ELECTROURETEROGRAM OF THE CAT

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The electroureterogram (EUG) represents a prospective method for functional investigation of the ureters and serves to account for the effect exerted on the ureters by a number of pharmacological substances (4, 5). The electrophysiologic investigations of *Bozler* (8) carried out on longitudinal ureteral segments of dog, cat, guinea pig and rats gives us some idea about the action potentials of the smooth musculature in these organs. However both the latter findings and the curves from the ureters of dogs, cats and rats, recorded for the first time by Orbelli and *Brücke* (cited by 10), show discrepancies (1, 4, 5, 7).

Recently in the pertinent literature data has been published demonstrating the importance of the three ureteral segments — pyeloureteral, middle and prevesical — for the development of urinary tract diseases (3). Histologic studies have revealed two to three cavernous blood corpuscles within the ureteral wall which divide the ureter into three and more seldom into four cystoids (6).

The studies of *Bakuntz* (2) show that the rhythm of the ureteral peristalsis arises in a pace maker, located at the very beginning of the ureter— the so-called pararenal segment.

Due to controversial literature reports, we undertook the task of recording the normal ureterogram of cat under conditions of acute experiment with extraureterally inserted electrodes as well as to compare the bioelectric activity of the three ureteral segments.

Material and Method

The experiments were conducted on adult cats with weight ranging from 2,5 to 4,5 kg. The results in a series of 18 experimental animals were analyzed; in the three of the total EUG bipolar recording was made solely from the middle third — bipolar. In five animals only the bipolar EUG ureter-leg was recorded.

For narcosis, i. m. application of 10% urethane solution, 10 cc per kilogram body weight was used. Within an hour of narcosis induction two pararectal incisions were made on the abdominal wall. Through one of the incisions the internal organs were removed from the abdominal cavity, wrapped in gauze and imbued in physiological saline solution. Removal of the internal abdominal organs was carried out in order to obviate any contacts with the ureters or any eventual influencing of bioelectric activity. At a distance of 1,5—2 cm in the middle of each physiological segment, the ure-

ters were dissected from the surrounding tissues after cutting the parietal membrane of the peritoneum, taking care not to cause hemorrhages. For EUG recording the method applied at the urological clinic of the High Medical Institute in Bratislava, Czechoslovakia, as modified by the authors was employed. The so denudated areas were placed over the internal surface of the sickle-shaped silver-plated electrodes. In bipolar recording the intraelectrode distance measured 2 mm. The plane width of each electrode was $2^1/_2$ milimeters. Manipulations were performed with minimal trauma to the ureter and without interrupting the free urinary discharge. The ureteral segment was laid down freely on the electrodes set on racks perpendicular to the ureter in the horizontal plane.

Recordings were obtained under conditions of adequate anesthesia of the animals and traced for several hours. They were carried out with bladder emptied spontaneously or by means of puncture. The animals were placed in isolation chamber.

The EUG were led off in one of three ways: 1) between two electrodes with intraelectrode distance as already mentioned above, 2) bipolar derivation ureter-leg with pin point electrodes inserted into the leg and 3) simultaneous unipolar recording from the three ureteral segments (of the type of enlarged unipolar leads in ECG).

The recordings were made with three-channelled cardiograph PST3 S300 of the firm Schwarzer at amplification 1 millivolt/1 cm and paper speed 15 cm/1 min.

Results and Discussion

Two types of complexes were registered — 1) small, low voltage, more frequent, of shorter duration, mono- and biphasic and 2) large with higher voltage slower, rather longer lasting three and more-phasic.

Small complexes were observed only in the upper and middle thirds. It is interesting to note that they were recorded both independently and simultaneously with the big ones at different ratios — 1:1, 6:1 etc. (Fig. 1 and 2).

The small complexes averaged 12,6 per minute averaging 0,98 seconds. In the upper third they disclosed a wave above the isoelectric line averaging 0,52 millivolts and a wave below the isoelectric line — averaging 0,28 millivolts. In the middle third they had a wave above the isoelectric line averaging 0,47 millivolts and a wave below the isoelectric line averaging 0,28 millivolts (mv).

The large complexes recorded averaged 6,3 per minute and lasted mean 1,8 seconds. They displayed an intricate configuration consisting of several phases. In one animal a shape was registered very similar to that reported by *Bozler* concerning the bioelectric responses of the longitudinal ureteral pieces of guinea pigs. In the large complexes the voltage of the biggest wave above and below the isoelectric line was measured. The biggest wave above the isoelectric line in the upper third averaged to 0,79, in the middle third— 1,74 and in the lower third — 1,70 mv. The biggest wave below the isoeectric line in the upper third averaged 1,27 mv, in the middle third — 1132 and in the lower thrid — 1,08 (Fig. 3).

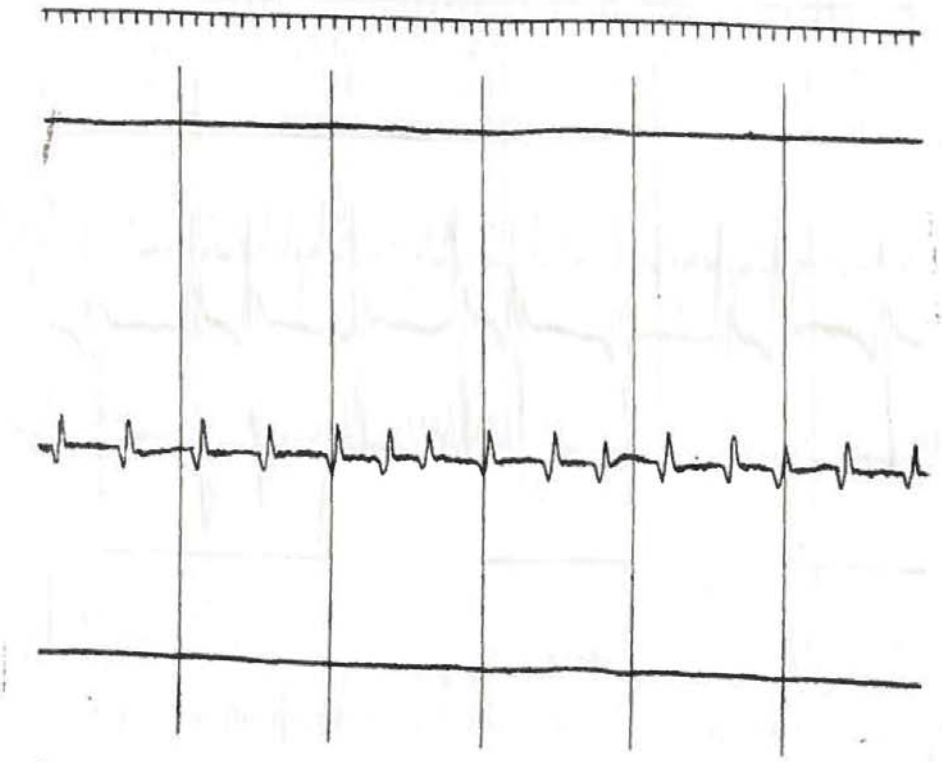

Fig. 1. Small complexes from the middle third of the cat's ureter.

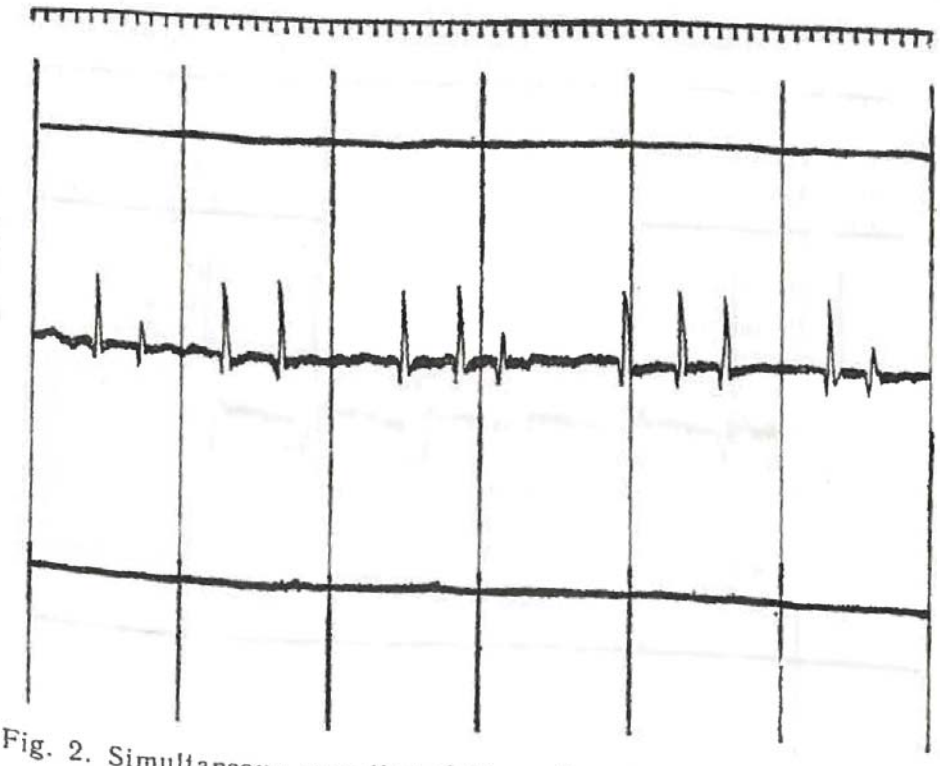

Fig. 2. Simultaneous recording of big and small complexes from the middle third of the ureter of cat.

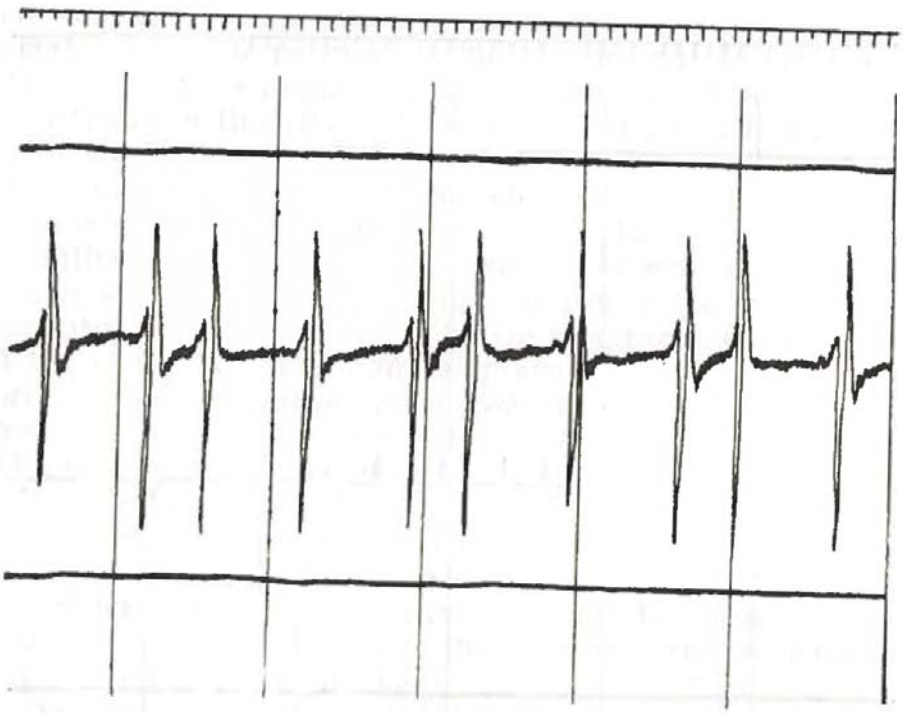

Fig. 3. Large complexes from the middle third of cat's ureter.

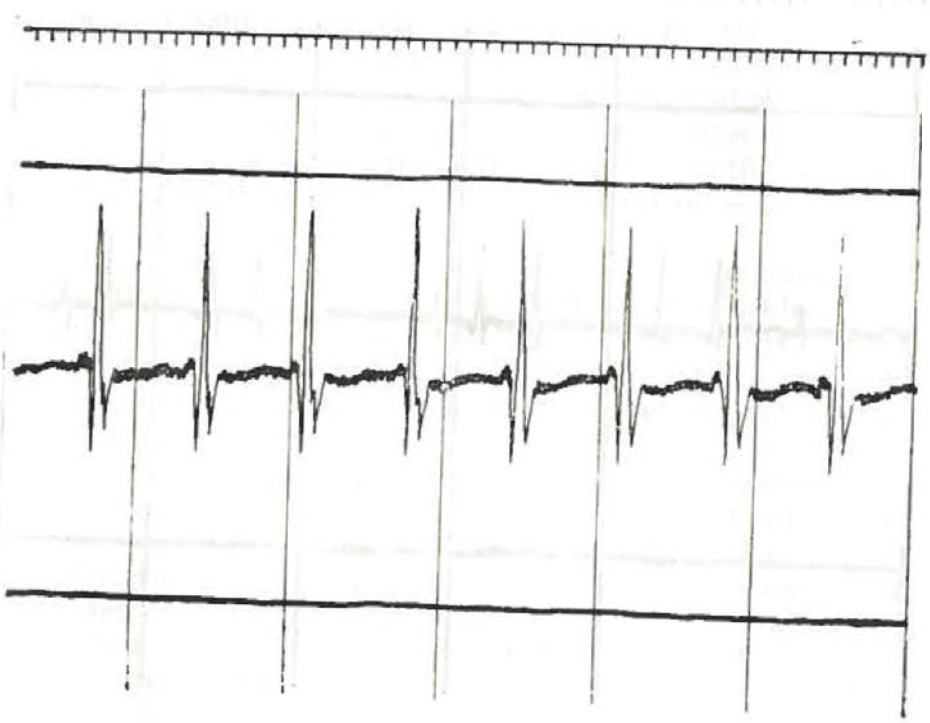

Fig. 4. Recording in ureter left-leg lead from the middle third of cat's ureter.

We believe that the small complexes should be considered as a manifestation of regional bioelectric phenomena in the individual physiologic sections of the ureters and seldom exceed its confines. The large complexes are an expression of the bioelectric activity of the peristaltic waves, consecutively involving the three physiologic segments. It should be pointed

Fig. 5. Simultaneous unipolar recording of bioelectric activity from the three ureteral segments (of the type of enlarged unipolar leads in ECG).

out that in certain cases, bioelectric activity was noted only in a single segment and electric «silence» in the remainder, or else a later appearance of the bioelectric activity. In this respect the lower third appeared to be the most inert.

The ureter-leg tracings obtained were rather similar in nature to those discribed above with the difference that they were invariably slightly bigger with longer duration and increased biggest wave below the isoelectric line. Only in isolated cases larger deviations in the form were observed (Fig. 4).

The tracings registered during simultaneous recording of the three segments of the ureter (of the type of enlarged unipolar leads in ECG) with strongly pronounced activity in all three segments produced a characteristic picture. A big wave was observed consecutively in the curves of the upper, middle and lower third which gives some idea about the transition of bioelectric activity consecutively in the three segments (Fig. 5).

REFERENCES

1. Бакунц, С. А. *Известий А. Н. Арм. ССР*, I, 1961, 1.
2. Бакунц, С. А. Вопросы физ. вег. нерв. с-ми и можечка А. Н. Арм. ССР. 1964, 85—96.

3. Голигорский, А. М. Кацыф. Хир. лохоночно мочеточникова сегмента, Кишинев, 1966.
4. Кузьмина, В. Е. *Урологии*, 1958, 4, 11.
5. Пытел, А. Ю. *Урологий*, 1960, 6, 9—16.
6. Baker, R., J. Huffer. *The J. of urology*, **70**, 1953, 6.
7. Rozler, E. *Biological symposia*, 1941, 3, 95—109.
8. Kneuker, A. W. *The J. of urology*, **75**, 1956, 2.
9. Malatinsky, E. Rozhleoly v chirurgii X, **10**, 1966.
10. Sleator, W., H. R. Butcher. *Am. J. physiol.*, 1955, 180, 2—261.

ЭЛЕКТРОУРЕТЕРОГРАММА КОШКИ

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РЕЗЮМЕ

Основной задачей настоящей работы являлся запись электроуретерограммы (ЭУГ) при помощи экстрауретерально расположенных электродов в условиях острого опыта с трех функциональных сегментов уретера кошки. Технически записи были сделаны тремя способами: 1) биполярно—между двумя точками мочеточника на расстоянии 2 мм; 2) биполярно — мочеточник—нога и 3) униполярно — одновременно с трех сегментов (по типу увеличенных униполярных отведений ЭКГ). По первому методу записаны два вида комплексов. Низковольтажные, коротковременные более частые, моно- или бифазные с регионарно-сегментарным значением комплексы в верхней и средней третях. Более высоковольтажные, более длительные, более редкие, многофазные комплексы во всех третях мочеточника, как выражение проходящей биоэлектрической активности последовательно через все три мочеточниковые сегменты. Самой «молчаливой» в биоэлектрическом отношении оказалось нижняя треть. Записи при расположении электродов уретер — нога приближались по их параметрам к биполярным мочеточник — мочеточник. Кривые, которые наблюдаются при униполярной записи одновременно от трех сегментов мочеточника, дали возможность сделат оценку распространения перистальтической волны по длине мочеточника.