Original Article

BIOCHEMICAL AND HAEMODYNAMIC EFFECTS OF CRYSTALLOID SOLUTIONS ADMINISTERED DURING PERIOPERATIVE PERIOD

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SUMMARY:

Forty five (45) ASA grade I & II patients aged between 21 to 55 years, scheduled for electiv abdominal surgery (incision not exceeding 15 cm with minimal blood loss, under general anaesthesia were randomly allocated into three groups (A, and C). Patients of Group A, B and C received infusion of 5% dextrose aqua, normal saline and 5% dextrose in normal saline respectively throughout peri-operative course (upto 24 hours after operation). Each group received post operative period. Parameters recorded were mean arterial pressure (MAP), Pulse, Serum elecirolyte (Na+, K+), amount of fluid in fused and urine output during operation and postoperatively Blood samples for serum electrolyte estimation were taken just before induction, immediately before reversal and twenty four hours after surgery. A standard anaesthetic technique was followed for all groups.Percentage increase from pre-operative values were calculated for mean arterial pressure, pulse rate and serum electrolytes. The ratio between urine output and fluid infused during per- and post-operative period were calculated. There were statistically significant ($p<0.05$) difference between group A and C in per- and post-operative change in pulse rate and statistically significant difference ($p<0.05$) in post-operative output / input ratio between group A and B and highly significant ($p<0.01$) between A and C. Electrolyte containing fluids of higher osmolality caused increased diuresis in per-operative period and increased pulse rate in post-operative period. So, although there are few difference between three fluids, these didnot produce any effects(beneficial or detrimental) on the body system under normal conditions.

INTRODUCTION:

Peri-operative fluid and electrolyte administration to be daily challenge in the practice of anaesthesia. Crystalloid solutions are normally given during surgery to maintain cardiovascular stability and urine output[1]. The use of colloids during operation has been reported by Shire et al[2]. to reduce the volume by 50%. This may be considered undesirable because of the danger of renal impairment.

Now-a-days commonly used crystalloid solutions during peri-operative period in this country are 5% dextrose in aqua, normal saline and 5% dextrose in normal saline. They may have different haemodynamic effects and produce electrolyte changes,which may be different. The purpose of this study is to compare these solutions and the changes they produce whether detrimental or beneficial to the body.

Aims of study:

1. To asses the electrolyte changes with different types of fluids.
2. To evaluate the haemodynamic response to different types of fluids.

METHODS:

45 adult patients of either sex, aged between 21 to 55 years of ASA grade I & II were included in this study. they were randomly selected from elective operating list for abdominal surgery (incision not exceeding 15 cm) informed consent was obtained from each patient .

On arrival to operation theater blood pressure (systolic and diastolic pressure) pulse rate and rhythm were recorded. A I G size intravenous cannula was inserted and a sample of blood (3cc) was drawn in a dry sterile test tube for serum electrolyte (Na+, K+) estimation. Patients were randomly allocated into three groups (A, B and C). Patients belonged to group A received 5% dextrose aqua, group B received normal saline (9% NaCI) and group C received 5% dextrose in normal saline

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throughout preoperative period j intraoperative and 24 hours after reversal). Urine output measured properly collected by catheter.

Anaesthetic technique was standard. Inj. sodium thiopentone (5 mg/kg) followed by suxamethonium (1mg/kg) were given for induction of anaesthesia and endotracheal intubation. Anaesthesia was maintained by using nitrous oxide (66%), oxygen (33%), Halothane (5-1%), pancuronuin (0.06-0.08 mg/kg) and pethedine (lmg/kg). Normocapnia was maintained throughout the intraoperative period. Reversal was as usual using neostigmine (40-45 mg/kg) and atropine (20-25 μgm/kg).

Blood sample was drawn shortly before reversal and after 24 hours for serum electrolyte estimation. Serum electrolytes (sodium, potassium) were estimated by flame photometry and mean arterial pressure was worked out.

Post-operative analgesia was maintained by intramuscular pethedine (1.5 mg/kg) 6 hourly. Each group received 2 ml/kg/hr of fluid for pre-operative insensible loss (since last oral intake) which was given as initial volume and 2 ml/kg/hr of fluid for pre-operative insensible loss. Thereby estimating surgical trauma 4-8 ml/kg/hr of fluid was given.

During post-operative period 40 ml/kg/day of fluid plus losses through drains were given. Urine output was recorded every 6 hours for 24 hours after operation.

Parameters recorded (during surgery and for 24 hours after operation)

1. Pulse and blood pressure (every 10 minutes during surgery and 2 hourly in the post-operative period.)
2. Urine output (intra-operative and 6 hourly in the post- operative period.)
3. Serum electrolyte (Pre-operative, Per-operative and 24 hours after reversal).

RESULTS:

Table I gives the details of the Patients (age and weight) and duration of operation. There were no significant difference between three groups regarding age, weight and duration of operation.

Details of the parameters noted (group A, B and C) are shown in table II.

Table III gives the percentage change from pre-operative values (except fluid input and output) and table IV gives the comparison between three groups regarding their percentage change from pre-operative values.

Urine output/Fluid infused ratio (0/1) of three groups are given in table V and table VI gives the comparison of their ratios. The ratio is significant ($p<0.05$) between A and B and highly significant ($p<0.01$) between A and C.

In table IV there were no significant difference between group A and B and there were also no significant difference between group B and C. There were significant difference between group A and C at per-operative and post-operative change in pulse rate.

Table I

Age, Weight And Operative Time Distribution

	Group A (N=15)	Group B (N=15)	Group C (N=15)
Age (years)	40+ 8.37	34± 8.82	38.46± 7.11
Weight (kg)	57.33± 8.89	54.2± 9.42	51.66 ± 11.79
Duration (minutes)	69.33± 27.5	64.66± 17.36	73.33± 33

Table - II

Details of Parameters Records

	Mean Anterial Pressure (mmHg) Mean ± SD			Pulse Rate (beats / min) Moan ± SD			Fluid Output (ml)Mean±SD		Urine Output (mlMean±SD		Urine electrolytes (Mean ±SD Na+ (mmol/L) Samples			K + (mmol/L) Samples		
	Pre	Per	Post	Pre	Per	Post	Per	Post	Per	Post	1st	2nd	3rd	1st	2nd	3rd
Gr. A	100.66	99.32	86.2	95.37	97.11	89.77	670	2726.66	48.33	2386	138.6	139.66	139.66	4.41	4.8	4.77
	1062	10.19	7.86	11.57	9.78	10.5	314.98	500.30	88.87	1046.84	2.91	3.33	2.99	.68	.56	.87
Gr B	93.53	93.78	86.45	86.93	95.55	90.38	603.33	2526.66	45	1503.33	140.73	140 .51	140.31	4.58	4.28	4.65
	11.76	10.64	14.01	9.85	7.86	7.16	166.33	480.64	91.7	593.25	2.54	3.21	2.83	.72	.03	42
Gr. C	89 12	89.92	81.93	83.6	94.75	84 92	666.66	2416.66	95 33	1450.66	139	140.4	138.6	4.57	4.68	4.59
	12.96	8.81	10.09	*1.77*	8.43	9.34	24.76	395.3	173.73	743.73	2.71	2.61	2.99	.53	*56*	*.74*

Table III

Percentage of Change From Preoperative Values

	Mean Arterial Pressure		Pulse		Serum Electrolytes			
					Na+		K+	
	Per	Post	Per	Post	Per	Post	Per	Post
Gr. A	0.70 [a]	12.72[a]	3.53[b]	3.64[a]	0.78 [b]	0.76 [b]	7.05[b]	7.20 [b]
	+ 10.62	± 12.93	±13.77	± 11.08	± 1.95	± 3	± 10.43	± 20.8
Gr. B	0.61 [a]	7.6 [a]	11.3[b]	5.67[b]	0.34 [b]	0.164[a]	0.276 [b]	4.56 [b]
	+ 10.81	+ 11.25	± 9.85	± 16.36	± 2.81	± 2.69	± 13.08	± 13.08
Gr. C	1.85 [b]	7.71[a]	14.76[b]	4.76[b]	0.84 [b]	0.438 [a]	5.92[b]	7.36[b]
	±14	±11.25	±15.14	± 14.4	±2.96	±3.1	±12.25	±21.61

a = % Decrease b =% Increase

Table IV

Comparison of Percentage Change From Pre-Operative Values of Three Groups (Except Fluid)

	MAP (mmHg)		Pulse (beats/min)		Electrolytes (mmol/L)			
					Na+		K+	
	Per	Post	Per	Post	Per	Post	Per	Post
Gr. A	0.707[a]	12.72[a]	3.53[b]	3.64[a]	0.78[b]	0.76[b]	7.05[b]	7.20[b]
	± 10.62	± 12.93	± 13.77	± 11.08	±1.95	±3	± 10.43	± 20.8
Gr. B	0.61 [a]	7.6 [a]	11.3[b]	5.67[b]	0.34[b]	0.164[a]	0.276[b]	4.56 [b]
Results	± 10.81	±11.25	±9.85	± 16.36	± 2.81	± 2.69	±13.08	± 13.08
't' test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Gr. B	0.61 [a]	7.6 [a]	11.3 [b]	5.67 [b]	0.34 [b]	0.164 [a]	0.276 [b]	4.56[b]
	± 10.81	± 11.25	± 9.85	± 16.36	± 2.81	± 2.69	± 13.08	± 13.08
Gr. C	1.85 [b]	7.71 [a]	14.76 [b]	4.76 [b]	0.84[b]	0.438 [a]	5.92 [b]	7.36 [b]
Results	± 14	± 10.5	± 15.14	± 14.4	± 2.96	± 3.1	± 12.25	± 21.61
't' test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S	N.S
Gr. C	1.85 [b]	7.71 [a]	14.76 [b]	4.76 [6]	0.84	0.438 [a]	5.92	7.36
	±14	±10.5	± 15.14	± 14.4	±2.96	± 3.1	±12.25	±21.61
Gr. A	0.707[a]	12.72[b]	3.53[b]	3.64[b]	0.78[b]	0.76[b]	7.05[b]	7.20[b]
Results	± 10.62	± 12.93	±13.77	± 11.08	± 1.95	± 3	±10.43	± 20.8
't' test	N.S.	N.S.	S	S	N.S.	N.S.	N.S.	N.S.

a = % decrease from pre-opvalues
b =% increase from pre-op values
NS = not significant S = significant (*p<0.05)

Table V

Urine Output / Fluid Infused Ratios of Three Groups

	Per-operatives	Post-operative
Group A	0.047	0.86
	±0.076	±0.29
Group B	0.061	0.62
	±0.11	±0.25
Group C	0.126	0.57
	±0.26	±0.27

Table VI

Comparison of Urine Output / Fluid Infused Ratios of Three Groups

	Per-operatives	Post-operatives
Group A	0.047	0.86*
	±0.076	±0.29
Group B	0.061	0.62
	±0.11	±0.25
Results 't' test	NS	N.S.
Group B	0.061	0.62
	±0.11	±0.25
Group C	0.126	0.57
	±0.26	10.27
Results 't' test	N.S.	N.S.
Group C	0.126	0.57
	±0.26	±0.27
Group A	0.047	0.86**
		±0.076
Results 't' test	N.S.	N.S.

NS = not significant
S = significant (*p<0.05)
HS = highly significant (**p<0.01)

DISCUSSION

Crystalloid solutions are normally given during peri-operative period (in addition to replacement of significant blood loss) to maintain cardiovascular stability and urine output[1]. Some authorities recommend only 'Balanced salt solution such as Hartmann's solution[2-5]. But Hartmann's solution is costly and it is not rational to overload circulation with electrolytes routinely. Some recommend isotonic (5%) glucose followed by Hartmann's solution[6], whilst others recommend iso-osmotic mixture of glucose and saline[7]. Recently there has been a move to restrict the volume of infused crystalloid by use of colloids[8]. The use of colloids during operative period has been reported by Shire's and colleagues[9] to reduce the volume of fluid given during operation by 50%, but post-operative urine output also decreased by 50%. This may be considered because of the danger of renal failure. So, crystalloids are alive and well[10].

There are a few studies regarding the comparison of crystalloids during peri-operative period as far as information available. Roberts et al[11] compared Hartmann's solution (ringer lactate) with dextrose aqua and found a deficit in extra-cellular volume, as measured by radioactive sulphate of 1.9 ± 0.81 (p<.003) compared to the per-operative volume was found in the dextrose group. This is accompanied by a decrease in mean urinary sodium excretion (-57%, p<0.05). The use of Ringers lactate resulted in no change in ECV and no change in sodium excretion. As a result of these findings, it appears that post-operative sodium retention in a physiologic response to decreased ECV, which can be prevented by the administration of electrolyte containing fluids.

In this study, three crystalloids have been compared. Table III shows that in group A (5% dextrose) there is greater reduction of Mean Arterial Pressure (MAP) from pre-operative value (-12.73%), in comparison with group B (normal saline, - 7.6%) and group C (dextrose in normal saline).

The pulse rate is increased in the per-operative period in all three groups due to increased sympathetic activity and action of muscle relaxant pancuronium. It is more marked in group B (+ 11.3%) and C (+ 14.3%) than in group A(+ 3.53%). In the post-operative period pulse rate is decreased in group A(- 3.64%), but in group B it is + 5.49% and C + 4.76%, it is lower than per-operative values, but still higher than pre-operative values. There are statistically significant difference (p<0.05) between groups A and C. The most probable cause of increased pulse rate with group B and C could be due to Bainbridge reflex [12] . This reflex is initiated by expansion of ECV due to infusion of salt containing fluids. There are no rhythm disturbance in any group of patients. Sodium level is increased in group A in per-operative (0.78%) and post-operative (0.76%) period, which is due to increased secretion of aldosterone as a consequence decreased sodium load in extra cellular fluid". In group B (-0.164%) and C (-0.438%) in post-operative period there decreased levels as a result of increased sodium load. Potassium level is more or less increased in the peri-operative period in all three groups due to increased released of potassium from traumatized tissues.

There is fluid retention in the body as a response to surgery and anaesthesia. Table- V gives the output and input ratios of three groups during per and post operative periods. In per-operative period there is

least output in group A (0.047), more in group B (0.061) and highest in group C (0.128). It is due to osmolality of the type of fluid. But in post-operative period diuresis is highest in group A (0.86) lower (0.62) in group B and lowest in group C (0.57). This is due to hormone (ADH) from post-pituitary [14]. This ratio is statistically significant ($p<0.05$) between group A and B during post-operative period and highly significant ($p<0.01$) between A and C. Therefore, it is evident that increased osmolality causes anti-diuresis.

So, from above observations it is evident that there are some differences between electrolyte and non-electrolyte containing fluids and a few difference between electrolyte containing fluids. It is also found that previously healthy patients with a uneventful peri-operative course can tolerate most bizarre fluid regimens. Haemodynamic and electrolyte problems are much more common with pre-existing renal and cardio respiratory diseases.

CONCLUSION:

From this study it may be concluded that although there were few significant difference between infusion of three fluids, these did not cause any serious changes in the body systems under normal conditions. But it is advisable that haemodynamic and biochemical parameters should be within normal range during peri-operative course for safety of the patients.

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