Outflow of intracellular fluid and volume reduction of red blood cell volume during hemodialysis

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INTRODUCTION AND AIM

The amount of intracellular fluid (ICF) is about twice larger than that of extracellular fluid (ECF) in physiologic state. And ICF contains important electrolytes such as phosphate (P) and potassium (K) with higher concentration than ECF. We considered increment and reduction of ICF has a great significance in hemodialysis (HD) patients. However, volume change of ICF has not been fully studied, because of the lack of precise evaluation methods.

P is one of the major osmotic substances in ICF and, a certain amount of P outflow from cells during HD has been recognized. P outflow is considered to accompany with water outflow.

In this study, we focused on red blood cell (RBC) size change during HD. Quick alteration in RBC volume is caused by alteration in ICF volume. The relationship between RBC volume reduction and P metabolism during HD was analyzed, and usefulness of RBC volume observation to evaluate the ICF volume alteration and P removal was studied.

METHODS

Eighty seven patients undergoing maintenance 4-hour HD were enrolled. Complete blood count and measurement of serum P, K, Na, urea nitrogen and total protein (TP) concentration at pre and post HD were performed. Reduction rate of RBC volume (ΔMCV%), reduction rate of plasma volume (ΔPV%) and outflow rate of P (OFR_P) were calculated. ΔMCV% was calculated by dividing mean cell volume of RBC (MCV) difference between pre and post-HD by pre-dialytic MCV. ΔPV% was calculated with the data based on pre and post-HD serum TP concentration alteration. OFR_P indicates outflow rate of P from all cells at the end of HD and is considered to relate to outflow of ICF from all cells. Serum P concentration is kept almost constant during the last 2 hours in 4-hour HD. During this time, it is considered that the removal amount by HD and the outflow amount of P from the cells are almost equal. The removal rate of P by HD is almost equal to the product of the plasma flow rate (Q_p) and the serum P concentration. Therefore, the OFR_P was calculated as the product of Q_P and serum P at the end of HD. We also analyzed the relationship between ΔMCV% and other metabolic parameters.

RESUTS

Figure 1

On HD therapy, MCV significantly decreased and mean cell hemoglobin concentration (MCHC) significantly increased but mean cell hemoglobin (MCH) was not significantly changed.

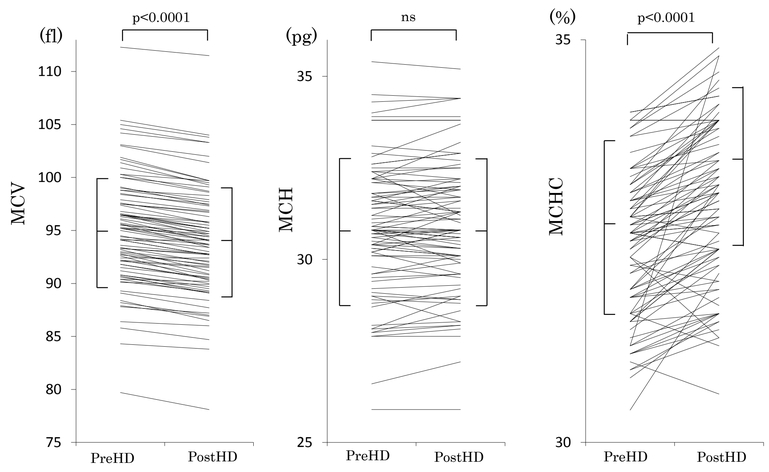


Figure 2

ΔMCV% significantly correlated with ΔPV%.

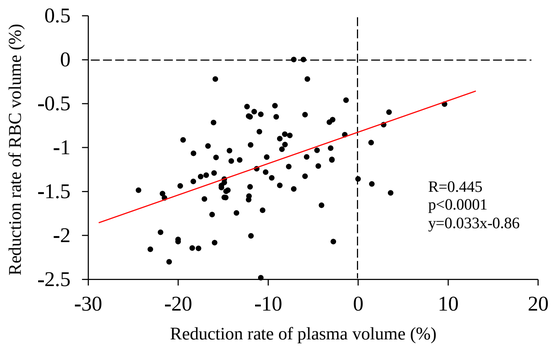
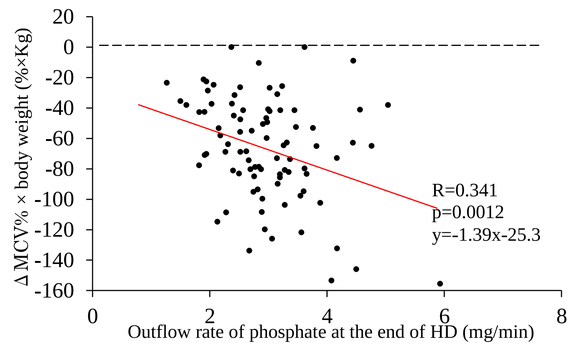
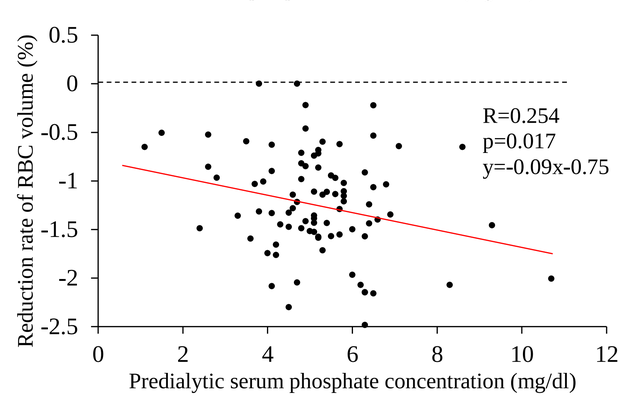


Figure 3

ΔMCV% corrected by body weight significantly correlated with OFR_P.



ΔMCV% also significantly correlated with serum P concentration at the beginning of HD.



The same relation was not detected between ΔMCV% and other metabolic markers.

DISCUSSIONS

RBC is reduced its volume without alteration of hemoglobin content during HD (Figure1). That indicates ICF of RBC is reduced through HD.

Higher ΔPV% indicates increase of serum colloid osmotic pressure. Increase of serum colloid osmotic pressure was considered to be one of the most important factors for reducing ICF of RBC during HD(Figure2).

The rate of MCV reduction was shown to relate to P metabolism (OFR_P and predialytic P concentration). OFR_P indicates outflow rate of P from all cells at the end of HD and is considered to relate to outflow of ICF from all cells. The total amount of ICF of RBC is only about 5% of total ICF of all cells. Although amount of P outflow from RBC is considered to be much smaller than total amount of P outflow from all cell, the rate of MCV reduction relate to ICF outflow from all cells(Figure3).

The rate of MCV reduction was higher in patients with higher serum P concentration. Larger amount of P and water was considered to accumulate into cells in patient with higher P concentration(Figure3).

CONCLUSIONS

Measurement of ΔMCV% is useful to assess ICF outflow during HD.

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