Bull Yamaguchi Med Sch 42(3-4) : 105-108, 1995

Comparative Effects of Acetate and Bicarbonate Dialysates on the Hemodynamic and Respiratory States During Continuous Hemodiafiltration in Critically Ill Patients.

Yoshinori Nishiyama[1], *Masaharu Ito*[1], *Shuzo Oshita*[2]

[1]Department of Anesthesia, Ehime Rosai Hospital, 13-27, Minamikomatsubara, Niihama, Ehime, 792, Japan
[2]Department of Anesthesiology, Yamaguchi University Hospital, Ube, Yamaguchi, 755, Japan
(Received June 8, 1995, Revised December 25, 1995)

Abstract The purpose of this study is to examine the comparative effects of acetate and bicarbonate dialysates on the cardiopulmonary functions during continuous hemodiafiltration in 8 critically ill patients. They were dialysed with acetate dialysate for initial 24 hours (stage 1), which was exchanged to bicarbonate dialysate for the next 2 hours (stage 2). Thereafter, bicarbonate dialysate was reexchanged to acetate dialysate (stage 3). Hemodynamic and respiratory parameters were estimated in each stage. No significant difference was recognized among the three stages in any parameter. We concluded that acetate and bicarbonate dialysate had similar effects on the cardiopulmonary functions in the critically ill patients.

Key words: Continuous hemodiafiltration, Acetate dialysate, Bicarbonate dialysate, Hemodynamic and respiratory states.

Continuous hemodiafiltration (CHDF) has been widely accepted as a therapy for renal failure in critically ill patients such as multiple organ failure[1]. However it is still unknown what kind of dialysate would produce the most stable cardiorespiratory states. We compared the hemodynamic and respiratory functions in two different dialysates during CHDF.

Materials and Methods

The study protocol was approved by the Committee on Medical Ethics of our hospital. Informed consent was obtained from the patients or their relatives. Eight patients treated with veno-venous CHDF were studied. The profiles of the patients were summarized in table 1. Intermittent hemodialysis was not indicated, because all patients had been suffering from circulatory instability. They required mechanical ventilation for the treatment of respiratory failure.

For monitoring cardiovascular function, radial artery was cannulated, and Swan-Ganz catheter was placed from the subclavian or right jugular vein. Catecholamines or vasodilators were administered, if necessary.

Acute renal failure was diagnosed when the blood urea nitrogen and serum potassium rose to more than 70 mg/dl and 5.0mEq/l, respectively, and then CHDF was commenced. In the case of acute pernicious beriberi, CHDF was started when serum potassium increased over 6.0mEq/l.

CHDF was performed by percutaneous femoral venipuncture with Mahurkar dual

lumen catheter (Quinton Instrument, Seattle, USA). Hollow fiber filters with polysulfone high performance membranes (Hemofilter F40, Frezenius AG, Bad Homburg, West Germany) were used in all patients. To prevent obstruction of the filter with clot, nafamostat mesilate was infused in the arterial limbs continuously, and activated coagulation time was maintained at 150～180sec. Blood flow rate was 100～200ml/min, and dialysate was run in a countercurrent manner with 600～1200ml/h. The volume of the ultrafiltrate was 60～240ml/h, and substitution fluid was not used in the present study.

The study was consisted of the following three stages. The patients were dialysed with acetate dialysate (Sublood A, Fuso, Osaka, Japan) for initial 24 hours (stage 1), which was exchanged to bicarbonate dialysate for the next 2 hours (stage 2). Thereafter, bicarbonate dialysate was reexchanged to acetate dialysate (stage 3). Bicarbonate dialysate was prepared domestically. The compositions of the dialysates were shown in table 2.

Cardiopulmonary parameters were measured at the time immediately before the exchange of dialysate, and at 120 minutes after that. During the study, zero fluid balance was achieved by means of controlling the rate of infusion. Dosage of cardiovasoactive substances and the conditions of mechanical ventilation and CHDF were kept constant during the experimental periods. The following variables were measured:

1) Hemodynamic data: heart rate(HR), mean arterial pressure(MAP), mean pulmonary arterial pressure (MPAP), pulmonary capillary wedge pressure

Table 1. Profiles of the patients

Pt.	Age(yr)/Sex	Diagnosis	Renal disease	Outcome
1	70/F	Congestive heart failure after aortocoronary bypass	Acute renal failure	Survived
2	73/M	Congestive heart failure after aortocoronary bypass	Acute renal failure	Died
3	70/M	Congestive heart failure after aortocoronary bypass	Acute renal failure	Died
4	58/M	Congestive heart failure after aortic and mitral valve replacement	Chronic renal failure	Survived
5	66/F	Septic shock	Acute renal failure	Survived
6	77/M	Septic shock	Acute renal failure	Died
7	53/F	Acute pernicious beriberi, shock	Anuria, hyperkalemia	Survived
8	71/F	Acute myocardial infarction	Chronic renal failure	Survived

Table 2. Compositions of dialysate

Ions(mM/L)	Acetate dialysate(Sublood A)	Bicarbonate dialysate
Na^+	140	139
K^+	2	2
Ca^{++}	3.5	3.4
Mg^{++}	1.5	1.5
Cl^-	107	104
Acetate	40	—
Bicarbonate	—	38

Table 3. Hemodynamic and gas exchange parameters during CHDF

	Acetate dialysis (Stage 1)	Bicarbonate dialysis (Stage 2)	Acetate dialysis (Stage 3)
HR (beat·min^{-1})	100±17	101±18	98±12
MAP (mmHg)	85±22	85±23	83±20
MPAP (mmHg)	20±4	23±8	24±5
PCWP (mmHg)	13±5	12±6	14±6
CI (l·min^{-1}·m^{-2})	2.9±1.1	2.7±0.9	2.7±0.7
LVSWI (kg·m·m^{-2})	30±10	29±7	29±9
PaO_2/F_IO_2	2.2±0.8	2.3±0.7	2.3±0.8
$PaCO_2$ (mmHg)	39±8	40±11	41±9
$P\bar{v}O_2$ (mmHg)	32±4	32±3	32±3
$\dot{Q}_S/\dot{Q}_T$ (%)	16±5	15±4	15±6
$\dot{V}O_2$ (ml·min^{-1}·m^{-2})	140±36	139±22	142±25

Values are mean±SD (n=8)
No significant difference was recognized among the three stages in any parameter measured or calculated.

(PCWP), cardiac index(CI), left ventricular stroke work index (LVSWI).

2) Gas excange data: percentage intrapulmonary shunt ($\dot{Q}_S/\dot{Q}_T$), PaO_2/F_IO_2, $PaCO_2$, $P\bar{v}O_2$, oxygen consumption ($\dot{V}O_2$).

Blood gas analysis was done by a blood gas analyzer (Model 278, CIBA-Corning, Medfield, Massachusetts, USA). Arterial and pulmonary artery oxygen contents were determined with a co-oximeter (Model 2500, CIBA-Corning). Cardiac output was measured by the thermodilution technique and oxygen consumption was calculated using Fick's principle. Other hemodynamic and gas exchange parameters were calculated using standard formulas.

All data are presented as mean±SD. Statistical analysis was done by Friedman test. Probability values less than 0.05 were considered significant.

Results

Cardiopulmonary parameters were summarized in table 3. No differene was recognized among the three stages in any parameter measured or calculated. Base excess was 0.0±3.3, 0.1±3.0 and 0.1±2.8mEq/L at the stage 1, 2 and 3, respectively.

Discussion

There have been some reports[2)3)] suggesting that high serum acetate level might produce vasodilation, myocardial depression and disturbance in pulmonary oxgenation. The patients dialysed intermittently with bicarbonate dialysate were reported to be unsusceptible to hypotension or hypoxia as compared to acetate dialysis[4)].

CHDF has recently become a choice of therapy in the patients with shock or cardiac failure, because it dose not cause hemodynamic instability. However it is still unknown what would produce the most stable hemodynamics during CHDF. The present study demonstrated that acetate and bicarbonate dialysates resulted in similar effects on the hemodynamic and respiratory functions in critically ill patients.

We suspect that the serum acetate level during CHDF might not be elevated as high as that during intermittent acetate dialysis, because the flow rate of dialysate during CHDF was 100~200ml/min, and comparatively lower than that in the intermittent hemodialysis with the ordinary flow rate of 500ml/min. This is one of the reason why acetate and bicarbonate dialysates had similar cardiorespiratory effects in the present study. However the period of bicarbonate dialysis was comparatively short in this

study. If it was much longer, the result might be changed slightly.

Sterilized bicarbonate dialysate for CHDF is not commercially available. Moreover it is troublesome and costly to prepare it domestically. We consider that acetate dialysate can be safely used for CHDF, unless the patients have been suffering from liver failure or severe diabetes mellitus, the conditions being known to cause acetate intolerance particularly[5].

Acknowlegments: The authors thank Prof. Takefumi Sakabe for his critical review of the maunscript.

References

1) Hirasawa, H., Sugai, T., Ohtake, Y., et al: Continuous hemofiltration and hemodiafiltration in the management of multiple organ failure. *Contrib Nephrol* **93** : 42, 1991.
2) Aizawa, Y., Ohmori, T.. Imai, K., et al: Depressant action of acetate upon human cardiovascular system. *Clin Nephrol* **8** : 477, 1977.
3) Ikeda, T., Hirasawa, Y., Aizawa, Y., et al: Effect of acetate upon arterial gases. *J Dialysis* **3** : 135, 1979.
4) Vincent, J. L., Vankerweghem, J. L., Degaute, J. P., et al: Acetate induced myocardial depression during hemodialysis for acute renal failure. *Kidney Int* **22** : 653, 1982.
5) Novello, A., Kelsch, R. C.. Easterling, R. E.: Acetate intolerance during hemodialysis. *Clin Nephrol* **5** : 29, 1976.