Which One is More Effective: Ethylene Vinyl Alcohol (EVAL) or Polysulphone Dialyzer?

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Introduction

The principle of hemodialysis (HD) was first described over a century ago while the first human HD treatment was performed in 1923 with collodion tubes (1). Since that time a variety of different hemodialyzer configurations and membranes have been used. In 1967, Lipps et al. helped develop the hollow fiber artificial kidney (HFAK). Membranes made from synthetic polymers, in general, are considered as being biocompatible membranes and tend to be treated as a homogenous group. Over time, there has been a progressive increase in the use of synthetic and modified cellulosic dialyzers, and a corresponding decrease in the utilization rate of unmodified cellulosic dialyzers (2). However, all of these membranes have multiple and different characteristics. In the present prospective study, we investigated the effects of polysulfone (PS) and ethylene vinyl alcohol (EVAL) membranes on some of the serum biochemical parameters (albumin, total protein, calcium, phosphorus, uric acid, cholesterol, trygliceride etc.), mean arterial pressure (MAP) in before and after the HD session, urea reduction ratio (URR), complete blood count, recombinant human erythropoietin (rhEPO) dose, and iron sucrose dose.

Patients and Methods

The study included 18 patients (male, 11; female, 7; age [years] = 64.0 ± 13.1, the duration of hemodialysis [months] = 43.0 ± 44.9; frequency and time of hemodialysis : 3 times a week, 4 hours in 18 pts) on the hemodialysis program. In the first 6-month period, only EVAL membranes (KF201, Kawasumi, Japan) were used to treat the patients. In the second 6-month period, we used PS (Hemoflow F6S, Fresenius, Germany) membranes. The data were obtained through 12 months . In an attempt to deliver the same dose of dialysis to all patients, we used dialysers having similar hollow fibre configurations, clearence characteristics, and surface area. Blood flow rate was maintained between 300-350 ml/min. Dialysis water was obtained from reverse osmosis. Bicarbonate-based dialysate was used in all cases, and dialysate flow rate was 500ml/min.

In the laboratory assessments, the levels of albumin, uric acid, total cholesterol, trygliceride, calcium, phosphorus, complete blood count, serum iron, and the total iron-binding capacity (TIBC) were measured with conventional autoanalyzer in the blood samples taken prior to hemodialysis following a period of one night-fasting. Pre- and post-dialysis the level of urea of the same HD session were also measured to calculate the urea reduction ratio (URR) as the indicator of hemodialysis efficacy. Arterial blood pressure (ABP) was measured in the pre- and post-dialysis periods (Sphygmomanometer, Erka, Germany). All the patients were treated with rhEPO and parenteral iron sucrose.

Statistical Analysis

The Pearson correlation test was used to assess the relationship between the values obtained from all patients. Mann-Whitney U test was used to compare the mean values obtained from the EVAL and PS dialyzers periods. The values were given as mean ± standard deviation (SD), and $p < 0.05$ was considered statistically significant. All statistical processes were performed on Windows using SPSS 11 software.

Results

The clinical characteristics of the patients are shown in Table 1.

Table 1 Clinical characterization of the patients

	Patients (n: 18)
Gender (male/female)	11/7
Age (years)	64.0 ± 13.1
Duration of dialysis (months)	43.0 ± 44.9

The clinical and biochemical characteristics of the patients in pre- and post-EVAL and PS periods are shown in Table 2.

Compared to pre-EVAL period , the mean URR was lower in post-EVAL period, 60.7±14.8 and 52.7 ± 8.9, respectively ($p<0.05$). The level of calcium was higher in post-EVAL period than pre-EVAL period, 9.9±0.7 and 9.1±0.7, respectively ($p<0.05$). Compared to pre-EVAL period, post-HD MAP value in the post-EVAL period was significantly higher, 97.4±10.7 and 87.9±12.4, respectively ($p<0.05$).

Compared to pre-PS period , the mean URR was higher in post-PS period, 65.7±8.3 and 52.7 ± 8.9, respectively ($p<0.001$). The level of calcium was lower in post-PS period than pre-PS period, 9.2±0.7 and 9.9±0.7, respectively ($p<0.05$).

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Table 2 The clinical and biochemical characteristics of the patients in pre- and post-EVAL and PS periods

Parameters	Pre-EVAL period	Post-EVAL and Pre-PS period	Post-PS period
Albumin (mg/dl)	3.5±0.4	3.5±0.3	3.5±0.2
Calcium (mg/dl)	9.1±0.7	9.9±0.7[a,b]	9.2±0.7
Phosphorus (mg/dl)	5.6±1.7	4.9±1.3	5.6±1.6
Total cholesterol (mg/dl)	176.7±43	176.1±35.3	166.2±32.6
Trygliceride (mg/dl)	127.3±61.5	130.1±40.2	133.2±50
Uric acid (mg/dl)	9.2±1.1	8.3±1.5	8.2±1.6
Leucocyte (cell/mm3)	7.3±1.8	7±2[b]	8.8±2.6
Hemoglobin (g/dl)	11.7±1.6	12±1.8	12.1±1.4
Hematocrit (%)	35.5±4.9	36.3±5.8	35.5±4.3
Platelet (cell/mm3)	206.8±60.7	213.7±65.4	183.8±76.8
URR (%)	60.7±14.8	52.7±8.9[a,c]	65.7±8.3
Transferin Saturation Index (TSI) (%)	41.8±18.1	38±18.5	52.5±28.4
rhEPO dose (U/month)	16000±16392	18944.4±17739.7[b]	8000±14712.9
Iron sucrose dose (mg/month)	238.8±383.6	438.8±318.3	327.7±239.6
Pre-HD mean arterial presurre (MAP) (mmHg)	98.7±10.6	101.3±11	98.1±6
Post-HD mean arterial presurre (MAP) (mmHg)	87.9±12.4	97.4±10.7[a,b]	86±7.8

[a] Significant differences between pre- and post-EVAL periods are $p < 0.05$

[b] Significant differences between pre- and post-PS periods are $p < 0.05$

[c] Significant differences between pre- and post-PS periods are $p < 0.001$

Compared to pre-PS period, post-HD MAP value in the post-PS period was significantly lower, 86±7.8 and 97.4±10.7, respectively ($p<0.05$). The mean rhEPO dose (U/month) was lower in post-PS period than that of pre-PS period , 8000±14712 U/month vs 18944.4±17739 U/month , respectively ($p<0.05$).

Discussion

Much work has been aimed at highlighting the different results achieved with cellulose-based or synthetic membranes. The conclusions reached by the various studies are far from unanimous and are often markedly discordant. Many parameters taken into account for comparative evaluation: firstly survival, then various forms of morbidity, nutritional status, metabolic alterations, hospitalization time, etc. In most of studies have reported that there are no major or even significant differences between different forms of synthetic membranes (3).

An obvious difference between synthetic and cellulosic membranes is chemical composition. Synthetic membranes are manufactured polymers that are classified as "thermoplastics". In fact, for most of the synthetic membranes, the hemodialysis market represents only a small fraction of their entire industrial utilization (2).

Many of the synthetic polymers used in the manufacturing of the synthetic membranes are hydrophobic (4). PS membrane is hydrophobic, but EVAL has both a hydrophilic and a hydrophobic component in its molecule. Therefore EVAL membrane has been recognized as having excellent biocompatibility (5).

In this study, we measured the dose of delivered dialysis, but we did not determine the course and outcome of renal failure. Most of the clinical studies had investigated the effects of the dialysis membranes on mortality in patients with acute renal failure (6). The investigators compared synthetic membranes (approximately 50 % of them) with cuprophane membranes and found no significant difference between these membranes in patient outcome (6).

In literature, we could not find a study group who compared the effects of the dialysis membranes which belong to the same "thermoplastic" family. In conclusion, we investigated that the patients dialysed with PS membranes needed much less rhEPO than the patients dialysed with EVAL membranes. We also found that, compared to EVAL era, a more adequate dialysis dose could be reached by using PS dialyzer. But the present study is a kind of mini-survey including an insufficient number of patients. Therefore, further investigations are needed to clarify this issue.

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