CARDIOVASCULAR RESPONSE OF RATS EXPOSED TO 60-HZ ELECTRIC FIELDS

ABSTRACT

Recent studies have shown that exposure to high strength electric fields can influence ECG patterns, heart rates and blood pressures in various species of animals. Our studies were designed to evaluate these reported effects and to help clarify some of the conflicting reports in the literature. Various cardiovascular parameters were measured in rats exposed to 60-Hz, 80 or 100 kV/m fields for periods up to and including 4 month durations. In addition, physiological reserve capabilities were measured in rats exposed to 100 kV/m for 1 month and then subjected to cold stress. No significant differences in heart rates, ECG patterns, blood pressures or vascular reactivity measurements were found between exposed and sham exposed rats after 8 hours, 40 hours, 1 month or 4 months of exposure. Electric field exposure did not alter the animals' physiological response to cold stress. While our studies cannot be directly compared to the work of other investigators, our failure to detect any cardiovascular changes is probably the result of eliminating secondary field effects such as microcurrent shocks, corona and ozone formation.

SUMMARY

There have been many reports concerning the effects of high strength electric fields on the cardiovascular system. Changes in the electrocardiogram (ECG), namely a prolonged PR interval and QRS duration, were observed in mice and guinea pigs exposed to 50-Hz electric fields (Blanchi, 1973). Elevated heart rates were seen in chickens exposed to 25-50 kV/m fields although this effect wasn't reproducible (Poznaniak, 1977). Clinical findings have shown that switchyard workers exposed to electric fields showed signs of unstable pulse and arterial pressure (Asanova, 1966). Higher mean arterial pressures were found in rabbits exposed to 80 kV/m, 50-Hz electric fields for 500 hours (Cerretelli, 1976). The response of the cardiovascular system to controlled hemorrhaging was measured in dogs exposed 15 kV/m fields for 5 hours (Gann, 1976). The exposed animals, when subjected to controlled bleeding, exhibited a lower arterial and pulse pressure as well as higher heart rates.

Many of these observed effects might be explained by the secondary factors that are associated with electric field exposure (i.e., corona, ozone, hum, vibration, spark discharge). Our exposure system was designed to eliminate such secondary factors. A series of experiments were made that showed our exposure system to be free of corona discharge and ozone

formation. Animals were not subjected to spark discharges from the caging, watering, or feeding systems. In view of the reported effects of electric fields, we are presently investigating the effects of 60-Hz electric fields on cardiovascular function of rats.

Electrocardiogram and heart rate measurements were made on rats exposed or sham-exposed to 80 kV/m for 8 hours or 100 kV/m for 1 month. Heart rates were also measured on animals exposed for 40 hours to 80 kV/m or 4 months to 100 kV/m. ECG and heart rates were obtained using transthoracic surface electrodes attached to each side of the upper thorax. All measurements were made 1 hour immediately after electric field exposure on conscious animals that had been acclimated previously to special holders. ECG evaluations were made from high speed (100 mm/sec) recordings, with the duration of the PR interval and QRS segments measured using a 10 x comparator. Heart rates were obtained from tachograph recordings of the ECG. We found that electric field exposure for periods up to and including 4 months duration at 80 or 100 kV/m did not effect the ECG or heart rate of rats.

Blood pressure and vascular reactivity measurements were made on rats that were exposed for 35 days or 120 days to 100 kV/m. Blood pressures were monitored through a strain gauge pressure transducer which was connected to a cannulae in the left femoral artery. Systolic, diastolic and mean systemic pressures were monitored continuously. Vascular reactivity was measured as the increase of the mean systemic blood pressure produced by phenylephrine, an α receptor stimulator, introduced into the left femoral vein. We found that exposure to 100 kV/m for 35 or 120 days

did not affect blood pressure or the vascular reactivity response.

Another experiment was conducted to assess for physiological reserve capabilities in rats subjected to stress. Heart rate, deep colonic temperature and skin temperature were recorded on rats immediately after exposure or sham-exposure to 100 kV/m for 1 month. Once baseline values had been obtained, the animals were subjected to cold stress (-13 $\pm$ 1°C) for 1 hour, with simultaneous recordings made of heart rate, colonic and skin temperatures. Measurements were continued for 1 hour after cold stress exposure. Exposure to 100 kV/m for 1 month had no effect on the heart rate, colonic and skin temperature before, during or after cold exposure.

The differences in animal species and exposure regimen make it difficult to directly compare our findings to those of other investigators. Our failure to detect any cardiovascular changes might be the result of these differences or the results of our efforts to eliminate secondary field factors (e.g., shocks, corona, etc.).

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