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Full Length Research Paper

The effects of dialysers on some blood biochemical parameters in hemodialysis patients

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The aim of this study is to compare some blood biochemical parameters in hemodialysis (HD) patients treated with different dialyser filters. In 70 hemodialysis patients, in six-month period, the monthly retrospective analysis of blood biochemical values has been studied. The differences in urea input/output, creatine input/output and phosphorus (P) levels were evaluated. The dialyser blood flow rate was found to be between 280 to 300 ml/min and dialysate flow rate was 500 ml/min. We found a decrease in urea and creatine levels. At the end of six-month, the most widely used dialyser was 1.5 L (50.8% of total used dialyser), followed by 1.7 L (19.4% of total use) and 1.4 L (17.4% of total use). The least used dialysers were 1.3 L (0.5% of total use used dialyser) and 1.2 L (1.3% of total use used dialyser). The average phosphorus (P) levels were different among the filters 1.4, 1.7 and 2.1 L ($P < 0.05$) and between 1.5 and 2.1 L ($P < 0.05$). We found 87.6% decrease in urea and creatine, which was associated with only 3 filters (1.4, 1.5 and 1.7 L). In conclusion, the frequently used dialyser filter was1.5 L in our center, but we observed that 1.3 L was more effective in decreasing creatine and urea levels. On the other, even though we observed difference in phosphorus levels, this difference might be multifactorial and unrelated to filters used.

Key words: Dialyser filters, phosphorus, urea, creatine.

INTRODUCTION

The goal of hemodialysis therapy is to improve the patients' well being and quality of life (Hakim and Lazarus, 1995). Disequilibrium in dialysis duration, blood flow rate, dialysate flow rate, the amount of captured fluid and the clearance of toxins, such as urea might cause mortality and morbidity risks. The choice of dialyzer becomes a more important determinant in maintaining this equilibrium (Ouseph and Hutchison 2008). A dialyser used for hemodialysis (HD) has a 2-fold purpose. First, its membrane acts as a semi-permeable barrier for the transfer of solutes primarily from blood to dialysate, but also in the opposite direction (Tokars et al., 2000). Removal of low molecular weight uremic toxins occurs almost exclusively by diffusion, while convection and adsorption generally assume an important role in the removal of larger compounds, such as peptides and proteins (Vorbeck, 1999; Weinreich et al., 2006). The second basis function of a haemodialyser is the ultrafiltration of plasma water (Clark and Ronco, 2001).

Fundamental properties of haemodialyser membranes are as follows: (1) they must have high clearance, (2) they should provide adequate ultrafiltration, (3) the possible loss of protein and amino acids must be minimum, (4) they must be biocompatible and cytokine release and trombojenite activation should be minimal, (5) priming volume should be low, and (6) the cost should be low (Chelamcharla and Leypoldt, 2005).

According to the dialyser membrane, material membranes are classified as: (1) cellulosic: processed cotton dialyser obtained, (2) cellulosic substituted, (3) cellulosynthetic, (4) synthetic, such as polyacrylonitrile (PAN), polysulfone, polycarbonate, polyamide and

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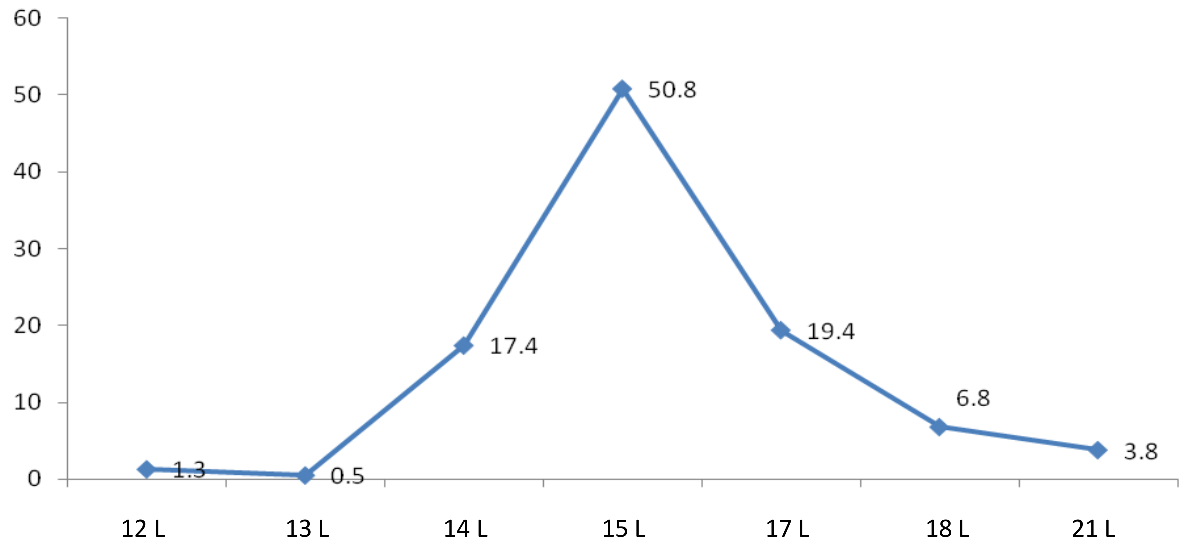

Figure 1. The use percentage of filters in six-months.

polymethylmethacrylate (PMMA) membranes, and (5) bioactive: vitamin E-coated dialyser membranes. According to the dialyser membrane structures, membranes are classified as:

1. Parallel plate: Layers pass between the blood and dialysis solution all through the layers of the membrane. This type of dialyser, are not preferred nowadays.
2. Hollow fiber membranes (Klinkmann and Vienken, 1995).

The purpose of this study was to: (1) compare plasma levels of urea and creatine ratios before and after dialysis in patients dialyzed with different membranes; (2) examine the association between different dialyser filters and plasma P levels during HD; and (3) examine the correlation between the utilisation of different filters during the 6 months HD treatment.

MATERIALS AND METHODS

Seventy stable haemodialysis patients from one dialysis centre, who were eligible and gave consent, were randomized between January and June in this study. Five patients dropped out during the course of the study due to hypotension (n:2) and fistula problem (n:3). The assessment of hepatitis B virus-hepatitis C virus (HBS-HCV) positivity was evaluated by the infectious diseases specialist. The study was conducted according to the principles of the declaration of Helsinki and was approved by the local ethics committee. All participating patients gave written informed consent.
During six months, patients received 3 times hemodialysis sessions per week with the implementation of bicarbonate treatment. Each session was 4 h and arteriovenous (AV) fistula was used as vascular access. The lowest flow velocity was 280 ml/min and the mean flow velocity was 300 ml/min. The dialysis fluid flow rate was 500 ml/min. Phosphorus was restricted in diet.

We used polysulfone dialyser membranes: 1.3, 1.5 and 1.8 L, and polyflux dialyser membranes: 1.2, 1.4, 1.7 and 2.1 L. The urea, creatine and P levels were determined in routine laboratory. Percentages of reduction in urea and creatine values were calculated using the values of blood samples withdrawn from each patient before and after each HD sessions. These values were studied in a double blind manner on a monthly basis for all the filters; the percentage decrease in the six-month average has been given to the researcher responsible for the statistical analysis.

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) 16.0 package programme. Analysis of variance and Tukey test was used to detect differences between dialyzers. The significance of differences between different time points was assessed by the paired-sample T Test. The correlation was assessed using Spearman’s rank correlations. Similarly, the interaction between clinical and laboratory indices was assessed using chi-square for discrete variables. Results are expressed as mean ± standard deviation. Differences were considered statistical by significant if $P < 0.05$.

RESULTS

At the end of six-month, the most widely used dialyser was 1.5 L (50.8% of the total used), followed by 1.7 L (19.4% of the total used) and 1.4 L (17.4% of the total used) (Figure 1). The least used dialysers were 1.3 L (0.5% of the total used) and 1.2 L (1.3% of the total used). Use rates for polysulfone dialyser membranes were: 1.3 L: 0.5%, 1.5 L: 50.8% and 1.8 L: 6.8%, and for polyflux dialyser membrane: 1.2 L: 1.3%, 1.4 L: 17.4%, 1.7 L: 19.4% and 2.1 L: 3.8% (Figure 1). Among all the filters the average reduction in urea (Figure 2) and creatine (Figure 3) ratios was highest in 1.3 L filters. This reduction comprised of the total six-month period, and the reduction urea, varied between 59.27.11 and 73.08% (Figure 2). Creatine percentage reduction was found between 60.30 and 64.98% (Figure 3). Phosphorus levels indicate statistically significant difference: among 1.7 and

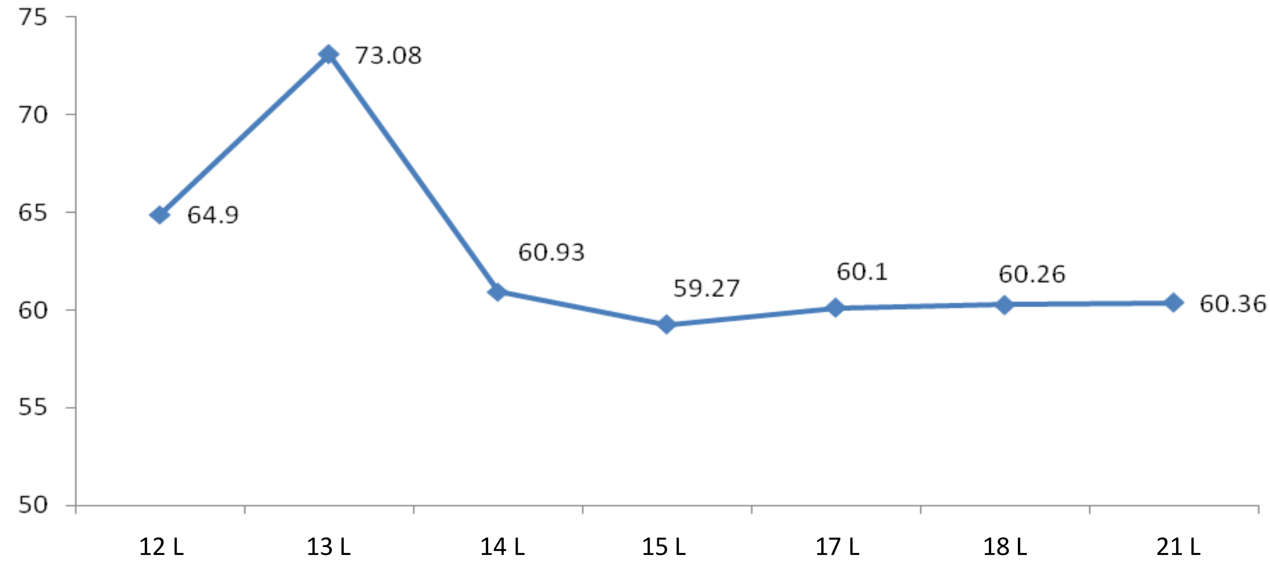

Figure 2. The average percentage of reduction in urea ratios in six-months.

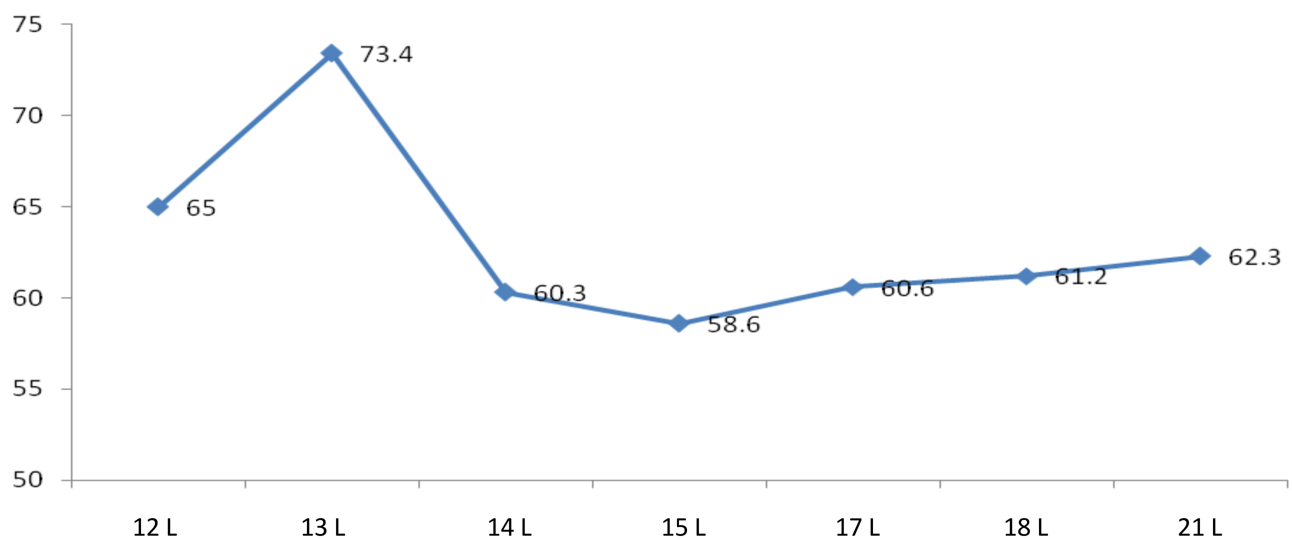

Figure 3. The average percentage of reduction in creatine ratios in six-months. Urea and creatinine reduction ratios were not statistically different among the filters (P >0.05).

2.1 and 1.4 L in January (P < 0.05) and between 1.5 and 2.1 L (P < 0.05) and between 1.5 and 2.1 L (P < 0.05) in April (Figure 4).

DISCUSSION

Cardiovascular disease including sudden death, myocardial infarction, cardiac arrest, malignant arrhythmias and other cardiac causes is the major cause of death among hemodialysis (HD) patients (Kanbay et al., 2010). The dialyser structure and material, affect the HD process (Yazar et al., 2009). In our study, the most important factor affecting the treatment of hemodialysis patients was the selection of dialysers. Even though, we started with 77 HD patients, because non-compliance occurred, we end up with 66 HD patients. The urea clearance values of dialysers are specified by the manufacturers. Generally, 200, 300, 400 ml/min blood flow rates, reports the values of clearance. User's guides for urea clearance values obtained during dialysis, is useful for dialyser comparison. The same situation can be applied to creatine clearance (Erek et al., 2007). We evaluated the changes in urea, creatine and phosphorus

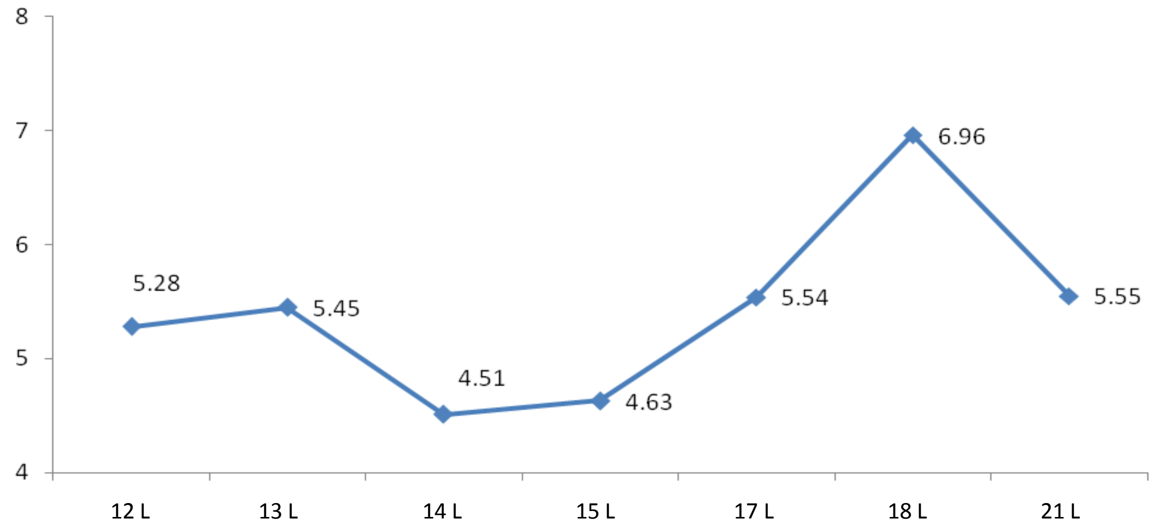

Figure 4. The average phosphorus (mg/dl) in filters in six-months. *14 L compared with 17 L, significant difference (P <0.05), **15 L compared with 17 L, significant difference (P <0.05), ***18 L compared with 14, 15 and 17 L, significant difference (P <0.001, P <0.001 and P <0.05).

levels in HD patients using different filter types and pore sizes. In this study, the most preferred filter diameters were 1.4, 1.5 and 1.7. The percentage of reduction in urea and creatine values rates were not statistically different between different filter types used. We therefore presumed that the importance of clearance of toxic substances was not related with the usage, but not the type. Although, there were no statistically significant difference in phosphate values, patients' blood phosphorus levels and dietary patterns, in particular, can vary depending on the multifactorial causes, and not as a result of the filters used (Locatelli et al., 1996; John et al., 2003).

Conclusion

In this study, it was observed that percentage reduction in the six-month time period treatment between the proportion of urea and creatine was statistically significant in 7 different filters. At the same time, the blood phosphorus levels found statistical significant difference between the filters. However, it is considered that there might be more than one factor responsible for the blood phosphorus levels of patients.

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