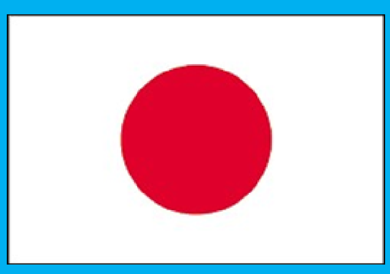

The analysis of clear space of phosphate

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BACKGROUNDS

- Clear space (SC) is calculated as (amount of intradialytic solute removal)/(predialytic solute concentration).
- CS has been known to be useful for evaluating efficiency of hemodialysis (HD). CS can be used to evaluate removal efficiency of various solutes as well as urea nitrogen (UN). Many studies concerning CS of phosphate (iP) (CSp) has not been reported because the estimated amount of intradialytic iP removal (eRp) has been difficult to provide.
- We have developed a formula for calculating eRp and reported at EDTA 2011 and 2012. We can easily calculate CSp as $CSp=eRp/Pa_0$, where Pa_0=predialytic serum iP concentration.
- During HD, UN flows passively into extracellular fluid from intracellular. However, iP flows actively only when it is required. We considered this difference result in a gap between CSp and CS of UN (CSun).

AIM

- The aim of this study is to analyze intradialytic efficiency of iP removal by clarifying the differences between CSp and CSun.

METHODS

Blood sampling were performed in 198 HD sessions of 67 patients. eRp (mg/HD) was calculated using following formula previously reported; $eRp=33.06\ Qb(1-(3Ht_0+2Ht_T)/500)\ ((1-0.125T)+1.75(UN_T/UN_0)^{1/T})Pa_0+(1.726T-2.174)Pa_T)+0.0689UF(Pa_0+Pa_T)$, where Qb=blood flow rate (dl/min), Ht_0 and Ht_T = pre- and postdialytic haematocrit (%), T=duration time of HD (hour), UN_0 and UN_T = pre- and postdialytic serum UN concentration (mg/dl), Pa_T = postdialytic serum iP concentration (mg/dl), UF = ultrafiltration (dl/HD). CSp (L/HD) and CSun (L/HD) were calculated as $CSp=eRp/10Pa_0$ and $CSun=(0.6(UN_0-UN_T)DW+UN_0UF)/UN_0$, where DW = postdialytic body weight (Kg).

Alterations in CSp and CSun by change in following conditions were analyzed. (1) Predialytic iP and UN level. (2) Qb. (3) Duration of HD. We performed the following 4 studies.

(1)-1 We calculated CSp in HD with the highest and the lowest Pa_0 in the week in 29 patients ($CSp_{(High)}$ and $CSp_{(Low)}$). We also calculated CSun in HD with the highest and the lowest UN_0 in the same patients ($CSun_{(High)}$ and $CSun_{(Low)}$). We compared $CS_{(High)}$ with $CS_{(Low)}$.

(1)-2 We calculated CSp and CSun in 9 patients ($CSp_{(PrePB)}$ and $CSun_{(PrePB)}$). After administration of iP binders, we calculated CSp and CSun in same patients ($CSp_{(PostPB)}$ and $CSun_{(PostPB)}$). We compared $CS_{(PrePB)}$ with $CS_{(PostPB)}$.

(2) We calculated CSp and CSun in 21 patients ($CSp_{(LowQb)}$ and $CSun_{(LowQb)}$). After increasing their Qb, we calculated CSp and CSun in same patients ($CSp_{(HighQb)}$ and $CSun_{(HighQb)}$). We compared $CS_{(LowQb)}$ with $CS_{(HighQb)}$. $CSp_{(HighQb)}/CSp_{(LowQb)}$ was compared with $CSun_{(HighQb)}/CSun_{(LowQb)}$.

(3) In twenty patients with 4-hour-HD, we calculated CSp and CSun in the initial 3 hours ($CSp_{(3h)}$ and $CSun_{(3h)}$). Then we also calculated CSp and CSun in entire HD ($CSp_{(4h)}$ and $CSun_{(4h)}$). We compared $CS_{(3h)}$ with $CS_{(4h)}$. $CSp_{(4h)}/CSp_{(3h)}$ was compared with $CSun_{(4h)}/CSun_{(3h)}$.

RESULTS

(1)-1 $CSp_{(Low)}$ was significantly higher than $CSp_{(High)}$ while $CSun_{(High)}$ and $CSun_{(Low)}$ did not significantly differed (figure 1).

(1)-2 $CSp_{(Postpb)}$ was significantly higher than $CSp_{(PrePB)}$ while $CSun_{(Postpb)}$ and $CSun_{(PrePB)}$ did not significantly differed (figure 2).

(2) $CSp_{(HighQb)}$ and $CSun_{(HighQb)}$ were significantly higher than $CSp_{(LowQb)}$ and $CSun_{(LowQb)}$ respectively. $CSp_{(LowQb)}/CSp_{(HighQb)}$ was significantly higher than $CSun_{(LowQb)}/CSun_{(HighQb)}$ (figure3). Low Qb vs High Qb = 174.8±20.7 vs 201.9±10.8 ml/min.

(3) $CSp_{(4h)}$ and $CSun_{(4h)}$ were significantly higher than $CSp_{(3h)}$ and $CSun_{(3h)}$ respectively. $CSp_{(4h)}/CSp_{(3h)}$ was significantly higher than $CSun_{(4h)}/CSun_{(3h)}$ (figure4).

Figure1. Alteration in CS by difference in predialytic iP or UN consentration

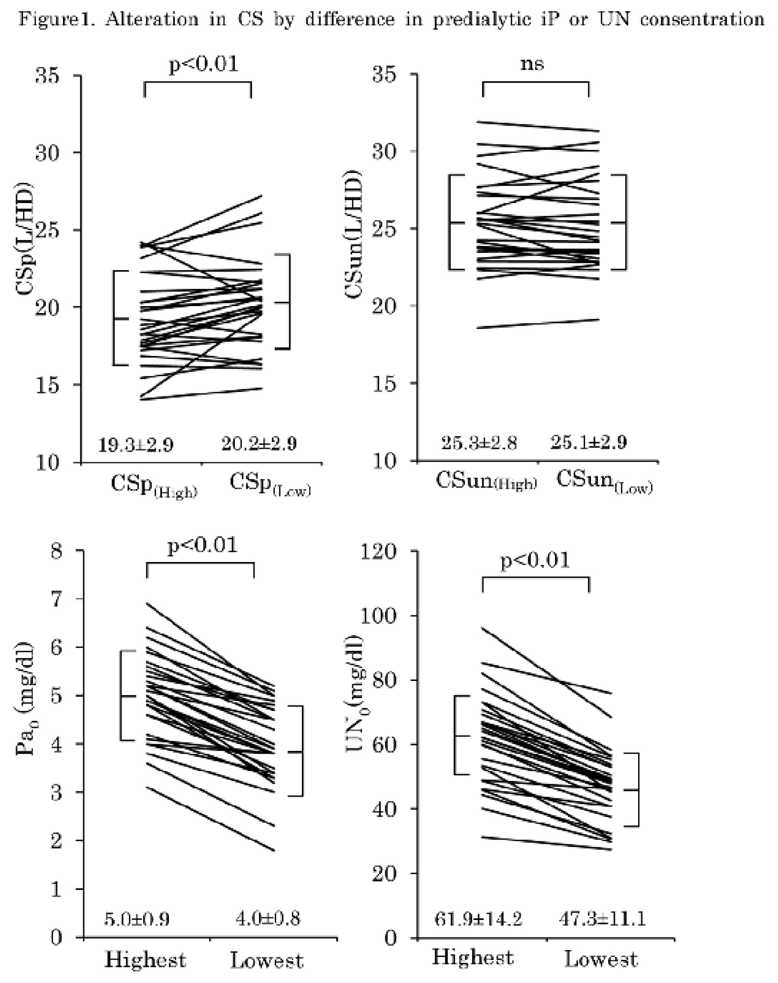


Figure2. Alteration in CS before and after administration of iP binders

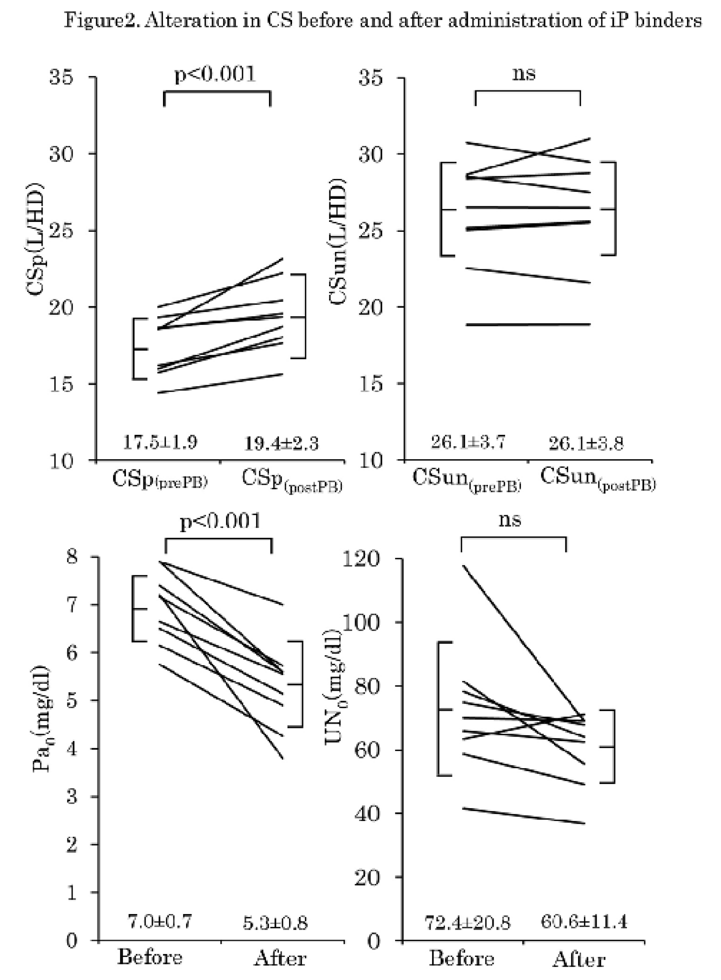


Figure3. Alteration in CS by difference in blood flow rate

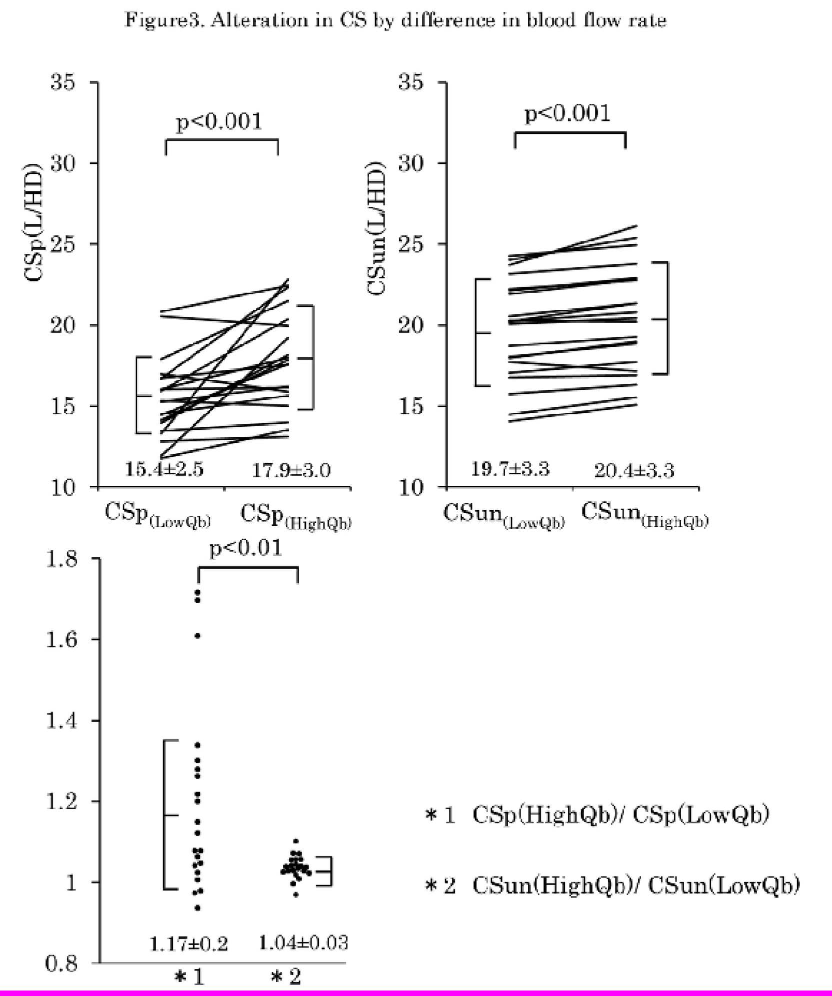
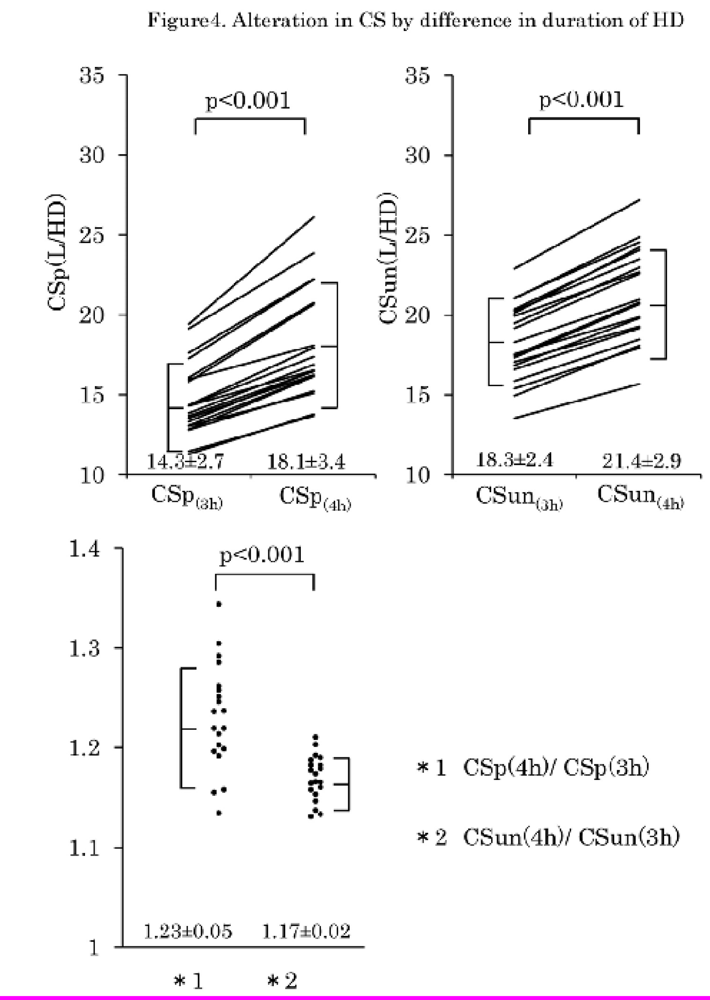


Figure4. Alteration in CS by difference in duration of HD



CONCLUSIONS

- Under the same HD conditions, the lower Pa_0 level resulted in the higer CSp. On the other hand, CSun was constant regardless of UN_0 level.
- Extension of HD duration and increase of Qb greatly improved CSp than CSun.

DISCUSSIONS

The reason why difference between CSp and CSun occurs

During HD, UN flows passively into extracellular fluid from intracellular. However, iP flows actively only when it is required. The active iP inflow prevents an excessive fall in the serum iP concentration. We considered this difference result in a gap between CSp and CSun.

The conditions of high efficiency of iP removal

The duration and speed of the active flow are considered to determine the amount of iP inflow and removal. Intracellular iP flows actively into extracellular fluid in case of serum low iP level. The lower iP concentration is considered to cause the faster iP inflow.

__Predialytic low iP concentration__ gets lower concentration with HD. Faster iP inflow is considered to occur from early phase of HD. __Higher blood flow rate__ also gets lower iP concentration with HD. In this condition also, faster iP inflow is considered to occur from early phase of HD. __Extension of HD duration__ causes longer duration of the active iP inflow. In these conditions, we can get higher efficiency of iP removal.

This opinion was compatible with the results of the present study.

51ERA-EDTA

584--SP

M) Dialysis. M6) Bone disease in dialysis patients.

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