Effect of Partial Dialysate Recirculation on the Efficiency of Kiil Dialysers

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Efficiency of dialysis depends very much on dialysate flow rate (Murray et al, 1964). Dialysate recirculation has been used to increase dialysate flow and to augment the efficiency of coil haemodialysers. The present study was undertaken to evaluate the merits of this technique in improving the performances of a parallel flow haemodialyser.

MATERIAL AND METHODS

In vitro and in vivo studies were performed on a Watson Marlow double layer Kiil dialyser, at 37° C.

In vitro studies

'Blood' consisted of an aqueous solution containing 2 g/l urea and 200 mg/l creatinine. Deionised water was used as dialysate. Sarns' roller pumps propelled 'blood' at a constant rate of 200 ml/min and fresh dialysate at rates of 250, 500, 750 and 1000 ml/min. Furthermore, at each fresh dialysate flow rate, dialysate was recirculated at rates of 500, 1000 and 1750 ml/min. Flow rates were measured directly by timed collection from 'blood' and dialysate outflow lines. Recirculating flow was determined by a flowmeter.

Inflow and outflow pressures were monitored both for 'blood' and dialysate. During all experiments outflow pressure was maintained at 50 mm Hg for 'blood' and at 0 mm Hg for dialysate. Dialysance was determined according to Wolf's formula using both the 'blood' and the dialysate concentration differences for urea and creatinine across the dialyser. Since both values were in agreement, only results obtained from 'blood' differences will be presented.

Dialysance was determined twice at 5 minutes interval, at each dialysate flow rate. At least ten minutes of equilibration after change of the experimental conditions were allowed before any specimen was collected. Urea and creatinine in 'blood' and dialysate were determined in duplicate by standard Technicon methods.

In vivo studies

A monitoring system providing the possibility of partially recirculating dialysate (CAL/RP DASCO) was used. Blood was circulated at a rate of 200 ml/min with a Sarns roller pump and dialysate flowed at a mean rate of 330 ml/min. Dialysate was recirculated at 1750 ml/min. Outflow pressure was 0 mm Hg for dialysate and 170 mm Hg for blood.

Dialysance was determined at each dialysate flow rate in 4 experiments. In two experiments dialysance was determined first with no dialysate recirculation and in two others first with recirculation. Blood creatinine and urea averaged 86.5 mg/l and 1.02 g/l respectively.

RESULTS

Results are given as mean ± SEM. 'In vitro' results confirm previous findings that urea and creatinine dialysance augment significantly with increases

Table I. Influence of dialysate flow and recirculation on urea and creatinine dialysance

Fresh dialysate flow ml/min	+ Recirculation ml/min	Number of experiments	$\dot{D}$ * urea ml/min	$\dot{D}$ * creatinine ml/min
250	0	5	86 ± 7	66 ± 4
	500	5	76 ± 3	63 ± 2
	1000	5	80 ± 2	65 ± 5
	1750	5	85 ± 6	69 ± 2
500	0	5	102 ± 3	83 ± 4
	500	5	102 ± 4	84 ± 3
	1000	5	106 ± 3	92 ± 4
	1750	5	109 ± 4	87 ± 4
750	0	4	112 ± 4	89 ± 6
	500	4	111 ± 2	92 ± 3
	1000	4	112 ± 4	95 ± 2
	1750	4	117 ± 4	96 ± 3
1000	0	5	118 ± 2	96 ± 4
	500	5	119 ± 2	97 ± 4
	1000	5	124 ± 2	102 ± 3
	1750	5	125 ± 5	102 ± 4

* mean ± SEM

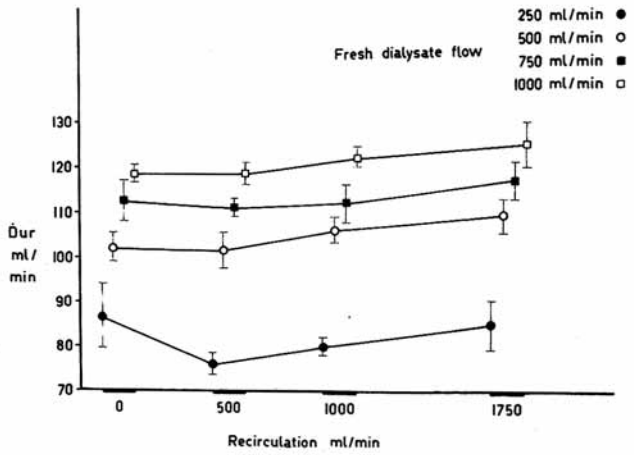

Figure 1. Effect of partial recirculation of dialysate on urea dialysance (Dur)

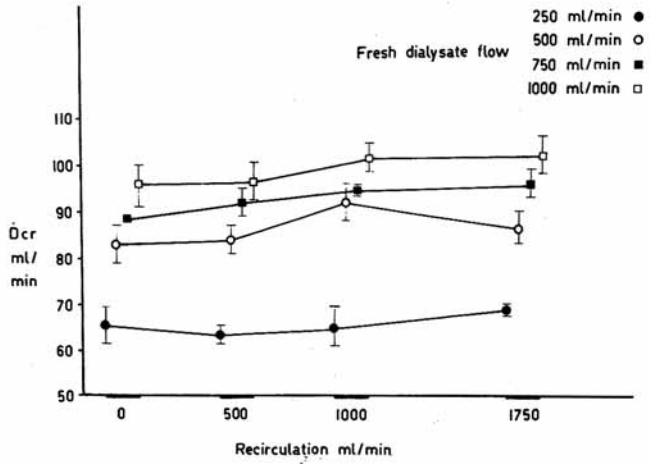

Figure 2. Effect of partial recirculation of dialysate on creatinine dialysance (Dcr)

in dialysate (Table I and Figures 1 and 2). Creatinine dialysance rises by approximately 50% when dialysate flow increases from 250 to 1000 ml/min. By contrast, similar and larger increments in dialysate flow achieved with recirculation fail to improve significantly urea and creatinine dialysance (Figures 1 and 2). Creatinine dialysance augments by less than 10% at each fresh dialysate flow rate when dialysate is recirculated at a rate of 1750 ml/min.

'In vivo' observations confirm the inefficiency of partial recirculation of dialysate. Creatinine and urea dialysance averaged 70 $\pm$ 1.9 ml/min and 82 $\pm$ 3.7 ml/min respectively without recirculation and 74 $\pm$ 0.6 ml/min and 85 $\pm$ 4.5 ml/min with a 1750 ml/min recirculation.

DISCUSSION

It has been reported that circulation of dialysate in three dialysers connected in series does not appear to reduce significantly the efficiency of the dialysis of the last patient as compared with that of the first (van Ypersele et al, 1965). This observation suggests that the concentration of urea and creatinine obtained in the outflowing dialysate does not curtail the diffusion of these compounds in the next dialyser. Since increased dialysate flow is known to increase dialysance, it was felt that recirculation of dialysate might lead to an improvement in the performance of parallel flow dialysers.

The present study confirms the critical importance of dialysate flow in determining the efficiency of dialysis. By contrast, they demonstrate that, contrary to our expectation, augmenting dialysate flow by partial recirculation of dialysate does not improve significantly dialysance.

This discrepancy cannot be accounted for by differences in the haemodynamics of the blood layer. Blood flow was maintained constant throughout all experiments. Inflow and outflow pressures of blood and dialysate were identical at every total dialysate flow rate whether or not recirculation was used. It appears rather that any improvement resulting from an increased dialysate flow and a better mixing of the dialysate is offset by the decreased blood to dialysate gradient for urea and creatinine produced by recirculation.

SUMMARY

Recirculation of dialysate is routinely used to augment the efficiency of coil haemodialysers. The present study evaluates the benefit of such a manoeuvre on the efficiency of a parallel flow Kiil haemodialyser.

Urea and creatinine dialysance were determined both 'in vitro' and 'in vivo' at fresh dialysate flows ranging from 250 to 1000 ml/min and with dialysate recirculation ranging from 500 to 1750 ml/min. Urea and creatinine dialysances are significantly improved when fresh dialysate flow is augmented. The same parameters, however, are not significantly modified when dialysate flow is increased by partially recirculating dialysate.

These results suggest that partial recirculation of dialysate does not improve the efficiency of parallel flow haemodialysers.

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