DIURNAL RHYTHM OF MITOTIC ACTIVITY IN SOME PARTS OF THE NEPHRON IN MICE

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The investigation of the diurnal rhythm of cell division in organs where this activity is on a low level is attracting increasing attention at the present time.

The data concerning the existence of a diurnal periodicity of cell division in the kidneys are conflicting. Although most authors [1-6] recognize the presence of a diurnal rhythm of cell division in the epithelium of the nephron, others [9] categorically refute this. It should be noted, however, that different authors used different experimental techniques and different methods of interpreting their findings.

The object of the present investigation was to determine the mitotic activity in different parts of the nephron in mice at different times of day and night.

EXPERIMENTAL METHOD

Adult male CC57BL mice weighing 17-20 g were used in the experiment. The animals were sacrificed every 3 h in the course of the 24-h period. The kidneys were fixed in Carnoy's fluid, embedded in paraffin wax, and sections cut to a thickness of 7 μ were stained with hematoxylin-eosin. The preparations were examined under a magnification of 630×. The numerical results were analyzed by the Fisher–Student method. The mitotic index (MI) was determined for the proximal tubules and for the descending and ascending parts of the loop of Henle.

The investigation had to be restricted to these parts of the nephron, first because of the need for examining large numbers of cells in each case (75,000 for the proximal tubules and 50,000-60,000 for each segment of the loop of Henle) and, second, on account of the complex topography of the organ [8]. Topographic bearings were obtained from the data of McFarlane [7], according to whom the inner zone of the cortex consists mainly of the cells of the proximal portion of the nephron, while the outer and inner zones of the medulla are respectively occupied mainly by the cells of the ascending and descending segments of the loop of Henle.

EXPERIMENTAL RESULTS

The experiments revealed the presence of a diurnal rhythm of mitotic activity in the cells of the proximal tubules (see figure). The mean MI for the 24-h period for the cells of this portion of the nephron was 0.08 ‰, i.e., approximately one-ninth of the figures given by Dobrokhotova and Kurdyumova for the renal cortex in rats [2]. The mitotic activity in the epithelium of the proximal tubules, reached a maximum at 10 A.M., with a value of 0.223 ‰. The mitotic activity then fell gradually, and between 10 P.M. and 4 A.M. it reached a minimum (0.005-0.008 ‰), after which it rose again to the maximum. The change in the number of mitoses from one time to another in some cases was not statistically significant, but when the comparison was made between the time of maximal and minimal mitotic activity the difference was close to significant (P about 0.02).

So far as the times of the maximum and minimum of mitotic activity in the cells of the proximal portion of the nephron are concerned, they were close to those reported by other authors [1-6] for the renal cortex as a whole (maximum in the morning and afternoon and minimum in the evening and night). This can be understood if it is remembered that the overwhelming mass of cell material in the cortical layer consists of cells of the proximal portion of the nephron.

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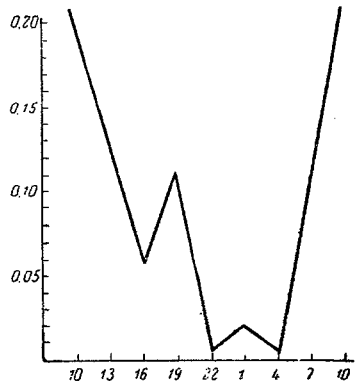

Fig. 1. Diurnal fluctuations in mitotic activity in the cells of the proximal portion of the nephron in mice. Abscissa – time of day; ordinate – mitotic index (in $^0/_{00}$).

Mitotic activity in the cells of the ascending segment of the loop of Henle was found only at one of the times of investigation, namely at 10 A.M., and even then it was extremely low ($0.02^0/_{00}$). This fact is noteworthy, because it was at 10 A.M. that the mitotic activity was at its highest in the cells of the proximal tubule.

No mitotic figures were found at any time during examination of the cells of the descending segment of the loop of Henle, which could be confidently attributed to those cells.

The results relating to the mitotic activity of the cells of the loop of Henle are in agreement in with conclusions reached by Williams [9], who, after investigating the rat kidney, likewise found no mitoses in the descending portion of the loop of Henle, and showed that the mitotic activity of the cells of the ascending portion of the loop of Henle was much lower than in the cells of the proximal tubules.

It may be concluded from the results of this investigation that a diurnal rhythm of cell division exists in the proximal portion of the nephron of the mouse kidney, and that mitotic activity is absent in the descending portion of the loop of Henle throughout the 24-h period.

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