ESTIMATION OF THE EFFICACY OF PERITONEAL DIALYSIS

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E. B. Gorbovitskii, B. G. Gol'dina and V. I. Unik

Department of Medicine, Scientific-Research Institute of Experimental Surgical Apparatus and Instruments, Moscow
(Presented by Academician V. V. Parin)
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Methods of extra-renal cleansing of blood have a great importance in the practice of medicine. The overwhelming majority of them are based on the use of the dialysis principle. Dialysis may be carried out by using artificial semipermeable membranes (for example, cellophane in special apparatus of the "artificial kidney" type) or naturally occurring membranes (pleura, peritoneum, mucous membrane of the gastro-intestinal tract). The most effective in the latter group is the peritoneum in so-called peritoneal dialysis. Its relatively high efficacy is conditioned by the large area of the peritoneum, and consequently, a large area of dialysis surface. In man the area of the peritoneum comprises 20,000 to 22,000 cm^2, which is only a little less than the working area of the renal parenchyma.

In our country,the experimental study of peritoneal dialysis was begun by S. M. Schenderov [1] in the laboratory of Prof. V. V. Parin. .The author showed that the life of nephrectomized rabbits might be prolonged by the use of this method.

Peritoneal dialysis is used in two modifications: constant flow and intermittent. The first is maintained by continuous perfusion of the peritoneal cavity and the second by periodic filling of the peritoneal cavity with the dialysis solution.

This study was designed to compare both variants of peritoneal dialysis.

METHODS

Twenty-seven experiments were performed on nine nephrectomized dogs of both sexes, weighing from 19.9 to 20.4 kg. The experiments were carried out with morphine-hexanal anesthesia. At 48 h before the first dialysis the animals were subjected to bilateral nephrectomy. For intermittent dialysis a polyethylene fistule of special construction was sutured in the anterior abdominal wall. During the dialysis period a catheter was placed in this fistula to conduct the dialysis solution in and out. The catheter was a polychlorvinyl tube 500 mm in length and six mm in diameter. Multiple small openings (0.7 mm) were made along the length of the catheter to facilitate the even and unobstructed flow of fluid. The solution was introduced in two liter volumes warmed to body temperature. The dialysate was prepared in the following proportions: CaCl—160 g, KCl—4 g, $MgCl_2$—2 g, NaH_2PO_4—1 g, $NaHCO_3$—20 g, $CaCl_2$—2 g, glucose 30 g, distilled water to 20 liters. To each liter of solution 100,000 units of penicillin and streptomycin were added. In addition, to prevent fibrin clots from forming in the catheter or in its openings 10 mg of heparin was added per liter of solution. The solutions were changed during the intermitten dialysis every one to $1^1/_2$ hours.

In carrying out continuous dialysis two fistulas were sewn into the anterior abdominal wall: for entry and for exit of the dialysis solution. The fistulas were placed on both sides of the midline. Before the start of the dialysis two liters of dialysate were introduced into the abdominal cavity. To obtain comparable results the rate of solution input was established so that the volume of fluid flowing per unit time corresponded to that in the intermittent dialysis (two or 1.3 liters/hour). The duration of each experiment both with intermittent dialysis and with the continuous procedure was three hours.

Results of Different Types of Peritoneal Dialysis

Intermittent dialysis (17 experiments)			Continuous dialysis (10 experiments)		
Change of solution	amount of urea removed (in g)	decrease in plasma urea concentration (in %)	rate of solution flow (in liters/h)	amount of urea removed (in g)	decrease in plasma urea concentration (in %)
After one h	3.99-9.1	15-30	2	3.6-10.5	14.5-36
After $1^1/_2$ h	1.9-5.0	16-21	1.3	3.47-5.9	8.6-23.4

In the experimental animals the plasma urea content was measured before and after dialysis as well as the amount of urea removed in the dialysate. Peritoneal dialysis was performed daily up to the death of the animal. Pathological examinations were done on animals which died.

RESULTS

The experiments showed that animals withstand the procedure of peritoneal dialysis well. The removal of fluid from the abdominal cavity was done evenly and in the overwhelming majority of cases without difficulty. The presence of fistulas made it possible to begin each session rapidly. As a result of the peritoneal dialysis there is a marked decrease of blood urea content of the animal because of its removal in the dialysis solution.

In the table are presented data concerning the quantity of urea removed and its decreased concentration in the blood in nephrectomized dogs under various experimental conditions.

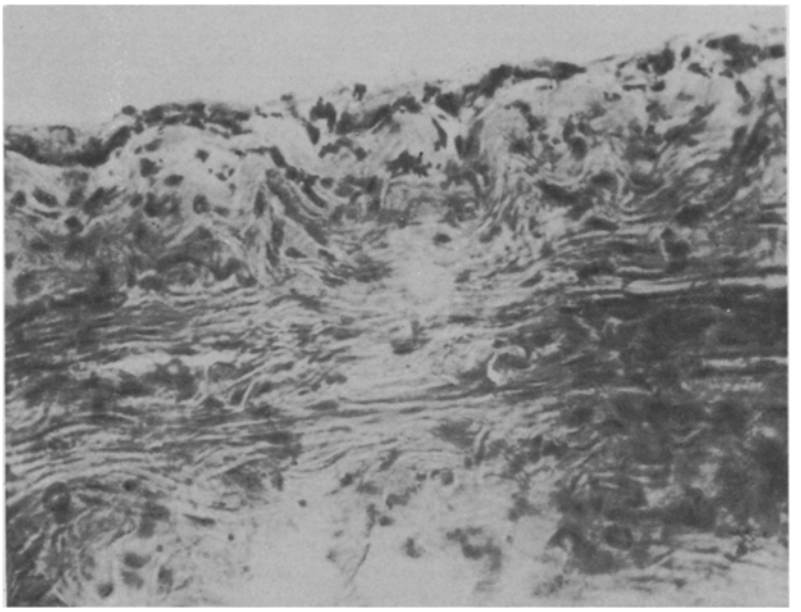
It follows from data in the table that in experiments with intermittent dialysis using two experimental regimens the better results are obtained when the solutions are changed in one hour.

The results of similar experiments with continuous peritoneal dialysis show that the more rapid changes in dialysate within the abdominal cavity, as in intermittent dialysis, also leads to more rapid exodus of urea. At the same time it is seen from the corresponding sections of the Table that intermittent dialysis is basically no less efficacious than continuous dialysis.

The use of peritoneal dialysis has lead to greater length of survival of nephrectomized animals in comparison with control animals. Thus, dogs without kidneys subjected to peritoneal dialysis lived for 4-12 days, whereas dogs in the control group lived only 3-5 days. Despite the daily use of dialysis, the nephrectomized animals refused food and sometimes would not drink. Beginning with the third to fourth day they began to vomit bile. Gradually they became markedly emaciated and weak. The dogs diet with the phenomena of general atony and adynamia. As a rule, before death they entered a condition resembling coma. In certain animals convulsions occurred.

Upon pathological examination of the bodies of dogs and subsequent histological studies it was established that there were no marked differences in the morphologic picture (both of the abdominal organs and the other organs and tissues) after both types of peritoneal dialysis. The complication of peritonitis, as a rule, was not present, and single instances noted in our experiments [2] were related to technical errors. From the viewpoint of the serosal membrane over the abdominal cavity a certain thickening, loosening, edema, some hyperemia and single leukocytes were observed in most cases (see figure). All this, evidently, was the result of the high functional load on the peritoneum. Occasionaly small organized hemorrhages were encountered in the epiploic fat, which were the result of adhesions of the catheter to the adjoining portions of the omentum which occurred because of the increase in hydrostatic pressure with removal of the last portions of the dialysate from the abdominal cavity. Other changes found in the nephrectomized animals (circulatory derangement—edema, hemorrhage, dystrophic changes and partial necrosis of various degree in the myocardium, changes in blood vessel walls etc) may not be connected with the dialysis procedure and are the results of renal insufficiency from which the dogs perished. The fact that similar changes were observed in the control nephrectomized animals which did not undergo peritoneal dialysis, testifies to this.

The studies have shown that under the conditions of our experiment, peritoneal dialysis ensured the prolongation



Some thickening, loosening and desquamation of single cells of the parietal peritoneum after three sessions of continuous peritoneal dialysis. Hematoxylin-eosin stain. Magn. 280 ×.

of life in nephrectomized dogs. It became clear in the course of the experiments that the amount of products of nitrogen metabolism which was removed did not significantly depend on the method of peritoneal dialysis (continuous or intermittent) but was related to the perfusion schedule.

LITERATURE CITED

1. S. M. Shenderov, Byull. eksper. biol., No. 2, (1962), p. 125.

All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
