Proc EDTA (1982) Vol 19

ULTRASHORT HAEMODIAFILTRATION: LONG TERM EFFICIENCY AND HAEMODYNAMIC TOLERANCE

V Wizemann, P Rawer, G Schütterle

Zentrum für Innere Medizin, Giessen, FRG

Introduction

In haemodiafiltration (HDF) high solute removal occurs due to simultaneous diffusive and convective mass transfer [1]. Favourable long term tolerance and haemodynamic responses to haemodiafiltration had been evaluated with a $1 m^2$ polyacrylonitril dialyser. An ultrafiltration rate of 70–90ml/min and a substitution volume of nine litres allowed a single treatment to be terminated after 180 minutes. The introduction of large surface area haemodiafilters with high ultrafiltration and high diffusive clearances offered the potential advantage of shortening treatment time. After more than 15 months of ultrashort HDF we have examined this method of treatment for efficiency and haemodynamic tolerance.

Patients and methods

Twelve patients (eight males, four females, mean age 49 ± 11 years) have been treated by HDF (two hours thrice weekly) for more than 15 months. Five patients were anuric, in six residual creatinine clearance was < 3ml/min, and in one 4ml/min. Selection criteria for the study were an interdialytic weight gain of less than 3kg, stable haemodynamics and a fistula which guaranteed a blood flow of 300ml/min. Prior to the study all patients were established on long term haemodialysis (HD, 3 X 4 hours/week) and showed no evidence of any other disease likely to affect the parameters measured. HDF was performed with volume-balanced controlled ultrafiltration (A 2008 C, Fresenius AG) and automatic balancing of substitution fluid. Dialysate (HDY 144, Braun AG) flow was 500ml/min. As substitution fluid either 4.5 or 9 litres of HF 23(Fresenius AG) was used. Each treatment lasted two hours, independent of remaining substitution volume. In all patients blood flow was 300ml/min. Three types of haemodiafilters were used (PAN 20, Asahi Medical Co; Filtryzer B 1-L, Toray Industries Inc.; Haemoflow D 6, Fresenius AG). Haemodialysis was performed with standard machines and Tri-Ex 3 (Extracorporeal) dialysers.

Haemodynamic measurements were made in six patients who were in a stable condition. In each patient the haemodynamic effects of a four hour HD were compared to those of a 90 minute HDF. Weight loss was standardised for each patient. Measurements were carried out as previously described [1]. Small solutes were measured by routine methods, cardiac arrhythmias were recorded by a 24 hour tape and classified according to Lown and Graboys [2].

Results

Pre-dialysis values of serum urea, creatinine, phosphate and uric acid were respectively reduced by 48 per cent, 43 per cent, 36 per cent and 58 per cent after 120 minutes of HDF (Figure 1). In the same patients four hour dialysis led

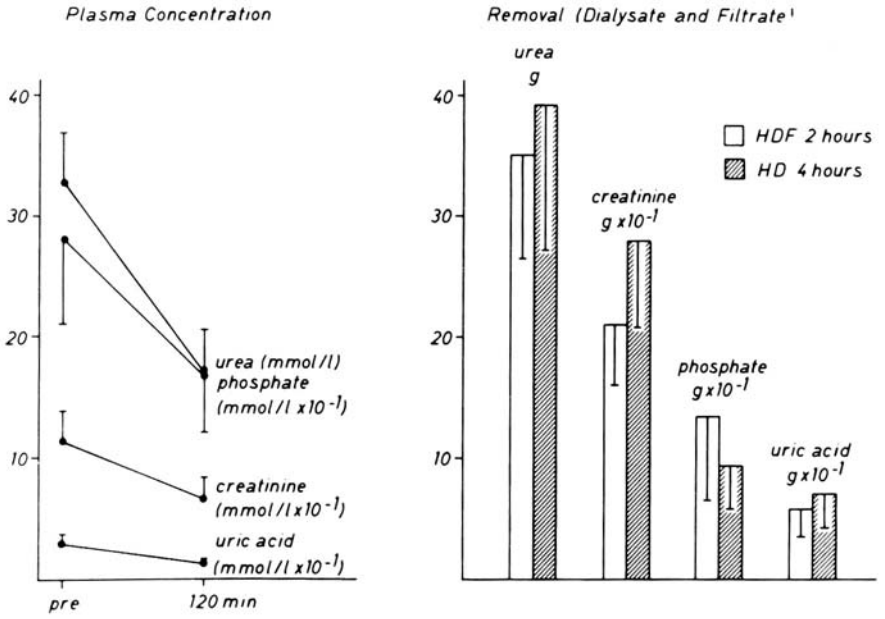

Figure 1

to reduction of the same parameters by 59 per cent (urea), 50 per cent (creatinine), 38 per cent (phosphate) and 55 per cent (uric acid). During HDF high removal rates could be achieved (Table I) but overall elimination of uraemic waste products was slightly less than during a four hour HD (Figure 1). Concerning phosphate removal, convective transport during HDF could be responsible for higher excretion. Long term surveillance of biochemical parameters did not reveal a deterioration of predialysis values when compared to data obtained during a treatment with 3 X 4 hour HD (Table II). Body weight prior to dialysis did not differ between

TABLE I. Removal rate (mmol/min)

	HDF (120 min)	HD (240 min)
Urea	4.8 ± 1.2	2.7 ± 0.9
Creatinine	0.15 ± 0.07	0.10 ± 0.02
Phosphate	0.54 ± 0.31	0.19 ± 0.06
Uric acid	0.03 ± 0.01	0.02 ± 0.01

TABLE II. Clinical and biochemical parameters

		Haemodialysis 3 X 4 hours/week	Haemodiafiltration 3 X 2 hours/week > 15 months
Body weight	kg	62.7 ± 12.9	63.0 ± 13.0
Blood pressure			
pre-systolic	mmHg	156 ± 10	158 ± 14
pre-diastolic	mmHg	86 ± 9	87 ± 10
post-systolic	mmHg	145 ± 20	139 ± 15
post-diastolic	mmHg	80 ± 6	80 ± 6
Potassium	mmol/L	5.7 ± 0.8	5.2 ± 0.6
Urea	mmol/L	35 ± 8	34 ± 7
Creatinine	mmol/L	1.23 ± 0.21	1.19 ± 0.21
Phosphate	mmol/L	2.61 ± 0.60	2.70 ± 0.62

HD and HDF, the same held for arterial blood pressure before and after the treatments (Table II). Weight loss during 240 min HD was 0.67 ± 0.22kg/hour, during 120 min HDF 1.25 ± 0.34 kg/hour.

Haemodynamic measurements: Prior to dialysis, cardiac stroke volume was increased considerably indicating fluid overload (Figure 2). Rapid volume loss during HDF resulted in a marked return to normal, which was accompanied by a simultaneous increase of total peripheral resistance and a moderate increase of heart rate (Figure 2). During HD the same pattern of reactions was observed, but stroke volume remained elevated at the end of HD. Norepinephrine concentrations in the plasma paralleled the rise of peripheral resistance during HDF and HD.

In ten patients, in whom the occurrence of cardiac arrhythmias had been known clinically, frequency and grade of arrhythmias was recorded during a four hour HD and during a two and a half hour HDF. In terms of Lown-grades there was no difference between HD and HDF.

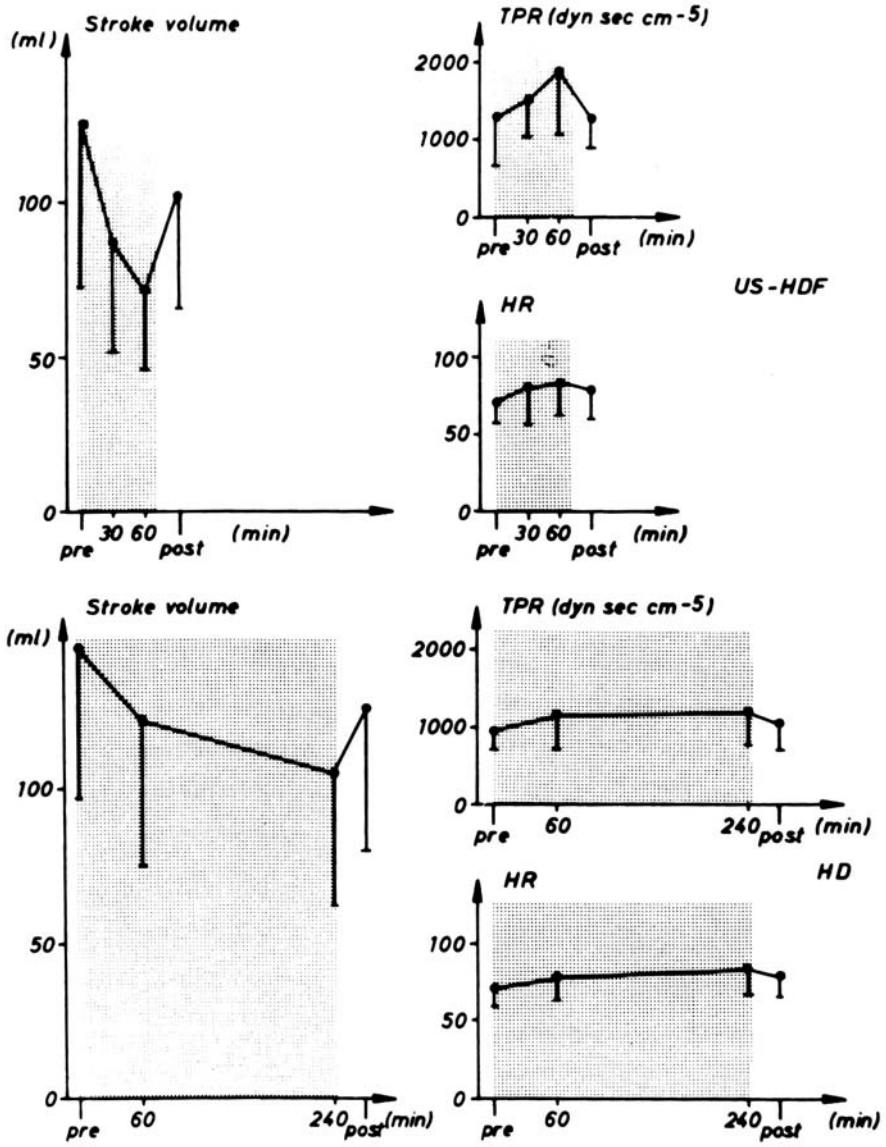

Figure 2. Stroke volume, heart rate (HR) and total peripheral resistance (TPR) during HD and HDF

Discussion

In high efficiency haemofiltration, using four needles and a double extracorporeal circuit, the tolerance to rapid removal of uraemic toxins without weight loss has been reported as very good [3]. In our study identical high removal rates for urea,

creatinine and phosphate were achieved during HDF, mainly by diffusion. So-called disequilibrium syndrome was not observed, indicating that transmembranous transport of small solutes might not be responsible for patients' discomfort. The limits of the rapidity for the removal of uraemic toxins are still to be defined. Fifteen months of observation of our patients did not reveal any clinical or biochemical disadvantage attributable to high efficiency ultrashort HDF.

Epidemiologic studies of dialysis-induced hypotension show the predominance of volume depletion as a causative factor [4]. Although the rate of weight loss during HDF was nearly twice that during HD the mechanisms providing an adequate counter-regulation and thereby stable haemodynamics appeared to be intact. However, a selection criterion for our study was a stable blood pressure during HD. Therefore, patients suffering from symptomatic hypotension were excluded from this study of ultrashort HDF. The same holds for patients with coronary heart disease who were excluded because there is lack of direct evidence that rapid volume depletion does not interfere with coronary blood flow. Assuming that control of ultrafiltration can be guaranteed, high-flux HD (120 min) is as effective as HDF in removing small uraemic solutes and in stable patients there is no difference between the two methods in haemodynamic tolerance [5]. However, in all patients, in whom an effective removal of small and larger solutes is preferred, HDF is the superior method. The duration of a single HDF treatment depends on the haemodynamic stability of the patient.

References

1 Schütterle G, Wizemann V, Seyffart G, eds. *Hemofiltration 1981.* Hygieneplan Oberursel
2 Lown B, Graboys T. *Cardiovasc Med 1977; 2:* 219
3 Dongradi G et al. *Proc EDTA 1981; 18:* 176
4 Degoulet P et al. *Proc EDTA 1981; 18:* 133
5 Wizemann V et al. *Nieren- und Hochdruckkrankheiten.* In press

Address for correspondence: V Wizemann, Zentrum für Innere Medizin, Klinikstrasse 36, D-6300 Giessen, FRG

Open Discussion

HAMPL (Berlin) I want to make one comment. Could you explain the high initial value for stroke volume. I found high values of over 100 and for dialysis patients stroke volumes before treatment of nearly 100 (normally 70) though I have seen values of more than 130 in some patients. This means to me that patients must have a high overload.

WIZEMANN That is the conclusion we have drawn from this study. I suppose all patients are overhydrated, probably there was acute overload causing such a high stroke volume.

HAMPL Yes, but it is more than in the usual population and I think that this is the higher risk one has in dialysis patients.

WIZEMANN Well what is normal haemodynamics in dialysis patients? Our patients were stable but I agree that probably fluid overload caused the high stroke volume.

HAMPL It should not be more than 100 if the patients have a haemoglobin about 10 as in the chronic population. If you have patients with a haemoglobin of five or six then you can have 110 not more.

DRUEKE (Paris) I am somewhat concerned about the possible long-term complications in patients treated with ultrashort haemofiltration. Apart from possible cardiovascular problems could you please define more closely what have been the other exclusion criteria in your patients for this very short treatment. Would you treat in this way patients with severe osteodystrophy, patients with subjective signs of polyneuropathy and so on?

WIZEMANN We only included in the study patients who were generally stable and who had no signs of any other disease than renal insufficiency. We excluded all patients with signs of severe hypertension, osteodystrophy or polyneuropathy. I would recommend such a short treatment only for patients who have no complications.

BALDAMUS (Frankfurt) Dr Wizemann you found similar haemodynamic patterns in haemodiafiltration as in ordinary haemofiltration. Both procedures have convective transport in common. Since the ultrafiltration rate is lower in haemofiltration than in haemodiafiltration how much convective transport do you need to achieve the better tolerance to fluid removal seen in haemofiltration?

WIZEMANN I can't go back on this because it is unclear what causes the better haemodynamic stability of haemofiltration. The ultrafiltration rate depended on the membrane; Cuprophan was about 40 to 60ml per minute and in the DIN membrane it was about 80ml per minute. I don't think that the rate of convective transport is responsible for the good haemodynamic tolerance, there might be other factors. It could be a problem of sodium balance and I am not sure if we don't induce a positive sodium balance with the haemodiafiltration. It could be a problem of temperature which is shared by the haemofiltration technique, and the third point which is my personal opinion, I think the good documented haemodynamics are due to the balancing system of the machine. We have a volume balanced controlled ultrafiltration and it is my view that this is a major factor in inducing haemodynamic stability.

BALDAMUS I would like to comment on the sodium balance in haemofiltration. The haemodynamic stability of haemofiltration is not due to a positive sodium balance as suggested by Gotch. The effect of sodium you see in dialysis

is unrelated. Secondly I would like to comment on the equipment. The equipment with controlled ultrafiltration was applied in dialysis as well as in haemofiltration, but still the haemodynamic differences were evident. Thirdly the effect of temperature remains controversial.

BOMMER (Heidelberg) What about haematocrit in your patients. In my experience haematocrit is a very good parameter for the quality of long-term haemodialysis. In our experience haematocrit increases if better dialysis equipment, for example better dialysers, have been used.

WIZEMANN I agree with you. I think that the haematocrit is an excellent parameter for measuring the quality of dialysis. We have performed haemodiafiltration for four years performing it three hours three times weekly and we could calculate a weekly inulin clearance of 50 litres. We saw no effect on the haematocrit. The haematocrit did not deteriorate.