EXTENSION OF THE LIFE OF NEPHRECTOMIZED RABBITS BY PERITONEAL DIALYSIS

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Until now, nephrectomy has been widely used to study the part played by the kidneys in various physiological and pathological conditions. If however the solution of a problem requires the nephrectomized animals to survive for a considerable time, the difficulty arisesthat they soon die from uremia. Replacement of the renal excretory function becomes particularly important in many anuric conditions which occur clinically.

In the last 15years, a number of apparatuses have been proposed which been called artificial kidneys, and which make use of the principle of dialysis through a semipermeable membrane to free the blood from nitrogenous waste products.

However, the danger of many complications associated with the use of the artificial kidney, the high cost and complexity of operation of an apparatus of this type, and the large number of persons required to operate it have led to a search for effective methods free from these shortcomings. The result has been the development of peritoneal dialysis.

The principal is that the peritoneum and the walls of the capillary vessels are semipermeable membranes, and do not allow high molecular weight compounds such as proteins to pass, but are freely permeable to products of nitrogen metabolism of low atomic weight which accumulate in the blood when the kidneys have ceased to excrete.

If into the abdominal cavity a fluid is introduced which contains no urea or other nitrogenous metabolic products, these substances enter the fluid from the blood. The same thing happens with the ions which accumulate in the blood in uremia, and which may be eliminated by peritoneal dialysis. Foreign workers have made use of peritoneal dialysis of this kind in experiments on dogs [2] and rats [3].

In 1955, V. V. Parin was the first in this country to draw attention to this method of substituted renal function [1]. However, until now, no use has been made in the USSR of this method for pathophysiological investigations, nor are there any Russian references to it.

We have applied it to 16 nephrectomized rabbits.

To carry out the peritoneal dialysis, we introduced a plastic cannula into the abdominal cavity, by the arrangement shown in Fig. 1. A midline incision of the skin beginning 3 cm above the symphysis pubis and continuing upwards 5-6 cm was made under ether anesthesia. At the upper end of the incision, the skin was freed some distance from the underlying tissue to facilitate the subsequent suturing of the fistula to the abdominal walls. The muscles were then seized in forceps, a slight cut was made in the abdominal wall, and the abdominal cavity opened under visual observation. From this time on until complete closure of the cavity, the anesthesia must be quite deep in order to prevent any arousal of the animal or any increase of intraperitoneal pressure, which would interfere with the operation. The cannula which was first sterilized under a mercury vapor quartz lamp and in alcohol, with the plug unscrewed, was introduced into the upper end of the incision, and by means of a sharply curved No. 12 needle the fine silk thread was sutured to the abdominal wall. The needle was passed first through the muscles (but not through the skin) from outside inwards, then through the opening in the flange of the fistula and finally through the peritoneum and muscles from within outwards. The thread which had passed through the tissue and the flange of the fistula was tied beneath the skin (Fig. 2). All the apertures in the flange of the fistula were tied in this way. When this process

had been completed, the abdominal cavity was closed, and the skin sewn up. The skin around the fistula was tightened by means of a purse-string suture. Next, 50,000 I.U. of penicillin were injected into the abdominal cavity, the plug of the fistula was screwed in, and the operation was then complete. On the following days, 50,000 I.U. of penicillin were injected into the abdominal cavity.

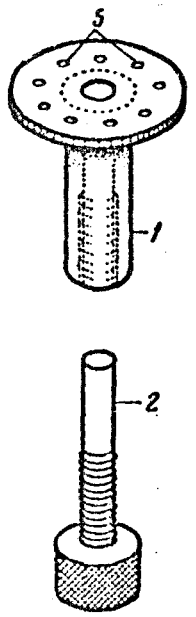

Fig. 1. General view of the fistula (2/3 natural size).

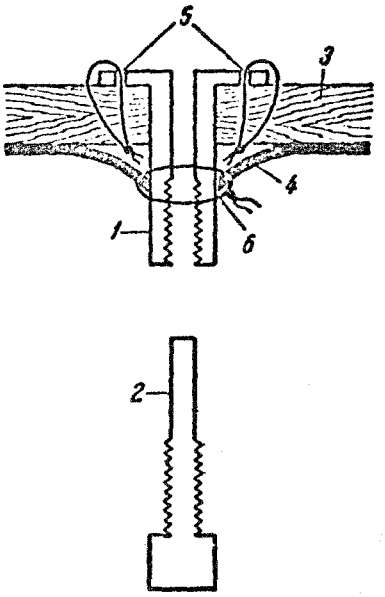

Fig. 2. Diagram to illustrate the implantation of the fistula into the abdominal cavity. 1) External part of fistula; 2) plug; 3) muscles; 4) skin; 5) aperture in flange of fistula; 6) purse-string suture in skin.

It was found that a fistula sewn into the abdominal cavity in this way is well retained, and causes very little reactive change. Only in one case was there a very limited peritonitis restricted to the region around the internal aperture of the fistula.

A catheter can then be introduced into the abdominal cavity through the fistula, and fluid introduced and withdrawn from it. The catheter is a polythene or chlorvinyl tube 20-25 cm long, with one end closed, there are several small apertures 1 mm in diameter at the blind end, which face in several directions. To avoid nipping the intestine or the omentum when the catheter is withdrawn, its external diameter should be about 1 mm less than that of the internal diameter of the fistula.

The composition of the fluid introduced was the same as that used for the same purpose by Grollman [2]. However, in use it was found that if Grollman's procedure is followed throughout, quite frequently calcium is deposited in the form of insoluble carbonates.

In practice, the solution was prepared as follows. A solution was made up in 1 liter of distilled water to contain 5.77 g NaCl, 0.05 g $MgCl_2$, 0.2 g KCl and 3 g $NaHCO_3$. Before carrying out the dialysis, about 200 ml of the solution were placed in a 250 ml measuring flask, and 7.5 g of glucose added. Next, the solution was saturated with carbon dioxide, and 0.05 g of $CaCl_2$ were added. The volume was then made up to 250 ml by adding the stock solution, and was boiled. It was then cooled to 20°, and the loss from evaporation was made good by adding distilled water.

The peritoneal dialysis was begun on the day after the nephrectomy, and was repeated twice daily between 9.00 and 10.00 a.m. and 4.00 and 5.00 p.m. The procedure consisted in introducing into the abdominal cavity 100-120 ml of the solution warmed to 37-38°. The rabbit was fixed on its back, and the plug removed from the fistula. The catheter was introduced through the fistula, and to its outer end a 150 ml syringe was connected, and the solution gently introduced. The catheter was then removed and replaced by the plug which was screwed up, and the animal was then weighed. For the next 1½ hours, the animals were allowed to move about the laboratory in order to facilitate movement of the fluid within the abdominal cavity. After 1½ hours, they were again fixed in position, the

plug removed, and the maximum possible amount of fluid was withdrawn by the catheter. The fistula was then closed, and the animal once more weighed. The rabbits refused food, but were fed through a firm but elastic tube connected to a 20 ml syringe. The principal food given was vitaminized 50% glucose solution [2]. For each meal, 15 ml of this solution and 8 g of dried milk per kg weight, were given and a uniform mixture was made by means of a homogenizer; the mixture was slowly introduced over the back of the tongue. Feeding was repeated 2-3 times per day.

In eight rabbits nephrectomized in two stages in which no measures were made to substitute kidney function, only two survived for four days, the remainder died earlier. The mean length of life of this group was 64½ hours (36-108 hours).

By contrast, the nephrectomized rabbits treated with peritoneal dialysis twice per day remained in good condition for 5-12 days; the mean survival time after bilateral nephrectomy was 200 hours (135-290 hours).

Thus peritoneal dialysis made it possible to treble the survival time of rabbits. There is reason to suppose that in the future these results may be considerably improved.

SUMMARY

A method is described of substituting renal excretory function by peritoneal dialysis; the survival time of nephrectomized rabbits was increased three times.

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