DIALYSATE GLUCOSE CONCENTRATION AND PLASMA OSMOLALITY DURING HAEMODIALYSIS IN ACUTE RENAL FAILURE

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The dialysis disequilibrium syndrome may be prevented by early haemodialysis at frequent intervals for short periods of time (Rosen, O’Connor and Shaldon, 1964) and using a slow acting dialysate (Scribner, 1963). However, many patients with acute renal failure are referred to dialysis centers with high levels of biochemical disturbances and BUN’s between 200 and 300 mg\%. Moreover short and frequent dialyses are costly and not always feasible in busy units with limited personnel.

Slow dialysis, using a two layer KiiI dialyser is time consuming and does not prevent dialysis disequilibrium (Maher and Schreiner, 1965). Many still prefer Kolff’s Twincoil for dialysing patients with acute renal failure. Dialysate solutions according to the well-known standard prescription which is packed with each coil made by Messrs Travenol/Baxter, contain only 200 mg\% fructose and 200 mg\% glucose. Transfer of hexose molecules from this dialysate to the plasma will only be slight and rapid metabolism will prevent any significant increase in the patient’s plasma. No compensation for rapid decrease of blood urea will occur with this dialysate composition. In cases with high initial BUN rapid lowering of plasma osmolality may result in an osmotic gradient across the blood-brain barrier and between extra- and intracellular water. High bicarbonate dialysate concentration may result in post-dialysis metabolic alkalosis with secondary rise in plasma p\text{CO}_2, several hours after dialysis. This may aggravate disequilibrium manifestations. Intravenous administration of different hexose solutions could not prevent decrease of plasma osmolality during rapid removal of urea and other solutes in our cases. Moreover in overhydrated patients administration of intravenous fluid during haemodialysis has to be avoided.

Kennedy, Luke and Linton (1964) suggested that raising of the glucose concentration of the dialysate resulting in an increased transfer of glucose to the patient, might be a solution of the problem. The effects of high dialysate glucose concentration on plasma osmolality and the significance in prevention of osmolality gradients between CSF and plasma or between extra- and intracellular fluid however have been subjected to different opinions (Alwall, 1964; Kerr, 1964).

Rosen et al. (1964) using a rinsing fluid with 2\% glucose and 30 mEq. bicarbonate still found a mean increase of CSF/plasma osmolality gradient of 7.6 mOsm/kg.

The present investigation has been performed to determine plasma glucose concentration and plasma osmolality during haemodialysis, using high glucose dialysate concentrations.

Methods

Uraemic patients were dialysed for periods of 6 hours on a standard Twincoil dialyser with blood flow rates between 160 and 250 ml/min at 39°C. Dialysate bicarbonate concentration was 24 mEq/l and total dialysate sodium was equalized with plasma sodium adding a sufficient amount of sodium acetate. Dialysate glucose concentration of 1.5, 2.0 and 3.0\% were used. No fluids were administered intravenously or to the extracorporeal circuit. Blood
samples were obtained immediately before, immediately after and in a few cases 4 to 6 hours after haemodialysis. BUN was estimated using the modified urease method of Chaney

![Graph showing glucose levels during dialysis](image)

1. **Dialysate glucose 1.5% 6h. haemodialysis**
2. **Twin coil 39°C**

![Graph showing plasma osmolality](image)

**Fig. 1**

and Marbach (1962), blood glucose was determined using the glucose oxidase method of Hugget and Nixon (1957).

Plasma osmolality was estimated by cryoscopy using the Fiske osmometer type G 62.

**Results**

In Figure 1 the data of a 24 years old uraemic woman are presented during and after 6 hours

![Graph showing plasma osmolality after dialysis](image)

**Fig. 2**

haemodialysis with 1.5% dialysate glucose concentration. A rapid decline of BUN during the first hour is apparently not fully compensated by a rapid rise of plasma glucose resulting
in a rapid decrease of plasma osmolality during the first hour of dialysis. During the next 5 hours the BUN fell more gradually to 50 mg% and the blood glucose increased to 790 mg%. A further decline of plasma osmolality however occurred towards the end of 6 hours haemodialysis. Glucose transfer to the plasma in this case was insufficient to compensate for rapid disappearance of urea and other osmotically active solutes from the blood. 

In 9 other cases identical results were obtained. A mean decrease of plasma osmolality of 16 mOsm/kg was noted during 6 hours haemodialysis with 1.5% dialysate glucose as shown in Figure 2. Next 10 dialyses were performed with 2% dialysate glucose and the mean plasma osmolality before and after haemodialysis remained practically unchanged (Figure 3).

![Plasma osmolality before and after 6hrs. haemodialysis](image)

**Fig. 3.**

In only a few dialyses was 3% glucose used with an average increase of plasma osmolality by 11 mOsm/kg (Figure 4).

![Plasma osmolality after 6hrs. haemodialysis](image)

**Fig. 4**

All results are summarized in Figure 5. With a dialysate glucose concentration of 1.5%, plasma osmolality at the end of a 6 hours’ Twincoil dialysis always decreased and figures were obtained between minus 4 and minus 32 mOsm/kg with a mean of minus 15.

With 2% glucose in the bath an osmolality shift between minus 10 and plus 12 mOsm/kg was noted with a mean of minus 1.

Only 3 observations were done with 3% dialysate glucose because any risk of excessive osmotic dehydration or undesirable decrease of plasma sodium had to be avoided. In all 3 cases a rise of plasma osmolality was noted between 7 and 15 mOsm/kg.

The differences between pre- and post-dialysis plasma osmolalities with 1.5 and 2.0% glucose are statistically significant.
Discussion

Addition of 2% glucose to the dialysate for prevention of haemodialysis disequilibrium in cases of acute renal failure with high initial levels of biochemical disturbances is to be preferred to intravenous administration of glucose or fructose solutions or to addition of urea to the rinsing fluid. A dialysate glucose concentration of 2% may prevent a significant shift of osmolality during 6 hours Twin coil haemodialysis by raising plasma glucose concentrations to levels between 400 and 900 mg%.

Fig. 6

Dialysate glucose 2%
6hrs. haemodialysis
Twin coil 39°C

4.25.65
J.B. 30 yrs.
Epilepsy
Ac. Ren. Failure

Blood
CSF

Osmolality
mOsm/kg

Glucose
mg%

Urea N.
mg%
DIALYSATE GLUCOSE CONCENTRATION AND PLASMA OSMOLALITY DURING HAEMODIALYSIS

Rather wide scatter of post-dialysis plasma glucose concentrations may be ascribed to different flow rates and to differences in glucose metabolism in azotaemic individuals as described by Westervelt and Schreiner (1962) and by Kennedy, Luke, Dinwoodie and Linton (1964). The effect of raising plasma glucose concentrations to very high levels may be slightly diminished by some transfer of glucose to the CSF as shown in Figure 6.

In this case the decrease of CSF urea concentration which accounted for 9 mOsm/kg was nullified by an increase of 8 mOsm glucose. CSF osmolality remained unchanged during dialysis notwithstanding a decrease of urea concentration.

High glucose concentration decreases rapidly after haemodialysis because glucose is rapidly metabolized. Between 1 and 3 hours after the end of dialysis, plasma osmolality may decrease as shown in Figure 7.

Slight symptoms of dialysis disequilibrium may occur in this period and therefore in this particular case, intravenous administration of glucose solution was started.

**Conclusions**

1. In severe azotaemic cases, 2% dialysate glucose concentration may prevent significant changes in plasma osmolality during rapid haemodialysis.
2. This dialysate glucose concentration may prevent signs of haemodialysis disequilibrium during 6 hours Twincoil haemodialysis.
3. 2% dialysate glucose concentration is preferable to intravenous administration of hexose solution or to addition of urea to the bath.
4. Between 1 and 3 hours after haemodialysis slight signs of haemodialysis disequilibrium may still occur.
5. Early haemodialysis preventing the uraemic syndrome and severe azotaemic disturbances, still remains the method of choice.

REFERENCES


