DYNAMICS OF THE ELECTROCARDIOGRAM OF *Macaca rhesus* DURING THE 24-HOUR PERIOD RECORDED BY A TELEMETRIC METHOD

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UDC 612.172.4-019:599.824"52"

By means of the telemetric method of recording the EKG, the true pulse rate and the dynamics of the EKG during the 24-h period can be determined in monkeys.

By means of a telemetric method, it has been shown that the resting pulse rate of *Papio hamadryas* is much lower than revealed by the EKG recorded by the usual method [4]. Certain new qualitative features of the EKG have also been revealed by radiotelemetry.

Bearing in mind species differences in a number of physiological functions in baboons and macaques [2], in the present investigation an attempt was made to analyze the EKG of *Macaca rhesus* to determine these differences.

EXPERIMENTAL

Experiments were carried out on 10 rhesus monkeys (7 males and 3 females aged from 2 to 6 years). For six months 8 of the monkeys had been kept in special primatological armchairs. The EKGs of 5 of the monkeys were recorded not only in the armchair, but also during free movement (when they were taken from the armchair and set free in the cage). Two monkeys were examined only under conditions of complete freedom of movement (without having been placed in the armchair). The investigation continued for two years. The EKG was recorded on a single-channel ink-writing electrocardiograph, both through a wire lead and radiotelemetrically [3]. The transmitter was placed on the animal's back in the pocket of an apron, which the monkey had previously become accustomed to wearing. The EKG was recorded in Nebb's anterior lead. Disc electrodes were implanted subcutaneously into two monkeys, while in the rest the electrodes were safety-pins, which were passed through a fold of skin. Of the 10 monkeys tested, 8 took part in experiments to study motor conditioned reflexes to food, while 2 monkeys were not used in other experiments. Clinically, all the monkeys were healthy. The EKGs of 8 monkeys were recorded every 2 h during the 24-h period. The recordings were made at a distance of 20-30 m from the monkey.

EXPERIMENTAL RESULTS

According to the EKG data recorded by means of wire leads, the pulse rate of the monkeys was 214-250/min. This is in agreement with published data [1, 6, 7]. No age differences were found in the pulse rate. All R-R intervals were equal, and no signs of respiratory arrhythmia were present. Compared with *P. hamadryas*, in *M. rhesus* a slightly higher pulse rate and a more stable EKG were observed; the T wave was always positive. In healthy baboons neither a positive nor a negative T wave could be recorded.

When the EKG of the rhesus monkeys (both fixed in the armchair and also "at liberty" but in the presence of people) was recorded telemetrically, the pulse rate was 20-30% lower than that given by the EKG recorded by wire leads. At complete rest, when no people were with the monkeys, the pulse rate was lower still, even during the daytime, while signs of respiratory arrhythmia could be detected on the EKG (Fig. 1: 2, 7).

Laboratory of Physiology and Pathology of Higher Nervous Activity, Institute of Experimental Pathology and Therapy, Academy of Medical Sciences of the USSR, Sukhumi. (Presented by Academician V. V. Parin.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 69, No. 4, pp. 29-32, April, 1970. Original article submitted June 23, 1969.

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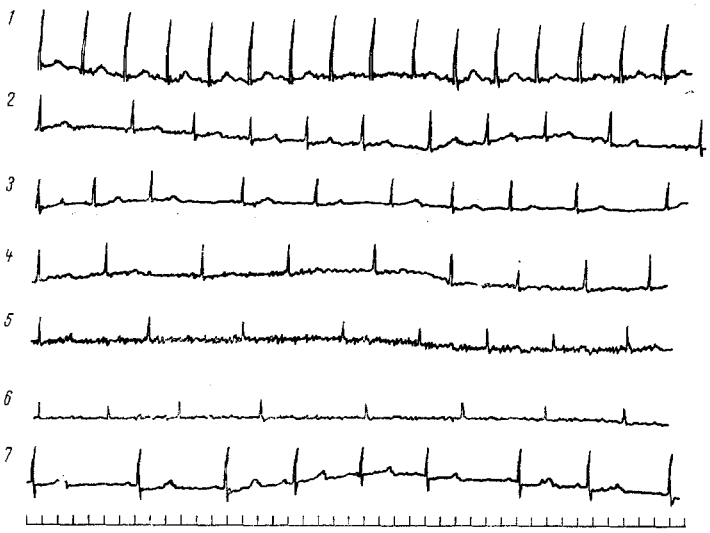

Fig. 1. Dynamics of EKG of a monkey aged 3 years during the 24-h period. 1) EKG recorded by usual method (wire leads, 11 A.M.); 2-7) telemetric recording of EKG; 2) at 11:30 A.M., 30 min after attachment of transmitter; 3) at 4 P.M.; 4) at 8 P.M.; 5) at midnight; 6) at 4 A.M.; 7) at 8 A.M.

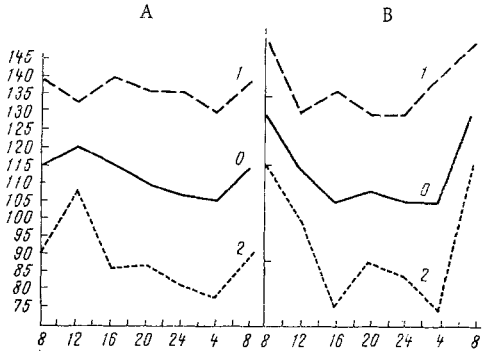

Fig. 2. Dynamics of pulse rate in adult rhesus monkeys (A) and in adolescent animals (B). 0) Mean data: 1) mean data for highest pulse rate observed in monkeys; 2) mean data for lowest pulse rate observed in experiments during the 24-h period. Abscissa, time of day (in h); ordinate, pulse rate per minute.

Analysis of the EKG curves recorded telemetrically at complete rest demonstrates that the mean pulse rate of the rhesus monkeys was 115/min, which is considerably below the "normal" (180-200) based on EKG recordings with wire leads (1, 5, 6). During telemetric recording of the EKG, the difference in pulse rate between M. rhesus and P. hamadryas revealed by recording of the EKG in the usual manner still persisted. Analysis of the respiratory arrhythmia which can be observed during the daytime in monkeys only by telemetric recording of the EKG shows that slowing of the pulse during inspiration and its quickening during expiration were slightly more marked in the rhesus monkey (166-100/min) than in P. hamadryas (125-86/min). In both cases the measurements were made at 4 P.M.

Telemetric recording also revealed age differences in the pulse rate: in monkeys under 3 years old it was higher than in monkeys aged 3-6 years (Fig. 2A, B). The T wave remained positive in the telemetric

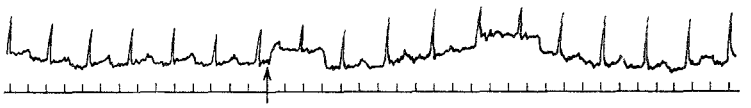

Fig. 3. Radiotelemetric recording of EKG before and during stimulation of hippo-campus (8 mA) through implanted electrodes. Arrow denotes beginning of stimulation. Monkey fixed in armchair.

recordings. No significant differences in the pulse rate were found by telemetric recording of the EKG in monkeys which sat for long periods in the armchair and were then allowed to walk freely about the cage. Telemetric recordings of the EKG for the 24-h period indicate considerable slowing of the pulse at night. From midnight until 4 A.M., for instance, the pulse rate fell to 70-75/min (Fig. 2A, B), which was never observed when the EKG was recorded by means of wire leads, and the experimenter necessarily present close to the monkey.

At night the respiratory arrhythmia was much more marked than during the day (Fig. 1). The qualitative differences in the EKG also had a marked 24-h periodicity; at night the voltage of all waves was reduced, but in the rhesus monkeys invertion of the T wave was never observed at night, as it frequently was in the baboons.

It must be emphasized that the telemetric method enables the EKG to be recorded without induction or other interference, and not only while the monkey is moving freely about the cage, but also during stimulation of various brain structures through implanted electrodes (Fig. 3). Hence, where wild animals such as rhesus monkeys are concerned, even though several generations have been kept in the nursery, telemetric recording of their parameters is an essential method for determining the true values of the pulse rate and, perhaps, other physiological parameters.

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