

Volume Changes of Dialysate During Peritoneal Lavage As Determined by Means of Radioactive Isotopes¹

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Although peritoneal dialysis has been introduced into clinical use since more than 15 years; yet a critical study of changes that take place in the volume of fluid used during this procedure has not been done. This is why it was decided to study the changes of dialysate volume during peritoneal lavage.

MATERIALS AND METHODS

Peritoneal dialysis was performed on three groups of mongrel dogs, each including 11 animals weighing between 7 and 12 kgms. Volume determination was done by an isotope dilution technique; the isotope being human serum albumin tagged with I¹³¹ in 6 dogs from each group (1) and radioactive colloidal gold Au¹⁹⁸ in the remaining 5 animals.

The irrigating fluid contained 139.5 mEq. sodium, 4.2 mEq. calcium, 112.2 mEq. chloride, 31.5 mEq. bicarbonate and dextrose. The dextrose content varied in the three groups of experimental animals. Thus, in group I it was 1.2 per cent, in group II it amounted to 4.2 per cent, while in the third group the dextrose concentration was 7.0 per cent.

The dialysis was performed according to Grollman's intermittent technique (2) on dogs under pentobarbital anesthesia. A multiholed polyethylene catheter was introduced into the peritoneal cavity through a trocar and cannula. To prevent leakage from around the catheter, a purse string suture was applied. About ten microcuries of the radioactive isotope⁵ (radioiodinated human serum albumin or radiogold) were added to a measured volume of 255 ml of the dialysis fluid and the mixture rapidly introduced through the catheter, after keeping exactly 5 ml as a standard. Roughly 6 ml samples from the fluid were collected at

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⁵Different lots of radioisotopes were used, and were obtained from Amersham (U.K.).

10 minutes intervals for a period of one to two hours. To ensure obtaining a well mixed sample, about 20 ml of dialysate were withdrawn from the catheter before taking the sample, and were re-introduced immediately afterwards. At the end of each experiment a blood sample was taken. Finally, radioactivity in the standard as well as in an accurately measured 5 ml volume from each sample was counted in a scintillation well counter (Th. activated sodium iodide crystal).

The dialysate volume at any time was calculated from consideration of radioactivity detected in the sample collected at this specific time in relation to activity of an equal volume of the standard.

RESULTS

In all experiments the dialysate increased in volume throughout the period of lavage. This increase in volume proved to be a biphasic exponential function of time, starting with a rapid component and ending with a slower one. The duration of each of these phases, rate of change and final volume attained were dependant on the concentration of dextrose in the irrigating fluid (Fig. 1). From this figure it can be seen that during the early phase the time that should be taken by the fluid to double its volume would be 130, 65 & 14 minutes when the dextrose concentration was 1.2, 4.2 & 7.0 per cent respectively. The second phase of

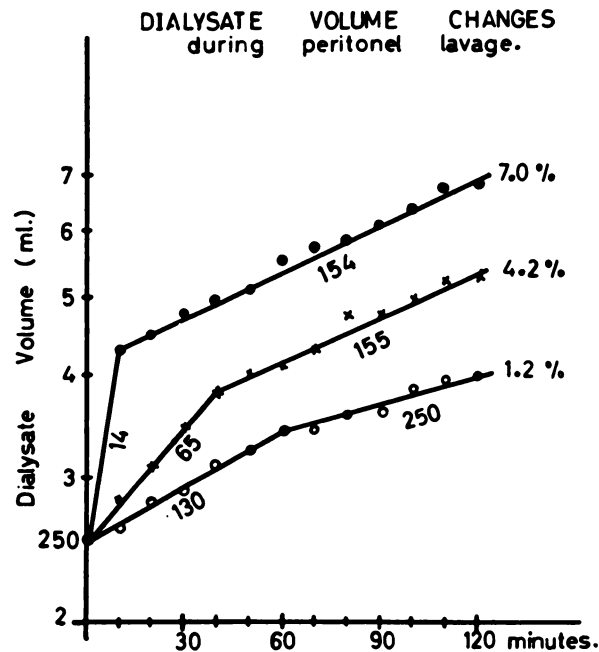


Figure 1 showing the relation between dialysate volume in ml and time of dialysis in minutes, drawn on semilog scale.

Concentration of dextrose in irrigating fluid is written on the right side of each curve (1.2, 4.2 & 7.0%)

Time for dialysate to reach double its volume as calculated in minutes is indicated under each phase of every curve.

the curve was definitely much slower than the first one. With both 4.2 & 7.0 per cent dextrose the dialysate would reach double its volume during this slow phase in 155 minutes; while with a dextrose concentration of 1.2 per cent this time interval amounted to 250 minutes. The average final volume attained after two hours of dialysis was 400, 540 & 700 ml with a dialysing fluid containing 1.2, 4.2 & 7.0 per cent of dextrose respectively.

When human serum albumin tagged with I^{131} was added to the irrigating fluid, radioactivity detected in the blood after an hour of dialysis amounted to 2.09 ± 1.04 (Mean \pm 1 S.D.) per cent of the injected dose per litre blood; with a range of 0.38 to 3.78 per cent. On the other hand, with radiogold at the end of two hours of peritoneal lavage the blood contained 0.26 ± 0.16 per cent of applied dose per litre blood; the range being 0.09 to 0.54 per cent.

DISCUSSION

The first experiments with peritoneal lavage were carried out as early as 1877 (3). About 50 years later, Ganter (4) did the earliest trials of this technique in human subjects. However, peritoneal dialysis did not become a well established procedure for clinical use except after 1945.

Since the peritonium acts as a semipermeable membrane, fluid within the peritoneal cavity equilibrates osmotically and chemically with fluid in the extracellular compartment. Therefore the electrolyte content and/or volume of extracellular fluid can be altered, and catabolites and other substances can be removed from the body by putting appropriate solutions in the peritoneal cavity. This is why peritoneal dialysis has been used in the treatment of renal failure, poisoning with dialysable agents, toxemias whether endogenous or exogenous (5) and to induce negative water balance in conditions of overhydration such as congestive heart failure, pulmonary edema and hypertensive encephalopathy (6 & 7). For this latter purpose, a dialysing fluid more hypertonic than the usual one should be used. It should be remembered that even the usual fluid used for dialysis which contains 1 to 2 per cent dextrose is hypertonic in relation to the body fluids.

In 1946 Abbot & Shea (8) reported that with a solution containing 1 or 2 per cent glucose it was possible to withdraw more fluid from the peritoneal cavity than had been injected. Fifteen years later, De Wardner (9) using an irrigating fluid containing 2 per cent glucose stated that 10 minutes were the optimum time for the solution to come into equilibrium with extracellular fluid. But, these workers did not record the rate nor magnitude of the increase in volume as has been done in the present work. Moreover, from the present results it can be seen that 10 minutes might be enough for fluid containing 7.0 per cent dextrose to reach near osmotic equilibrium with extracellular fluids; but this does not hold true for the less concentrated solutions. In the present series of experiments it was noticed that the rate and magnitude of the increase in volume of irrigating fluid were more marked the higher the dextrose content of this fluid. Furthermore, this increase in volume began at a high rate and ended with a slow one. These findings appear logic and are consistent with what would be predicted from consideration of the osmotic forces.

The use of radio-iodinated human serum albumin for estimation of volume of fluid in the peritoneal cavity has been discussed by Baker *et al* (10) and they found that this method depending on the principle of isotope dilution was reliable. This was confirmed in the present study by the finding that the level of radioactivity which leaked into the blood was low when the same isotope was used. With colloidal gold Au¹⁹⁸ the blood level of activity was still much lower even after a longer time interval, denoting that radiogold would be better than radio-iodinated human serum albumin for volume determination. Another advantage for radiogold would be its shorter half life; thus being more safe for clinical use.

SUMMARY

Changes in volume of dialysing fluid with different dextrose content were estimated during peritoneal lavage in dogs by means of radio-iodinated human serum albumin and radioactive colloidal gold.

The volume of dialysate increased throughout the period of lavage. This change in volume was a biphasic exponential function of time; starting with a rapid component and ending with a slower phase. The rate of change as well as the final volume of dialysate were directly related to the dextrose concentration in the irrigating fluid.

For volume determination, radiogold proved to be better than radio-iodinated human serum albumin since its leakage into the blood was less together with its shorter half life; thus being more accurate and safer for clinical purposes.

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