Solute removal characteristics of hemodiafilter under back-filtration conditions

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Intermittent Infusion Hemodiafiltration : I - HDF

Intermittent Infusion Hemodiafiltration（I-HDF）has been developed to improve the peripheral circulation of the patient and to reduce the occurrence of hypotension during a dialysis treatment.

The objectives of I-HDF are : (1) to correct the patient's circulatory blood volume (BV) reduction, (2) to enhance the plasma refilling rate (PRR) from the extravascular to intravascular, and (3) to enhance the solute transport from extravascular compartment accompanied with plasma refilling.

In conventional HDF, the substitution fluid is continuously infused into the blood circuit. In a typical I-HDF, on the other hand, some 200 mL of ultrapure dialysis fluid was infused into blood component through the dialysis membrane at a rate of 150 - 200mL/min, every 30 min. The amplitude of the BV change is maintained within a range of approximately 5%(Fig.1).

The validity of the I-HDF therapy has been already reported[1-3)].

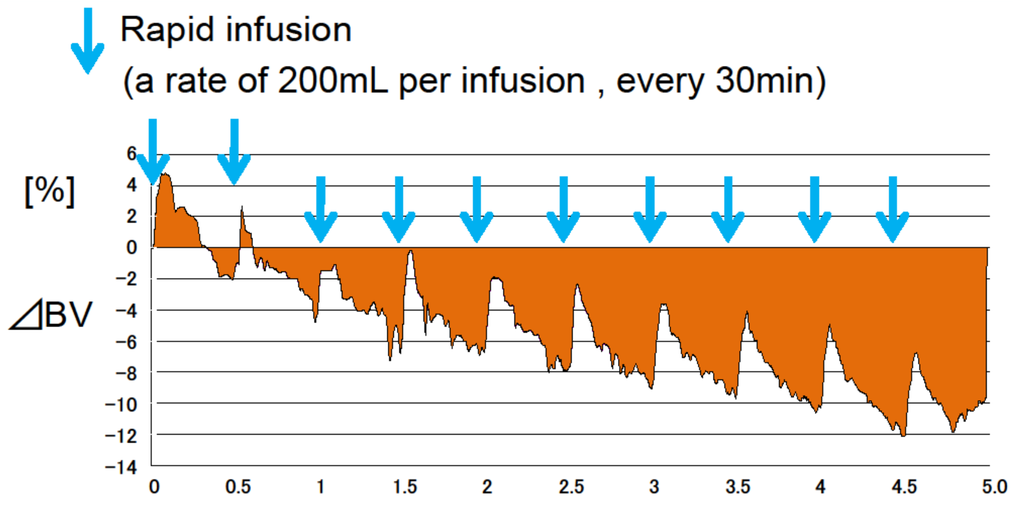

Fig.1 Blood volume changes during I-HDF

1) Eguchi K, et al.: Development and clinical effectiveness of intermittent infusion hemodiafiltration (I-HDF) as a new therapy (in Japanese). J Jpn Soc Dial Ther 2007;40:769-774.
2) Eguchi K, , et al.: Clinical assessment of intermittent infusion hemodialysis (I-HD) using backfiltration of ultrapure dialysis fluid by an automated dialysis machine (in Japanese). J Jpn Soc Dial Ther 2009;42:695-703.
3) Mineshima M and Eguchi K: Development of Intermittent Infusion Hemodiafiltration (I-HDF) using ultrapure dialysis fluid with an automated dialysis machine. Blood Purif 2013;35(supple 1):59-63

Objective

In the I-HDF, ultrapure dialysis fluid is infused intermittently into blood component through the dialysis membrane by using back-filtration technique. However, the solute removal characteristics under back-filtration conditions have not evaluated yet. The aim of this study is to clarify it during *in vitro* experiments.

Methods

Some *in vitro* HDF experiments were carried out using a polyetersulfone (PES) membrane hemodiafilter MFX-15Seco (NIPRO Co. Ltd., Japan). Plasma harvested by plasma exchange treatments was used as "blood" side solution. Ultrapure dialysis fluid was also used "dialysate" side solution.

Figure 2 shows a circuit for the experiment. The supplied flow rates to the hemodiafilter at blood and dialysate side were 200mL/min and 500mL/min, respectively. Filtration rate (Qf) was set as 50, 15, 0, -50, -100, -150, and -200mL/min. The clearance (CL) values for urea, creatinine(Cr), uric acid(UA), inorganic P(iP), β2 and α1-microglobulin (MG) and albumin (Alb) were evaluated by the following equation.

$$CL = [Qb \times Cbi - (Qb-Qf) \times Cbo]/Cbi.$$

We collected samples at 150 seconds later after the start of the experiment to achieve a steady-state for each Qf condition.

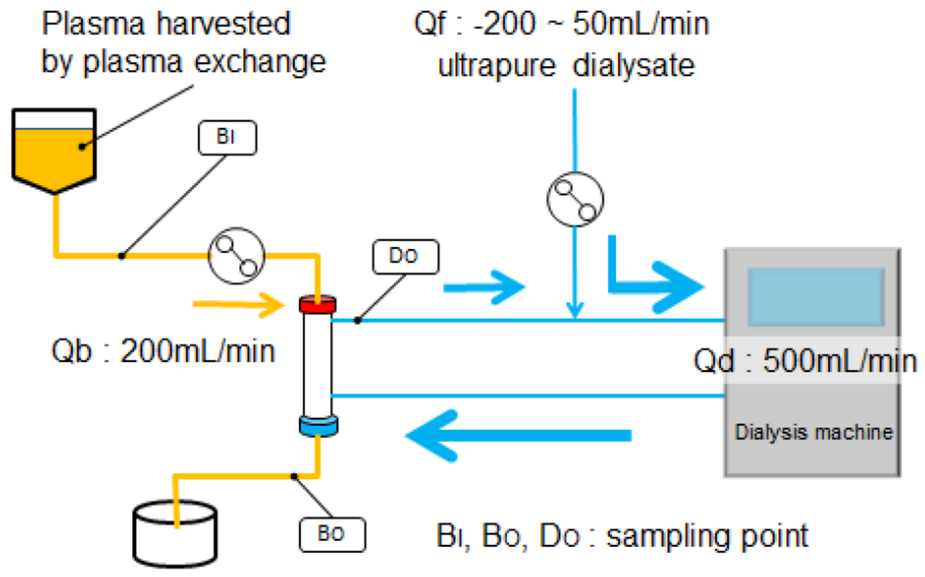

Fig.2 Circuit for experiment

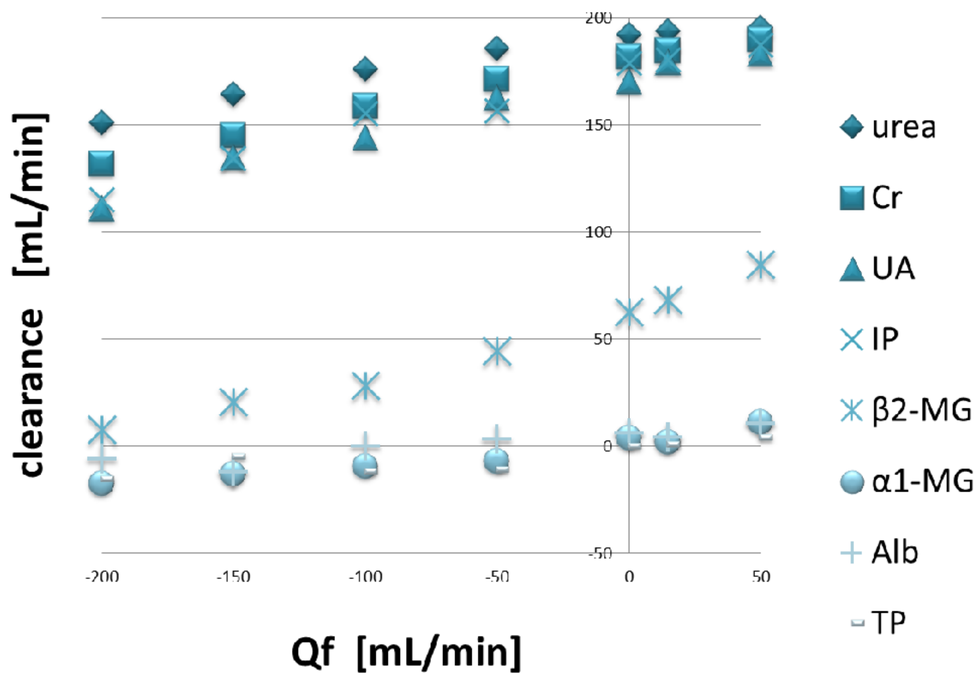

Fig.3 Relationship between CL and Qf

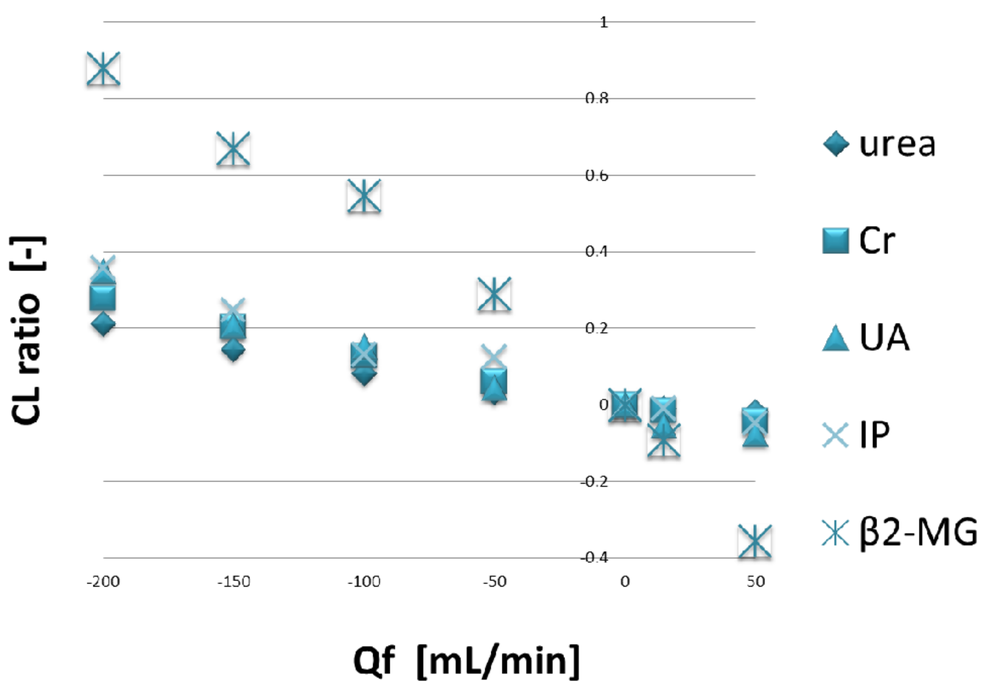

Fig.4 Relationship between CL ratio and Qf

Results

As shown in Fig.3, the CL values decreased with decrease of Qf in all solutes. Fig. 4 shows the CL ratio defined as CL value at any Qf divided by the CL value without filtration (Qf=0). The CL ratio decreased with increasing the molecular size of the solutes. For example, CL ratio values for urea, Cr, UA, iP, and β2-MG were 0.79, 0.72, 0.65, 0.64, and 0.12, respectively at -200mL/min of Qf. Furthermore, α1-MG and albumin removal were not observed under back-filtration（negative Qf).

Discussion

The α1-MG and albumin CL values could not be evaluated yet because it was very small. The CL ratio values for urea and Cr were relatively high (>0.7) although Qf was -200mL/min. It seems that the small molecules like these solutes strongly depends on molecular diffusion. The Qb value is most dominant factor for CL values in small molecules. On the other hand, the β2-MG CL value decreased 88% (CL ratio = 0.12) at -200 mL/min of Qf. The middle and large molecular weight solutes strongly depend on convective transport.

Conclusion

Solute clearance of the hemodiafilter decreases with decrease of filtration flow rate. Its tendency is remarkable in middle and larger molecules because their removal depends on the convective transport due to filtration. In small molecules, however, clearance reduction is relatively small even though back-filtration occurs in the hemodiafilter because of their higher diffusive transport.

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