys as compared to other organs. In the present study, we aimed to investigate the effects of EMR emitted by the cell phones, which are intensively used in all countries, on the rat kidney tissue in order to predict their possible effects on human kidneys.

MATERIALS AND METHODS

Twenty-one adult male Wistar Albino rats were allocated into 3 groups, each comprising 7 rats, and housed in standard cages measuring 40 × 60 cm. Group 1 was exposed to cell phone for 8 hours/day in speech mode and for 16 hours/day in standby mode for 20 days; their kidneys were then removed. Group 2 was exposed to EMR for 20 days, and their kidneys were removed after an interval of 20 days. Group 3 was the control group and the rats were monitored in a standard laboratory environment without any exposure to EMR. The rats were maintained on a 12 hour/12 hour light/dark cycle at 21 °C and 40% to 60% relative humidity, and they were provided food (MBD Experimental Animal Food, Gebze, Kocaeli, Turkey) and water ad libitum.

In the present study, Philips Genie 900® (Singapore) cell phone was used as a 1800-MHz continuous wave electromagnetic energy generator, which has the highest specific absorption rate (SAR, 1.52 W/kg) on the market. Cell phones were fixed in a hanging position 1 cm above the cages. Cell phones were left on charge for 24 hours, and 8 hours/day in speech mode and 16 hours/day in standby mode. One of the removed kidneys was prepared for light microscopic examination and the other was prepared for electron microscopic examination.

Specimen Preparation for Light Microscopy

For light microscopic examination, the kidneys were removed, fixed in a 10% formaldehyde solution, treated with serial alcohol solutions of increasing concentrations, and then cleared with toluene. For general morphological assessment, sections approximately 5 μm in thickness were stained with hematoxylin and eosin and examined using an Olympus BX51 photomicroscope. During microscopic examination, tissue sections were examined for the presence of damage of Bowman's capsule, glomeruli, and the proximal and distal tubules, vascular congestion, and inflammatory cell infiltration. Of these three criteria, each was scored as absent (0), minimal (1), moderate (2), and severe (3). At least 5 microscopic fields were examined for scoring. Each slide was assessed by two separate investigators (N.Y. and F.E.) and the final score was determined based on the consensus of these two investigators. The total score ranged from 0 to 9. Both of two investigators (N.Y. and F.E.) were blinded to each of three groups.

Specimen Preparation for Transmission Electron Microscopy

For transmission electron microscopic examination, the kidneys were removed and fixed in a 2.5% phosphate-buffered glutaraldehyde solution (0.1 M, pH 7.4), and then post-fixated in a 1% phosphate-buffered osmium tetroxide solution. After dehydration in serial alcohol solutions of increasing concentrations, the samples were embedded in Epon 812 and polymerized at 60 °C in an oven. Using a Jeol 1200 TEM (Tokyo, Japan) scanning electron microscope, tests were performed on thin sections nearly 60 nm in thickness, which were obtained and stained with uranyl acetate and lead cit-

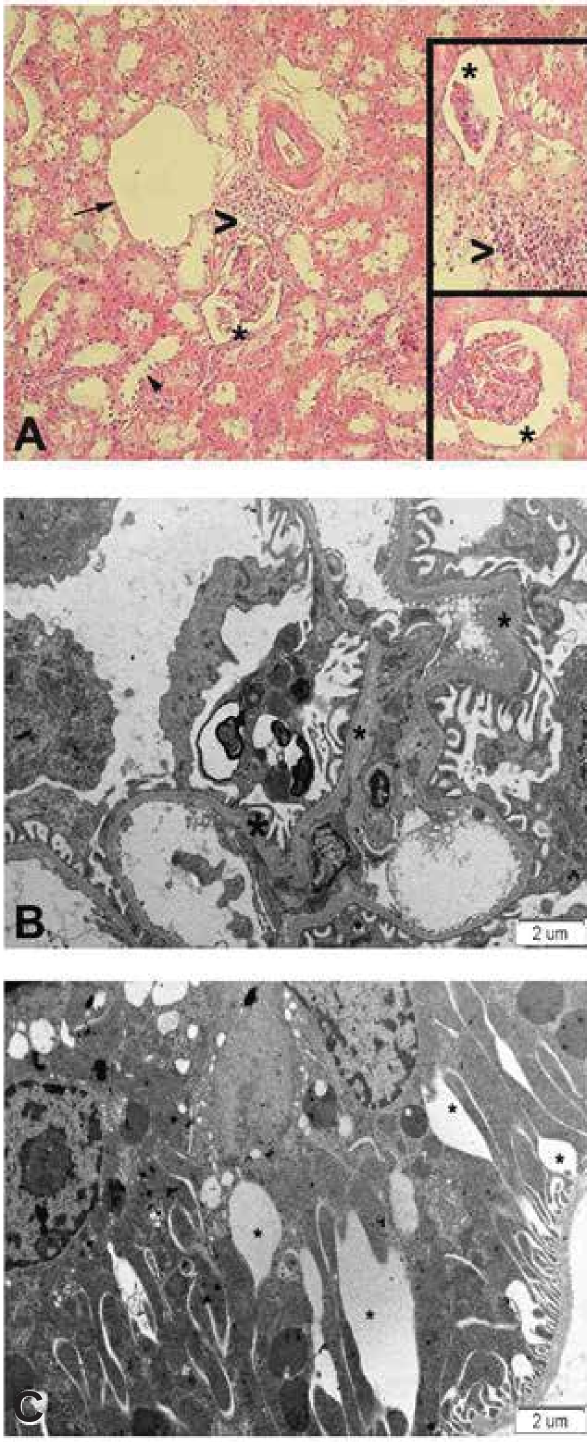

Figure 1. Group 1. Dilatation of Bowman's capsule and glomerular damage (*), formation of large spaces between the tubules (arrow), tubular damage (arrow head), perivascular edema and inflammatory cell infiltration (>) **(A)** Irregular thickening of the basement membrane (*), local irregularities of pedicels; **(B)** Dissociation of the junctions between the tubular cells (*); and **(C)** A: Hematoxylin and eosin staining, original magnification: ×100, small picture: ×200; B & C: Electron micrograph.

rate.

The present study was approved by the Ethics Committee of Marmara University Faculty of Medicine. Mann-Whitney *U* test was used for statistical analysis. A *P* value of less than .05 was considered statistically significant.

RESULTS

Light microscopic examination of the kidney tissues obtained from group 1 revealed glomerular damage, dilatation of Bowman's capsule, formation of large spaces between the tubules, tubular damage, perivascular edema, and inflammatory cell infiltration (Figure 1A). Similarly, glomerular damage, dilatation of Bowman's capsule, formation of large spaces between the tubules, and tubular damage were observed in group 2 (Figure 2A). Control group was observed to have a regular morphology of renal parenchyma (Figure 3A).

The mean severity score was 4.64 ± 1.7 in group 1, 4.50 ± 0.8 in group 2, and 0 in group 3. While there was no significant difference between group 1 and group 2 (P = .86), the mean severity scores of groups 1 and 2 were significantly higher than that of the control group (P = .001 for each).

Electron microscopic examination of the kidney tissues in group 1 revealed that podocytes had a regular appearance, whereas irregular thickening of the basement membrane, irregularity of the capillary endothelium (Figure 1B), and large dissociation of the junctions between the tubule cells (Figure 1C) were observed. While podocytes and pedicels had relatively regular morphological appearance in group 2, local irregularities of the capillary endothelium, thickening of the basement membrane (Figure 2B), and large dissociation of the junctions between the tubules were observed (Figure 2C). In the control group, podocytes, pedicels, basement membrane (Figure 3B), and tubules (Figure 3C) were observed to have a regular morphology.

DISCUSSION

Advances in science and technology have introduced many newly developed devices. Such technological developments offer various benefits to people's lives. However, they have certain disadvantages that threaten human health. Electromagnetic radiation emitted by many devices that are used in everyday life affects many living kinds. Cell phones

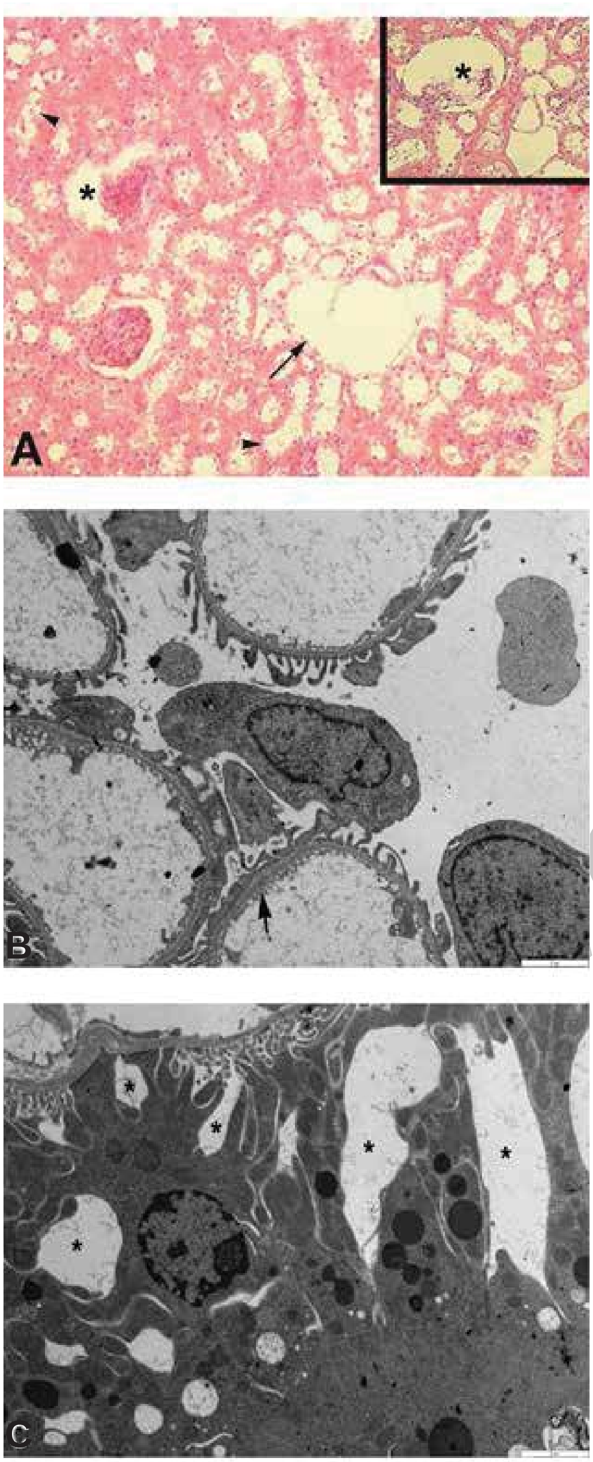

Figure 2. Group 2. Dilatation of Bowman's capsule and glomerular damage (*), formation of large spaces between the tubules (arrow), and tubular damage (arrow head) **(A)** Local thickening of the basement membrane and mild irregularity of the capillary wall (arrow); **(B)** Dissociation of the junctions between the tubular cells (*); and **(C)** A: Hematoxylin and eosin staining, original magnification: ×100, small picture: ×200; B & C: Electron micrograph.

are the leading devices that emit EMR and have an increasing use worldwide.[6] The effects of EMR emitted by these devices and base stations on human body have still not been clarified.

Radiofrequency waves emitted by cell phones are thought to cause detrimental effects at cellular and molecular level.[7] Previous studies have reported that radiofrequency waves emitted particularly by the third generation cell phones might have an effect on the immunological status, nervous system, hematological status, cardiac functions, urinary system, normal growth and development, and genetic.[6,8,9] Electromagnetic radiation emitting from base station and cell phones have destructive effects on tissues in two ways. First, thermal effects occur via increase in corporeal heat by electromagnetic energy, which is absorbed by body. Second, non-thermal effects appear as change in brain functions and sleep, attention deficits, and headaches.[10] Along with this, EMR may also lead to DNA damage.[11] This information suggests the need for further research on the effects of cell phones and base stations on human health.

Studies on the effects of EMR emitted by cell phones have yielded controversial results. There are studies in the literature reporting that cell phones do not have an effect on blood-brain barrier, testes, sperm morphology, seminiferous tubules of the rats, and Leydig cells and do not cause a significant change in mean fetal heart rate.[12-15] Similarly, in comprehensive studies conducted in the USA and Denmark, it was reported that cell phone use was not associated with increased risk of brain tumor.[16,17]

There are also studies suggesting that EMR emitted by cell phones have negative effects on human health. Akdağ and colleagues observed that EMR led to histopathological changes in mouse testes and reported that chronic long-term exposure to EMR might affect amount of epididymal sperm, sperm morphology, and weight and morphology of the testes and epididymis.[18] There are also studies reporting that EMR emitted by cell phones leads to a change in the diameter of seminiferous tubules and rectal temperature.[13] It should be kept in mind that high levels of EMR used in the studies may lead to testicular heating; thus, unfavorable effects observed in the studies may result from increased temperature.

Close proximity of cell phones to the kidneys as well as

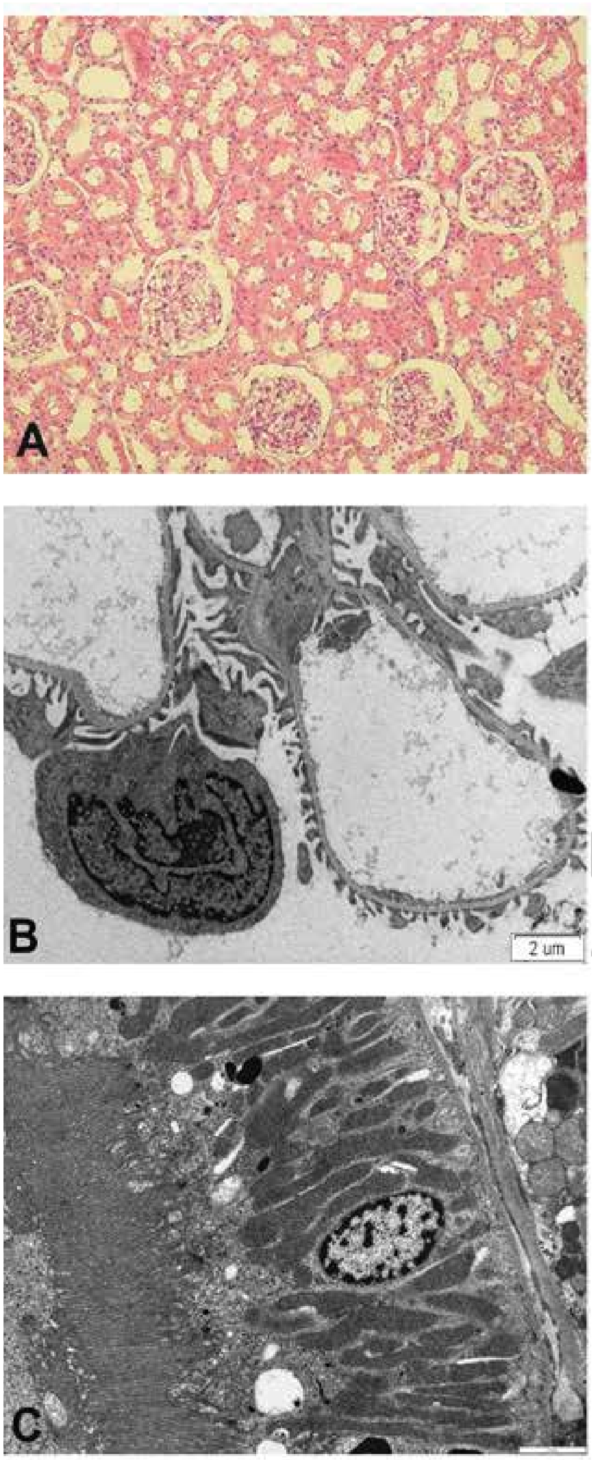

Figure 3. Control group. Glomerular and tubular structure of regular morphology **(A)** Podocytes, pedicels, and basement membrane; **(B)** and tubular structure; and **(C)** that have a regular morphology. A: Hematoxylin-eosin staining, original magnification: ×100; B & C: Electron micrograph.

higher risk of the kidneys to be affected by external factors indicates the need for research on the effects of cell phones on the kidney health. In their study, Özgüner and associates showed the formation of free radicals associated with cell phone use and the negative effects of these free radicals on the rat kidney tissue.[1] Devrim and coworkers reported that EMR led to an increase in the levels of oxygen radicals in the kidney tissue.[19] In our study, negative effects of EMR on the kidney tissue were shown by light and electron microscopic examination. This tissue damage was thought to be associated with oxygen radicals.

Studies have indicated that the kidneys are radiation-sensitive organs.[20] We showed tubular damage in our study. Furthermore, on electron microscopic examination, we observed dissociation of the junctions between the tubules. Tubular damage plays an important role in all causes of acute renal failure. In addition, observation of glomerular damage indicates the severity of this damage. Irregularity of the capillary endothelium observed on electron microscopic examination indicates the severity of glomerular damage.

Further support of these findings with clinical studies will necessitate large-scale measures to be taken for cell phone use. Reducing cell phone usage intervals, using protective clothes, and keeping cell phone devices away from body as far as possible may be the protective measures.

The limitations of the present study include the inability to predict clinical consequences of the histological findings, higher exposures of rats to EMR compared with EMR dosages produced by usual daily cell phone usage, and the lack of molecular research accompanying histological changes.

CONCLUSION

In our study, we showed negative effects of EMR on the rat kidney tissue. Considering these detrimental effects, individuals at high risk should take preventive measures. If these findings are supported by further clinical studies, in addition to individual measures, legal regulations should be enacted in order to minimize the risk.

CONFLICT OF INTEREST

None declared.

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