

## Blood biochemical parameters of the radio-link station workers

DAŞDAĞ S.<sup>1</sup>, BALCI K.<sup>2</sup>, AYYILDIZ M.O.<sup>3</sup>, ÇELİK M.S.<sup>1</sup>, TEKEŞ S.<sup>4</sup>, KAPLAN A.<sup>5</sup>  
*Departments of Biophysics<sup>1</sup>, Physics<sup>2</sup>, Hematology<sup>3</sup>, Biology<sup>4</sup>, Biochemistry<sup>5</sup> School of Medicine, Dicle University, Diyarbakur*

**Objective** The aim of this study was to investigate the effects of radiofrequency (RF) and microwave (MW) on the people occupationally exposed to non-ionizing radiation.

**Method** The study was carried out on 19 persons from 25 to 59 years old, 9 of them were radio-link technicians and the others were workers. We determined 22 biochemical parameters of blood serum.

**Results** Headache, dizziness and inability to hear were

observed clinically. An increase was observed in cholesterol, uric acid, total protein and creatin levels. The level of creatin kinase decreased.

**Conclusion** The effect of low frequency radiation (e.g. radiofrequency and microwave) on serum biochemical parameters are variable. We believe that the effect of RF and MW on human must be investigated widely.

**Key words** Radiofrequency, biological effects.

### Introduction

The applications of radiofrequency and microwave energy are numerous and there is an increasing demand for these technologies.

Equipment utilizing this form of energy is using in telecommunications, commerce, industry, medicine, radio, astronomy, research and at home (for example: microwave oven, television, radio, hand wireless etc.). As it is known, radio-frequency (RF) and microwave (MW) energy play very important role in our daily life. Many people do not take care about the hazards of microwave and radiofrequency radiation. It has been reported that, electromagnetic radiation such as radiofrequency and microwave, alters some functions of biological systems. We believe that people occupationally exposed to RF and/or microwave should be more careful about the hazards of these radiation than ordinary people. In this purpose, first we investigated the effects of high voltage transmission line on humans (1) and then a clinical investigation on the people occupationally exposed to RF and/or microwave in broadcasting and television transmitter stations (2). The results obtained from the above mentioned two studies showed similarity. Finally, we decided to continue our study on people who work at radio-link stations. We also programmed to investigate the hormones levels in people occupationally exposed to RF and microwave. The other studies (3-6) reported interesting results for people occupationally exposed to RF and MW.

### Material and Method

The study was carried out on 19 persons from 25 to 59 years old, 9 of them were radio-link technicians and the others as workers. All of them are still working at the radio-link stations with

167 MHz (VHF), 420 MHz (UHF), 2 GHz (UHF) and 6 GHz (SHF) of which output powers were 200.0, 10.0, 1.5 and 4.0 watt, respectively. Working years of subjects were 10 to 22 years.

First, we gave out a questionnaire consists 12 questions to everybody under investigation. Then we determined 22 parameters of their blood serum. The measured parameters were alanine aminotransferase (ALT), aspartate aminotransferase (AST), lactate dehydrogenase (LDH), alkaline phosphatase (ALP), phosphorus (Phos), cholesterol, uric acid, sodium (Na), potassium (K), urea, creatinine and creatin kinase (CK). The percentage of serum proteins such as albumin, group specific component, ceruloplasmin, post albumin, transferrin, haemopexin and post transferrin were also determined.

After determining the percentage of serum proteins, albumin/globulin ratio was evaluated. The percentage of serum proteins by Polyacrylamide gel disc electrophoresis and the levels of the other parameters in the blood serum were determined by auto analyser. On the other hand, the results were compared with control group covering voluntary and healthy people occupationally unexposed to RF or microwave. The result tested by using student's t test.

### Results

According to the results of filled questionnaires, people who work as radio-link technicians suffered from headache(10%), dizziness (20%) and inability to hear (10%). On the other hand, the people working at the same stations as a worker sometimes suffered from headache (27%) and dizziness (10%). The radio-link technicians also suffered from electric shock (66%) when being in contact with a metal. Some of the people under investigation had some diseases such as renal disease (15%), hepatitis (15%), diabetes (5%) before this study was carried out.

Accepted for publication: 14 October 1998

When we asked "Do you suffer from electric shock when you are away from this stations", the answer by radio-link technicians was "No" (88%). The results of the questionnaires such as headache, dizziness and electric shock are consistent with the findings of the other similar studies (1,6).

In the second step of this study, we determined the levels of 15 parameters in the serum and the percentage of 7 serum protein fractions in the serum. Cholesterol, uric acid, creatin, CK and total protein levels were found statistically significant ( $p < .05$ ,  $p < .01$ ,  $p < .001$ ). An increase were observed in cholesterol, uric acid, total protein, and creatinine levels. However the level of CK decreased. The

parameters were found to be within reference ranges. The percentages of albumin, group specific component, post albumin and haemopexin were found statistically significant when compared with the control group ( $p < .01$ ,  $p < .001$ ). The percentages of albumin and hemopexin increased. The percentages of ceruloplasmin, transferrin and post transferrin were not changed in the serum. Also, albumin/globulin ratio was not changed in the serum of people who work at the radio-link stations. The results obtained in this research are given in the tables I and II that were supported by other scientists (1-10).

Table I. The levels of blood serum parameters in people who work at radio-link stations.

Parameters	Reference Ranges	Control Group X $\pm$ SD	Experimental Group X $\pm$ SD	t	P
ALT	10-601 U/L	18.99 $\pm$ 19.30	23.60 $\pm$ 12.50	0.697	p>0.05
AST	10-421 U/L	35.10 $\pm$ 21.50	25.47 $\pm$ 6.31	1.385	p>0.05
LDH	71-225 IU/L	126.40 $\pm$ 52.80	144.63 $\pm$ 28.23	1.017	p>0.05
ALP	20-90 IU/L	25.00 $\pm$ 7.00	57.31 $\pm$ 14.66	1.808	p>0.05
PHOS	3-4.5mg/Dl	2.62 $\pm$ 0.42	2.78 $\pm$ 0.44	1.230	p>0.05
CHOLESTEROL	150-250 mg/dL	164 $\pm$ 13.00	190.70 $\pm$ 42.04	2.550	p<0.05
URIC ACID	2.1-7.8 mg/Dl	4.44 $\pm$ 1.23	6.63 $\pm$ 1.90	3.775	p<0.001
Na	133-145 mEq/dL	141.70 $\pm$ 2.62	143.42 $\pm$ 2.58	1.669	p>0.05
K	3.5-5.5 mEq/dL	4.08 $\pm$ 0.43	3.85 $\pm$ 0.41	1.437	p>0.05
UREA	15-40 mg %	28.50 $\pm$ 5.40	30.42 $\pm$ 5.00	0.933	p>0.05
CREATININE	till 1.5 mg %	0.88 $\pm$ 0.16	1.05 $\pm$ 0.20	2.833	p<0.01
CK	22-269 IU/L	96.80 $\pm$ 59.20	54.60 $\pm$ 25.15	2.155	p<0.05

Table II. The percentage of serum proteins in people who work at radiolink stations.

Parameters	Control Group X $\pm$ SD	Experimental Group X $\pm$ SD	t	P
Total protein (gr)	7.46 $\pm$ 0.39	8.51 $\pm$ 1.24	9.859	p<.001
Albumin (%)	28.50 $\pm$ 3.69	25.70 $\pm$ 3.70	3.211	p<.01
Group Specific Component (%)	6.87 $\pm$ 2.78	9.00 $\pm$ 1.87	4.230	p<.001
Ceruloplasmin (%)	4.56 $\pm$ 3.12	3.42 $\pm$ 1.38	1.627	p>.05
Post-Albumin (%)	9.16 $\pm$ 3.01	12.79 $\pm$ 2.26	4.510	p<.001
Transferrin (%)	10.08 $\pm$ 1.64	10.08 $\pm$ 1.67	0.000	p>.05
Haemopexin (%)	3.17 $\pm$ 1.00	4.23 $\pm$ 0.71	4.076	p<.001
Post-Transferrin (%)	49.11 $\pm$ 3.47	47.46 $\pm$ 3.97	1.417	p>.05
Albumin/ Globulin (%)	0.39 $\pm$ 0.07	0.34 $\pm$ 0.06	0.75	p>.05

## Discussion

Serum biochemical alterations have been reported to result from exposure to RF/MW energies. These effects generally appear to be transient and no well-defined characteristic response pattern has been determined, nor is it known whether the changes are direct or indirect effects of exposure. It is difficult to explain the changing mechanism of blood serum parameters. Some reactions to RF/MW exposure may lead to measurable biological effects which remain within the range of physiological compensation. On the other hand, some reactions may be potential or actual health hazards. A four year surveillance of a

large group of radar workers in the USA did not demonstrate any important clinical or pathophysiological differences between the exposed and control groups (11). Nervous system changes and behavioral effects of exposure of man to MW have been reported. Most of the reported effects are subjective such as fatigue, headache, irritability, loss of appetite, sleepiness and memory difficulties. Most of the subjective symptoms are reversible (12). Dose dependent transient elevations in serum urea and uric acid were noted following far-field exposure of rabbits to 2.45 GHz for two hours at intensities of 100 and 250 W/m<sup>2</sup>. Single or repeated exposures of

rabbits to 3 or 10 GHz at 50-250 W/m<sup>2</sup> resulted in alterations in serum albumin/globulin ratio, attributable to effects on the liver or adrenals. Although the obtained results showed similarity with the results of our other studies (5,6). Exposure is preferably controlled by engineering measures alone such as total enclosure, partial enclosure with leakage limited to that permitted by device emission standards, or the use of safety interlocks to prevent access to high-exposure areas. Finally we would like to emphasize that this study revealed no pathological findings since all of the values of blood parameters were within normal limits. We consider that, the differences between the radiation exposed and control groups may be due to a general response of the organism to electromagnetic radiation-induced stress.

### References

1. Çelik MS, Daşdağ S, Akdağ Z, Kaya H, Aydınol B, Tekeş S, Balcı K.: The Effects of High Voltage Transmission line on Humans. *Biotechnology and Bio E* 6/4:33-36, 1992.
2. Daşdağ S, Balcı K, Çelik MS, Kaplan A, Bolaman Z, Tekeş S, Akdağ Z.: Neurologic and Biochemical Findings and CD4/CD8 ratio in People Occupationally Exposed to RF and Microwave. *Biotechnology and Bio E* 6/4: 37-39, 1992.
3. Cleary SF.: Uncertainties in the evaluation of the biological effects of microwave and radiofrequency radiation. *Health physics* pergamon press 25: 387-404, 1973.
4. Kalada TV, Fukolova PP, Gontsarova NN.: Biologic effects of radiation in the 30-300 MHz range. *Polish Med Publ, Warsaw* 52-57, 1974.
5. Frey AH.: Effect of microwave and radiofrequency on the central nervous system. Symposium of biological effects and health implications of microwave radiation. Richmond, Va., BRH / DBE 70-2:134-139, 1969.
6. Klimkova-Deutschova E. Neurologic findings in persons exposed to microwaves. *Polish Med Publ, Warsaw* 268-272, 1974.
7. Baranski S.: Histological and Histochemical Effects of Microwave Radiation on the Central Nervous System of Rabbit and Guinea Pigs. *American Journal of Physical Medicine* 51, 4:182-191, 1972.
8. Cleary SF.: Biological Effects of Microwave and Radiofrequency Radiation. *CRC Critical Reviews in Environmental Control* 7, 2: 121-116, 1977.
9. Wangeman RT, Cleary SF.: The invivo Effects of 2.45 GHz micro-wave radiation on rabbit serum component and sleeping times. *Rad Environ Biophys* 13:89-103, 1976.
10. Lin JC.: Health aspects of Radio and Microwave Radiation. *Environmental J Pathol Toxicol* 2(6):1413-1432, 1979.
11. Barron CI, Baraff AA. Medical considerations of exposure to microwaves (radar) *J Am Med Ass* 168:1194, 1958.
12. Orlova TN. Clinical aspects of mental disorders following protracted human exposure to super-high frequency electromagnetic waves. In: *Cerebral mechanism of mental illnesses*, Kazan, 1971, pp:16-18

### Correspondence to:

Doç. Dr. Süleyman Daşdağ  
Dicle Üniversitesi Tıp Fakültesi  
Biyofizik ABD Öğretim Üyesi  
21280. Diyarbakır, TÜRKİYE