

Continuous Ambulatory Peritoneal Dialysis and Pulmonary Functions

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Introduction

The use of CAPD in patients with chronic renal failure has directed attention to the possible adverse effects of CAPD upon breathing (1,2). Instillation of 2 litres of dialysis solution into the peritoneal cavity produces the minimal changes either symptomatically or as clinically significant decline of lung functions, which may be seen during the first few weeks of CAPD (2). According to Gökbel et al. (3) the infusion of 2 litres of dialysis solution into the peritoneal cavity led to the decrease of functional residual capacity and to the increase of inspiratory capacity. The findings can be attributed to the increased diaphragmatic contractibility. CAPD appears to be safe from a respiratory standpoint in those patients with normal or nearly normal respiratory functions. The reduced DLCO has been reported in some studies even among those patients with normal spirometry (4-7) and the low value of the DLCO persists even after the correction of anemia by erythropoietin. Erythropoietin treatment led to the increase of the DLCO, maximal voluntary ventilation, forced vital capacity and peaks expiratory flow rate in hemodialysis patients (8). Rises of these parameters following erythropoietin administration might be the result of a gain in respiratory muscle strength consequent to anemia correction. The reduced total DLCO was explainable by a reduced membrane component of the DLCO, the pulmonary capillary blood volume was normal (1). Functional alternation in the pulmonary alveolocapillary membrane may exist in chronic renal failure caused by interstitial edema, fibrosis and calcification of alveolar walls can be found regularly at autopsy (5,9,10).

Some authors recommend to perform CAPD or intermittent peritoneal dialysis in supine position in patients suffering from chronic bronchopulmonary diseases because in this position intraperitoneal pressure is the lowest (11-14).

The aim of the study was the investigation of influence of single 6-hour peritoneal dialysis on pulmonary functions in CAPD patients using dialysis solutions with 1.5 % or 2.5 % of glucose.

Patients and Methods

Fifteen CAPD patients in stable condition without significant uremic syndrome (Kt/V was 1.95 ± 0.2) and without peritonitis were investigated. Among them were 8 women

and 7 men, mean age was 56.5 ± 5.5 years. The patients suffered neither from lung disease nor from ischemic heart disease. Among the patients there was no smoker. In the period between two peritoneal dialysis i.e. between the 6th and the following 0th hour the patients had „dry weight“ and they were not hyperhydrated. Causes of chronic renal failure were: chronic glomerulonephritis (10 patients), chronic tubulointerstitial nephritis (3 patients) and diabetic nephropathy (2 patients). The duration of CAPD ranged from 6 to 40 months. CAPD consisted of 4 daily exchanges of 2 litres of peritoneal dialysis solution with 1.5 % or 2.5 % of glucose. The C.A.P.D. Clear Flex L3 System (Heintel, Vienna, Austria), was used in all patients. During the study patients advised to consume free protein diet. The anemia in two patients was treated by erythropoietin (Janssen-Cilag).

In CAPD patients in sitting position parameters of acid-base balance and pulmonary functions were investigated. Parameters of the acid-base balance and pulmonary functions were investigated in the 0th, 3rd and 6th hour of single peritoneal dialysis. The acid-base balance was investigated using radiometer ABL 330. Parameters of pulmonary functions were investigated using apparatus „Masterlab“ (Jaeger) and DLCO was measured by a single-breath technique as recommended by the American Thoracic Society. The obtained DLCO values were corrected according to the actual Hb levels of patients using the Cotes formula (15,16).

Results

Laboratory parameters in patients during CAPD who underwent single peritoneal dialysis using dialysis solution containing 1.5 % or 2.5 % of glucose showed for the compensated uremic syndrome (haematocrit: 0.33 ± 0.03 , hemoglobin: 117.2 ± 18.0 g/L, serum urea: 7.50 ± 2.5 mmol/L, serum creatinine: 656.2 ± 87.5 μ mol/L, serum total proteins 65.72 ± 4.1 g/L).

The patients during CAPD using both dialysis solutions with various concentration of glucose and osmolality had the values of parameters of acid-base balance in the normal range or on the low margin of normal range. The patients during 6 hours were in compensated metabolic acidosis (

TABLE I - PULMONARY FUNCTIONS IN CAPD PATIENTS DURING 6-HOUR PERITONEAL DIALYSIS USING PERITONEAL DIALYSIS SOLUTION WITH 1.5 % GLUCOSE (n=15)

Parameter	Normal range	Time of investigation (hr)		
		0	3	6
1. FVC (L)		3.22±0.82	3.22±0.87	3.22±0.84
(% pred.)	> 80	92.1±15.3	92.4±18.1	92.1±15.4
2. FEV (L)		2.42±0.83	2.42±0.79	2.40±0.75
(% pred.)	> 80	84.2±22.0	85.4±23.5	84.8±22.8
3. FEV ₁ /FVC (%)	> 70	74.1±11.7	74.8±11.0	74.2±10.7
4. MEF ₅₀ (L/s)		2.66±1.4	2.61±1.4	2.64±1.3
(% pred.)	> 70	64.2±32.9	63.5±29.8	63.3±30.3
5. MEF (L/s)		0.93±0.57	0.96±0.61	0.93±0.57
(% pred.)	> 70	58.3±29.5	61.6±33.0	58.2±28.8
6. TLC (L)		5.45±0.89	5.50±0.88	5.49±1.10
(% pred.)	> 80	92.3±8.6	93.1±9.0	93.0±9.8
7. RV (L)		2.20±0.50	2.21±0.81	2.24±0.94
(% pred.)	< 120	106.6±18.6	105.0±27.7	105.2±33.1
8. RV/TLC (%)	< 50	40.7±7.4	40.0±11.5	39.5±11.4
9. DLCO (mmol.L ⁻¹ .min ⁻¹ .kPa ⁻¹)		6.54±1.7	6.41±1.5	6.34±1.5
(% pred.)	> 80	74.5±13.3	73.6±14.5	72.5±12.7

Amount of dialysate: 2090.9±238.8 ml/6 hr; % pred. = (actual value / predicted value)x100

TABLE II - PULMONARY FUNCTIONS IN CAPD PATIENTS DURING 6-HOUR PERITONEAL DIALYSIS USING PERITONEAL DIALYSIS SOLUTION WITH 2.5 % GLUCOSE (n=15)

Parameter	Normal range	Time of investigation (hr)		
		0	3	6
1. FVC (L)		3.27±0.80	3.27±0.90	3.22±0.76
(% pred.)	> 80		94.1±17.2	93.3±15.8
2. FEV (L)			2.40±0.81	2.43±0.82
(% pred.)	> 80		83.9±22.6	84.4±20.9
3. FEV ₁ /FVC (%)	> 70	72.5±11.4	73.7±12.0	73.6±12.5
4. MEF ₅₀ (L/s)			2.53±1.3	2.71±1.3
(% pred.)	> 70		61.0±30.8	65.2±30.3
5. MEF (L/s)			0.91±0.61	0.96±0.53
(% pred.)	> 70		56.8±31.1	61.5±27.8
6. TLC (L)			5.49±0.89	5.61±0.87
(% pred.)	> 80		92.7±8.1	95.4±12.7
7. RV (L)			2.18±0.78	2.25±0.74
(% pred.)	< 120		104.8±27.0	102.0±36.4
8. RV/TLC (%)	< 50	39.4±9.3	39.8±10.5	41.7±8.6
9. DLCO (mmol.L ⁻¹ .min ⁻¹ .kPa ⁻¹)		6.55±1.7	6.37±1.4	6.30±1.6
(% pred.)	> 80		74.8±15.0	72.9±12.6

Amount of dialysate: 2418.2±267.6 ml/6 hr; % pred. = (actual value / predicted value)x100

using peritoneal dialysis solution with 1.5% glucose: pH: 7.399±0.04, HCO₃⁻ : 22.20±2.5 mmol/L, BE: -1.96±2.6 mmol/L; using peritoneal dialysis solution with 2.5% glucose: pH: 7.395±0.04, HCO₃⁻ : 22.37±2.4 mmol/L, BE: -1.94±2.6 mmol/L).

By investigation of pulmonary functions using tests we have found that MEF₅₀, MEF₂₅ and DLCO were decreased. No changes of other pulmonary function tests during CAPD were found. Single peritoneal dialysis using solution with 1.5 % or 2.5 % of glucose had no different influence on pulmonary functions (Table I, II).

Discussion

The group of CAPD patients who were treated by peritoneal dialysis solutions containing 1.5 % or 2.5 % of glucose were without significant uremic syndrome and anemia and parameters of acid-base balance were in normal range or on the low margin of normal range (17,18). The investigation of pulmonary functions was performed in sitting position, because it is the most frequent position in our conditions (11-13). Pulmonary functions were normal in our patients using both types of dialysis solutions, except of MEF₅₀, MEF₂₅ and DLCO. Decreased values of MEF₅₀ and MEF₂₅ could be caused by initial elasticity loss of lung parenchyma and also by initial increased resistance in peripheral lung ways. The decrease of DLCO of the lungs

was found in most of patients as a result of anemia and of slight pulmonary interstitial edema. (5). In our study no influence of single peritoneal dialysis on pulmonary functions and acid-base balance was found. No significant change of DLCO during single peritoneal dialysis was observed because CAPD patients were not significantly hyperhydrated. The slight pulmonary interstitial edema is not possible to observe by physical examination of the lungs and the DLCO is a method of choice for this reason. Patients' „dry weight“ is necessary for correction of the minimal interstitial lung edema during CAPD. In our previous study hemodialysis patients were hyperhydrated and after the single hemodialysis the increase of DLCO (38.5 %) was found (7).

CAPD is the continuous intracorporeal method for the treatment of chronic renal failure which is safe from the point of view of alteration of pulmonary functions. This fact is true if the patients are without significant uremic syndrome and if no hyperhydration, no chronic bronchopulmonary or other lung disease and no significant anemia, eventually corrected by erythropoietin, are present (4,19).

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