SEPARATION OF DIALYSIS AND ULTRAFILTRATION – DOES IT REALLY HELP?

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Summary

Ultrafiltration alone for fluid removal has been used and assessed in a number of clinical studies.

A paired study of ultrafiltration alone against haemodialysis has shown that as compared to haemodialysis, ultrafiltration alone within the ultrafiltration rates used is well tolerated.

The use of ultrafiltration alone for both acute and chronic fluid overload has been shown to be an ideal therapeutic procedure.

In a third study using the Rhodial 75 system and RP6 dialyser in a group of non-fluid-overloaded patients the separation in time of ultrafiltration from haemodialysis has shown no obvious advantages over regular haemodialysis.

Introduction

At this congress last year at Hamburg Dr Bergström\(^1\) presented evidence that ultrafiltration without haemodialysis (ultrafiltration alone) caused less hypotension, nausea, headache and muscle cramps than fluid removal occurring during haemodialysis. We have applied this interesting development in a number of studies using standard dialysers across a range of ultrafiltration rates. Our initial study was paired comparisons of ultrafiltration alone versus haemodialysis for fluid removal.

Design of Study

Regular dialysis patients were used and each paired study was performed on consecutive dialysis days of the same patient. In an individual paired study the dialyser and the proportionating unit were the same, with the duration of each procedure the same. The ultrafiltration rate was kept as similar as possible in each procedure. Blood pressure and pulse were taken every 15 minutes and complications and intravenous saline given, were recorded. Osmolality, urea, creati-
nine, electrolytes, total protein, albumin, calcium, phosphate and glucose were measured from blood samples both pre- and post-procedure.

Method

For ultrafiltration alone, the dialysers were primed by the routine method and the patient was connected routinely. Dialysate was then disconnected from the dialyzer and the ultrafiltrate allowed to run from the dialyser through the dialysate inlet and was collected in a measuring cylinder thus allowing direct measurement of ultrafiltration rate. Ultrafiltration rate was controlled by altering venous pressure. During haemodialysis ultrafiltration rate was measured by a Datex weighing system and recorded by a Goerz Electro Chart recorder.

Osmolality was measured by a Fiske Osmometer and the other biochemical parameters were measured using the Auto Analyser method.

Percentage plasma volume change was calculated using the pre-procedure plasma volume and the changes in plasma protein concentration pre- and post-procedure. Pre-procedure plasma volume was obtained using the nomogram of Dagher et al.² using the pre-procedure weight.

Results

Ten paired studies were performed using ultrafiltration rates from 7 to 33 ml/min with the rates being extremely close in each pair. The average rate was 17.3 ml/min in ultrafiltration and 17.1 ml/min in haemodialysis. The duration ranged from 40 to 120 minutes. With haemodialysis all patients experienced one or more symptoms of headache, nausea, vomiting or weakness and most had significant falls in blood pressure, systolic averaging 15 mmHg and diastolic averaging 19.4 mmHg. Extra intravenous saline was required on three occasions.

No patient with ultrafiltration alone experienced these symptoms or required saline.

In haemodialysis the fall in osmolality of 10 to 20 mOsm/kg and the mean percentage fall in plasma volume of 11.6% contrast strikingly with those during ultrafiltration alone, 0 and 2.8 respectively.

Secondly in a clinical application we have performed 32 unpaired studies of ultrafiltration alone for fluid overload, in regular dialysis patients, 18 in the chronic situation and 14 for acute left ventricular failure. Left ventricular failure was dramatically relieved and chronic fluid overload was easily controlled. No patient in either group developed hypotension, nausea or headache during the procedure. Ultrafiltration rates used ranged from 10 to 31 ml/min.

We would thus support the claims of Bergström for ultrafiltration alone. To achieve this we have used a wide range of dialysers including Gambro Lundia Major and Optima, RP6, Meltec Multipoint 1.03 m², Ultraflo 1.0 and 1.5 m² and EX 55 and 29 without technical difficulties. In the acute situation in spite of not prewarming the dialyzer with dialysate, in only one patient was a fall in body temperature symptomatic.

Also at Hamburg, Dr Shaldon³ illustrated a potential method of dialysis separating in time ultrafiltration from haemodialysis. Gambro Ltd have developed a
system in which this method of dialysis can be applied.

A crossover study was performed to assess this interesting new method in the role of routine dialysis.

Crossover Study

The crossover study consisted of (A) Dialysis for 4 hours versus (B) Ultrafiltration/Dialysis (UF/dialysis) which involved ultrafiltration alone for 1 hour then dialysis for the next 3 hours with the ultrafiltration rate zero.

For the purposes of the study we used the RP6 dialyser and the Rhodial 75 unit which has the facility of dialysing at zero ultrafiltration rate. Patients used in the study were not fluid overloaded and were on regular haemodialysis using the Rhodial 75 unit and RP6 dialyser. Alternating procedures were performed on each patient and the volume to be removed was calculated from the interdialysis weight gain and the washback volume. Blood pressure and pulse were recorded half hourly and symptoms were recorded on a standard questionnaire at the end of the procedure. Blood samples were taken pre- and post- for osmolality, urea, creatinine, electrolytes, calcium, phosphate, protein, albumin and haematocrit.

Method

Biochemical parameters were measured as described earlier and haematocrit was measured by a Coulter counter. Ultrafiltration alone was performed as described earlier, dialysate used was McCarthy’s Ltd. Renalyte giving a pre-dialysis dialysate sodium of 136 mmol/L.

Results

Sixty procedures were performed on 7 patients with 30 in each method of dialysis. There was little difference in the incidence of headache, nausea and hypotension between the two groups, headache in dialysis 7, in UF/dialysis 4; nausea in dialysis 7, in UF/dialysis 5; hypotension requiring saline in dialysis 8, and UF/dialysis 6. Hypotension during UF/dialysis occurred during the ultrafiltration phase and was usually associated with ultrafiltration rates of 40 ml/min and above. A phenomenon was observed in which in spite of satisfactory elevation of blood pressure with intravenous saline, further hypotension occurred after dialysate was reconnected to the dialyser even though no further fluid was removed.

Figure 1 illustrates this phenomenon in a 22-year old male in whom hypotension during the ultrafiltration phase was partially corrected by 400 ml of normal saline and subsequently during the dialysis phase in which no fluid was removed he became hypotensive again.

These observations probably reflect the combined effect of low plasma volume and vasomotor instability contributed to by changes in osmolality and substances such as acetate. Symptomless hypotension has been noted during the dialysis phase in some patients who were not hypotensive at the end of the ultrafiltration phase.
Figure 1. Plasma osmolality

Figure 2
It should be noted that in the first two studies described the ultrafiltration rates used did not exceed 33 ml/min.

In this study ultrafiltration rates used were regularly above 30 ml/min during the ultrafiltration phase in order to remove the required volume of fluid during the hour.

Muscle cramps occurred on 8 occasions in dialysis, intravenous saline being required in 3, and on 13 occasions during UF/dialysis, 6 requiring intravenous saline. There was no difference between the mean fall in osmolality between symptomatic and asymptomatic patients in both groups.

Figure 2 shows the mean percentage fall for osmolality, urea, creatinine, and potassium for both methods of dialysis. Standard deviations are indicated. There was no significant difference of any parameter between the two groups but an impression was gained that urea and creatinine removal in UF/dialysis is not as efficient as in routine dialysis.

Figure 3 shows the mean percentage rise of bicarbonate, total protein and

![Figure 3](image)

haematocrit in both groups; standard deviations are indicated. Again for all parameters there was no significant difference statistically between the two methods.

**Discussion**

Ultrafiltration alone for fluid overload is simple, safe and well tolerated. For the average non-fluid-overloaded patient separation of ultrafiltration and dialysis in time has no obvious advantages over haemodialysis using the RP6 dialyser and
the Rhodial 75 unit. The Rhodial 75 unit provides a facility with which it is possible to obtain a predetermined ultrafiltration rate throughout dialysis for an individual patient. Single pass proportionating units do not have this inbuilt facility to monitor and control ultrafiltration rate, thus contributing to the observed higher incidence of complications during dialysis with them. A recent and welcome development has been an ultrafiltration monitor produced by Regreen Electromedical Division which gives a dynamic visual readout of ultrafiltration rate in ml/min and is easily connected to standard proportionating units.

Acknowledgments

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References


Open Discussion

WALLS (Leicester) We have recently been carrying out some very similar studies and would agree with your second conclusion that the symptomatology using an ultrafiltration and dialysis procedure is not significantly lessened in patients whose fluid balance is reasonably well maintained. I would, however, be interested in your slide showing your percentage changes in plasma volume. We have been using an $^{125}$I-albumin method for measuring plasma volumes and find something like a 20 or 30 per cent drop during the ultrafiltration. I would like to know how you only get a 2 or 2.8 per cent drop in plasma volume during ultrafiltration.

JONES We purely calculated plasma volume using a nomogram and using the pre-procedure weight to obtain plasma volume pre-procedure and then calculated the changes in plasma volume from the changes in plasma protein concentration before and after.

WALLS I am not sure how valid that is, because I think Dr Bergström himself has shown that plasma volume falls by at least 20 per cent during the ultrafiltration procedure.

KOPP (München) I would like to congratulate you on your paper, but I totally disagree with your first statement that ultrafiltration alone for fluid overload is safe. It is by no means safe, because you may end up with a dead patient after a couple of hours because of a rebound hyperkalaemia after your ultrafiltration.
procedure. This severe rebound hyperkalaemia must be corrected (by dialysis).

KERR (Newcastle-upon-Tyne) Could I just comment on the last two discussion points. Firstly, the difference in plasma volume changes may be related to the rate of ultrafiltration. If you ultrafilter fast there isn’t time to reabsorb fluid from your overloaded extracellular fluid volume, whereas if you ultrafilter more slowly, as in our first study, there may be. And secondly, of course, in saying that ultrafiltration is safe I am sure that Dr Jones wasn’t implying using it as a substitute for moving potassium in hyperkalaemic patients.

OHTA (Nagoya) In Japan we have separated dialysis and ultrafiltration for ten years and we call this system ECUM (Extracorporeal Ultrafiltration Method) as reported at the International Congress of Nephrology in Mexico (1972). We pointed out several things. One is that it is a very good method for treating heart failure, especially pulmonary oedema, and it is a good method to establish dry weight.